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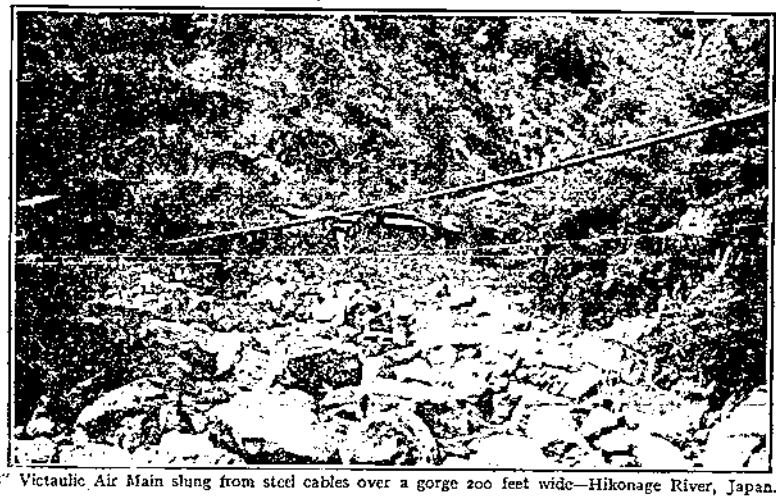

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CONTENTS.

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2,200—1.11.30.

1780—1861.

General Sir Charles William Pasley KCB FRS DCL

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SIR CHARLES PASLEY.

1780 *to* 1861.

I.

HIS LIFE: A SKETCH.

By LIEUTENANT-COLONEL P. H. KEALY, R.E. *(retired)*.

THE history of the Corps of Royal Engineers since its formation as a separate body in 1716 may be divided into four periods, the third of which is perhaps the most important and interesting. Corresponding with important landmarks in European history, this period may be taken as extending from 1793, the beginning of the long war with the French, till the end of the Crimean War, when the Board of Ordnance ceased to exist.

There were two dominating personalities in the Corps during that period, Sir John Burgoyne[1] and Sir Charles Pasley[4]; they were contemporaries, Sir John being some eighteen months younger, but were widely different in character, and exercised their decisive influence on the development of the Corps on different lines.

This year is the 150th anniversary of the birth of Sir Charles Pasley, and it is proposed to give a sketch* of his life, and then to deal in more detail with some of his many outstanding activities.

Born at Eskdalemuir, Dumfries, on 8th September, 1780, Charles **1780**
William Pasley was the son of Charles Pasley, merchant of London, and, as one of the family, was consulted by his elders and became a leader amongst his contemporaries. The two families of Pasley of Craig and Malcolm of Burnfoot (cousins) produced in two generations one baronet and seven knights. This outburst of brilliance is perhaps due to Sir Charles Pasley's grandmother, Magdalen Elliot, who traced her descent from King Robert III. of Scotland.

* The writer is largely indebted to British Museum MS. 41766, being a life of Pasley by Colonel John Charles Tyler; to *The School of Military Engineering*, 1812–1909, by Col. B. R. Ward; to the same author's 5th edition of Pasley's *Essay;* to Porter's *History of the Corps of Royal Engineers;* to Jones' *Sieges in Spain;* and to original letters and Jones' Diary in the R.E. Museum.

[1] John Fox Burgoyne, Bart., G.C.B. 2nd-Lieut., 29.8.1798. General, 5.9.1855. Field-Marshal, 1.1.1868. Died 7.10.1871. *War Services:* Malta, 1800; Sicily, 1806–7; Egypt, 1807; Sweden, 1808; Peninsula, 1808–9 and 1809–14; New Orleans, 1814–15; France, 1815–18; Portugal, 1827–8; Turkey, 1854; Crimea, 1854–5. I.G.F., 1845–68.

Admiral Sir Thomas Pasley, 1st Baronet, was uncle to Sir Charles, and commanded a Division under Lord Howe on the Glorious First of June, 1794.

Pasley was a good classical scholar at an early age, but apparently learned little at the local school he attended. He joined the Royal
1796 Military Academy in August, 1796, and was nearly expelled for
1797 practical joking. On the 1st December, 1797, he received his commission in the Royal Artillery and joined at Woolwich. Writing home soon after he says, "At this time, when every body of men are subscribing for the defence of the country, our Regiment has not been the last—the officers each six days' pay and the non-commissioned officers and privates three days' pay." A similar contribution is recorded by Connolly as having been made by the Royal Military Artificers.

1798 On April 21st, 1798, he was transferred to the Royal Engineers, for which Corps he had been intended from the first. He was posted to Portsmouth, where amongst other works he was employed on the building of Fort Monckton, and started the career which he followed "with that sort of headlong ardour that I believe has been a part
1799 of my character from boyhood." In March, 1799, he sailed for Min-
to orca, where he was busy with fortifications for two and a half years.
1801 In 1800, Sir Ralph Abercrombie passed through Minorca on his way to Egypt, and was so struck with the character of Pasley, whose acquaintance he made there, that he would have taken him with him to Egypt had not Capt. D'Arcy,[2] the Chief Engineer, said he could not spare him.

The Peace of Amiens lasted from 1801 to 1803, the terms of which were most distasteful to Pasley at the time, as to many others, and in his later writings he especially condemned the handing back of Malta to the Knights of St. John; one of the many occasions in our history when, seemingly, the government of the day has not realized that in their effort to display a generous spirit to the late enemy they must needs betray or be less than just to their friends.

1801 In November, 1801, Pasley was ordered to Malta, where he found his friend Burgoyne.[1] During 1802, he visited Egypt on leave, and was back again in Malta when war was once more declared. He wrote, "I had yesterday the pleasure of receiving your letter by the *Amphion* frigate which brought out Lord Nelson and the welcome news of war. I have not yet been able to see the celebrated character, who was received on his landing by the loyal acclamations of the Maltese, being no less a favourite with the multitude here than in England. He took seven prizes by the way and sails in a few days to assume command of our fleet before Toulon."

[2] Robert D'Arcy, C.B. Lieut., 17.1.1776. Maj.-Gen., 12.8.19. Died 13.5.1827. *War Services:* Minorca, 1781; Portugal, 1798; Minorca, 1798; Copenhagen, 1807; Walcheren, 1809.

During the time of the Toulon blockade which Lord Nelson maintained from 1803 to 1805, Pasley was sent, in 1804, to report himself 1804
to the Admiral and to examine certain engineering questions in connection with the proposed fortification of the Magdalene Islands. "I had long had a great desire to behold this illustrious character whose heroic deeds have filled the world with astonishment, and will form the admiration of posterity. His appearance, a thin, middle-aged figure, would be by no means striking if the want of an arm and a shade over one eye did not suggest to you the memory of the high services he has rendered to his country. Who would not be content to lose a few spare limbs, and life itself, to have rendered such services! Our conversation was short and commonplace, and I did not sit near him at dinner, but I remarked the keenness of his look and gesture which announced the decision of his soul." Pasley was also much struck by "the zeal of the captains of the Fleet, and how interested they seem in everything concerning their ships and men, which appear entirely to engross their minds."

Pasley was with our force which went on the expedition to help Naples in 1805 and which retired to Sicily on the Russians with- 1805
drawing from the undertaking. Sir John Stuart in 1806, seeing how 1806
careless and swollen-headed the French Commander had become, decided to strike a blow, and embarked a force of 5,000 men at Messina which landed in Calabria to create a diversion in favour of the garrison of Gaeta, which was holding out gallantly against the French. The Engineers who accompanied the force were Captain C. Lefebure,[3] Commanding Engineer, Second Captains C. W. Pasley[4] and J. T. Jones,[5] Lieutenants G. Lewis,[6] W. Nicholas,[7] G. Macleod,[8] and G. C. Hoste,[9] a band of outstanding officers all of whom either earned high distinction and honours or suffered gloriously at the sieges in the Peninsula. The result of the expedition was the victory of Maida

[3] Charles Lefebure, 2nd-Lieut., 25.9.1793. Major, 8.3.1810. *War Services:* Holland, 1793–4; Trinidad, 1797; Porto Rico, 1797; Sicily, 1805–7; Peninsula, 1808–9 and 1810. Killed by a round shot at Matagorda, near Cadiz, 22.4.1810.

[4] Charles William Pasley, K.C.B., F.R.S., D.C.L. 2nd-Lieut., R.A., 1.12.1797. 2nd-Lieut., R.E., 1.4.1798. General, 20.9.60 Died 19.4.1861. *War Services:* Sicily, 1806; Copenhagen, 1807; Peninsula, 1808–9; Walcheren, 1809. Severely wounded at capture of Flushing. The subject of this sketch.

[5] John Thomas Jones, Bart., K.C.B. 2nd-Lieut., 30.8.1798. Maj.-Gen., 10.1.37. Died 26.2.1843. *War Services:* Sicily, 1805–6; Peninsula, 1808–9; Walcheren, 1809; Peninsula, 1810–13; Netherlands and France, 1815–16. Severely wounded at Burgos, 1813.

[6] George Griffith Lewis, C.B. 2nd-Lieut., 15.3.1803. Lieut.-Gen., 12.8.58. Died 24.10.1859. *War Services:* Sicily, 1805–11; Peninsula, 1813; France, 1817. Lost a leg at San Sebastian, 1813.

[7] William Nicholas, 2nd-Lieut., 21.12.1801. Bt. Major (posthumous), 27.4.12. *War Services:* Sicily, 1805–7; Egypt, 1807; Sicily, 1807–9; Peninsula, 1810–12. Died at Badajoz 14.4.1812, of wounds received on April 6th.

[8] George Francis Macleod, C.B. Lieut., 1.7.1801. Bt. Lieut.-Col., 21.6.17. Lieut.-Col., 23.3.25. Died 26.7.51. *War Services:* Sicily, 1806–9; Walcheren, 1809; Peninsula, 1811–12; Holland, 1815. Severely wounded, Badajoz, 1812.

[9] George Charles Hoste, Kt., C.B. 2nd-Lieut., 20.12.1802. Bt. Major, 17.3.14. Colonel, 23.11.41. Died 21.4.1845. *War Services:* Sicily, 1805–7; Egypt, 1807; Sicily, 1807–11; Holland, 1813–15; (Waterloo) France, 1815–16.

on July 4th, when the French were completely routed. In those days, there was little for the Engineer officer to do professionally on the field of battle, and he often acted as staff officer, or galloper, or extra A.D.C. to the general. There is no record of any particular part played by Pasley on this day, but he was much impressed with the quality of our troops.

1807 After the battle of Maida, Pasley returned to England. In July, 1807, a Baltic Expedition set sail to seize the Danish capital and fleet at Copenhagen. Pasley sailed as the only engineer with Lord Cathcart on the preliminary expedition, and thus commented on the project:—"The enterprise of forcing the Danes—a nation of centuries!—to give up their fleet and capital, by an army which they can match in numbers, is of the most hazardous nature, particularly as Copenhagen is a fortified place." The expedition was successful, and Pasley described his own experiences to Burgoyne as follows:—"Amongst the Engineers we had a great deal to do and went through much fatigue. I was at one time 28 hours without sleep, but his Lordship in his dispatches was certainly fully as complimentary to us or more so, than we deserved. This service has pleased me very much with my profession, which in case of a siege is the most important branch by far of the military duty, and government has established a good precedent in their liberality to the Ordnance Corps, General Blomfield, the Commandant of Artillery, has been made a baronet, and Colonel D'Arcy,[2] the Commanding Engineer, has a pension of 24 shillings per diem for life. This is noble encouragement for the young enterprising officers, and times must go very hard with me if I do not at some future period come in for the loaves and fishes, if they adhere to the rule, for I had long made up my mind to distinguish myself, if I can. And fortune has for the last two years favoured my views by bringing me into all the pleasant and all the successful service that the British Army has had. I have long given up the idea of making money, which I see in our line is quite impossible. But now they give us this opening—Death, or the Four and Twenty shillings shall be my motto, or the Baronetcy. . . . I saw that the best soldiers in the world are of no avail unless properly managed. I must admit that one masterly thing was done, when Sir Arthur Wellesley, with very inferior numbers, entirely routed the Danish militia, 8,000 strong, taking one quarter of them prisoners, and he is the man whom I should wish to see at the head of the first large British army that acts."

After being employed on the building of Martello towers on the east coast, he volunteered his services to the Spanish leaders in the
1808 Peninsula, who in 1808 had risen against Napoleon. He was ordered to Spain as C.R.E. to Sir David Baird, and was then attached to General Leith, who was on a mission with Spanish troops in the Asturias, to reconnoitre and report on the country. Lefebure,[3]

Birch[18] and J. T. Jones[5] were also with the mission. Pasley found the Spaniards glad to welcome them and most solicitous for their safety. He relates how after Blake's total defeat by the French, he was sheltered by a broken band of worn-out Spanish soldiers, who undertook to follow his leadership if he would give them a day or two's rest first; and when he said he could not wait, he was conducted to safety past the French posts and over the mountains by the least weary of the band. With Blake's defeat, the British mission ended. On November 18th, 1808, he joined Sir David Baird's staff at Astorga, as extra A.D.C., and, on the 25th, owing to his knowledge of Spanish, Sir John Moore's in the same capacity. He combined his duties on the staff with those of an engineer throughout the retreat to and battle of Corunna. The efforts of the engineers to blow up the bridges during this retreat were only in one instance successful in effecting *complete* destruction. In many cases the bridges were destroyed sufficiently to delay the enemy for many hours, and in some cases days; that the work was not more successful was to be ascribed to the lack of practical training on the part of the engineer officers and to the scanty means they had for carrying out the work. His experience on this retreat fixed Pasley's resolves in two directions; his first resolve to fight for the proper training of the engineer troops, officers and men, culminated in the formation of the S.M.E. at Chatham; his second resolve, to attempt to rouse the nation from its inferiority complex *vis-à-vis* the French power on land, was fulfilled when he produced his *Essay on the Military Policy and Institutions of the British Empire*, a book to be described later, which had a great influence in shaping our national policy. At Maida, Pasley had seen at first hand the fighting qualities of the British troops, and now he recorded his impressions of this retreat of 250 miles in these words:—"The only satisfaction derived is to know the infinite superiority of our soldiers to those of the rest of the world. Braver men never existed. In every attack, the enemy were baffled or beat off. They never could make the smallest impression upon our troops, nor did they ever occasion the least terror or confusion." Pasley was present when Sir John Moore died, and he returned home from Corunna with the rest of the Force. He left Lefebure[3] and Birch[18] behind, both wounded and in hospital, having devoted himself to nursing them so far as his duties would permit.

His next service was with the expedition to Holland under the Earl of Chatham,[20] which sailed in July, 1809. Pasley expressed a hope that the leader might inherit something of his father's spirit and not prove "one of those retreating and re-embarking generals, who had succeeded to the Marlboroughs and Peterboroughs of former times." Affairs were not, however, to prove to his liking, and a month later he expressed himself in vigorous terms to his friend Squire.[14] As might be expected with a man of his character, Pasley 1809

could express himself forcibly when faced with incompetence or any suspicion of someone letting the Corps down, though with a prodigality of commas, when he had had time to think, that makes his sentences read in a rather disjointed manner. However, this letter runs all right :—"I this day* landed your horse and sent him by your servant. I only landed yesterday morning, and saw our works before Flushing. In six days, since the trenches were opened, we have only made one 6-gun and one 6-mortar battery, with a parcel of infernal in-and-outs from 800 to 1,000 yards from the place. Little Coote's wing was to do it all, so D'Arcy[2] was the man, but now Fyers[10] has begun since last night. The Corps of Engineers is disgraced and d—— for ever. The cry of the whole army and navy is against us. I found Jones[5] when I landed in a state of deep *despair*. Boteler[11] wished that the first shot might take off his head. The French are making counterworks, and do them faster than ours. We were offered the *whole* army to act under us. The Staff Corps, everything at our disposal. Such means, such power, such circumstances would have put life into a statue, by heavens it would have called a dead body from the grave, but what could we do with a parcel of old women at our head, with fellows without souls, to direct the operations of armies, with fellows old in years, poor in spirit, beardless in military experience, destitute of knowledge, not merely blockheads but blockbodies. I have not seen Birch[18] yet, but I am sorry to say he and Jones[5] are at daggers drawn. Colonel Douglas told me that he sincerely pitied us all. General Brownrigg says that the engineers are not fit to be employed in war. We want not their pity, and are more fit to be employed in war than them. I have formed my plans. I shall see the Captains (Rudyerd[12] excepted who is a married man). If they choose they will sign with me a protest against the operations. If not I shall write one myself, and neither earth, heaven nor hell shall alter my resolution."

With the arrival of Colonel Fyers[10] to take over charge, matters improved: Birch[18] was in charge of the right attack and Pasley was put in charge of the left. He proposed to move forward at once and intrench, and his plans were approved with modifications. But on the night of the 14th, it was discovered that the French garrison were cutting the eastern dyke to let in the sea. This would have made the position of the attackers, which was already sufficiently difficult owing to the water, an impossible one,

* 3.7.1809.

[10] William Fyers. 2nd-Lieut., 11.11.1773. Lt.-Gen., 12.8.19. Died 27.10.1829. *War Services:* America, 1775–83; Walcheren, 1809.

[11] Richard Boteler. 2nd-Lieut., 1.1.1804. Lt.-Col., 29.10.1828. Perished in the wreck of the *Calypso*, February, 1833. *War Services:* Buenos Ayres, 1807; Peninsula, 1808–9; Walcheren, 1809; Peninsula, 1811–14.

[12] Charles William Rudyerd. 2nd-Lieut., R.A., 23.1.1793. 2nd-Lieut., R.E., 14.6.93. Died 19.10.1813. *War Services:* Holland, 1793–5; Holland, 1799; Walcheren, 1809.

and a force under Colonel Pack was sent out at once to stop them. Pasley led the storming party of 100 men, which was successful at the expense of 5 officers and 30 men killed and wounded. Amongst the wounded was Pasley, who received a bayonet thrust in the thigh and a shot through the body. Mulcaster,[15] writing to Burgoyne[1] on September 12th, 1809, from Badajoz, thus described the affair. After telling of the receipt of the news of the capture of Flushing he said, "Our poor friend Pasley is badly wounded. He is, however, doing well. He had a musket ball through his body, and a bayonet stab in the thigh. He was wounded leading the storming party which carried one of the advanced works under Colonel Pack. He struck one Frenchman, disarmed a second, stabbed a third and was attacking a fourth when he fell. What a desperate dog!"

Pasley himself gave a less picturesque account of the affair, but stated how he scarcely felt the wounds at the time and was able to walk, apparently unattended, to the rear. As a matter of fact the shot through the body had injured his spine, he was laid up for months, and his recovery was despaired of. Burgoyne[1] wrote to him from Vizau in March, 1810, saying:—"I was much concerned 1810
to hear of your accident at Flushing, but would not write till I could congratulate you upon your entire recovery, which I understand now there is no doubt of. I do it therefore now with heart and soul. What will be your motto now? 'Death or a pension' is over, the first you have narrowly escaped, the other I presume you have got. I shall expect you soon to adopt Lord Nelson's 'Westminster Abbey or Dignities.'"

Owing to the effects of his wounds, Pasley's chances of further service in the field were over when he was only 28 years of age, and it is necessary to turn back somewhat to pick up the threads which will show what it was which led to the extraordinary success of his later life. Something of the part played by the junior officers of the Corps in the early years of the eighteen hundreds must now be made clear. The Corps contained at that time in its junior ranks a body of young men who in their professional zeal, and the keenness of their anxiety for the national glory and personal distinction have seldom been surpassed. Pasley writing at a later time thus described his contemporaries:—"The very inefficient state of the Engineer Department, strange to say, appeared to be unknown, not only to the rest of the Army, from the Commander-in-Chief to the youngest ensign, but even to the senior officers of the Engineers themselves, though several of them had served in the American War, of whom

[15] James Moncrief. Ensign, 28.1.1762. Colonel, 18.11.90. *War Services:* Havanah, 1762; America, 1776–80; Holland, 1793. Killed at the Battle of Hondschoote near Dunkirk, 7.9.1793.

Colonel Moncrief,[13] the most distinguished, fell at Dunkirk. But it had been deeply felt and lamented by those officers who had commenced their military career in the first war with the French republic in 1793, and had afterwards served in Egypt, and on other expeditions terminating in a less satisfactory manner. Young or in the prime of manhood, full of enterprise and zeal, meeting and comparing notes together in the metropolis after the desultory expeditions in which they had served, and afterwards those employed in 1810 in the construction of the lines of Torres Vedras, meeting from time to time in some central spot, they excited each other and inspired their juniors with an *esprit-de-corps* and a devotion to the service of their Sovereign and Country that I do not suppose were ever exceeded. Captain Charles Lefebure,[3] who had served in the West Indies and in Holland and had been Commanding Engineer under Sir John Stuart in Calabria (afterwards unfortunately killed at Matagorda near Cadiz), was at first the most influential of these officers, partly from his character and example, being one of the most high-minded and disinterested men I have ever met with. He it was who first pointed out to me and other officers his juniors as early as 1805, the inefficiency of the Corps for want of disciplined and instructed Sappers and Miners. Of those employed in the Spanish Peninsula some years later, my intimate friend Captain John Squire[14] a man of superior literary, classical, as well as professional attainments, contributed most to keep up this noble spirit, and it was gratifying to me, on our meeting from time to time, after having been separated on different expeditions, and in corresponding with him, to find that our opinions on the state of the Corps and on the management of the war, for which he invariably advocated the most vigorous measures, always agreed." Burgoyne,[1] writing from Vizau in April, 1810, said :—" I am entirely on your side respecting the Corps and in everything else, and feel assured we want a great deal more than I will explain to you by letter. I had been brooding over these ideas for some time myself, but meeting nobody to encourage me, or to whom I dare broach my opinions, I could scarce believe I was myself sincere in them. Yours and Squire's[14] letters have given me confidence in these ideas and made me fit for anything. I have written to sound Mulcaster[15] and wait with impatience for his answer. I long to gain him, knowing him to be a clever fellow, and what is more, a smart, dashing, indefatigable officer."

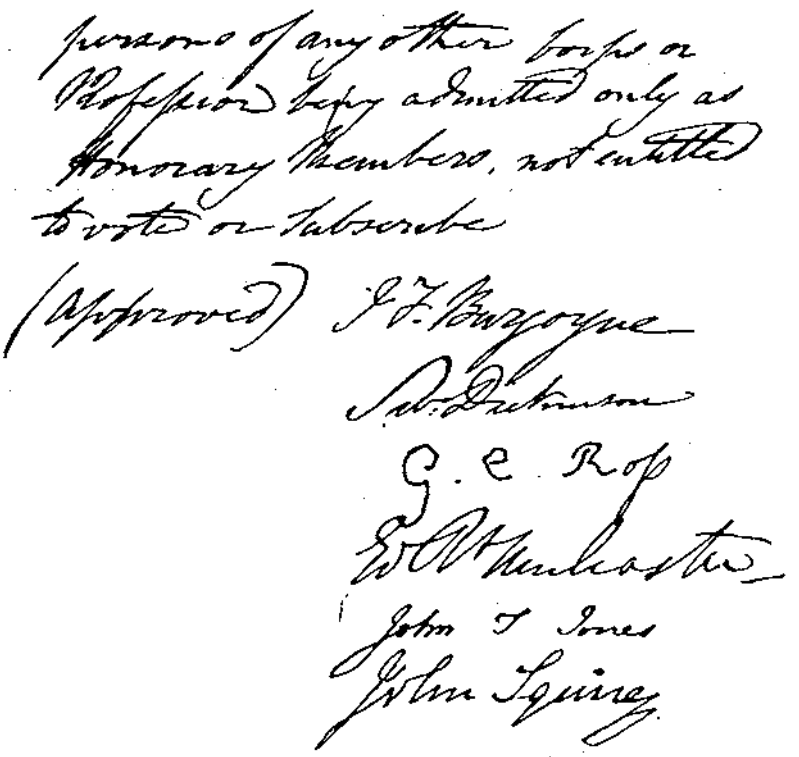
Amongst the Burgoyne papers in the R.E. Museum is a letter from

[14] John Squire. 2nd-Lieut., R.A., 27.4.1793. 2nd-Lieut., R.E., 1.1.1797. Bt. Lieut.-Col., 27.4.12. *War Services:* Holland, 1799; Egypt, 1801; Buenos Ayres, 1806–8; Sweden, 1808; Peninsula, 1808–9; Walcheren, 1809; Peninsula, 1810–12. Died from fatigue, Truxillo, 19.5.1812.

[15] Edmund R. Mulcaster. 2nd-Lieut., 1.3.1804. 2nd-Capt., 24.6.09. *War Services:* Sicily, 1807–8; Peninsula, 1808–9 and 1809–12. Killed at 3rd siege of Badajoz, 25.3.1812.

Mulcaster[15] to Burgoyne[1] (to "My dear Goss" from "your ever faithful friend, Mulco") which is dated January, 1810, and which shows that they had had under discussion for some time a project for forming amongst the officers of the Corps a "Society for procuring useful military information." This society actually took shape, and was confined to Captains and Field Officers of the Corps, the original members, all serving in the Peninsula at the time, being: Captains

SOCIETY FOR PROCURING USEFUL MILITARY INFORMATION.



Facsimile of Signatures on Article of Association

J. F. Burgoyne,[1] S. Dickenson,[16] G. C. Ross,[17] E. R. Mulcaster,[15] John T. Jones,[5] and John Squire.[14] In January, 1811, they agreed to elect to the society the following:—Birch,[18] Nicholas,[7] Goldfinch,[19]

[16] Sebastian Dickenson. 2nd-Lieut., 1.10.1804. 2nd-Capt., 29.5.10. *War Services:* Buenos Ayres, 1807; Walcheren, 1809; Peninsula, 1810–11. Killed at 1st siege of Badajoz, 11.5.1811.

[17] George Charles Ross. 2nd-Lieut., 1.7.1799. Capt., 24.6.09. *War Services:* Peninsula, 1809–12. Killed at Siege of Cuidad Rodrigo, 9.1.1812.

[18] John Francis Birch, C.B. 2nd-Lieut., R.A., 18.9.1793. 2nd-Lieut., R.E., 1.1.94. General, 20.6.54. Died 29.5.1856. *War Services:* Holland, 1793–5; Minorca, 1798; Egypt, 1801; Copenhagen, 1807; Peninsula, 1808–9; Walcheren, 1809; Peninsula, 1810–11.

[19] Henry Goldfinch, K.C.B. 2nd-Lieut., R.A., 1.3.1798. 2nd-Lieut., R.E., 24.6.98. Lt.-Gen., 11.11.51. Died 21.11.1854. *War Services:* Copenhagen, 1807; Peninsula, 1809–14.

Fanshawe,[20] Pasley,[4] Boothby,[21] Thackeray,[22] Parker,[23] Lewis,[6] Marlow,[24] Douglas[25] and Arnold.[26] It seems likely that the exigencies of active service prevented this society from performing much useful work for its members; many were killed or wounded at the sieges of the next few years, but the mere fact of its formation bears testimony to the spirit which was alive amongst the less senior ranks of the Corps. It devolved upon two of the members to bear somewhat vehement testimony to the need for reform in the Corps; one, John T. Jones,[5] thereby fell into disfavour with the Right Honourable and Honourable Board, whilst the other, Charles Pasley, succeeded in carrying the reforms through.

As regards outside testimony to the spirit of the Corps at the time of the Peninsular War, Lord Wellington gave frequent praise in his dispatches to his Engineers both collectively and individually: in letters to General Murray and Lord Liverpool, however, after the capture of Badajoz in 1812 he was unfair and ungenerous as to their supposed lack of skill in their profession, knowing as he did, and no one better, the total lack of trained personnel there was with which to carry out siege works.* And after the Siege of San Sebastian, Lieut.-General Sir Lowry Cole wrote to Lieut.-Colonel Burgoyne, "I shall feel great pleasure at all times in doing justice to a corps

* Jones' Diary in R.E. Museum. "Saturday, 15th February. Lord Wellington this day held a meeting on the subject of the best attack of Badajoz. There were present General Castaños, Genl Girard—the Spanish Brigadier General of Engineers and Lt Colonel Fletcher. The Spaniards and His Lordship were for making the same attack as the French. Lt. Col F. proposed attacking the Bastion of Sn. Trinidad from the ground in front of the Picurina redoubt, but not being able to state his reasons, viz., the British Engineers not having establishment of either Sappers and [or] Miners and being therefore unequal to the task of contending with the mines of those fronts—no one of the Council would accede to his opinion—but Lord Wellington being reminded of our deficiencies agreed to the project saying he regretted extremely our deficiencies as it obliged him to undertake an attack he did not approve but that knowing our means he believed it to be the only attack in our power to get thro. What a reflexion on those who have governed the Engineer Service for the last nineteen years of war."

[20] Edward Fanshawe, C.B. Lieut., 1.7.1801. Lt.-Gen., 20.6.1854. Died 22.11.1858. *War Services:* Cape, 1805–6; Buenos Ayres, 1807; Peninsula, 1808–9; Walcheren, 1809.

[21] Charles Boothby. 2nd-Lieut., 1.1.1804. Capt., 21.7.13. Permanent Half-pay, 15.6.1815. Died in Holy Orders, 19.8.1846. *War Services:* Sicily, 1805–7; Sweden, 1808; Peninsula, 1808–9 and 1809–10. Lost his leg at battle of Talavera, 1809.

[22] Frederick Rennell Thackeray, C.B. 2nd-Lieut., R.A., 18.9.1793. 2nd-Lieut., R.E., 1.1.1794. General, 20.6.54. Died 19.9.1860. *War Services:* Surinam, 1799; St. Martin's and St. Bartholomew, 1801; Sicily, 1806–7; Egypt, 1807; Sicily, 1807–12; Peninsula, 1812–14.

[23] Edward Parker. 2nd-Lieut., 1.1.1804. Capt., 21.7.13. *War Service:* Egypt, 1807; Sicily, 1807–11; Peninsula, 1812–14. Killed at Orthes, 27.2.1814.

[24] Benjamin Marlow. 2nd-Lieut., R.A., 14.7.1798. 2nd-Lieut., R.E., 30.8.1798. Lt.-Col., 1.12.15. Died 11.10.1818. *War Services:* Copenhagen, 1807; America, 1812–14.

[25] William Douglas. 2nd-Lieut., 1.7.1801. General, 3.4.62. Died 10.2.1864. *War Services:* Sicily, 1809–12.

[26] James Robertson Arnold, K.H., K.C. 2nd-Lieut., R.A., 1.3.1798. 2nd-Lieut., R.E., 29.8.98. Lt.-Gen., 11.11.51. Died 27.12.1854. *War Services:* Malta, 1800; Egypt, 1801; Demarara, Essequibo, 1803; Surinam, 1804.

throughout the younger branches of which there is a spirit that no other corps I know of possesses to the same degree."

It has been stated earlier that the battle of Maida impressed Pasley with the fighting qualities of the British troops, and it appears that from that time he formed the project of bringing before the British public the unsound principles on which our foreign policy was being conducted. He was convinced that if "Government would only give us an opportunity of making the experiment on a great scale, the British Troops would beat the revolutionary armies of France, as our forefathers had done those of Louis XIV." He planned to write an essay in two parts on the military policy and institutions of the British Empire, Part I of which was issued in 1810. The first two chapters had actually been written early in 1808, but active service prevented any further writing until the wounds received at Flushing put an end to his active service, and gave him enforced leisure. The first edition was issued in November, 1810, and the fourth edition was issued in the beginning of 1813, surely an unprecedented success for such a publication. Captain Jones,[6] writing from Wellington's H.Q. in March, 1811, said, "Lord Wellington reads it, Marshall Beresford reads it, in short it is universally read amongst us and as universally admired." It was received with an equal chorus of approval in the various papers of the time, *The Times* saying:—"The work has, we learn, excited greater attention among the higher classes of political readers in the country than any since the time of Mr. Burke." As will be explained later, the second part was never written, but the Fourth Edition was re-issued in 1857, and a fifth edition by Colonel B. R. Ward (R.E.) in 1914. The main theme of the essay was that we must act on land with our utmost vigour and smash Napoleon's power or be ourselves eventually smashed as soon as a period of peace had given Napoleon time, with the aid of all the countries which he had overrun and which were at his disposal for such assistance, to build up again his naval power: when, with all the odds against us, we must succumb to the whole power of the Continent. He especially decried our "evacuating policy," as he termed it, by which we landed forces in different parts, got the local people to implicate themselves with us, and then cleared off and left them to the mercy of our enemies. A bold policy, with Great Britain as a principal and not as an auxiliary, especially in Spain, was what he advocated. And whether it was due to his essay or not, that was the policy eventually adopted by us with success.

Such a notable public effort must undoubtedly have greatly strengthened Pasley's position in his efforts to get the needs of the Engineer Department attended to, and he was listened to by the Board of Ordnance with attention. He was not the only officer who had tried to move the I.G.F. to take some steps to get the necessity

for the training of a body of sappers and miners recognized. Porter relates how Sir John Jones,[5] when Adjutant of the Royal Military Artificers at Woolwich after the Corunna campaign in 1809, repeatedly urged the advisability of giving the men a thorough training in field work and employing them with the army; but General Mann,[27] the Inspector-General of Fortifications, always met his proposals with the statement that "good workmen were like old gold, to be treasured up and not risked in the chances of war." Jones later on, in 1812, when writing to the I.G.F. on the same subject, went so far as to say that "Nero fiddled whilst Rome burned," an indiscretion, for which the writer received well-deserved censure.

Pasley himself, in writing to Colonel Fyers[10] at the Board of Ordnance on 12th May, 1809, gave his ideas on the subject of rendering the Corps of Royal Engineers more efficient, "which is now under agitation, and if agreeable to General Morse[28] and yourself, I am desirous of having this enclosure laid before the Master General of the Ordnance." Pasley's testimony has already been given above to the fact that "as early as 1805, the inefficiency of the Corps for want of disciplined and instructed sappers and miners" was a matter of discussion amongst the junior officers of the Corps, and it appears certain that the idea that a corps of sappers and miners was a necessity for work in the field had been simmering in the office of the Board for some time.* In 1809, Pasley wrote direct apparently to the M.G.O., Lord Chatham,[29] about the state of affairs at the Shop, and bet his commission he would make good his words! Lord Chatham ignored the wager, said he disagreed about the Shop, but was prepared to receive Pasley's statement; which was to the effect that during the peace after the American War, the education at Woolwich Academy had been "in so perfect a state as the military science of the time admitted, and the cadets never received their commissions without passing public examinations, of which the mathematical part was conducted by the Astronomer Royal and at which the Duke of Richmond,[30] the M.G.O., presided in person with laudable zeal. But on the increased demand for officers in consequence of the war with

* Papers have lately come to light in the Record Office which on further examination may show that between 1760 and 1770 a proposal to form a Corps of Sappers, Miners, Gabioniers, Pontoniers, etc., was put forward by a senior R.E. officer, complete with sketches for colours, uniform and equipment. It is probable that the raising of the R.M. Artificers to look after permanent fortifications blocked any scheme for field Engineer troops.

[27] Gother Mann. Ensign, 27.2.1763. General, 19.7.1821. Died 27.3.1830. *War Services:* Dominica, 1778; Holland, 1793–4. I.G.F., 1811–30.

[28] Robert Morse. Ensign, 8.2.1758. General, 25.4.1808. Died 28.1.1818. *War Services:* St. Malo, 1758; Martinique and Guadeloupe, 1759; Belleisle, 1761; Germany, 1762–3. I.G.F. 1802—11. "A good old fellow upon the whole, but no warrior."—*Pasley*.

[29] John, 2nd Earl of Chatham. Master General of the Ordnance, 1801–6 and 1807–10.

[30] Charles, 3rd Duke of Richmond, M.G.O., 1782–83 and 1784–95.

the French Republic, the course had been cut short without being methodized, many important subjects having been omitted altogether and a smattering only of others taught."

During 1810, Pasley was on leave, recovering from his wounds, busy with the production of his *Essay on the Military Policy*, and thinking over the subject of the defects in the Corps. In 1811, things began to move: Pasley addressed Lord Mulgrave,[31] M.G.O., on the inefficient and dangerous state of the Department generally, "from which failures and disasters appeared to me to be inevitable in any siege the British Army might attempt, accompanied by the unmerited disgrace of the Corps to which I belonged—unmerited, because no corps can improve itself." Lord Mulgrave proved consistently sympathetic to Pasley's ideas, and further developments are thus described by Pasley himself at a later date. He had been posted to Plymouth in 1811, on recovering from his wounds sufficiently to resume duty, where he had found things pretty bad and had had to discharge "about 150 superannuated men (not old servants) and little helpless boys, who were put upon the works through charity." "I took the opportunity, whilst stationed at Plymouth in 1811, first as second and afterwards as Commanding Engineer *pro tempore*, to carry into effect, at my own expense, a system of practical and theoretical instruction for the junior officers of the Corps of Royal Engineers, and for the non-commissioned officers and privates of the Department, a Company of whom, then termed Royal Military Artificers, volunteered to work at the operations of a siege in the summer of that year, after their regular working hours for the day were over, and they were accordingly practised in the construction of a gun and mortar battery, and portions of parallels and approaches, after having previously made fascines and gabions from materials purchased in the neighbourhood." Pasley also attended schools to study the systems of Bell and Lancaster, and by the adoption of those systems worked out textbooks which enabled the volunteers of the R.M. Artificer Company who attended night-school, to teach each other. The men were rough and uneducated, and the instruction had to be of the simplest.

1810

1811

Pasley reported his success to Lord Mulgrave in December, 1811, and said he would not write the Part II* of his Essay, but would devote all his energies to improving the Department. He thus summarized what it had been his intention to write in this second part as far as the Engineer Department was concerned:—"In this work I should have suggested several improvements that appeared to me from my own experience and reflection to be essential, and more especially in

* Dealing with the Institutions of the British Empire.

[31] Henry, 1st Earl of Mulgrave, M.G.O., 1810–18.

the important department in which I had the honour of serving, which was at that time so imperfectly organized that I considered the British Army, though admirably adapted for battle from the excellent discipline of the Cavalry, Artillery and Infantry and Riflemen or Light Troops, to be incapable of succeeding in a siege, though one of the most important operations of war, without either having recourse to the barbarous measure of incendiary bombardment, or without an enormous sacrifice of the lives of officers and soldiers in sanguinary assaults, which might be rendered unnecessary by a more efficient organization of the Royal Engineer Department, and especially by forming a well-instructed and well-disciplined body of Engineer soldiers, diligently exercised in all the operations of a siege, particularly in military mining and also in the formation of military bridges. The better instruction of the junior officers of the Royal Engineers appeared no less essential, for at that time they were not even taught the theory of the attack of fortresses at Woolwich Academy, where the course of instruction was very imperfect, and the examinations for commissions were merely a matter of form, and no genuine tests of proficiency. As for practical instruction, they had none, for they were sent on service without ever having seen a fascine or a gabion, without the smallest knowledge of the military passage of rivers, of military mining, or of any other operation of a siege, excepting what they might pick up from French writers, of which a striking proof occurred in Sir John Moore's retreat, when all attempts to blow up stone bridges to impede the progress of the enemy, made by officers of the Corps, myself amongst others, failed in effecting complete demolition, with the exception of one only, which Lieut. Davy,[32] a very promising young officer, succeeded in completely destroying, but at the expense of his own life, which he lost from not understanding the very simple precautions necessary to insure the safety of the person who fires the train of a mine. For my part, I should not even have known how to make a battery in the attack of Copenhagen, the first siege in which I was employed, but from the information I derived from a French book on the subject. Such were the ideas which I intended to submit to the public in 1809."

Lord Mulgrave[31] on receiving the letter reporting progress replied that he derived the greatest satisfaction from learning of Pasley's success, and he commended Pasley's decision not to publish to the world " the inefficiency of any Department for the improvement of which the cheerful co-operation of the chiefs and seniors is requisite. I am, however, persuaded that your own discretion has prevented any statement which could by its publication wound the feelings of higher ranks of the Branch of Service which your meritorious zeal is directed to improve to the utmost of your power."

[32] Henry Davy. 2nd-Lieut., 1.11.07. Lieut., 2.5.08. *War Services:* Peninsula, 1808–9. Killed at Betanzos on the retreat to Corunna, 10.1.1809.

The Master General was not the only senior officer whom Pasley endeavoured to enlist on his side: he wrote also to the Duke of York, then Commander-in-Chief, and received a favourable reply. It appears from a letter to Burgoyne that he had addressed the Duke of Wellington also on the same subject. In the letter dated March 2nd, 1812, he says, "I think his Lordship rather used me ill. I sent him a present of my book, which as a Gentleman he ought to have acknowledged. At the same time I wrote to him a full account of the difficulties we laboured under owing to the want of men trained to the making of fascines, gabions, etc., and sapping. This letter, which was dated 27th July, 1811, he never thought proper to answer. I wrote him, because I thought Fletcher[33] would be too timid to say anything about the Department that would implicate Morse.[28]"

In February, 1812, on hearing from Colonel Rowley,[34] Deputy I.G.F., that General Mann[27] the I.G.F., wanted the training of the R.M. Artificers in fieldworks put in hand, Pasley came to London. A committee of Field Officers of the Corps, of which General Morse[28] was the President and Colonels Bridges,[35] Rowley [34] and Bryce[36] were members, assembled to give a report to Lord Mulgrave[31] on the subject. The report of this committee appeared on 14th March, and their recommendations may be summarized as follows:—(1) They considered the officers of the Corps of Engineers should also be the officers of the Military Artificers, although this was at variance with the usage of other countries. The men to be armed with brown carbines and bayonets. (2) Pasley's course and methods of instruction were approved. (3) Every officer of Engineers, whom circumstances would permit, should have the advantage of the Central School, and every officer in future, on his first appointment, should invariably be ordered on this duty. They concluded, "We are fully aware that to execute the difficult and extensive duties of Director of the School there must be united a portion of Science, experience, perseverance and temper which falls to the lot of few men. But, besides the zealous co-operation which we trust that he would find in all ranks—we have no doubt such encouragement will be afforded, by the M.G., as would give a stimulus to laudable ambition and authority to the Director." 1812

Thus was a blessing pronounced on a scheme for which the more

[33] Richard Fletcher, Bart., K.C.H. 2nd-Lieut., R.A., 9.7.1788. 2nd-Lieut., R.E., 29.6.90. Lieut.-Col., 24.6.09. *War Services:* Martinique, St. Lucia and Guadeloupe, 1794; St. Lucia, 1796; Syria, 1801; Egypt, 1801; Copenhagen, 1807; Peninsula, 1808–9 and 1809–13. Killed at storming of San Sebastian, 31.8.1813.

[34] John Rowley. 2nd-Lieut., R.A., 23.6.1786. 2nd-Lieut., R.E., 23.8.87. Maj.-Gen., 19.7.1821. Died 1.12.1824. *War Services:* Holland, 1793–5.

[35] George Bridges. 2nd-Lieut., R.A., 1.4.1776. 2nd-Lieut., R.E., 12.12.1776. Maj.-Gen., 12.8.1819. Died 1.6.1825. *War Services:* Cape, 1795.

[36] Alexander Bryce, Kt., C.B., K.C.H. 2nd-Lieut., R.A., 24.8.1787. 2nd-Lieut., R.E., 12.3.1789. Maj.-Gen., 27.5.25. Died 4.10.1832. *War Services:* Egypt, 1801; Sicily, 1807–11; Netherlands and France, 1815–16.

junior members of the Corps had been pressing for so many years against the opposition of Headquarters and the Board of Ordnance.

Lord Mulgrave[31] had expressed the desire that Pasley should be the first Director, but a difficulty meantime had arisen which threatened to wreck this part of the scheme. In February, Pasley had presented a memorial to Lord Mulgrave, asking for his recommendation for promotion to the rank of Brevet Major. The grant of brevet rank to officers of the Ordnance Corps, where promotion was strictly by seniority, had only recently been obtained, and Pasley found that his juniors (Burgoyne, Nicholas, Macleod, J. T. Jones) were getting brevets for services in the Peninsula, whilst he held that his wounds and other services were no less meritorious. To his surprise, though his claims were backed by the I.G.F., Lord Mulgrave refused to recommend him. Two grounds were adduced for his refusal, first, that the contemplated work of training was not of such importance as to justify the recommendation, and secondly the war service, though admitted to be most meritorious and worthy of recognition, had been performed under *a different Administration!* Lord Mulgrave was adamant about the recommendation, and Pasley was equally determined that without the brevet rank he would not accept the Directorship, and it is necessary to turn to the Peninsula to see how the deadlock came to an end.

In the *Journal of Sieges in Spain*, second edition, the author states that "on the failure of the attack of Badajoz, in 1811, the most pressing applications were made, that half a dozen companies might be selected from the Royal Military Artificers to be formed into a body under the name of Royal Sappers and Miners, that officers should be permanently attached to the companies so selected, and after some instruction in their art, the six companies should be sent out to aid the troops in their future siege operations."* The application was repeated after the capture of Ciudad Rodrigo, which took place on January 20th, 1812.

In the Diary of Major J. T. Jones,[5] Brigade-Major to Sir Richard Fletcher,[33] is an entry dated 29th January, 1812, which starts:—"A Journal of the Siege and a plan of the attack (of Ciudad Rodrigo) was sent by the mail of this day to Lord Mulgrave and to Lieut.-General Mann.[28] Col. Fletcher made a representation to the Inspector-General of Fortifications of the necessity of a corps of Sappers and Miners to be immediately formed and sent to this country." (See Appendix I.) Next, Lord Wellington sent a dispatch to the Earl of Liverpool, dated 11th February, 1812, in which

* It would appear that the author's recollection of the exact details of the proposals are at fault. This second edition, which varies considerably from the first published in 1814, came out in 1827. The details given above are practically the same as those given in Appendix I, dated January 29th, 1812, whilst the *Journals* state "This application was repeated in the most forcible manner *previously to* the siege of Ciudad Rodrigo." This should apparently be "*after* the siege."

he said, " I would beg to suggest to your Lordship the expediency of adding to the Engineers' establishment a corps of sappers and miners. It is inconceivable with what disadvantage we undertake anything like a siege for want of assistance of this description. There is no French *corps d'armée* which has not a battalion of sappers and a company of miners. But we are obliged to depend for assistance of this description upon the regiments of the line ; and although the men are brave and willing, they want the knowledge and training which are necessary. Many casualties among them consequently occur, and much valuable time is lost at the most critical period of the siege." Then followed the third siege and capture of Badajoz, when the losses in the assault of the breaches were dreadful, and casualties amongst the nineteen officers of engineers employed at the siege amounted to four killed and nine wounded. Of these, the casualties amongst the engineer officers who conducted the different columns to the assault were two killed, one mortally wounded, and two severely wounded. After the capture, Wellington sent through Lieut.-Colonel Torrens, Military Secretary to H.R.H. the C.-in-C., a letter to the Earl of Liverpool, strongly urging the formation of a corps of trained sappers and miners. This letter, which is given in full in Appendix II, was misplaced* and lay forgotten amongst a bundle of unimportant papers for 57 years. It was first printed in the *Athenæum* of the last week of April, 1889, and was reprinted in the *R.E. Journal* of June, 1889. The letter is headed " Camp at Badajoz, April 7, 1812," and arrived in England whilst there was the deadlock between Lord Mulgrave and Pasley over the grant of brevet rank and the appointment as Director of the new School. The effect of the letter was immediate ; Pasley became a Brevet-Major and Director of the School by the end of that same month !

(To be continued.)

* See note in Vol. IX of Wellington's *Dispatches*.

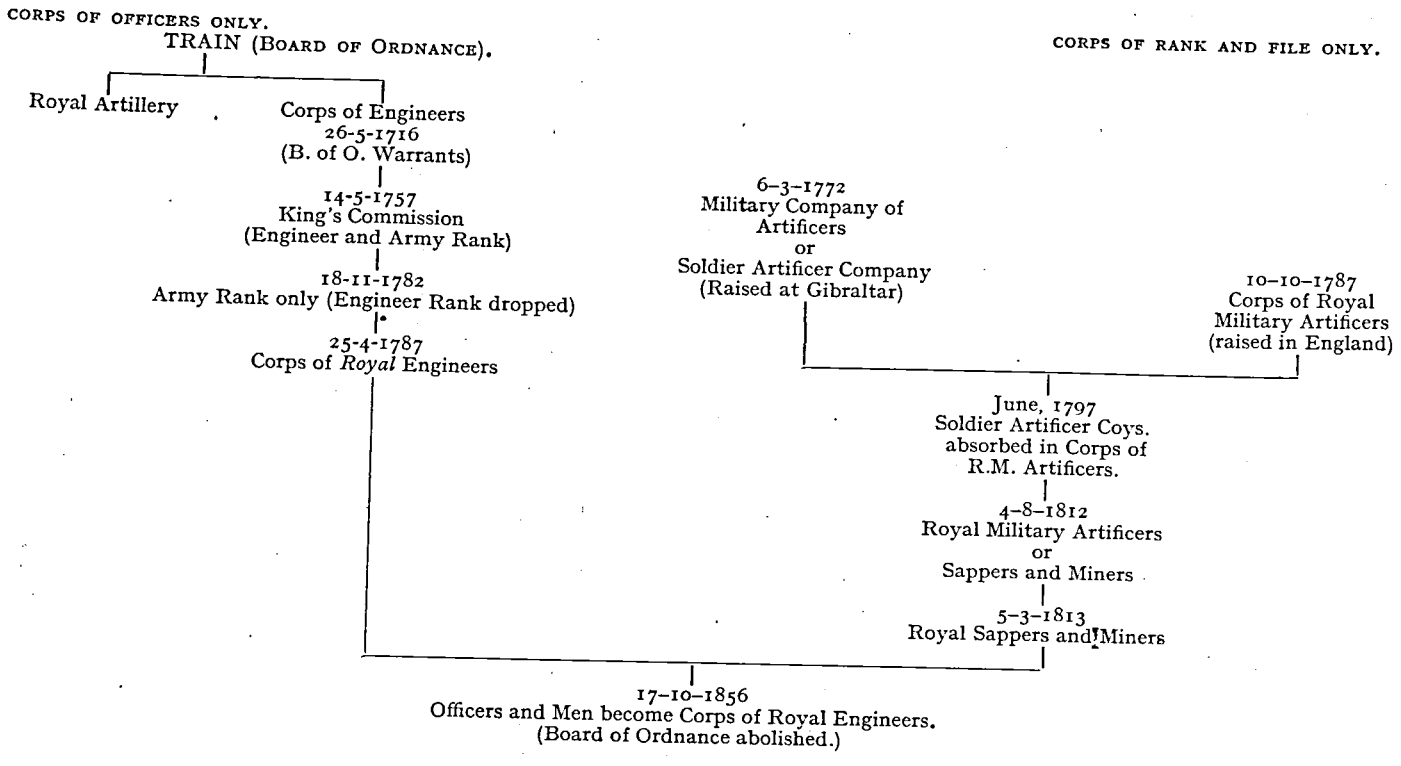


CHART SHOWING THE DEVELOPMENT OF THE CORPS OF ROYAL ENGINEERS.

APPENDIX I.

(Extract from the diary of Major J. T. Jones, R.E., Brigade-Major to Sir Richard Fletcher, Commanding Engineer in the Peninsula.)

CIUDAD RODRIGO, JANUARY 29TH, 1812.

A Journal of the Siege and a plan of the attack was sent by the mail of this day to Lord Mulgrave and to Lt.-General Mann. Col. Fletcher made a representation to the Inspector-General of Fortifications of the necessity of a Corps of Sappers and Miners to be immediately formed and sent out to this Country.

Copy of a paper transmitted to Lt.-Col. Rowley.

Suggestions for the speedy formation of an efficient Corps of Sappers and Miners from the present Corps of R.M. Artificers.

1. Eight Hundred Rank and File, including Serjeants, to be selected from the Corps of R.M. Artificers—these men to be divided into ten companies of 80 men each, to be styled the Corps of Royal Sappers and Miners. The remaining — men to form as at present Companies of R.M. Artificers for garrison duty.

2. The uniform of the Corps of Sappers and Miners and of the Companies of Artificers for garrison duty to be red.

3. The ten Companies of Royal Sappers and Miners to be officered by the ten junior second Captains, the ten junior first Lieutenants and the ten senior second Lieutenants of the Corps of Royal Engineers.

These officers for the time being to be considered actually and *bona fide* officers of Sappers and Miners, performing every kind of regimental duty and wearing the same uniform as the men.

The other officers of the Corps of Royal Engineers to wear a blue uniform as at present and to be considered distinctly as having no charge of the above men, nor being liable to be called upon for the performance of any regimental duty whatever.

4. The Companies of Artificers for garrison duty to have officers of their own and which might be made a fine field of encouragement and promotion for the Serjeant-Majors of Sappers.

5. No Sub-Lieutenant to be attached to the Companies of Sappers and Miners, but three or four Serjeant-Majors to be allowed on the establishment of the Corps.

6. The officers, N.C. officers and privates of the Corps of Sappers and Miners to have a higher pay than the rest of the Army in like manner to the Staff Corps and in a similar way to be divided into Classes.

7. All men at first to be indiscriminately enlisted for the Corps of R.M. Artificers and then the proper subjects to be transferred to the Sappers and Miners—this measure will admit of any bad subjects or unfit men being returned to the Artificer Companies for garrison duty.

8. Intelligent men to be enlisted for the Corps of Sappers and Miners whether mechanics or not provided they can read and write and understand arithmetic.

9. The men to be all thoroughly trained to the Sap—the Carpenters and Miners to the forming of galleries and mines and the whole to the tracing out of works, profiling, levelling, etc., etc.

10. Six Companies of the Corps of Sappers and Miners to be with the Army in the field in Portugal—two Companies with the Army in the Mediterranean and the other two at the Head Quarters of the Corps in training as a depot from which to keep up the effective force of the Companies in the field and in readiness to accompany any small expedition which may leave England.

The following advantages of the above plan were pointed out in an accompanying letter :—

1. By officering the Companies of Sappers and Miners from the Corps of Engineers, all jealousies of rank and employment between the officers of Engineers and the officers of Sappers is avoided.

2. Every officer of Engineers in his turn has the opportunity to become acquainted with regimental duty and the care of troops, and the objection frequently urged against giving Engineers commands, that they know nothing of the discipline and manœuvring of troops, is done away.

3. The Corps of Engineers will imbibe a proper degree of military knowledge, at the same time that the senior officers are put on a footing with the Staff of the Army and will not be subject as at present to have their situations lowered by being made to perform regimental duty beneath the rank they hold in the service.*

4. The men of the Sappers and Miners will be properly looked after, which never can be the case whilst the officers have a superior duty to perform. The Engineer Officers commanding Companies of R.M. Artificers in this Country, from their professional avocations, seldom or never see their men.

5. Under this establishment the Corps can never become a burden on this Country—as when there are no armies in the Field the men can be employed on the permanent works going forward in England and the officers can act as Engineers.

6. By the Companies being commanded by the junior second Captains —the Commanding Engineer must invariably be senior to the officers of Sappers and Miners and will have the direction of the Corps, as the Qr. Mr. General of an Army has the direction of the Staff Corps, but the discipline of the Sappers must rest with the senior officer of Sappers.

APPENDIX II.

Letter from the Duke of Wellington to the Earl of Liverpool :—

Camp at Badajoz, April 7, 1812.

My Dear Lord,—My dispatches of this date will convey the account of the capture of Badajoz, which affords as strong an instance of the gallantry of our troops as has ever been displayed. But I anxiously

* Sir Chas. Shipley as a Lieut.-Colonel was obliged by Lieut.-General Grinfield to fall in and do duty with a single company of R.M. Artificers—a degradation which could not have occurred to a Lieut.-Colonel in the line.

hope I shall never again be the instrument of putting them to such a test as that to which they were put last night. I assure your Lordship that it is quite impossible to expect to carry fortified places by *vive force* without incurring great loss and being exposed to the chance of failure, unless the army should be provided with a regular trained corps of sappers and miners. I never yet knew a head of a military establishment or of an army undertaking a siege without the aid of such a corps, excepting the British Army. There is a body of sappers and miners attached to every French corps and each of the armies in the East Indies has one: and every army in the world except ourselves. The consequence of being so unprovided with the people necessary to approach a regularly fortified place are—first, that our engineers although well educated and brave, have never turned their minds to the mode of conducting a regular siege, as it is useless to think of that which it is impossible in our service to perform. They think they have done their duty when they construct a battery, with a secure communication to it, which can make a breach in the wall of a place; and, secondly, these breaches are to be carried by *vive force* by an infinite sacrifice of officers and soldiers. To this add that storming a breach, or attacking a place by escalade, is an operation of a very different description from fighting a general action. In the latter every man, generally speaking, has an equal chance; but in the former the officers, the bravest and best of the non-commissioned officers and soldiers, go first. The loss falls upon these; and five minutes after the breach is carried women and children might enter it instead of men. You see in the attack of Badajoz we had six out of seven general officers employed, all their staff, and a very large proportion of the officers killed or wounded. In the attack of the Picurina it was the same, and we lost 200 out of 500 men employed. These great losses would be avoided, and, in my opinion time gained in every siege, if we had the properly-trained people to carry it on. I declare I have never seen these breaches more practicable in themselves than the three in the walls of Badajoz; and the fort must have surrendered with these breaches open if I had been able to approach the place. But when I had made the third breach on the evening of the 6th, I could do no more. I was obliged then to storm or give the business up, and when I ordered the assault I was certain I should lose our best officers and men. It is a cruel situation for any person to be placed in, and I earnestly recommend to your lordship to have a corps of sappers and miners formed without loss of time.

Believe me, my dear lord,
Ever yours most sincerely,
WELLINGTON.

MAINTENANCE OF LANDING GROUNDS.

A Lecture delivered at the S.M.E., Chatham, on October 9th, 1930, by H. A. LEWIS-DALE, Esq., M.INST.C.E., M.I.MECH.E., *Assistant-Director of Works, Air Ministry.*

I HAVE been asked to lecture to you on this subject, because, under certain circumstances, the Royal Engineers will be responsible for works services in connection with aerodromes. My remarks this afternoon will be directed more particularly to that essential and vital part of an aerodrome—the landing ground.

Although the actual landing ground constitutes but a part of the Engineer's responsibility, it is undoubtedly the most vital point of that responsibility from the pilot's point of view. Bad and neglected landing grounds have their corollary in an abnormal number of crashes, endangering life and limb and causing the loss of many thousands of pounds in the value of machines and resulting generally in impaired efficiency of operations.

The problems connected with hangars and other technical buildings and the regimental accommodation—important as they are—are similar in character to works which you are normally called upon to deal with, but the formation and the maintenance of landing grounds involve problems of a special nature, which are exercising not only the Air Ministry Engineering Staff and municipal authorities in this country, but similar authorities overseas.

These landing ground problems are not, of course, new, but have become more pressing and urgent during recent years for at least three reasons :—

(*a*) The rapidly increasing size and weight of aeroplanes.
(*b*) The more intensive uses to which a landing ground is subjected.
(*c*) Landing grounds have in many cases steadily deteriorated due to past neglect, and lack of foresight as to the factors (*a*) and (*b*).

SELECTION OF SITES.

Before going on to discuss the special problems of maintaining a satisfactory surface, it is worth while to mention briefly some of the factors which should be taken into consideration when selecting a site, as it is obvious that the final choice of a site has a considerable

bearing on the question not only of the first costs of construction, but also on the cost of subsequent maintenance.

Factors which influence the selection of a site (apart from purely military considerations) are :—

(i) Extent and nature of ground required.
(ii) Air approaches.
(iii) Meteorological conditions.
(iv) Building facilities.
(v) Rail and road facilities.
(vi) Water, power and lighting supplies.
(vii) Facilities for drainage.

I propose to pass somewhat quickly over headings (i) to (vi), and to concentrate during the time at my disposal more particularly on the all-important question of drainage, and on the methods to be adopted to obtain and to maintain an efficient landing surface under all conditions of weather and user.

(i) Extent and Nature of Ground.

An approximately level area is required not less than 600 yards in all directions, and preferably 1,000 yards. An unobstructed area of this size is seldom found ready-made in England or thickly-populated centres, and the removal of hedges, trees and other obstructions, and the piping and filling in of ditches and grading of surface are usually involved. High-lying ground is generally preferable as ensuring more freedom from fog and from drainage difficulties : ground surrounded by hills which cause dangerous air currents is to be avoided.

Land laid in permanent pasture, free from sharp changes of inclination and without ridges and furrows, is most suitable.

Gradients in excess of about 1 in 40 are undesirable. The surface and sub-soil should be of a porous nature, sufficiently solid to take the impact and weight of large aeroplanes. A good rough test of a ground is to drive a fully-laden 3-ton pneumatic-tyred lorry slowly across it, and if the wheels do not sink in, the ground is likely under ordinary circumstances to be a good one. In this connection, however, it should be noted that soggy ground can often be improved if time permits by suitable drainage work.

The following description of how an apparently most unlikely site is now being developed as a landing ground overseas may be of interest. (Figs. 1 and 2.)

When originally surveyed in 1926, the ground was covered with scrub and patches of trees and was practically a flat swamp, subject to periodical flooding during high spring tides. The sub-soil, to a depth of 6 ft. and probably much deeper, consisted of blue clay, soft enough for a walking-stick to penetrate several feet into the ground.

There was, however, no alternative to this site within a radius of many miles, except certain uneven rubber and mining areas, which would have been most expensive to acquire and which failed in many ways to fulfil the conditions necessary for a satisfactory landing ground.

Unlikely though the above-mentioned site appeared, expert opinion was held that, after necessary engineering works had been carried out, a reasonably good landing ground would be obtained. This

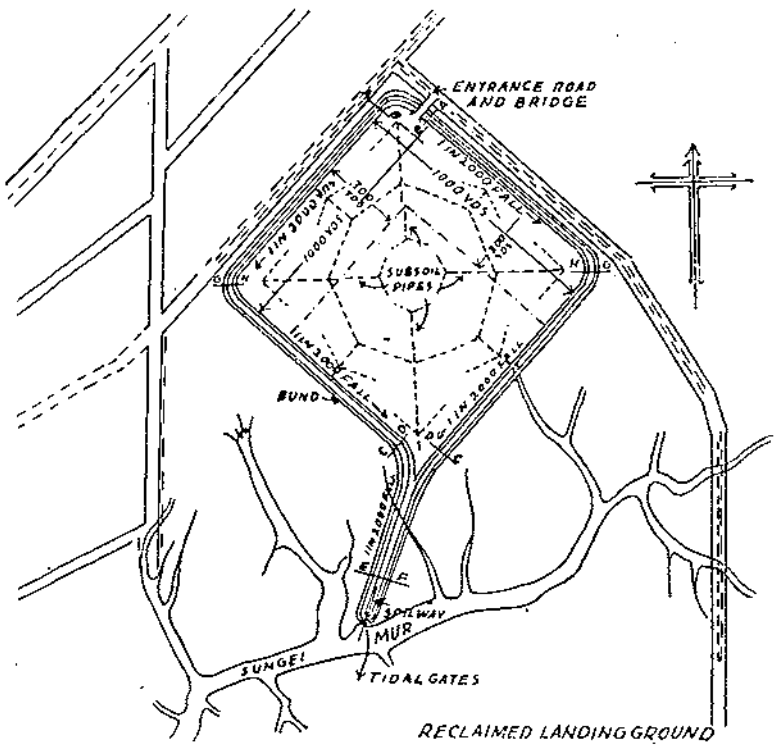


FIG. 1.

expert opinion was reinforced by the fact that a smaller but similar area hard by had been reclaimed and protected from tidal action and was actually in use as a recreation ground. An experiment was made of driving a 3-ton lorry over this ground after heavy rain—a fairly good test to which the surface stood up remarkably well.

Briefly, the engineering work which is being carried out is as follows:—

(*a*) The enclosing of the site by a bund to exclude tidal water.
(*b*) The formation of a ditch inside and parallel to the bund to collect and retain rainfall, with tidal sluice into adjacent river.

(*c*) The clearing and grading of the site, and laying of sub-soil drainage pipes.

(*d*) The formation of an L-shaped level area, which will be extended later as funds permit. If found necessary, this will be slightly "domed" to give rain-water a natural run-off, but this was not done in the case of the recreation ground referred to.

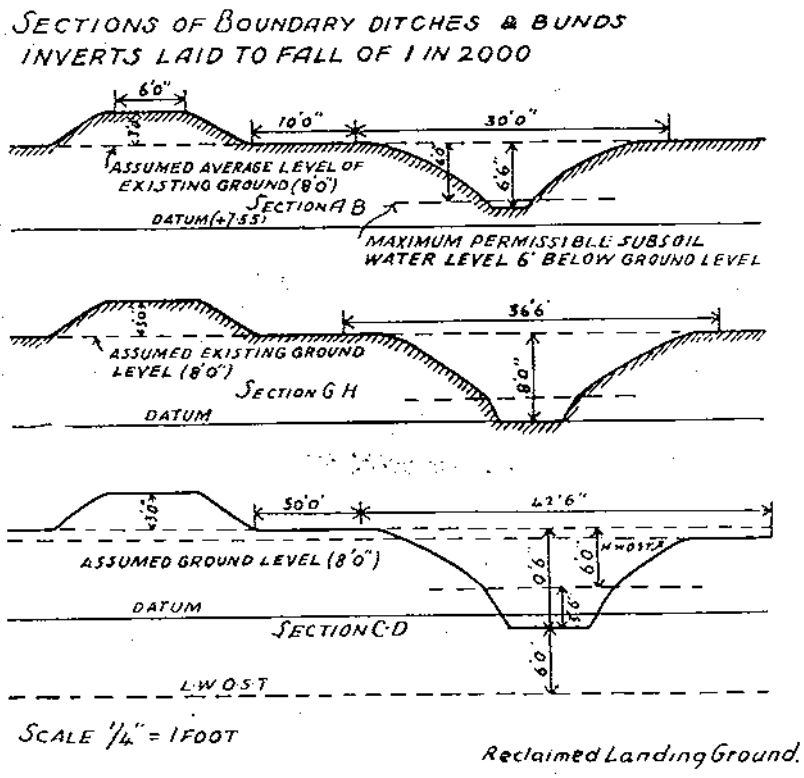


FIG. 2.

(*ii*) *Air Approaches.*

Permanent obstructions of the nature of church spires, high buildings and tall factory chimneys, may rule out the selection of a site admirable in other respects. Such obstructions as trees, hedges, telegraph poles, etc., are not insuperable as they can be removed if necessary.

(*iii*) *Local Meteorological Conditions.*

The liability of a district to rainfall, flood, fog, mist, high wind, squalls, which in excess are adverse factors in choosing a site, must be studied.

(*iv*), (*v*), (*vi*).

The importance of adequate *building facilities, rail, road and water communication, water, electric light and power supplies, etc.*, where a permanent aerodrome is concerned, is so obvious as merely to require mention here, but this summary of the factors necessary to be taken into consideration when selecting a site would be incomplete without a reference to them.

LANDING GROUND.

In constructing a new aerodrome, the landing ground, with its drainage and surface problems, should be tackled immediately the site is acquired, and all the time which is necessarily occupied by the erection of either temporary or permanent hangars and other accommodation should be utilized in getting the landing ground into good condition.

This time may be a longer or shorter period, depending upon military necessity, but even a few weeks of concentrated effort can work wonders in improving landing conditions.

It may here be stated that the formation of the leading edge of concrete or other hard aprons in front of the sheds should be done at the outset, so that work carried out on the landing surface shall not subsequently be disturbed by excavations. All traffic in connection with building operations should be kept within this leading edge and off the landing ground.

DRAINAGE.

The drainage of a landing ground differs from other forms of drainage in that water from large surfaces has to be collected and disposed of outside the landing area, without resorting to open ditches and gutters. The natural conditions which go to make a good landing ground, viz., levelness of surface and freedom from obstruction, are those which often cause considerable difficulties in maintaining a dry and hard landing surface. The problem is further accentuated by the ground having to withstand a user which in its nature is constantly breaking up the surface, and tends to interfere with the under-drainage.

MAINTENANCE OF SURFACE.

The impact of an aeroplane, weighing several tons and landing at a speed of 60 miles per hour, braked by a tail-skid which is in the nature of a plough, all occurring over and over again in practically the same spot and in all weathers, are the conditions which have to be faced at the present time. The tail-skid in heavy planes will probably be abolished soon in favour of landing-wheel-brakes, but as

things are at present this devastating ploughing action on the surface of the aerodrome has to be allowed for and made good as it occurs.

It will be helpful to consider the landing ground as consisting of three parts (Fig. 3) :—

(*a*) The area A occupied by the hangars and other buildings and aprons.

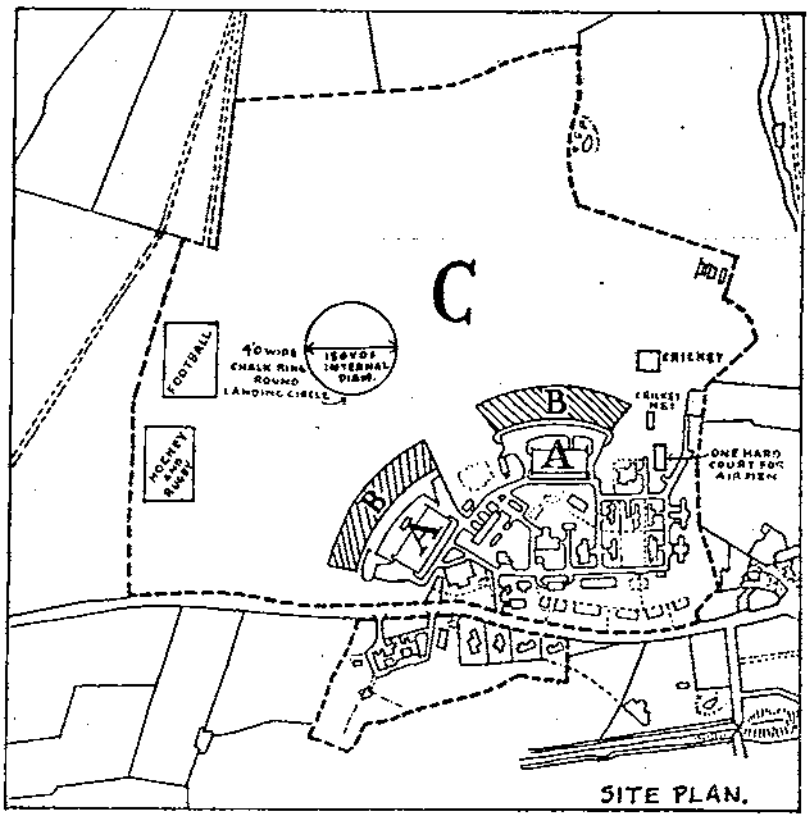


FIG. 3.

(*b*) The area B adjoining the aprons and extending, say, 50 to 100 yards outwards, on which traffic is very concentrated and where the starting and taxi-ing of machines take place.

(*c*) The rest of the landing ground which can be termed the "outfield," area C.

Area A.

The impervious area occupied by the roofs of hangars and hard surfaced aprons and roads is often as much as ten acres, one boundary of which abuts on to the landing ground at the very points where aeroplane traffic is most concentrated. It is, therefore, essential that water falling upon this area should be efficiently and quickly carried

off. To ensure this, the aprons should be carefully graded during construction, gulleys and underground drains being provided to carry the water right away from the abutting surfaces already referred to. This, no doubt, seems obvious, but many cases have come to notice where a landing ground has suffered by water from these impervious surfaces being allowed to flow over the landing ground instead of being properly carried away.

Area B.

The area outside the apron and extending, say, 100 yards into the landing ground, is the most difficult part of the landing ground to deal with, in respect both of drainage and maintenance of surface. This is the area on which the traffic, both when taking off and when landing, is most concentrated, and where the damage caused to the surface from the action of tail-skids when the machine is taxi-ing is at a maximum. The constant churning up of the ground, unless specially treated as will be described later, generally results in a veritable quagmire when the weather is wet or a dust heap when the weather is dry, which is not only a danger to men and machines in landing, but also causes clods of mud and dirt to be carried into hangars and machines. A clod of dirt from the pilot's boots is a really potential source of danger among delicate controls.

In many cases, it is futile to attempt to maintain a grass surface under these conditions, and recognizing this, the Air Ministry has, during the past two years, conducted experiments on a large scale to arrive at a surface in front of the aprons which will provide a remedy, and to meet the following conditions :—

(*a*) Hard enough to take the weight of machines.
(*b*) Soft enough to allow the tail-skids to bite.
(*c*) Capable of quick and easy repair when scored by the tail-skids.
(*d*) Reasonably cheap in first cost and in maintenance.
(*e*) Capable of carrying off flood water quickly and effectively.
(*f*) Freedom from dust, non-sticking and non-skidding.

Obviously a mere extension of the concrete or tarmac apron is not a solution of this problem : first, the expense would be enormous, and secondly, machines cannot safely land upon so hard a surface. The result would be that once more the traffic would concentrate on the softer surface in front of the extension, with similar results to those already described.

The experience of the Air Ministry is that there is no cut-and-dried solution of this problem, owing to the widely differing nature of the soil and sub-soil of various localities. Each case has to be investigated and dealt with on its merits, but experiments have definitely established that it is possible in many cases to obtain a firm and dust-

less surface by mixing oil of a suitable grade with the natural earth of the landing ground.

The first step in these experiments was to get the soil analysed. The Shell Mex Co., Ltd., were willing to undertake an analysis of any soil sent to them and by actual experiment in their laboratories to arrive at the most suitable grade of oil and the quantity of mixture per square yard for the particular ground it was desired to treat.

These laboratory experiments established that natural soil of a clayey nature incorporates extraordinarily well with road oils marketed by the Shell Mex Co., and large-scale experiments have been carried out at two aerodromes in accordance with the detailed specification given in Appendix A.

I would particularly draw attention to the clause in this specification dealing with the drainage of the treated area. Oiling the area, of course, makes it impervious to water, and it is essential to take such steps as will ensure storm water being quickly carried off the surface, and away in underground conduits from the adjacent grass surface. This can only be effected by means of French drains, cut after the oiling is completed, as described in the specification, the size and spacing thereof being dependent upon the natural fall of the ground. It is particularly important that an adequate French drain should be provided along the edge of the oiled surface which meets the grass surface of the landing ground.

Other points to emphasize are :—

(*a*) that thorough mixing of the oil and ground shall take place, otherwise pot holes and drag of surface will soon occur ;

(*b*) that the treatment is carried to a sufficient depth (depending upon the soil, but never less than 9 to 12 inches) to ensure tail-skids of machines not ploughing through the oiled surface ;

(*c*) that the correct grade of oil or bitumen emulsion is employed.

The cost of the above treatment, including drains, works out at about 2s. 4d. per yard super for an area of 12,000 square yards.

In a case where the surface consisted of stiff clay, a variation of the method outlined above was adopted. The whole site was excavated to a depth of 12 inches and burnt in heaps to hard ballast. After screening, the coarse material was returned to site, spread and rolled as foundation 9 inches thick, the remaining 3 inches of fine material being mixed with a bitumen emulsion ("Colas," in this case) spread and rolled to form a top impervious layer. The drainage was dealt with exactly as in the case of the oil and natural earth treatment, and the total cost was about 3s. 4d. per yard super for 12,000 square yards. Subsequent maintenance costs will be trifling.

A detailed specification of the burning and oiling process as applied to a particular case is given in Appendix B.

So much for the question of the drainage and maintenance of the surfaces of the concrete or tarmac aprons, and the surfaces of the landing ground immediately adjacent thereto. The oiled treatment promises to be eminently successful in those cases where the ground is of a clayey nature, and for areas where there is heavy and concentrated traffic and much taxi-ing. The ruts made by the skids can easily be rolled out and levelled, as they are more or less clean cuts, as opposed to the complete uprooting of the turf on a grass surface, and after the first oiling, maintenance is reduced to a minimum. On the other hand, any attempt to maintain a grass surface by returfing, or by ploughing up and sowing, means putting that section of the ground out of action for months, and in the end only provides a surface which is subject to precisely the same troublous conditions within a short period of use.

I am not claiming that the oiled treatment is universally necessary, or practicable. The Air Ministry has not succeeded in finding an emulsion which is entirely suitable for very light and sandy soil, but experiments in this direction are being proceeded with. We learn from an American publication called *Airports*, dated June, 1930, that a solid and compact ground has been obtained by mixing sandy soil with steam-distilled Mexican petroleum and asphalt of a suitable specification. Light soils, however, generally have good natural drainage, and even where grass cannot be successfully grown, they can often be kept in reasonable condition by watering and rolling. But oiling is probably the most practicable solution for dealing with that portion of the landing ground adjacent to the aprons in the heavier clayey type of ground I have previously described, and in America many hundreds of acres have been dealt with in a similar manner.

The method can be successfully applied to a light soil by importing a quantity of clayey material to the ground and incorporating it with the natural soil and oil. This, of course, adds to the cost, but it has been successfully done in America, and failing other means of making a satisfactory and dustless surface is worthy of consideration.

Area C. "Outfield."

Then as regards the remainder of the landing surface, which I will call the "outfield." As conditions are at present, the majority of landing grounds in this country are grass. Abroad, they often consist of more or less compact sandy wastes.

It is an axiom that the ground must be properly drained, but any scheme proposed must be thoroughly thought out before it is embarked upon. A contoured plan is a necessity. On it should be indicated all existing drains, and actual observations of the conditions of the ground and outfalls after heavy rainfall should be made and noted on the plan. The route and sizes of main lines of collecting

drains can then be decided upon. Where they cross the landing ground they must be of French drain type.

It is important to reduce pipe feeder drains to a minimum, and with this in view it is a good plan first to open up the main collector trenches, taking great care with the grading, and then to leave them open until sufficient heavy rains have fallen to allow of reliable data as to their effect on surrounding surfaces being obtained.

Ground which is disturbed by removing the natural turf and by digging trenches for the purpose of laying agricultural pipes, sometimes takes years to consolidate, and the landing ground must be closed to aircraft all the time operations are in hand and during a period for recovery afterwards. Mole drainage often provides a most useful and efficient substitute, in suitable soils, for the pipe system —it is cheap, and can be done over again after a period of years.

Before cutting up the ground for feeder drains, the engineer should, therefore, be quite satisfied they are necessary. Many sub-soils will carry the water away into main collector drains without pipe draining, especially when there is a good natural fall of the ground. Heavy ground such as clay requires much more intensive drainage than sandy, loamy soils.

Ridges and furrows must be levelled out. If good turf exists, and time permits, the best process is to strip off the turf, level out the ground, and replace the turf as soon as possible, agricultural pipe drainage being introduced if considered necessary.

Assuming the levelling and drainage problem to have been satisfactorily solved, there still remains the ever constant question of the maintenance of the " outfield," which requires far more attention than is popularly supposed. Where practicable, it is desirable to arrange for the ground to be let to a grazing tenant, as sheep keep grassland in good condition, but such tenant has to be under control, and it is necessary for the stock to be penned at intervals, especially if the ground is subject to night flying. In practically every case it is necessary to supplement the natural results of grazing by periodical application of artificial fertilizing agents, and harrowing and reseeding should be carried out when required, the whole object being to maintain the grass with a strong growth which will withstand the impact and skid effects of a high-speed aeroplane.

A petrol roller of a weight suited to the ground is a necessity and should be systematically and constantly used. Generally it will be found that a 2 to 2½-ton roller is quite heavy enough. Too heavy a roller is apt to destroy the under-drainage, damage grass roots, and may " pan " the surface. Cambridge rollers can often be used with great advantage to a grass surface. Other implements necessary are harrows, hay cutters, and a light motor tractor to draw them.

Agricultural implements of the description just mentioned are cheap and a good supply should be available, so that they can be

brought into immediate use as and when required. Many of the operations on an aerodrome can only be carried out when flying is not in progress, and may involve night work.

Particular attention is necessary along the lines of old hedges and ditches where settlement often occurs after filling in and piping.

Pot holes are easily formed and must be repaired before they become a danger to landing aircraft. Ridges and furrows have a tendency to re-appear, although some time they may have been rolled or otherwise levelled out.

All these, and many other similar conditions, need constant watchfulness to prevent deterioration of the ground. It is not an exaggeration to say that the life of a pilot is at stake when neglect takes place, to say nothing of the loss, which may amount to thousands of pounds, occasioned by damage to a machine.

LANDING GROUND RUNWAYS.

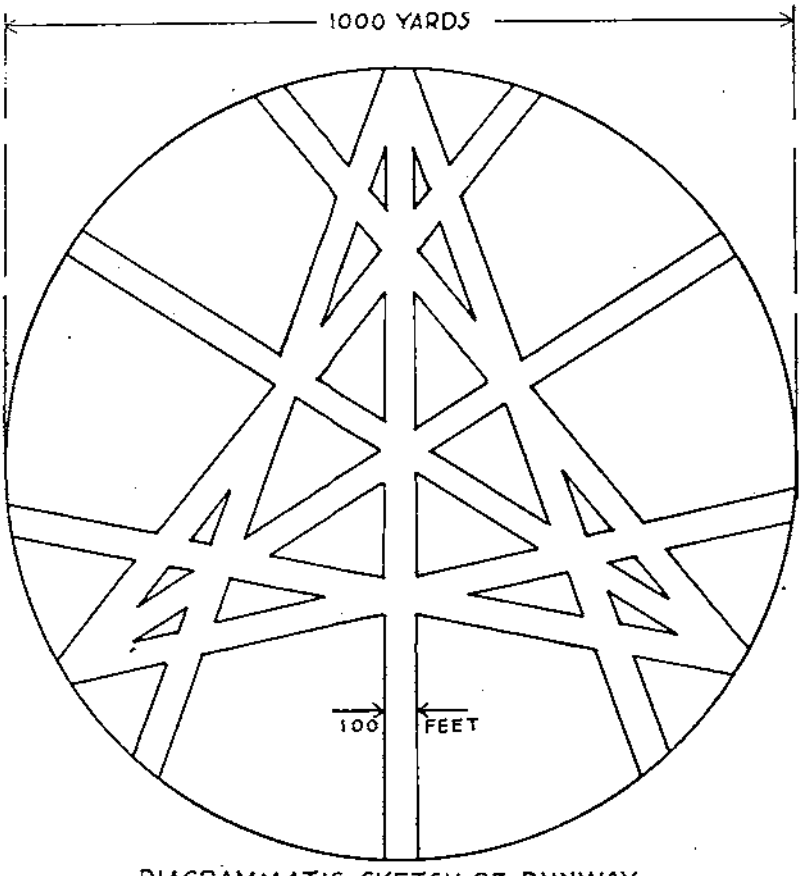
It may be necessary to fix on a site for a landing ground which is on marshy or soggy flat land, and instead of attempting to get the whole area into a fit condition for landing on, it is sometimes sufficient to concentrate on the formation of definite runways for the machines. Runways should be as long as possible and, in order to provide safe landing in all conditions of wind and weather, should box the compass in four or more directions. If necessary, the runways can be raised somewhat above the general level of the site. (Fig. 4.)

The runways may be of concrete or tarmac, or may consist of a consolidated oiled surface, built up on the lines previously described. There is at present considerable difference of opinion between both pilots and engineers as to the best type of surface for runways. Concrete or tarmac is expensive, and is generally considered to provide too hard a surface for fast landing machines, which rely upon a tail-skid for braking purposes, to pull up within a reasonable length. Turf of good, solid growth is, of course, an ideal runway surface where it can be grown and maintained in good condition—but there are many cases of badly drained sites, and of ground which is in other respects totally unsuited to the growth of good turf.

For the proposed runways, then, ruling out concrete or a similar hard surface, at any rate until machines are fitted with other means of braking than the use of a tail-skid, we are driven back to the oiled surface as previously described. Assuming a runway 50 yards wide, it should be slightly cambered with a rise of, say, three inches in the centre, to allow flood water to drain quickly to the sides, and along each side of the runway an adequate French drain should be laid.

In America, many of the landing grounds are provided with these runways, a typical layout of which is shown in Fig. 5.

It is quite possible that, as the intensity of use of aerodromes increases, the formation of special runways will be a general feature of landing grounds. In India, *e.g.*, there are hundreds of square miles of flat delta land subjected to periodical flooding, where the



DIAGRAMMATIC SKETCH OF RUNWAY ACROSS AERODROME.

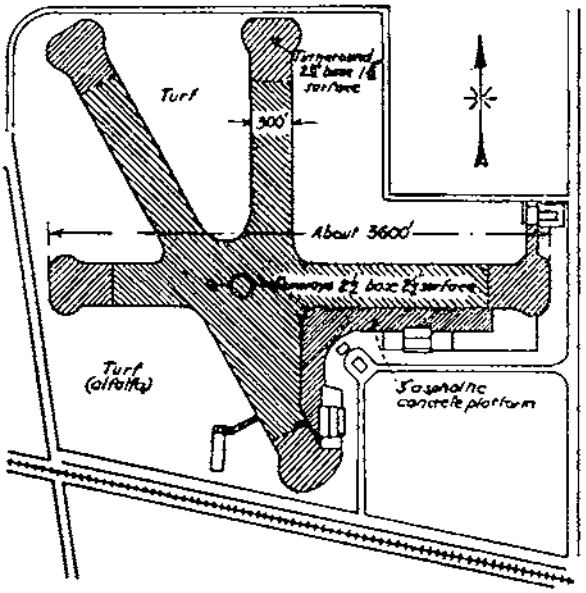
FIG. 4.

formation of raised runways would provide landing grounds at a considerably less cost than the alternative of raising the whole surface above normal flood level.

CONCLUSION.

Time has permitted of only a brief survey of the subject, but I have said enough, perhaps, to establish the fact that the care and maintenance of a landing ground is a matter of prime importance,

calling for considerable thought, zeal, commonsense and effort by those responsible. The point for all concerned to get well fixed in their minds is that the problem is of a specialist nature, and that the methods of agriculture (good enough for the maintenance of ordinary pasturage) have to be supplemented by special methods of maintenance to meet the extraordinary use to which the surface is subjected when the ground is used as an aerodrome.



LAYOUT OF RUNWAYS
AT
UNITED AIRPORT, BURBANK, CALIF.

FIG. 5.

APPENDIX "A."

LANDING GROUND—SPECIFICATION OF OIL TREATMENT.

First Operation—Oil Treatment.

1. Remove vegetable growth and cart and deposit where directed.

2. Break up soil to a depth not exceeding 6 in., and as small as possible, so as to ensure a grading of the soil to a degree that any lump will pass a 2-in. mesh in any direction.

For this purpose the "Simar Rototillar" or other similar machine is to be used.

3. After soil is broken up, as above described, the top 3 in. is to be shovelled aside in strips about 3 yards wide, and "Shelspra" added at

the rate of 1⅛ gallons per square yard to the bottom 3-in. layer of broken soil.

The "Shelspra" to be applied at a temperature of approximately 220°F., and the soil first turned over by hand, and then further thoroughly mixed with the oil by necessary use of the "Simar Rototillar" or other similar machine.

The bottom layer of soil mixed with oil is to be evened out and then to be thoroughly rolled with a 4-ton petrol roller.

4. The top 3 in. of soil over each strip 3 yards wide is then to be replaced, "Shelspra" applied as before described, at the rate of 1⅛ gallons per square yard, turned over by hand and then thoroughly mixed by the use of the machine before described, followed by distribution of the soil mixed with oil, so as to ensure a smooth and uniform surface to the natural gradients of the land. The surface then to be rolled to the extent required to ensure an even, smooth result.

5. "Shelspra" is a road oil, marketed by Shell Mex, Ltd., of Kingsway, and is a pure bitumen fluxed with a white oil to reduce its boiling point. It is to be applied hot at a temperature of about 220°F. as before described, and for this purpose the necessary boilers, etc., are to be provided by the contractor.

Second Operation—Under-Drainage.

6. The area described above to be oil-treated is to be drained after completion of the oiling process, to take storm water off oiled surface, as follows:—

(NOTE.—The area now to be treated is already drained with agricultural pipes, as shown on drawing. The existing subsidiary land drains are approximately 2 ft. below the existing surface, on the average.)

7. The new drains to carry water off oiled surface are to be formed at intervals of 50 ft. apart. To be inclined at an angle of 45° approximately to the front edge of the paved apron.

8. Excavate trenches to the necessary depths (average, 1 ft. 6 in.) and falls from front of apron to outside edge of oiled surface, but *in no case deeper* than the top of the existing land drain-pipes. The top 6 in. of material consisting of soil already oil-treated to be laid aside and afterwards carefully spread over surrounding oiled surface and rolled to make up any inequalities.

Provide and fill in to drain trenches up to within 6 in. of surface level hard broken brick or stone to pass a 2-in. mesh and to be held by a 1½-in. mesh.

Provide and fill in over last to drain trenches to a depth of 3 in. with hard broken brick or stone, as before described, but to pass a 1½-in. mesh and to be held by a 1-in. mesh.

The remaining 3 in. to bring drain trenches up to level of oiled surface is to consist of selected fine soil, not clay, filled in and well rolled on top of the hard, dry filling.

Great care is to be taken in order to ensure porosity, that *no oiled soil* is filled in over the drain trenches.

APPENDIX "B."

LANDING GROUND—SPECIFICATION OF BURNED CLAY AND OIL TREATMENT.

First Operation—Clay Burning.

1. Strip off the vegetation over the area indicated, load up and cart and deposit in suitable heaps in approved positions for use in subsequent clay burning operations.

Excavate over area indicated to a total depth of 12 in. below existing surface and load up, cart and deposit in heaps, in approved positions for burning.

2. The clay to be burned to a degree *greater* than the standard usually adopted for "agricultural" purposes and equal to the standard normally used when calcination is required to adapt the burned clay for use as ballast, as aggregate in concrete, etc.

To be burned in heaps of suitable size, and the work to be carried out by skilled clay-burners.

Approximately the process should be as follows :—

Start fire with top spit removed and dried, supplemented by sufficient dry brushwood. Cover over with a layer of clay and add fine coal, scattered over heaps in thin layers. As the clay is burned, more clay to be laid on fire, coal added and the processes repeated.

Care is to be taken not to allow the fire to burn out through the external surface of the heap, without applying fresh clay and adding the necessary fine coal.

The burned ballast is then to be screened against a screen of $\frac{1}{2}$-in. mesh, and the coarser and finer ballast to be stored in separate heaps for replacement as described hereafter.

3. The coarser ballast is to be replaced over the excavated area, spread and levelled and well rolled and consolidated with a 4-ton petrol roller to a finished depth of 9 in.

4. The finer ballast is then to be thoroughly incorporated (by turning over the requisite number of times) with "Colas" bitumen emulsion, or similar preparation, diluted with an equal quantity of water at the rate of $1\frac{3}{4}$ gallons per square yard, and replaced over the whole area in one 3-in. layer.

This layer to be spread and levelled and well rolled and the finished surface to be left smooth and even and at the same level as surrounding areas of ground undisturbed.

The "Colas" bitumen emulsion or other similar preparation, described above, can be emulsified in water for *cold* application.

THE COMBINED DISPLAY, ROYAL TOURNAMENT, 1930.

By Bt. Lieut.-Colonel N. T. Fitzpatrick, D.S.O., M.C., *p.s.c.*, R.E.

The " combined display " at this year's Royal Tournament proved a novel item in the programme. As it was also a novelty in the way of an experience, these notes about the display in particular and the Tournament in general are written in the hope that they will interest those concerned in similar undertakings in the future.

The origin of the combined display was most fortuitous. A biggish parade ground demonstration, given by the 17th Field Company, R.E., to O.T.C. contingents, in August, 1929, proved of such surprising interest, that, with a light heart and without any knowledge either of Olympia or Tournaments, the venturesome suggestion was made that something of the sort might be put on at the Royal Tournament of 1930.

The suggestion found favour, we were asked to send along a cockshy of what it was thought could be done, and so, still without any " producer knowledge " either in front of or behind the scenes in London, we got busy with a plot. We remembered that the length of the tan in the arena was some four times its width, and that the dimension of the latter was about that of a cricket pitch. We also took it that the whole turn should last fifteen minutes at the most and we cast about for something which would portray, if possible, a real life affair, with a connected story running through it and the maximum amount of snap in execution.

The net result of a short deliberation on the matter was the conception that the turn should be a river crossing and a plot was worked out showing how it was proposed to make a " river " with its " banks," " throw " three bridges across, " throw " real troops over and " throw " the whole party in and out of the arena in fifteen minutes.

The cockshy was accordingly written up on these lines. The whole plot, on a sheet-and-a-quarter of foolscap, went duly forward, through the Divisional Commander (who gave it his blessing, together with " Lightening, London," as the Company's telegraphic address) and thence onwards and out of our minds for many months —till suddenly, in January, 1930, we heard that the plot in its original form was " approved."

This was more than we had really bargained for. We imagined that, even were our scheme ever approved, it would have been returned with all manner of comments as to what was and what was not considered practicable, but the only instruction we received was that the whole turn should on no account take more than fifteen minutes. How it was all to be done was entirely the " producer's " affair, and it was left to us to discover the means of giving tan the buoyancy of water and turn the cockshy into a practical proposition.

We got busy, taking it from the outset that the plot in its original form would somehow prove practicable, and the following plan of operations was sketched out :—

Experiment forthwith and decide as early as possible on the means by which the Kapok Assault Bridge, the 30-cwt. raft, and the Light Box Girder, could be " thrown " (as realistically as possible) across 40 feet of camouflaged " wet gap " laid on a dry arena. The whole to be capable of being made and dismantled within the allotted time. Ruling factors: reality, pace, simplicity. Maximum Sappers available, 80.

Complete experiments and order all gear required by 1st April.

Have all gear at hand by 1st May.

Rehearse and complete the technical side of the operations by 12th May.

Rehearse at Bulford as a combined force with R.A., Light Tanks and Infantry, 13th to 24th May.

To London, 25th May.

Rehearse Olympia, 26th and 27th May.

Opening show, 28th May.

The first bridge to be tackled was the Kapok Assault of seven bays.

To maintain the semblance of reality it was essential that the normal equipment should be used and we had to devise a means by which the complete length of bridge could be launched and delaunched in one motion and as it would be handled in real life.

After trying out various methods of acquiring " buoyancy," simplicity personified won the day. The bottom of each float was armoured with a sheet of three-ply with two hard-wood guide buttons attached to the under side; and across the camouflage river was laid, as part of the scenery, a slide way of two wooden rails—upper surface planed and polished. These simple fitments successfully eliminated the " μ " of tan and the whole bridge became capable of being launched and delaunched in a most realistic manner, *vide* Photo No. I.

To save arena time, it was decided that the bridge would have to

enter the arena already assembled for launching, and that the portability of this bridge would be demonstrated by dismantling and loading aboard a light six-wheeler on the " far bank."

Having tried out the whole operation from the drill point of view, the whole issue was sent off early in April to our friends the Dorsets at Portland, where they rehearsed on their own and became word-perfect in Kapok work before joining up at Bulford for the combined rehearsals.

The next affair to be dealt with was the light raft for ferrying over the close-support vehicles, *i.e.*, Carden-Loyds, weighing 30 cwt.

Here the original plot took up for a home-made type of Kapok raft, but on talking things over with the R.E. Board, the suggestion was made that our raft should be replaced by the new Folding-Boat gear.

The suggestion was immediately followed up and after visits to and help from Christchurch and Mr. Straussler, the designer of the Folding Boats, we decided that this project was feasible, provided we could obtain the very latest pattern of boats with quick-spring-folding arrangements, and provided also that we could have specially light superstructure built up for the show. The question of transport also called for special consideration, since the plot necessitated the whole of the raft equipment both entering and leaving the arena on M.T.; these 21-feet-long boats entailed in consequence the design of some special form of transport, which would lend itself to particularly quick loading and unloading in the arena. The manner in which the boats were to be " launched " and " floated " on tan was, however, allowed to remain a mystery, until trials solved the preliminary unknown as to how these boats would behave when carrying a light tank on dry land instead of water.

The new boats were obtained, the special superstructure was designed by the Company metaphysicist, and built up for us in record time by Mr. Straussler, the day for the folding boats' novel experience duly arrived, and the raft was assembled on a football field.

Up crawled the first light tank and the raft rocked about in a realistic manner, but all went well, till the driver, who had been so impressed upon to creep across at minimum speed during the trial run, stalled his engine and stopped dead at the critical position of the middle of the centre span; then, in an attempt to regain momentum in the most delicate manner possible, the driver suddenly made his vehicle execute a series of most astounding pig-jumps without any forward movement, all in the middle of the centre span. These astonishing evolutions produced impacts far and away above that allowed by the metaphysicist, and the road-bearers

carried out in rapid succession a series of deflections that must have surprised the whole hierarchy of prime Oregon. However, everything held, a series of runs was then successfully carried out in low-reduction gear and the behaviour of both boats and superstructure showed that the scheme was practicable as regards loads.

Next came the question of transport for the boats. Each folding boat crew numbered eight men, who had to enter the arena seated in their personnel light six-wheelers, and we had to devise the most compact means of taking boats and crews up to the river on one side and away on the far side. Various schemes of slinging the equipment on to the personnel vehicles were tried out, but had to be rejected, the use of a Carrimore had also to be discarded owing to loading which would not have been handy enough for arena purposes, and so it became necessary to design a special trailer for each boat. In this matter, as with many another, our friends in the Ordnance Depot at Tidworth proved invaluable, and from a sketch design and specification they produced a brand-new trailer in a fortnight, followed this up with a second a week later, and the whole outfit worked admirably.

The last problem with the folding boats was their "flotation." Here, brute force, strip parquet, lino, slideways, etc., all proved of no avail, and we eventually hit on the plan of launching them out on rollers. These were put together in frames the width of the "wet" gap; over the rollers one was able to push out and haul in the boats in quite a realistic manner, and the boats proved themselves truly noble in the way they stood up to taking their loads whilst on the roller bearings.

Photos II and III show how the folding-boat gear worked.

The final bridge to be tackled was the Light Box Girder. As in the case of the Kapok Assault Bridge, we decided, on account of time, that each girder would have to be run in made up complete with launching noses (2¼ tons each girder) so that it could be launched straight over and leave only the handling of the launching noses, decking and riband work to be done in the arena. Considerations of time and space also prevented the girder transport (one medium six-wheeler per girder) being used during dismantling, and owing to the 90 feet of length of the assembled girder it was impossible to send them out of the arena with the rest of the combined force *via* the Addison Road Entrance. We decided, in consequence, that the place of assembly for the girders would have to be taken as being outside the arena at the Blythe Road end, that the girders would have to return always to a "park" at that end and that this matter should be explained in the programme.

The necessary means of running the girders up from their "park" to the arena river was happily to hand in the company in the shape

of two axles of the Reavell compressor. The standard launching rollers were raised, so that the girders, after travelling in on the compressor axles, could be slid off on to the rollers, and the width of the river was so adjusted that with three sections of girder—48 feet—the weight could be taken by a party on the forward launching nose before the front of the girder bit into the tan and camouflage.

All this turned out to work satisfactorily (see Photo No. IV), and all we lacked was a complete new set of launching noses, for those sent up with the girder had been already "tested to destruction" and made quite unserviceable for Olympia. Five new noses were accordingly ordered early in March, from Messrs. Boulton & Paul, for delivery by 1st April, and thus the purely technical side of the turn was more or less finished.

There remained on the construction side only the provision of a "river" and "banks" which could be brought in and set up in the arena with due accuracy as regards the positioning of gaps, rollers and slides. The whole of this scenery had to be capable of being set up in one minute and dismantled in half a minute with one carry of 40 men.

Here again, Ordnance, Tidworth, were invaluable. Nothing seemed too much trouble for them, and they undertook to do any stitching and painting which proved beyond the resources of a company's shops.

The two 80 feet by 12 feet "banks" were made up out of old marquee canvas walls, sewn together and mounted on four panels per bank. Each panel was kept down to a two-man carry, and the canvas on each set of four panels was arranged to open out into the 80 feet by 12 feet "bank" with three "gaps," one for each bridge.

The "river" was the bane of our lives. Here we required a camouflage stream 80 feet by 40 feet. This obviously had to go down in two halves and required the lightest possible hardy material for the job. After thinking of various materials, but having had to reject them all for one reason or another, we eventually decided on balloon fabric. This substance we hoped to find just right in weight and hardiness; also we pictured it just the right colour, a sky-blue which would only need "flecking" with white to give the exact contrast we had in mind of bright water between the banks camouflaged up green, yellow and brown.

What with one thing and another, however, we did not "arrive" at this fabric idea till just before Easter, by when time was getting on and there remained only a few days in which to obtain a balloon before Easter. Telephonic application being made to the R.A.F. it was found, as was almost to be expected, that the R.A.F. were

hardly accustomed to supplying balloons to individual members of H.M. Forces. One and all, however, were most helpful in quoting the particular superior authority from whom they generally obtained balloons and so the telephone request—"Could you possibly give me a spare balloon"—went on and on up the aerial tree. Finally, by our importunity in 'phoning an Air Marshal at his Sunday breakfast, combined with the A.M.'s truly wonderful equipoise under such a trial, we were at last able to send and obtain delivery just before Easter.

Having landed our balloon in triumph, a chance enquiry at Olympia about its dissection resulted in us being told that balloon fabric was the *bête noire* of the Olympia fire brigade, and that neither they nor various other bodies connected with Olympia would let us come near Olympia, the Tournament, or anything else connected with the coming party, if we had a vestige of this fabric about us.

The fat was now properly in the fire, for there we were within a few days of featuring in this river crossing episode but without any semblance of our "river."

A visit had to be paid post haste to the heart of the City, where we learnt of a place which did supply materials for non-combustible rivers, and down the material was brought by the next returning passenger train. Immediately on arrival, all the sempstresses in the Ordnance got busy cutting and sewing it up, and then on went the painters to work to an overtime limited only by the short summer nights of May.

Our special train was due to leave Bulford on a Sunday morning; by the Thursday afternoon, one half of our river had been finally painted and we were beginning to breathe freely again when down came a thunderstorm, complete with a cloud-burst, which nearly washed the Ordnance Park away and completely washed our half-river away. We eventually took delivery of our "stream" a few hours before the train left and our first trial was at Olympia—however, all was well on the day and the photographs show how the scenery worked.

So much for the construction, and now as regards rehearsals. The powers-that-be were extremely good and put the whole combined force—Davey's Section of 7th Light Battery—Dean's 2 Sub-sections Light Tanks of 5th Bn. R.T.C. and Spencer and Wood, with their 2 platoons of Dorsets (some 75 strong and probably the strongest platoons in the Kingdom)—under me from 13th May, and we rehearsed, worked and played together for the fortnight before coming up.

Owing to the way in which the moves of all components of the combined force had to dovetail in with one another, rehearsals had

to be carried out on a full-size replica of marshalling area, arena and exit. The exact site was providentially close at hand in the lines of the 26th Field Brigade, R.A., who were extremely kind in lending it all to us. As a result, we were able to coach every man to become *au fait* with every detail as regards the real site, and also to tell the Tournament Committee exactly what the marshalling of the unusual combined force entailed, so that the special arrangements necessary for stables and our parking could be made beforehand.

As regards the actual rehearsals. The various movements were gradually worked up together; first, we went through the Sapper moves and obtained a general knowledge of what latitude was available, then the parts of the Gunners and Tanks were arranged for and, finally, the working of the Infantry was dovetailed in. After concentrating on the space problem during the first week, we concentrated on time during the second, and eventually we left Bulford knowing, as far as one could, that we would be able to do the show in fourteen minutes.

The turn being an all-arms one, both in spirit and in fact, it was essential for the force to acquire an *esprit de corps* as a force before going up to London, and this we got by games at Bulford. Inter-unit football, cricket, sports, etc., ending with a concert, did the trick, and the whole army went up to London on the 25th of May, right on its toes and all together.

Rehearsals at Olympia led to extraordinarily few changes; we found that the making of any, even the most minute, was impracticable without a special rehearsal of that particular point, whilst our arena allotment only allowed time for a couple of runs for our scene shifters and two full-dress rehearsals. In consequence, we opened up without any change, and the programme description of the turn is attached in the Appendix.

As regards the actual performances. During the first few shows there was a certain amount of stage fright, but after a very short time this wore off and then the only effect of the big audience was to make each man do his very best.

To commence with, the Committee insisted on us being the last turn in each programme. Our work-a-day affair, however, was not the best ending for a programme which was full of shows of pomp and glamour, but even when we were last, it was remarkable that this turn held a crowd on the point of dispersal as well as it did. After a few performances, our display was brought on in the body of the programme and all went very well; people were struck, as "A.A." said in *Punch*, how the forcing of a river passage by an army could be accomplished in less time than "A.A." himself could normally force his individual passage across Piccadilly Circus.

Photos V, VI, VII and VIII show respectively the display when

starting, with bridges nearly ready, traffic going over, and towards the end of the turn.

Throughout the time, one was somewhat on tenterhooks as to whether everything would work out exactly right, for although the handling of all the gear came to appear pretty simple, there were, as a matter of fact, many small things which might somehow have gone adrift and upset matters. We were, however, very fortunate, detailed inspections after each performance took up for the stitch in time, and, thanks to the way everyone did his utmost, we carried out our 33 performances and did the show before a total audience of a quarter of a million with only one hitch, which was caused by incorrect placing of rollers.

The numbers in the combined force came to 8 officers, 230 men, 21 mules, 2 guns, 6 light tanks and 8 lorries.

As regards expense: after disposing of gear on conclusion, the turn cost the Tournament about £300 for special equipment and scenery, the latter remaining in London as Tournament property.

Our conclusions about putting on a turn at Olympia are many, but the following seem most worthy of note.

About the show to be given at the Tournament. It is strongly recommended that any turn should be initiated and directed by someone who has had previous experience of the Tournament as an actual performer; there are so many facts and factors which can only be appreciated by those who have been "on," and without this knowledge a "producer" is at a considerable disadvantage in not knowing exactly what can be staged and what will go down.

The circumstances are peculiar and the situation is a fairly big one. The primary object of the Tournament is to make money for Service charities, the majority of the audience is non-military and will only pay to go and see what it likes. There are certain types of displays that the public and Press know they like, *i.e.*, displays with pomp and ceremony, such as pageants and musical rides, brisk turns with an element of danger, such as naval field gun displays, artillery drives and the rope-climbers, items which demonstrate great precision of movement such as arms drill and P.T., whilst any affair of at all a humorous nature is immensely popular. But one would be well advised to be careful in putting on anything too technical, instructive and work-a-day, which is devoid of glamour and pace. The small section of the daily audience of 16,000 who are militarily connected may read a programme description of anything new, but to the bulk of every audience each turn must be in itself obviously bright and arresting. There were no loud-speakers at the Tournament, but if these are introduced they would help considerably with shows like ours. Those who have been through a Tournament could make a pretty shrewd guess as to what reception a proposed turn would meet

with, but without that experience one could hardly make an accurate forecast.

Again, in framing a turn, both audience and men have to be considered in connection with applause. The former cannot be expected to applaud during each item unless presented with obvious "curtains," the men naturally get downhearted unless they receive their due meed of praise, and last, but most important, is the fact that, in the genuine interests of the arm concerned with any item, one must to a certain extent play to the gallery, which at Olympia is a big one. The only stage effect we worried about during rehearsals was our instruction to be in and out in fifteen minutes: the only "curtain" that ensued was an empty arena. This naturally did not give anyone a chance and one might have been tempted to try to alter the display in various respects. The introduction, however, of any alterations, no matter how small, cannot be risked without full-dress rehearsals, and as the opportunities for these at Olympia are so few, a turn has really to stand in the manner rehearsed before going up to London. We were, as a matter of fact, able to work up a few curtains, such as halting all traffic on the near bank to commence the crossing all together, but with previous experience of Olympia, we probably would have staged the show differently.

In arranging the staging of a turn, the length and width of the arena, together with the way the seats are arranged right round the arena, also deserve accurate appreciation. The arena is some 300 feet long by 80 feet wide, and the top row of gallery seats extends some 50 or 60 feet outside the whole of the actual arena perimeter. Owing to the distances thus introduced and the angles of vision, one should avoid doing anything within about 15 feet of the arena surround and the best type of display is the one which continuously fills the whole centre of the arena.

The correct selection of music also plays a far more important part than one imagines and requires very careful consideration. The same remarks apply to the positioning and details as regards stance of every man, and as for timing, the success of any turn lies largely in its amount of "go," and this depends on full use being made, not merely of every minute, but of every fraction of each second.

Lastly, and as regards matters off the stage, it should be borne in mind that the interest taken in equipment by the public, who walk round behind the scenes before and after the programme, makes it very well worth while to arrange park or stables in a really attractive manner with bunting, etc.; it may cost a bit but it is well worth while.

In conclusion, one feels bound to make some remarks in general about the Royal Tournament. It is an excellent opportunity to fly the flag for Corps and Service, and at the same time all taking part

derive a wealth of good from their labours. Getting up a show, particularly a technical one, develops ingenuity and determination, appearance in public develops confidence, and all who go up to Olympia meet other arms at close quarters, make many friends and learn much of skill-at-arms in all branches of the Service. The whole affair was run in an extraordinarily happy manner under the honorary secretaryship of Brig.-General Sir Wallis King, a host in himself, and I am sure that it is well worth while for each arm of the Service to do its utmost to put up a show at the Tournament every year.

APPENDIX.

COMBINED DISPLAY BY ARTILLERY, ENGINEERS, INFANTRY AND TANK CORPS.

The Passage of a River.

This Display shows how troops and the vehicles which must accompany them can rapidly be provided with means of crossing a water obstacle. The leading Infantry cross by means of an assault bridge, which they carry up and launch themselves. The first bridge to carry vehicles is provided by a folding boat, which is brought up, launched and put in position by the Engineers. Another bridge is necessary to take the heavier vehicles, such as Field Artillery and lorries. This is a girder bridge, which is brought up and put into position by the Engineers. The units taking part in the Display are the following : one section, 7th Light Battery, 2nd Light Brigade, R.A. ; 17th Field Company, Royal Engineers ; two sub-sections, Light Tank Company, 5th Bn. Royal Tank Corps ; two platoons, " A " Company, 2nd Bn. The Dorsetshire Regiment. The detail of the actions is as follows :—

The arena is set with a river, about 40 ft. wide, across the centre ; a small patrol of the enemy is watching this obstacle from the far bank. Armoured fighting vehicles approach and open fire. They quickly force the enemy patrol to withdraw, then move up to the river, which they find they cannot cross. The leading Infantry follow close behind the armoured fighting vehicles, and are also brought to a standstill by the river. Reconnaissance for bridging operations takes place at once. Meanwhile, two light Artillery howitzers approach ; one comes into action at once to cover the crossing, the other is off-loaded close to the river and the mules are taken back to join the rest of the pack animals.

The Infantry then carry forward and launch the assault bridge. As soon as it is over the Infantry double across to form a bridgehead to cover the further bridging operations. The assault bridge remains across the river, the only means of communication with the forward troops. The Engineers now bring up the materials for the folding boat bridge

Photo I.—Launching Infantry Assault Bridge.

Photo II.—Unloading Folding Boat Bridge.

Combined display, Royal Tournament

Photo III.—Folding Boat Bridge.

Photo IV.—Light Box Girder Bridge, and in background the Reavell Compressor Axle fitted with a Cradle.

Rehearsals at Bulford Camp

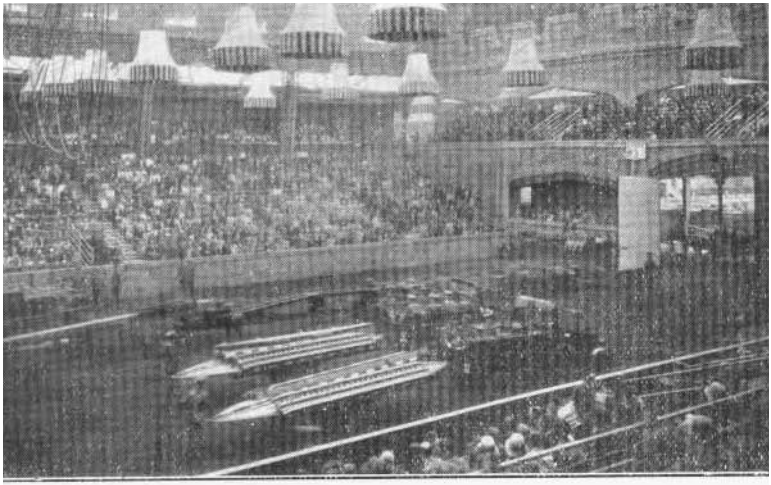


Photo V.—Entering the Arena.

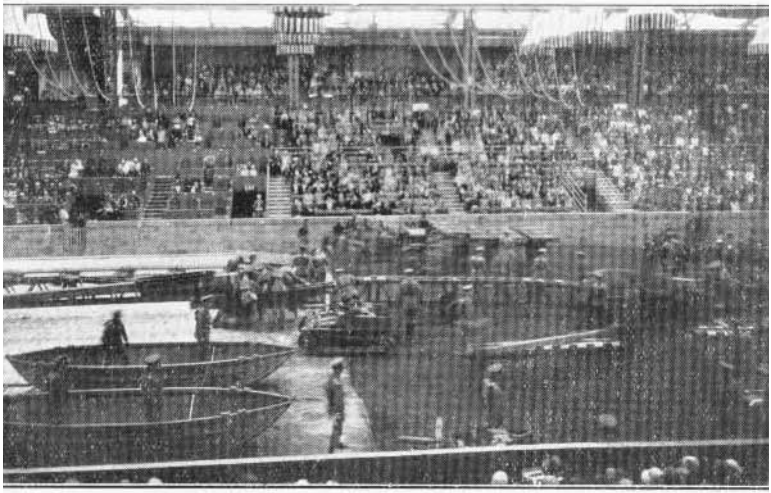


Photo VI.—Preparing to Cross.

Performances at Olympia

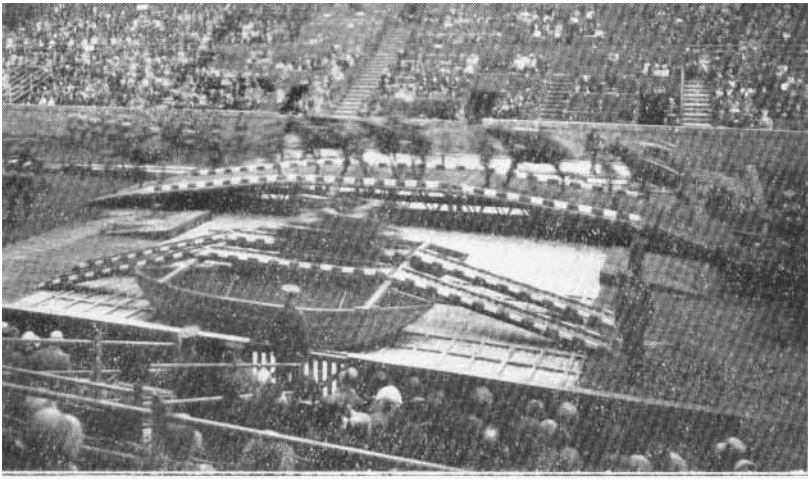


Photo VII.—Light Artillery and Light Tanks Crossing.

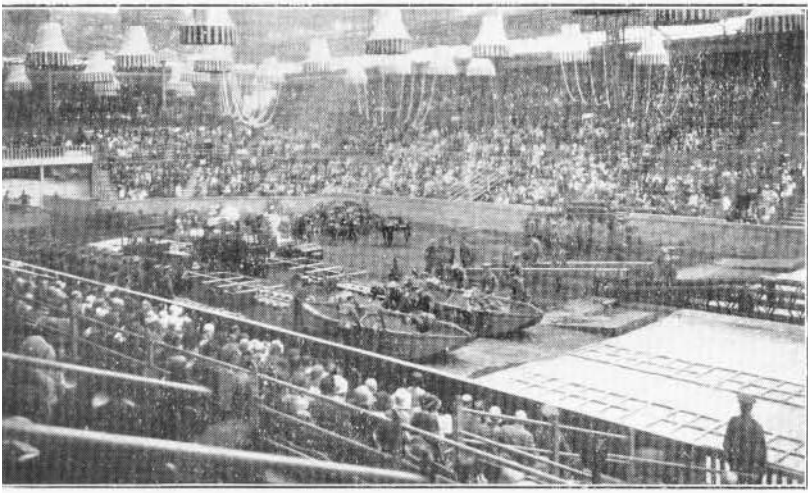


Photo VIII.—Dismantling after Crossing.

Performances at Olympia

and launch and build the bridge. As soon as it is completed, the armoured fighting vehicles cross. These are closely followed by the howitzer, which is man-handled over to come into action on the further side.

Meanwhile, the Engineers have been assembling a heavier girder bridge which is needed to take over the rest of the Field Artillery and other heavy vehicles.

The advance continues; the Infantry load up the assault bridge; the Artillery move forward; the Engineers take out the folding boat bridge and load it up on the farther bank. The troops advance out of the arena, Infantry and armoured fighting vehicles leading, followed by the Royal Artillery and Royal Engineers.

Owing to the circumstances in which the Display is produced, there is not time nor space to show the lorries which carry the Box Girder Bridge, which has consequently to be taken in and out of the arena on trolleys.

The impossibility of having water in the arena makes it necessary to place slide-ways on the ground in order that the floating bridges may be launched in the same way in which they would be put into a real river.

The following are the approximate times taken to complete the stages of the Display :—

Assault Bridge is over at the end of the 1st minute.

Folding Boat Bridge ready for Armoured Fighting Vehicles at the end of the 4th minute.

Box Girder Bridge ready for traffic of 12-ton load at the end of the 6th minute.

Assault Bridge dismantled at the end of the 8th minute.

Folding Boat Bridge dismantled at the end of the 9th minute.

Box Girder Bridge dismantled at the end of the 13th minute.

RESTORATION OF WHITBY WATER SUPPLY.

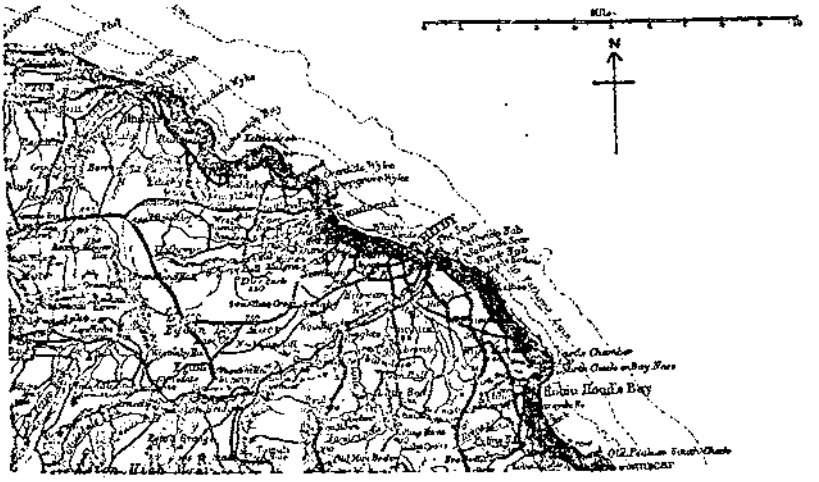
By LIEUTENANT C. E. MONTAGU, R.E.

IT has been suggested that the following brief account of the recent breakdown of the Whitby water supply and the part played in its restoration by a detachment of the 55th Field Company, R.E., may be of general interest, as the time factor and working conditions more closely resemble those met with on active service than those usually encountered in peace training.

GENERAL SITUATION.

Sleights is a small village situated four miles up the Esk Valley above Whitby. The village is divided into two portions by the River Esk, which was spanned by a masonry road bridge.

This bridge carried the Whitby water supply mains, which consisted of an old 7-in. C.I. pipe laid in 1864, and a newer 8-in. C.I. pipe dating from 1924. These pipes connected the high-level reservoir at Randy Mere to the local Sneaton Castle reservoir ; the head of water at Sleights being about 450 ft. The Randy Mere reservoir is 6 miles up the valley above Sleights on Egton High Moor, and is marked "R" on the map. It holds 13,000,000 gallons, while the Sneaton Tanks are 3 miles below the village and have a capacity of only 750,000 gallons. The latter figure represents about two days' supply for Whitby during the holiday season.



THE FLOODS, JULY 20TH TO 23RD. (*Sunday to Wednesday.*)

From the afternoon of Sunday, July 20th, heavy rain fell almost continuously over Yorkshire until Wednesday morning. This was particularly severe in the constricted valley of the Esk (over 11 in. being recorded) and the river level rose in places to 24 ft. above normal. Amongst much other damage to property, the Egton and Sleights Road bridges were swept away and several railway bridges between Grosmont and Sleights were damaged. It was remarkable that only one life was lost from drowning, when it is remembered that the water was in places 8 to 10 ft. above road level and cottage floors.

Sleights bridge itself gave way in the early hours of Wednesday, July 23rd.

REPAIRS, JULY 23RD TO 25TH. (*Wednesday to Friday.*)

On hearing of this failure, the Whitby Waterworks Department engaged a Newcastle contractor to effect temporary repairs. This contractor was engaged in work on the Whitby sea front and was thus able to get his labour on the site at once. Owing to the height of the floods and lack of material, progress was slow, however, and it was not until Thursday night that a light structure was got across. The old masonry piers had fallen, leaving gaps of 51 ft., 47 ft. and 33 ft. to be spanned. The fallen masonry was concreted up to take light trestles, upon which were supported three spars per bay. The spars were cut close to the site, averaging seven inches in diameter, and were very whippy. They were launched on a two-inch S.W. cable, which had been got across with lines thrown by the local life-saving apparatus. A trestle in the longest gap was also placed.

Meanwhile, the water company were getting seriously disturbed. Their daily consumption had not been appreciably cut down by appeals for economy, and by Friday morning the Sneaton reservoir was empty.

They had wired on Thursday for their consulting engineer from London, and had telephoned to the Chief Engineer, Northern Command, to ask if any R.E. assistance could be given. As a result, Mr. Hawksley, of Messrs. T. C. Hawksley, Westminster, arrived at 9 a.m. on Friday, and two officers from Catterick visited the site at 11 a.m.

Efforts to obtain suitable piping for connection across the gap had, up to now, produced nothing, so it was most fortunate that a stock of 9-in. Victaulic pipe was lying at the Pumping Station near Catterick Camp. This was to have been used for extension work in the following week, but permission to borrow it was obtained from the C.R.E. by telephone, and seven 18-ft. lengths arrived at Sleights on Friday evening.

During the afternoon, War Office approval was obtained for the 55th Field Company to give any assistance possible, and after returning to Barracks at 4.30 p.m. after a long day, a party of one officer and 18 other ranks was collected and dispatched by private bus at 8 p.m. They arrived about midnight and were billeted in the local Institute, close to the bridge site. It was arranged that they should commence work at 6.30 a.m. on Saturday morning, when the night shift went off duty.

Meanwhile, some 4-in. steel piping had been obtained from Middlesbrough, and by 1 a.m. on Saturday morning had been got across the spar bridge and connected up to the 7-in. main. The night work was carried on with the aid of five large acetylene flares which were most effective. This 4-in. pipe, however, could not alone deal with the demand, and until Saturday afternoon was only capable of filling the main pipes and getting a little head into the Sneaton Castle reservoir.

Sanitation was at a standstill; thousands of visitors were cancelling their holiday bookings and the Whitby Waterworks telephone line (and operator) was overheating!

R.E. WORK, JULY 26TH TO 27TH. (*Saturday to Sunday.*)

The Sappers started work at 6.30 a.m. on Saturday and were fully occupied until 9 p.m., meals being taken by shifts.

Some 40-ft. lengths of 12 in. x 6 in. timber had been obtained during the night and these had to be substituted for the light spars, as the latter had too much whip to deal with the 9-in. pipe. The work of substitution without starting the leaded reducing joints of the small main was tricky, and in the end it was only found possible to change over two longitudinals per bay. Strengthening of trestles with additional legs and bracing was carried out and concreting-up of pier bases was commenced to prevent scouring or settlement.

The work was visited by C.R.E. during the morning, and a second officer with 12 other ranks were sent over from Catterick, arriving in time to take on the night shift from 9 p.m. to 5 a.m. Sunday morning, in conjunction with six of the contractor's gang.

During this period, the general strengthening of the bridge continued and a portion of the 9-in. pipe was laid. This was supported on 9 in. x 3 in. timber nailed across the road bearers at 3-ft. centres. Owing to the original pipe alignment and position of the fallen piers, the line of the 9-in. pipe was far from central on the bridge, while the 4-in. pipe described perforce a truly wonderful curve.

It was water, however, not symmetry, that Whitby wanted, and by mid-day Sunday the 9-in. pipe was running full. By cutting off the rim of the Victaulic pipe, it was just possible to make the connection to the old main with 8-in. collars.

From this point onwards, the time factor ceased to be of much importance and all civilian labour was withdrawn, while a normal 8-hour day was worked by the R.E. detachment.

Precautionary Measures.

Once the 9-in. pipe was through, the problem arose as to how to keep it there.

Although the river had now returned to its normal level, it was obvious that if any serious rise should again occur, the temporary structure could not hold.

To attach the pipe to a suspended cable seemed the best solution, and work on this was put in hand at once. It was not considered advisable to take the weight off the bridge on to the cable, owing to the likelihood of starting end joints when water was urgently needed. It was, therefore, attached with slings adjusted to give the correct curve. The joints between 18-ft. lengths give about three inches' play, so it was anticipated that only the end joints would need re-making if the bridge went.

The weight of the pipe line came to approximately 3 tons, and the necessary 3-in. S.W. rope was obtained from Middlesbrough on Monday, July 28th. Two-inch slings were obtained locally. Cable piers, 15 ft. high with 12 in. x 6 in. legs, were erected, and the cable taken to anchorages consisting of double 12 in. x 6 in. timber, 6 ft. long, buried 4 ft. and concreted-in. The siting of these to avoid pipes and other obstacles required some care.

The only possible position on the north bank was within 18 in. of a railway siding. After waiting an hour for permission from a railway engineer who never turned up, sleepers were cut and excavations started. A load of concrete aggregate was dumped on the line to settle finally any question of traffic before the anchorage was complete.

About two feet down, a telephone cable carrying 25 lines materialized —plumb on the line of the suspended cable! Fortunately, it was possible to draw through about 4 ft. of slack and divert the lines round the edge of the excavation, where they were boxed in to prevent damage.

General work on strengthening the bridge and masonry piers proceeded simultaneously with the cable work and the job was completed on the afternoon of Wednesday, 30th.

Two-inch bull-dog clips for sling attachments were not immediately available and the work of obtaining these and substituting them for inferior clips and half-hitch attachments was left to be done later locally.

The interest in the work displayed by the general public was somewhat embarrassing at times, and police were finally detailed to keep the site clear.

NOTES.

Liaison.

It was anticipated that some difficulty as to control would be experienced, as there were on the site (*a*) a civilian contractor and his labour, (*b*) Waterworks Department labour, (*c*) Mr. Hawksley, Consulting Engineer to Waterworks, from London, (*d*) R.E. Detachment.

Actually, no trouble was encountered. The contractor merely became a supplier of material and stores, while his labour worked under Mr. Hawksley with the Waterworks men. The R.E. Detachment remained under their own officers, who assisted Mr. Hawksley whenever possible. This gentleman worked like a Trojan and, except for meals, was actually on the site continuously from 9 a.m., Friday, July 25th, to 12 a.m., Sunday, 27th, when he returned to London.

Tools.

The R.E. Detachment brought a limited supply with them and had also the use of contractor's tools when required. Care had to be taken to prevent loss or confusion, and deficiencies were few.

Materials.

Except for the Victaulic piping and a few bull-dog clips, spikes and dogs, all material was supplied by the contractor. It was arranged that bills for replacement for the articles from Catterick should be sent direct to the Waterworks Department.

Transport.

One private 35-seater bus and one R.A.S.C. medium 6-wheeler were used for transport of the personnel, kit and tools. The charge for these was borne by the Waterworks Department. The carriage of the 9-in. piping was arranged direct by the Department.

Rations and Accommodation, etc.

Rations for three days were carried from Catterick. The Detachment were put on the higher rate of ration allowance for the remaining two days and food was bought locally. Coal and light were provided free in the local institute. This was comfortable and clean, with a kitchen and all necessary sanitary arrangements.

FUTURE PLANS.

The present structure is only intended to carry the two water mains and is the property of the Waterworks Department.

No site for a permanent bridge has as yet been fixed, but the county authorities propose constructing a semi-permanent road bridge just upstream of the present site and hope to complete this early in September. Provision for carrying the water mains is being made on this bridge, as it is not likely that the permanent bridge will be put up for several years.

The old bridge completely submerged on the morning of July 23rd.

Fallen pier used as base for a temporary trestle. 16.00 hours, July 26th.

Both pipes running full. Midday, July 27th.

Restoration of Whitby water supply

View from north cable pier, July 29th, showing level crossing gates just behind the south anchorage.

Cable in position with temporary sling attachments. July 30th.

The temporary bridge looking downstream showing preparations for foundations of the semi-permanent road bridge.

Restoration of Whitby water supply

NOTES ON THE ENGINEERS OF THE U.S. ARMY.

By "PONOCRATES."

IT is always of interest to discover how someone else is setting about a task similar to our own. For this reason, the following notes are offered on the Engineers of the U.S. Army. As will be appreciated from the magnitude of the undertakings placed under the charge of American military engineers, at the present time, this foreign corps is one well worthy of study.

(A) STRENGTH AND ORGANIZATION.

(*i*) *In Peace.*

The American "Corps of Engineers," as it is entitled, has a regular peace establishment of about 560 officers and 5,000 other ranks, though, as in the case of other arms, the American authorities maintain this Corps often much under strength. These figures compare with about 1,150 officers and 7,100 other ranks in the case of the Royal Engineers. It has to be remembered, however, that whereas the British Army at home and abroad numbers about 210,000, the corresponding figure for the Regular American forces is only 125,000. Most of the American Regular Army units in peace are maintained either in cadre form or in detachments. The peace distribution of Engineer units is not, therefore, of great interest.

In addition to the regular personnel, the 18 National Guard Divisions and 27 Organized Reserve Divisions have the same proportion of Engineers as the regular divisions, though not fully recruited in peace.

(*ii*) *In War.*

The infantry divisions of the U.S. Army each contain one "combat regiment" of Engineers, and the cavalry divisions one "combat battalion, mounted." These units perform all the engineering duties required within the formations concerned. In war, for engineering tasks outside the province of divisional engineers, the Americans contemplate employing "general service regiments," the number in the field varying according to the numbers of Army Corps. They correspond closely to British Army Troops Companies and are responsible for construction of roads, bridging, railways, installation of water supply, electrical and mechanical duties and supply of stores.

In addition to these divisional and non-divisional units, a large reserve of engineers is to be maintained in the field, organized in "auxiliary battalions," on a scale of about one per division. These are intended for the reinforcement of engineer units in any part of the field of operations and give considerable power of manœuvre to the engineer-in-chief. They differ mainly, it would seem, from the "general service regiments" mentioned above in the type of training received, *i.e.*, they are less specialized.

Special engineer units contemplated for war are "camouflage battalions," "railway operating and maintenance battalions," "topographical battalions," "bridge trains" and "dump truck trains."

The "combat regiment" of the Infantry Division is about 38 officers and 800 other ranks strong. It is organized into 2 battalions of 3 companies each, each of 2 platoons. There are thus 12 platoons (the smallest engineer unit) in the division. It is interesting to note that in the British Infantry Division there are also 12 of the smallest engineer unit, the section.

The "combat battalion mounted" of the Cavalry Division numbers 15 officers and 330 other ranks and is organized into 3 companies.

(B) PEACE EMPLOYMENT OF ENGINEER OFFICERS.

Possibly the most interesting feature of the U.S. Corps of Engineers is the employment of its officers in peace.

The services of a large proportion of the officers are utilized in public works. Thus regular engineer officers are employed on the improvement of harbours and waterways, the construction of public buildings, parks, lighthouses and the survey of lakes, all in the home zone of the United States. In the past two years, the problem of the control of the Mississippi floods has been placed in the hands of army engineers. These are duties allotted in addition to the more normal ones of military engineers, such as road and other construction in the overseas American territories of Alaska, Panama, Hawaii and the Philippines. American military engineers built the Panama Canal and defences between 1903 and 1914, and military engineers are, according to the American press, now surveying the route for the proposed new canal through Nicaragua. In the performance of these extensive public works, the Corps of Engineers handles enormous sums of public money. Thus, for the year 1929–30, the budget for non-military activities, which consist in the main of public works administered by the engineers, amounted to over 25½ million pounds sterling.

The history of the attainment of their influential position with regard to the public works of the United States is also interesting.

During the period of expansion of the United States westwards, the western areas reached at any particular stage were the scenes of constant wars with the Indians. These danger zones were controlled by the Army and all engineering in them consequently devolved upon the Army engineers. With the gradual move of the frontier westwards, the sway of the military engineer was extended until it ran right across the continent to the Pacific. The situation which developed then was not dissimilar to that existing in India in the days when Royal Engineer officers were responsible for nearly all the engineering in that country. It is remarkable in the case of the American Corps that they have to-day maintained their position as public works engineers in the face of keen civilian competition. That this is so is undoubtedly due to the fact that it is found cheaper to employ Army engineers and that the Engineer Corps hold an unblemished record in the administration of large sums of money over a very long period.

In the American Army, as in ours, the Signal Corps is separate from the Engineer Corps. The Engineer Corps, however, is responsible for survey, as in the British Service. The Army carries out survey of public works and is responsible for map-making in military zones. The military survey service, however, has no place comparable to ours as regards survey of non-military lands at home. There is no American analogy to the Ordnance Survey of England and Wales, and, in the sphere of survey, conditions are exactly the reverse of those in general engineering, in that civil survey predominates over military survey. A final point of difference between the British and American Corps is that, in the U.S.A., searchlights are worked by personnel of the Coast Artillery Corps and not by engineers.

(C) Training of the Corps of Engineers.

Officers for the " Corps of Engineers " are found mainly from the regular output of West Point. A few come in from civil life direct. West Point provides a strenuous test. The course lasts four years, and the curriculum includes many non-military subjects, for many of the cadets do not go into the Army at all. In consequence, young engineer officers receive a wide general education. They are subjected to severe discipline and the raw material entering the Corps is thoroughly prepared for the wide duties of the military engineer. At the same time, the syllabus contains a large proportion of engineering subjects, handed down from the time when West Point was primarily an engineering college. In fact, the college course is said to cover the same ground as the first three years of a university engineering course. Young officers receive their commissions considerably later than is our custom, for they mostly enter West Point

between 19 and 21 and pass out between 23 and 25. The number of commissions given has been approximately 25 each year recently.

On leaving West Point, about half the young officers go direct to river and harbour duty (*i.e.*, public works) and half go to engineer regiments. After some three years, in which a portion of time with troops is essential, officers are sent off on purely technical civilian engineering courses, lasting about a year, at places of learning such as Institutes of Technology and Polytechnics and the Universities of Cornell and California. After this course, the officers return and go through a prolonged course at Fort Humphreys in Virginia, the engineer centre corresponding to the S.M.E., Chatham, where it is intended that the various forms of knowledge acquired in the previous four to five years shall be consolidated. After five to six years' service, officers leave Fort Humphreys. By that time they are expected to have made up their minds as to the type of work that suits them best and are variously allotted to public works, duty with regulars, or with the Organized Reserves and National Guard, at home or abroad, as required. With the greater proportion of their officers at home, the turn for foreign service does not come round very frequently.

A regimental institution exists similar to the Institution of R.E., under the title of the "Society of American Military Engineers," "dedicated to the National Defence," which produces an attractive and high-class journal containing many articles which would interest British engineer officers.

A SUBALTERN IN THE INDIAN MUTINY.

Containing some letters of Lieutenant Edward Talbot Thackeray, Bengal Engineers, afterwards Colonel Sir E. T. Thackeray, V.C., K.C.B., R.E. (1836–1927).*

Edited by BREVET COLONEL C. B. THACKERAY, D.S.O. (*late Lieutenant-Colonel, R.A.*).

II.—DELHI (THE RIDGE).

The ancient fortress of the Moghuls stood on an almost flat plain, the River Jumna sweeping round one side of its walls. It was protected on the land side by a twenty-four-foot deep scarp and ditch, with bastions and fortified gateways. The only commanding ground was a low spur, running away to the north. The river was spanned by a bridge of boats, out of range of guns on this spur. Of the total perimeter of seven miles, little more than a mile of the northern face was " invested " by the force under General Barnard. The enemy were thus free to receive supplies and reinforcements, or to sally forth in battle array. It was not a siege, properly speaking, for the besiegers were, contrary to all the accepted canons of war, hopelessly outnumbered and under-gunned. The investing force was, in fact, itself in a state of semi-siege.

The strength of the attackers lay in their hold on the long, low Ridge, the hog-backed spur captured by Barnard on the 8th June, some two miles in length and sixty feet above the *terrain*. But only its southern extremity commanded the city, menacing the fortress like the point of a spear barring its northern front. Its left flank was partially protected by the River Jumna. Fortunately, thanks to lack of enterprise on the part of the enemy, communications with the Punjaub were never cut, though with Bengal and the capital, Calcutta, they were very precarious. Most of the Indian troops were armed with the old muzzle-loading Brown Bess. Consequently, much of the fighting was hand-to-hand, the last instance of its kind on a large scale and over a prolonged period in modern warfare. There were many fluctuations in the strength of the Field Force. Reinforcements dribbled in from outlying stations. In the earlier stages the total strength was about 3,000 British and Indians,

* These chapters are an abridgment of the first part of a future publication. Extracts from Sir E. Thackeray's *Two Indian Campaigns* (published in 1896 by the R.E. Institute), and other reminiscences, are distinguished by his initials, thus, [E.T.T.].

with 22 field guns; at the assault it was roughly three times that number, with the addition of an inadequate siege train, and two to three thousand native irregular contingents; but this total included 3,000 sick and wounded. The strength of the enemy was never less than treble, and sometimes five or six to one, with a great preponderance of artillery, supported by masses of semi- or un-disciplined armed men.

The old cantonment on the Ridge, with its hutments, had been gutted by the mutineers. The British camp was pitched under cover of the Ridge, and clear of bombardment, but it lay exposed, and was frequently attacked on all sides. "The ground round Delhi, which was traversed by several canals and roads, was a tangled mass of old ruins, dense woodlands, rice fields, insalubrious swamps, and walled garden enclosures. It offered innumerable facilities to armed men of any degree of discipline, but the many combats of which it was the scene were rather trials of strength between small bodies than operations by masses." [E.T.T.]

For many weeks, hardly a day passed without the troops being turned out for some real or threatened attack, or to carry out some offensive operation. The rebels used our bugle calls, and their bands played British tunes. "Cheer, Boys, Cheer," was a favourite. The distant strains of music and the sounding of bugles and trumpets invariably heralded trouble, either the arrival of fresh reinforcements, or a forthcoming sortie. The latter took place three or four times a week, but always, says Thackeray, "with a uniformity of failure, of which it would be tedious to recite the details." The counter-attacks sometimes cost us two or three hundred killed and wounded. They were carried out with an *élan* that took them to within grape-shot of the rebel guns on the city walls, and stringent orders had to be issued against pursuing the enemy so far.

The heat and the torrential rains of the monsoon caused much suffering and disease. There were hundreds of deaths from sunstroke, and cholera, that most dread scourge, was always present. The air was tainted with corruption. Corpses of men and animals lay unburied in "No Man's Land," and the plague of flies was indescribable. Medical arrangements were perforce inadequate, and hardly a case of amputation survived. The daily casualties from sickness, and in the incessant fighting, amounted to forty or fifty a day. After a regular engagement they frequently ran into three figures. Our losses in killed and wounded alone during the three months' 'siege' were nearly 3,000, and the assault and capture cost another 1,400. Artillery ammunition supply gave cause for anxiety. At one period, in order to husband our resources, we were reduced to making use of the round shot fired at us by the enemy. Prices were fixed for the different calibres, and men and followers did a brisk trade in the retrieved ammunition. At first, the camp servants raced to pick up

the round shot, as they rolled down the slopes. There were many burnt fingers, until they learnt that the prize was nearly red-hot.

One of the greatest anxieties arose from the danger of desertion or mutiny among the native troops on the Ridge. On at least one occasion, treachery at the picquets led to a daring incursion by rebel horsemen into the heart of the camp. Unfortunately for them, it chanced to be the lines of the superb Bengal Horse Artillery, and their redoubtable commander, Tombs, roused from his hard-earned slumbers, rushed from his tent, breathing fire and imprecations. A ding-dong *mêlée* ensued round the guns, in which Tombs and his subaltern, Hills-Johnes,* won their V.C.s.

Officers of the Engineers played an outstandingly conspicuous part in the siege, out of all proportion to their rank. Promotion was rapid, but at the outset all, except the Chief Engineer, were subalterns, the senior among them, Lieut. Alex Taylor, having fourteen years' service. Before Major Baird Smith joined, three enterprising and highly talented Engineer subalterns, headed by Wilberforce Greathed, were in the innermost councils of General Barnard. Without consulting his Chief Engineer, his Artillery Commander, or other senior officers, the General accepted the plans of assault drawn up by the three young officers, although no breach had been made in the walls. Orders were issued accordingly, but on more than one occasion an unforeseen hitch at the eleventh hour prevented the assaulting troops from taking action.

The prominence of the Engineers at Delhi was due to the peculiar staff arrangements of that period. The whole direction of siege operations was left in the hands of the Engineers, who were employed not merely as technical advisers, but performed for the time being the duties of a general staff. As the editor of Sir Archdale Wilson's Letters points out: "It seems incredible that the officer in supreme command should be compelled to resort to advice and requests in a matter affecting the general conduct of operations; but the custom of the service then ruled that no interference with the Engineers when engaged in their special work could be permitted."

Barnard's first Chief Engineer was an old Major, who arrived at the seat of war accompanied by his Persian wife, with twenty or thirty camels in her train, and half that number of carts. He was very soon placed on the sick list, and was succeeded, early in July, by Major Baird Smith, an experienced officer of forceful personality and the highest professional attainments. Baird Smith and Alex Taylor formed an admirable combination. The older man, handicapped by ill-health and a painful wound, played a statesmanlike and convincing part in the councils of the General, and used his pen and tongue with effect, whilst the junior was the man of action.

* Afterwards Major-General Sir H. Tombs, V.C., K.C.B., and General Sir J. Hills-Johnes, V.C., G.C.B.

The conduct, not only of the siege proper, but of the assault and capture of the city depended largely upon the daring personal reconnaissances of Taylor and his subordinates. Baird Smith's penetrating brain moulded into shape the plans devised by Taylor, which the iron determination of the younger officer carried into execution. It is now generally agreed that the desperate schemes of the fire-eating Sapper subalterns stood little chance of success. Lord Roberts gives his opinion that, "the failure to give effect to the young Engineer officers' plan may be looked upon as a merciful dispensation of Providence, which saved us from what would most certainly have been an irreparable disaster."

The Delhi Field Force fretted at the delay, but they were exasperated by the taunts of speakers and scribblers, not only at home, but in India, who seemed to think that Delhi had no walls, nor men and guns behind them, or, if it had, that they would fall, like the walls of Jericho, at the blast of our bugles. All honour to the men who lost not a spark of their dauntless spirit, through those months of trial.

FOURTH LETTER (CONTINUED).

E.T.T. to his Aunt, Miss Henrietta Shakespear.

DELHI.
July 2nd.

. . . . Our batteries are on the top of the hill, about 1,300 yards from Delhi. Since the 8th we have been here now three weeks, making batteries on the hills and pounding away into the town, but I fear without much damage. The enemy come out about twice a week and skirmish. In fact, two or three of these sort of affairs have been regular battles and we have lost many men. On the 8th I felt rather strange, being under such a fire, but three weeks of it with eight hours every day in the battery accustoms you to it. I have had some wonderful escapes, as we have almost all, but the Engineer officers have been very fortunate, though we have lost about twenty men, killed and wounded, of the Sappers, which, considering our very small number, is very great . . . but I thank God for having preserved me in such good health.

We are very comfortable now, as we have taken possession of a nice house which once belonged to some unfortunate Europeans, who were murdered at the massacre here. They hardly left one house untouched. The place where we are is where our cantonments were. Fancy us leaving a place like Delhi with all our stores and guns in it, with nothing but native troops. Not a European regiment in it. I will not say anything about the General, etc., as you will, I hope, hear all about it in the paper.

Who do you think I met in the middle of the fight on the 8th,

just after we had taken the heights—Robert Low.* He is orderly officer to General Barnard. His regiment has not yet mutinied, but I suppose will, as about thirty regiments have now. Sir T. Metcalfe† is in camp. His house which was a beautiful place, but now completely destroyed, is occupied by our picquets. Hundreds of the mutineers have been killed since we have been here, in the skirmishes which take place almost daily. I have some of the numbers of their regiments taken off their caps. They use our bugle calls and come out in red coats. Is it not a dreadful thing, fighting against, as it were, our own men whom we have educated and made soldiers and armed? They are fighting us with our own guns and everything.

We are a very jolly party and have a nice mess. You will perhaps like to hear, though I tell you of it, that the General Commanding thanked Champain and a party of Sappers and me for making a battery one night, and said we had used great exertion to finish it. . . . The Artillery have very hard work in the batteries. A man sits on the parapet; when he sees the flash from the enemy's batteries, he says "Down," and down we all bob beneath the parapet. The worst is getting up there, as the shot come crashing about in a most unpleasant way. There is a large house on the Ridge, called Hindu Rao's house. There was a dreadful shot came through it one day, when our men were asleep and killed one officer and seven men of the Ghurkas and wounded four. . . . I am sorry to say all Oude has gone, and the Gwalior contingent. They receive reinforcements every day in the city, but we have been doing so, too, and they say we shall be in Delhi before the week is over. We have had part of the 8th and 61st Queens come in this week, and two regiments of Sikhs. The Sikhs are all right and capital fellows. We have lost about twelve officers in the force, killed since the 8th. Our native Sappers that are left have behaved very well: two of them were hit by a shell close beside me, as we were going into the batteries. One poor fellow had his leg taken off, and died in an hour, and the other was severely wounded. I tied up his leg myself as there was no doctor. The men behave splendidly in all the regiments. A Carabineer was hit by a shot which took away his arm and leg. He said, "Oh, there goes my arm and leg. Give me a glass of water, please." . . . How thankful we ought to be that the Sappers did not mutiny before, when we were at Roorkee, as they might have killed us all. The China troops have, I believe, been stopped and are coming to reinforce us.

July 3rd. Last night we were all ready for the assault and very eager for it. Some of the Irregular Cavalry mutinied in camp and the General counter-ordered it, much to everybody's disgust. I am

* Thackeray's cousin, afterwards General Sir Robert Low, G.C.B., of Chitral.

† Sir Theophilus Metcalfe, Bart., C.B., married Robert Low's sister. He was magistrate of Delhi.

afraid his policy is not much approved of. The Engineers had planned it and everything was ready. There were to be five storming parties, two Engineers' officers, Lieuts. Greathed and McNeill, and myself, with a party of Sappers, were to have led one party and blown in a grating with powder bags, through which the canal used to run into the city, but the water of which we have turned off. I have told you this, as I do not think it likely the plan of attack will be the same way. And now, my dear Aunt, I must come to the conclusion of this long epistle. I hope my next will be from inside Delhi, and hope God will spare me to see you all again at home. Depend upon it, everybody will do his best at the assault. I am afraid the last post has been robbed. . . . I am in excellent health and spirits. We have twenty-two Engineer officers now, Colonel Baird Smith commanding. I am afraid we shall not get medals for the campaign, as it is against Mutineers, but everybody thinks we deserve them.

* * * * * *

Hindu Rao's house, the key of the position, was held throughout by the incomparable Sirmoor Battalion of the Gurkha Regiment, under Major Charles Reid.* Neither he nor his gallant little hill-men ever left its vicinity, except to try conclusions with the mutineers. He himself never once visited the camp, until carried into it wounded on the day of the final assault. The Sammy House, within grape-shot of the bastions, was another of the most exposed points, on which night attacks were frequently made, a continuous roll of musketry being kept up all night. "I remember seeing the corpses of the mutineers after one of these attacks piled in heaps to a height of several feet. . . . The picquets at the Sabzi Mundi may, perhaps, be awarded the palm for the deadly nature of the combats which they sustained. Hand-to-hand encounters were of frequent occurrence. On one occasion, during one of these fights, a rebel Sepoy thrust his head through an opening of the wall. A Gurkha Sepoy below the wall seized him by the hair and chopped off his head with one blow of his *kukri*." [E.T.T.]

"A few days after the commencement of the siege," Thackeray relates, "I was ordered to take a party, consisting of about 100 unarmed coolies, a few native sappers, and three non-commissioned officers, and six elephants, to Metcalfe's house to destroy some walls, and to clear the ground around the picquet which was stationed at this spot. Metcalfe's house, which had been the residence of the Assistant Commissioner of Delhi, Sir Theophilus Metcalfe, who was present during the siege, was a large house surrounded by a beautiful park. It is situated on the right bank of the River Jumna, distant about a mile from the city. After the massacre of the Europeans at

* Afterwards General Sir C. Reid, G.C.B.

Delhi, on the 12th May, the house had been gutted, the valuable library belonging to Sir Theophilus, and all the furniture and effects being plundered and destroyed by the mutineers. (They were said to be valued at £90,000.) Before starting for Metcalfe's house, I had explained to the serjeant in charge of the elephants that he should take the turning to the left, and we started as it was getting dusk. I rode at the head of the little detachment, and on arriving at the park gates, turned to the left with the sappers and coolies. After journeying some distance towards Metcalfe's house, I halted the party and galloped back to the gates. It was now dark, and I could see or hear nothing of the elephants. I then conjectured that the serjeant in charge must have tarried somewhat behind, and in the darkness must have failed to notice that we had turned to the left through the park gates, and, in fact, at that moment he must be quietly walking along the road with the six elephants towards the enemy's picquets at Ludlow Castle, about 300 yards distant. All this passed through my mind in much less time than it takes to write it. I turned my pony to the left, and galloped in the darkness in the direction of Ludlow Castle. I was only just in time. The serjeant was calmly walking along the road to destruction with the six elephants, with their *mahouts*, and some of the coolies. I touched him on the shoulder, and turned him round without speaking. The enemy's advance post at Ludlow Castle could not then have been more than 80 yards distant, but the night was very dark, and they heard no sound. We got back to the park, and arrived at Metcalfe's house in safety. Here we worked during the night, the elephants using their trunks to tear down trees and brushwood, and using their vast weight to push down the mud walls of the servants' houses, and other buildings, that were in too close proximity to the Commissioner's house. . . ." [E.T.T.]

On the morning of 5th July, Sir Henry Barnard, the Acting Commander-in-Chief, held a lengthy consultation with Colonel Baird Smith, the newly-arrived Chief Engineer, who was in favour of an immediate assault *de vive force*, as recommended by Alex Taylor. He reserved his final decision. Within an hour Barnard was struck down by cholera, and died that afternoon. The general feeling was that he was unequal to the great task before him. His complete ignorance of India led him to listen to the advice of every plausible talker. But whatever judgment may be passed on his generalship, he was a gallant commander and a most chivalrous gentleman, who won the hearts of all who served under him.

He was succeeded by Major-General T. Reed,* who, though he was Barnard's senior and provisional C.-in-C., had been prevented by sickness from assuming command previously. He only retained the command for twelve days, when he was compelled to retire invalided

* Afterwards General Sir T. Reed, G.C.B., 1796–1883.

to the hills. Major-General Archdale Wilson, of the Bengal Artillery, who was never in good health, was appointed to the command, over the heads of other brigadiers. Lord Roberts speaks of the choice as the best under the circumstances. He was a conscientious officer of average ability, and a good administrator. Colonel Keith Young, the Judge Advocate General, a shrewd observer, described him as "rather over-careful," "wary," and "painstaking," "a gentlemanly, quiet, steady 'old fellow,' looks to everything himself, and gives clear and distinct orders." He greatly improved the discipline, comfort and general conditions of the troops.

Every account tells of the magnificent fighting spirit of the men, in spite of sickness, in face of tremendous odds, and under an Indian sun at its hottest. Their morale and mettle were beyond all praise; but, as will happen with the best fighting troops, their discipline was growing lax under the strain. Wilson ameliorated the hard lot of the camp followers, who though they did splendid work and suffered heavy casualties, were not always well treated by the men. Thackeray speaks thus of the coolies, who were enrolled as pioneers. "Strange to say, these men, who were at once transferred from the peaceful tasks of day-labourers to the most dangerous duties of working parties in siege operations, never exhibited a symptom of fear, but worked under the hottest fire like veterans, and were invaluable. The casualties among them were inevitably very numerous, but no instance occurred of their having hesitated to obey any order, whatever its consequences might have been." And again: "It may be remembered that the siege took place during the rainy season, so that the troops were continually drenched. The Engineer officers had to take parties of unarmed coolies out at dusk, to work between the Ridge and the city, their work usually consisting of felling trees and bushes, and clearing the ground in front of the picquets. Attacked by the enemy in the darkness and rain, it was really wonderful how patiently these poor coolies bore their sufferings, and their conduct was a matter of universal admiration." Lord Roberts also has a word of praise for them. During the first night of the construction of Major Scott's battery within 180 yards of the wall, "to arm which, heavy guns had to be dragged from the rear under a constant fire of musketry . . . 39 men were killed and wounded; but with rare courage the workmen continued their task. They were merely unarmed pioneers, and with that passive bravery, so characteristic of natives, as man after man was knocked over, they would stop a moment, weep a little over a fallen friend, place his body in a row along with the rest, and then work on as before." Thackeray mentions that thirteen were killed by one rocket ricochetting among the coolies. The *bheesties* (water-carriers) deserved the highest praise. Many of them were killed taking up water to the men in the firing line.

During July, Thackeray writes, "many of us suffered from

dysentery, and cholera had now begun its dire work. All the troops suffered alike. The officers received a daily tot or ration of rum, like the men. Many of us carried a soda-water bottle, containing the rum ration, into the trenches, and I attribute having survived the exposure and wet at this time in a great measure to this cause." A letter to his brother about this time mentions that he was suffering from dysentery and skin disease. "I fancy it is from drinking bad water and partly from exposure." But he never missed a day's duty during the siege. "I have not received any pay now for five months," he says, and adds generously, if inconsequently, "so mind you take as much of what I have at home as you like," for an invalid sister, "as there is no occasion for it at Delhi."

One of the most important and dangerous works carried out by the Engineers from time to time was the destruction of bridges, for which purpose small columns were on several occasions sent out from camp, and fought many desperate engagements. "Attempts were also made to destroy the main bridge of boats across the Jumna, near the fort, by floating down rafts with infernal machines, but none of them were successful. On the rafts were barrels of gunpowder, to which pistols at full cock were attached, in such a manner that a sudden jar would discharge the pistol and ignite the gunpowder. We used to row the rafts out into mid-stream, and then abandon them to the stream. None of them, unfortunately, reached the bridge of boats." [E.T.T.] They stranded on sandbanks, where they ignominiously exploded, or were captured by the enemy. The Sappers came in for a good deal of chaff, as everyone not on duty was lined up on the Ridge to watch the fun. Sapper "stunts" were a standing joke in camp. At one time, mining operations on the part of the enemy were suspected at the Metcalfe stable picquet. A counter-shaft was sunk, and at first the sound grew louder. But the noise of our miners caused the enemy to abandon their design. Others said that the noises were susceptible of simpler explanations. This method was often used on later occasions: the officer stood waiting, revolver in hand, and as soon as the partition was broken down, charged through at the head of his men.

FIFTH LETTER.

ENGINEERS' CAMP
(before Delhi).
July 26th, 1857.

E.T.T. to his brother, F.St.J.T.

You see we are still here and not inside Delhi yet. I believe all our letters from England have been stopped or lost. At least, none of us have had any for about six weeks. It will be quite a new sensation getting a letter.

We are waiting still here for reinforcements and I believe they will soon be here. We could take Delhi, they say, any day, but have

not enough men to hold it. The city is an immense place and when the troops get in the streets, we should lose a great many men, as the *pandies* (our name for the enemy) would be sure to retire there. They come out on an average about two or three times a week and attack us. We take it very coolly and invariably drive them back, they losing three or four hundred men every time, killed and wounded, and doing us very little harm. We are entrenching our position and are perfectly secure from their attacks. They say that the fate of India depends upon us meeting with no repulse at Delhi and the General (Wilson) is determined to wait till we have more troops.

When you come to think of it, our men have behaved wonderfully well. We have been here for nearly seven weeks, with a force of from two to three thousand men and had to repulse an enemy of ten to twelve thousand men. Twenty-four times have they come out. I have seen them myself often through my glass, filing out of the city, cavalry, artillery and infantry, taking an hour to come out. They have tried every point of our position, right, left and centre, and invariably with the same result. Our men have waited for them, till they came as near as they could, which is never very near, and then gone at them. The ground is most favourable for them between this and Delhi, being nothing but trees and rocks. They get behind these and pick off our men. It is a very savage kind of warfare.

I have a very bad piece of news to give you, and I am sure you will be sorry to hear it. Poor Jones, one of my oldest and best friends, who came out with me and who I have been with for nearly five years, is dead. He was out with a working party making a breast-work when the enemy brought some guns outside the city. The first shot they fired, a six-pounder, went through his left leg and carried away the calf of his right leg. His left leg was amputated immediately and he was doing very well for two days. I was with him in the afternoon the day it happened. He said he felt no pain and was talking to me in very good spirits. On the third day afterwards, fever seized him and he died on the fourth day. . . . He is a great loss to us all. I can hardly believe he is dead. Don't you remember our dinner at Southampton? Poor Jones and his brother, you and I. I little thought then he would so soon be gone. . . . I cannot realize his death at all, I have known him so long.

We have suffered very heavily (I mean the Engineers). One officer, Walker, died of cholera. Captain Greensill, H.M. 24th, who was attached to our Corps, was shot dead by one of our own men at night, who mistook him for an enemy, and now poor Jones. His effects are to be sold to-night. He had brought out a most beautiful outfit with him of guns, rifles, etc. As for our men, we left Roorkee with 45 European Sappers, N.C. officers, and 10 have died of cholera alone in the six weeks here, 1 killed and 4 or 5 wounded, so we have

hardly any fit for duty. Carnegie was slightly wounded by a musket ball in the arm, but is well now. I have been, thank God, most fortunate. I am in excellent health and have been under heavy fire three or four days out of every week and have never been touched. Walker, of the Bombay Engineers, has been badly wounded, and Geneste, of ours, slightly. Poor Innes, of our Engineers, who came out in the ship with me and Jones, has been killed at Allahabad, and I believe several other Engineer officers.

The *pandies* are beginning to find out their mistake. There is no doubt that the King of Delhi, the King of Oudh,* and others, have been for a long time stirring up the native regiments and told them that we wanted to force them to be Christians. The Mussulmen are in a great measure at the bottom of it. They thought that there were so few Europeans in India that they could kill us all at the same time, but at Meerut and Delhi they broke out too soon. They never thought we could get our troops together as we have. Out of 74 native regiments about 6 have remained staunch. The rest have either mutinied or been disbanded. At Agra, the Europeans have had to retire into the fort. At Cawnpore, Sir Hugh Wheeler, after holding out for three weeks with 100 men against three or four native regiments, was obliged to capitulate, having no ammunition left. The brutes allowed them to get into boats, and then killed them by firing at the boats. Two or three, I believe, escaped, Sir H. Wheeler among them.†

We have, I believe, now, all the China Expedition at Calcutta, and our turn is coming. We have the Gurkhas and Sikhs Regiments with us, splendid fellows, like Europeans. It enrages us to hear people at home in the papers talking of the mild and pious Hindu. If they had seen and heard some of their atrocities out here that we have had, they could not say so. Our men prefer shooting themselves to be taken prisoners by them. I hope this will let Government and John Company see what it is to have placed Delhi in the hands of native regiments, and to have been so sparing of having Europeans out here. . . .

The rains are going on now. Sometimes we are out in the rain twelve or twenty hours at one time. . . . Robert Low is in camp. He dined with me the other day. His regiment, the 9th Cavalry, has mutinied. The loss of officers in the campaign and massacres previously has been very great. We get all the news from England all right, but no letters. I shall, as you may imagine, and all will, be very glad when the reinforcements come and we all get into Delhi.

* Neither of these titular sovereigns was proved to have conspired against British rule previous to the Mutiny. The King of Delhi was found guilty of *subsequent* crimes, and deported. The King of Oudh was not tried.

† The whole garrison, with the women and children and wounded, were eventually massacred, except four—Lieuts. Delafosse and Mowbray Thomson, Private Murphy and Gunner Sullivan—who succeeded in escaping. The European garrison numbered 410, not more than half of them trained soldiers, with about 100 loyal Indians. There were in all 376 women and children.

Poor Jones met a soldier's death, but I cannot help feeling his loss. Remember me to Mr. Hood and Wm. Thackeray. Thank him for the revolver. I wish I could see your new rooms at Lincoln. We are very well off here, as we have a bungalow to live in. . . . Good-bye and God bless you. . . .

[Later] . . . . We have twenty-five Engineer officers here now and are very lucky in having a house. From the deaths of so many of our officers (two were killed at Cawnpore and several others), I have had about ten steps in the corps since I have been out here. I hope you wrote for me to poor Jones' brother.

The Sapper mess was in one of the bungalows left standing in the cantonment outside Delhi, where the camp was situated, behind the Ridge. The officers' tents were pitched round it. The central room was occupied by a billiard table on which at first some of them slept. Then it was converted into a dining table, at which twenty or more sat down. Miss Taylor, in the Life of her Father, General Sir Alex Taylor, gives a lively picture of the mess, which never lost its good spirits.* Colonel Baird Smith, the Chief Engineer, who had wretched health, seldom dined there. His next senior and right-hand man, Captain Alex Taylor, otherwise "Musha," aged thirty-one, was the oldest in mess, the others being subalterns, some with over twelve years' service. There were in all thirty-two. Next came the witty and versatile Wilberforce Greathed, who, after his brief spell as

* It may be of interest to record the subsequent ranks and some of the services of the thirty-two members of the Sapper Mess on the Ridge at Delhi. Many of them served with distinction in other campaigns, not here recorded.

Generals and Colonels Commandant, R.E.:—Sir A. Taylor, G.C.B., President, Indian Defence Committee; President, Cooper's Hill College.—Sir F. R. Maunsell, K.C.B., and Sir Aeneas Perkins, K.C.B., both C.R.E.s in the Second Afghan War.—Sir G. Chesney, K.C.B., C.S.I., C.I.E., *M.P.* for Oxford; Military Member of Viceroy's Council; President, Cooper's Hill College; a brilliant political and military author.—General J. Walker, C.B., F.R.S. (Bombay Engineers), Surveyor General of India.

Lieutenant-Generals:—H. W. Gulliver.—C. T. Stewart.—J. Tennant, C.I.E., F.R.S. —H. R. Brownlow.

Major-Generals:—W. W. Greathed, C.B. After very distinguished military services, was head of the Irrigation Department of India.—W. E. Warrand.—Julius Medley.—C. S. Thomason.—R. S. B. Pemberton, C.S.I., Director of Railways; Member Viceroy's Council.

Colonels:—R. Baird Smith, C.B., *A.D.C.* Shared with John Nicholson and Alex Taylor the chief credit for the capture of Delhi. Became Master of the Mint. Died 1861.—A. Lang.—Sir John Bateman-Champain, K.C.M.G., Director of Indo-European Telegraphs. D. Ward.—Sir E. T. Thackeray, V.C., K.C.B. (civil), C.B. (military). Chief Commissioner, St. John Ambulance Brigade, was mentioned in dispatches for services in Italy during the Great War. Died, 1927, *æt.* 91—the last survivor.

Lieutenant-Colonels:—J. Laughton. Was Chief Engineer, Delhi Field Force, until invalided and relieved by Major Baird Smith.—T. Hovenden.

Major:—P. Murray.

Captain:—Greensill, H.M. 24th Regt. (attached), killed at Delhi.

Lieutenants:—Killed or died of wounds.—D. C. Home, V.C., and P. Salkeld, V.C. Both died within a month of winning the V.C. at the Kashmir Gate, Salkeld of wounds received, and Home by the accidental explosion of a mine.—F. L. Tandy.—E. Jones. Died during the Mutiny:—M. S. Geneste.—W. Fulford.—E. Walker. Retired soon after the Mutiny:—A. McNeill.—H. A. L. Carnegie.

Of the 32, 8 were killed or died during the Mutiny, and 12 were wounded. This record takes no account of officers of the Corps in other parts of India.

General Barnard's unofficial adviser, became a mere extra A.D.C. to General Wilson. He was commonly known as the "Insulting Engineer," the native corruption for Government Consulting Engineer. Frederick Maunsell, *preux chevalier*, Adjutant and then Commandant of the Sappers and Miners, the remnants of which he had helped to save from mutiny at Meerut; James Tennant, mathematician and astronomer, known as the "Objector General"; George Chesney, Brigade Major, the perfect Staff Officer, a man of brilliant parts; Henry Brownlow, with his caustic humour; Geneste, gallant, idle and capable, the actor and linguist of the Corps; Philip Salkeld, one of the party of twelve, including ladies, who escaped from Delhi by letting themselves down with sheets over the ramparts, and made their way to Meerut after a week of amazing adventures. He, with another Sapper, Duncan Home, led the little band of heroes who blew in the Kashmir Gate. Both were subsequently killed. There was Arthur Lang, who, as all agreed, earned many Victoria Crosses, though he was never awarded the decoration; and there were Fulford, who died, Tandy and young Ned Jones, who were killed; Gulliver, Hovenden and Warrand; "Jules" Medley, Thomason, the two Walkers, James (Bombay) and Edmund, who died of cholera. Captain Greensill, H.M. 24th Regt. (attached), was accidentally shot. They were as gallant and capable a brotherhood as ever sat round a camp table, and Lord Canning only voiced the general opinion when he spoke of the Bengal Engineers as "accomplished all-round men, every one of them, of clear intellect and cool courage."

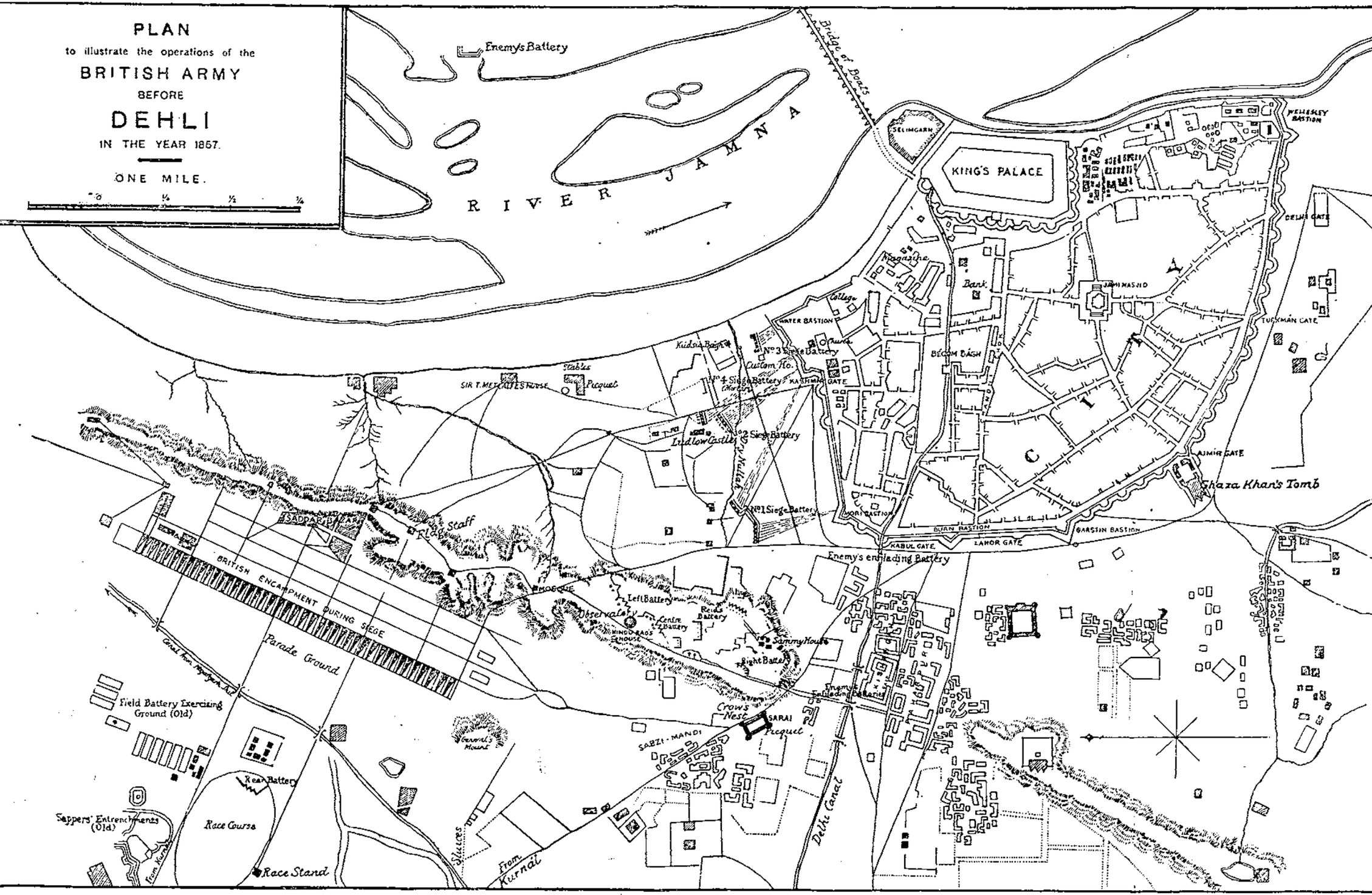
From Sir A. Taylor's *Life* we learn that "the youngest of them was Edward Talbot Thackeray, a lad of twenty . . . . who was immediately dubbed 'My Lord,'" one of his Addiscombe nicknames. In amusing contrast was his friend, Charles Thomason, an eccentric and lovable Highlander, called 'Robinson Crusoe,' from the bizarre clothes which he affected, even in times of peace, their design and manufacture being left to his servants. He had a theory about heat rays, and covered his person with a patchwork arrangement of green cloth, soon mottled yellow by the sun. This "was anathema to 'my Lord,' who considered it a disgrace to his corps, and proposed that a subscription should be raised to give Robinson Crusoe a more conventional outfit. Robinson Crusoe himself enjoyed the joke, smiled indulgently and continued to protect his spine scientifically." It was not long before 'Lord Tall Boot,' in common with every other officer in the Force, was himself in a state of rags. "We were glad," he wrote, "to purchase articles of clothing or uniform of any kind at the sale of the effects of officers who had been killed or died."

There were few amusements on the Ridge, for every man was constantly on duty, but, as the weeks passed, recreations were

organized, cricket and pony races. For those not actively engaged, cards were a means of whiling away the long hours at night in the batteries and trenches. Thackeray was fond of telling a story, which had been the round of the messes at Delhi, anent a certain very imperturbable officer. He and another were playing *écarté*, when a round shot crashed in upon them, taking off his opponent's head. He picked himself up, his eye-glass still firmly fixed, and piously ejaculating, in the words of a romantic poem, "Oh, Pilot, 'tis a fearful night," swept up the pack of cards, together with all the loose cash, and betook himself elsewhere. Gambling on a considerable scale went on after Delhi and Lucknow, when arrears of pay had been received and money was plentiful. Some of the less scrupulous were laden with loot. A young sapper officer, who rarely played, was induced to take a hand at Loo, a favourite game at that time. He had no loot and little ready money. So he staked his Engineer's allowances, month by month in advance, up to the rank of Major, that is, if he should escape the rebel bullets and reach that exalted rank. He lost. The winner, who was a V.C., a distinguished officer in another corps, drew this convenient allowance, amounting to several hundred pounds, for a great many years. One wonders whether, towards the end, he had any qualms about it.

There was no serious difficulty in keeping communications open with the outside world, to the north and west, by runners and pony *dâk* (mail). But Oudh, Bengal and Calcutta were cut off. It was weeks before authentic news came about Cawnpore and Lucknow. Secret dispatches were often written in French, Latin or Greek, or a combination of the three—which speaks well for the classical training of the public schools. Officers managed to write daily to their wives in the hills, and the wives to send them creature comforts. The Judge Advocate General, for instance, every now and then asks his better half to send him down half a dozen of port wine, and a couple of bottles of curaçao, or some cherry brandy and apricot jelly. Parsee merchants did a roaring trade. The bazaar was "crowded with people from the villages, with everything for sale in the greatest profusion." The Artillery Mess was famous for its beer, which fetched four or five rupees (at that time eight or ten shillings) a bottle, and brandy twenty rupees. Their *chef* was a *cordon bleu*, a magician, like all Indian *khansamahs*, who never failed, under the most adverse conditions, to produce six-course dinners, and "about the best gram-fed mutton and pastry in India." But this is only one side of a picture, in which heat and dust and rain and sickness predominated, to the accompaniment of cannonade and musketry fire, alarms and excursions.

(To be continued.)


PLAN
to illustrate the operations of the
BRITISH ARMY
BEFORE
DEHLI
IN THE YEAR 1857.
ONE MILE.
Enemy's Battery
Bridge of Boats
RIVER JAMNA
SELIMGARH
KING'S PALACE
WELLESLEY BASTION
DELHI GATE
Magazine
Bank
College
JAMI MASJID
WATER BASTION
TUCKMAN GATE
Kudsia Bagh
No 3 Siege Battery
Custom Ho.
BEGAM BAGH
Stables
SIR T. METCALFE'S House
Picquet
No 4 Siege Battery
KASHMIR GATE
Ludlow Castle
No 2 Siege Battery
AJMIR GATE
Shaza Khan's Tomb
No 1 Siege Battery
MORI BASTION
JUAN BASTION
GARSTIN BASTION
KABUL GATE
LAHOR GATE
Staff
BADARPUR KARI
Enemy's enfilading Battery
BRITISH ENCAMPMENT DURING SIEGE
MOSQUE
Left Battery
Observatory
Centre Battery
Right Battery
MINOO RAO'S HOUSE
Sammy House
Parade Ground
Field Battery Exercising Ground (Old)
Crow's Nest
SARAI
Picquet
SABZI-MANDI
Rear Battery
Sappers' Entrenchments (Old)
Race Course
Race Stand
Sluices
From Kurnal
Delhi Canal

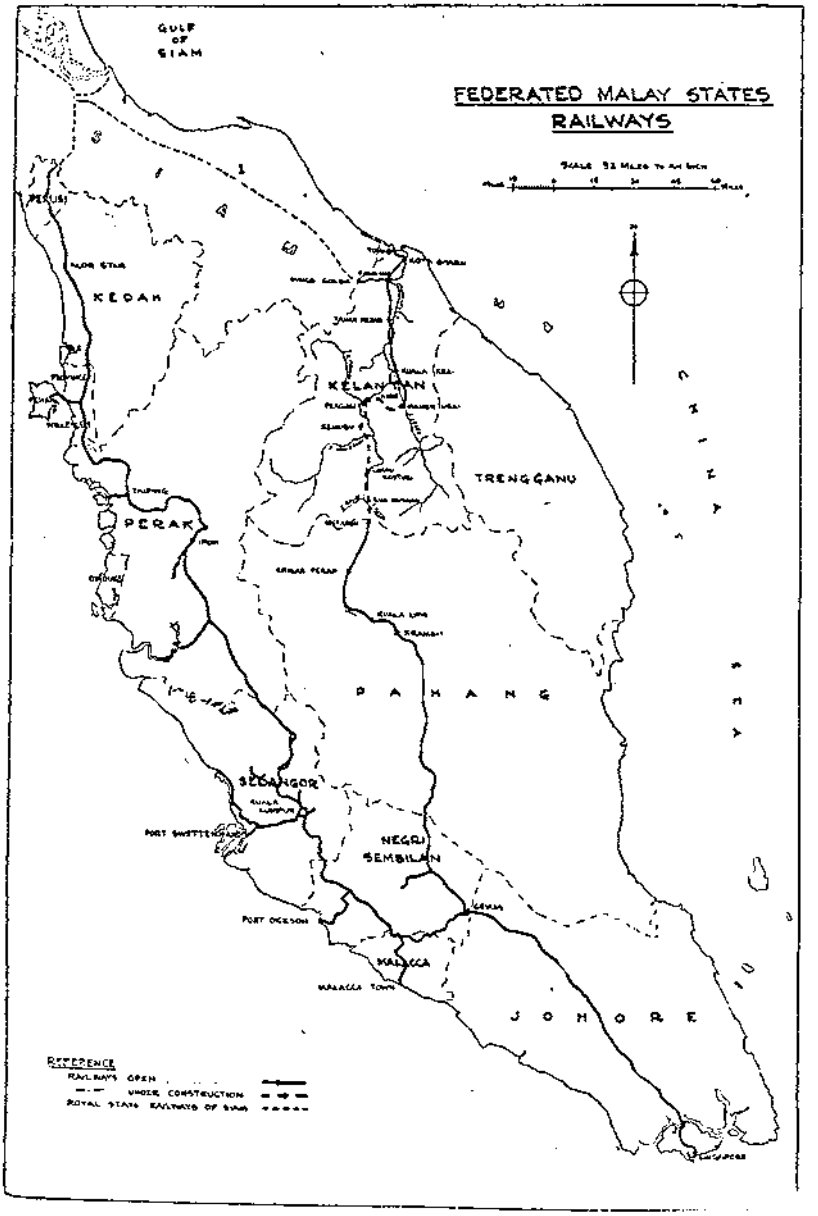
THE KELANTAN SECTION OF THE EAST COAST RAILWAY, F.M.S.R.

By LIEUT. LL. WANSBROUGH-JONES, R.E.

THE East Coast branch of the F.M.S. Railways is being constructed purely as a development line to open up the states of Pahang and Kelantan, which are known to have rich mineral and agricultural resources. The line, which is metre-gauge, runs roughly north and south along the 102° meridian from Gemas on the Johore-Negri Sembilan boundary to Tumpat near the mouth of the Kelantan river, and the total length is about 327 miles. The survey for the line was started in 1909 and completed in 1915. Construction was begun at Gemas in 1907, and on the Pahang section in 1912 ; it was suspended during the War, but was recommenced in 1919, together with a short stretch in Kelantan from Tumpat to Sungei Golok and Kuala Krai. By 1921, when work was again stopped, the line had been completed from Gemas to Chigar Perah in the south and from Tumpat to Sungei Golok (where it joins the Royal Siamese Railway) in the north. When work was started afresh in 1924, there remained the partially constructed lengths from Tanah Merah to Kuala Krai and from Chigar Perah to Merapoh to be finished, and the stretch from Merapoh to Kuala Krai, on which no work had yet been done.

The latter stretch, which forms the subject of this article, is by far the most difficult section of the whole line ; and has involved very heavy earthwork and tunnel construction, in addition to bridge and culvert work under the most varied conditions imaginable. The engineering problems encountered have been complicated by the extremely broken nature of the country and the liability to damage from flood, with the result that the stretch in question is probably the most vulnerable section of line in the whole F.M.S. Railway system. During 1924, work was started north of Chigar Perah and, on the completion of the Guillemard bridge over the Kelantan river, the line from Tanah Merah to Kuala Krai was opened to traffic. Eight bridges were constructed during the year, and Hume pipe works were installed at Chigar Perah and Kuala Krai, the latter being moved later to Kemubu. Slow progress was made in 1925, owing to very heavy earthwork and a considerable number of stream diversions, but five bridges were erected and two tunnels practically completed. The tunnels presented more difficulty than was anticipated, owing to the varying nature of the ground through which they were driven. The presence of large pockets of shale and loam in the limestone hills

caused frequent slips in the headings, particularly in Tunnel No. 4, where one face eventually had to be closed down, as slips and flooding from underground streams made it unworkable. Towards the end



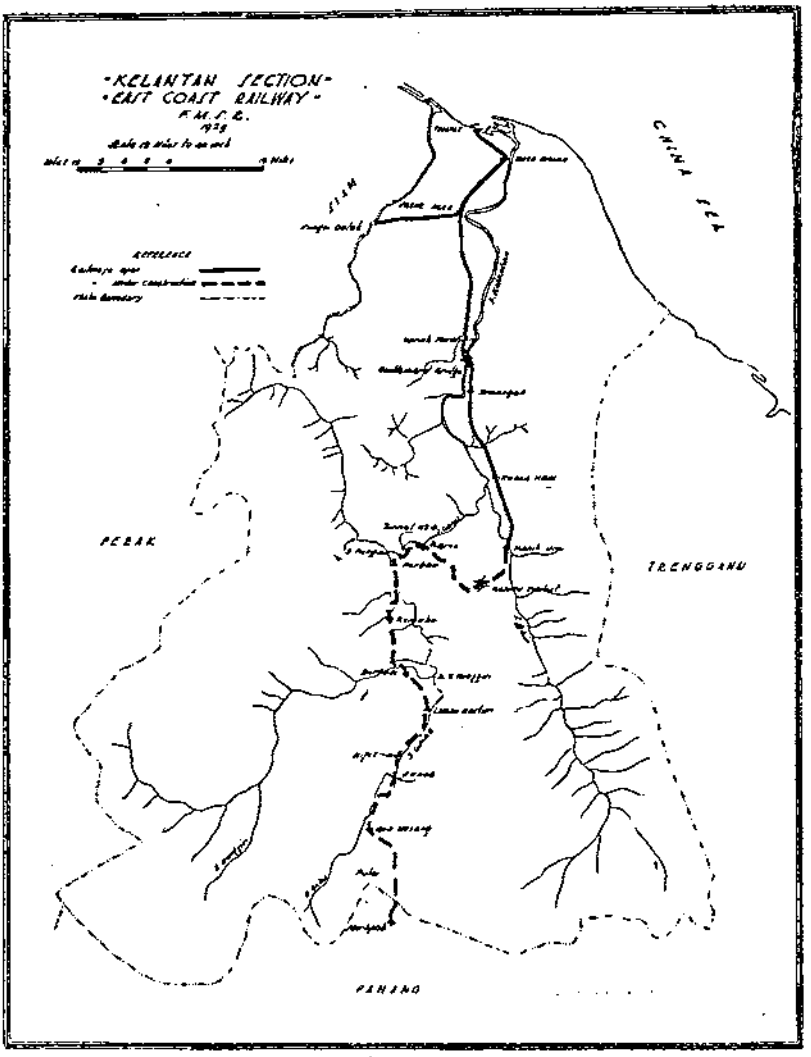
of the year, the earthwork suffered heavily from monsoon rains, and difficulty was experienced in obtaining labour to restore the formation as, with the development of the country, coolies were attracted to the new rubber estates.

By the middle of 1926, two more tunnels had been finished, and by December the headings had been driven in three more and well advanced in two others. Five bridges had been completed, and the section from Chigar Perah to Merapoh was ready to be opened to traffic; also certain lengths had been re-surveyed and a new alignment had been adopted near Kemubu, which cut out two tunnels. At the end of the year there occurred the most disastrous floods yet known in Malaya, affecting particularly the states of Kelantan and Pahang, where the greater part of the year's work was obliterated and the entire length of the East Coast Railway disorganized. Between the 15th and 20th of December, 1926, there was heavy rain all over Kelantan and Pahang, but not enough to cause any abnormal rise in the rivers. From the 20th to the 29th, however, it was practically incessant, and at one station in Kelantan, where the rainfall recorded for the month was 62·45 inches, nearly 45 inches fell during these last ten days. The rivers rose above their normal flood levels on the 23rd, and continued to rise at the rate of some six inches an hour until the 30th, when the floods began to subside, but the water in the rivers did not drop to the normal flood levels until about January 5th, 1927.

On the 29th, 30th and 31st the situation along the whole line became very serious. The construction camps at Kuala Krai, Manek Urai, Pergau, Kemubu, Nipis, Gua Musang and Chigar Perah were all wholly or partially destroyed, and all stores and records lost or irreparably damaged. During these three days the rivers were about thirty feet above their normal flood levels, the maximum recorded rise being at Bertam, where the Nenggiri River rose over seventy feet. Flood velocities of eleven and fourteen feet per second were recorded in the Galas and Ketil rivers respectively. Extremely severe conditions were experienced in the construction camps during this period, as all nationalities were eventually driven to refuge in the few buildings that remained in the highest parts of the camps, and the numbers were everywhere increased by parties of refugee Malays who came down from the head waters of the rivers for food and shelter.

The conditions at Chigar Perah are quoted as being typical of those prevailing all along the line. There all the buildings were destroyed with the exception of a small office measuring about twenty feet by thirty-five feet, in and under which were collected six Europeans, including two ladies, and over two hundred coolies of different nationalities and sexes, for a matter of nine days, with no communication with the outside world. Communication between camps, which was maintained by river and along the formation during construction, became impossible during the flood, as both these means disappeared, the one being unnavigable and the other under fifteen to twenty feet of water. The camps were thus completely isolated,

and the construction staffs and coolies were subjected to severe privations ; food shortages occurred at most points, and systems of rationing had to be introduced. A very noticeable feature throughout the flood was the attitude of the Chinese and Tamils who formed the greater part of the coolie gangs ; these men made little effort to



assist in saving food and necessities until it was too late, and preferred to sit down in apathy and terror and watch their shelters and belongings washed away and broken up in the streams. Great energy was shown by Sikhs and Malays, and many lives were saved and much material salved through their agency ; the Malays particularly showed much enterprise in building " rakits " (bamboo rafts) for distributing food and restoring communications.

The year 1927, which should have seen the sections Kuala Krai–Manek Urai and Chigar Perah–Merapoh opened to traffic, had to be spent almost entirely on reconstruction. At the time of the flood the activities of the Construction Department extended over a hundred and twelve miles from Kuala Krai to Chigar Perah, and throughout this length the camps had virtually disappeared, the yards and buildings that remained being left everywhere under about two feet of silt; nearly all the rolling stock was lost and damaged, and the formation completely destroyed in many places. The most serious damage of all was done at Manek Urai, where two two hundred and fifty-foot spans of the bridge over the Lebir River were carried away. To the north and south of this stretch, sections which had been handed over to the Open Lines Department were so badly damaged that they had to be restored to the Construction Department for repair; the worst of these was the Sungei Golok line, where two spans of a hundred and fifty feet, two of sixty feet, and one of forty feet were destroyed and huge gaps made in the formation. The total loss through the damage and disorganization caused by the flood on construction works was estimated at $3,000,000* in Kelantan and $300,000 in Pahang; the total loss of life was never accurately determined, but the Constructional Staff lost one European and thirteen Asiatics.

To cope with the enormous work of reconstruction on Open Lines, the whole of the Construction Staff in the south was transferred to the section between Krambit and Kuala Lipis, and by June 1st the line had been sufficiently restored to allow a restricted service. In the north, the situation was so bad that the Engineer-in-Charge decided to abandon the headquarters at Pergau and the section of line between there and Manek Urai, and base everything on Kuala Krai, from which point the work of reconstruction was extended north and south; a course which was dictated largely by the immense damage to buildings and stores and the lack of food and transport. The flood was obviously an abnormal one, and unlikely to occur again, and work was so far advanced that it was not feasible to re-locate it at a higher level, so that in one or two places only, where the local conditions made it possible, were the formation levels altered; notably at Manek Urai, where the bridge abutments were raised four feet, and to the south of Kuala Gris. Here the line, which runs through a deep gorge alongside the Galas River, had been completely obliterated, and a safer trace was located higher up, the new alignment involving four extra tunnels. At Manek Urai bridge the water was five feet above the top booms of the two hundred and fifty-foot girders (they are compression bowstring trusses twenty-three feet high at the centre) when the spans carried away; the smaller hundred-

* The value of the Singapore dollar is 2s. 4d.

foot spans at the south end of the bridge remained intact, and it was established that the failure was due to the enormous pressure of timber which had drifted down from clearings upstream, and had become knotted together by bamboos into a tangled mass that defied all attempts at clearing. Little damage was done to the piers and abutments, but as the girders were badly twisted, and one had been carried some way downstream, it was decided that it would be cheaper to break up the wrecked spans where they lay and put in new ones than attempt to salve them; a policy that was amply justified later on, despite the fact that there was only one two-hundred and fifty-foot span available in the country at the time. On the whole the Hume pipe culverts stood up very well to their work, but in a great many cases the wing walls were scoured away and collapsed. Settlement of the tunnel walls accounted for the occurrence of several cracks in the linings, and in one case the hill through which the tunnel was being driven slipped bodily and caused a certain amount of internal damage; the work on the tunnel section was not, however, seriously impeded, and the damage was made good without much trouble. By the end of February, 1927, ballast trains had been run from Tumpat to Sungei Golok and from Kuala Krai to Manek Urai, and the latter section was handed over to the Open Lines Department in the middle of October, by which time the line from Pasir Mas to Kuala Krai had been repaired. A temporary bridge was completed at Manek Urai by June 19th, but progress south of that point was slow owing to lack of transport. The difficulties of reconstruction were enhanced by sickness which broke out immediately after the flood, and by lack of coolies, many of whom left as soon as the water had subsided, and did not return until "open lines" had been restored.

By 1928, re-organization was complete, and reconstruction well in hand; the end of the year saw the erection of twelve bridges and the completion of one tunnel, four other bridges were in various stages of construction and the earthwork had been practically restored throughout. Apart from the tunnels, which are mostly between Manek Urai and Pergau, the chief works in hand for 1929 were the erection of Renoh Bridge and the Kasuku Viaduct, and the handing over of the section Merapoh–Gua Musang to open lines; after the events of the winter of 1926, however, some apprehension existed as to the effect of the monsoon, and it was questionable whether the section ought not to be left in the hands of the Construction Department until the spring of 1930. In October, the viaduct had been completed and the falsework was being dismantled, but unforeseen delays had occurred at Renoh*, and the situation there was rather a critical one, as the temporary bridge, which was only about twelve feet above

* The erection of the girders was successfully accomplished before the monsoon broke.

normal river level, was almost certain to be lost in the December rains, and there remained only six weeks in which to erect two two hundred and fifty-foot spans and clear the waterway of the falsework below them.

Practically all the bridges on the line have been erected on timber stagings or sleeper cribs built up between the piers to the level of the bottom booms, but one or two of the smaller spans have been launched complete. The falsework and temporary bridges across dry gaps are made of jungle timber cut on the site, but this wood cannot be relied upon to give more than six months' service, as it is not only soft and full of sap, but is also very prone to the attacks of white ants. The Chinese have become very adept at the working and handling of jungle timber, and a gang of twelve can frame up and erect a trestle twenty feet high, from round baulks roughly hewn, in an eight-hour day. Over waterways, or at points where the ground is at all soft, the falsework is generally built on to square hardwood piles (10" x 10" or 12" x 12") driven to about a quarter of an inch set, for which work Sykes' quick-action piling winches and McKiernan-Terry No. 6 hammers have been used, and have given very good service under the most exacting conditions. The trestles for temporary bridges are usually built with square hardwood transoms and ledgers, and are spaced at fifteen-foot centres, an axle load of twelve tons being carried across this span either by three clusters each of five 60-lb. F.B. rails or by three 14" x 14" hardwood stringers. The average cost of jungle timber falsework has worked out at about $25 per foot run of gap, and the enormous economy effected by the use of round baulks can be judged from the fact that the approximate prices per ton for round and square timbers of the sizes mentioned are $15.00 and $55.00 respectively.

Sleeper cribs filled with broken stone are now placed on the upstream sides of the trestles in temporary bridges to minimize the risk of damage from flood; they have not a chance as yet of proving their worth, but though in a small spate they may prevent damage from scour and floating timber, it is doubtful if they would have any real effect in a serious flood. In an attempt to prevent a repetition of the disaster at Manek Urai, the experiment is being tried of tying down the ends of the large spans of permanent bridges on their upstream sides by means of three-inch steel rods attached to the bottom booms, and to pairs of 6" x 3" R.S.J.s let into the piers or abutments about fifteen feet below the level of the bedplates. The rods are divided in the centre, and are fitted with right and left-hand screw threads so that they can be tensioned up after fixing. This arrangement has not yet had, and it is naturally hoped will not be given, an opportunity of proving its efficacy.

The F.M.S. Railways have standardized a series of spans both for deck and through bridges, and all gaps are crossed with

combinations of these spans. The standard spans now in use are as follows :

Deck spans, 20, 30, 40, 60, 80, 100 feet,

Through spans, 20, 30, 40, 60, 100, 150, 200, 250 feet,

and of these all but the two longest through spans, which are bowstring trusses, have parallel booms.

The design of the footings for the piers and abutments is naturally determined by the local conditions. As a general rule, open foundations are put down if the soil is reasonably good and the excavated depth below ground level does not exceed twenty feet, but where there is any possibility of scour or a suitable bearing stratum lies only at a considerable depth, the load is taken on concrete wells sunk in pairs about six feet apart. These wells are concrete cylinders varying in external diameter from twelve feet to eighteen feet and in thickness from eighteen inches to three feet six inches, the dimensions depending on the span the foundations are supporting. They are built up in sections five feet long and are sunk under their own weight by dredging, the sections being bonded together by half-inch rods placed at one-foot centres concentric with the well and about one foot in from its external face. The first section, which is ten feet long, is sunk in a pit dug by hand and is built on to a steel or concrete curb having a cutting edge the same diameter as the well ; the excavation is continued by grab and steam winch, and subsequent sections are cast on as the well sinks until it has reached a depth at which trial borings have revealed the presence of a suitable stratum, when the bottom is examined by a diver and, if satisfactory, is cleaned up and sealed with five or six feet of mass concrete. The two wells are then filled up to the top with sand and joined together by a reinforced concrete slab upon which are erected the abutments or piers, as the case may be. The usual rate of progress, including all operations, for such a well is about two feet in three days under normal conditions. There is a possibility that, when wells are driven through a soft stratum towards a hard one some way below, they may take charge and sink out of sight. A case somewhat like this occurred on the Sungei Golok line, where trial borings had revealed a suitable stratum about fifty feet down. This, however, proved to be very thin and, although it did not actually take charge, the well drove straight through it into a layer of soft shale and showed no inclination to slow up, sinking more and more under the weight of additional sections until excavation was discontinued at a depth of about seventy feet. In this case the well was not sealed, but was filled with sand, which mushroomed out at the bottom and consolidated the soft stratum until no settlement was discernible. Test loads were then applied, first to the sand core and then to the concrete shell to assist consolidation, and as no further settlement took place, the foundations were considered safe. The bridge has now been open to traffic for

more than two years, and there has been no sign of movement in the foundations.

The East Coast Railway has been built to unusually high standards for a development line, and it is doubtful if the limitations of four degrees of curvature and a ruling gradient of one in a hundred are really justified. A little more latitude in these standards to, say, five degrees of curvature and one in seventy gradients would have resulted in a much more economical trace, particularly in the Kelantan section. It is unlikely that the line, which is due to be completed in 1931, will pay any interest on capital expenditure for another fifteen years, but the resources of the country through which it is being built are so great that there is little doubt that, once they are developed, the policy of the F.M.S. Railways in constructing a line up the East Coast of Malaya will be amply justified.

The state of Kelantan consists of a fertile and densely populated coastal plain about a thousand square miles in area, lying behind a low sandy coast line about sixty miles long; to the south of the plain the country is hilly and broken, the main hills being those of the main range of the Peninsula, which forms the boundary between Kelantan and Perak, and the Tahan range on the Pahang border. Many of the peaks in these two ranges are over six thousand feet high. This part of the state is thinly populated, and has, until recently, remained almost inaccessible, owing to the difficulties of river navigation and the complete absence of other means of communication; it contains the greater part of the foreign-owned estates, however, and is now being opened to settlers by the East Coast Railway.

The climate of Kelantan is probably better suited to Europeans than that of any other part of Malaya, it is dry, cooler than Kedah and Perak and may almost be described as bracing. The country has many attractions. Unspoiled and undeveloped by Chinese immigration, it still possesses all the original characteristics of Malaya, and has become one of the last retreats of the Semang (Negritoes) and Sakai (Blowpipe men), who are the two chief aboriginal races of the Peninsula. The scenery is magnificent, particularly on the Nenggiri River and on the upper reaches of the Galas River. There is plenty of big game, but the country is too close to allow hunting, and the only people who get any shooting are planters and engineers who happen to be on the spot; one sometimes hears of parties going out after seladang and elephant, but these expeditions are only occasionally successful. The chief species are tiger, seladang (bison), rusa (deer), tapir, porcupine and, in the south, elephant.

About eighty-five per cent. of the timber in the state is useless, and there is a shortage of chengai and merbau, which are the two most valuable hardwoods; also the absence of a properly trained Forestry Department has led to the devastation of the wild rubber and gum forests to such an extent that it has now become necessary

to prohibit the exploitation of these jungle products. Soft woods are comparatively plentiful, but have hitherto been too inaccessible to be profitable ; it is hoped, however, that with the opening up of South Kelantan by the railway a prosperous timber industry may be developed.

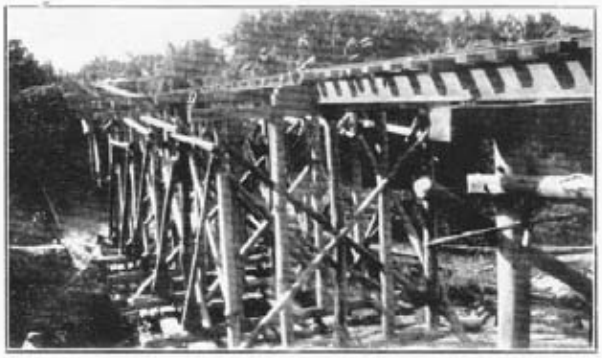
The mineral resources of Kelantan have not yet been fully surveyed, but both tin ore and gold have been worked with success on a small scale by Asiatic methods (open cast mines), and although large-scale mining has hitherto been a failure, there is a reasonable possibility that, with improved facilities for transporting and prospecting, tin ore deposits in sufficient quantity to justify large-scale working may be found in the main granite range which divides the state from Perak, or in that which forms its boundary with Trengganu. Prospecting for tin is being done on a large scale, and a rich and extensive deposit of iron ore has been found at Temangan, which has easy access both to the railway and the Kelantan River, and is favourably situated for exploitation. It is understood that the concessions for this area have been let to a Japanese syndicate.

Hitherto the only means of communication in the state have been the rivers, and the bulk of the goods traffic has been carried on the Kelantan River, which is very shallow and difficult of navigation. Shallow draft launches and small passenger boats can get up as far as the Nenggiri River, but the difficulties of navigation increase so rapidly in the hilly country to the south of that point, that only native praus, some of which are now being fitted with outboard motors, and native poling craft can be used. Kelantan trades almost entirely with Singapore, and up to the present the traffic has been carried by small coasting steamers plying a regular service between Singapore and Bangkok, which call at Tumpat. Trade is much hampered by the lack of any natural harbours or sheltered anchorages, and the water is so shallow that steamers have to lie about two miles from the shore and load from native lighters ; during the north-east monsoon, which blows from November till March, communication between the steamers and the shore becomes very difficult, and frequently has to be suspended. The chief exports of Kelantan are rubber, copra, dried fish, cattle and betel nuts, and with the exception of the copra industry, which is confined to the coast, it seems likely that the bulk of the trade between the state and Singapore will eventually be carried by the East Coast Railway.

The East Coast Railway has a considerable tactical, as well as commercial, importance in facilitating communication and transport with the east coast of Malaya, and in relieving the main line of the F.M.S. Railways (through Kuala Lumpur and Penang) of through traffic in case of emergency.

False work at Renoh Bridge site.

Manek Urai Bridge.

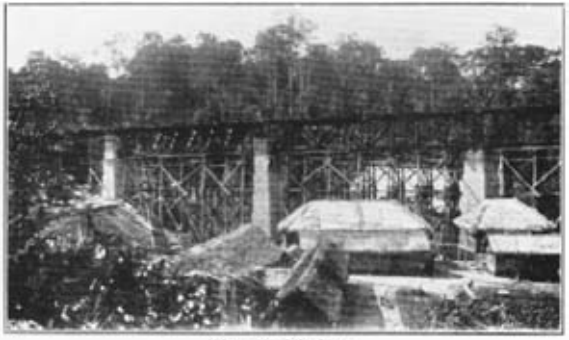


Temporary bridge of round jungle timber.

Temporary bridge of squared timber.

The Kelantan section of the East Coast railway, FMSR

Kasuku Viaduct.



Kasuku Viaduct.

Well sinking for bridge foundations at Kasai.

Well sinking for bridge foundations at Kasai.

The Kelantan section of the East Coast railway, FMSR

THE RECONSTRUCTION OF THE TIDWORTH BRIDGE BY THE 17TH FIELD COMPANY, R.E., IN APRIL, 1930.

By LIEUTENANT W. B. SALLITT, R.E.

THE reconstruction of the "Old Black Bridge" at Tidworth had long been overdue. Built in 1910, as a temporary structure, it had been at best no more than a makeshift, knocked up at short notice with whatever money and materials were available at the time, and as it had aged it had not improved in appearance. Two of its spans were of steel and the remaining six were bridged with a clumsy arrangement of wooden stringers.

A centre pier in the middle of the main road had always been a danger to road traffic, and the bridge had also become dangerous for rail traffic. Many of its timbers were rotten, and although wedges had been inserted in nearly every joint in an effort to maintain correct rail level, when a train crossed the bridge timbers shifted, splinters flew and each span in turn sagged ominously. Unsightly trestles and crumbling abutments completed the picture, *vide* Photo 1, and it was a miracle that the structure had lasted so long.

The bridge was finally condemned, and in January, 1930, the 17th Field Company were ordered by C.R.E. 3rd Division (Lt.-Col. L. V. Bond) to work in conjunction* with D.C.R.E. Tidworth (Major H. E. Roome) and put up a new steel girder bridge, as part of its collective field works training.

The work entailed closing the W.D. Railway into Tidworth, also the main Salisbury–Marlborough Road, and consequently had to be done as quickly as possible. The Company were instructed to carry out the work as a continuous operation, and arrangements were therefore made to work continuously in eight-hour shifts. The last train was to pass over the old bridge at 2 p.m. on Thursday, April 24th, and it was estimated that the new bridge would be open to traffic at the same hour on Monday, April 28th.

THE OLD BRIDGE.

The old bridge, shown in detail in Fig. 1, was 131 ft. long, and had eight spans, whose lengths varied from 12 to 20 feet. It carried a single-line track, with rail level 16 ft. 3 in. above the road.

* The distribution of responsibility between D.C.R.E. and the Company worked out very well, and the actual instructions on this matter are given in detail in Appendix II.

The two spans which bridged the main road consisted of composite girders, whose cross-section is shown in Fig. 2. The rails were spiked to 12 in. x 12 in. baulks, lying inside these girders, supported on three trestle towers.

The remaining spans, of which a cross-section is given in Fig. 3, had an upper and lower course of wooden stringers, separated by 9 in. x 9 in. traverse members. The upper course consisted of two 9 in. x 9 in. stringers supporting the sleepers, the lower of 12 in. x 12 in. stringers supported by corbels lying on the transoms, and two 24 in. x 12 in. stringers placed vertically beneath the rails and continuous over trestles I, V and VII.

Timbers were secured together with a profusion of dogs, bolts and iron straps, and the whole superstructure was a tangle of rotting wood and rusty metal.

All the trestles were of wood, except I and VII, which were of reinforced concrete. The bankseats, also of concrete, were castellated to prevent lateral movement of the stringers.

Between piers V and VI ran the River Bourne, and although barely 15 ft. wide, this stream was a source of trouble throughout the work.

FACTORS INFLUENCING THE NEW DESIGN.

1. *Loads.*

The bridge had to take "Molly" and "Betty," the two engines which run over the W.D. Railway; axle load, 12 tons.

2. *Spans.*

(*a*) The Wiltshire County Council insisted on the removal of the pier in the middle of the road, and would not permit any reduction of the width of the road.

(*b*) On the grounds of economy, use had to be made of the four composite girders of the old bridge and four of the 18 in. x 7 in. x 33 ft. R.S.J.s obtainable from the Railway Training Centre, R.E., Longmoor.

(*c*) At least one of the existing abutments had to be used if possible.

THE DESIGN OF THE NEW BRIDGE.

The design of the new bridge consisted of four spans, giving a total length of 122 ft. (see Figs. 4 and 5). Wooden stringers were replaced by steel girders supported on wooden trestles, open sleepering took the place of the old close work, and guard rails and guard timber were also provided.

1. *Girders.*

The roadway of 41 ft. was to be bridged with four 24 in. x 7½ in. x 90 lb. R.S.J.s, the River Bourne with the four 33-ft. spans from

Longmoor, and the two abutment spans were to be bridged with the old composite girders, which had to be crossed over during the reconstruction, so that the 22-ft. girders could be used on the east end and the 24-ft. on the west end of the bridge.

2. *Trestles.*

The design followed that shown on Pl. 29, *M.E.*, Vol. VIII, the legs and rakers being housed into the caps and sills. All serviceable timber in the old bridge had to be used again and, in consequence, trestle making could not begin until the entire bridge was demolished.

3. *Footings.*

The old footings were unsuitable for the following reasons :—

(*a*) As the old trestles had no groundsills, the old concrete footings had been shaped up to support the legs (*vide* Fig. 2) and thus could not be used for the proposed new sills.

(*b*) The old trestles in the middle and on either side of the road were not at right angles to the line of the bridge, but were parallel to the road. This had been desirable in the old bridge to reduce the effective width of the obstruction in the middle of the road, but in the new design, with its clear span over the road, slewed footings were unnecessary, and, furthermore, they would have thrown abutments out of square with the embankments and complicated the design of the former. It was, therefore, decided to erect the trestles square with the rails. The footings of trestles II and IV (Fig. 4) were to be altered to take the new trestles, and a new footing was necessary between the Bourne and the east abutment; excavation for the latter had to be carried to a depth of six feet before a solid foundation was reached. Steel straps let into the concrete were to be used to secure the trestle sills.

4. *Abutments.*

Design took up for two concrete retaining walls, with earth filling behind.

As traffic had to pass over the bridge within 72 hours of the walls being built, it was considered essential to use concrete blocks. Temporary wing-walls of C.I. sheeting were to be erected to hold back the filling and to form the shuttering for permanent walls to be constructed later.

The new east abutment coincided in plan with the old abutment, but the castellations had to be removed and two courses of 1 ft. 6 in. cube blocks had to be laid to make up to rail level. The west

abutment, a new construction 10 ft. long, 6 ft. high, and 1 ft. 6 in. thick at the top, was to be built with four courses of the same 1 ft. 6 in. blocks, to give an effective height from ground level to the underside of the girder of 3 ft. 6 in.

ORGANIZATION.

Whereas during the design the chief consideration had been economy, the ruling factor for execution was to be speed to complete the job within four days. The 70 available Sappers were divided into two alternating shifts, " A " Shift, 40 strong, and " B " Shift, 30 strong, and these had to work round the clock in the following reliefs :—6 a.m. to 2 p.m., 2 p.m. to 10 p.m., 10 p.m. to 6 a.m., etc. The disparity in strength was caused by the concentration of all the carpenters and bricklayers in " A " Shift in order to expedite trestlemaking and abutment construction on the second day.

To speed up things to a maximum, it was decided to use all available mechanical resources. All derricks, ordinary holdfasts, winches, etc., were to be dispensed with and the girder launching, trestle erection, etc., was to be carried out with our own derrick lorries (Morris and Guy), supplemented by a 2-ton portable crane on loan from Ordnance. A list and short description of the power tools available in the Company is given in Appendix I.

Preliminary work comprised :—

Under D.C.R.E. Arrangements.

The new concrete footings were prepared a month before work started and the necessary number of concrete blocks were cast for the abutment walls.

To admit of night work being carried out continuously, five 20-ft. poles, carrying powerful flood lights, were erected on the site.

Two trucks filled with earth were shunted into sidings on either side of the bridge for use in the abutments.

Under Company Arrangements.

Each trestle in the new design was numbered, each member of it was given a letter, and all sound timber of the old bridge was earmarked, so that on dismantling it could be quickly dumped where required for trestle making.

The 45-ft. and 33-ft. girders were off-loaded from railway trucks on the embankments on each side of the bridge.

A temporary bridge of pontoon superstructure was laid over the Bourne between piers IV and VI (Fig. 4), and subsequently another bay was laid alongside it to form a wide platform on which the derrick lorry could manœuvre.

The Work.

It had been estimated that the job could be completed in four days, as follows :—

1st day—dismantling.
2nd day—construction.
3rd day—erection and launching.
4th day—sleepering, platelaying and clearing up.

Parties commenced work on Wednesday, 23rd April, when the preliminaries of clearing the site, laying a bay of pontoon bridge, etc., were carried out.

" A " Shift, starting work at 6 a.m. on Thursday, drew tools and stores, erected a store tent and loosened all accessible nuts in the bridge (Photo 1.)

The last train crossed the bridge at 2 p.m. ; " B " Shift came on at the same hour, accompanied by heavy rain, and it was soon very difficult to walk on *terra firma*, whilst movement on the timbers and girders of the bridge was most precarious.

The first problem met with was the freeing of the 12 in. x 12 in. baulks out of the troughs in the composite girders. It was hoped to be able to lift these baulks out of the seatings and use them as ways over which to slide the girders out on to the embankments, but this proved impossible for, even when all wedges had been removed, the baulks were found to be held fast by the bitumen which had been poured in between them and the girder webs. The derrick lorry was called to the rescue and with it all four composite girders, each weighing some four tons, were lowered straight down on to the road. The extraction of the 12 in. x 12 in. baulks was not easy and various methods were tried in vain.

The method which eventually proved successful was to drive a bolt into the end of the baulk, by means of which one end of the girder could be picked up by the derrick lorry ; the girder was then hammered downwards with sledges until steel wedges could be driven in between the flange and the baulk ; once a start had been made in this manner, extraction became a matter of minutes.

Meanwhile, the demolition of the wooden spans was causing much trouble. Most of the nuts had to be mutilated as the bolt heads were either inaccessible or countersunk and could not be prevented from turning round in the rotten wood. To add to the troubles, many of the timbers, which weighed nearly a ton each, could not be lifted by hand off the bolts ; nor could the bolts themselves be driven out. Again, various methods had to be tried, and the most successful proved to be to harness the baulk to a lorry by means of a tow rope. In nearly every case the bolt either sheared or buckled when the lorry was driven off down the road.

By 6 a.m. on Friday, the four composite girders were in the road, the end spans had been cleared ready for abutment construction, and although most of the trestles were still standing, it was evident that these could be easily pulled down by the derrick lorry.

Trestle construction was slightly delayed, owing to the trouble experienced with the composite girders, and could not be started till 10 a.m. on Friday; in consequence, it was decided that the 6 a.m. shift of carpenters would have to work right through until 10 p.m. This meant a 16-hour shift on top of a soaking, but the men worked splendidly, and by 10 p.m. on Friday, four trestles were finished, two abutment walls had been built and the general picture at site is shown by Photo 2.

The next shift had the trickiest part of the trestle erection to deal with, and as it had poured with rain all night, working conditions and visibility made things none too easy for them. Of the four trestles ready for erection, two formed the pier on the east side of the Bourne. The derrick lorry could lift the trestles just high enough to drop the sill in between the iron straps of the footings, but it could not carry them to the site, owing to their weight of 2 tons each. The crane, on the other hand, could carry the trestles about but had not sufficient lift to place them in position. In consequence, both crane and lorry had to be used in conjunction and the manœuvring involved was a lengthy and tricky operation. In the attempt to reach pier VI, the crane became bogged in a short length of ground between the road and the temporary pontoon bridge, and it was necessary to lower the trestle on to the ground, extricate the crane without its load and man-handle the trestle forward, until the derrick lorry could manœuvre near enough to lift it into position. All this proved a long process, but eventually two trestles were erected and braced together by 4.30 a.m. on Saturday, and another party had finished filling behind the new abutments, using earth brought to site in railway trucks.

In the meantime, it became necessary to extemporize a method of raising the composite girders out of the roadway on to embankment level. The method adopted here was the use of locos. as main tackle, primitive perhaps, but requiring careful manipulation. Having raised the girders in due course, it was then decided to launch first of all the two which spanned the east bay. It had been hoped to launch these over the standard equipment box girder rollers, but the rivets projecting from the bottom flanges made the first girder bounce so alarmingly that the method was voted too dangerous, and the second girder was pulled out by the derrick lorry, with the Morris on the embankment acting as preventer.

The remaining trestles were up by 4 p.m. on Saturday; unfortunately, however, one of them was slightly out of plumb, but as this trestle had been finished by night and in pouring rain, with only

the headlamps of a lorry for the men to see by, this defect was perhaps excusable. To remedy it, the bracing had to be removed and a sling fastened round the cap, and attached to the crane cable; the trestle righted itself on winding in, but sprang back when tension was released. Quarter-inch steel wedges were, therefore, hammered in between the raker and the sill, the trestle was properly trued up, and all was at last ready for the remaining girders.

The span which now had to be bridged was the centre one over the main road. It was known that the launching of the 45-ft. girders quickly and without derrick, holdfasts, etc., would have to be very carefully arranged for, and the following was the method it was decided to try out. To save time, the four girders were bolted together in their pairs prior to being launched. A Morris was driven along to a level crossing, a quarter-mile from the west abutment, and thence backed along the railway line to the embankment for use as preventer tackle. The medium derrick lorry was positioned for use as main tackle as in Photo 3, but to the east of trestle IV of Fig. 4. The pairs of girders were then launched out over box girder rollers placed on the cap of the new trestle 2 (Fig. 4), and also on the cap of the old centre trestle, which had been left standing (*vide* Photo 2) for this particular purpose. When the nose of the girder had been hauled close up to trestle IV (Fig. 4), the nose was allowed to dip to free the roller under the tail at trestle 2; the tail was then positioned on trestle 2, the nose raised to free the roller on the old centre trestle, and the nose then finally lowered on to trestle IV.

Both of the centre span pairs of girders were launched in the same way, they were out by 4 a.m. on Sunday morning, and when it became necessary to remove the old centre pier, it was found that it required very little persuasion.

The derrick lorry was then run round underneath the 45-ft. girders and its derrick erected between them to launch the 33-ft. girders from the eastern embankment. The other Morris acted as preventer, and the girders were slid out with very little trouble, inside the channels of the composite girders.

The two remaining composite girders were slid out on rails, using the Guy and Morris again, and all the girders were over by 11 a.m. on Sunday.

The remainder of the day was spent in lining up the girders, taking levels and making the necessary small adjustments in height. All levels were corrected, so as to give a constant gradient, accurate to $\frac{1}{8}$ in., over the bridge. These necessary adjustments proved aggravating and tedious for, after three successive nights out, the brain was not at its best for accurate levelling work and computation, whilst packing involved the raising of each girder in turn.

Sleepering commenced at 11 p.m. on Sunday, and the first truck (empty) crossed the bridge at 8 a.m. on Monday, by which time the bay of pontoon superstructure over the Bourne had been dismantled and a great deal of clearing had also been done.

Monday morning was spent in fastening down the guard timber, a job in which the pneumatic wood auger proved the greatest value, and making up under the new sleepers on either embankment. The centre pier was also demolished, the concrete base pillars being removed bodily with the lorry and tow rope. The stumps and base were finally demolished with the compressor and a road maintenance party had the road open to traffic by 2 p.m.

At the same moment, "Molly," who had been getting up steam all the morning, appeared with two trucks, and as the shifts were just changing over, the whole Company saw her pass over the bridge, 96 hours to the minute after the last train had crossed the old bridge (Photo 4).

CONCLUSIONS.

1. From an engineering standpoint, the outstanding feature of the work was the value of the medium derrick lorry and the compressor, whose engines ran almost continuously throughout the job.

It may be of interest to tabulate the tasks performed by the derrick lorry, and consider how much longer these would have taken, using any form of standing derrick with its accompaniment of tackles and holdfasts.

(*a*) Off-loading eight 2-ton girders from railway trucks.
(*b*) Lowering four 3-ton composite girders from a height of 16 ft. into the road.
(*c*) Extracting the 12 in. x 12 in. baulks from inside the composite girders.
(*d*) Demolishing the old timber bridge; the combined lifting and towing properties were invaluable.
(*e*) Turning over trestles during construction (5 minutes).
(*f*) Towing crane into position.
(*g*) Erecting trestles.
(*h*) Launching girders weighing up to 3 tons over gaps up to 45 ft.
(*i*) Positioning girders on trestle.
(*j*) Lifting up guard timbers from the road and depositing where required on the bridge.
(*k*) Picking up and placing on trailers for removal about 30 tons of timber in 2½ hours.

The compressor was used a great deal for augering and concrete-breaking,

THE RECONSTRUCTION OF THE TIDWORTH BRIDGE BY THE 17th (FIELD) COMPANY, R.E., IN APRIL, 1930.

Photo 1.—The old bridge (2 p.m., first day).

Photo 2.—After 16 hours.

Reconstruction of the Tidworth Bridge

Photo 3.—After 40 hours.

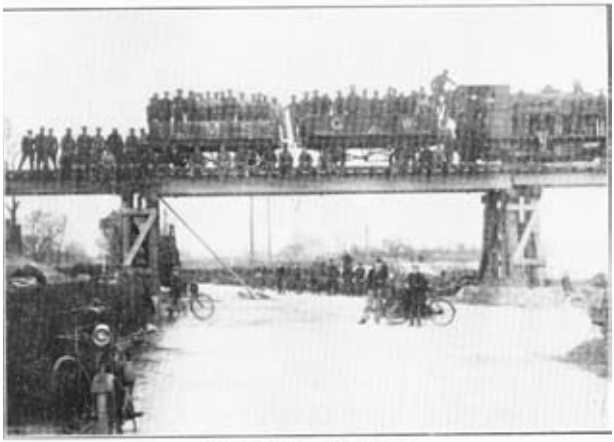


Photo 4.—After 96 hours.

Reconstruction of the Tidworth Bridge

2. The work served as an illustration of the twofold value of mechanization in a job of this type, when conditions approximate closely with those obtaining on active service. Not only was the work simplified and accelerated by the use of power tools, but the efficiency of the men themselves was enhanced; although the bridge was five miles from Barracks, the work could be carried out without camping at the site, and thus the men could be provided with hot meals in Barracks at the beginning and at the end of each shift.

3. A further conclusion was that the alternative eight-hour shifts could only be worked on jobs of comparatively short duration. A man needs more than eight hours to get rested, especially if the eight hours include two meals and two five-mile journeys in a lorry. Although even on the last day there was no diminution of efficiency or enthusiasm for the work, the pace could hardly have kept up for more than another day or so.

4. An oxy-acetylene plant is essential for work of this nature, and the one borrowed from Ordnance had plenty to do.

5. It would not have been possible to attempt to carry out a job of this size and urgency had the Company not been a mechanized Field Company.

APPENDIX I.

Power Tools Employed on the Work.

(1) A Guy 6-wheeler derrick lorry, having a derrick mounted on the rear of the chassis. Height of derrick, 21 ft., and capable of being erected in half a minute.

The winding gear gives a 4-ton horizontal pull and will lift 1 ton without sprags, and 4 tons with them.

(2) Two 6-wheeler Morris tool lorries with a winding gear giving a 3-ton horizontal pull. The cable can also be carried over a 10-ft. derrick mounted in the rear of the chassis, whereby weights of 15 cwt. or 3 tons can be lifted with and without sprags respectively.

(3) An Erco band saw, driven by a small petrol engine of the motor-cycle type; this can be operated by three men and is held in position by means of three handlebars. It will cut through a 12 in. x 12 in. baulk in less than a minute.

(4) The compressor, capable of working two pneumatic tools simultaneously. The following were employed on the bridge:—

(*a*) Concrete drill.
(*b*) Concrete breaker.
(*c*) Wood auger. Thanks to the R.E. Board, this machine had been supplied from the Consolidated Pneumatic Tool Company, and proved invaluable. It will bore a $\frac{3}{4}$-in. hole through 12 in. of new oak in 45 seconds.

(5) In addition to the Company tools, a 2-ton crane was loaned by Ordnance; this gave only a 14-ft. lift, and although very unwieldy to move about, it provided valuable assistance in erecting trestles.

(6) An oxy-acetylene plant, also loaned from Ordnance, was used to cut the straps securing the legs of the old trestles, and for welding up several of the new straps which were damaged by the fall of timber during the dismantling of the old bridge.

APPENDIX II.

EXTRACT FROM C.R.E. 3RD DIVISION'S INSTRUCTIONS FOR COLLECTIVE TRAINING PERIOD, 1930.

* * * * * * *

6. *Field Works Schemes.*

The following special or combined schemes will be carried out :—

(1) *Scheme A (Heavy Bridging)—17th Field Company.*

Repair of Railway Bridge over the main road opposite Lucknow Barracks, Tidworth, for D.C.R.E., Tidworth.

The O.C. 17th Field Company will be responsible for :—

(1) Checking D.C.R.E.'s design, calculations and list of materials for incorporation in the work.

(2) Assisting D.C.R.E. with an officer and draughtsman for making the detailed working drawings (this officer will also assist the D.C.R.E. for getting out list of materials).

(3) Working out scheme of erection and providing (or indenting on D.C.R.E. for) the stores required for erection, including the lighting set for night work.

(4) Providing loading and unloading parties as necessary.

(5) Receiving, stacking and accounting for all stores and materials at site.

(6) Arranging with D.C.R.E. the date of erection (D.C.R.E. will arrange with local authorities).

(7) Arranging with Garrison Adjutant for allotment of site for camp at the material dump, sanitary services, etc.

(8) The erection of the bridge (and safeguarding the public during erection).

(9) Clearing the site.

All expenses will be debitable to the D.C.R.E.'s allotment for work, except expenses of camp and move, which will be charged to the T.G. of R.E. 3rd Division.

FIG I

TIDWORTH BRIDGE

OLD ARRANGEMENT

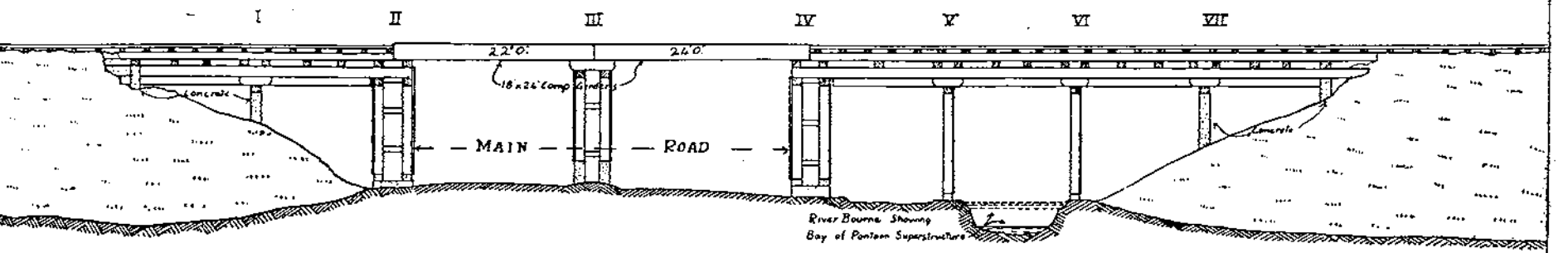


FIG. II.

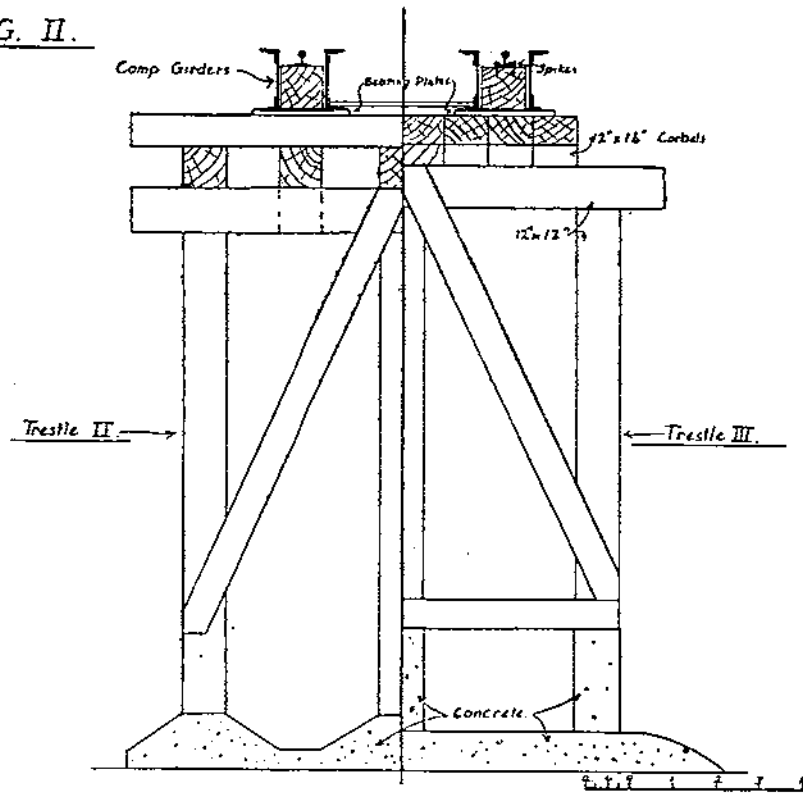
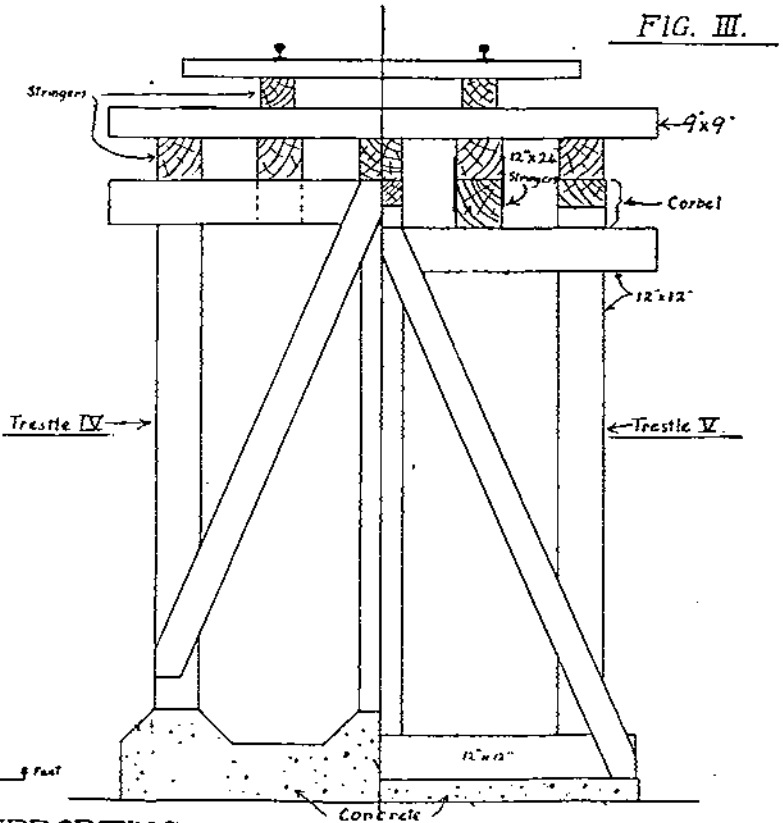


FIG. III.



METHODS USED FOR SUPPORTING COMPOSITE GIRDERS & STRINGERS

J.B. Longcliff
Spr. R.E. 17th Fld. Coy
21.3.30

~ TIDWORTH BRIDGE ~

~ NEW ARRANGEMENT ~

FIG IV

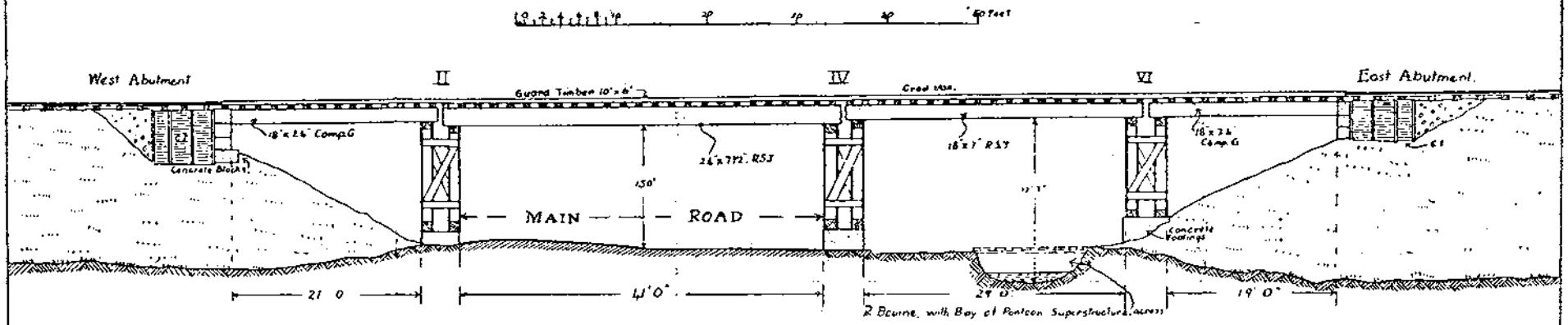
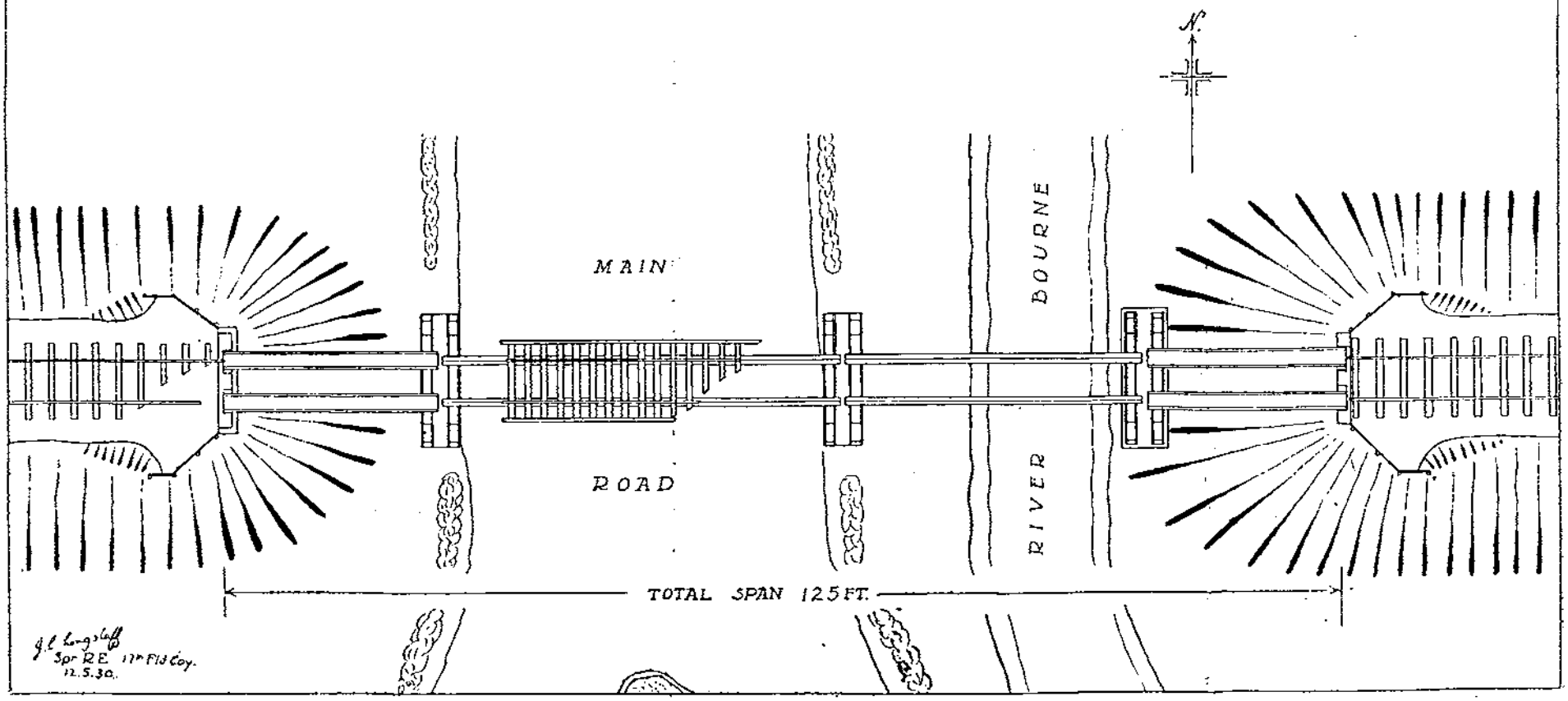


FIG V



J. L. Long Capt
Spr R.E. 17th Fld Coy.
12.5.30.

THE ABOR MILITARY AND POLITICAL MISSION, 1912–13.

(*Continued.*)

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

3. THE SIYOM (*Continued*).

Feb. 27. Puitgong-Siyom junction. Seemed hopeful in early morning, and at 11, the beastly barometer having risen, I determined to get across the Siyom. Two (6 bamboo) rafts had been made the day before and these were carried down half a mile to the mouth of the Kebung and joined together, and at 1.30 the first party went over. Then a thunderstorm came on and it rained cats and dogs till dark, by which time only half the party were across, as the Siyom was coming down in flood, and at each crossing the raft was swept down about 300 yards. So I had to take the other half back to camp.

Feb. 28. Back with remaining half of party by 7.30, and got across, paddling the raft myself, which I found hurried things much more, though most tiring. Clouds still too low for really useful work. Camped at Rengku village. Minyongs frightened at first, but quickly got reassured and friendly. To bed. Raining again.

March 1. Started with rations for two days for Yillo Hill, 6,430. Cleared ridge at top of hill. Very cold, but plenty of good firewood. Mist rose and gave fair view. Worked till dark.

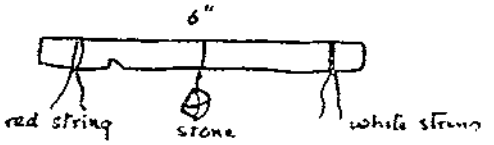
March 2. Rushed to hill, 100 yards along ridge, half-dressed, at dawn and got most wonderful view of the Po, Yorking and Parri snows. Lovely! Hamid Gul worked solid to 11 a.m. He surpassed himself and knocked out a splendid bit of work. I took heights with 3-in. theodolite, and questioned the Abors, both breakfasting while working. Splendid day. Reached Siyom, 5,400 ft. below, by 2.30; across 4.30. Took reading for Siyom level just before dark. *The Siyom comes from the north-west. Hurrah!**

March 3. Kaying camp. Boris will not come in and parley, and there are no signs of them yet. These Kaying and Tumbuin Minyongs are between the devil and the deep sea. They want, and are frightened not to help us, but if they do, they are frightened that the Boris will punish them by stopping their salt, etc., when we go away. I think things will probably be talked over when we get two marches on, but it certainly now looks like war, in which case I will

* This was one of the points the party were to clear up.—ED.

gladly lay down my theodolite for my pistol. They say the Boris' plan is to get us unawares in camp and rush us all at once, the usual tactics on this frontier with small parties. What we hope they will *not* do is to booby trap the precipices and cut down the bridges, etc., as it means we have to go so slowly. Another fine day, so the luck is with us. The work from the Yillo was a gift, and Hamid Gul will be working on the rays from it till the end of this Siyom sideshow.

March 5. Work very satisfactory. Rain starting again. Situation still interesting. Messages as below flying about. It would be interesting to collect more of them. Yesterday's from the Boris was thus :—



The notch means having come more than half-way into the country ; if we return, that is to the white string, it will be peace ; if we go on, *i.e.*, to the red string, it will be war ; the stone tied on means that their hearts are as hard as stone. In 1894, when the expedition started, the Danroth Padan Abors sent a bundle of hair, a handful of sand, a piece of charcoal wrapped in red cloth and a chile (red capsicum). The meaning being that their men were more numerous than the hairs of a man's head or the sand of the river shores ; that hearts were evil and bent on fight (black as charcoal, wrapped in red for blood), and that they were as keen or hot as chile for the fight. A stone in a basket also came in yesterday for one of the interpreters, which meant his son was ill (the hearts at home heavy).

March 6. Off 8 a.m. to the Sikon-Siyom junction just below Tumbuin, only 4 miles odd, as the coolies have to go back each day and bring up more rations, we neither wishing nor insisting on too many coolies. Rained hard all the time and it was beastly while the camp was being cleared and built. Porter and Hore determined to go cautiously and take no risks. The coolies and khalasies have made themselves spears from bamboos and hardened them in the fire. Still raining, but most comfy in our little hut.

March 8. Rain all night. Hore in at 10.30. Yangking *gâms* came in to say Mega Bori *gâms* would not come in. That the Boris were making booby traps above the path across the face of the cliff opposite and were cutting the bridge and that all the Bori of the near villages (400–500) were encamped in Mega, across the bridge. They then said to our *kotoki* Yango that he should come with them and they would show where the traps were. Very pluckily he said " Yes," and Hore took the risk of letting him go. Sure enough, as Hore guessed, all these stories had been bluff to try and frighten us, and

in half an hour Yango was back with 2 Bori *gâms*, who came in very frightened to make a personal try to stop us. Yango had found no booby traps, but only 20 Boris making a small stockade on the part opposite, as a sign to us not to proceed. The *gâms* went away, saying they did not want to fight but that, if we insisted in coming into their country, they would. They will probably make the best of a bad job and let us in quietly. This, for survey work, is just what we want, though I must say I feel disappointed at not having a bit of a scrap. Rain most of the day.

March 11. Rained all night. Porter in at 7 a.m. About 2 hours after dark, in spite of the candles we had sent them, 3 fellows had fallen down the *khud:* only 10 ft., but Porter decided it was too dangerous to go on. Lighting fires on the narrow path, he spent quite a passable night and wasn't too hungry next morning.

March 12. Nyoro Sibo camp. A two-shift *bandobast*, but delayed by having to build a temporary bridge over the Sire. Whole move about 2 miles. Rain all day. Beastly camp.

March 13. Opposite Bogu. Two-shift *bandobast*, but only 1½ miles. Not suitable camping ground ahead. Rain all day. Camp more beastly. We are moving so slowly, I fear I shall not be ready at Bogu when the rain stops, but Hore and Porter wish to keep concentrated till relations are established with the Boris, hence we all keep within a mile of one another. As they truly say, loaded coolies with a few sepoys are always a source of danger.

March 14. Started 8.30 a.m. As Hore and I rounded a corner, we saw the Bogu bridge (cane suspension) with one end lying in the water, and some 20 Boris on the opposite bridgehead who had evidently been waiting our approach to cut it down. On reaching the bridge, we also cut it down from our side, which will give them more trouble to repair. We then went on and the Boris opposite started shouting. The two *kotokis* went down the river and tried to get them into conversation: two came down to give signs of fighting and the rest bolted on ahead, evidently to warn others. We then reconnoitred on a little, going very cautiously at any nasty places in case of stone shoots, and decided to camp at the broken bridgehead; returned, followed on the opposite side by more Boris, one of whom had the impertinence to fire his arrow at us. While camp was being made, Hamid Gul and I cut a path up the hillside above and got a view of Bogu, and I made a small eye-sketch of the paths up to it. Also saw Payum and the Sike River at last. Cut some bamboos for rafting on way back. In camp at Bogu bridge at 5 p.m. Really quite an interesting day and it looks as if the Boris meant business at last. We heard from the Dihang that 200 Membos or Tibetans were with the Jambo Boris. We must now effect a junction with the Shimang parties and our convoy.

March 15. At night we were disturbed by a big tree, which crashed down through the jungle above us, and for a moment we thought the Boris had some game on. Coolies went off early to get some bamboos. Boris shouted across to us and we parleyed fruitlessly across the Siyom for about an hour. Porter and I went off to reconnoitre Siyom-Sike junction, which we reached, going very cautiously in case of traps, in about an hour. Good pool for fishing from other bank, but not long enough to run a big fish in. Saw some 32 Boris returning up-stream. Porter returned to camp. I went up spur above the junction, cutting a path for 2 hours. Wearing and dirty work. Cleared a little space and saw another village, Gameng, up the Sike; also Payin bridge over the Sike. The Yiyu bridge over the Sike is 200 yards over the junction. Have seen no other bridge over Siyom. Back 4.45. Only one raft ready and Boris have been shooting with arrows (wooden ones only) at coolies getting water from the river. No one hit, and they are probably only getting the range for our crossing.

March 16. Great discussion till 8 a.m. Porter for further delay, and I for not waiting after the 17th. Hore eventually decided on 18th. Self went down river for more bamboos. Returned to find Hore and Porter going over to have a parley with the Boris, who had come down unarmed and wanted to talk over matters. Did so and 3 of them returned our visits and were given presents. This sudden change of front is curious and probably has some outside reason. Bother! Bang goes a chance of a most exciting crossing under arrow fire. Two more rafts made (by 15 men in 2½ hours, with bamboos all ready) large enough to carry two paddlers and 3 or 4 men with rifles, etc. Great discussion in evening with Porter about the advantages of patience and giving these tribes around Assam time to cool down.

March 17. Porter and 18 rifles were paddled across at 7 a.m. No Boris in sight. They were up on the fields above the gorge by 8.15, which made the crossing absolutely safe. Whole party over in 3½ hours, using first 3 rafts, then 4. Towards the end, only 3 men or 6 loads allowed for each raft, as these green bamboos leak a bit and get less buoyant after some hours and there is always a risk of them buckling in the centre suddenly, as happened last year. Camp on fields near streamlet some 600 ft. above the river and 1,600 below Bogu village. Several Boris, men, women and children, came down to the camp and protested absolute friendliness, swearing it was the next village that had shot arrows at us and been so defiant. The villages also seem too small to muster sufficient numbers against us. Magnificent view of the Parri snows from the front door of our *basha*. The *damdin* flies are pretty bad and most of us have sore hands or knees.

March 18. Went up hill above with Hamid Gul. Hore having great discussions with various Bori *gâms*. Bogu very friendly. Nice to get some chickens again. Long time since we had any fresh meat.

March 19. Rain all day. News that Meade and Oakes will be in to-morrow.

March 20. Oakes and Meade in p.m. and rearguard slept the night out in the rain on the hill above. They have had very hard marches to get here in 6 days from Dosing and have to rest to-morrow to recoup. Things seem to have been going badly and I am beginning to doubt if we shall reach the falls this year. Oakes, when visiting Milang (or Orlong) on the Yamne River, was told of a Tibetan who came through 30 years before, and it seems there is no doubt it was Kinthup, who came down from Tibet, but was stopped by the Padan Abors. This practically proves that the Tsan-po is the Dihang, and shows how accurate Kinthup's report was.

March 21. Settled our programme with Hore and Porter. Willy-nilly, we must be back to the main line by about April 27, asking for more convoys or *dâks*. So we start to-morrow and hope for fair weather and luck. Yiyu *gâms* in, so it looks as if we may get through splendidly. They are in an awful funk, and think we want their country.

March 22. Oakes and Meade went off with returning convoy, taking back theodolite, camp bed, spare clothing, etc., as every coolie will be of value during these last 6 weeks till we get back to the main line. With the convoy came out a Tibetan interpreter, quite well educated, and knows a lot about these tribes. He says the Mimats are an outlying tribe of Tibetans on the N. side of the main range. They are not cannibals. They are very short-necked, and it is said of them, "They make much glad if they fall down, as can then see heavens." But I fear they will be on the other side of the frontier and we shall not have time to see them. To-day we shifted with 6 weeks' food in 4 shifts to a camp on the Sike-Siyom junction, and Hamid Gul and I worked from a field hill just above the village, with a view up both the Sike and Siyom. Though the *gâms* had got over their fright it was some time before the villagers came out of the village to look at us. But, by the afternoon, they were reassured we were not really going to be brutes, at any rate for the moment, and we were surrounded by the whole village, including women and children, making signs and examining our clothes and accoutrements and thoroughly enjoying the treat. This tribe has never been allowed by the lower tribes to trade down to the plains and had only heard of us as the Maharani's people. The immemorial custom of these parts is that each tribe remains in its own area and does not allow surrounding tribes through that area. Though trade

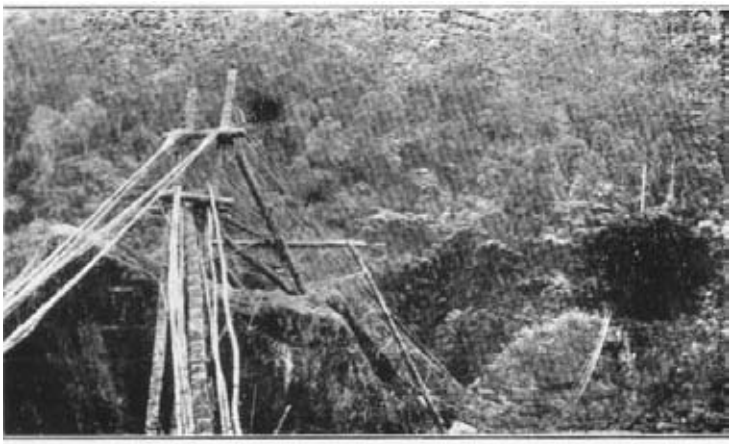
is busily carried on between them, there are no through-traders. Hence you will see that some tribes who have more to sell are beginning to see the advantage of our opening up the country, as then they can get through themselves to the plains.

March 25. Yiyu camp. Attitude of Boris still a bit doubtful. Preparations for start to-morrow. Porter remains here in stockade with 12 rifles and Hore and I with 36 rifles and 18 days' rations make a dash up the Siyom.

March 26. Off at last, after finishing Porter's little fort for him. Passed under cliff, where there were marks of removed booby trap, so these Bori villages are hedging. Passed through Dupu and camped just beyond. Plenty of women and children. Seemed friendly and not frightened. Weather fine, but dull haze, and cannot see clearly more than 4-6 miles. The guide ("Mutton face") tells of 30-40 villages in front, some big, so we may be forced to return in the end. They say that the path, which is obviously precipitous, has been blocked and the galleries broken down. A silly ass of a sepoy has cut his knee with a *kukri*.

March 27. Hamid Gul and I went ahead and we all got into Ro about 11 a.m., the sepoy hobbling with difficulty. Great nuisance, and has decided Hore to halt to-morrow, especially as it is safer to reconnoitre the road ahead first. From here start the precipices of this extraordinary gorge the Siyom has cut west to east straight across the Parri-Yorking snow spurs of the main India-Tibet range. The Ro *gâm* says he will show the path up to where it has been broken by the next village, Pa-um, but no man can get through now. There is a lot of lying done in this country. Village brewed *apong* for us, and Hore and I chatted with them after the camp had been built. My watch, which I tell them is my sun, always fills them with wonder, as they think the ticking is that of a small animal alive, working hard inside to make the second hand go round like the sun. We now have the story that one or two rich Tibetans, possibly Chinese, came over the Siyom pass a few months ago with 50 coolies, and that the Boris murdered him (or them), sacked the stuff and sent the coolies back. The passes are not yet open, but remain open it seems from about May 15 to December 1.

March 28. Not a bad day. Camp halted for the sick sepoy. Hore and I went ahead to reconnoitre. After 1½ hours' walking (passing one stone shoot which had been let down, on the way), reached the path where it crosses a ravine and ascends straight some 600 ft. Then it goes along a bare cliff, the most terrifying place I have yet seen, with rock or earth slides overhanging it in places. The path creeps about half a mile across the cliff, with 3,000 ft. sheer slide or drop, with nothing between you and the Siyom. The path up to the ravine had been on the side of a very steep, rocky, jungly-clad slope, but comparatively easy and very well-marked, showing



Memka Bridge.
(Some are 300—400 feet long.)

Looking up the Siyom Gorge, from above Yiyo village.

The Abor military and political mission, 1912-13

THE ABOR MILITARY AND POLITICAL MISSION, 1912-13.

Rotung Village.

Temporary Bridging

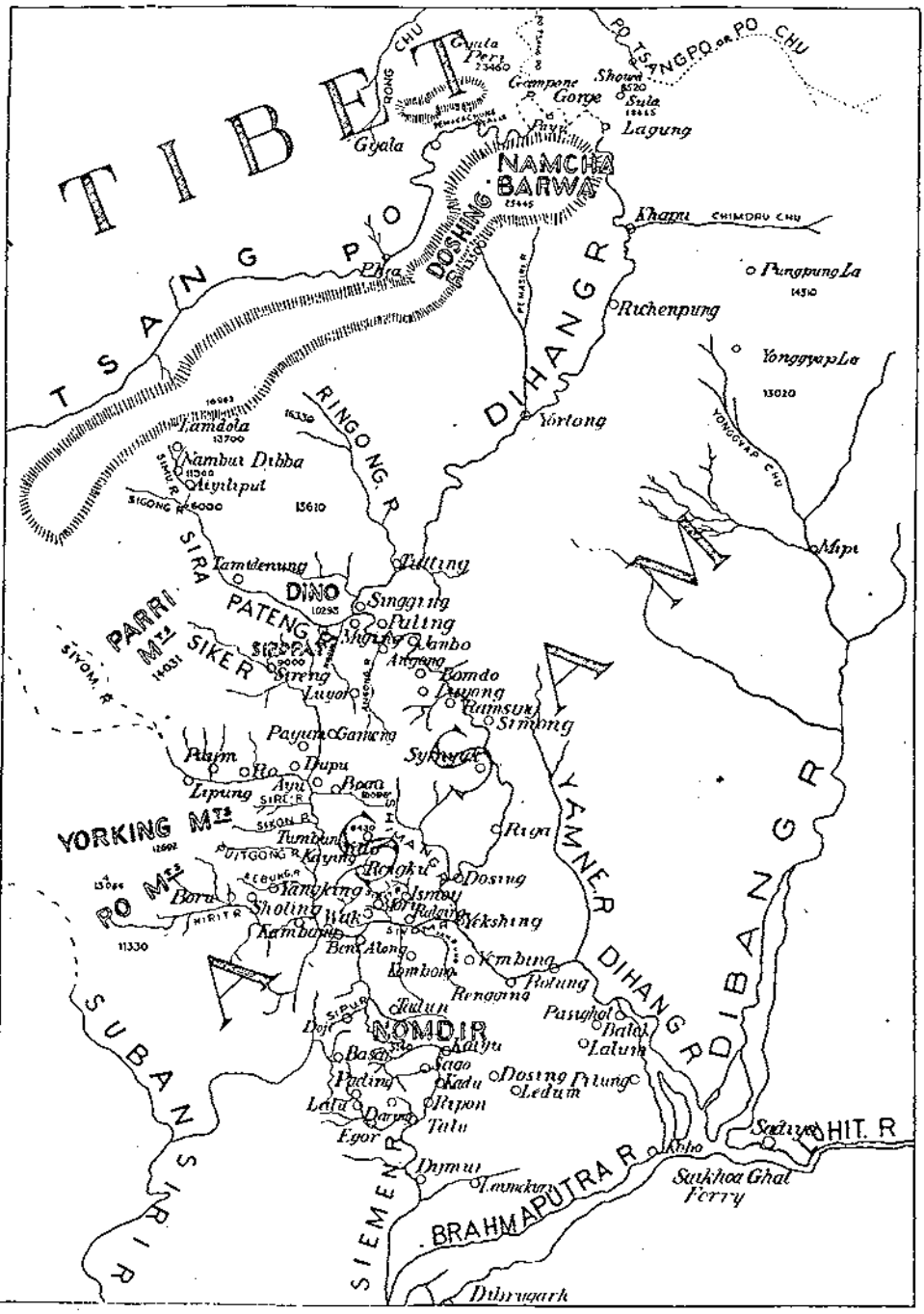
The Abor military and political mission, 1912-13

it the main high road for the Boris in the upper Siyom. At the ravine we heard the sound of tree-cutting, and then saw the path ahead was blocked, a ladder taken away, and a pile of stones on top. Hore, who, though he has worked hard for peace, is dying for a scrap, managed with some 4 rifles to scramble round the first obstacle and then ascending the ridge to the left of the path, got some 700 ft. above the ravine. This, we think, made the Boris bolt, and leave the stone shoots they were going to make. Here I joined him, having previously left an ambush in rear, and the Ro *gâm* (who had been our guide) in their charge with strict orders not to let him bolt, and to gag him if he made any noise. We then got back to the path and worked up through the debris of fallen trees to where it reached the ridge and started crossing this awful chasm. It was obviously madness to go across at once, as the chances were that there were stone shoots above which would have swept us all down 2,000 ft. below. I suggested that I had better remain the night here, as it made sure of the path up to this point, and I could send 3 men to see if they could get up the hill above and so round this precipice. Consequently, here we are, 8 rifles and myself, 3,500 ft. up on the edge of this beastly precipice, with 2 water-bottles and some bread and 2 sticks of chocolate to sleep the night out, all for the sake of mapping a little bit more of this corner. Bah! It is coming on to rain, but luckily we have been able to rig up something of a shelter.

March 29. The shelter proved of very little value and it was a wretched night. The 3 men sent out did not return, being benighted on the hill above. As soon as it was light, having placed the ambush again and taking one sepoy, we crept about half-way over the cliff. We did not go right over because it was probable that the Boris would be watching that end. The path is generally cut in about 2 ft. but in 2 places it was merely small ledges of an inch or two on the rock for foot and hand and some of these places were across a diminutive ravine. We crawled across very gingerly while the Siyom roared up to us through the mist from below our feet. After getting back, the 3 sepoys soon turned up, having got up (in some places pulling themselves up with their rifles) to above the cliff, had found no stone shoots, but had seen a similar cliff round the next corner. The plot now thickens. Still leaving my ambush (now 5 men) at one end of the precipice path, I took the 3 remaining sepoys to the ravine stream, clearing the path of the debris on the way. We were washing in the stream below, when our breakfast rolled up and a chit from Hore to say he had rounded up Ro village at 4.30 a.m. to find it empty. They had evidently had guilty consciences and had bolted across the river at midnight. Hore had rounded up the village to get men as securities to go across the cliff first, and said he was coming on as soon as camp was struck. Meanwhile, the relieving ambush piquet went up while I had breakfast, and after

some delay returned with the full armour of two Boris. What had happened was this. Soon after I had gone, the sentry warned the ambush of two Boris approaching across the cliff and, getting ready, they apparently surrounded them, but in their efforts to get them alive, let them both break through. The two Boris, brandishing their swords like Dervishes, jumped into the jungle and got away, goodness knows how, but leaving their weapons, bows, arrows, etc., behind. This was sickening. The sepoys ought not to have bungled it, though it is no easy matter to catch two slippery savages alive. We wanted them not only as guides, but also as ransom to start parleying with the next village, Pa-um, across the cliff. But almost immediately afterwards came another chit from Hore to say that hostilities had commenced at the village and he wished me to come back. So I quickly returned to the piquet and retired in a circle, so that the Boris, if watching, would think we were just sending a flank up to get them in rear, and then quietly retired down into the ravine, as there was slight risk that they might spot we were retreating and dash across to hurl rocks down after us. The two Boris who had escaped, not expecting that we should sleep the night out, and not expecting us very early, had come across to pile rocks ready for our coming. We could hear many others cutting down trees and shouting to one another on the other side, evidently making all haste to give us a warm reception. Got back to Hore about 1 p.m. Just as they were moving out of their camp, two Boris had shot at them, with arrows, and some coolies had a narrow escape. One also threatened the *kotoki*, who tried to prevent their shooting. So Hore opened fire, and though one fellow very nearly got a bullet through his head, to the sepoys' shame neither was hit. No doubt these were young bloods, but this was really a bit too thick and war was then and there declared. When the Boris had bolted, Hore had their bamboos and screw pines cut down; rice, most of the pigs and chickens taken, and the rice houses burnt. But left the living houses and nine-tenths of their rice supply lying outside. When I got back, Hore asked me, as I expected, whether I thought the value of being able to map two marches ahead (fighting our way there) till our "out" rations were finished, was worth the risk of separating ourselves completely from Porter, with Pu-U cliff behind, and with several villages on the warpath between us. As 2 marches ahead would not carry us round the Siyom corner, which is probably opposite Lipung, I told him definitely in my own mind, it certainly did *not*. He then decided to return to join hands with Porter, giving Hamid Gul to-morrow, if fine, to do what more might be possible. This, of course, is a great blow, but as things stand at present it would be madness to push on, and, besides, Dundas particularly told Hore not to risk involving himself so that help

THE ABOR MILITARY AND POLITICAL MISSION, 1912-13.



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

would have to be sent, as that would delay the more important advance to the falls.

March 30. It seems certain now that the villages ahead will fight, as they have refortified the ravine and Pu-U cliff. The democratic system is a difficulty in this country, as there are always the two parties, the one for peace and the other for war, and in this case the peace party does not seem strong enough to dictate to the rest. Only remains to return. Sickening, but, when all ways and means have been honestly and thoroughly tried, it is no use crying over spilt milk. I doubt if 75 per cent. of the coolies could have got across that cliff with their loads, though these might have been hauled with a rope in one or two places. A Minyong Abor, about 50 yards across, turned quite green and clung to the side and refused to go on.

April 2. Met Bogu *gâms* with a chit from Porter saying the Sike villages are getting uneasy, so it is as well we decided to return. The *gâm* was delighted to find us returning, and on the way back broke into a weird chant. On inquiring its meaning, he told us it was a song of how the *takins* (wild goat-cows) of the hills had once upon a time turned back the elephants of the plains. To which Hore promptly retorted that when the elephants came again next year they would build an elephant road back in Ro Camp.

April 3. Yiyu again. Back nine days earlier than we were expected, but to the intense relief of Porter, who was naturally a little anxious. There is no doubt that Hore tried just far enough and not too far. Most cheery being together again. Cleaned myself. Rain all day.

(*To be continued.*)

ENGINEER UNITS OF THE OFFICERS' TRAINING CORPS.

By MAJOR D. PORTWAY, Cambridge University O.T.C.

WITH each year showing reductions in the personnel of the Regular Army, and no corresponding reduction of our Imperial commitments, the question of reserves and of replacement of casualties becomes of ever increasing urgency; it is thus that the recognized source of supply of junior officers in Royal Engineer field units for such purposes in an emergency is a matter not without importance. Few officers of the Corps see much of O.T.C. Engineer units, and no details having ever appeared in the *R.E. Journal*, some notes dealing with this topic may be of interest.

The Officers' Training Corps, which was the creation of the late Viscount Haldane, came into being about the year 1907, and, since the recent conversion of Clifton College to Infantry, only the Senior Division possesses Engineer units. These are four in number, there being companies of three sections at Cambridge and at London Universities, Glasgow and Edinburgh Universities each providing a company of two sections. Oxford University had a small unit for two or three years after the War, and this sometimes joined up with Cambridge for its training. It is perhaps a fair criticism of the lack of interest officially taken by the Corps in these units that nowhere do they appear in the Corps List in any shape or form, nor is there any authority for the officers to regard themselves as part of the Royal Engineers (T.A.), although entitled to Engineer pay.

It is a matter for regret that no liaison of any kind is possible between these four O.T.C. units—their camps are held at different times and usually at different places, and doubtless they have developed on somewhat different lines. It is thus probable that each has desirable features that might with advantage be adopted by the others, and perhaps the O.T.C. staff at the War Office, aided by the Inspectorate Branch, might issue useful information on these lines.

The remarks herewith deal, therefore, with one unit alone—that of Cambridge University—and make no attempt to give any account of training methods adopted by the other three.

Recruiting at Cambridge is mainly from undergraduates reading Engineering, though no attempt is made to dissuade those reading other subjects from joining. The fact of a common department and a common academic interest is a unifying influence which other technical units, such as the Signals and Survey, do not possess. The

two senior officers of the unit are both University Lecturers in Engineering, membership of the Staff of the Engineering department being almost a *sine qua non* for such; the two cadet officers, who are generally appointed, are the most promising undergraduates of the senior years. In connection with the officering of Senior O.T.C. contingents the regulations are those of the Junior contingents, but the circumstances are widely different. Whereas a Headmaster has only to detail an assistant master to a School O.T.C., there is no such equivalent in a University contingent, and the young don shows a marked reluctance to amateur soldiering. The Engineering staff at Cambridge already supplies the O.C. Field Battery, and until recently the O.C. Survey Company, and with no one else showing any desire to carry on the work, the two present officers appear likely to emulate Tennyson's babbling brook as far as their O.T.C. activities are concerned.

Since the War, a marked improvement in the status of cadets of the Senior Division has been made—they are now recognized as officer cadets, they are provided with an officer's pattern uniform, and in all branches are definitely training in the duties of a subaltern officer. It is a corollary of this that recruits to the Senior Division should have already received some training in a Junior contingent, and this is nearly always the case, though of the few who have joined with no previous military experience some are among the keenest and ultimately the most efficient. This improvement of status has been a real advantage—the undergraduate, though light-hearted and not immune from that exuberance so inseparable from congregated youth, reacts in a marked degree to an appeal to his sense of trust and responsibility—a tip which the officers who may be put in future charge of the very excellent course for N.C.O.s of these units in the spring at Chatham will do well to note.

At Cambridge about forty freshmen are enlisted yearly, making the strength of the unit, allowing for wastage, about one hundred. The main working day is perforce Sundays, as week days are fully occupied with work and games, though recruits' lectures and parades are held in the evenings of other days. Equipment has much improved of recent years, and is now fairly ample, and in the first half of the academic year a normal course of field works—mainly bridging, digging and demolitions—is carried out. The number of necessary parades is fifteen, but most cadets considerably exceed this. It is in the second half of the training year that the most interesting term-time work is done, when some permanent construction is always carried out. In 1928, for example, a bridge of 50-foot span for 4-ton axle loads was built over the Great Ouse at Erith on behalf of one of the Colleges; in 1929, several weirs were constructed on the upper reaches of the Granta on behalf of a fishing syndicate, and this year two bridges over the river Stour 25 miles from Cambridge have been built on behalf of

a nobleman and retired General Officer. One of these, of 45-foot span for 2-ton axle loads, is of R.S.J.s on concrete abutments, with sleeper roadway, the other being a suspension bridge of somewhat greater span for foot passengers; for such undertakings, the Company goes out in motor-buses on Sunday mornings, the arrangement being that the beneficiary pays the cost of stores and transport, with bread, cheese and beer for the workers, plus ten per cent. of the cost for expendable stores, which is a euphemism for a dinner in camp. In addition, the unit undertakes demolitions of a useful nature for colleges and private individuals in preference to the normal demolitions of the rail, girder and wire-rope variety. Many tree stumps have disappeared in the Cambridge district as a result of such activity, but the culminating exploit in this direction was the unwontedly successful demolition of the concrete floor of a former observatory in the garden of a private house, where some tons of concrete spreading over a wide area of the town on a peaceful Sunday afternoon drew a not altogether welcome attention on all sides to the unit's existence. The official ration of explosive is not large, but the gift of a hundredweight of gelignite, by the father of an officer cadet who was a director of a firm making explosives, has done much to supplement the supply through normal channels. Musketry is carried out by every member of the unit in the Easter term, and the unit carries out its full share of the normal military activities of the Corps—tactics, lectures for Certificates A and B, night marching, etc., being carried out under the direction of the Adjutant under Regimental arrangements. A new departure was made a few years ago in appointing a Sapper as Adjutant, and it is hoped that Royal Engineers will in future take their turn with other arms of the Service in filling this appointment.

It is at camp that the most valuable training is carried out, though unfortunately not more than about eighty per cent. of the strength is generally present, rowing at Henley, representing the University at cricket, tennis, swimming or shooting, the taking up of employment by third-year men, all furnishing valid excuses for non-attendance. For many years both before and since the War, the Cambridge contingent has favoured Christchurch (or Mudeford hard by) for camp—training facilities are ideal, and in this connection O.C. Experimental Bridging Establishment has been uniformly helpful, in return for which the unit has been able to provide this officer with working parties for his demonstrations. The adoption of the same place year after year makes for economy, and facilitates arrangements, in addition to which, the near proximity of Bournemouth and the sailing facilities of Christchurch harbour make for popularity and the enjoyment of leisure moments. This feature of a voluntarily enlisted unit is not without importance, especially in the case of Engineers, for whereas readers of literary subjects leave Cambridge from June to October, for most engineering men the O.T.C. camp spans almost the

whole vacation between the end of May Week and the beginning of the Long Vacation term, when they return to work in Cambridge.

Training at camp is largely devoted to bridging, but drill and engineering schemes are not omitted, and visits are always paid to the Tank Corps Depot, who always stage an admirable demonstration, and alternatively to the Air Force at Old Sarum, where the Cambridge University Air Squadron is in camp, and the R.E. Pontooning Camp at Wyke Regis. Some new feature is usually included in camp, this year's change being night operations, wherein the opposing forces were taken down the river in pontoons driven by outboard motors.

In conclusion, the question arises as to whether these units are adequately fulfilling their functions. These are two in number: (*a*) the supply of the Territorial Army and Supplementary Reserve with officers in time of peace, and (*b*) the provision of officers for the Army in time of war. As regards the latter, there is no doubt at all —these units produce officer-cadets, nearly all of whom have acquired at the end of their three years a reasonable proficiency in military engineering, and who would join up to a man in a national emergency. As regards the former, the number who go on to Territorial and Supplementary Reserve units is frankly disappointing. This is mainly due to the exigencies of the engineering profession, wherein two years' post-graduate workshop practice is demanded before a student is qualified, and during which it is rarely possible for a commission to be taken up. It is a subject of some difficulty, not less so owing to the dislike of the generality of young Englishmen to peruse anything in the nature of an official publication, but if a pamphlet rather on the lines of the recently issued "General guide to a commission in His Majesty's land forces," but solely containing the necessary R.E. information in considerably greater detail, were drawn up, it would be of considerable use. It should contain the places where Supplementary Reserve and T.A. Engineers units are stationed, and a supply should be available for the use of O.T.C. Engineer unit commanders, who would doubtless give a copy to every man on leaving his unit, and in reply to the not infrequent enquiries that are now received. There is little doubt that excellent field-unit subalterns are available to fill present shortages—men who would do the job well and would enjoy the work if they but realized how to set about obtaining the appointment, and more careful staff work might do something to retrieve some of the valuable material for officering the auxiliary forces that is at present wasted.

SOME OUT-OF-THE-WAY PLACES.

By LIEUT.-COLONEL L. E. HOPKINS, D.S.O., O.B.E.

I.—Diarbakr.

THE country of Abubakr the Caliph, and the town of the same name, is now less remote than when I visited it in 1903, but it appears to be quite as little known as it was then. There appears to be no more recent information about the place than 1910, and even that does not seem to be fresh, and the only news is that there is no longer a British Consul there. It would be possible nowadays to reach the town by car from the Bagdad Railway in a day, but in 1903 it took me thirteen marches from Alexandretta, averaging 25 miles a day.

Diarbakr is chiefly remarkable for its Roman walls of black basalt, which are in an excellent state of preservation. There are a few buildings outside the Northern Gate, but approaching the town from the west there is not a sign or sound of habitation, and it is difficult to believe that a town of 40,000 people, which Photograph 1 shows, lies just behind the sinister black walls. Photograph 2 shows the walls above the Tigris on the east side of the town. The river can be just seen on the right of the picture.

The walls were built in their present form, so it is said, by Constantine in the 4th century. The curtain walls are 50 feet high, and the towers which stand out in front of them are some feet higher than the curtain. The place was considered one of the worst frontier stations of the Roman army, but is a paradise compared with some British frontier stations. When Shapur attacked the town, it was garrisoned by two legions sent from Gaul for insubordination. Khosru, Saladin, and Taimur, among others less famous, are said to have besieged the place. Thirty years ago it used to be considered a place of strategic importance, the key to Mesopotamia and of the approach to the Mediterranean, which Russia might be supposed to covet. The town, standing high above the Tigris on a great cultivated plain stretching away to the snow-covered Karajah Dagh on the west, seemed in those days to provide an ideal site for a great military centre. Like much of Asiatic Turkey, the country is bare of trees, and firewood is brought from the hills some distance north.

The third photograph shows the raft on which we floated down to Bagdad 500 miles downstream, an exciting journey, as far as Jezireh, through the gorges and rapids. The bridge shown is the old Roman bridge just below Diarbakr.

Photo 1.—View of Diarbakr.

Some out of the way places

Photo 2 Roman Walls.

BAMPUR

Photo 3. Raft on Tigris Roman Bridge.

BAMPUR.

Photo 4. The Fort.

Photo 5.—Persian Baluchis.

Diarbakr & Bampur

Photo 6.—Mahseer Fishing near Road to Khatmandu.

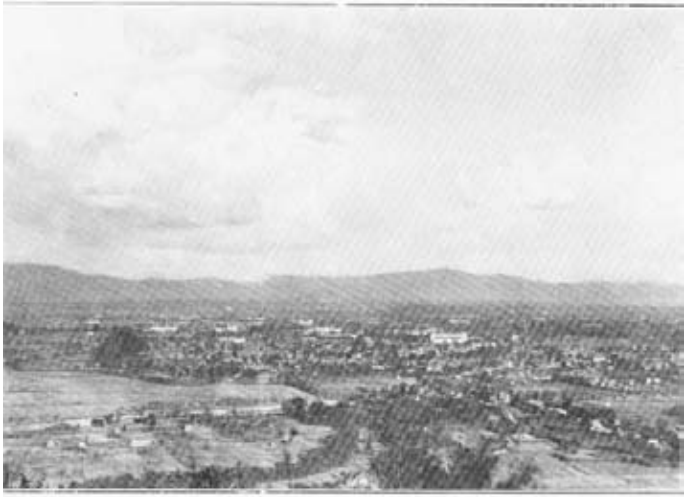


Photo 7.—Khatmandu. Capital of Nepal.

Khatmandu

Photo 8.—Temple in Old Khatmandu (Patan).

Temple in Old Khatmandu

The streets of the town are paved with stone, but are so narrow that the Governor's phæton had to be handled round corners. Houses show a blank wall to the street, through which a small iron-studded door admits to a courtyard overlooked by a raised verandah, and containing perhaps one or two orange trees. The inns were primitive and verminous, but good food obtainable, and everywhere the most excellent coffee and cigarettes and that delightful liqueur of which M. Catoni, our Consul at Alexandretta, possessed an excellent brew. Distilled from grapes and flavoured with aniseed, it has the taste of Kümmel and the consistency of vodka. It was known as Mastic, if I remember right. At that time in Turkey, it was not good form to drink alcohol in public, but it was always offered to Christians in a furtive sort of way, and it was understood that Turks were not fanatic prohibitionists in their own homes.

Certainly the Turks I met in those days were good fellows. Big, jolly, and frank, they were the gentlemen of the country, and I have the pleasantest recollections of them. The Turks stood out obviously among Jews, Arabs, Kurds, Armenians and Persians and the numerous Christian Sects, as the ruling race of the country. It is to be hoped that they are not making a mistake in turning to modernism and throwing away the traditions of their race.

Good food is to be had everywhere in Turkey and Persia, in great contrast to Hindustan, a country which Babar speaks of in his Journals with great contempt, because of its lack of good cheer, hospitality and the carousing of which he was perhaps too fond.

I stayed at Karabagche, a peculiar village on the last stage before reaching Diarbakr, peculiar because the whole village lives under one roof nearly 100 yards across. I suppose it was so built for warmth in winter. Our horses occupied the entrance, the eyes of cattle could be seen glowing down a dark passage to the left, and on the right our men shared a room with a camel. My room, however, was clean, and round the sides were thick felt rugs, and a fine charcoal fire in the centre. The only ventilation and light was admitted through two holes in the flat roof.

II.—Bampur.

This is nominally the headquarters of Persian authority in Persian Baluchistan, but practically it is seldom visited by any Persian. It is too far from civilized Persia, and the true Persian does not care for the lowlands below 5,000 feet above M.S.L. Syed Khan of Geh, a local chief, was nominally governor on behalf of Persia when I visited the place in 1912 and 1913, but at that time every valley in the surrounding hills had its own Khan and all of them are practically independent. They are a wild highland breed.

There is no town or village at Bampur; nothing but the fort,

built of sun-dried bricks, which, as can be seen in Photo 4, is quite imposing. The fort, too, is uninhabited except by a few *chokidars*, who had a shot at me when I was passing on my way north. It appeared, on enquiry, to be a case of nerves. It must have been nervous work for a few men living in a fort big enough for a battalion. There is another fort about 20 miles east at Farah, which another Khan had at that time recently seized and was giving Syed Khan a good deal of anxiety. Small wars are always in progress in that part of the world. The people are primitive but not uninteresting or uncivilized. They have a good deal of Persian polish and manner.

The governor usually spends the spring at Bampur, camped in the fields, and at that time the climate is very pleasant, but as a rule he lives in his fort at Geh, in the mountains, half-way to the Persian Gulf. There is a stream, from the hills in the east, which flows through the Bampur Plain and into the Jaz Morian Hamun and along it a belt of cultivation half a mile wide, in which and among the thorn trees there is the best black partridge shooting I have ever had.

Away from the cultivation the usual sandy plain rises slowly to the hills 20 miles south, the summit of which is about 5,000 feet above the sea along the Makran Coast. Forty miles to the north is the volcanic peak, the Kuh Bazman, which rises to about 11,000 feet above the sea.

There are four principal mountain gorges by which Bampur is approached from the Makran Coast, and it will be a long time before a motor finds its way up there. Perhaps through Fanoch it could be done, perhaps it has already been done. But it would not be impossible to reach Bampur from the north by car. From Bander Abbas it would also be practicable; except for the 20 miles up the Minab river, the rest is plain sailing.

All along the south side of the Hamun-i-Jaz Morian is an immense cultivable plain, hardly inhabited at all. There are many ruins of towns at the western end, and the few nomad inhabitants are a very interesting race of fair-haired European type, obviously the remains of some old Greek invasion. They are fine, big men, and in their black frock coats and high felt hats look very modern and a great contrast to the wiry aboriginals of the Hills along the Makran Coast, with their robber chieftains of probably Arab descent.

III.—Khatmandu.

In 1926, the Government of Nepal was contemplating the construction of a light railway as far as possible towards the capital, and my services were lent to the Maharajah to advise on the project. As no person not a Nepalese is allowed to enter Nepal without the

Maharajah's permission, I was very glad of this opportunity to see a country which few have visited and which was reported to be extremely inaccessible. The report is certainly not exaggerated. I have never been over a worse road. The 20 miles from the railway to the foot of the Himalayas is covered by motor, and for a further 20 miles into the hills there is a good cart road, which has probably by this time been completed for motor traffic. Alongside the road is one of those delightful Himalayan rivers, clear and blue and foaming over white boulders and sand. Those whose only experience of fishing is in the dismal rivers of England or Scotland, have a new pleasure before them in these Himalayan streams. They are full of the "mighty *mahseer*," which is a better sporting fish than salmon or trout, and there are several other kinds of fish which take a fly. (Photo 6).

The second day's march ends with a steep ascent of 2,000 feet to a fort and rest-house. There is no attempt to grade the path which goes straight up the hill at an angle of about 45°. We were carried up this hill in chairs and one felt it would be safer on the ground than on the shoulders of the carriers.

The third march descends 2,000 feet and then gradually rises to a summit about 7,000 feet above M.S.L. From there the path descends 2,000 feet to the Khatmandu Valley, down what is practically a stone staircase through the forest. We were met at the foot of the hills by the Maharajah's big Hudson car and soon covered the 10 miles into the capital. This car, we were told, was carried into the country lashed to a framework of poles on the heads of 64 carriers, who must have had a difficult task in negotiating the two passes.

Khatmandu, as may be seen in Photograph 7, lies in a delightful valley. It is about 4,000 feet above M.S.L. The town is a strange mixture of mediævalism and fine modern buildings, which would suit Clive Street, Calcutta. The Maharajah's palace is on the scale of Buckingham Palace. The houses of the nobles are hidden in large gardens surrounded by walls of red brick about 16 feet high. Nepalese troops were to be seen drilling in thousands on the large parade grounds or marching on the roads in the neighbourhood.

There are several old towns which were former capitals and now only half-occupied. They seem to consist largely of temples of the type shown in Photograph 8. It is said that the pagoda type of roof originated in Nepal. The houses are all well built of red brick, usually three stories high. The Nepalese are short men and the height of the rooms is made to suit them, giving the three stories a dwarfed appearance. One remembers the Gurkha trenches in France, which were built on the same scale as these houses.

"PINKING."

By CAPTAIN K. A. LINDSAY, R.E.

A CONSIDERABLE amount of research has been carried out during the last few years, to investigate the causes of pinking in internal combustion engines, and with the advent of the highly efficient modern automobile engine, the prevention of this undesirable feature is extremely important.

The sound known as "pinking" must be familiar to many car drivers, but it may be as well to point out that a good example is that given by an old type L.G.O.C. bus, starting off fully loaded, and can be defined as a distinct metallic "knock" not due to any mechanical defect. Apart from the unpleasant noise, "pinking" is very liable to affect the lubrication of an engine, owing to the rupturing of the oil-film in the bearings by the very rapid rise in pressure.

It is a very common fallacy to confuse pre-ignition with "pinking," and it has often been suggested that they are one and the same thing. Pre-ignition in a petrol engine, as its name implies, is the firing of the charge before the pre-determined moment; it generally occurs in an engine requiring decarbonizing, when the charge is exploded by the incandescent carbon deposit. However, the trained ear can easily distinguish between the dull "clonk" of pre-ignition and the sharp metallic sound of "pinking." In addition, it has been proved experimentally by Ricardo,* that "pinking" occurs *late* in the firing stroke. It is, however, true that sustained "pinking" will quickly lead to pre-ignition, which in turn may lead to the complete shut-down of the engine.

The only practical way to stop "pinking" in a given engine, using a specific fuel, is to reduce the load, and, therefore, the mean effective pressure. The design of engines for automobiles and aircraft is confined to certain limits as regards cylinder dimensions; the R.A.C. rating influences the former, while the desirability of the maximum horse-power per lb. weight governs the latter. The highest possible M.E.P. is therefore required, and the elimination of pinking is of the greatest importance.

From the economic point of view also, the highest efficiency is desirable. The first method which strikes the mind of the engineer for increasing the efficiency of an engine is to raise the compression ratio, and, up to 6 to 1, a modern high-speed petrol engine of normal

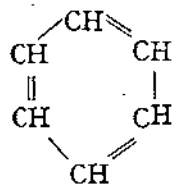
* *Engineering*, March 18th, 1927.

bore can be run satisfactorily. Above this, however, experience proves that, without doped fuel, " pinking " will result on full throttle.

There is, therefore, no doubt that the future development of the internal combustion engine must depend largely on the extent to which the problems connected with " pinking " are overcome. Scientists are still in controversy over the phenomenon, and it is outside the scope of these notes to delve deeply into the chemical side of the problem, but it is hoped that the following compilation will shed some light on a rather obscure subject.

It can be shown theoretically and practically that the thermal efficiency of an engine increases with the compression ratio, but the liability to " pink " of the fuel used must limit this ratio.

It has been found, as a general rule, that alcohol and the aromatics or ring compounds, such as benzene (C_6H_6) of the form :—



are very much less liable in this respect than the " paraffin " series or chain compounds, such as Heptane (C_7H_{16}) of the form :— $CH_3—CH_2—CH_2—CH_2—CH_2—CH_2—CH_3$.

Particulars relating to these fuels are given in the table on the following page.

Before passing on to dopes or special fuels, the importance of alcohol and benzene (commercially known as benzol), for military purposes should be pointed out. Both these fuels can be produced in the British Isles, both are good non-pinkers, and the former is particularly suitable for air-cooled high-speed engines.

Experiments in the past have shown that certain substances, sometimes discovered accidentally, considerably diminish " pinking." Both exhaust gases and steam mixed with the charge are very efficient in this respect, a difference of ± 17 per cent. by weight of exhaust gases will lower or raise the flame temperature 25°, equivalent to a range of compression of from 4 : 1 to 5 : 1.

In 1922, Midgley and Boyd carried out certain experiments, using their bouncing-pin method for determining the " pinking " characteristics of fuels. The apparatus consisted of a steel pin resting on a diaphragm fixed in the cylinder-head of an engine ; the effect of " pinking " was to bounce the pin, which touched electrical contacts, thereby recording the degree of " pinking."

Working on an apparently erroneous hypothesis, they tried the addition of iodine and bromine to the fuel, with the result that the

Fuel.	*% by weight.*		*Specific gravity.*	*Air/fuel ratio by weight.*	*Calorific value lb. cals. per lb.*	*Highest useful compression ratio.*	*Temperature of initial combustion.*	*Ignition Temperature.*	*Remarks.*
	C	*H*					C	C	
PARAFFINS (C_nH_{2n+2})									
Hexane (C_6H_{14})	83·7	16·3	0·67	15·3	10,760	5·1	266	450	Compression Ratio figures were obtained by means of a Ricardo variable compression engine.
Heptane (C_7H_{16}) ...	84·0	16·0	0·69	15·2	10,680	3·75	240	—	
AROMATICS (C_nH_{2n-6})									
Benzene (C_6H_6) ...	92·3	7·7	0·88	13·2	9,710	6·9	670	520	Temperature of initial combustion is the temperature at which oxidization commences under normal conditions.
Tolvene (C_7H_8) ...	91·3	8·7	0·87	13·4	9,810	7·0	550	516	
Xylene (C_8H_{10}) ...	90·5	9·5	0·86	13·6	9,980	7·0	540	500	
ALCOHOL. ETHER.									
Ethyl Al (C_2H_5OH)	52·2	13·0	0·80	8·9	6,560	7·5	520	510	Ignition temperature is the lowest temperature at which inflammation will start under normal conditions.
Ether $(C_2H_5)_2O$ ...	64·9	13·5	0·74	11·1	9,340	3·9	—	—	

former diminished "pinking," while the latter had the reverse effect.

They then proceeded to experiment with nearly every chemical substance, finding several with the required properties, lead tetraethyl amongst others.

Much work has been carried out since, both in Europe and America, and the three best "dopes" discovered up to the present are, lead ethyl, and carbonyls of nickel and iron; unfortunately all three are poisonous.

Certain substances, it should be noted, have exactly the reverse action to dopes, and, if drawn in with the charge, can cause such excessive "pinking" as to necessitate stopping the engine. Benzoyl peroxide $(C_6H_5Co)_2O_2$, is one of the best examples of these knock-inducers.

If a suitable method could be devised for carrying any of these substances in a gas cloud, it is not outside the bounds of possibility that an advance of enemy tanks could be stopped by these means, if the necessary concentration could be obtained.

It is only within the last few years that the phenomenon of "pinking" has been studied to any great extent, but during this time many hypotheses have been put forward.

Before examining these, it will be as well to consider the usual circumstances under which "pinking" develops.

These can be summarized as follows:—

Pinking is prevalent:—

(i) *Fuel.* With the paraffin series as opposed to the aromatic series.

(ii) *Speed.* With low engine speed.

(iii) *Design.* With a combustion chamber having a high compression ratio, containing pockets, and with a long flame travel.

(iv) *Carbon deposit.* When decarbonizing is necessary.

(v) *Ignition.* With an advanced spark.

In addition to dealing with the above, any satisfactory hypothesis should also explain the anti-knock action of steam, exhaust gases, and other "dopes."

About fourteen different hypotheses have been evolved to explain "pinking," but it will be sufficient to describe only six of them, showing their reasoning as regards certain phenomena, and how they fall short in the explanation of others.

1. DETONATION. The explanation generally accepted amongst engineers until recently was that "pinking" and detonation were synonymous. The symptoms are certainly very similar, but experiments by Egerton and Gates have disproved the idea. The latter

have shown that neither lead tetra-ethyl nor nickel carbonyl, which stop "pinking," have any marked effect on detonation, while increased compression, which causes "pinking," slightly lessens detonation.

In addition, it appears unlikely that a detonation wave, which has a definite period of evolution, could develop in the confined space of a small cylinder.

2. Two Frenchmen, named Jolibois and Normand, pointed out that sharp edges in the combustion chamber tend to accelerate the flame velocity; this is true, and it is also possible that colloidal lead, as they suggested, deposited on these edges might counteract their effect. But it has been shown that knocking begins at once if a pinking fuel is substituted for a doped one, even though the lead is still present on the surface of the combustion chamber.

3. Three Americans, named Church, Mack, and Boord, having noted the effect of multiple spark-plugs on "pinking" in a cylinder, put forward the idea that the very fine particles of anti-knock metal undergo such rapid oxidization as to develop sufficient heat to raise them momentarily much above the temperature of the yet unburnt gases in which they are present. They, therefore, become incandescent and function as multiple miniature sparking plugs.

This hypothesis does not explain the action of knock-inducers.

4. Wendt and Grimm suggested that electrons are emitted from the reacting molecules in the flame, and that these electrons ionize and activate the unburnt molecules, causing detonation.

If this hypothesis were correct, the "pinking" would be affected by a magnetic field; this has been tried experimentally and disproved.

5. Another hypothesis, a German one, supposes that the primary factor in "pinking" is *electrical non-conductivity*, the higher the conductivity of a fuel, the less is the liability to knock. It is assumed that if the fuel is a perfect insulator, such as benzene, it will become electrically charged by friction with the inlet pipe, when rapidly drawn into the cylinder on the induction stroke. Differences in potential therefore arise, which are further accentuated by compression. When the gas mixture is fired, the combustion is too quickly accelerated, thus giving rise to knock. If, however, the fuel is conductive, as benzene, for example, there are no electrical disturbances, and ignition takes place normally.

This hypothesis is difficult to confute, and certainly satisfies several phenomena, including the anti-pinking action of metallic dopes. However, research based on it, carried out in Germany, has not met so far with any great success.

6. It now remains to explicate Callender's nuclear drop hypothesis.

It has already been stated that Ricardo proved that "pinking"

develops late in the firing stroke ; which suggests that " pinking " is due to a sudden rapid burning of the unburnt charge, and Callender proceeded to investigate the cause of this.

It is an experimental fact that whereas steam and alcohol vapour get drier when compressed, petrol and benzol vapour tend to fog, while the vapour of the paraffin series develops minute droplets which grow bigger as the pressure rises and do not evaporate as one would expect. The evaporation of these drops is further prohibited by the short period of the compression stroke. A test with Shell aviation spirit showed that with an 8 : 1 ratio, 50% of the fuel was present in the form of liquid drops.

A colleague of Callender's, Dr. Mardles, now suggested that in some way the partial oxidization of the fuel might act as a detonator, and cause the droplets to burn towards the end of the firing stroke.

Tests were carried out on a variable compression engine, by starting up normally, switching off, and continuing running the engine driven by an electric motor. Peroxides were traced in the exhaust under conditions when " pinking " would normally occur, and not otherwise.

A further series of experiments was carried out in which mixtures of fuel and air were passed through quartz tubes in a furnace and burnt. Through one tube a fully vaporized mixture was passed which burnt with a steady flame. Through another tube a fine spray of fuel with air was passed ; in this case intermittent flashes were seen, which, in view of Dr. Mardles' hypothesis, suggested the ignition of the peroxides present on the surface of the drops. The addition of lead ethyl stopped both the formation of the peroxides and the flashes, while the addition of amyl nitrate, a knock-inducer, increased the phenomena.

Another fact, which appears to have some connection, is tha tall fuels liable to " pink " have a temperature of initial combustion much lower than the ignition temperature (*vide* table on p. 686). It appears likely, therefore, that the peroxides form during the compression stroke with " pinking " fuels, owing to the low temperature of initial oxidization.

Callender therefore concluded that " pinking " is due to the accumulation of peroxides in liquid drops during compression. These peroxides act as primers, causing the very rapid inflammation of the droplets.

It is certainly difficult to disprove this hypothesis, and referring to page 687, it appears to bear out the phenomena enumerated there:

(i) *Fuel.* The paraffin series has a low temperature of initial combustion compared with that of the aromatic series.

(ii) *Speed.* With a high engine speed it is fair to assume that there will be less time for the peroxides to form.

(iii) *Design.* A combustion chamber with a high compression ratio and pockets will assist the formation of droplets.

(iv) *Carbon deposit.* When decarbonizing is necessary, the compression ratio is increased.

(v) *Ignition.* The effect on " pinking " of retarding the spark is difficult to explain. It is possible, however, that owing to the period of flame travel being shorter, there is not sufficient time for the vibrating effect to be produced.

During the period that Callender was carrying out his experiments at the Air Ministry Laboratory at the Imperial College, other scientists were arriving independently at very similar conclusions, and, although they do not agree on all points, it is possible to compile a working hypothesis, which may be useful to the engineer during the period which must necessarily elapse before a theory can be evolved by the experts.

This hypothesis is as follows :—

During the compression stroke, the fuel in the cylinder undergoes a certain amount of oxidization, the degree of oxidization depending on the comparative temperatures of initial combustion and ignition of the particular fuel.

Late in the firing stroke, when the temperature and pressure have fallen, the peroxides are reduced and ignite the unburnt fuel.

The inequalities in the state of the charge give rise to irregularities in burning, which result in a vibratory condition of flame.

A wave of compression is started, which rebounds from the cylinder walls and travels through the products of combustion and unburnt gases, producing a knock late in the firing stroke.

The action of anti-pinking dopes is either to reduce the peroxides as fast as they form or to prevent their formation, thereby keeping the mixture uniform, and resulting in a steady burning during the firing stroke.

In conclusion, it is quite possible that more than one action may cause " pinking," and that, in addition to the last hypothesis, the electrical conductivity of the fuel may play an important part.

OFFICE ORGANIZATION IN A SMALL UNIT.

By LIEUTENANT A. J. KNOTT, R.E.

IN these days of big ideas of military training, strategy and such subjects, criticism may perhaps be directed at this article on the grounds that it is wasting space and the time of those who read it, both of which might more profitably be given up to less trivial matters. The reply to such criticism is the old adage, " Look after the pence and the pounds will look after themselves " ; in other words, pay a little more attention to such trivial matters as office work and the small details of administration, and there will be more time and energy available for the consideration of the bigger things. No officer wishes to be chained to an office stool more than is absolutely necessary, but as things are at present, there are only two courses open to many officers who are responsible for offices ; either they *must* spend a very large part of their time in the office, doing what is mainly clerks' work, or they must leave the office to run itself. If they choose the latter alternative they may be lucky, and avoid serious trouble, but it is far more likely that, sooner or later, they will be caught out by a complete breakdown of the office organization at some important moment, resulting in a large " raspberry " for them.

Before proceeding any further, let it be quite clear what type of offices is intended to be covered by the remarks in this article ; those of approximately the size and capacity of that of a Field Company are the primary object of discussion, though the suggestions offered may be equally applicable to offices of other small units ; they are definitely not intended to apply to Headquarter Offices and similar institutions, where, presumably, the organization is more permanent and therefore less liable to dislocation.

The Field Company suffers more or less permanently from a shortage of really good clerks. Occasionally there comes a period of bliss, when a first-class clerk finds his way into a small unit for a time, but it is not to be expected that he should stay long ; either he is wafted away to some bigger job, or his time with the Colours expires. It often happens, too, that the best clerk in such a unit is a man who is not a clerk by trade at all, but a carpenter or other tradesman ; in this case, it is not fair on him to keep him in the office permanently ; he must be given the opportunity to improve, or at any rate maintain, his trade efficiency. The " rate of flow " of N.C.O.s and men through

a Field Unit is surprisingly rapid, and it is necessary always to be prepared to have any or all of one's office staff whisked away at short notice. These considerations make it clear that lack of continuity and a not too high standard of individual efficiency have got to be taken into account by officers in charge of small offices. This fact being recognized, it is all the more important not to rely too much on any one individual or set of individuals.

Although considerations of peace-time training are uppermost in a question of this sort, it must not be forgotten that the office of, for instance, a Field Company has to function to a considerable extent in war. On active service it is more essential than ever that constant supervision of details by officers should be unnecessary, and that no individual should become in any respect indispensable. In war, routine work will certainly not disappear altogether; the issuing of orders, etc., will entail work on the part of the office staff that it does not normally perform in peace, but in which a certain amount of practice may be obtained in manœuvres and other operations. Really sound training of the personnel of small office staffs is therefore essential, just as much as of the actual fighting troops, in order that they may carry out their duties satisfactorily in war. A fool-proof organization is also necessary in order that casualties may not seriously dislocate the system. This state of affairs can only be arrived at by ensuring that, in peace-time, the whole organization is so cut and dried that, firstly, it will run without constant supervision on the part of an officer and, secondly, that the duties of each individual are so detailed that any N.C.O. or man of average intelligence can perform them satisfactorily without long practice.

Let us now consider the various individuals who make up the office staff. Normally, these will be the C.S.M., C.Q.M.S., Pay N.C.O. and assistants to each of these according to individual requirements. The number, rank and duties of these assistants will be considered later; let us take the principals first. How many officers are there who, when faced with a letter or problem which requires an answer, can say without hesitation which member of his office staff will have to deal with the various stages through which the reply must pass before it reaches its destination? There must be many who do not trouble themselves about this at all, who draft the answer in their own hand, put it in their "Out" tray, and hope for the best. Then, if there is a clerical error, or the letter goes to the wrong person, they cannot really know whom to blame; their only course of action is to send for the Serjeant-Major, and take it out of him, though he may be absolutely innocent. If there were a sound office organization, with which the officer was fully conversant, he would be able to go straight for the man who was really responsible for the mistake.

The position of the Company Serjeant-Major merits some consideration. It is sometimes the case in peace that he spends a large part

of his time in the office, particularly if he is by nature clerically minded. This will not be possible in war, and even if it were possible, it would be most undesirable. The C.S.M.'s duty is to be " out and about " ; there will always be a hundred-and-one things which require his attention, and if he is constantly hampered by the knowledge that the office work cannot go on properly without him, he cannot be expected to see to them. This principle applies equally in peace, so let the peace-time organization of the office be such that the C.S.M. does not play any very vital part in it. Certain returns, states, etc., and Daily Orders (Part I) are his job, and his alone; apart from these, he should not be in any way an essential part in the mechanism of the office.

The next essential member of a small office staff is the Pay N.C.O. He is really the most highly-specialized person in the office, and often the hardest to replace. Although he often has friends at hand whose advice he can ask, he must be fully acquainted with all the details of his always tricky job. Good accountants are not easily come by, and, once discovered, are not lightly to be given up. No one, however, is indispensable, and some arrangement must be made to replace this specialist in the event of his going sick or leaving the unit. *R.E. Corps Memo.* states that there should always be a N.C.O. under instruction in Pay duties, and proficiency in these duties is a valuable qualification for any N.C.O. to hold. It is, therefore, advisable to ensure that there is always at least one N.C.O. in a unit trained in Pay duties, in addition to the actual Accountant, and if there is not one already trained, to get and keep one under instruction. A learner in the office is distinctly valuable, as it is seldom easy to arrange for a man to come into the office from outside at a moment's notice.

The work of a Pay Accountant is by no means light, and with the London system of accounting the volume of work to be got through at the end of each month assumes no small proportions, and will usually entail the sacrifice of considerable spare time if it is to be done conscientiously. It is not easy to add or check figures with other people constantly walking in and out of the office, or discussing football and other extraneous subjects ; for this reason, many Pay Accountants are compelled to leave much of their work till the evening or the week-end. No officer would willingly condemn any of his N.C.O.s to evening or week-end work when it could be avoided, and, though it may not often be possible to give the Pay N.C.O. an office to himself, even a quiet corner in the main clerks' office, away from the hum of the ordinary day's work, will be of considerable benefit, and save an appreciable amount of time on the monotonous job of adding figures and balancing accounts.

Although in the majority of cases he works in a separate office, the C.Q.M.S. is just as much a part of the office staff as any of the others. In order to obtain that appointment, a N.C.O. has

to be certified by his Commanding Officer as qualified in the duties thereof. In spite of this, many N.C.O.s, particularly those on the Mounted Roster who become C.Q.M.S.s of Field Units, are not clerically-minded at all, and find ledgers and similar accounts very difficult to master at first. Is it fair, then, to expect them to take over and perform efficiently a job which they have never done before and which at best is not easy, and may well become most tricky and complicated, without some assistance? If the unit in question is the only one of its kind in a station, the C.Q.M.S. requires more knowledge of the details of his job than if there are others of his calling at hand whose advice he can ask. In any case he will learn more quickly, and forget less easily, if he has to find things out for himself, than if he can always go next door and be told the answers to his daily problems; besides, no two problems are exactly alike, and the answer which may have solved his neighbour's problem perfectly may not be the right one for his own conundrum.

The work of the C.Q.M.S.'s department may be divided into two parts: outdoor work, looking after quarters, personal interviews with R.A.S.C. and R.A.O.C. (which are so much more effective than any amount of writing), repairs to barracks, etc., and indoor or office work, checking vouchers, making out indents, posting up ledgers, etc. If a C.Q.M.S. is to attend to his outdoor work really thoroughly, it is only reasonable to provide him with someone in the office who can carry out purely routine duties, such as checking packages or making out returns. These duties, although they may sound quite easy, are beyond the powers of many men, and the C.Q.M.S.'s assistant will become a menace instead of a help unless he is a man of real intelligence, who has some education and is neat and methodical. Given such assistance, there is no reason why the "Q" side of a small unit should ever go seriously wrong; without it, the C.Q.M.S. is apt to become genuinely overworked and, with the best of intentions, will almost certainly let his officer down sooner or later.

Returning for a moment to the case of a unit which is by itself, or indeed in any station where there is no Quartermaster or R.Q.M.S., the C.Q.M.S. may be called upon to perform the duties of either or both of these. He cannot then be expected to carry out his own company duties and those of the R.Q.M.S. efficiently and conscientiously. There are two possible solutions to a situation of this sort; either the C.Q.M.S. may be given an increased staff but made to retain the whole responsibility, when he must do his best to keep an eye on all the varied activities of the members of this increased staff, or the work may be divided into two distinct parts, one under the C.Q.M.S. himself, the other under a selected senior N.C.O. The decision between these two alternatives must depend largely on circumstances and individuals. If the C.Q.M.S. is an exceptionally capable man, he may be able to exercise sufficient supervision over

two or three assistants, and so keep the show running well, but there are not very many men who can do this, and the responsibility is large. Bearing in mind the fact that training in C.Q.M.S. duties is valuable for any senior N.C.O., it will more often be found advisable to create two separate departments, each with its own staff and, if possible, its own office. If this is done, the cut must be complete and decisive, and it is not difficult to arrive at a logical and fair division of labour. A suggested allotment is to make the C.Q.M.S. responsible for all matters involving the R.A.S.C. (Barracks, Supply and Transport), while the senior N.C.O. deals with all questions concerning the R.A.O.C. (clothing, equipment, etc.). If each of these two men is given an intelligent storeman-clerk, and steps are taken to define their respective responsibilities carefully, so as to avoid confusion or duplication, this system should work very well.

The question of the number, rank and duties of the other personnel of the staff of a small office is open to much debate. The Pay N.C.O. can and should deal with all questions and correspondence concerning pay and allowances and, except where the " Q " department is directly concerned, with questions of rations. It is open to question whether he should have any dealings with unit funds accounts. These are less tightly bound by regulations than public accounts, and thus demand closer supervision by an officer ; they should, therefore, be administered entirely by him, though pure routine work, such as the filing of receipts, can quite well be done by one of the clerks.

The registering and filing of letters is a department which seems to give more trouble than most. Frequently one hears of letters being wanted which cannot be produced at the critical moment. In order to avoid possible confusion, it is desirable that one individual should file and register *all* letters, but *all* the clerks must understand the system in use, so that any of them can at any moment take on the work. There always seems to be a tendency among soldier clerks to avoid registering letters if possible, the excuse being that they appear unimportant, or will never be required again. This is thoroughly unsound, as the most unlikely-looking letters are often suddenly wanted, possibly a year or two after they were originally received ; if they were not carefully registered when they came in, and the person who actually received them is not then in the office, they are not forthcoming, and trouble ensues. Against this, one does not want to litter up the files, particularly in a small office, with purely routine correspondence which will never be wanted. A useful compromise is to insist on every single letter or minute being registered in, however trivial it may appear at first sight, but to put those which are unlikely to be wanted again in a separate " rubbish " file or on a spike. At the end of each month, or at other suitable intervals, this " rubbish " file or spike can be carefully gone through by an officer, who can weed it out, putting those letters which must

be kept (these will be fairly obvious after a few weeks) in the appropriate file, and destroying those which have no further significance. By a method like this, trace is kept of everything which comes into the office, and at the same time purely transitory matters are not allowed to clutter up the file cupboards, making important files difficult to find. On the subject of actual filing systems, everyone has his own ideas, and most systems have their merits. Two things, however, are essential :

(1) That some really efficient form of index, preferably alphabetical by subjects, shall be kept, by which a letter dealing with any subject can be traced, even though it were received in the office before the advent of any of the present members of the staff ; and

(2) That the system shall be one which permits of files being closed and put away as " dead " when no longer required, without all trace of them being lost, and which makes it impossible for subjects of files to become confused or the main subject side-tracked.

The normal division of work into the three branches, " G," " A " and " Q " will not apply in a small unit without modification. The branches exist, of course, but it is the " Q " branch which has to be kept separate while the " A " and " G " are combined. The " G " and " A " branches in a small office cannot really be separated ; questions of personnel are inextricably mixed up with questions of training, and any attempt to keep the two branches in water-tight compartments will result either in unnecessary duplication or in some of the work falling between the two stools. The " Q " branch we have already discussed ; the other two branches are the main work of the ordinary clerks, of whom two should normally be sufficient. The division of work between the two must vary according to circumstances and to the individuals concerned, but assuming that one is a N.C.O. and the other a Sapper, the following arrangement will work quite well. The Chief Clerk registers and files all letters, assists in the administration of funds accounts, drafts replies to correspondence when he is able to do so ; the second clerk acts as typist for both the Pay N.C.O. and the Chief Clerk, amends official books, keeps up the men's documents and generally understudies the Chief Clerk. This last is most important, as he must be able to take over any or all of the Chief Clerk's duties at a moment's notice. According to the volume of work or correspondence which comes in, it may be desirable to have a third man in the office. He can run messages, clean the office, etc., in the ordinary way, but can also be of great use in carrying out thoroughly straightforward jobs such as copying returns, amending books, etc.

A system such as this is reasonably fool-proof. If the Pay N.C.O.

goes sick, his assistant can carry on with that department; if the Chief Clerk becomes non-effective for any reason, the second clerk can replace him with the assistance of the orderly. In fact, the whole system can be progressive; as any member of the office staff drops out, the next man down the scale in that department replaces him, and the bottom place in that department is filled by a new man from outside. The only people who need ever come completely raw into the office are a new learner of pay duties or a new orderly; neither of these should seriously impair the efficiency of the office, and both should be able to pick up their duties very quickly.

The question of actual responsibility must be mentioned. The Pay N.C.O. and the C.Q.M.S. are directly responsible to the O.C. for their respective departments; the Chief Clerk is also responsible for the general work of the office. The second clerk is under the orders of both the Chief Clerk and the Pay N.C.O., and this is liable to lead to friction or confusion. One of these two, whichever is the senior, must be definitely put in charge of the general administration of the office, and it will rest with him to decide questions of precedence of work and other minor difficulties, if any. Correspondence should, in theory, be opened by an officer, but often this is not done; in this case the Senior N.C.O. in the office should open all letters and pass them to the individual whose job it is to deal with them. This duty may, in practice, very well be performed by the Chief Clerk, even if he is not the senior N.C.O. in the office, but whoever does it, it is important that it should always be the same man; this will ensure that there is never any question as to who received a particular letter, or as to how it came to be lost.

If some such system as that outlined above is adopted and is really running smoothly, as it should do without any trouble, the office work of the officer should be cut down to a minimum. He has under him three individuals, the Pay N.C.O., the C.Q.M.S., and the Chief Clerk, each of whom is an expert in his own department, and two of whom are replaceable at a moment's notice. The question of an understudy to replace the C.Q.M.S. is more difficult and cannot be discussed in detail here, beyond mentioning again the fact that all senior N.C.O.s should acquire a knowledge of C.Q.M.S.'s duties, and it will therefore pay to draft them all in turn into his department, so that they may learn something of that side of the work of a unit, without which they must inevitably lose some of their efficiency as R.E. N.C.O.s. There is practically nothing in this article which is not pure commonsense, but many of the points mentioned are apt to be overlooked owing, it is to be feared, to the normal officer's natural horror of being thought an office wallah. The office habit, than which there are few worse vices, is brought on and fostered far more by lack of attention to such details than by passing them over as things not worthy of the notice of a Sapper officer.

THE L.G.O.C. OMNIBUS REPAIR WORKSHOP AT CHISWICK PARK.

By BT.-MAJOR G. MACLEOD ROSS, M.C., M.ENG., A.M.INST.C.E., R.E.

THE main object of this shop is to provide for the efficient annual overhaul which every one of the 4,000 buses of the L.G.O.C. fleet undergoes.

This overhaul may be divided into the repair and renewal of the bodywork, and the complete stripping of the chassis and its subsequent re-assembly.

The shop, designed to meet these two main requirements, is arranged in a series of 60 ft. wide aisles, divided across the short axis into two parts by the stores, one end being devoted to bodies—repair, manufacture of parts, and painting—the other end to chassis stripping and re-assembly.

The construction of the building is steel-frame, breeze walls and a pent roof covered with R.A.P.M. and roof lights, a concrete floor, 1½-ton Morris runways with pneumatic operated hoists where required, a combined heating and ventilating system, employing hot or cooled air as demanded.

An extensive system of cableways, sunk in the floor, provides for the movement of the bodies, whilst moving platforms and lines of rollers are a feature of the chassis side of the shop.

Generally speaking, the whole shop is designed for its normal job, and provides no extravagant plant for the unusual, and it is patent that the necessity for reducing standing charges to a minimum has guided the design of both shop and plant.

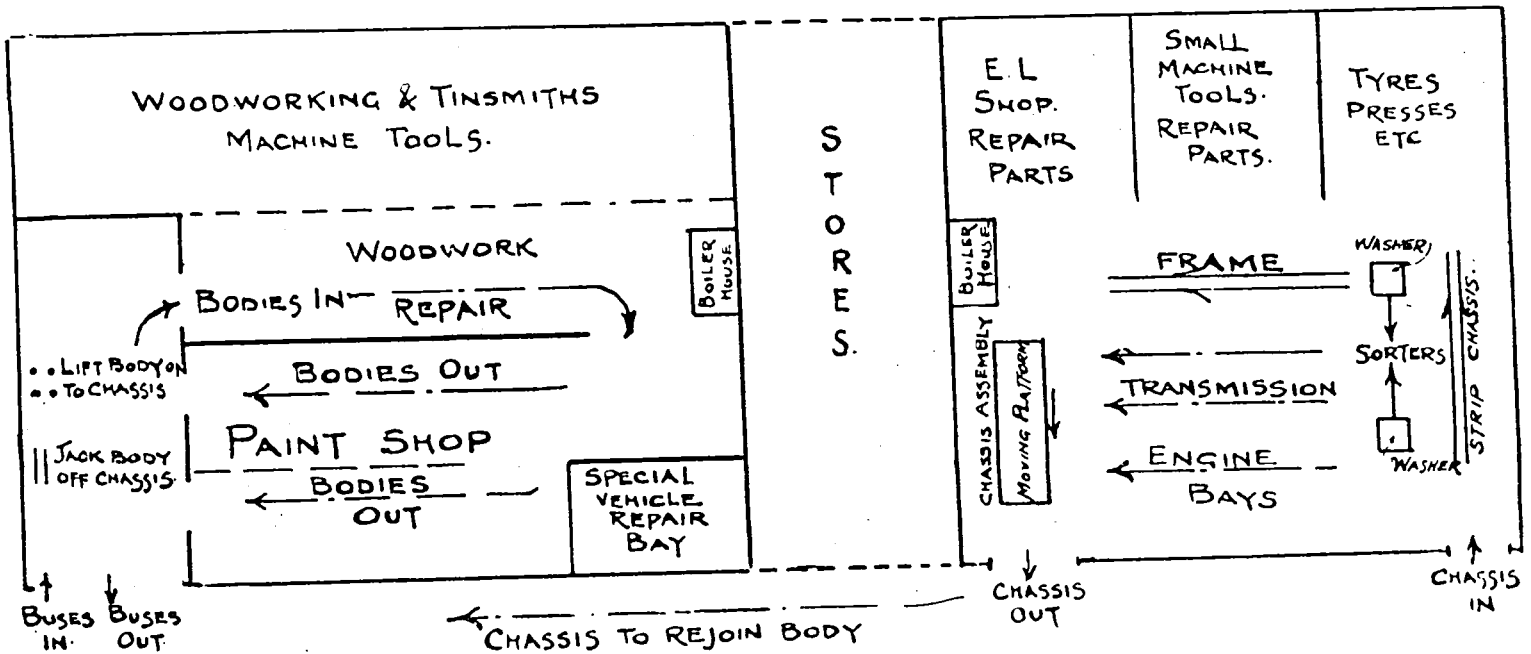
As a side line, provision is made for accidental damage, breakdown, and for non-standard vehicles, the last being dealt with at a separate bay.

The L.G.O.C. organization is such that at local garages, complete units only, *e.g.*, an engine or a transmission assembly, are replaced. Each garage carries a definite reserve of such spare unit assemblies, any faulty units are dispatched after replacement to Chiswick, whilst only damaged vehicles, or vehicles due for the annual overhaul, come whole to Chiswick.

On arrival, the vehicle for annual overhaul is first stripped of cushions, etc., and is then passed on to a large jack, where the body is lifted off and the chassis removed and run over under its own power

SKETCH LAYOUT OF L.G.O.C. REPAIR SHOP AT CHISWICK PARK.

—NOT TO SCALE.—



to the chassis end of the shop. The body is then lowered on to a wheel-trolly, on which it remains until it is finally repaired and painted, and it is lifted back on to a new chassis at this same spot.

THE BODY.

The body is next stripped of advertisements and all broken panels, and woodwork.

It then enters the shop proper and is repaired as to woodwork and finally painted.

Interest attaches to the method of painting the red side panels. For these, after a coat of flatting has been put on by hand, a final coat is applied by pouring on paint out of a watering can with a wide, flat spout, surplus paint being collected for subsequent re-use in a trough running the length of the bus.

This method, which has been devised locally, is an interesting commentary on the prevailing vogue for spray painting, which is found to be less simply managed, requiring shielding of the glasswork, etc., and much more expensive as regards plant.

This final coat dries in one hour, and thereafter a single coat of varnish completes the work of the paint shop.

All notices are put on the bus body by means of water transfers, subsequently touched up with paint as necessary, and then varnished.

The trolly on which the body rests being attached to the capstan-driven cableway, it is then pulled along one space towards the point where a chassis will be met with.

THE CHASSIS.

The chassis is run over to the opposite end of the shop and placed on a line, where it is gradually stripped. All parts go into a washer, from which they are put on runways, off which they are picked by the inspectors of the various bays—engine, transmission, frame, etc.—to which they pertain and are sorted and coloured red, green, blue, depending on whether they are for scrap, immediate use, or repair.

These bays build up complete units once more from salved or new parts received from the stores, and these units all parallel on to a slow-moving platform, at right angles to the bay lines on which the chassis are re-assembled, the time for a chassis re-assembly being three hours.

From here the completed chassis is taken out under its own power and run in, being finally sent to the original entrance, where a new body is lifted on.

Re-cushioning, notice-boarding, advertisements, licensing and police inspection complete the vehicle, which is then ready for delivery to a garage.

The chassis shop includes bays for the repair of electrical apparatus and of the reparable parts taken off the stripped chassis. Progress and co-ordination between the various sub-sections of the chassis and body sections is effected by attaching one man to each sub-section to note progress and effect liaison.

Each section is under an engineer, whose office is situated in the section shop.

Points of interest are :—

1. The sub-division into chassis and body sections.

These may be wide apart, but woodwork and painting are most efficiently placed under one roof, whilst all engine work is also under one roof.

Ablution places and latrines are also inside the shop, the former unscreened.

2. The washing of the chassis parts ensures easy detection of faults, and saving in handling, storage, and assembly time.

3. The modest efficiency of the plant employed is noticeable. The Morris runways are preferable to travelling gantry cranes, since they are lighter, cheaper, handier, and provide power where it is wanted.

4. The general layout shows once again how essential it is for the designer of the shop to know exactly the operations proposed by the users of the shop, and, more essential still, the need for the users to have a definite plan on which to organize their work, and finally, having decided on a plan, to adhere to it.

SIR THEO D'O LITE AND THE DRAGON.

By CAPTAIN J. C. T. WILLIS, R.E.

AT a certain time and in a certain town there was an Error. And the Error was a Dragon. And the citizens in the town lived in fear of him. And one day there journeyed to the town a Knight of the name of Sir Theo d'O Lite, and he set up his tent by a table made of logs, and out of the logs, which were arranged in columns, he now and then took a lozenge. And the lozenges were black and he hated them. But he had a high courage and an x 20 resolving power, for he was young and swung easily about his broad base as he did his work, thinking always of the fate of his poor father who perished at Chatham after suffering acutely from a broken diaphragm (Young Officers under instruction please accept this, the only intimation); he had but lately left his maker and was newly graduated. And he carried in his hands a volume of short reeds (seven figures).

And there came to Sir Knight as he sat by his logs outside the city, making quiet observations of men and things, a deputation of leading citizens. And the head of the deputation was Sir Veyor of the Borough. And they told the Knight of a Dragon which had long terrorized the town and could in no wise be eliminated. For the Dragon represented much work that had been done of yore. And his methods were shaky. And his results even more so. And they besought the Knight to do battle with the Dragon. Now the Knight was a level-headed man and, though he always carried alcohol on his person, it was not upon the alcohol but upon the bubble in it that he relied for his best results. But there were those, his detractors, who called Sir. Knight "double-faced." For, said they, he is ever on face right, or face left, and only when he is at last laid in his little wooden box will he be cured of this failing.

And Sir Theo listened to the tale of woe told him by the citizens, and his hairs crossed and his diaphragm rose at the thought of it. And when the citizens had made an end of speaking he cried, "To-morrow I will set myself up upon a hill without the city, upon the hill where is a house called the 'Sun' (off-licence), and there will I take solar observations, and being a geologist will study the pintz and quartz which are within, until such time as ye bring me the Dragon for to do battle." And it was so. And, behold, the following morning before the "Sun" (or its proprietor) had arisen, the Dragon came forth to battle.

Now the Dragon was a fearsome monster and covered with scales. The scales were of three kinds—large scale, of which he had 10,000; medium scale, of which he had 25,000; and small scale, of which he had 250,000. He had also an index. And his eyes shone like cadastrals, or like those of an observer when the three angles of his triangle add up to 180° 00′ 00″. His tongue was forked into two points and the points thereof were called "True North" and "Magnetic North." And his tongue was in his cheek, like that of an observer when the three angles of his triangle do *not* add up to 180°, or anything like it. But he was no longer young and increasing years had brought a marked convergency to a figure that was no longer capable of precise adjustment, and like plane-table legs, or the English yard, he possessed three feet. And his movements were slow and deliberate, as of an employee whose pension is even now in sight, and before each step he took a forward bearing and a reverse bearing and checked himself as against gross error.

And the Knight arrayed himself in all his panoply, his sun guard and his optical centring; and, illumined by an inner light (12 guineas extra), he wiped away all traces of collimation from his eye and turned upon his base.

Thus began the battle; the Knight and the Dragon doing battle for the peace of mind of the citizens of the town. And the Knight turned himself face right and face left, but never could close. And the Dragon, traversing slowly, breathed fire upon the Knight; but the Knight stood rooted to the ground, for none of the famous family of Theo d'O Lite can shift their legs and still remain level-headed. And the encounter waxed sore. And the heat of the Dragon's breath caused the very bubbles on the Knight to contract, and turned what had been a mean elevation into a marked depression. And Sir Theo's eyes grew misty.

Thus and thus did they fight all day and neither could gain the advantage. Could the Knight but close, the day was his. But as even wore on he grew stiff, his refraction was giving him trouble and he felt machine-divided. The Dragon's tail also hung limp, like a swinging traverse, and his scales expanded from the heat and were inaccurate. So they appealed against the light and the citizens allowed the appeal. For they, too, were thirsty. And the fight was to be rejoined at 10 a.m. on the following day.

And the fight that day was celebrated in song and story, but no historian durst tell the truth and even if he had Sir Theo would have censored it. For Sir Theo had gone into the fight that day with all his armour on but, alas, had forgotten to tighten his base plate. And so he could not close.

And that even Sir Knight bethought him and minded him of another house upon the hill, to wit "The Magnet" (to be consumed on the premises only). And thither he stole that night and took

with him his lance. And there he stayed and besought aid of the proprietor, who, in great courtesy, agreed, and polarized his lance for him. And the Knight gave the proprietor some quartz. And the Knight left with a slightly tangential screw, and passed through the sleeping city to the training quarters of the Dragon. He passed the silent cottages, past the Dragon's manager's house, where the manager was expressing " The utmost confidence in the result of the morrow " to the representatives of the *Morning Press*, past the room where a hired scribe was busy writing two articles for the subsequent signature of the Dragon, the one entitled " How I Won " and the other " How I Lost," past an ironware shop where Sir Knight was delayed by the adventitious collection on his polarized lance of four saucepans, a kettle and one teapot, this latter reputed to be silver but of a hall-mark which had long defied detection. These he removed with difficulty with the exception of the teapot, which, like many others before him, he retained for a closer inspection. So came he at last to the place where the Dragon lay sleeping. There wrought he with cunning, for with his lance he stroked the Dragon gently from nose to tail and for a long while, and lo, the sleeping Dragon also was polarized. And the Dragon purred in his sleep and dreamt that he had successfully answered an advertisement on " How to Acquire Magnetic Personality."

And the following morning what shall one say of the fight. For the Dragon, heavily polarized, and pointing always to the north, could turn neither to the east nor yet to the west. In fact, as the Austin Seven is to the tram, even so was the Knight to the north-pointing Dragon. And the Knight thrust his lance between the Dragon's scales where there was no overlap. And with one last grid reference the Dragon fell. And the Knight bound him and dragged him captive to his domain in the " Sun." And the citizens gathered round the " Sun " and waited without. Without the house and without refreshment.

And they waited long. And as they waited they heard sounds of laughter and revelry and the clink of glasses, and peering through the curtains they saw the Knight and the Dragon, and, lo, they were fraternizing, for they were drinking fudge (by the method of least squares). And lo, their errors were compounded and they meaned their results and interpolated to second differences. And, behold, there was no Error.

And in the even the citizens stole away and from the place in the " Sun " where the Knight and the Dragon stayed came softly o'er the wind the words :—

" Should cos and tangent be forgot
In the days of auld log sine."

Wing Commander Bernard Edward Smythies DFC RAF

MEMOIRS.

WING-COMMANDER BERNARD EDWARD SMYTHIES, D.F.C., R.A.F.

WING-COMMANDER BERNARD EDWARD SMYTHIES was killed as the result of an aeroplane accident on the 17th June, 1930, and the Air Force thereby lost a most experienced and valuable officer, whose work was appreciated by a wide circle not only in the Air Force but in the Navy, Army and Civil Service. For several recent years he had worked in the Directorate of Operations and Intelligence at the Air Ministry, and had represented it on many inter-departmental committees and on Sub-Committees of the Committee of Imperial Defence.

The son of Mr. A. Smythies, of Dolton, North Devon, he was born on December 9th, 1886. Educated at Cheltenham, he joined the Royal Military Academy in 1903, and was commissioned in the Royal Engineers in August, 1905. At the outbreak of War in 1914 he was acting as an Instructor in the School of Electric Lighting. Promoted Captain, R.E., in November, 1914, he was shortly afterwards attached to the Royal Flying Corps, and after a course of training at the Central Flying School, he was posted to the Royal Flying Corps as a Flying Officer in January, 1915.

His previous technical training and his experience in electrical matters led to his being posted to No. 9 Squadron, which was then responsible for the whole of the wireless activities of the Royal Flying Corps in France—flights of No. 9 Squadron being attached to other squadrons in the field for wireless duties. At that time few officers had any first-hand experience of W.T. work, whilst even operators were borrowed mainly from the Royal Engineers.

It is not surprising, therefore, that Smythies, with his wide technical knowledge, and an inherent scientific bent, was retained for a considerable time as a technical officer. At first he regarded his position with impatience, for, as he then urged, he had joined the R.F.C. to fly. Later, as he became immersed in what was obviously an increasingly important branch of air work, and as his technical duties permitted a certain amount of flying, he became more reconciled to his separation from active flying with a squadron. In April, 1915, the work of No. 9 Squadron was taken over by No. 1 Aircraft Park, and Smythies perforce went with the work.

By February, 1916, however, his importunities resulted in his being posted to full flying duties. For six months he was engaged on flying-training and night flying in England, before being given command of No. 64 Squadron, on formation. In October, 1917, he led this squadron over to France. Equipped with De Havilland 5 aircraft, the unit was employed on the 3rd Army front as a single-seater scout squadron, and was early engaged in the Cambrai battle of November, 1917. For the remainder of the war, Smythies commanded No. 64 Squadron, and during this period he was witness of the disastrous retreat of the 5th Army, on which front his squadron was thrown in. The squadron was also on the Arras and Ypres fronts during battle periods, and was active in the victorious advance of late 1918.

Writing some years later of the 5th Army retreat, he said :—

> "The sight of our retreat is unforgettable : miles of road packed four abreast with vehicles, tired troops in the open regardless of cover—all affording a wonderful target for enemy low-flying aeroplanes. History will relate why there were so few ; it was probably due to the concentration of our fighter patrols, to whom the low-flyer five miles our side of the lines was an easy and coveted prize."

The disasters of the March retreat left the morale of his squadron unmoved, however. Like most squadrons and especially fighter squadrons, the morale and efficiency of the unit rose and declined under influences largely independent of conditions operating on the ground with the Army. Generally the movement was in what he himself described as a cyclic evolution. He regarded his squadron as at the highest point of morale and efficiency in May, 1918, and he was not afraid to confess that by September of that year, largely owing to heavy casualties and replacements, the squadron was reduced to a collection of amateurs. Before the Armistice, however, the old *élan* had returned, and the squadron was well up the ladder again.

For his gallant services and for his tireless labours with No. 64 Squadron, he was awarded the Distinguished Flying Cross. With characteristic modesty, commenting on his work in the air in March, 1918, he wrote :—

> "This was my first experience of air fighting on a big scale : I was but an indifferent pilot and a thoroughly bad shot ; never, otherwise, could I have believed the difficulty of obtaining a vital hit on a fast-moving target. My flight commanders were admirable, one particularly being gifted with marvellous eyesight."

That was typical of Smythies. Steady and dependable, he shared all risks and set a quiet example. Hating exaggeration and intolerant of inaccuracies, he subjected the reports of his more imaginative

pilots to stern scrutiny, and cloaked the exploits of his own squadron in modest statements of fact.

After the war he served for two years in England, where once more his technical abilities led to his employment as an instructor in astronomy and mathematics at the School of Air Navigation. He then served a short period in India on Air Staff duties, and returned for the first Staff College course at Andover, graduating in April, 1923. He then once more commanded a fighter squadron—No. 41, before being appointed to the Plans Branch of the Department of the Chief of the Air Staff at the Air Ministry.

It was perhaps in this appointment that his abilities found their fullest scope. Gifted with a well-balanced and well-furnished mind, he proved himself an admirable Staff officer. The period of his service in the Air Ministry coincided with that marked development of inter-service consideration of defence problems, which was the natural consequence of the establishment of the Chiefs of Staff sub-committee of the Committee of Imperial Defence. Smythies took a considerable share in the preparation of material for the deliberations of the Chiefs of Staff Committee, and in that work, as in all other which came within his sphere as a Staff Officer, he showed himself to be accurate in knowledge and shrewd in judgment.

To plan a memorandum or to labour on an essay was a joy to him. He wrote in convincing and attractive style, and on three occasions he was a prizewinner in the annual " R. M. Groves Memorial Essay " competition.

After his tour of duty at the Air Ministry he commanded No. 99 Night Bombing Squadron. He believed that example in the air and the sharing of risks with his own pilots were essentials to a good commander, and he held that no full appreciation of the varying problems of air warfare could be acquired except by a certain amount of actual flying. Largely for these reasons he commanded a squadron whose efficiency was on a high level.

When he left this squadron in August, 1929, to take up the command of North Weald Station, he still continued to practise this precept of maintaining flying efficiency, although his appointment was essentially an administrative one. He was killed as he was taking off from the ground, due to the aircraft striking an obstruction.

If he had left any message he might well have chosen the words with which he closed an account of his war experiences which he once wrote :—

> " For us who still serve, the task lies ready at hand : only by studying the tradition and experience of the past can we equip ourselves to take advantage of the future, handing on to our successors that fine spirit which animated those who are no more."

N.H.B.

LIEUT.-COLONEL SIR JOHN NORTON-GRIFFITHS, BART., K.C.B., D.S.O.

EARLY in 1915, after mining on the Front in France had been in progress for a month or so, the W.O. informed G.H.Q. France that an officer named Major John Norton-Griffiths, of 2nd King Edward's Horse, who, by profession, was an engineer and contractor for the construction of tunnels in clay, had given certain information based on the experience gained in his work which appeared to have value with regard to our mining operations in France; and it was suggested that this officer should be allowed to come to G.H.Q. to place his information at the disposal of the Engineer-in-Chief.

Accordingly on Saturday, the 13th February, 1915, Major John Norton-Griffiths walked into the Engineer-in-Chief's office at St. Omer.

I was assistant to the Engineer-in-Chief at the time, and I think both he and I were relieved to find that the man in question really possessed practical knowledge of his subject, and was one to whom the word "impossible" was unknown, and whose forceful character and enthusiasm swept away all opposition to his proposals, and at the same time was a most interesting and amusing companion.

What Norton-Griffiths had come to France for was to press for the application of a system of tunnelling in clay called "clay kicking." He stated that as a contractor he had had long experience of this system, he knew that it was rapid and absolutely silent, and was quite sure that, if it was adopted in our mining, we would soon recover the initiative in that form of warfare which we had lost for the present.

He said that he was at that moment just completing a contract for making tunnels by this process for a drainage scheme at Liverpool, and was prepared to place the whole of his tunnelling personnel at the E.-in-C.'s disposal. He had brought with him one of his assistant engineers and a foreman to assist him in making an inspection of the nature of clay on our mining front.

The E.-in-C. and myself had both occupied the appointment of C.I.F. at the S.M.E., but neither of us had ever heard of "clay kicking," and were perhaps inclined to be sceptical, but after a long discussion it was decided that I should take Norton-Griffiths, his engineer and foreman (Lieut. Leeming and Serjt. Miles), down to the Givenchy front the next day. Starting at 8 a.m., we had to call at the headquarters of each formation to get a pass forward to the next. We went through five of these, at each of which Norton-Griffiths stated his case and gave an ocular demonstration of how

"clay kicking" was done, on the office floor,* much to the astonishment of his audience.

On arrival at Givenchy, the mine in the "orchard" was inspected and Norton-Griffiths was satisfied that the clay was suitable; his foreman was enthusiastic and said that the sight of that clay "made his mouth water." This satisfactory report was duly repeated at each headquarters as we returned to G.H.Q., where we arrived at 11.30 p.m.

The next day was spent in conference with the E.-in-C., thrashing out the details of the organization, personnel, transport and pay of the special companies which were essential if this system of mining was to be introduced.

Norton-Griffiths having convinced the E.-in-C. that they were necessary, the latter reported the fact to the General Staff, and a telegram was sent to the W.O. asking for authority to form these units; the necessary authority was received next day.

There was some discussion as to the title of the companies. Norton-Griffiths wanted them called "Moles," but the War Office traditions had to be followed, and they were christened Tunnelling Companies, but many of the companies kept the "mole" as a company sign, and on their Christmas cards.

The next day was Tuesday, and Norton-Griffiths returned to England to collect the original draft of R.E. for the Tunnelling Companies. The way he did this is worth while recording, for it gives a very clear idea of his method of working, and his extraordinary energy in getting things done. On Wednesday, he was in Liverpool closing down his contract, and selecting those men of his employees who would be suitable for the work in France. On Thursday, he appeared at Chatham with 18 men, who were then and there attested, clothed, and made into Royal Engineers. On Friday night, he returned to France with them, arriving at Bethune on Saturday, and saw them start work underground at Givenchy on Monday. I always think of this move as the quickest *intentional* move of the war.

Norton-Griffiths' own movements during the formation of the first five companies were meteoric. He was provided with a mandate by the A.G., G.H.Q. which enabled him to visit all units containing officers and men who had mining experience, and to select from them personnel for the Tunnelling Companies. He did this with his unfailing energy and enthusiasm, combined with his wonderful persuasive powers and irresistible good humour. He used to claim that his experience in lobbying in the House of Commons was of untold value

* Clay kicking is a method of excavating a tunnel in clay only. The clay kicker lies on his back on a wooden frame called "the cross," feet foremost, and works his way forward by means of a narrow-bladed spade called the grafting tool. He passes the spoil over his shoulder to his mate behind.

to him when he was up against a Commanding Officer who very naturally objected to being robbed of his best men in order that Norton-Griffiths might form a Tunnelling Company; but Norton-Griffiths always got his way, and the C.O.'s feelings were somewhat salved by the appearance of a Rolls Royce car at his headquarters with sundry wooden cases for disposal! Norton-Griffiths was here, there, and everywhere, holding parades, selecting officers and men, dashing across to England to collect certain men, stores or instruments, and conducting them personally from any of the channel ports at any hour day or night, to their final destination, occasionally finding time to look in at the E.-in-C. to report progress.

When the companies got down to their work, Norton-Griffiths was the E.-in-C.'s recognized liaison officer for mining work, and it was through his inspection reports that the E.-in-C. was kept up-to-date with regard to the mining situation. These reports recorded all his own doings and those of everyone else he met, and were written exactly as he felt at the time of writing. Some of the contents were highly secret, most of them were interesting, and all of them entertaining. We called these notes "Punch," and the issue of each new number was eagerly awaited by the E.in-C.'s Staff. Norton-Griffiths was quite indefatigable, and after the hardest day was always ready to spin a yarn about his early life, life in the House of Commons, or electioneering adventures as "Empire Jack," because he always had a map of the Empire and the Union Jack on his platform, and by degrees we began to understand the nature of the man who had come among us, and who told us, as he surveyed his work of creating the Tunnelling Companies, that no regular officer could have done it. I, for one, am perfectly certain he was right.

His powers of judging a man were remarkable, as I know well from my association with the Tunnelling Companies and their officers later on. He rarely, if ever, made a mistake in a selection for a commission. I asked him one day how he did it, and he said with a twinkle, "I look a man straight in the eye," and I can vouch for it that the ordeal of being looked straight in the eye by Norton-Griffiths was no mean one.

He was a man of action if ever there was one; and we in the E.-in-C.'s office were not the only people impressed by that quality. Some years after the war, I was going down Whitehall on the top of a bus watching the road being broken up by the pneumatic drills, which were just coming into general use for that purpose. The man next to me suddenly said, "Well, if Empire Jack had had his way they'd have been used for this long ago." I said, "What do you know about Empire Jack?" and he said that he had worked for him for some years, and added, "but he's a terrible man." "Terrible man?" I said, "why terrible?" He said, "Well, I was down at one of his

meetings in Wandsworth, and he was making a speech, and there was a fellow there interrupting and wouldn't stop, so Empire Jack just got down from the platform, walked to the man, knocked him out, and then came back and went on with his speech. Oh, he's a terrible man."

Anyone who was in contact with him could not help being impressed by his intense enthusiasm; his ability was undeniable, the only thing we never got quite used to was his total disregard for the proper military procedure.

Another characteristic of the man was his large-mindedness. His schemes were always on the grand scale. His nickname in the House of Commons, "Empire Jack," is significant, and he often spoke of his connection with contracts in Canada and Australia, which involved millions of capital. It was, therefore, almost natural to expect that he would foreshadow a mining scheme on a large scale, and so it happened. Early in August, 1915, he produced a very roughly worked out plan for extensive deep-level mining on the Messines front. This scheme was altogether too sketchy to be seriously considered, so he and I got down to details, and the result was the framework on which the mines used at the Battle of Messines were planned, and fired nearly two years later.

When mining was made a separate branch of the E.-in-C.'s office, and an Inspector of Mines at G.H.Q. was appointed, Norton-Griffiths' position as liaison officer was redundant; so, having collected the Staff for the new Inspector of Mines, and seen the office fairly started, he said he must return to England to resume his parliamentary duties; this was in April, 1916, but I think he was already seeking some new excitement, and after a very short stay in England we next heard of him wrecking the oil wells in Rumania.

His restless spirit has now "gone forward," but his work while he was attached to the Royal Engineers may be traced in those pages of history, which describe the achievements of the Tunnelling Companies. Without him, the companies as we knew them had never been formed, and their crowning success, the "Mines of Messines," had never been realized. *Lest we forget.*

R.N.H.

SIXTY YEARS AGO.

THE
ROYAL ENGINEER JOURNAL.
FOR PRIVATE CIRCULATION ONLY.

AUGUST 1st, 1870.

C TROOP.

The Corps having been augmented by C, or the Telegraph Troop, it is considered that it may not be uninteresting to give a brief sketch of this new equipment.

The Telegraph Troop consists of 24 carriages, viz.: 4 office waggons, 12 wire waggons, 3 general service waggons, 1 pontoon waggon, 1 forge, and 3 artificers' waggons.

The whole of these carriages have been constructed with springs, which is a novelty in military carriages, and are lighter in every case than those generally used for military purposes.

The wheels are the 3° class wheel, with madras nave and a 3″ tire.

The Office Waggons contain the instruments, writing materials, &c., and are constructed with a roof and sides of Clarkson's patent material.

The Pontoon Waggon, which carries a bay of super-structure 15′ and a pontoon boat, of the new pattern for putting the cable across a river; the bay is for crossing a small opening.

The Wire Waggon carries three miles of insulated wire; this wire is composed of 3 No. 20 B W G copper wires, tinned over; diameter of the conductor is .064″ insulated to a diameter of .206 with vulcanized India Rubber, and protected by a layer of strong canvass, covered by two thicknesses of tape primed with India Rubber, the diameter of the whole being .3 of an inch.

Each Wire Waggon has six drums, these drums revolve on pivots fixed on the sheers of the carriage.

The two rear drums are rolled up by a band worked from the wheel of the carriage. Each drum to be reeled up is transferred to the rear of the carriage and worked by the band. The wire is laid out along the road; the place selected is the fence or side of the road; when a road

has to be crossed, telescopic iron poles are put up which raise the wire sufficiently high to allow carriages to pass underneath.

The Cable is not easily cut by carts passing over it; indeed, a battery of artillery has gone over it very often without doing harm.

The junctions of the wires are made with Mathieson's ebonite jointers. This Troop comprehends twenty signallers. These men are equipped with telescopes and signal flags; their use is to prolong the line of communication and obtain the information which the regimental signallers may furnish, transmit it to the Office Waggon, from whence it is telegraphed to Head Quarters. The whole troop composes a unit of Field Telegraph, and is the proportion for a Corps d' Armee as laid down.—*W. O. Circular*, 26th Feb., 1866.

RETIREMENT SCHEME.

The question of retirement for the Royal Engineers is one of national importance, inasmuch as the efficiency of the Army depends on the efficiency of its different portions. It is a question which sooner or later must be viewed in connection with the question, how a Reserve Force shall be officered?

Without dwelling on this subject in its most important, a national bearing, we propose to offer to the officers of the Corps a precis of the proposals of the Committee of which Capt. Vivian was President, and which have been submitted to the Secretary of State. This Committee states, that the average promotion in the Infantry, purchasing and non-purchasing, at the present moment, is as follows:

Lt.-Colonel	23.3	years
Major	17.9	,,
Captain	8.8	,,
Lieutenant	2.8	,,

But assuming the above to be a correct statement, the Committee for some reason not stated assume the standard periods in the Artillery and Engineers to be as follows:

Major-General	40	years
Colonel	34	,,
Lt.-Col. with Major's pay	25	,,
Captain	18	,,
Second Captain	12	,,

In the case of the Royal Engineers, the Committee propose to add one year to the standard times, thus any officer may, by looking at the following table, see how he will stand with reference to Infantry officers:

	Infantry	Eng.	
Lt.-Colonel	23.3	26	with Major's pay
Major	17.9	18	1st Captain
Captain	8.8	13	2nd Captain

It is well known that there are but three ranks of Officers in the Army: *Company Officers, Field Officers, and General Officers;* thus to become a Field Officer, the Engineer must serve 8.3 years more than the Infantry officer.

There will, therefore, as the Committee justly observes, be no danger of his ever superseding the latter.

Lord Raglan's minute of the 12th July, 1854, may here be quoted.—"The situation of the Subaltern officer of Engineers is undoubtedly peculiar. He has various duties to perform, always important, very frequently onerous, as well as involving responsibility to an extent unknown to any officer of his relative rank in any other branch of the service." This is true of all ranks in the Engineers—under the proposed regulations the state of the Corps will be worse than when Lord Raglan wrote.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE REAL WAR, 1914–1918.

By B. H. LIDDELL HART.

(Faber & Faber, Ltd., London, 1930.) Price 12s. 6d.

A short history of the World War in 500 pages, with a very useful Bibliography, a fairly good Index, and some maps and sketches. The author was an undergraduate at Cambridge when the war broke out, obtained a temporary commission, was wounded on the Somme, and was unable to take any further part in the operations. His first-hand knowledge of many of the subjects he discusses is, therefore, limited, but being a clever man, he has managed to acquire and assimilate a vast amount of information from books, documents and "gup." He has used this material well, sometimes ruthlessly, and the result is a readable book in which the author's comments and deductions are well worth considering, whether one agrees with them or not.

In his preface, the author explains the title, "The Real War." He warns the reader that he is not going to gloss over disturbing facts so that individual reputations may be preserved at the price of another holocaust of lives, and that he cannot regard the repute of a few embodied handfuls of dust as worth more than the fate of a nation or a generation. He considers that the history of the war, as so far presented to the public, gives only one side of the story, that of the Cabinets and Military Headquarters: and that the other side—that of those who fought in the ranks and those who lost their best—has not received sufficient recognition. Therefore he uses the word "real" as describing what actually happened, not what has appeared in print. He further claims that the time has come when a "real" history of the war is possible, since all that can be known is known. The private diaries of Earl Haig and others have yet to see the light, so possibly he is a little "previous."

It is a feather in the cap of the official historian that the author holds him in sincere respect, and often quotes him.

Although the author states in his opening lines that the subject is so immense that it cannot be included in the scope or the space of a short history of the war, he gives us in his first chapter a very able summary of the "Origins of the War," and he follows this up with an equally clear dissertation on the "Opposing Forces and Plans." Both chapters will be useful to the military student.

In describing the various phases of the war, the author gives us his own conclusions in each case, and it is these that make the book so interesting. Referring to the British share in the French plan of campaign, he writes:—"When the General Staffs of the two countries "conducted their informal negotiations between 1905 and 1914, they "were paving the way for a reversal of England's centuries-old policy— "the exploitation of mobility given by Sea-Power—for a war effort "such as no Englishman had ever conceived. Lord Kitchener had a "remarkably accurate intuition of the German plan, and tried to avert "the danger threatening her as an appendix to the French left wing, by "advocating that the B.E.F. should concentrate near Amiens, where it "would be less exposed. But the vehement support given by the "Commander, Sir John French, and his Staff to the French plan, induced "Kitchener to give way." Later he "lamented his consent as a "mistaken weakness."

At some future date Captain Liddell Hart ought to give us a series of studies on various phases of the war. Here we have two interesting problems. What would have happened if the B.E.F. had concentrated at Amiens? And—was the landing of the B.E.F. on the Belgian coast a sound and practicable plan? The intuition of Lord Roberts, and of Mr. Winston Churchill, evidently pointed to the latter course. Lord Fisher had the same idea, the utilization of our sea-power, always in his mind.

The failure of the Germans to capture the Channel Ports in the initial stage of the war after the retreat of the Allied left wing was, he says, an incredible blunder, and cost them tens of thousands of lives when they attempted to repair the omission after the so-called "race to the sea"—a term which the author describes as inaccurate.

He attributes the failure of the Allies to make the victory of the Marne complete partly to the comparative weakness of Manoury's flank attack, but still more to the failure of the British and Fifth French Armies to drive rapidly through the gap which lay open before them. "Their direction of advance"—he writes—was "across a region intersected "by rivers, and this handicap was intensified by a want of impulsion "on the part of their chiefs, each politely looking to his neighbour, and, "timorously, to his own flanks." Critical though he is of the Allied leadership, he does not spare Moltke and the German Command for their conduct of the operations up to the battle.

And so, in discussing each phase of the campaign in France or other theatres, Captain Liddell Hart is able to intrigue us by some outspoken criticism which arrests our attention, for he crystallizes in print what we have ourselves always felt might have been the case. For instance, in

his summary of the Battle of the Somme, he writes :—" The folly of the " last phase from Sept. 25th onwards was that, having won at last the " crest of the ridge, and its commanding observation, the advantage " was thrown away by fighting a way down into the valley beyond. " Thereby the troops were doomed to spend the winter in flooded " trenches." Would not his criticism apply equally well to the fruitless Battle of the Ancre, in November, when the whole area was a sea of mud?

And still more would it not apply to the Battle of Paschendaele, where there is no doubt now that operations should have ceased on Sept. 24th, 1917, instead of being uselessly prolonged at such enormous cost into November? The tendency of the military commanders always to take the offensive without counting the cost is discussed by Captain Liddell Hart, curiously enough, in his naval chapter on the Battle of Jutland, or, as he calls it, the Battle of Blind Man's Buff. " A fundamental difference " —he writes—" between the higher naval command and military leader- " ship in the World War was that the Admirals would not intentionally " give battle unless reasonably sure of an initial advantage, whereas the " Generals were usually ready to take the offensive whatever the dis- " advantages. In this attitude the Admirals were true to their art, " the Generals were not. The sole reason for employing men who have " made war their profession is the presumption that by training they " have acquired a mastery of their art. Anyone with sufficient authority " or inspiration can lead or push men to battle, especially if he is fur- " nished with technically-trained assistants who can help him to regulate " the marshalling of the forces in movement and fire. For this shep- " herding of sheep to the slaughter, perhaps artful but essentially inart- " istic, a practised demagogue would have a definite superiority over the " tongue-tied professional warrior. But the custom of employing " a professional is based on the idea that through art he will be able to " obtain more profit at less cost. Only one consideration should over- " ride a commander's fidelity to the fundamental truths which govern " his art, and that is national expediency. . . . In the World War the " Generals were so full of lust for battle that they voluntarily sacrificed " art, and repeatedly sought battle at a disadvantage and against the " wishes of a Government reluctantly dragged in their wake. The " Admirals, in contrast, were so faithful to their art that they sometimes " ignored or evaded the express wish of the Government for battle, even " without an assured advantage. If their sense of reality was refreshing, " it tended to throw a heavier burden of expense on the armies, though " it is fair to point out that this might not have occurred if the Generals " had not been so extravagantly eager to shoulder it."

The criticism is clever. But it may be fairly urged that Captain Liddell Hart does not take into consideration the difficulties caused by Allied leadership, and that it is not only national expediency in the interest of his own nation that influences the conduct of its Commander.

The fact that " Jellicoe was the only man who could lose the war in an afternoon " is not ignored by the author. His conclusion is—" But, " if discounting all criticism, we admit that Jellicoe's handling of the " battle fleet was the flawless masterpiece that numerous naval admirers

"argue, the admission only strengthens the belief that the worst fault "of the Jutland Battle was that it was ever fought." The reviewer takes leave to disagree, for it taught our Navy lessons which it and the nation will never regret.

Space does not permit reference to others of the author's many outspoken comments, but one cannot conclude without referring to his interesting chapter on the "Battle of a Nightmare—The Meuse—Argonne," and the "Epilogue" which completes the volume.

H.B-W.

RECORD OF THE ROYAL GEOGRAPHICAL SOCIETY.

By Dr. H. R. Mill.

The Royal Geographical Society celebrated, in October of this year, the completion of the first hundred years of its existence by the formal opening of its new Lecture Hall and other additions to its building, and by the publication of the Record which is the subject of this review. The account was written by Dr. Mill, but was subjected to the invaluable supervision and criticism of Mr. Douglas Freshfield, a distinguished ex-President and one of the oldest Fellows of the Society. Two chapters are due to Mr. Hinks, the Secretary.

Dr. Mill has produced a most readable book. The mere collection of the facts, and selection of what could be included and what must be omitted, must obviously have involved very heavy work. But the book is no mere chronological record of events. It is written in most human fashion, and is enlivened by occasional anecdotes and sidelights on character and idiosyncrasies which make it delightful reading. Further, the plan of the book being a division into periods, the events in which are described in order, each period is prefaced, in order to provide a background for the account of the work of the Society, by attractive pen-pictures of the conditions of life in the country at the time. These, necessarily brief, but vivid and full of humour, are a most pleasing feature of the book.

The Record opens with a short account of geographical history and happenings prior to the formation of the Society, and then shows how, from the African Association and the Raleigh Travellers' Club, by a succession of steps which are now for the first time set out in orderly sequence, the Royal Geographical Society of London, as it was at first called, came into being in July, 1830. Few things in this book are more interesting than the record of the ten "Founders" of the Society. It is not surprising that it should have been an infant of vigorous growth with sponsors of such remarkable character and personality as these. Barrow, a man of humble origin but great ability, who became one of the greatest all-round geographers in the country; Baily, most intrepid of travellers, a founder of the Royal Astronomical Society, and one who "completed the whole round of Geography from adventurous travel to mathematical computation"; Britton, who started as a pot-boy and

ended as a leading antiquarian; Colby, a lifelong member of the Ordnance Survey, its chief organizer, and for over 30 years its Director; Murchison, soldier, country squire, artist, geologist, and later one of the greatest Presidents; and others whom there is not space to mention. It is perhaps surprising that such men should have worked together as an orderly team; but this was due, Dr. Mill says, "to the masterful efficiency of Barrow, to whom, more than to any other man, the strength of the foundations of the Royal Geographical Society was due."

The Society thus started happily, and, but for a period of stagnation in its second decade, flourished and increased in membership. The chief interest of the Society, at its start and for many years after, was exploration and discovery; and this was right at a time when the world still contained enormous tracts of undiscovered and unmapped country. It was not for some considerable time that the Council could be induced to recognize that there were other geographical activities worthy of consideration, such as education and research, and then mainly by the efforts of Galton and Freshfield. But at first it was exploration only, and the Society took, by general acknowledgment, the foremost part in undertaking, encouraging, or rewarding geographical discovery in all parts of the world, and by travellers of every nationality. Those were halcyon days when the Society's meetings were addressed by men whose names are now household words, recounting recent and romantic discoveries in the unknown regions of the world.

In the history of the Society certain names stand out, as having influenced its destinies or moulded its character, and among the chief of these may be mentioned Murchison and Markham, to whose periods of ascendancy three chapters are devoted. Roderick Murchison, having been a founder, was President four times and for sixteen years in all, and for some twenty years (1851–1870) was the ruling spirit of the Society. Clements Markham was a Fellow for fifty years, an Honorary Secretary for twenty-five, and President for twelve (1893–1905). The Society owes much also to its Secretaries, both honorary and paid, and Chapter VI deals mainly with these. Among the former, in addition to Markham already mentioned, the names of Freshfield and Leonard Darwin stand out, while of the latter Bates and Scott Keltie are conspicuous, both on account of the length of time they held office and of the influence they had on the Society.

The Society in its first forty years occupied various quarters, but in 1870 moved to 1, Savile Row, where it remained until 1913. To a younger generation this address is probably better known as the house of a famous Army tailor; but for over forty years it was, in Dr. Mill's words, "the Mecca of all true geographers, the home port of every traveller." To quote further, "The earlier homes of the Society have been swallowed up in the transformation of London, but even when 1, Savile Row also passes away the spirit of Geography must surely continue to haunt that corner." Great men resorted to that house; great events took place quietly there; and surely none more remarkable in its poignant tragedy than the return of Livingstone. Murchison had longed to welcome Livingstone in the new home of the Society but before

that could happen both men had died. The body of the great explorer was brought to Savile Row. "Now the sunset light with gentle irony shone through the western windows upon the silent meeting of the returned traveller, a mere vestige of humanity, and the waiting President, a marble bust."

Space forbids the quotation of many extracts from this interesting volume, but one more must be given, as being of special interest to readers of this Journal, apart from its intrinsic humour. Colonel Charles George Gordon was a Fellow of the Society, and a frequent visitor to 1, Savile Row. He was a man of very simple character, and extremely shy. "One day he suddenly addressed young Reeves in the map-room: 'Do you know, my boy, that the Prince of Wales sent his equerry to me the other day to invite me to dine with His Royal Highness; and I said to him that that sort of thing was not in my line at all; but if the Prince really wanted to see me, let him drop in and smoke a cigar in my rooms after dinner.' Reeves enquired timidly, 'But what did the Prince say to that, Sir?' 'Oh, he came along,' was the simple reply."

In 1913, the Society moved to its present home in Lowther Lodge. This move will always be associated with the name of Lord Curzon, the President to whose imagination and energy it was due. The scheme involved the sale of part of the open site, and the building of a lecture hall on the remainder. The war interfered with the completion of this plan, and it is only recently that it has been possible to carry it through. It was resolved to commemorate the Centenary by the completion of this much needed addition to the Society's premises. In Chapter XIV, Mr. Hinks describes the additions, which include a fine lecture hall, the first of its own, incidentally, that the Society has ever possessed, a council-room with other offices, a dignified library and map-room, together with much additional space for the reception and accommodation of Fellows.

Chapter XII, also due to Mr. Hinks, describes the war work of the Society. It is full of interest, and reflects great credit both on Mr. Hinks, who was responsible for the supervision, and on the small staff, mostly voluntary, who did the work. It included the very remarkable achievement of compiling more than 100 sheets of the 1/million map, covering practically all Europe and extending over Asia Minor to Arabia and Iraq. This map proved invaluable in the war and in the peace negotiations after.

The Record closes with a chapter of retrospect, illustrated by a historical chart, which shows in most interesting fashion the names and length of tenure of Presidents, Honorary Secretaries, and Secretaries, with the total membership of the Society and the number of elections in each year; the last two being appropriately named the Prosperity and Popularity curves. Appendixes include a list of Presidents, the composition of the First and Hundredth Councils, and a list of veterans. There is an excellent Index. The illustrations are good, and our only regret is that limitations of space prevented the inclusion of more.

Altogether this is an admirable Record, on which we congratulate the author, his collaborators, and the Royal Geographical Society.

E.M.J.

THE KITCHENER ARMIES: THE STORY OF A NATIONAL ACHIEVEMENT.

By V. W. GERMAINS.

(Peter Davies, Ltd. Price 7s. 6d.)

This book is written in a popular style, and can in no case be considered a book of reference. It is crowded with facts, but they are given in little order, and there is no index. Whether the facts are correct or not your reviewer is not able to judge, except in one instance, the date of embarkation for France of the 33rd Division. Here the author is certainly at fault, as our Tottenham Hotspurs were wallowing in the mud and chaos in front of Festubert some days before that time. It is to be regretted that he treats Lord Haig with such scant appreciation, but he has a natural antipathy for all "hoary" generals, and a positive dog-to-cat abhorrence of all Staff officers, which last may have been shared by many of the gallant members of the New Armies. In many ways this is an excellent book. The easy language of the author carries one forward at a racing pace. It is good that we should be reminded of this great crisis, perhaps the greatest in our history, in which so many of us may have played an infinitesimal part. The call of Kitchener to the War Office—his revolutionary opinion that the war would be a long one—his momentous decision to call out the New Armies—and the truly splendid response of British manhood to his call. Our author describes this as "the greatest strategic surprise known to history," and perhaps he is right. In language worthy of his great theme, he tells of the enthusiasm with which these citizen soldiers joined the Colours, of the stern persistency with which they carried out their training, amid innumerable difficulties and discomforts, of the splendid military force into which these enthusiasts were forged within a few months, and carries on the tale to its bitter end in the shambles, glorious in our annals, but still a shambles, of the Somme. Surely such a tale should never be forgot.

F.E.G.S.

A STUDY OF THE STRATEGY AND TACTICS OF THE SHENANDOAH VALLEY CAMPAIGN, 1861–1862.

ILLUSTRATING THE PRINCIPLES OF WAR, BATTLES DESCRIBED WITH SIX MAPS.

(Gale & Polden. 3s. net.)

In seventy pages, which includes the index, this book purports to study the strategy and tactics of the fighting in the Shenandoah Valley in 1861 and up to 17th June, 1862. The study unfolds in four chapters—Chapter 1 is a general summary, Chapter 2 a diary of events, in Chapter 3 the principles of war are "illustrated," and the last chapter contains "Comments on Battles."

Of necessity this condensed treatment of the valley fighting is bound to be sketchy, however carefully the book was written and edited; unfortunately bad editing and lack of clarity make parts of the book

actually misleading. For instance, the Bulls Run River is not in the valley—Bulls Run was not a valley battle, but it is discussed and described as if it was. Again, there seems to be something wrong with the following passage on page 11—" Lincoln had done all he could to prepare for a successful war, but he did realize that detachments made for the defence of the capital reduce the fighting strength," presumably the offensive fighting strength: If so, did he?

The sub-heads in Chapter 1 treat of reasons for the war, plans of campaign, mobility and training, bibliography, policy and strategy, geography, Jackson's operations, leadership and civilian interference, comparison of numbers on both sides, raids, personnel and armament. Each sub-head reads something like an indifferent answer to a promotion examination question, *e.g.*, discuss the value of raids from your knowledge of events in the Shenandoah Valley in 1861–1862—might be the question. Here is the answer!

RAIDS.

" Raids played an important part in this campaign. It is essential that they should be carried out with secrecy and rapidity. They can, however, never be decisive. They may cause inconvenience and lower an enemy's morale, but they cannot seriously effect a result. They must be relevant to the main situation." That is all, no mention of raids in the index. . . . Obviously the examinee knows nothing of any raids carried out during the campaign, and has relapsed into generalities.

The book is full of such generalities. I can, however, recommend it to any officer who, debarred by his social or sporting engagements from making a serious or reasoned study of his profession, wishes to equip himself with a veneer of military knowledge sufficient to enable him to bluff the authorities into retaining his services. He will find a set of usefully resounding platitudes on almost every page, and these he is recommended to underline and learn by heart. For instance—

" An important point to be noted in this campaign is leadership."

" The geography in the area of operations affected the strategy of the campaign."

" In this war also is brought out the lesson of mobility." Quite so, sir! Quite so.

" Regulations teach us that we must learn from past experience, and that it is necessary to build on the past to make the future secure." Pass the port, sir, pass the port!

These are only a few nuggets, more are available!!

As potted strategy for pallid students, the book fails to attain its object, if any.

E.E.D-S.

APPLIED MECHANICS FOR ENGINEERS (VOLS. I AND II).

By T. HODGSON, B.A., B.SC.

(Chapman & Hall, 9s. 6d. and 13s. 6d. respectively.)

These volumes will form part of a three-volume series, based on the lectures given at the City and Guilds Engineering College by Professor Henrici, to whose memory the work is dedicated.

Vol. I is devoted to Graphical Statics, and opens with a chapter on the Theory of Vectors, which is the key to the subsequent investigations of Mass Centres, Co-planar Forces, Bending Moments and Shearing Forces.

These in turn lead up to chapters on Force Diagrams of simple Rigid Frames, and Virtual and Potential Energy.

Vol. II is devoted mainly to Dynamics, but contains chapters on the Differential and Integral Calculus, and the application thereof to dynamic problems.

Vol. III, which is still in course of preparation, will deal with Differential Equations and their application to electrical and structural problems.

Both the published volumes bear traces of their acknowledged origin, the text being more akin to the incoherent arrangement of lecture notes, than to the measured sequence of a normal textbook.

This slight defect is, however, amply counteracted by the careful grading of the very illuminating examples, provided for the reader's amusement at the end of each chapter.

Although there is no doubt that the series would be of the greatest value to any Sapper officer who wished to brush up his knowledge of Statics, Dynamics or Calculus, it cannot be so wholeheartedly recommended to those who wish to discover quickly the method of tackling an individual problem without a wholesale exploration of general principles.

The publishers are to be congratulated on the attractive way in which the volumes are presented.

The diagrams are numerous, and are inset where they are required; the text is very clearly arranged and culminates in an excellent index; the misprints are reduced to a minimum.

A.D.C.

REPORT ON THE RAILWAY SYSTEM OF TANGANYIKA TERRITORY.

By BRIGADIER-GENERAL F. D. HAMMOND, C.B.E., D.S.O.

In 1929, General Hammond was commissioned by the Colonial Secretary "to inspect and report on the Tanganyika Railways."

His report describes the organization and administration of the railway system, its financial condition and traffic services, with his criticisms and recommendations, and contains a survey of future policy and development.

The Tanganyika Railways consist of 128 miles of metre-gauge: the central railway from Dar-es-Salaam to Kigoma on Lake Tanganyika 773 miles, with a branch from Tabora to Lake Victoria 236 miles, and a line of 272 miles from Tanga to Aruska. There is also 15 miles of 2 ft. 6 in., and 78 miles of 2-ft. gauge, making a total route mileage of 1,374. The Railway Administration also includes the "Allied Services" of Marine Department, Dockyard and Slipway, Harbours and Wharves, Harbour Extension Works, and Electricity Department. The Electricity Department is not reviewed in this report.

The Headquarters of the Administration is at Dar-es-Salaam; traffic working is organized on the Departmental System.

The several departments are dealt with in turn. The Engineering Department is in charge of new construction, surveys, and capital works, as well as of maintenance, which includes the maintenance of harbours, wharves and lighthouses.

The transfer of the latter duty to the Resident Engineer in charge of Harbour Works is recommended.

The report discusses the question of carrying out new construction departmentally or by contract, and is in favour of the latter, provided suitable local tenders are forthcoming.

The preparations for the construction of the Iramba Plateau line were too far advanced to admit of tenders being asked for from British firms.

The Loco Department has workshops at Dar-es-Salaam, Tabora and Tanga, *i.e.*, is organized in three practically self-contained districts.

The report throws an interesting light on the problem of training the local African drivers to a suitable standard of efficiency.

Wood fuel is used, except where on some sections the cost has risen to a point at which coal becomes cheaper.

While the figures given for operating showed on the whole satisfactory results, these were due in both Loco and Traffic Departments to personal exertion rather than system.

Such statistics as were maintained were meagre and their presentation too slow. On General Hammond's recommendation it has been arranged to form a statistics branch in the Accounts Department.

A proposal under consideration for the construction of a new single-ended traffic yard at Dar-es-Salaam is criticized, and alternatives suggested.

The report contains an interesting account of the working of the Marine Department, which includes buoying and lighting the coast, berthage and pilotage at Dar-es-Salaam and Tanga, and the operation of a steamer service on Lake Tanganyika.

An efficient Dockyard and Slipway are worked under the Chief Mechanical Engineer. A revision of the scale of charges is recommended which would make these self supporting.

The passenger and goods services and rates appeared to be giving satisfaction generally. The most important traffic carried is through traffic with the Belgian Congo. This, however, appears unlikely to increase, whereas the traffic from the Territory itself is increasing.

The financial situation of the railway is still weak, however. The cause is the small volume of business handled compared to the mileage maintained. This makes it particularly necessary for the Tanganyika Railways to increase their gross receipts and expand capital to do so.

Perhaps the most interesting chapter is that devoted to Future Policy and Developments. Funds have been allocated for the purchase of another steamer for the lake, and for improving the port at Kigoma. This will better equip the railway to meet developments which are taking place in the Congo and districts close to Lake Tanganyika.

The report recommends that the Kenya and Uganda Railways should take over and work the Tanga line and port as agents of the Tanganyika Railways, and explains how economies would be thereby effected.

The proposals under consideration for the construction of new branch lines are discussed and the order of priority recommended.

The writer describes how the question as to which route should be chosen for the southern line has been clouded by the demand for a so-called "Imperial Link" between the Tanganyika and Rhodesian railway systems. No adequate justification for this, economic, administrative or strategic, has been advanced, and the choice should be made solely from consideration of which route will best develop the country to the south of the central line.

It is pointed out also how railway development is in the interests of the Territory, by bringing in new revenues, even more than to the advantage of the railway itself, so that it is right that the Territory should assist such enterprises.

L.M.

SURVEY OF INDIA.

GEODETIC REPORT, VOL. V.

From 1st October, 1928, to 30th September, 1929.

(Published by order of Brigadier R. H. Thomas, D.S.O., Surveyor-General of India.)

The Survey of India, judging from the published annual reports, appears to be more willing than any other survey organization of the Empire to give those interested in such matters the results of its work and investigations. No other department of the Empire engaged in this kind of work publishes nearly such full and detailed accounts of its doings. This is very evident to anyone who has to examine the reports of Colonial Survey departments, as contained in the summary given by the Colonial Survey Committee. It is extremely difficult to find out what has been done, especially the cost of the various kinds of work.

It is understood this is due to the very meagre information given by the surveys and to the want of system and uniformity in making out the reports. It is, however, encouraging to note that the question of producing uniform reports, giving specific information of what the different colonies are doing, was discussed at the last Conference of Colonial Survey Officers—it is hoped this will bear some fruit in the future.

During the period under review, the field operations comprised gravity observations in the South and East India, principal triangulation in Assam and Burma, and high precision levelling in northern India.

As the observations for the international longitude scheme of 1926, at Dehra Dun, were carried out with the prismatic astrolabe, they also yielded values for latitude, an analysis of which shows a marked fortnightly variation, which is not in agreement with similar results found

elsewhere. The values have been plotted to show this variation with the age of the moon.

A series of observations for longitude was also carried out and the apparent changes have been shown by a graph. The extreme variation is about 0·2", but the conclusion is "the curve is rather irregular, but the changes cannot definitely be ascribed to anything but instrumental error."

With regard to possible gravity variation, the results derived from the re-observation of certain old pendulum stations (some of which were made twenty-one years before) indicate that gravity values in India are stable *inter se*. But "whether they are stable in relation to gravity values in Europe is an open question." The different values of g, found at Dehra Dun each time a connection was made with Europe, is discussed. Dr. Oldham had doubts about the stability of gravity at Dehra Dun, on account of its nearness to the Himalayas. This seems to raise an interesting point; if isostatic equilibrium is still incomplete in Himalayan regions, as is probably the case, it might reveal itself by variations of g at Dehra Dun—but, on the other hand, isostatic adjustments may be so slow that they could only be detected over very long periods, much longer than have elapsed since observations were begun.

Chapter IV of the Report is devoted to a long and detailed discussion of Gravity and Deviation of the Vertical, in Section I, by Major Glerime, R.E., while, in Section II, Dr. de Graaff Hunter treats of the Development of Gravity Formulæ. Section III, by Captain Bomford, R.E., deals with the Indian geoid. The chapter is illustrated by many charts and is a valuable contribution to Indian geodesy.

Under the head of Triangulation, there are some important remarks about the behaviour of the Wild Theodolite in the field. Unfortunately, it is only possible to acquire portability, compactness, rapidity of reading and lightness, by introducing many complications which may go wrong in the field, perhaps hundreds of miles from civilization, as happened with the theodolites used by the Survey. We have always been doubtful about these complicated instruments, notwithstanding their many apparent advantages, and could not advise their use in their present form, except where an ordinary theodolite is carried as a standby. On the other hand, while they are in order, they give exceedingly good results.

In the chapter on Levelling, by Mr. H. P. Morton, among other subjects, are some interesting remarks on the errors of hill levelling of precision. The conclusion is that, of the many errors to which levelling may be subject, the most likely one is due to ignorance of the exact length of the staff which may considerably affect the closing error. Where the rise is considerable, "the remedy lies in the use of invar staves, which it is hoped to introduce shortly."

Chapter VII, Research and Technical Notes, by Dr. de Graaff Hunter and Capt. Bomford, R.E., deals with Dynamic and Orthometric Heights as applied to Spirit Levelling; Height Correction to Deviation of the Vertical; Comparison of Spirit-Levelled and Triangulated Heights.

The Report is accompanied by numerous charts and index maps with two folders, one showing average heights for India in 30-ft. squares,

and the other an average contour map at 200-ft. intervals, except in certain flat areas where the interval is 100 ft.

A complete list of Survey of India publications is to be found at the end of the Report.

H.L.C.

STAR LISTS.

(American Geographical Society, School of Surveying, Publication No. 4.)

New lists of stars, for the use of observers with the prismatic astrolabe, have lately been issued which are of great importance to surveyors, and especially explorers, throughout the world.

These lists, which contain no less than 94,000 stars, have been compiled under the direction of Mr. Weld Arnold, of the American Geographical Society's School of Surveying. Their preparation and publication is due to the munificence of that well-known explorer and geographer, Dr. Hamilton Rice; than whom there is no more generous supporter of all things geographical as our own Royal Geographical Society has every reason to know.

The object of these lists is to render unnecessary the computation of an observation programme before beginning work with the prismatic astrolabe, or with Reeves' prism attachment for theodolites. The range of latitude with which the tables deal is from 60° north to 60° south. Ball and Knox-Shaw issued similar, though not nearly so extensive, lists in their Handbook of the Prismatic Astrolabe, also their lists are arranged by quadrants.

The tables are constructed for the star's passage across the 60° almucantar, for each degree of latitude between the selected limits. They give to the nearest minute the time of passage, the star's azimuth to the nearest quarter degree, its magnitude, designation and R.A. As every possible star appears in the lists they follow each other at intervals of only a minute or two.

At the end of the book is an article on the use and adjustments of Reeves' attachment, together with a set of forms and worked out examples, which should be appreciated by the beginner. For the benefit of explorers who intend to take with them a wireless time-receiving set, if he uses short waves between, say, 22 and 110 metres, he can obtain a set weighing only 5 kilograms, complete with spare batteries, tools and aerial.

The only criticism we have of this admirable book in its present form is that it contains, as far as the lists are concerned, a great deal more than any one surveyor on a particular job could require; he would, therefore, have to carry a certain amount of superfluous matter. We understand, however, that lists are also printed in pamphlet form by separate degrees of latitude for convenience in the field.

H.L.C.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1930. TOME II.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée belge pendant la campagne de 1914–1918. The narrative of the events connected with the "Combats de Hautem-Sainte Marguerite et de Grimde" is continued in the numbers of the *Bulletin* under notice—Parts IV to VI inclusive. The account which appears in the first two numbers is based on Belgian records and publications, whilst that in No. 3 is derived mainly from German documents which have become available to the public. The Commander of the Belgian 1st Division, which, on August 18th, was in the neighbourhood of Tirlemont, received a verbal order at 2 p.m. to fall back on Louvain. Troops of the 2nd Mixed Brigade (whose outpost line covered a front extending from Neerlinter to a point N. of Vissenaeken) were at this time already engaged with the Germans advancing on Neerlinter, and the artillery of the Brigade had just received an order to open fire on a hostile force which had reached the outskirts of Wommersen. Details of the part played by various units of the 2nd Mixed Brigade during the "Combat de Hautem-Sainte Marguerite" are given in No. 1. The Belgians suffered heavy losses and were compelled to withdraw from their positions towards evening.

On August 18th, positions S. of Tirlemont (along the *Chemin de fer de Diest*) were held by units of the 3rd Mixed Brigade. At 1.50 p.m. German artillery opened fire on Grimde (a suburb S.E. of Tirlemont), and soon after 2 p.m. German infantry also appeared in front of the line held by the 3rd Mixed Brigade. About 5 p.m. this Brigade was also compelled to fall back. The measures taken in connection with the retreat of the Belgian 1st Division, and for its protection during the retirement, are dealt with in No. 2. In this number, an account is given of the fighting in which the 3rd Mixed Brigade was involved in the neighbourhood of Petit Overlaer and Cumptich; and, in it, a sketch map is also provided showing the billeting areas assigned to the 1st Division for the night of August 18th/19th.

In No. 5 of the *Bulletin*, a brief account (based on German regimental histories, etc.) is given of the events of August 18th, 1914, from the German point of view. It was to the German First and Second Armies, together with the German II Cavalry Corps, that the task was given to cut off the Belgian Field Army from Antwerp. The German 2nd Cavalry Division, which was operating on the right of the German First Army (to which it was attached), crossed over to the N. bank of the Nethe at daybreak on August 18th, and pushed reconnoitring parties

far to the N. and W. without coming into contact with any part of the Belgian Army. An Army Order, timed at 10 a.m. on the 18th, was sent to this Division with instructions that it should advance in the direction of Aerschot-Brussels. However, in view of the exhausting work already carried out by this formation on a very hot day, its Commander decided to rest his troops at Oosterloo, instead of carrying out the instructions issued to him. The German II and IV Corps reached the line Hersselt-Montaigu-Molenbeek-Cappellen without encountering any opposition. Troops of the German III Corps came into collision at Budingen with Belgian cavalry, which retired after a small skirmish; the left flank of this Corps reached Stock on the 18th without opposition. It was with the German IX Corps, which formed the left wing of the German First Army, that the Belgian 1st Division had to deal at Tirlemont.

The movements of the German 17th and 18th Divisions, and the operations of the latter Division, which led the attack against Tirlemont, are briefly described in No. 3. It is now evident that King Albert adopted a prudent course in not accepting battle on August 18th; the contest would have been an unequal one. The measures which were adopted by the Belgian High Command in fact upset the plans of the German High Command.

Chronique de l'Infanterie. Parts VI, VII and VIII of an anonymous contribution under the foregoing title appear successively in the numbers of the *Bulletin* under notice. In Part VI the employment of machine-guns is dealt with: the subject is reviewed in the light of an article by Lieut.-Col. von Schobert published in the *Militär Wochenblatt* for September 11th, 1929. Attention is also called to the instructions laid down in the Belgian and Italian official Regulations regarding the tactical handling of machine-guns. In this part of the original article, the Belgian doctrine in relation to the counter-attack is compared with the Italian and German doctrines on the same subject. In all three armies a distinction is made between the *contre-attaque immédiate* and the *contre-attaque d'ensemble.* The former term is applied to the case where an attempt is made to obtain a decisive result against exhausted troops by an immediate thrust before the latter have had time to familiarize themselves with the characteristics of the region into which they have penetrated. The latter term is used in relation to an attack which is made on the supposition that the enemy has not yet had time in which to establish himself in new territory and properly to organize a defensive position therein. Matters relating to anti-gas training are also briefly touched upon in No. 1 of the *Bulletin.*

"Mechanization" and "motorization" are dealt with in Parts VII and VIII. The term "mechanization" is employed in the original article to denote the introduction in the armament of troops of a continuously increasing number of "automatic" weapons with a view to augmenting the fire effect of the arms with which troops are equipped, whilst at the same time a reduction is obtained in the numbers of the men which are required in the firing line on a front of a given extent. The term "motorization" is employed to signify the increased use of all forms of mechanically-propelled vehicles, whether of the armoured or the non-armoured type.

Part VII deals with mechanization : the bearing which this subject has on the new types of organization proposed for infantry units is briefly discussed therein.

Part VIII deals with motorization : the experiences of the Great War in relation to mechanically propelled vehicles and the requirements in relation to mechanical transport are briefly touched upon therein.

Les Opérations de nuit. The original article is contributed by Col. Denayer, Belgian General Staff, to No. 1 of the *Bulletin;* he discusses therein the instructions on this subject contained in the Belgian *Le Service de campagne* and *Règlement sur le combat de l'infanterie.* Details are given by Col. Denayer of night attacks carried out by Belgian and French troops during the Great War ; the conclusions to be drawn from these operations are also summarized by him.

La Siège de la Citadelle d'Anvers en 1832. Parts IV, V and VI of the article by Major Delvaux under the foregoing title appear successively in the numbers of the *Bulletin* under notice. Holland was not willing to accept the decision taken at the Conference of London. King William felt that the retention by the Dutch of the Citadel of Antwerp was a dynastic as well as an international question. He had acquired rights in Belgium under the Treaty of Vienna, and, in his view, it was necessary that all the signatories to this Treaty, and not a very small minority of them, should act in the matter, if an important change in the status of Belgium was really required. In consequence, a critical situation came into existence. The defensive measures adopted by Holland and particulars of the belligerent forces are given in No. 1 of the *Bulletin.* At this time the Dutch Field Army consisted of 45,000 men, 3,000 horses and 104 guns ; there were in addition fortress troops and volunteer corps. Including the land forces detailed for the defence of Antwerp, Holland was in a position to put 105,000 men in the field in a European theatre of operations.

The Dutch garrison of Antwerp and its forts consisted of 164 officers, 4,324 O.R. and 145 guns. The Dutch also had small naval forces near Antwerp and Flushing (33 boats in all carrying 4,025 men and 675 guns) ; other Dutch naval forces were stationed at the Helder and at Helvoetsluys.

The French *Armée du Nord* consisted of 65,000 men, 14,000 horses, 72 field-guns and 80 siege-guns. Some 16,000 French troops, in addition to the artillery and the sappers and miners, were employed in the siege operations against Antwerp ; they were covered by another force of 29,000 men—the personnel of the parks and a reserve force of 13,000 men are not included in these figures.

The Belgian *Armée d'Observation* consisted of some 67,000 men, 6,800 horses, and 78 guns. Including the *garde civique,* Belgium was in a position to put 105,000 men (out of a total population of 3,800,000 persons) in the field. The Franco-Belgian force in the Antwerp theatre outnumbered the Dutch defence force by approximately 25,000 men and a few guns.

The Siege Park of the French *Armée du Nord,* which was mobilized on October 1st, 1832, contained 36 siege guns and 14 howitzers of various calibres. This armament was at once added to by drawing on the

reserves at certain French fortresses. Thereby, the siege train was increased to 80 guns and howitzers and 6 wall-pieces.

The French siege train entered Belgium on the morning of November 15th; its personnel was provided by 14 artillery companies (of 120 men each), 6 companies of *sapeurs-mineurs*, an engineer detachment and a bridging brigade. The waterways of Belgium were utilized for the transport of guns and other material to the front, and much time was thereby saved.

Part IV concludes with an account of the early phases of the French operations against the Citadel, and the part played by the Dutch naval forces against the besiegers.

The operations against the Citadel of Antwerp fall into two distinct periods; the first of them extends from the night of November 29th/30th, when the first parallel was opened, to the night of December 13th/14th, when the St. Laurent lunette was captured; the second extends from the latter date to that of the capitulation. The text of the Convention entered into between the French and Belgian authorities on November 15th, 1832, providing for military co-operation, is set out in Part V, which also contains an account of the opening of the first and second parallels and of the batteries of the first artillery position; the measures taken in the Citadel by its garrison to guard against a surprise attack are also described therein.

Fire was opened by the artillery of the defence at noon of November 30th. An explanation of the circumstances which led to this first act of hostility is to be found in the correspondence which passed between Gerard and Chassé on November 30th; on this date the former demanded the surrender of the Citadel. This correspondence will be found in No. 2 of the *Bulletin*.

The task of arming the French batteries proved to be a difficult and perilous one, and it was not until the morning of December 4th that the guns were ready to come into action; at 11 a.m. on this date, 85 guns and howitzers opened fire against the defences of the Citadel. Some of the enemy's guns were dismounted, and a good deal of damage was done by the French artillery; the bombardment is described in No. 2.

The operations of December 6th to 13th inclusive are dealt with in Part VI. On December 6th, the supply magazine in the Citadel was set on fire by the French artillery; on the following day the powder magazine was blown up, and on the 8th the main barracks were destroyed by it. The Dutch garrison displayed a good deal of activity, and did much damage to the French trenches; the French sappers spent a busy night (on the 8th/9th) repairing the damage. The Dutch carried out a sortie on the evening of December 10th against the French lodgment on the Toledo bastion, and succeeded in destroying French saps. However, the French soon recovered the ground lost by them.

A description of the operations resulting in the capture of the St. Laurent lunette on December 13th is contained in No. 3 of the *Bulletin*. Part VI of the article concludes with extracts taken from the reports relating to these operations made by Serjeant Reymering and Lieut. Boers.

Les aspects militaires de la Révolution de 1830. Parts IV, V and VI of

the article under the foregoing title by Capt. Wanty are published successively in the numbers of the *Bulletin* under notice. The narrative of the events of September, 1830 are continued in Part IV. On September 23rd, Prince Frederick endeavoured to treat with the leaders of the Revolution, in the hope of restoring order without resort to force; he sent Lieut.-Col. de Gumoëns to Brussels for this purpose. An account of the negotiations, which proved abortive, is given in No. 1 of the *Bulletin*. It was recognized by the leaders of the Revolution that it was necessary to constitute some authorized body which should become responsible for any military and administrative action which might be decided upon. Accordingly on September 24th, a *Commission administrative* was created and assumed the direction of affairs.

Hostilities were resumed on September 24th: an account of the local operations which followed thereupon; the spread of the revolt to the Provinces; the setting up of a *Gouvernement provisoire* (to deal with Belgian affairs); and the early measures taken by the latter, are dealt with in Part IV. The Dutch met with reverses in the early days of the fighting; at the time, the majority of the men serving in the combatant units stationed in the revolting Provinces were Belgians. Defections in these units had been rare up to September 26th; after that date they increased largely. The situation became so serious that Prince Frederick who had been playing the part of a Conciliator, found it necessary to seek further instructions from The Hague.

The early military activities of the *Gouvernement provisoire* are dealt with in Part V. Van Haelen, a Spaniard who had had much experience of street fighting, had been appointed Commander-in-Chief of the Belgian forces; the early successes with which he had met turned his head and brought him into serious conflict with the *Gouvernement provisoire*. The friction continued to increase, and on October 5th Van Haelen was placed on the retired list.

The *Gouvernement provisoire* soon found it necessary to delegate its executive powers, and accordingly appointed a *Comité centrale*, which dealt directly with the *administrateurs généraux* who were placed in control of the special committees made responsible for the conduct of the War, for Supplies, for Public Safety and for Finance. The activities of the Government in relation to the creation of an independent Belgium, and the events which took place in the Provinces, are described in No. 2 of the *Bulletin*.

The successes of the Belgian volunteers at Brussels gave the *Gouvernement provisoire* the time necessary in which to build up the framework of an Army. Some of the commanders of the volunteer units who had already distinguished themselves in the early days of the Revolution were authorized to raise new units. An account is given in Part VI of the creation of Belgium's new Army and of the operations in which it took part for the liberation of Antwerp.

Two Belgian columns were eventually formed and advanced on Antwerp; they made junction at Vieux Dieu on October 24th. They continued their advance, meeting with opposition from Dutch troops, and were finally brought to a halt on the 26th before the ramparts of the Citadel.

A history of the events in Antwerp between August 28th and November 5th will be found in No. 5 of the *Bulletin*. The revolutionaries entered the city on the morning of October 27th, and at once sent a flag of truce to the Citadel demanding a formal surrender of the Dutch defences. Eventually, on November 5th, an armistice, the terms of which are set out in No. 3, was duly signed by the Dutch military authorities and the representatives of the *Gouvernement provisoire*.

L'aérostation de protection. The original article is contributed to No. 3 of the *Bulletin* by Capt. Comdt. Hupelier, who gives a brief account of the development of aerial entanglements during the Great War. He states that this form of passive defence against aerial attacks was introduced by the Italians, who used it first at Venice; it met with success, and, later, other belligerent Powers adopted this arrangement and developed it further. This form of aerial defence was extensively used during the final phase of the Great War.

W.A.J.O'M.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1930.)—Commandant Larcher begins "*La campagne du 1er corps en Belgique*" in this number. This corps, commanded by General Franchet d'Espérey, was on the left of the French Fifth Army, and was frequently acting as an isolated force. This instalment only deals with the first few days of the War, when the corps advanced to the line of the Meuse, where it took up bridgeheads about August 11th, 1914. The writer prefaces his description of the operations with remarks on the high standard of training instilled into his corps by Franchet d'Espérey and points out that success attended his actions, as far as was possible, during this critical stage of the War.

Lieutenant-Colonel de Boisboissel completes "*Les opérations au Maroc*" in this number. This final instalment is more interesting for a promotion examination candidate than for the casual reader, as it deals with the various staffs and services required for mountain warfare. Apparently the French used signal equipment of much the same kind as our own, while there is the ever-present resemblance to the N.W. frontier of India in the supply and transport services. The writer points out particularly that a base must be ready before it is used for issue; this is not realized by a great many staff officers, unfortunately. The instalment is illustrated by three interesting photographs of events in Morocco.

"*Réflexions sur le règlement anglais de* 1929," by Capitaine Morel, is a very interesting article on our *F.S.R. II*. The writer puts himself in the position of an Englishman, rather than a Frenchman, and so is able to find a reason for our present-day teaching. As he points out, our intervention by land in the Great War was contrary to our principles; the normal use for our army is to provide a true Expeditionary Force, small but well trained and well armed, and backed up by our industries at home. As is pointed out in the opening chapter of *F.S.R. II*, the use of armed forces in England is bound up with the political strength of the country, but armed forces in no way represent the total strength of the country. Here England differs obviously from France, who, once

she is engaged in a European war, must mobilize all available men for her army, which is her first and far the most important line of defence. Captain Morel therefore points out that our present-day emphasis on armoured vehicles and our search for flanks in army operations naturally follows the instinct of the country ; and though he plainly realizes that similar considerations cannot bear so much weight with the French, he evidently thinks that it is to our advantage to follow up these instincts. In conclusion, the writer draws attention to the fact that, four or five hundred years ago, the English infantry destroyed the stock of the armoured cavalry, which had been so long the greatest power in war. He then goes on to say that it will be interesting if the English produce a fresh revolution in war, by the general introduction of armoured fighting vehicles, and he points out that *F.S.R. II* points towards this second revolution, though with very great prudence.

"*Une étude de guerre de montagne en Afrique du Nord*," by Commandant Peyronnet and Capitaine Jousse, begins in this number. Between 1830 and 1840, the French carried out various expeditions in Algeria, and in 1929, Franchet d'Espérey, Inspector-General of Northern Africa, had similar operations carried out with modern troops, as a memory of the original French advances. This instalment is devoted to a short summary of the expeditions from Algiers to Médéa, which was the key of the routes to the south. It was not till 1840, when the French had developed a policy in Northern Africa, that it was decided to occupy Médéa permanently, and this was carried out by Marshal Valée successfully, against the opposition of the native tribes. The instalment is illustrated by a sketch map.

Capitaine Michel begins "*Monthyon*" in this number. The 55th Reserve Division took part in General Manoury's operations on the extreme left of the line on 5th and 6th September, 1914, and the writer describes these operations, partly from their own interest, and partly because this, being a reserve division, resembled those mobilized later on during the War. The instalment deals with the general condition and the advance of the 55th Division. The men were very tired by the long retreat, and had lost most of their equipment, but the order to advance invigorated them enormously. Unfortunately, orders were issued so late that there was simply no time for them to get through to the forward troops, thereby disorganizing the advance considerably. We must realize that it is not only with reserve divisions that this occurs. The instalment is well illustrated by a map, photo and sketch.

(*August*, 1930.)—Commandant Larcher continues "*La campagne du 1er corps en Belgique*" with a description of the fight at Dinant and of Franchet d'Espérey's plans to meet the main German attack. The Germans had effected an entry at Dinant when a well-timed counter-attack, carried out by infantry and artillery in close co-operation, drove them out. When the main German advance was expected, Franchet d'Espérey's plan was to draw the enemy on with his 1st Division and then to counter-attack with the 2nd. The instalment closes with the force of 30,000 men awaiting the German advance.

"*L'aviation de bombardement*," by Colonel Aubé, is a discussion of the present situation of aerial attack. This is always an important question,

particularly as the civil population is interested as well as the soldiers. As the writer points out, the railway station of Metz-Sablons was frequently bombed during the war, and yet little interruption to the railway traffic was caused. For future bombing to be more efficient, it is necessary to study the question thoroughly in peace time. Colonel Aubé discusses the value of bombs as opposed to shells, and the different targets to which they are suited, and finally comes to certain conclusions. At present, with peace-time effectives, he does not consider that bombing will have decisive effects, although reserves of the enemy may be immobilized provided that objectives are not multiplied. There are still many targets, such as troops on the march, which are difficult to bomb efficiently; so the writer points out that research must be continued. Some new invention may greatly increase the value of bombing, and then the whole subject must be considered afresh.

"*La campagne du Cameroun*," by Capitaine Girard, begins in this number. Naturally at the outbreak of war Great Britain, France and Belgium all felt drawn towards the German Cameroons; the difficulty was to find a combined plan. The French started by protecting the three or four possible roads of ingress by which the Germans could work their way into the French Soudan; when this was done they naturally turned to the offensive. After discussion between the British and French Governments a plan was agreed on and put into operation. Unfortunately it took days or even weeks for telegrams to get from one place to another; as a result columns failed to meet each other, and the general plan was more honoured in the breach than in the observance. This instalment takes us up to June, 1915, when a British and French column, who had succeeded in meeting earlier in the year, had really begun to make some progress. The article describes the action of the different columns and their efforts to carry out the general plan, and a sketch map is given.

"*Une étude de guerre de montagne en Afrique du Nord*," by Commandant Peyronnet and Capitaine Jousse, is completed in this number. The actual manœuvres between the blue and red forces are described shortly, and then the actual operations of 1830–40 are compared. There is no particular interest in the article. It is illustrated by a map, which does not, however, give a very clear idea of the difficulties of the country.

Capitaine Michel continues "*Un combat de rencontre; Monthyon*" in this number. An encounter battle is a true description, part of the French 55th Reserve Corps were absolutely taken by surprise by a burst of shelling during their advance. At the same time the Germans opposite them were extremely short of information, and actually launched an attack for reconnaissance only. Thus the battle of the Ourcq began on this part of the front, neither side knowing what the other was doing. After describing the early part of the fighting, the writer points out how both sides were at fault. They had no organized aircraft and their divisional cavalry was weakly handled. Hence they came upon each other, but unfortunately the Germans saw the French first and were able to develop their attack. This instalment is well illustrated by two panorama sketches, apart from maps and photographs, so that the detailed account of the action can be easily followed.

(*September*, 1930.)—Commandant Larcher completes "*La campagne du 1er corps en Belgique.*" This corps, which had started with an offensive, had to retire before the Germans after Namur fell, and this instalment describes its withdrawal. Thanks to the Corps Commander, General Franchet d'Espérey, who had trained his corps to a high state of efficiency, the retreat from Belgium was effected with little loss either of men or morale. At Oirhaye, where the Germans advanced on 23rd August, 1914, a brilliant counter-attack, led by General Mangin, drove them back; after this action the withdrawal suffered little from the attentions of the Germans. The writer is evidently a great admirer of both d'Espérey and Mangin; and his description of the presence of mind and coolness of them both, under very trying conditions, is worth reading.

Commandant Delmas begins "*La manœuvre de contre-attaque*" in this number. The article is one for serious study rather than for careless reading. The writer considers and expands the regulations for the counter-attack, and discusses every possible item that may arise. This article deals with the immediate and deliberate counter-attacks, not with the passage from the defensive to the offensive; and this instalment is confined to the immediate counter-attack, which is illustrated by an example from an action in Alsace.

Capitaine Girard completes "*La campagne du Cameroun.*" The stages of the Allied attack described in this instalment may be divided into three: the unsuccessful advance of 1914–15, the successful advance of 1915–16, and the final occupation of the country. The early operations in the Cameroons had consisted of isolated actions in spite of inter-allied conferences; now an effort was really made to control the attacks of the different columns. The first effort was completely checked, but in 1915–16 a real advance was made, and both the British and French columns achieved very considerable successes. After this, the final clearing up of the country was not so difficult, although the German resistance was always most determined. The casualties were considerable in proportion to the number of troops concerned, being about 25%. Unfortunately there is no map with this instalment, which teems with outlandish names, so the actual operations are hard to follow. The writer considers that good though the help of the British and Belgians was the French carried the brunt of the day, and they were rewarded by the big proportion of the country awarded to them at the Treaty of Versailles.

"*La politique des grands Caïds au Maroc,*" by Colonel de Mas-Latrie, is an interesting article on the French policy in Morocco. Before the Great War, the French governed a large part of the country by the establishment of powerful chieftains, supported by French money and arms, who controlled their territories completely as long as they behaved properly. This worked very well, and the effects of the Great War were not felt until 1916, when a Dr. Pröbster, a German Consul, started to give trouble. He disappeared fairly soon, but a revolt did take place before all disturbances were crushed. The difficulty of this system was that the chiefs, or Caïds, levied a toll on conquered tribes to find money to carry out some of the duties laid on them by the French. To try to

conciliate the people it eventually became necessary to modify and centralize the method of governing the country. This was fortunately made easier by the death of some of the original chiefs, and the French are now gradually taking over the control of the country themselves.

In the third instalment of "*Monthyon*" Capitaine Michel describes the second French attack on Monthyon, and the beginning of the retreat of the German Fourth Corps, protecting the right flank of Von Klück's army. The writer's conclusions are interesting. He points out that although the French mission was a vigorous offensive, the lack of air reconnaissance gave far too little information. On the other hand, Von Gronan, commanding the German Fourth Corps, gained his information by fighting, and then retreated in such a formation as to protect the German First Army. This corps was in a very important position, and it was successful in preventing a severe blow being struck against Von Klück. Attention is drawn to the failure of communications, which was particularly marked.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

(*July*, 1930.)—In an article called "Communications in Modern Warfare," Captain Gazin describes the arrangements made by the German 7th Army during their attack across the Marne and subsequent retreat from the Marne to the Vasle in July, 1918. He derives his information from a book by Von Baur, who was in command of the railway troops of the 7th Army in June, 1918. Apparently the German operations would have been impossible without the construction of a 10-km. length of railway connecting the Laon–Reims and the Soissons–Reims lines, Soissons being inaccessible owing to the damage to the Vauxillon tunnel and Reims being in the possession of the French.

"The Engineers and the inundations in the South-west" is a description by L.D. of the repair of a 60-metre breach in the high road between Moissac and Castelsarrasin carried out by the 3rd Regiment of Engineers.

A.H.B.

MILITAERWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*November–December*, 1929.)—This is an anniversary number, and celebrates the close of the sixtieth year of publication of the *Mitteilungen* by printing the congratulations of the leading German, Hungarian and Austrian military periodicals, as also those of the Minister for the Army, Vice-Chancellor Vaugoin; who himself has put up no mean record by completing his tenth year of office. A résumé of Austrian military publications since 1808 gives some account of the *Mitteilungen's* forbears, and of its own vicissitudes. Starting in 1870 as a paper for Artillery and Engineers only, it widened its scope and took its present

title in September, 1920, when the new Austrian army was formed. Since the latter date the paper has increased steadily in size from a volume of 254 pages to one of 960. If this increase mainly reflects the increased importance of and interest in science, it still shows that the *M.u.T.M.* is filling the bill. The magazine is first-class in every respect. It issues valuable special numbers like those on air-fleets and mountain warfare, and independent publications of wide interest like "The World's most important Campaigns," which contains nearly 200 maps and costs only a few shillings. Only the greatest keenness and the services of officers willing to forego payment could produce such an achievement. That the *Mitteilungen* survived the war is a matter of congratulation; that it weathered the break-up of the Hapsburg Empire and the disappearance of the old Austro-Hungarian army is still more wonderful.

The Official Austrian History of the War. Major-General Kerchnawe deals with the third number of "Austro-Hungary's Last War," which is being issued in 30–36 parts. The number here reviewed covers to a certain extent the dramatic climax of the 1914 campaign, on the issue of which depended the four succeeding years of hardship—the battle of Ravaruska-Lemberg, the first siege of Przemysl (*anglice* Chaymisl, as near as makes no difference), and the October offensive culminating on the San and at Ivangorod, in which for the second time Conrad von Hoetzendorf sought a decision, this time in close association with the German 9th Army. The parallels with the Marne are striking. Field-Marshal Conrad himself wrote ten years later, "This breaking-off was no tactical necessity, for the situation was not bad. The operative circumstances were, however, untenable. And it is certain that in the breaking-off of the battle in the dark days of Ravaruska very much longer was waited than at much the same time in the days fraught with decision on the Marne." Gen. Kerchnawe says, "The old Austro-Hungarian army did not leave this bloody theatre defeated: Russian arms and the Russian soldier had not conquered there; nor had Russian leadership. The battle of Lemberg–Ravaruska was no more than the inevitable termination to the sad and pitiful chapter of complete political lack of purpose, passivity and reprehensible neglect of the army, 'the resultant of all political lack of vision and lack of clearness of thought' in the decades preceding the war, as the Official History discreetly but clearly shows. The conquered of Ravaruska were the leading statesmen and political leaders of Austro-Hungary *before* the war. It is they who have the sad fame of having made smooth the enemy's road to final success. The Russians were hardly less astonished at their 'victory,' than the French were at the wonder of the Marne."

The Brain of the Army—a review of a Russian work of three volumes by the Chief of the General Staff, Schaposchnikoff. The author investigates the position of the General Staff before the war, the place it held in the nation as supreme director of the army, and specially inveighs against the encroachments of the General Staff upon the internal and external political life of the State. In order to be able to work out clearly his doctrine and conclusions for the future, Schaposchnikoff takes an example out of history, and rejecting Russians, Germans, French and

British alike, selects for this purpose, owing to the greater wealth of records available, the activities of the Austro-Hungarian General Staff and of its Chief, Field-Marshal Conrad, based upon the latter's memoirs.

Although an ex-officer of the Imperial Army—he was a Colonel and Chief Staff Officer of a Corps in 1914—Schaposchnikoff is an exponent of the ideas of the present Russian form of government, and opposed to the "capitalist" Western powers. All armies and all General Staffs before the war are labelled by him "capitalist and imperialist." He runs down what he calls the "War-mandarins" and the "G.S. tin-gods." His Austrian reviewer takes him to task for this, and doubts whether the new type of Chief of the General Staff, as sketched by Schaposchnikoff, will ever do as much as the "War-mandarins," like Field-Marshal Conrad did "in the greatest war of a thousand years."

German Fate at the Breakdown, by Gen. Ratzenhofer. This title, like that of the same author's article in the last number, needs elucidation. What it means is: an enquiry into the fate of the officers and men of German descent serving in the Austro-Hungarian army at the end of the war. A published statement that there were 97,000 such, who were taken prisoner, has stirred Gen. Ratzenhofer to much research and statistics. He points out that of such a total there would not be more than 13,600 who belonged to front-line troops. He points out further that hostilities ceased on the Austrian side on November 3rd, and that between that date and November 11th the Italians, by sending forward small detachments on the main routes to intercept the masses streaming homewards, took over 400,000 prisoners, mostly without resistance. Both facts should help to draw the sting.

Army-leaders of the Entente in the World War. Three obituary notices on the Grand Duke Nicholas, Cadorna and Foch.

A Contribution to the history of Armoured Trains, by Major Mayer. This article is based upon the British *Detailed History of the Railways in the South African War*, a study of which has left Major Mayer convinced that, even making all allowances for the differences between a South African and a European theatre of war, the introduction according to plan of a sufficient number of powerfully gunned armoured trains in European warfare would be valuable under the most varied circumstances. He cannot understand why at the outbreak of the Great War the Central Powers had neglected to increase the fighting strength of their cavalry division by including in them armoured trains.

The Use of Heavy Machine-guns and Infantry Offensive Spirit, by Major-General Büttner. The author compares the heavy machine-gun with the original idea of a machine-gun, viz., that the latter was merely a weapon with the ballistic properties of the infantry rifle, which on account of the rapidity of its fire was able to develop from a small space a great fire-power, and at short and medium ranges to work destructively within a short time against living targets in the open. These requirements are met to-day by the light machine-gun. Over and above them, the heavy machine-gun is able to keep down an enemy under cover by continuous fire for some considerable time; by suitable choice of firing-position, to fit the trajectory to the terrain; to obtain the utmost use out of the infantry fire-power up to the limit of its capacity; under

certain conditions, to shoot over areas and one's own troops without danger to the latter, and at long range to cover even unseen spaces with a dense cone of fire, formed to suit the occasion. The moral effect of the heavy machine-gun both on the enemy and on one's own troops is also far greater than that of the light machine-gun. The manifold properties of the heavy machine-gun open up varied possibilities of employment. Wilfully to forgo these would be like driving a car at pedestrian pace. The heavy machine-gun is thus taken as being indispensable.

Turning to the offensive spirit the author analyses it, but does not connect it with the heavy machine-gun in any particular way, as might be expected from the title of the article. The heavy machine-gun is one of the "means of supporting the attacking infantry, through the judicious application and the best possible utilization of which the leader must create the foundations upon which the offensive spirit is built up."

The Development of Artillery Material since 1914. When Major Heigl started this series of excellent articles in May, 1927, he deferred the subject of field-guns with splayed carriages both for the opening up of other sources of information and to allow for a development then in progress. He is consequently now in a position to show that no field-guns other than with splayed carriages are any longer built. It is impossible in this respect, both historically and constructively, not to think of the veteran, who brought about a revolution of field-gun construction, the French 75-mm. field-gun C 97 of Deport, which after over thirty years is still so good to-day that its replacement is not yet *en train*. Instead of a gun which after firing had to be brought back again laboriously into position and re-aimed, there appeared in 1895 a field-gun firmly nailed to the ground and capable of firing twenty-five rounds a minute. It had the first barrel-recoil fit for service in the field and the first Q.F. breech-block.

Germany and Austria were ten years behind in following suit. In 1911 the same firm followed with another epoch-making invention, the splayed carriage, embodied in the Italian 75-mm. Deport gun M 11, which also had an extraordinary complication in a field-gun, double recoil. In Austria as elsewhere the invention either received no attention or was contemptuously dismissed until about 1920. It was then that on land the 155-mm. Filloux gun became the pioneer of the splayed carriage principle.

Progress since 1914 is then shown by descriptions of the following :—

The British 18-pr. field-gun Mk. IV on Mk. V Deport carriage, system Vickers (three photographs and three drawings with names of parts).

The 75-mm. Schneider field-gun M 18/22 (two photographs).

The American 75-mm. field-gun M 23.

The 75 and 76·2-mm. field-guns, design M 29 Bofors (two diagrams and two detail drawings).

The Japanese 75-mm. field-gun.

The 85-mm. Schneider gun-howitzer, for the Greek army (photographs of firing-position and on the line of march).

The 9-cm. Bofors gun M 29 (two photographs of firing-position, front and rear, and one on the line of march).

The 75-mm. Schneider L.F.A. field-gun L/40 M 26 (photographs of firing-position and on the line of march).

Included in the above-mentioned descriptions are a list of data in each case and an opinion of the gun's powers, appearance, peculiarities, etc.

Two Types of Infantry-Gun by Vickers-Armstrong. The many demands upon an infantry-gun to-day can scarcely be solved by one calibre. Hence various firms have, in order not to complicate unduly infantry equipment, built guns with two barrels, either having the two barrels at the same time next to each other, or one above the other, or capable of being quickly interchanged, or so constructed that the barrel of smaller calibre can be inserted in the larger barrel.

This article by Capt. Däniker, of the Swiss Army, known to readers of the *R.E. Journal* by his articles on machine-guns, introduces to us a quite original type of infantry-gun with two barrels—the Vickers 44-mm. and 60-mm. infantry-gun—with full descriptions, drawings, list of data and photographs. There is also described the "Ordnance Q.F.S.A. 47-mm. 20 calibres infantry-gun" by the same firm. In this case there is a single barrel, and hence a medium calibre had to be selected, which allows of easy comparison with the Beardmore, Pocisk and other infantry-guns.

The Responsibility for the World War.—Reviews a book by C. Raymond Beazley, an English professor of History connected with the Labour Party, which is appearing in parts in the *Berliner Monatshefte.* As evidence of a presumptuous attitude towards Germany on the part of many Englishmen, we are asked by this gentleman to accept the statement of an English statesman, "The patriotism of an Englishman is one of the noblest feelings of our nature, but the patriotism of a German is the last refuge of a scoundrel." This egregious utterance, without acknowledgments to Dr. Johnson, has now been seriously accepted and is as seriously broadcast. Verily, sarcasm is a dangerous tool. Professor Beazley also says that from 1901 English politics were conducted more and more under the device *Delenda est Germania*, a perversion of Cato's *ceterum censeo* which is unwarrantable, incapable of proof, and most misleading. It is difficult to see what good a book of this sort can hope to do. If the samples given are fair ones, the book is more likely to promote misunderstanding than remove it.

"All Quiet on the Western Front"—a deception! This pamphlet by Müller-Scheld is recommended, as a corrective, to all who have read Remarque's book, by Lt.-Col. Regele, the author of "The Forcing of the Save" (*R.E. Journal*, March, 1930), who gives it first place amongst all the indignant rejoinders that work has called forth.

"*July*, 1914," by Emil Ludwig. "In all his books this writer moves ceaselessly between history and romance, between reality and phantasy, and between the desire for truth and tendenciousness. In none of his books has he wandered so far from the historical foundation as in "July, 1914." It is suited to an age which likes its history in piquant style. The book is quite cleverly written railway reading—no more!"

F.A.I.

HEERESTECHNIK.

(*December*, 1929.)—*The Fourth General Meeting of the German Society for Photogrammetry*. This took place in October last at Berlin. The following is a list of lectures given :—

(*a*) Résumé of the technical and economic problems of small-scale survey by aeroplane photographs.
(*b*) Results of the trial survey by means of the panorama camera of the Photogrammetry Co., Ltd.
(*c*) Photogrammetry on journeys of exploration, with special reference to the Russo-German Alai-Pamir Expedition.
(*d*) The degree of reliability of the Hungarian photographic maps.
(*e*) Photogrammetric surveys with recording theodolites.
(*f*) Cinematogrammetric determination of aeroplane movement.
(*g*) Processes for the determination of the position of aircraft in flight.

In the first and second lectures the different opinions were represented, that for small-scale map-making, as in colonial territories, long-focal distance cameras should be used, as better for bringing out detail ; and against this, that short-focal distance cameras with a wide angle are best, so as to bring as much as possible on to one plate, and thus get a better general view. The lecturer, Aschenbrenner, showed a series of photographs taken by an instrument of his own design, the panorama camera, which is specially suitable for making small-scale maps in hitherto unsurveyed country. The pictures taken by it permitted, even at 1 in 65,000, easy recognition of the detail necessary for map-making.

The panorama camera saves time and money, since the photographs taken by means of it are about forty times as large as long-focal distance photographs taken at the same height. As regards accuracy, a strip of country 30 km. long was bridged over by six shots of the camera. Mapping was carried out at 1 in 100,000, starting and finishing points being fixed. Twelve control points distributed over the area had an average position error of 34 metres.

Even in countries already surveyed it is easy to think of cases in which, principally to save time, the panorama camera can be usefully employed.

The panorama camera of the Photogrammetric Co., Ltd., of Munich, has been made by C. A. Steinheil Sons under the direction of Ascehnbrenner. It is a multiple camera, consisting of one central and nine side cameras, so arranged that in one exposure simultaneously nine photographs are taken on one and the same plate, 18 x 18 cm. Focal distance is about $5\frac{1}{2}$ cm. The nine pictures will, when pieced together, be found slightly to overlap. A transforming apparatus is now needed to transform the side-pictures on to the plane of the centre-picture and on to the scale of the centre-picture. Through this transformation one obtains a complete picture 27 x 27 cm., corresponding to one taken with a picture-angle of 120° and the same focal distance. The area covered by a single picture is a square, the length of the side of which is about five times the height of the aeroplane. For carrying out picture-triangulation another

instrument is required—the transferring apparatus. The company proposes to carry out with this camera a trial survey of an area of 10,000 qkm. ($62\frac{1}{2}$ miles x $62\frac{1}{2}$) under official control.

As regards lecture (*e*), Dr. Fuss showed his recording theodolite with photographic reading of angles, made by the firm of Carl Bamberg of Friedenau, Berlin. It determines the vertical and horizontal angles of the line of sight of a quickly moving object at desired intervals—down to half a second. A chronograph is used with it to record on the film the time of observation next to the reading of the angle. These observations are carried out from two or more stations, and simultaneous registration is arranged for at all stations by a common circuit which includes a clock.

Dr. Fuss subsequently showed a development of his recording theodolite in the kinotheodolite of the Askania Works. This instrument records, on a strip of film 14 x 18 mm., picture of the object in the field of view, time, and angle-readings. The shortest interval in this case between exposures is one-fifth of a second. The kinotheodolite requires two—better three—stations. Both instruments have been described in the *Zeitschrift für Instrumentenkunde.*

In lecture (*f*) Dr. Raethjen described his kinematogrammetric method of measuring aeroplane direction and speed, in which his apparatus, together with the photograph of the aeroplane, projects an oriented system of co-ordinates on the film as if it were drawn upon the sky. A description has been published in *Bildmessung und Luftbildwesen*, 1929, No. 3.

The last of the lectures described an aerophotogrammetric method, and was illustrated by photographs taken from the *Graf Zeppelin* in February, 1929. This method has the great advantage over the two foregoing, that the aircraft is not earthbound by having to remain in the neighbourhood of the instruments.

Road-making of the American Expeditionary Force in the Great War. A historical report of the activities of the Engineers of the A.E.F. has been published, from docks and harbours, railway construction, camps, water-supply, electric power central stations to the procuring of building material. Out of this report certain particulars about roads have been extracted for three reasons, (1) neither in the German nor in the French post-war literature are such detailed reports to be found, (2) road-making was precisely the branch in which the Americans were widely mechanized, (3) the importance of military road-construction must increase as armies become more and more motorized. Two quotations are given in further justification :—" The greatest significance of the Engineers in a future war will probably be for the maintenance and improvement of the lines of traffic, and their highest aim must be, for all possible eventualities serviceable roads." " It follows from the late war that our Engineers up to 80% and more will be occupied with road-making and bridge-making."

Many of the figures are instructive. Thus, for an army of half a million, the Chief Engineer in Washington in July, 1917, estimated that there would be necessary for road-making proper 3,000 trained workmen, 6,000 assistants and 1,500 drivers ; for quarrying, 1,500 trained men, 3,000 assistants ; grand total, 15,000, or 3·3% of the whole force.

This figure is high, especially when compared with the allowance of Pioneers to each German Division at the beginning of the War, viz., 1%.

By the end of October, 1918, there had arrived in France 36 companies for road-making, and 18 companies for quarrying, or about 11,000 men in all; who were quite insufficient. Other formations had consequently to be called upon to furnish labour; and the more so as operations extended. Finally, at the beginning of November, while the American 1st and 2nd Armies were carrying out the Argonne offensive, 28,300 men were occupied in road-making, or about 4% of the fighting troops. By March 1st, 1919, when the troops were flooding back to the ports, and the repairs, which had been sparingly carried out during the winter, had to be hurried on, the number employed on roads had risen to 110,000.

As regards road-metal, the total yield of all quarries in the American area and forward L.-of-C. amounted in September to 55,000 tons, and in November to 85,000, against 100,000 tons required.

On the L.-of-C. in the spring of 1919 seventy-eight quarries delivered 50,000 tons of road-metal a week, solely for roads; while in the ten days, 11th–20th March, 127,000 tons were used on the roads occupied by American troops, and in three and a half months over one million tons.

It appears from these figures that the American Army in France narrowly escaped a fiasco owing to the breakdown of the roads, and that this escape was due to the opportune cessation of hostilities.

The deductions are made that the demands on road-making and road-maintenance in war are so heavy that they can only be met when a perfect organization has been worked out beforehand, and men, machines and transport are provided in sufficient numbers. A necessary limit to the personnel can, however, in modern road-making be made up for by an increase in the number of machines.

A Life-belt knapsack. The inventor of the "Sändig" combined knapsack and life-belt set himself the task of finding a means by which the fully-equipped soldier could be safe from the danger of drowning without having to carry the extra load of a life-saving device. He ruled out of consideration any rubber contrivance needing pumping up, because of its not being ready when the emergency arises, and because the slightest damage puts it out of action. He also ruled out a cork-belt as too heavy and cumbersome for marching.

As regards size the "Sändig" differs practically not at all from the service equipment, and in weight not materially. It can be pierced by bayonet or bullet, and still perform its function. It will keep the fully-equipped soldier above water when worn as a knapsack. When worn as a life-belt the soldier can use his rifle in the water.

Several packs together can form a machine-gun raft, and two kept apart by poles will make a floating stretcher. What will interest the soldier more is that the "Sändig," when opened and laid out, adds to his comfort very greatly owing to its soft padding.

The article is illustrated with all the appropriate photographs.

Early Military Wireless. *Telefunken* for September, 1929, recalls the first war use of wireless telegraphy to memory. Two German columns operating against the Herreros twenty-five years ago kept in touch by this means, and were thus enabled to bring the operations to a successful

conclusion. The claim of "first war use" cannot be substantiated. Successful use had been made of wireless in the Russo-Japanese War, when, for instance, a turning movement by Japanese cavalry was reported to Russian Headquarters in time for counter-measures to be taken. Previous to that, without having any such striking success to record, we had used wireless telegraphy in the South African War.

Increase of Performance in Infantry Weapons. Capt. Däniker, of the Swiss General Staff, adopts the method of starting from weapon-effect and drawing therefrom conclusions for the demands which may be made upon the weapon itself. As regards where this weapon-effect is to be sought he points out that hand firearms work through the sheaf of fire, or cone of bullets, for not only machine-guns or a number of rifles produce a cone, but also the single infantry rifle does so—a cone in this case which certainly as regards time is a very thin one.

To judge of a cone of fire, the first item is its shape, *i.e.*, whether the trajectory is flatter or more curved, the next is its space-thickness, depending on dispersion in height, length and breadth, and the last, its time-thickness. The ideal lies in a cone which is capable of regulation according to circumstances.

Comparative heights and breadths of 50% dispersion at 300 metres are then given in a table for various heavy machine-guns (Maxim, Hotchkiss, Vickers, Colt), for light machine-guns (Furrer and ZB 26), and for light machine-guns on light carriages (Madsen, Furrer and ZB 26, the two last on recoil-absorbers).

The figures show that the stabilized machine-gun with the company is in the right place to take over the tasks hitherto entrusted to the heavy machine-gun, and which the light machine-gun has been unable to perform. Captain Däniker is emboldened to ask whether the stabilized light machine-gun may not replace the heavy machine-gun altogether. —(*To be concluded.*)

The Great British Wireless Exhibition in London, 1929. At this date the interest lies less in what was exhibited than in how it appeared to German eyes. Herr Dickes has a great deal to praise in the exhibits, but finds Olympia far too small for such an exhibition, and that in the number of stands, number of exhibitors and especially in the number of separate sound-proof rooms for demonstration purposes the British exhibition is far behind the latest German Wireless Exhibition (*vide R.E. Journal,* September number).

Of valves, Herr Dickes was told that English valves were the best in the world. He does not contest this statement, but thinks there should be added to it that they are undoubtedly the most expensive. He found that great progress had been made in development of the S.G. valve, that they were to be found in numerous receivers and that 60% of all receivers on show were using them as H.F. amplifiers. Cossors are praised for eliminating microphone-effect by strengthened parts.

Of receivers, the English practice seems to be to make them general service, for battery drive or mains drive, and also for reproducing gramophone records. Of those shown 75% were boxed receivers, some of which were of really excellent quality. Two are deserving of special mention, Box o' Trix made by Eric J. Lever, Ltd. (1 valve), and a 4-valve

receiver made by the Rees-Mace Manufacturing Co., Ltd. Of mains-operated receivers, the Philips is praised as pleasing by its compactness. More than in Germany, an extended use of mains-operated receivers in Great Britain is prejudiced by the manifoldness of voltages, frequencies and different kinds of current. Besides, perhaps less than 40% of all British households have electric light at all. In the face of these facts battery-drive is likely to hold its own for some time to come, but the amount of apparatus for mains working exhibited was surprisingly large. A noticeable receiver was a Marconiphone Co. 5-valve with three stages of H.F. amplification using three screened-grid valves. Generally it appears—at least in England—that multiple-valve receivers are dying out.

Extraordinarily numerously represented were the so-called radio-gramophones, or combined broadcasting receiver and gramophone, eminently suitable for places of entertainment having no orchestra, for a turn of the hand gives wireless instead of gramophone, or the other way about, when there is a pause in the wireless programme. Regarding sources of current, Herr Dickes says of the comparatively few accumulators and H.T. batteries shown, that they do not appear to be inferior to German products. All accumulators were lead-plate, the Edison accumulator not being represented: a sign that the alkali-accumulator has not yet found its way into British broadcasting. Very little apparatus was shown for use with mains, the explanation being that, as in Germany, one has already got on to the building of mains-operated receivers. A very fine all-metal rectifier was, however, shown by the Westinghouse Brake and Saxby Signal Co., Ltd. It is made in two patterns, for H.T. and L.T., each pattern being built for varying performances. These all-metal rectifiers need no attention, have no parts that wear out, but slight fall of voltage, and a high degree of efficiency.

The trumpet loudspeaker has died out also in England, and the electromagnetic is beginning to yield to the electrodynamic. The electrostatic loudspeaker was not represented. Amongst components, condensers, coils, etc., nothing new could be discovered. They are neither better nor worse than their German counterparts.

On the subject of literature, besides the four well-known leading wireless journals, mention is made of *Television*, which chiefly does propaganda for Baird's system, and *World Radio*, the official organ of the B.B.C. The latter is praised for publishing the Brussels Laboratory Frequency-charts of European Broadcasting Stations, an example which "it would do no harm" if German journals would follow.

Water-supply in the American Army in and after the Great War. Compiled from two sources, the historical report of the Chief Engineer of the American Expeditionary Force, and a later article by one, Scott, "Water-supply in the Field Army," which appeared in *The Military Engineer.*

This first article deals with organization, which appears to have been as follows:—

(*a*) Projects and Design. Where the responsibility for these lay depended upon whether they were for the Armies or for the Lines of Communication. In the case of the Armies the responsible person was the Chief of the Water-supply Depart-

ment in the office of the Chief Engineer, American Expeditionary Force. In the case of the Lines of Communication the officer responsible was the Chief of the Water-supply Department in the office of the Chief Engineer, L.-of-C.

(*b*) Stores. Responsibility for provision and replacement rested upon the Director of Engineer Services and Technical Stores at the Headquarters of the L.-of-C. This officer had a Chief of the Water-supply Department of his own Staff serving under him, and was himself under the Chief Engineer, A.E.F.

(*c*) Execution of Work. This was done by the 26th Engineer Regt., the commander of which was both head of the Water-supply Department in the office of the Chief Engineer of the Force, and head of the Water-supply Department in the office of the Director of Engineer Services and Technical Stores ; an arrangement which must surely have done much to ensure smooth working.—(*To be continued.*)

The Journal of Explosives. A congratulatory notice on the completion of twenty-five years of issue. Thanks are included that the journal, in addition to its work for explosives in civil life, has had a prominent part in the development of military explosives, especially by publishing the results of foreign experiments, trials and successes. It is hardly possible to avoid referring to the fact that so far from this being the original intention of the magazine, it was started with the pious hope, " through the improvement of war material so to increase the dangers of war as to make peace certain." The same idea occurred to a Frenchman, H. Noalhat :—" *Le complètement de nos moyens de meurtre sera l'aurore de la paix universelle.*"

(*February number*, 1930.)—*Increase of Performance of Infantry Weapons* (*concluded*). Capt. Däniker, before discussing the advantages of replacing the heavy machine-gun by the light machine-gun on a carriage, has to deal with two points, nature of feed and cooling-system. Present practice is for the light machine-gun, on account of being served by one man, to have a magazine, and for the heavy machine-gun, in order to get long continuous fire, to have a belt. Conversion of the light machine-gun to belt-feed is possible, and has been done in the case of aeroplane armament. Or, since magazines can be changed very rapidly, the magazine might be retained in the stabilized light machine-gun. The chief disadvantage would then be the extra weight. As regards cooling, the light machine-gun is air-cooled, the heavy machine-gun water-cooled. Views about cooling-systems are even now much divided ; but in the war both systems did good service. From the experience of the Hotchkiss it may very well be accepted that air-cooling is also a possibility even for heavy machine-guns. It also seems likely that in time a serviceable automatic air-cooling system will be found. Or, again, light machine-guns for special purposes may be given water-cooling.

There is consequently nothing in the way of putting those light machine-guns, which are to be used for replacing heavy machine-guns, on an equality with the latter also in these two points, by comparatively simple reconstruction.

Even if it is decided to convert the light machine-gun on light carriage

to belt-feed and water-cooling, it will still have a large number of components in common with the present light machine-gun. The training-question also comes in.

Infantry-fire can be classified as short range and long range. Each of these classes can be divided into two, viz., fire with narrow cone against clearly visible targets and with good observation of results, and fire with large cone against targets not exactly located, and with observation of results difficult. At short range these two kinds of fire cannot be provided by one and the same weapon; the narrow cone falls to the rifle; the larger cone, lighter in space but denser in time, is the province of the machine-gun. At long range both kinds of fire can be provided by one and the same weapon, the heavy machine-gun, or equally well by the light machine-gun on light carriage.

Against the efforts towards unification there is the tendency—certainly not unjustified—to carry through a separation of calibre. Since the automatic rifle and the light machine-gun are both for short-range work they might easily go over to a lighter bullet with very great muzzle-velocity. This is important, as it would simplify considerably the manufacture of a serviceable, not too heavy, automatic rifle. That bullet-effect would remain sufficient has been shown by Gerlich (*vide R.E. Journal*, Sept., 1930, p. 552). The great advantage of separation of calibre would be that the light weapons, rifle and light machine-gun, can become lighter without prejudice to their effect. The heavy machine-gun from this separation would reap an advantage only if its bullet becomes heavier. This will result in no economy of ammunition unless the explosive bullet is introduced. In this case it will be able to operate effectively against aeroplanes. From trials it appears that the necessary bullet would have to weigh at least 50 grammes (say 1¾ oz.). Such a weapon would be too heavy to serve the infantry as a heavy machine-gun.

The advantages of a separation of calibre in the infantry are thus not as convincing as they appear at the first blush; at any rate, not until various other points are cleared up. Opposed to them stands the great disadvantage—the destruction of the unity of infantry ammunition. This disadvantage is now so much the more important, since the stabilization of the light machine-gun by means of the recoil-absorber has opened up promising perspectives.

Water-supply in the American Army in and after the Great War (concluded). The whole of the water-supply for the A.E.F. was thus carried out by the Water-supply Regiment (26th Engineers), which had ample stores, and which furnished detachments and working parties as and when required on the L.-of-C. or in the zone of the armies. It had to increase the supply in the ports of disembarkation, to find fresh sources of supply for camps, depots and hospitals, and to bring existing supplies in towns and villages up to the requirements of the troops, both as regards quantity and cleanliness. The chief source of fresh supplies whenever feasible was artesian wells, which had the advantage of rendering filtering arrangements unnecessary. Where artesian wells were not feasible, water was generally obtained by suction pumps, or directly from rivers, when it had to be filtered and disinfected. Some

of the quantities which had to be provided daily were, at St. Nazaire, over three million gallons; in each of the five largest hospitals, half a million gallons. These quantities were insufficient to allow of water-closets; so that excreta had to be burnt. The largest sterilization station was at Tours, and dealt with between $3\frac{1}{2}$ and $4\frac{1}{2}$ million gallons daily. There were nine laboratories specially equipped for water-analysis, and in most cases affiliated to a medical laboratory. Along the railways used by the American troops the supply of water had to be materially increased. An idea of the difficulties met with is given by the following instance. At St. Nazaire, which lies on granite, the peace-time arrangement was to carry water from a spring 15 miles away. The Americans hoped to make sufficient provision by storing the winter rainfall in a new 350 million gallon reservoir. The dry winter of 1917–18 disappointed these hopes, and in the spring of 1918 a pressure-line had to be run 15 miles from the spring. The supply still proving insufficient a reservoir had to be constructed by throwing a dam across one of the mouths of the Loire.

The highly specialized and centralized organization which had grown up in war fulfilled its purpose under the circumstances then and there existing, for that particular theatre and for that particular warfare. It was hardly likely to survive in peace. The Keller Committee of 1919, which laid the foundations of the present American Engineer organization, laid down the entirely new principles of decentralization and as little specialization as possible.

According to the present organization, the troops of all arms are responsible for providing sufficient water for their own needs. Their labours to this end extend, and are confined to, maintaining or improving existing wells, springs, and reservoirs, and making watering-places. As the Pioneer regiment belonging to each division has to carry out every kind of engineering work, water-supply is included in its duties, and for this purpose it carries hand and force pumps, sailcloth containers, and water sterilizers; but it only assists the troops by improving their arrangements.

At Corps H.Q. the same holds good. There are no special water-supply troops, but special water-supply equipment is held in the Pioneer Park, enough for twelve watering-places of 3,500 gallons daily each. If water-supply is required on a scale beyond the power of the Corps Pioneers, the Army Water-supply Battalion will send assistance.

This latter is a mechanized unit of three companies (two provision, one maintenance), detachments of which are responsible for provision and maintenance of water-supply in each of the sectors of the Army area.

The co-ordinating hand of this decentralized system is that of a special officer on the staff of the Major-General commanding the Engineers at Army H.Q. He is the latter's adviser on water matters, orders the necessary stores and distributes them, issues type plans, collects and distributes all information about water, and regulates uniformity of procedure.

In many other armies one is inclined still—or once again—to look upon the question of military water-supply as something negligible; the

American Army, on the other hand, has faced the question and done well in creating an organization thoroughly adaptable to circumstances.

The new Tefag-Ristow Wireless Alarm. Ristow is the name of the police captain who invented this alarm to save watch-keeping in police-stations, which must be able to accept a call at any moment, day or night; while Tefag appears to be the abbreviated name of the Telephon-fabrik Aktiengesellschaft of Berlin which is bringing it out. Capt. Ristow's alarm is an improvement on existing wireless alarms, as it is less affected by atmospherics and by interference from other stations. His patent lies in the call being given, not by the appropriate impulses sent out by the calling-up sender working a relay directly, but by a local circuit-closer actuating a delay-action relay after a preliminary signal, a dash lasting three to six seconds. If the call appropriate to the station is not now received, the arrangement is self-restoring by means of a current-impulse pendulum.

The article is unnecessarily marred by its claiming as a record that wireless telegraphy was recently used in France for the first time between two wireless stations, both of which were in motion, actually, an aeroplane and a tank. It is perhaps a pity that the craze for records should be allowed to escape from sport and the newspapers. Science may surely dispense with such brightness as records afford.

Communication between two wireless stations both in motion is as old as wireless telegraphy in ships, say 25 years. Wireless reception in a moving station on land is as old as reception in trains, say 12 years. Wireless communication between aeroplane and moving tank was carried out at Farnborough in 1924; and no reason is known why it should not have been done in France before that date.

Indigenous Motor-spirits and Motor-oils. With the increase of motorization the question of to what extent a nation can supply from internal sources its own needs in motor-spirits and oils is of vital importance. Germany, being without earth-oil, has started putting her house in order, as this article shows. A general survey is given beginning with the sun's energy and leading through earth-oil, pit-coal, brown-coal, and vegetation rich in cellulose to petrol, benzole, brown-coal petrol, and alcohol respectively. Another branch, cutting out the vegetable world, arrives at alcohol *via* water-power, electricity, carbide, acetylene and acetaldehyde. The items of chief interest in this chart are benzole, produced from pit-coal; and brown-coal petrol, produced from brown-coal.

Benzole is Germany's greatest indigenous motor-spirit. It is used both for motor-cars and aeroplanes. Where in other countries unmixed petrol is used, the Germans have largely gone over to petrol-mixtures, *e.g.*, petrol 40%, alcohol 20 to 40%, benzole 40 to 20%, thus furnishing no less than 60% of what they consume out of home products. Brown-coal petrol is a purely German spirit, its origin being the brown-coal found in Central Germany. It is the so-called synthetic petrol of the J. G. Farbenindustrie, obtained by their high-pressure hydrogenization process, and hardly differing chemically from earth-oil petrols. A mixture of this synthetic petrol with benzole is sold under the name of Motorin, a 100% home product.

The article then deals with the chief requirements of a good motor-

spirit, good volatility, mechanical and chemical purity and the requisite resistance to compression. Volatility is best judged by the vaporization-curve and Ostwald's characteristic. Chemical purity means principally the absence of resin-forming and corroding substances. Firmness under compression depends upon the nature of the petrols where petrol alone is used. Of these the best anti-knock are the Baku petrols. In the case of mixtures it depends upon the content of the natural anti-knock liquids like benzole and alcohol, or the artificial ones like lead (tetra) ethyl and ironcarbonyl. (*To be continued.*)

Technics and the State, from Babylon to the present day, by S. Hartmann, published by Cotta's, Berlin, price mks. 2/80. The author traces the connection between technics and the State, and points out that the closeness of this connection, whenever technics have been sufficiently advanced, is the true State-building and State-preserving power. He shows how the formation of States, their growth, and the high development of culture, *e.g.*, in Babylon, Assyria and in Egypt, were closely bound up with the skill of their waterworks-engineers, and how Rome grew to be the mistress of the world on its highly developed road-building. He explains that the Middle Ages in Europe produced no lasting great State, because technics were kept down by the selfishness of the guild-system. Finally, he cries out for statesmanship to lead and direct the technics of to-day.

F.A.I.

CORRESPONDENCE.

EDUCATION OF R.C.E. OFFICERS.

(The following has been communicated by Major G. R. Turner, M.C., D.C.M., R.C.E., the Corresponding Member for Canada.)

After graduation from the R.M.C., Kingston, officers commissioned in the R.C.E. are posted to Halifax, N.S., for 15 months' regimental duty. As the Royal Canadian School of Military Engineering is located at Halifax, the young officers have the opportunity of gaining instructional experience as well as experience on Engineer Services and Works.

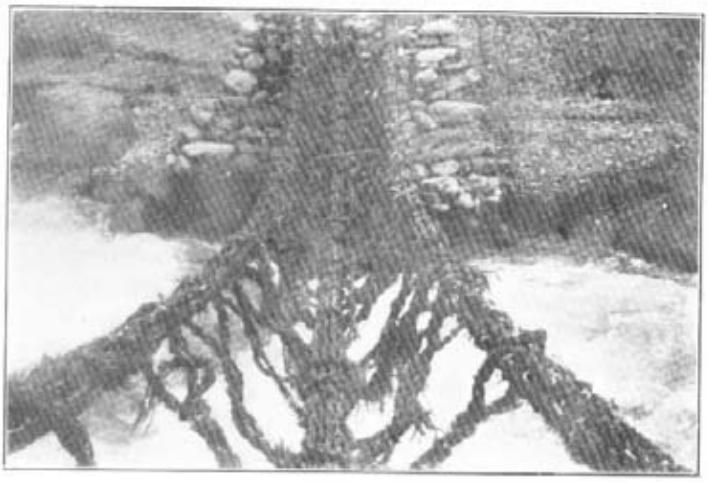
On completing this 15 months' regimental duty, the officers proceed to McGill University, where, under an arrangement with the University authorities, they undergo a special course, and can obtain in one year, if successful in their examinations, the degree of Bachelor of Science in Civil Engineering.

These officers, who have graduated from McGill in May, proceed to England in the following August to undergo the regular course at the S.M.E., Chatham. In addition, attachments to various R.E. units before the officers return to Canada are authorized if funds permit.

This system provides civil engineers, but no fully-trained electrical and mechanical officers, and McGill University will not give a degree in

WILLOW TWIG BRIDGE.

Near Dras, Ladakh, Kashmir.



Willow Twig Bridge

electrical or mechanical engineering after one year's study there to graduates of the R.M.C. unless these graduates have completed third-year work in these subjects. Owing to the amount of laboratory work involved, it is impossible for young officers to cover the third-year work in these subjects by private study.

In order to provide electrical and mechanical engineers, three young officers who graduated from R.M.C. in June, 1930, and who are now at Halifax, have been enrolled at the Nova Scotia Technical College, Halifax, in third-year electrical engineering. The third-year work in electrical and mechanical engineering is practically identical; consequently, these officers could enter the final year at McGill and obtain the degree of Bachelor of Science in either of these branches.

The choice of electrical or mechanical for the final year at McGill will depend on the reports obtained from Nova Scotia Technical College, and, if officers show no particular aptitude for these particular branches of engineering, they will be required to enrol in the fourth-year civil engineering course at McGill.

Consideration is being given to the question of making the third-year electrical and mechanical course at Nova Scotia Technical College obligatory for all young officers with the final year normally in civil engineering at McGill, and only officers showing a particular aptitude in electrical and mechanical subjects being allowed to continue in these subjects at McGill. For normal work on engineer services in Canada, it is considered that the third-year electrical and mechanical course will suffice, as the fourth year in these branches deals mainly with design.

To summarize, the educational qualifications of R.C.E. officers will be:

Royal Military College: four years.
Nova Scotia Technical College: one year (electrical and mechanical).
McGill University: one year with degree of B.Sc. in civil, electrical or mechanical.
S.M.E., Chatham, England: One and a half years (including attachments).

This will ensure a high standard of engineering education to the great advantage of military engineers in their connections with the engineering profession generally.

WILLOW TWIG BRIDGE.

DEAR SIR,

The two annexed photos show a bridge near Dras, Ladakh, Kashmir, made entirely of willow twigs; a good example of the use of local, and rather unpromising, materials. Such bridges are constantly made by the local inhabitants.

The span is about 30 feet, with a sag of about 5 feet. The footway consists of a cable of 9 or 10 willow ropes, each about 4½ inches in circumference, and the handrails of about 6 similar ropes. The ropes are laid similarly to hemp ropes. The anchorages are made by weighting down the ends of the main cables with heavy stones.

The bridge can, of course, be used by foot passengers only. It was tested with a live load of 13 stone centrally placed.

Not a scrap of any material, other than willows, was used in its construction; the reason of this is that, besides poplar, willow is the only tree growing at that altitude (10,000 feet above sea level).

I believe there are longer bridges made of the same materials in that part of the world, and it would be interesting to know the maximum span extant.

Yours, etc.,

F. C. MOLESWORTH, *Colonel.*

R.E. CO-OPERATION WITH CAVALRY.

Fieldworks and Bridging School,
S.M.E., Chatham,
4th October, 1930.

The Editor, *R.E. Journal.*

DEAR SIR,

In the *R.E. Journal* of September, 1930, there appeared an article entitled "R.E. Co-operation with Cavalry." In this article it was stated that two Field Troops could construct a medium bridge 105 ft. long in half-an-hour from the arrival of the equipment at the site, which is assumed to be an "average" one.

The bridge referred to consists of the bridging equipment of the Cavalry Division, so that two of the piers are trestles and two are pontoons. To complete such a bridge in half-an-hour is quite beyond the powers of the most highly-trained sappers. Several minutes must elapse before enough stores are unloaded to start any actual construction. Then a trestle has to be assembled and launched and the other has to be taken to the far side and launched there. The actual results on manœuvres, etc., show that, under easy conditions, a more reasonable figure would be 1½ hours, increased to 2½ hours by night.

Yours faithfully,

I. S. O. PLAYFAIR, *Major, R.E.*

The Advertisement Controllers—Messrs. C. Rowley, Ltd., 53-54, Avenue Chambers, Southampton Row, London, W.C.1.—would deem it a favour if members of the Institution would mention "The R.E. Journal" when communicating with Advertisers.

LADY GROVER'S HOSPITAL FUND FOR OFFICERS' FAMILIES.

THIS Fund, instituted in 1911, is intended to assist Regular Officers of the Royal Navy, Royal Marines, Army, Royal Air Force, Royal Indian Marine and Ecclesiastical Establishments, on the active or retired list, by assisting to defray the expense of residence in or attendance at any recognized Nursing Home or Hospital in Great Britain or Ireland, that may be incurred by their wives or children.

It also assists widows of such officers, their unmarried daughters if over the age of 21 years, and the mothers and sisters of unmarried officers if dependent on them.

The annual subscription, payable on the 1st January, is:—

Army.—Captain and under, £1 7s. 6d.
Major and above, £1 11s. 6d.

The subscription for widows and unmarried daughters is one guinea.

Members joining after the 30th June pay only half the subscription for the year.

Further particulars and copies of the rules may be obtained from the Secretary, Miss James, 13, Longridge Road, London, S.W.5.—[*Advt.*]

COOMBE HOUSE, CROYDON.

R.E. OFFICERS are reminded that they and their dependents may be received at Coombe House as guests when they are in need of a rest or change. It offers a haven for a time to officers when retiring or going on half pay, or while looking for a permanent home on returning from abroad.

Coombe House is situated at the foot of the Addington Hills, about two miles out from East Croydon, whence trains run to Victoria every twenty minutes.

The house and grounds are delightful. Those who have been there have greatly appreciated them, and all the arrangements made for their comfort by the retired officer and his wife whose hospitality has prompted the scheme.

It may be desirable to state once again the few conditions which apply to Coombe House.

(1) Guests are not expected to contribute in any way.
(2) The maximum duration of a visit is 28 days.
(3) R.E. officers on the active and retired lists, their families (with the exception of children under 16), and the widows of R.E. officers are invited.
(4) Those who wish to go to Coombe House during a period of convalescence must have reached such a stage of recovery that they are able to return to normal diet, and do not require meals brought to their rooms.

The accommodation limits the number of guests to four at one time. With this limit it is necessary at times to arrange for selection among applicants, and adjustment of the dates for visits. The responsibility for these arrangements rests with the R.E. Corps Committee. Applications should therefore be made to the Secretary of that Committee in person, by telephone, or by letter. The address is Room 231, War Office, and the telephone number Victoria 9400, Extension 467. No particulars are normally asked of applicants, other than the dates which would be most convenient to them for their visits. Applications are, of course, treated as confidential.