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Colonel C. W. Pasley,
Director of R.E. Establishment, Chatham.

Charles Pasley

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SIR CHARLES PASLEY.

IV.

SUBMARINE WORK.

LIEUT.-COLONEL P. H. KEALY, R.E. (*retd.*).

THE last few years of Sir Charles Pasley's time as Director of the R.E. Establishment at Chatham were occupied with the problems of the removal of wrecks by submarine explosions.

THE BRIG "WILLIAM."

On October 18th, 1837, a letter was addressed by the Water Bailiff on behalf of the Lord Mayor of London, to the Board of Ordnance, as follows:—"The Brig *William* of about 200 Tons Coal having sunk in the river Thames a short distance below Tilbury Fort in the month of May last, the Lord Mayor as Conservator employed a person to weigh the wreck, but his attempts have unfortunately proved unsuccessful. And being apprehensive that any operation which may be attempted for removing the wreck, unless it can be carried into effect in a very short period must also fail, His Lordship is desirous of ascertaining whether the wreck can be with safety blown up with Gunpowder, so far at least as to render it no longer an obstruction to the Navigation, and for that purpose is anxious to obtain the opinion and Assistance of a properly qualified Engineer. 1837.

"I am therefore commanded to request that you will be pleased to move the Board of Ordnance to give the necessary permission for the Survey and Assistance of such officer as they may think proper to appoint."

1837. This letter was referred to Col. Pasley for report, and in reply he stated on the 31st October that he had made the necessary enquiries and found that the efforts made to weigh the vessel had been by means of a system which had not been tried out previously. He suggested that the old and approved method of weighing by lighters and cables should first be attempted under the superintendence of an officer or Master of the Royal Navy, "and if they should fail, which I do not think at all probable, I shall be happy to blow the Hull of the vessel to pieces as a last resource, which I have no doubt will remove the obstruction, but which of course will be attended by the destruction of the vessel and the loss of the Cargo of Coals, with which she was filled when sunk."

In a report attached to the letter he went into full details and said, "I am of opinion it will be practicable to blow this vessel to pieces, by charges of gunpowder properly secured and placed close to her sides, and as near to her keel as possible, having frequently fired such charges under water at the bottom of the Medway, for the practice and instruction of the Officers and Men under my Command, and having also practised the blasting of rock under water for the same purpose. If it should be necessary to resort to this expedient, I shall be most happy to offer my personal services to superintend with one or two officers and a Party of Men to assist in the execution." He had found the brig was lying in seven fathoms at low water.

On December 15th, 1837, the Lord Mayor informed the Board of Ordnance that the attempt to weigh the *William* had proved unsuccessful, and asked that the arrangements for the blowing up of the wreck might proceed. Colonel Pasley was accordingly authorized to carry on.

The stores which he demanded were gunpowder from Tilbury Fort, the lighter with its diving bell and apparatus, two large wooden or metallic cylinders, common powder barrels, a "considerable quantity of Bickford's safety fuses invented by a Cornish gentleman of that name, which never fail when fired at depths not exceeding 3 or 4 fathoms, but on trying them to-day on the Medway in a spot ten fathoms deep, they failed to communicate with a charge, which I had sunk at that depth for the sake of experiment. Consequently I shall require the patent flexible three-quarter-inch leaden pipes used by brewers etc. to secure these fuses, as the water on the spot where the *William* is sunk appears to be too deep for them to act with certainty, unless thus secured." Mr. Purdo, the Master Attendant at Chatham Dockyard, kindly undertook to place the charges, "but all the laborious parts of the operation can be done by a party of the Royal Sappers and Miners, who may be quartered at Tilbury Fort, under an officer of Engineers. These men can go down in the Diving Bell after preparing the charges and can do everything that is required except using the diving helmet, which acts independently

of the bell. Two divers, therefore, accustomed to the use of the diving helmet will be necessary, that the true position of the cylinders may be ascertained previous to explosion. 1837.

" Before I conclude, I beg to explain that there are two methods of blowing up any object, first by a great number of small charges, by which mode the *Arethusa* of Liverpool, as large a vessel as the *William*, was blown up at Barbadoes in 1831 by a party of Royal Sappers and Miners under the directions of Lieut.-Colonel Reid of the Royal Engineers, which was done in very shoal water, as the vessel had been driven on shore by a hurricane and I am informed that there was only a depth of four feet at low water.

" The second mode which I propose for the *William* is by a few large charges, as being more suitable to deep water where there is much greater difficulty of placing them properly.

" One or two boats will be required during the operation, which may be borrowed from H.M. Dockyard at this place, and which the soldiers under my command can man. . . ."

In his next report Pasley estimated the expense of one explosion, exclusive of the hire of the lighter, at £107. He proposed to take no risks of failure and of the loss of the big charges which he was proposing to use, and concluded, " It is under this consideration that I have named two or three weeks for making my preparations so very perfect as to leave nothing to chance.

" This delay will not be deemed unreasonable, considering the nature of the operation, for which we have no precedent in the History of Mankind ; as the attempt to blow up a ship in such deep water has never been made since the invention of gunpowder."

Permission was given for the two great casks lined with milled lead to be made up in Chatham Dockyard, and two models of these casks were made up, to hold thirty pounds of powder, for experimental purposes.

Things, however, did not progress as quickly as had at first been anticipated. Writing to the Lord Mayor on January 5th, 1838, Pasley reported further difficulties with the fuzes. The Bickford fuze would not burn in the leaden pipe, which got choked with the melted pitch and fragments of hemp from the fuze. Pasley accordingly had recourse to " an expedient of my own invention which I had given up for some years, as being more expensive than Bickford's and rather inferior to it, and I admit still that it is inferior in shoal water, but not in great depths, for this succeeded perfectly at the depth of 70 feet. Having already wasted 80 lb. of gunpowder in fruitless trials, at great depths with Bickford's fuses, I only put a musket ball cartridge at the end of this, which was fired with perfect effect. 1838.

" My next experiment will be to blow up a cask at 8 or 10 fathoms depth of water ; and as it is possible that by some accident water may get into the leaden pipe, I have placed the charge in a tin

1838. cylinder, having two very unequal divisions, both water tight, one of which contains only one pound of powder and the other 29 lb. The object of this experiment, which is of great importance, is to ascertain whether firing the one pound will ignite the 29 pounds also. If this succeeds, as I expect, I shall have all the data necessary for constructing the large cylinders; for although every precaution will be taken to prevent it, it is not impossible but that through some accident water may get into the leaden pipe, and spoil the powder connected with it. In this case I propose to lose only ten or twelve pounds, instead of sacrificing the whole of the valuable mass of gunpowder in the cylinder, the saving of which will be of great importance, as in the event of such failure we will haul it up to the surface again and remove the damaged powder. . . .

"I enclose herewith a sort of advertisement which may be published in the newspapers previously to the operation, as a caution to shipping, subject to such alteration as the Lord Mayor may be pleased to approve. . . ."

The proposed advertisement ran as follows:—

"CAUTION.

"To the Masters of vessels passing Gravesend.

"A charge consisting of rather more than one ton weight of gunpowder will be prepared and fired under water against the hull of the Brig *William* sunk a little to the eastward of Tilbury Fort. On the day appointed for the operation Yellow Flags will be hoisted by the Coast Guard Ships in the river Thames, and at Tilbury Fort previously to the explosion which will take place at dead low water or as soon after as possible; guns will be fired every two minutes to warn ships and boats to keep out of the way, and after the danger shall be over, the firing of these two-minute guns will cease.

"It is requested that vessels and boats will keep as close in to the Gravesend shore as they possibly can during this time, and that no ships will anchor within a quarter of a mile of the spot."

January. Experimenting continued, and on January 12th Pasley had to report a further hitch:—"I have the pleasure of stating for information of the Lord Mayor that we succeeded this day in firing 30 lb. of powder at eight fathoms depth of water, which produced very little effect at the surface, but blew the small barrel inclosing the tin case in which the powder was contained entirely to pieces, and it also blew to pieces two sand bags which were used for sinking a large cask, against which our explosion was intended to act.

"I am rather disappointed in the result of this experiment as I had hoped that the destruction of the large cask would have been the consequence. I propose to try a similar experiment, as soon as we

can get the apparatus ready, in which I will place the small barrel and large cask in close contact, having doubts whether this was the case to-day, as we lowered the large cask first and drew the powder down to it afterwards. 1838. January.

"It is my intention to try as many experiments on a small scale as may be necessary to satisfy myself and the officers under me of the efficiency of the mode which I have in contemplation for destroying the Brig *William*, that is to fire two large charges of 2500 lb. of powder each, one against one side and the other afterwards against the other side of the hull of the vessel; as long as any doubts remain as to the probable success of this operation, I will not order the big cylinders, or go to any expence. The Lord Mayor must therefore not be disappointed at whatever delay may take place before we commence our operations; and no steps should be taken about advertisements in the newspapers, until you hear further from me." . . . The letter has a postscript: "N.B. A curious effect was produced by our explosion to-day which killed a great number of small fishes that came up to the surface immediately afterwards."

On January 17th Pasley reported unofficially that the experiment had been repeated with complete success and stated he now had no doubt of the perfect success of his plan for blowing up the *William*. Before making his official report to the Lord Mayor he wished to repeat the experiment once more. However, very cold weather set in, and on January 22nd he had to write and say he had been able to do nothing more as the pontoon raft and boats used in the experiments were frozen up in the Medway. He said he was, however, quite satisfied, as were his officers, of the probable success of his future plans.

He again emphasized the necessity for the closest contact between the charges and the sides of the vessel to ensure the success of the explosions. He put off the attack on the wreck till the spring, when the weather would be better.

The good people of Gravesend had expressed considerable anxiety as to the possible effect of the explosion of these large charges so near their town. To allay their alarm, Colonel Pasley was able to relate a variety of incidents which he had either himself witnessed or knew of, showing that vessels with considerable quantities of gunpowder on board had blown up without the least damage to other vessels moored in the immediate vicinity; he did not himself consider the danger zone extended for more than 100 yards from the wreck in any direction, and that therefore the inhabitants of Gravesend might rest assured that they were not in the slightest danger. His reason for telling vessels to hug the Gravesend side of the river was chiefly that there might be no danger of their running foul of any of his gear near the wreck.

Having satisfied himself of the feasibility of his plan for blowing

1838. January. up the wreck, Pasley now made enquiries as to divers and diving apparatus. He first got into communication with a firm, Messrs. Edwards and Deane, of Gosport, who were professional divers, and who stated they had recovered many guns from wrecks, including the *Royal George* and *Mary Rose*, and had used gunpowder charges under water. As this firm would not state any fixed price, or indeed any price at all for their services, he decided not to employ them. What he required were the services of a diver who should go down and by feel (the water being so muddy), ascertain whether the charges were in the correct position and tight up against the hull. After making further enquiries from Mr. Kemp, who had carried out the first attempt to raise the brig by means of airtight cylinders, Pasley decided to borrow a diving dress and the necessary air pump, etc., from Mr. Kemp, who expressed his complete willingness to lend them, and to train and employ as divers men of the Royal Sappers and Miners, whom he knew he could trust.

February. Meantime he had tried out a further and final experiment on exploding a 30-lb. charge arranged as before in two compartments and attached to a large cask, which was completely destroyed. The final success was reported to the Lord Mayor on February 27th, and he stated he was now giving orders for the preparation of the two large cylinders for the charges.

May. On May 5th, 1838, Pasley reported for the information of the Lord Mayor that he proposed to send the Diving Bell Lighter with the two large cylinders of gunpowder to Gravesend on the 14th inst., "and to proceed without delay in the proposed demolition of the Brig *William*.

"This morning," he continued, "I sent a Corporal down to the bottom of the Medway, who fixed two eye-bolts to a piece of timber placed there, and went through the same process that I propose to adopt for fixing the charges under water as near to the bottom of the brig as possible. This man had never used a diving helmet before, and yet he remained under water for three-quarters of an hour, which has satisfied me that there is neither difficulty nor danger in the use of this apparatus, which I also know by my own experience, having gone down first myself, which I thought was the best way of forming an opinion of the practicability of the proposed operation. One of our Serjeants has also made the same experiment, so that I have no doubt that we shall be able to manage the diving operations at probably one fiftieth part of the expence that would have been incurred by accepting the offer of Messrs. Deane and Edwards, who urgently requested to be employed but would not name their terms.

"It will be proper to have an advertisement published in the newspapers some time next week to caution Captains of vessels against anchoring too close to the spot, or passing too near it on the days fixed for the explosions; but I think that the precautions

suggested in the first form of advertisement I sent you will be more than the occasion requires, because I have since seen and had a great deal of conversation with Mr. Rich, now Master of the Dockyard Tender, the *Mercury*, who was in the maintop of the Frigate *Amphion* which was blown up close to Plymouth Dock Yard, when ready for sea with all her stores complete and having her magazine full of gunpowder. Mr. Rich assures me that this tremendous explosion, which blew the ship to pieces and destroyed more than 200 persons who were on board at the time, whilst he and about 40 others escaped after they were thrown into the water, did no injury whatever to any surrounding objects, though near to the Dock Yard as before mentioned, and though a sheer hulk with a number of men on board lay alongside of the frigate at the time." 1838. May.

The lighter with the diving bell was not, however, ready in time to leave on the 14th, but Pasley reported it would leave as soon as practicable. He also sent to the Lord Mayor the final form in which he wished the "Caution to Mariners on passing Gravesend" to be published. A Government lighter with the word GUNPOWDER in large letters on a board attached to the masthead would be moored over the wreck, and when the charge was about to be fired red flags would be flown from Tilbury Fort and from the Revenue Cutters in the river. The advertisement was duly published in *The Times*, *Herald*, *Chronicle* and *Advertiser*, and handbills were distributed amongst the shipping and Customs Officers.

The instructions issued to Capt. Yule and Mr. Purdo are given in Appendix IV.

The final arrangements were that the lighter would be towed from the Medway at daybreak on the 21st May to the scene of the wreck. The first charge would be laid at low water, and if everything was satisfactory, the explosion would take place at high water. But, as owing to the strong tides, it was only possible for underwater work to be carried out for about three-quarters of an hour at slack tides, it might be impossible for the work to be completed until the 22nd or 23rd.

The arrangements were duly carried out on the morning of the 21st, when an unfortunate accident occurred, and the diver, Corporal Henry Mitchell, was drowned. Captain Yule, R.E., who was in command of the 8th Company, Royal Sappers and Miners, was in charge of the operations. After the diver had been down some time, alarm was felt at the absence of signals, and on hauling on the life-line it was found it was foul of some part of the wreck. Colonel Pasley arrived at this juncture, and he at once went down with Captain Yule in the diving bell at considerable risk. They were unable to find the man owing to the tide, and further operations may be told in Pasley's own words :—" On Monday morning an unfortunate accident happened to the Corporal employed with the diving apparatus,

bell. The same vessel afterwards ran foul of the lighter, which was riding at single anchor, and drove her more than a quarter of a mile up the river. This unfortunate accident will cause considerable loss of time. Had it not occurred, Mr. Purdo in charge of the naval part of the operation, as well as Capt. Yule and myself had sanguine expectations of recovering the sunken cylinder, and of firing the other cylinder in the course of the day." 1838. May.

On Friday, 25th, the report to the Lord Mayor said that affairs at Gravesend had assumed a promising aspect. By the exertions of the Royal Sappers and Miners, the large cylinder had been recovered and opened in Col. Pasley's presence. It was found that the large charge was completely undamaged, in spite of the cylinder having been at the bottom of the Thames for 48 hours, and two of the iron bands having been started owing to the collision. It was thought that the explosion would now take place on Monday, May 28th.

On the 26th Colonel Pasley had again to report that a large vessel had the previous night very nearly run foul of the lighter, which had been moored again over the wreck, " from which the Guard on board and a skilful old seaman in charge believe that the crew of the vessel were only prevented by the guard repeatedly firing their musquets, and the impression on the mind of the seaman, whom I saw afterwards being that it was intentional; and Mr. William Kemp and Captain Bush who were employed last year in attempting to weigh the Brig *William* and a Steamer, having informed me, that their respective vessels were repeatedly run foul of by colliers, which they believe to have been done on purpose, in consequence of which Mr. Kemp was obliged to give up the undertaking, after incurring a considerable expence, and Captain Bush's Steam boat itself sunk over the other which he was attempting to weigh; I beg leave to request that you will cause the following advertisement to be inserted in the newspapers if approved by the Lord Mayor, which may prevent wilful collision.

" I beg to explain that the Guard on board are only provided with blank cartridges, so that his Lordship need not apprehend any injury being done by them to the crews of vessels running foul of the lighter. In respect to cutting away the rigging of vessels running wilfully foul of her, I believe that it is legal and at all events I think that the threat of the measure, which was suggested to me by a Captain of the Navy, will have the desired effect of preventing outrages of this sort, which if not guarded against may throw back our operations many days and cause considerable extra expence."

It was not, however, necessary to put these drastic measures into force, though they were duly promulgated, for on Monday the 28th complete success was attained, and Colonel Pasley

1838. May. was able to report as follows for the information of the Lord Mayor :—

"Sir, I have great pleasure in stating for the information of the Lord Mayor of London that we succeeded in firing one of our large powder cylinders containing a charge of 2500 lb. against the western side of the Brig *William* this afternoon a little after high water, when the ebb tide had just strength enough to force the cylinder against the side of the vessel a little above the bed of the river.

"The effect exceeded my expectations, a large column of water was thrown up evidently mixed with coals which had been the cargo of the vessel, and on rowing to the spot we found that all or most of her timbers floated at the surface, and as we found the step mast and parts of the beams and deck, the Naval Officers who were present agree in the opinion that the Brig must have been blown entirely to pieces ; and should their opinion be correct, which we will be able to ascertain tomorrow by sounding and by sending down the diving bell at low water to examine the wreck, it will be unnecessary to fire the second cylinder which I had prepared with the intention of using it against the eastern side of the brig. It appears probable that the Oak Timbers of the vessel being waterlogged and having their fastenings of bolts run through them will remain at the bottom, but as there seems reason to believe that they must be all shattered and broken to pieces, it will be easy to get hold of them by creeping and pulling them up so as to clear the bed of the river of them. If today's operation should have succeeded in effecting the complete demolition of the Brig *William*, I have great pleasure in acknowledging how much I am indebted to the zealous skilful and indefatigable exertions of Mr. Purdo, Master Attendant of Chatham Dock Yard, who conducted the naval part of the operation quite to my satisfaction ; and I could not but remark the zeal and activity of the Dock Yard riggers and of the seamen of the Royal Navy employed under his orders. Captain Yule and Lieutenant Hornby of the Royal Engineers and a strong detachment of Captain Yule's Company of Royal Sappers and Miners not only executed the mining part of the operation, but assisted in the naval part under the superintendence of Mr. Purdo. The mechanical construction of the powder cylinders, and of the lead pipe, screws, etc., and of their fitments, upon the perfection of which the success of the operation depended, as much as on anything else, were executed by the Master Artificers of Her Majesty's Dock Yard at Chatham under the able superintendence of Mr. Howe, Clerk of Works of the Royal Engineer Establishment whose zeal and ability especially in the Mechanical Department are well known to the Corps.

"P.S.—I ought to have mentioned that Captains Fisher and Tucker and other officers in charge of the Port of Gravesend or employed in the Custom House and Revenue Department were of the greatest service to us by keeping off vessels, etc., so much so that I think we

1838. May. owing to the entanglement of a rope in part of the wreck, which terminated in the loss of a valuable life but which from the circumstances no skill nor experience could have prevented. The same man had gone down once before this accident had occurred, and after walking along the side of the wreck, came up and reported everything favourable. This melancholy event, which has grieved me more than words can express, retarded the whole of our operations for that day, until we recovered the body, which was done by two Serjeants and a Private whom I sent down in the Diving Bell, and who did not succeed until 12 hours afterwards at the period of low water, it being impossible to use the diving bell without great danger, except at slack tide, and their first attempt at high water, when they were down an hour, proved unsuccessful."*

On Tuesday morning there was difficulty with the lead pipe, the joints of which had become strained :—" This rendered it absolutely necessary to postpone the intended explosion till the period of low water of the same day, and owing to the change in this operation we cut the lead pipe about 20 ft. shorter. The cylinder was then lowered and the lead pipe moored by means of a small red buoy, which I had made for the purpose, to keep the end of it out of the water. Mr. Purdo disengaged the lighter from her mooring and the whole of the officers and men employed retired in boats, and as soon as they appeared out of danger, I directed Capt. Yule to fire the train, which he did, and also rowed away with his boat's crew. Everything now seemed to be right, and the train which I had regulated to burn 13 minutes before the explosion, had burned about half that time, when we were mortified to perceive that the flood tide which had begun to set in, gradually dragged the red buoy under water, together with the end of the pipe, and this extinguished the train. In short the small buoy, though I had made it larger on purpose than that which we had previously used in our experiments on the Medway, was incapable of resisting so strong a tide as that of the Thames.

" Being prepared however for the contingency of the lead pipe being swamped by some accident, and the explosion failing as it did on this account, I gave orders on quitting Gravesend last night, that they should commence at the necessary operations by daylight this morning for mooring the lighter again and disengaging the cylinder and lead pipe from the wreck and hauling them up to the surface, which might have been done without any difficulty, but unfortunately a large ship called the *Charles* from Tobago, ran foul of our moorings in the night and carried away the lead pipe, and caused the ropes by which the cylinder was to have been hauled up to become entangled, so that it will be impossible to recover it without the diving

* Pasley put up a stone over the diver's grave at his own expense, recording the circumstances of his death.

could scarcely have effected our operations in the strong tides of that crowded river without their zealous and efficient assistance." 1838.

When the river bottom was examined it was found that practically nothing remained of the wreck except part of the bows,* and it was accordingly suggested by Pasley that the remaining large charge should be used for getting rid of other wrecks in the neighbourhood. Eventually a vessel, the *Glamorgan*, lying near the Essex shore with a cargo of iron bars, was completely destroyed. In the progress of this work, experiments were carried out to observe the effect of a small charge placed for blowing a hole in the deck, the idea being to gain access to a cargo without scattering the hold and its contents; useful data were gathered in this way.

The complete success of the operations and the ridding of the river of a dangerous obstacle to navigation gained for Col. Pasley the sincere thanks of the Lord Mayor and Court of Aldermen, and to show their appreciation, they asked Colonel Pasley to attend their Court on November 8th to receive the Freedom of the City of London which had been voted him. The Freedom was presented in a box worth 50 guineas, and in his speech on the occasion, Colonel Pasley again bore generous testimony to the assistance rendered by those who had worked with him.

The story of the demolition of the Brig *William* has been given in some detail as being pioneer work carried out by the Corps in a new field, that of the use of explosives on a large scale in deep water. But it also brings out various points in the character of the subject of this sketch.

At this time Colonel Pasley was in his 58th year, yet his enthusiasm for experimenting and adopting new methods was unabated. The thoroughness with which all the preliminary work was carried out was characteristic of the man; nothing that could be tried out beforehand or foreseen was left to chance, and the completeness of the instructions issued to the officer in charge of the party of Royal Sappers and Miners is noteworthy. His scrupulous care in the expenditure of public money is evident. Personal courage and eagerness to face risks had been a feature of his life, and his action over the diving is a fine example of the unwritten rule of the Service. Diving was quite an unknown thing in the Corps then, so, before sending down Corporal Hawkins in the diving dress when it arrived, Pasley first donned it and descended himself; as he wrote, he was satisfied "that there is neither danger nor difficulty in the use of this apparatus, which I also know by my own experience, having gone down first myself, which I thought was the best way of forming an opinion of the practicability of the proposed operation."

Another pleasant trait in his character was the generous tributes

* The bows were got rid of by explosives in August, 1838, under the executive charge of Serjt.-Major Jones, of the Royal Sappers and Miners.

he was always ready to pay to the services of others, but he could be a veritable "tiger" in standing up for the good name of the Corps, especially if he thought anyone was trying to filch credit which was fairly the due of himself or those under his command. He was a strict disciplinarian.

THE "ROYAL GEORGE."

As a result of the experience gained with the Brig *William* and the successful outcome of his work, Pasley next proposed to take on the removal of the wreck of the *Royal George*, which had been a danger to shipping at Spithead since she sank at her moorings there in 1782. "In the famous reach of Spithead, and immediately off the entrance of Portsmouth Harbour, the ill-fated *Royal George* lies buried in the Ocean. This ship, carrying 100 guns and considered as one of the finest in the Navy, was sunk by accident in August, 1782. Some repairs being wanted on her keel, to save the delay of going into the Harbour, she was hove on one side by the removal of her guns, when a sudden squall threw her broadside on the water, and the ports not having been lashed down she filled and sank in about three minutes. Admiral Kempenfelt and upwards of 400 of her crew, besides 200 women, perished in her."—(*Beauties of England and Wales* 1805.)

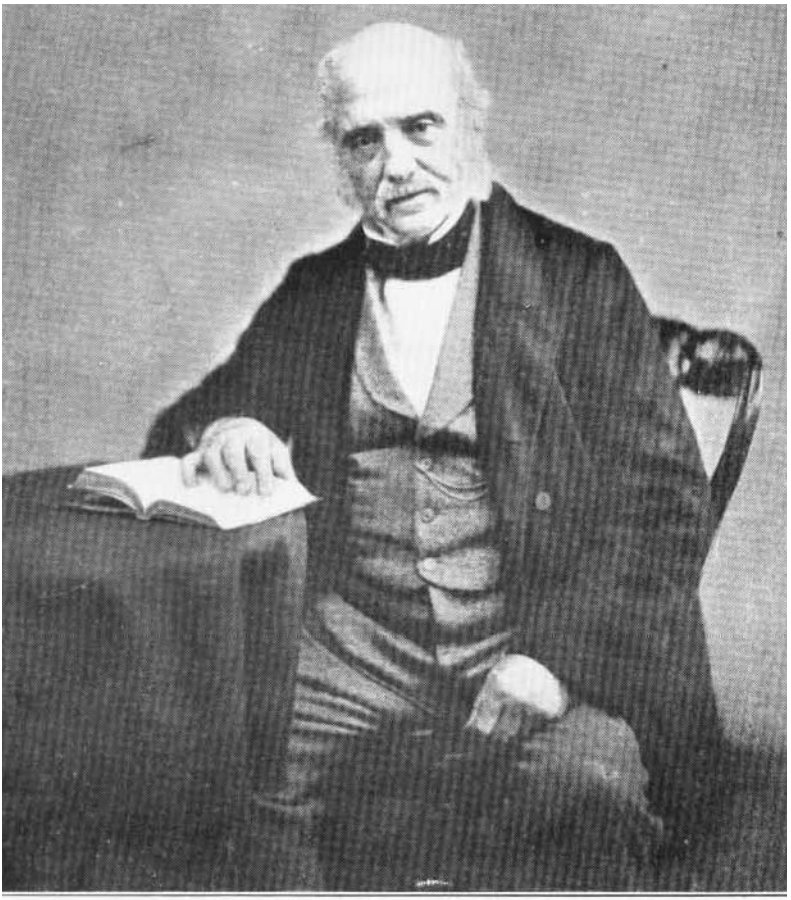
Whether the initiative came from Pasley or from the Admiralty, it was decided with the concurrence of the Board of Ordnance that Pasley should undertake the removal of the wreck.

One of the great difficulties experienced with the explosion of the charges in the case of the *William* had been with the fuze in its leaden pipe. Knowing that this would work, barring accidents, Pasley had not tried swapping horses while crossing the stream, though other ideas had occurred to him. One was the use of a rubber pipe reinforced with a spiral of wire running down the inside, instead of the leaden pipe which was less flexible and more liable to leak. Orders had actually been placed for a length of 75 feet of such a pipe, but it could not be got ready in time. From his diary it appears that on April 11th, 1838, that is to say, before the blowing up of the *William*, Pasley had become convinced that it would be possible to fire charges under water by means of "galvanism," and he paid a visit to Wheatstone, who was a friend of his, and discussed the question with him. As a result, when he got to work on the *Royal George*, the regular method of exploding the charges was by means of a "voltaic battery."

1839. The work on the *Royal George* started in August, 1839, and continued for six seasons.*

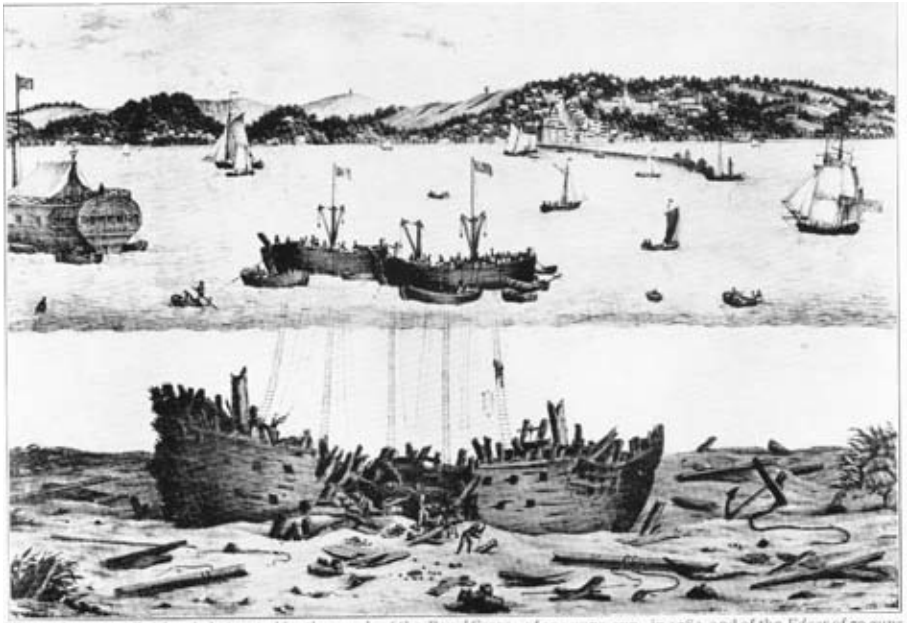
Previously to starting work at Spithead, Pasley carried out experiments in the Medway on the diving bell with a view to improving its

* The account is based on Pasley's diaries as extracted by Colonel J. C. Tyler, and on Vol. I of Connolly's *History of the Royal Sappers and Miners*.



Sir Charles Pasley,
aged 77.
R.E. Establishment, Chatham.

Charles Pasley aged 77



The anchorage at Spithead obstructed by the wreck of the *Roy. 1Georg.*, of 104 guns, sun. in 1782, and of the *Edgar* of 70 guns blown up and sunk in 1711, having been cleared by the removal of these wrecks, the operations against which commenced in August, 1839, and were renewed every succeeding summer until 1844 inclusive, under the direction of Major-General Pasley. This drawing represents the divers of the Royal and Honble. East India Company's Sappers and Miners at work at the former wreck, five of whom were generally employed every slack tide during the last four years of these operations, in which they used exclusively the improved diving apparatus made by A. Siebe, at his manufactory, 5, Denmark Street, Soho, London.—(*Copy of inscription on original drawing.*)

Wreck of the Royal George

shape. The bell used for the work on the *William* was rectangular in section, and had proved very dangerous in the strong tides of the Thames. The Chatham Dock Yard bell was accordingly altered in shape by artificers of the Corps till it resembled in horizontal section that of a boat twelve and a half feet long and four and a half broad. It was tested from the *Anson*, 72, in the Medway, off Gillingham, and was found to be a great improvement on the previous pattern. It proved, however, to be so heavy and unwieldy, requiring 49 men to raise it, that after two trials at Spithead it was discarded and returned to Portsmouth Dockyard. Thereafter reliance was placed entirely on the divers. 1839.

The first detachment of the Sappers and Miners employed at Spithead consisted of Serjeant-Major Jenkin Jones, one bugler, one clerk and thirteen rank and file under Captain M. Williams, R.E., afterwards relieved by Lieutenant J. F. A. Symonds. The trades were collar-maker, cooper, carpenters, blacksmiths and tinmen. The *Success*, a frigate hulk, was anchored near the wreck, and the party lived on board. Two lumps were moored 100 fathoms apart with the wreck between them, and from these lumps the Sappers worked in two parties, each with its own diver and in friendly rivalry. The officer commanded one party and the Serjeant-Major the other.

For the first two seasons professional divers were employed, but certain of the Sappers soon volunteered to be trained in the work of diving. Corporal Harris and Private William Reid were the two first to descend, and the former proved a most skilful man throughout the operations. A large number of charges were exploded, both large and small, which shook the wreck and enabled the divers to send up a large assortment of timbers and miscellaneous articles, so that it was evident at an early date that the cost of the operations would be paid for by the value of materials recovered.

On September 17th, Pasley made known his intention of firing a charge of 260 lb., and Lord Durham and his son came out to see it.

The explosion was carried out successfully.

Another big explosion was staged on 23rd September, and took place before a large and distinguished audience, including Lord Dundonald and Capt. Basil Hall, R.N., who was a constant attendant at the operations.

For exploding the charges Daniell's cells were used, but there is no information as to the fuze. The leads used at first consisted of wires wrapped round with tape over which a waterproof composition was placed. As an improvement, Serjeant-Major Jones made up a waterproof composition consisting of pitch softened by beeswax and tallow; this was smeared over the wires before the tape was applied, and over the whole of the apparatus, and all the parts which could be saturated in it were so treated. These improvements were devised by Captain Sandham.

1839. All the trades work necessitated by the operations was carried out by the Sappers, some of it of a hazardous nature. They repaired the diving dresses, air pipes, pumps, etc., but the most ticklish job was the soldering of the cylinders with the charges in them, and the stopping of leaks. The story is told that a foreman in Portsmouth Dockyard was asked to send an experienced man to solder up the loading hole of one of the cylinders, but when the man who was sent saw the job, he said he would not do it for 1,000 pounds! Eventually one of the Sappers, Pte. Skelton, though inexperienced in the work, carried out the soldering successfully, and became an expert at all this kind of work.

If it was necessary to empty a cylinder of powder, a hole was cut in the side, through which a man entered and scooped out the contents with a copper shovel. At these times all fires were extinguished, hides put on the decks and kept wet, and the men worked in slippers.

The season ended on November 6th, and the men returned to their headquarters at Woolwich.

1840. In February, 1840, Lord Minto, the First Lord of the Admiralty, wrote to Pasley :—" I have always felt the most entire confidence in your success, but I confess that, considering the novelty of the attempt and the many difficulties to be encountered, I did not expect you to accomplish so much in the first season as you have been able to effect. It is a great work, not only as regards the clearing of the anchorage, but as the introduction of a new and valuable source in submarine engineering."

Operations started again early in May. Pasley used to spend the early part of the month at Chatham, and the rest at Portsmouth, where his family took up their residence for the season. On June 22nd, after two smaller charges had been fired in the morning, a large charge of 2,300 lb. of gunpowder was fired by Lieutenant Symonds, using 10 Daniell's cells. Fifty or sixty boats and yachts had come out to see the fun, and the explosion was also witnessed by both the Admirals and a large number of officers, by the Bishop of Norwich and the Russian Ambassador. Another large explosion took place on August 5th, when, amongst others, Lord Hill and the Marquess of Anglesey were present.

The work was very similar to that of the previous season, but the Sapper divers held their own well with the professional civil divers, and were found to work with a better will. Corporal Harris, as before, distinguished himself, sending up " with exciting rapidity planks, beams, staves, iron knees, grape-shot, fragments of gun carriages, abundance of sheet lead, remnants of the galley and a thousand etceteras." He had to his credit a complete 32-pounder gun carriage, and, but for the snapping of the slings, a gun also.

Various accidents to the divers occurred, but none of them fatal,

and the victims were always ready to go down again when they had recovered. 1840.

Pasley himself went down in the Siebe diving dress, and became so engrossed in his observations that he forgot to answer the signals from above; as a result he was hauled up by the life-line, to his great disgust.

Connolly describes an exciting incident during this season in the following words:—"During this season at Spithead there was a strong gale from the eastward, and the storm-flag was hoisted at Gosport. No boats would venture out, and the *Success* frigate, with a part of the detachment on board, was in danger of parting from her anchors and drifting to sea. Lieutenant Symonds was on shore at the time, and thinking his presence necessary to secure her safety, determined to attempt the passage. The civil divers, accustomed to perilous boat service, said no boat could live in such a sea, and the Port-Admiral refused his permission for Lieutenant Symonds to proceed unless on his own responsibility. Unable from the raging storm to row out of the harbour, he, with four sappers, hauled the gig along the shore for more than two miles, and when a good offing was gained, the lug-sail was hoisted and the boat pushed off. With the tact and sagacity of a skilful pilot, Lieutenant Symonds guided the gig, now skirting the furious wave, now skimming across its angry top, and anon lost for a time between the furious billows of a long deep trough. To lessen the danger of the fearful venture, the men lay down in the boat for ballast, and pulling off their boots, used them, with noble exertion, in baling out the water as she shipped the sea. At length, to the utter amazement and joy of the party on board, the gig reached the frigate. Then, however, the peril was increased, for frequently like a log she was dashed against the hull of the vessel, and as frequently nearly foundered; but by the spirited exertions of the brave lieutenant and his intrepid crew, the boat was eventually secured and all gained unhurt the deck of the *Success*. Lieutenant Symonds then took such further precautions as were indispensable for the safety of the ship, and she successfully outrode the storm. The names of the gig's crew were Privates John Hegarty, Andrew Anderson, Thomas P. Cook, and John Campbell; the two latter became colour-sergeants in the Corps."

All the timbers and guns as they were brought up were taken to the Dockyard, where they were eventually sold by public auction, which more than covered the cost of demolition. During this season 15,000 lb. of gunpowder were expended.

Work for the season of 1840 ended on October 27th.

The third season's work opened on May 3rd, 1841, and Lieut. G. R. Hutchinson, R.E., was in executive charge. This year there were no professional civil divers employed, and diving was carried out exclusively by the Sappers. Six divers worked at a 1841.

1841. time, and were six, seven and sometimes more hours a day under water at a depth of 60 to 70 feet. They became very skilled in packing the loads in the slings, and in the course of the season sent up 18,600 c. ft. of wood, which was taken to the Dockyard.

Serjeant Samuel March, a skilful draughtsman, made sketches of any interesting articles that were brought up. A sketch of a gun is in the R.E. Museum, and other sketches are with the material for the Nautical Museum at Greenwich.

Corporal D. Harris and Lce.-Corpl. R. P. Jones were the two most skilful of the divers. Jones was the first to get to the bottom of the wreck, and sent up 13 feet of the keel. Amongst the smaller articles recovered were a stick of Dutch sealing-wax and a dog-collar inscribed "Thomas Little, Victory, 1781." The owner of the dog was a midshipman of the *Royal George*.

Much experience of diving was gained, and it is amazing that though there were several mishaps and accidents, no lives were lost. One day two of the divers, Jones and Skelton, met under water, when Jones was surprised to hear a voice singing:

> "Bright, bright are the beams of the morning sky,
> And sweet are the dews the red blossoms sip."

This was the first time it was realized that divers could speak to each other, but the exertion of doing so was too great to encourage the practice.

Many mishaps occurred owing to weights falling on the divers, but the nearest approach to a fatality was when an air pipe burst and the diver was nearly dead when hauled on to the deck. He recovered after a month in hospital.

On another occasion owing to a mistake in the signals an explosion took place when a diver was still coming up and was a few feet below the surface. He was unable to resume his work for four days.

Not all those who tried were able to carry on with the diving, as they suffered from headaches, giddiness and spitting of blood; the successful divers stuck to their work like men, in spite of rheumatism and the biting cold, which so benumbed their hands they could hardly feel to sling their findings. To assist the divers large rakes and half-anchor creepers were drawn over the shoal to help clear away the mud and expose the wreckage.

The season closed on October 29th.

On November 23rd, 1841, Pasley was promoted to Major-General, and his long tenure of 29 years of the appointment of Director of the R.E. Establishment, which he had founded, came to an end. He was at the same time appointed Commissioner of Railways under the Board of Trade, but was able to continue his superintendence of the work on the *Royal George*.

May 7th, 1842, saw the divers again at work. This year the party consisted of a Corporal and 23 R. and F. of the Royal Sappers and Miners, and nine men of the East India Company Sappers who were training at Chatham. 1842.

In little more than two months Corpl. Harris, almost unaided, removed the wreck of the *Perdita*, a lighter 60 ft. long, which had sunk during an unsuccessful effort to weigh the *Royal George* in 1783. The lighter was lying in mud 50 fathoms south of the wreck. Harris's efforts were herculean, and he was sometimes completely overcome by fatigue. This diver seems to have been an unusually unselfish character: on one occasion he met a diver named Cameron on the bottom, who led him to the spot where he was working. For a considerable time Cameron had fruitlessly laboured in slinging an awkward timber of some magnitude, when Harris readily stood in his place, and in a few minutes, using Cameron's breast-line to make the necessary signals, sent the mass on deck. It was thus recorded to Cameron's credit; the circumstance later became known, and Harris was officially commended.

The foremost divers took great risks at all times, forcing their way amidst the broken and jagged timbers. Lce.-Corporal Jones at one time had the exclusive task of sending up the pig-iron ballast, and he pursued it working over his head in mud—his hands got so torn that he had to call a halt for a few days. In one day, besides slinging innumerable fragments, he sent up nearly three tons of iron ballast.

It was during this season that an incident occurred which might form in these days an episode in a film drama. Private Girwan, a very powerful man, and Lce.-Corporal Jones, had a struggle at the bottom of the sea. They had both got hold of the same piece of timber, and neither was prepared to yield it to the other. Jones eventually, wishing to avoid a collision with the powerful Girwan, made his bull-rope fast and attempted to escape by it. Girwan, however, seized him by the legs and tried to pull him down. Jones struggled and succeeded in getting his legs free: then taking a firm hold of the rope, he kicked vigorously from his suspended position at Girwan. One of the kicks broke a lens in Girwan's helmet, and as water at once poured in, he was hastily hauled on board, and spent two or three days in Haslar Hospital. These men were afterwards good friends and worked amicably together.

At the end of 1842 almost all the floor timbers had been got up, and 101 feet of the keel, leaving only some 50 feet more at the bottom; and out of 128 tons of pig-iron ballast, 103 tons had been safely wharfed.

In 1843 many charges were fixed by Harris, Jones and Girwan to shift a bank of shingle. This was done successfully, and the remainder of the wreck was got rid of. Girwan slung the largest and most remarkable piece of the wreck met with during the season, "consisting 1843.

1843. of the forefoot and part of the stem, connected by two very large horse-shoe copper clamps bolted together . . . the length of this fragment was 16 feet, measured obliquely, and its extreme width 5 feet." He recovered also an enormous fish hook, no less than 8 feet 9 in. in length from the eye to the bow. Thirteen guns were recovered late in the season.

After the removal of the *Royal George* was practically completed, a lighter was detached to the wreck of the *Edgar** in the neighbourhood. The lighter had on board a party of 13 petty officers and seamen of H.M.S. *Excellent* to learn the art of diving under the instruction of Lce.-Corpl. Jones. Five guns only were recovered and two pieces of timber. The season was very rough, with violent gales, which repeatedly drove the lighter from its moorings. During these operations a charge of 18 lb. of powder was fired at the wreck of the *Royal George* whilst Jones was under water at the *Edgar* half a mile away. The report seemed to Jones like the discharge of a cannon, though almost inaudible to those on deck immediately above the *Royal George*.

1844. The anchorage having been reported clear as far as the *Royal George* was concerned, the party reassembled for the last time in May, 1844, to attempt to recover the guns of the *Edgar*. The party consisted of 1 serjeant and 13 R. and F. of the Corps, and an equal number of E.I.C. Sappers, with numerous seamen and riggers. Lieut. H. W. Barlow, R.E., was in charge.

On May 23rd Corpl. Jones discovered the wreck. "The sweeps from the boat having been caught by an obstruction below, Jones descended by them till he found himself astride a 32-pounder iron gun, which was peeping through a port-hole on the lower deck. It happened at the time to be unusually clear at the bottom, and to his amazement there stood upright before him the midship portion of the vessel, with an altitude above the general level of the ground of 13½ feet. From the open ports, in two tiers, yawned the mouths of about twelve pieces of ordnance, grim and deformed with the incrustations of 133 years. This part of the *Edgar* was not much shaken by the explosions, but when the fore and after magazines took fire, the head and stern of the vessel were blown away from the body and scattered to distances exceeding 300 fathoms. The midships, sharing but little in the convulsions, went down like a colossal millstone, scarcely heeling on her bottom; and the armament of the decks remained as if ready for battle, without a carriage unjerked from its platform, or a gun from its carriage. All the woodwork, however, was so completely decayed by the ravages of worms, and the insidious action of the sea, that when the guns were slung, they were hauled through the decks, as if no obstruction interposed."

During the season nearly all the guns were recovered, including

* This ship, built at Bristol in 1668, was wrecked by an explosion in 1711.

those scattered by the explosion far and wide. Nineteen of these 1844.
were to the credit of Jones, besides a large number of other articles in great variety. General Pasley recorded: "Whatever success has attended our operations, is chiefly to be attributed to the exertions of Corporal Jones, of whom as a diver I cannot speak too highly."*

His old enemy and friend, Girwan, was nearly killed by the air pipe of his apparatus blowing off the pump on deck, added to which his safety valve would not shut.

Skelton, another of the divers, was accidentally drowned off Southsea Castle.

Corporal Harris had gone to Bermuda, and carried out a lot of underwater work there. He repaired the damaged bottom of the R.M.S. *Tay*, and for some years was employed on widening and deepening the entrance into the harbour of St. George.

In addition to the *Edgar*, the wreck of the *Mary Rose* was also dealt with.†

Thus ended successfully the work which had extended over seven seasons, in the Thames and at Spithead. The reputation of the Corps for this new class of submarine work was established, and their services were requisitioned for various similar jobs. Two that are recorded are the getting rid of sunken barges at Sheerness in 1842 and the blowing up in 1870 of the *Golden Fleece*, sunk in 1869 off Cardiff, besides the work carried out by Corpl. Harris at Bermuda, as mentioned above.

The sequel to this work of Pasley's lay in the formation of the first submarine mining company of the Corps in 1871.

APPENDIX IV.

INSTRUCTIONS FOR CAPTAIN YULE, R.E., AND WILLIAM PURDO ESQUIRE, MASTER ATTENDANT OF HER MAJESTY'S DOCK YARD, CHATHAM, RESPECTING THE PROPOSED DEMOLITION OF THE WRECK OF THE BRIG WILLIAM SUNK OFF TILBURY FORT.

No. 1. Mr. Purdo will superintend the Naval part of the operation, in which Captain Yule will afford him the assistance of as many men as he may desire. Captain Yule will superintend the proposed explosions.

2. The Lighter containing the Diving Bell, and the Powder Cylinders, etc., is to be moored head and stern directly over the wreck, with her

* He sailed for China in 1845, with the reputation of being the best diver in Europe. He was present in 1847 in the expedition to Canton, and took part in the capture of the forts. He was at the capture of Bomarsund and the Aaland Islands in the Baltic in 1854, and served in the Crimea as a Serjeant.

† This ship foundered on July 20th, 1545, under the eyes of King Henry VIII., who was, at the time, in company with Sir Richard Lee, his celebrated Military Engineer, watching the manœuvres of his fleet in action with the French. The *Mary Rose*, much injured by their shot, foundered in the act of tacking. Her Captain, Sir George Carew, and 400 men went down with her.

head towards London. The Centre of the Lighter to be over the Centre of the Brig William as nearly as possible.

3. Some time before Low Water, on Monday morning next when the Tide is moderate, Captain Yule will send down a Non-Commissioned Officer with Mr. Fraser's improved Diving Apparatus, who will fix a couple of eye bolts, on the East side of the Wreck, at the height of about three feet from the bed of the River, and about 9 feet apart. A couple of Ropes will be handed down to the Diver, on his making a signal that he is ready for them, which he will pass through the eyes of those bolts, and send them up to the surface.

4. One end of each of these Ropes will be fixed to one of the Powder Cylinders, whilst the other will be retained on deck ready to be hauled upon.

5. The Cylinder will be gradually lowered, until it is nearly at the bottom of the River, when the two Ropes before mentioned will be hauled upon, in order to bring it in close contact with the side of the Brig. Great care must be taken during this operation, not to strain the Leaden pipe containing the Train, the coil of which must be eased off gradually, so as always to be rather slack than otherwise.

6. The Diver, who will have come up during the last operation, will go down and fix the ends of the Cylinder by a couple of Chains to the eye bolts, by which it will be suspended, pressing against the side of the vessel, and will cast off the ropes before mentioned.

7. When this is done, a Red Flag will be hoisted on board the Lighter, which will be a signal for hoisting a Red Flag also in Tilbury Fort, and it is expected that the Revenue Cutters in the River will take up the same signal. One of the two Red Flags received from Her Majesty's Dock Yard at Chatham, will be previously delivered to a man stationed at the Flag Staff at Tilbury Fort, for the purpose above mentioned.

8. The Lighter will be removed from her moorings, after delivering the coil of the leaden pipe on board of a Launch or Cutter, which will also receive the Red Buoy by which the lead pipe is to be moored.

9. The Officer and Men in this Boat will slack out the lead pipe as the tide rises, which they may do, by uncoiling about 2 feet of it every half hour, keeping it in the same state before mentioned, that is, always rather slack.

10. When the tide is about to turn, the whole of the lead pipe must be uncoiled, taking care not to break or bend the top. The screw cap will be taken off, and it will be examined to see whether water has got in. If it should be found perfect, it will be permanently attached to the Red Buoy, which must previously have been moored head and stern by small cables and anchors, and it must be turned down in the form of a swan's neck properly balanced, and the portfire attached to it calculated to burn 8 minutes, after which it will be lighted, and the boat will row off to the landing place at Tilbury Fort. The extreme end of the lead pipe, bent as above directed, must be to leeward. Colonel Pasley proposes to be present at this period, and to give orders personally for lighting the portfire. A gun on the ramparts of Tilbury Fort will be fired by a person appointed for the purpose, at the time that the Portfire is lighted.

11. When the explosion shall have taken place, the red flags will be hauled down.

12. The same thing will be done, in case of the explosion failing through any accident, but not until Colonel Pasley shall himself give the order, after being satisfied that all danger is over.

13. In either case, the lighter will be brought back to her original moorings over the wreck, and if the explosion shall have taken place, the second Cylinder will be fixed in the same manner to the other side of the Brig, not exactly opposite to the former, but about 20 feet from it, which arrangement will be obtained, by sending the Diver down in the first operation from the Larboard side, and afterwards from the Starboard side of the Lighter.

14. In case of the first explosion failing, the Diver will be sent down with a knife to cut the lanyards, which fix the parts of the two chains by which the cylinder is confined, after previously making fast a rope, or a couple of ropes to the Cylinder to haul it up by. When it approaches the surface, the tackle of the Derrick will be made fast to it, and it will be hauled out of the water into the Lighter. The pipe leading to the centre of the Cylinder, and containing the damaged powder will be unsoldered and taken out, and the whole apparatus replaced ready to fire a second time, for which the preparations will be made exactly as before directed. The Diver, after cutting the fastenings of the chains, will unhook the ends of them from the eye bolts and bring them up.

15. Corporal Mitchell will be employed as the Diver, and if he should find it too fatiguing to execute the whole operation, after he has put in the eye bolts and passed the ropes through them, the fixing of the chains may be done by Serjeant Young, who has also practised diving.

16. If the scaling ladders should be found inconvenient, which ought to be tried as soon as possible after the arrival of the Lighter off Gravesend, the rope ladder will be used by the Divers.

17. If the second explosion should affect the Demolition of the Brig, to such a degree, as to blow her to pieces capable of being removed by boats, this will be left to the private boatmen on the River, whom the Lord Mayor has permitted to remove the parts of the wreck for their own benefit, after the second explosion, but they are not to be allowed to meddle with it before.

18. If the two great charges should not produce the above effect, a number of small charges of about 40 lb. each, will be placed in tin oil bottles with leaden pipes, etc., attached to them and fixed successively to blow up the deck and complete the demolition of the Brig. These will be fixed by means of the Diving Bell Apparatus, as may be found most convenient and a red flag will be hoisted at the time, but as little or no danger is apprehended from these small charges, they may be prepared and fired at any time of tide, that may be found convenient, and a couple of boats to warn vessels not to go too near the spot will be sufficient caution, it being presumed that 50 yards will be a sufficient distance to ensure safety. The powder for this service must be drawn from the Deputy Storekeeper at Gravesend.

19. A lead pipe containing a small powder hose must be soldered on to the conical end of these tin bottles, previously passing the end of the

hose through a cork, which is to fit the neck of the bottle and to have a toggle to prevent its being drawn out. The cork must be put in with white lead. A garden line must be attached to the hose, which line will also secure the toggle.

When this is done, the tin bottle must be filled with powder, by a hole previously made on the slope of the cone, prepared with a neck to be filled with clay, and a cap, to be soldered up in the usual way.

20. A couple of small telegraphs have been sent to make signals between the Lighter and the Tender, or between the Lighter and boats, as may be necessary. Mr. Purdo will be provided with the key of this telegraph.

Chatham, 20th May, 1838.

DEAR YULE,

1. In reference to Article 3 of the Instructions, let the Diver fix the eye bolts as high as he conveniently can, instead of 3 feet from the bottom. But they should not be lower than 3 feet or they will be useless.

2. In reference to Article 4 of the Instructions, one end of each of the ropes therein mentioned is to be made fast to one of the rings at the ends of the Powder Cylinder. If fixed anywhere else, it will spoil the operation.

3. In reference to Article 6, if the Diver cannot conveniently cast off the ends of the ropes, let him cut them taking care in so doing not to injure the lanyard attached to the chains by the same rings. I beg to explain that he may cast off or cut whichever he finds easiest.

4. Lastly. One of the Cylinders that is Larboard side No. 2 must have its leaden pipe screwed on: take care to introduce a leather collar with the Hoses sewed together by Corporal Ritchley. The wires are not to be connected: after this the whole will be ready to be let down into the water first by the Derrick tackle, and afterwards by a smaller rope if necessary, when fairly in the water, and these preparations must be made before the Diver descends, and must not be put off late on any account, delay may cause you to lose the tide, because the Diver has to act after the cylinder goes down which therefore ought to be lowered at or a little before low water if possible. The side of the Cylinder painted red is to be attached to the Brig.

I remain, Dear Yule,
Yours faithfully,
(signed) C. W. PASLEY,
Colonel, Royal Engineers.

P.S.—In reference to Article 15, Serjeant Young must be all ready dressed, except the helmet, in readiness to relieve Corporal Mitchell if necessary without loss of time.

N.B.—I have directed Mr. Howe to send this afternoon by a van addressed to you a parcel containing a new macintosh Diving Dress, and a second set of Guernsey frock Drawers, etc. which must be sent on board the Lighter to be used to-morrow morning when your operations ought to commence at the first dawn of day.

MECHANIZATION AND DIVISIONAL ENGINEERS.
(Concluded.)

By BREVET LIEUT.-COLONEL N. T. FITZPATRICK, D.S.O., M.C., *p.s.c.*, R.E.

PART III.—THE FIELD PARK COMPANY AND SOME PARTICULAR POINTS IN THE TRAINING OF A MECHANIZED UNIT.

THE first of the articles in this series dealt with the Field Company, the second gave an account of various kinds of bridging, and it was originally intended that this last article should conclude the series by drawing attention to various points in our training which have been introduced through mechanization. So much work, however, has recently been done in connection with the Field Park Company that it is proposed to give first of all some notes on this unit, and so round off the brief review of Divisional Engineers, before going on to the question of training.

THE FIELD PARK COMPANY.

Establishment.

It will probably be of news to many of the more junior officers of to-day to hear that the Field Park Company never existed during the last War amongst our Divisions on the Western Front. The experience gained, however, together with recent developments, shows that this type of unit will be an essential part of Divisional Engineers of the future, and accordingly a start was made in putting together an establishment.

To commence with, it was proposed that the transport of this unit should be partly horsed and partly lorries, but it was realized that this would be unsatisfactory and the whole of the transport is now to be M.T. The details of the establishment have received considerable attention during the past summer, and the general outline of a Field Park Company will probably be as follows :—

(i) H.Q.
(ii) Two Sections.
(iii) M.T. Section, consisting of :—

A Group—
Field Work Tools and Stores.
Compressors.
Medium Derrick Lorry.
Water Supply Equipment.
Power Tools.
Lorries for collection of stores.

B Group—
Kapok Bridging.
Folding Boat Bridging.
Medium Bridging.

C Group—
Workshops Lorry and Tools.
Electric Light Set.
Divisional Reserve of Tools.
Administrative.

A total of about 170 men and some 40 vehicles, probably a Major's command.

Role.

The role of the unit will be to provide the essential nucleus of a Divisional Engineer Workshop, to supply any men possessing particular training in the use of power tools or plant sent on to Field Companies, to act as a holding unit of the special engineering equipment of a Division, and to carry the divisional bridging equipment. In addition, the personnel of the Field Park Company should be able to reinforce a Field Company when necessary.

Equipment.

Owing to the many demands that may be made by various units in a Division for Field Park Company technical gear, bridging equipment and entrenching tools, it has been difficult to estimate the amount of gear that this unit should actually carry. Scales of equipment have to be kept down to an absolute minimum, but by provision throughout of compact and up-to-date plant, it is hoped that all the essential equipment will be found transportable in the M.T. allowed.

As regards Group A. It is proposed that the Field Works equipment should be provided on a scale only just sufficient to equip the two sections in the Field Park Company for ordinary Field Works, inclusive of heavy bridging. Compressors and the medium derrick lorry are, however, included in this new layout, and with compressor ramps made part and parcel of light derricks, a Field Park Company with its one medium derrick and a couple of light derricks, should be very well equipped in an economical way to do really rapid work on any job requiring lifting tackle.

Details of the water supply gear have hardly been settled, but a considerable proportion of the plant will probably be of a flexible and economical power type, capable of raising as well as forcing.

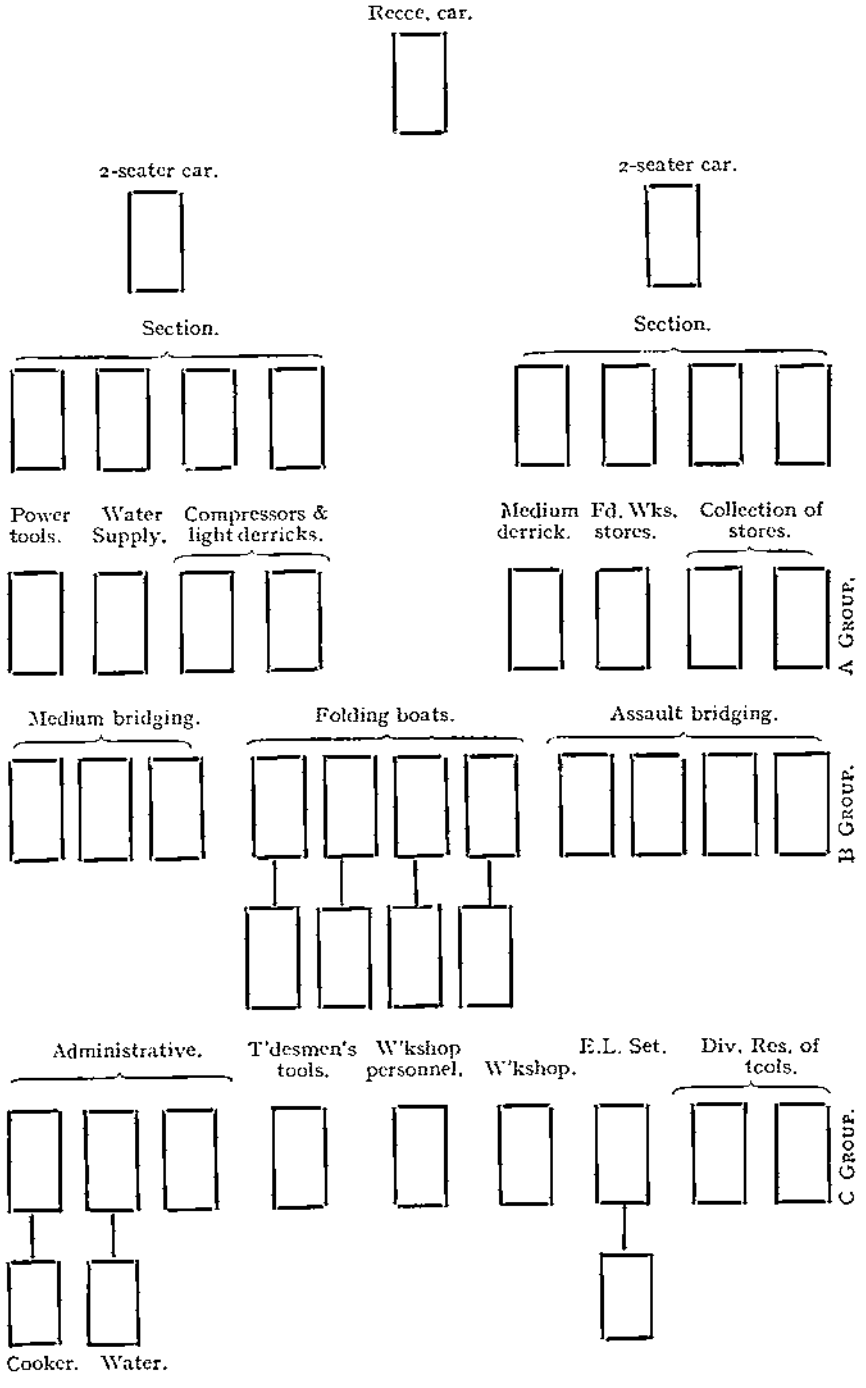
As regards power tools generally, final decisions have not yet been arrived at beyond the fact that the unit is to be properly equipped with the up-to-date engineering plant required by a Division.

17th Field Park Company, R.E., Bulford. August, 1931.

Mechanisation & Div Engineers.

FIELD PARK COMPANY, R.E.

M.T.



As regards Group B—the bridging.

The general policy which has been adhered to recently is that an infantry division should only carry as divisional equipment the amount of bridging necessary in a bridgehead operation to put over troops and close-support vehicles, leaving the passage of heavier loads, such as medium lorries, to be accomplished with equipment brought up from the Pontoon Bridge Park.

Working on these lines, the scale of bridging tentatively considered comprises some 400 feet of kapok, probably 8 folding boats for either rafting or bridging, and a few bays of medium bridge for miscellaneous purposes.

As regards Group C.

The main interest of this section will centre around the workshops and the E.L. set. Both of these are important items which must be capable of coming into action quickly, and be of a type that will run smoothly under service conditions. A good deal of data is available as regards each plant, but as yet neither of them has been "sealed"; it is hoped, however, that a Mark I of each set will soon be available for trials during manœuvres, etc.

M.T.

Turning to questions of transport and dealing firstly with the problem of transporting personnel.

Recent trials allowed for a complete motorization of all personnel in light 6-wheelers. It seems questionable, however, as to what extent men in a Field Park Company need be motorized, and as personnel of this unit might equally well be moved in various types of M.T., the whole of this question will probably be reconsidered.

As regards compressors, the best means of transport is still under discussion. The single compressor on a single light 6-wheeler is excellent from a working point of view, but may be considered wasteful in M.T. Up to date, however, suitable compressors have not been produced of a size allowing two or more being loaded up on to one medium lorry. A possible alternative may lie in compressors on two-wheel trailers, a type which is now under consideration, but as yet has hardly been tried out in this country for military purposes.

To come to a point in connection with heavier loads, there is the problem as to what forms the best type of transport for folding boat equipment. Recent trials with loads carried partly on G.S. 3-ton 4-wheel trailers showed that this type of trailer introduces serious difficulties in negotiating sharp corners, and it may be advisable to avoid any such trailers for the transport of divisional folding boats. The alternative in this case may lie in a specially fitted type of pontoon superstructure lorry.

Summary.

The above is a very brief review of the Field Park Company, together with some of its problems. The unit contains a good deal of gear that can hardly be used in peace under anything approaching service conditions, and as a result questions concerning the tactical employment of the unit are apt to be neglected both during manœuvres and on schemes. On service, however, the proper handling of a Field Park Company will often be of vital interest to a division, and in consequence it is suggested that the proper working of this unit deserves careful study.

PARTICULAR POINTS OF TRAINING BROUGHT ABOUT THROUGH THE MECHANIZATION OF DIVISIONAL ENGINEERS.

Appreciation of Mechanization.

The first point which requires mention is the necessity for an accurate appreciation of the advance in efficiency of a mechanized unit for most types of work. The point may seem an obvious one, but as a matter of fact it is not easy for all concerned to gauge the advantages in the increased mobility of men and equipment, and in the capabilities of the power and power tools now available. Questions constantly arise as to how quickly under the new conditions one can complete reconnaissances and carry out work, and a pretty exact knowledge of what can be done is required.

The mechanized unit, as a whole, has to acquire a general sense of "power-mindedness," with a natural inclination amongst all ranks to do every job in the quickest, most up-to-date and most economical manner.

As regards control, owing to the greater distances a greater amount of decentralization will often be necessary, and in consequence N.C.O.s of all ranks should be kept well in the picture so as to pull, at a moment's notice, every ounce of their weight.

Maintenance of the Objective.

The forces harnessed seem, so to speak, to be typically "centrifugal," for mechanized parties of all natures can so easily fly off at a tangent. The winning of the commander's battle, however, and that alone, is, of course, the crucial consideration, and this fact requires to be kept constantly in mind for a proper direction of matters mechanized.

M.T. Drivers.

Every driver of an M.T. vehicle is an exceedingly important man. Mechanization results in many more eggs being placed in one basket, and as a single machine which suddenly refuses to go may lead to awkward consequences, the motto is to aim for an exceedingly high standard of "motor mastership."

As regards actual units in the Corps, we have " mechanized " to such a small extent up to date, that one can hardly as yet see how best to deal with the M.T. driver problem. In other arms a cadre of instructors is trained at an Army school, and they in turn train the unit personnel. It is possible that we may be able to do a little better than this by giving all our future M.T. drivers a short course at Chatham, and thus continue the high standard of efficiency we have always had with our H.T. drivers.

As regards M.T. recruits, young Sappers should always provide the requisite proportion of potential good M.T. drivers, and from our experience in the 17th Company, a unit would be well advised to put carefully selected men on to the job of driving and to pay constant attention to M.T. training.

C.S.M. and C.Q.M.S. and M.T. Serjeant.

The detail for both the C.S.M., C.Q.M.S., and M.T. Serjeant in a mechanized Company is apt to be somewhat intricate and has often to be done at considerable speed. The three men have to work well together, and each of them has a really live job.

Map Reading and Marches.

Reading a map when in charge of a column travelling at 15 miles per hour is quite *autre chose* to doing the same thing at 2½ miles per hour, and taking the wrong turning with M.T. can lead one into all sorts of trouble.

The writer advises any commander of a M.T. column to have a " navigator " beside him to " con " the actual route, the commander thus being free to read the messages which are constantly coming in to him, also to look about and study country in general instead of a route in particular.

Map reading on the part of the men also requires special practice for similar reasons, as small parties with corporals in charge have often to be led off to distant jobs. Training in map reading and map copying is most important.

Reports.

Apart from the difficulty usually experienced in getting news sent back, one can see much attention having to be devoted to this point in mechanized units whose men work farther afield from their Headquarters.

The completion of a job must invariably be reported with proper speed, and this may vary from a priority wireless message at the nearest station, down to the ordinary post. The point of training lies in instilling the doctrine that every job has to be properly reported and the subject is one which can actually be properly practised in peace.

Research Work.

It is usually difficult during times of peace to make much progress in ordinary units in the practical side of military research, owing to lack of funds, etc. In spite of the constant changes in many directions, it is submitted that the military engineer can, as a matter of fact, do a considerable amount of useful research at very small expense by keeping abreast of developments. It is all a question of keeping our eyes very wide open to see what is going on in the military world and in civil engineering, and keeping up-to-date in all respects.

A.A. Defence.

Great strides have been made in the amount of protection that air defence brigades can give for the moves of formations, and great strides have also been made in the protection which a unit, such as an Infantry Battalion, can arrange for itself. Moves of small units such as Field Companies may, however, often have to be carried out without any air defence brigade to help, and a mechanized Field Company, as it now stands, seems particularly vulnerable to air attack.

The writer feels that adequate mobile A.A. Defence can be devised. Pairs of A.A. Lewis Guns, used as in naval picket boats, but mounted on 6-wheelers and spaced throughout a column, would probably give enemy aeroplanes a warm reception, and it is thought that something on these lines will be required.

A mechanized Field Company is at present defenceless while on the move, a state of affairs which seems so undesirable that it is thought that this problem will require attention.

M.T. Miscellanea.

To touch briefly on domestic problems such as embussing, debussing, and moving in and out of bivouac with M.T. Embussing and debussing require a definite " drill " for the purposes of command and control, and also to save time and losses of equipment. As regards bivouacs, all is perfectly easy under good conditions, but under service conditions one would have to watch starting-up arrangements, also things like exits and gateways, pretty carefully to avoid being made late at a starting point. As regards " getting there," the writer recommends a practice of giving every M.T. driver, before he moves off, a destination, so that in case of accidents the man may be able to " get there " on his own—but these and many similar things would all come under " motor-mastership," too big a subject to be tackled now.

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).*

(*Concluded.*)

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

VI.—FIVE VICTORIA CROSSES.

FIVE V.C.s were awarded to the Bengal Engineers during the Mutiny. It is due to the memory of that gallant and distinguished Corps, to which Thackeray was so proud to belong, to place the achievements of the other four beside his own.

These five Crosses were awarded to four officers and one N.C.O. Three of them were given for the blowing-in of the Kashmir Gate, namely, to Lieutenants Duncan Home and P. Salkeld and Serjeant J. Smith (who also received a commission), together with Bugler R. Hawthorne, of the 52nd Foot. The official account of that heroic action concludes the record contained in these pages. The last of the five V.C.s was Lieut. J. McLeod Innes,† who captured an enemy gun single-handed, on February 23rd, 1858. He had also distinguished himself greatly on many occasions at Lucknow, where he was in charge of the defences, at the two reliefs of the Residency, and afterwards at the taking of the city.

The Victoria Cross, which was won by Lieut. E. T. Thackeray, on 16th September, 1857, at the capture of Delhi, was not bestowed for nearly five years. The circumstances of this delay are in themselves not without interest. The official correspondence gives a graphic picture of the affair—casually mentioned in Letter 6—as an incident in the day's work. The letters from Major Maunsell and Colonel Baird Smith are quaint examples of a more florid epistolary style than is now usual in formal communications.

Briefly stated, it was not until nearly a year later, when it became known that Major G. A. Renny, of the Bengal Horse Artillery, had been recommended for the Cross on the occasion of the enemy's counter-attack on the Delhi Magazine, that steps were taken to bring to light Thackeray's share in the exploit. The vital importance of the

* Previous numbers contain nine letters written by Lieut. E. T. Thackeray.

† Afterwards Lieut.-General J. McL. Innes, V.C., C.B., F.R.S.

Magazine was a signal feature of the service. He was the only Engineer officer present, and he had made light of it. His Commanding Officer and friends felt that his claim to equal recognition ought to be substantiated. The ensuing delay is explained in the letters which follow. They are published by permission of the India Office and War Office.

From Major F. R. Maunsell, Commanding Sappers and Miners, to Colonel R. Baird Smith, C.B., and A.D.C., Bengal Engineers, late Chief Engineer, Delhi. (Dated Roorkee, the 25th November, 1859.)*

1. The perusal in General Orders of the acts of bravery performed during the late Campaigns, for which the distinction of the Victoria Cross has been granted, leads one present at the siege of Delhi to recall the many daring deeds done during that memorable time, feats of bravery and British coolness which were of such constant occurrence and so necessary in that trying position, that no reward or distinction was thought of, or perhaps deserved, than the deed carried with it.

2. Certain deeds, however, which appeared to shine out more conspicuously have been rewarded with the coveted distinction alluded to, and in one of these an officer of the Corps, which I had the honour to command, was so prominent and associated with those who obtained the Cross, that I think I am justified in considering him as well worthy of the decoration.

3. Lieutenant Edward Talbot Thackeray, Bengal Engineers, the officer I allude to, commanded a party of Sappers and Miners on the occasion of the repulse, on the 16th of September, 1857, by a few men of the 61st, Artillery and Sappers, of the enemy's attack on the Delhi Magazine, and on which Major Renny, Artillery, earned the Cross by his daring.

4. Lieutenant Thackeray had been employed the whole morning in making sand-bag loopholes on the walls and traverses across the doors under a close and heavy musketry fire during which several lives were lost. At noon the enemy made their attack, ascending the wall by scaling ladder, from which they kept up a fire on the defenders. Against this wall inside there were some thatched sheds (*vide* sketch in margin) which the enemy set fire to with lighted rags on poles. (This was a part of the wall repaired, after the explosion of the Magazine, in May, 1857.) It was there that Major Renny threw over shells with lighted fuzes. Lieutenant Thackeray being unable to put out the fire from below, and fearful of gunpowder and other stores, ascended the roof and had bags of water handed to him by a servant of Lieutenant Vicar (61st). He thus emptied several bags,

* Afterwards General Sir F. R. Maunsell, K.C.B., Colonel Commandant, R.E.

and the fire was extinguished. While thus employed, the enemy, from their ladder and below, were firing at him and throwing stones and bricks. Lieutenant Thackeray was close to Major Renny and in danger either from the lighted shells, the fire of the thatch, or the enemy's missiles, but it was not until the fire was quite extinguished that Lieutenant Thackeray descended from his perilous position.

5. The event above narrated was not made known at the time; Lieutenant Thackeray being the only Engineer officer present, and his modesty prevented him from bringing it forward, and I was incapacitated from wounds received during the assault, and did not hear of events as they occurred. I had before become aware of Lieutenant Thackeray's character for cool intrepidity.

6. Some time has been lost in obtaining the accompanying letter from an eye-witness, Lieutenant Vicar, which in corroboration of the above statement and with your recommendation as Chief Engineer of the Brigade, will, I hope, procure for Lieutenant Thackeray the honour of the Victoria Cross.

(The letter referred to was received in answer to an application made to the officer commanding H.M.'s 61st Regiment, under instructions from Major Maunsell.)

No. 121. *From Lieutenant and Adjutant H. G. Weims, Commanding 61st Regiment, to Lieutenant Thackeray, Bengal Engineers. (Dated Port Louis, Mauritius, the 10th September,* 1859. *Forwarding letter from Lieutenant Vicar.)*

In reply to your letter of 10th July, 1859, which has followed me from India, I have the honour to state that I am quite sure that you were one of those engaged in extinguishing the fire, caused by the rebels in the Delhi Magazine in their attempt to re-capture it on 16th September, 1857.

You were pouring bags of water on the flames, standing on the roof, and if you remember, when I was handing up the shells to Major Renny, I begged of you to come down when the attack of the rebels slackened, as your close proximity to the lighted shells rendered your position one of extreme danger.

I may add that the attention of the General Commanding-in-Chief, having been attracted to the gallant conduct of a soldier of the 61st Regiment on the same occasion, a letter was written by his order to Lord Clyde, requesting him to report as to whether he was in Lord Clyde's opinion deserving of the Victoria Cross. This letter having been forwarded for a report to the Officer Commanding 61st Regiment, he reported that it did not appear that any one man had exceeded in gallantry, all the others engaged and the names of one officer and seven men (two of whom were killed in the flanking turrets) were submitted as having been conspicuous on the occasion.

The water-carrier from whom you obtained the bags was my servant, who was fortunately with me in the Magazine.*

From Colonel R. B. Smith, C.B., Mint Master, late Chief Engineer, Delhi Field Force, to the Adjutant General of the Army. (Dated Calcutta, the 5th December, 1859.)

I have the honour to submit for the favourable consideration of His Excellency the Commander-in-Chief, a letter, dated the 25th ultimo, from Major F. R. Maunsell, Commanding the Corps of Bengal Sappers and Miners, bringing to my notice, for the first time, an act of rare personal valour and devotion on the part of Lieutenant Edward Talbot Thackeray, of the Bengal Engineers, done while that officer was serving with the Engineer Brigade at the Siege of Delhi.

2. The special circumstances of the case are so clearly and fully related in para. 3 of Major Maunsell's letter and so authenticated by the testimony of Lieutenant Vicar, of Her Majesty's 61st Regiment, an eye-witness of Lieutenant Thackeray's gallantry, that I need add nothing to the details they supply, except to express my cordial admiration of the cool, and I may add from my previous experience, the characteristic daring with which Lieutenant Thackeray took his place on the burning roof of a shed filled with live shells and other combustible matter, and there remained under a heavy fire of musketry from the enemy until he had entirely extinguished the flames, saving thereby, at imminent danger of his own life, the lives of many of the gallant defenders of the post, who must inevitably have perished had an explosion occurred. This result is in itself a high reward but a deed so intrepid, so well timed, and so successful, may, I trust, be deemed by His Excellency to be worthy of special

* The name of this brave Indian servant is not recorded. It is to be hoped he was suitably rewarded.

General Sir R. Harrison, Royal Engineers, in his *Fifty Years in the British Army* (1908), gives an account of this affair, which fills in some of the details. "On 16th the Arsenal was captured by the 61st Foot, 4th P.I., and Beluchi Battalion, but the rebels set fire to some thatched houses adjoining its walls, and at the same time occupied a covered position to fire on anyone attempting to extinguish the flames. It seemed impossible to get at the rebels to eject them, when Lieut. G. A. Renny, Bengal Horse Artillery, climbed up the Arsenal wall, and being handed 5½-in. mortar shells with lighted fuzes by Lieut. Vicar, 61st Foot, he threw them down amongst the rebels, who fled speedily. Simultaneously, Lieut. Thackeray, Bengal Engineers, climbed up the wall and threw buckets of water handed up to him upon the flames."

The act for which Brevet Major G. A. Renny was awarded the V.C. is described in *The Gazette* of 25th March, 1859. "Early in the prenoon of that day a vigorous attack was made on the post by the enemy, and was kept up with great violence for some time, without the slightest chance of success. Under cover of a heavy cross-fire from the houses on the right flank of the Magazine, and from Setinghurh and the Palace, the enemy advanced to the high wall of the Magazine and endeavoured to set fire to a thatched roof. The roof was partially set fire to, which was extinguished at the spot by a sepoy of the Balooch Battalion, a soldier of the 61st Regt. having in vain attempted to do so. The roof having been again set on fire, Captain Renny, with great gallantry, mounted to the top of the wall of the Magazine and flung several shells with lighted fuzes into the midst of the enemy, which had an almost immediate effect, as the attack at once became feeble at that point, and soon after ceased there."

The sepoy of the Balooch Battalion and the man of the 61st Regiment, whose names I have not traced, certainly deserved the Cross equally with the Gunner and Sapper officers.

recognition, and I therefore respectfully and most cordially support Major Maunsell's recommendation of Lieutenant Thackeray for the decoration of the Victoria Cross, and solicit for that brave young soldier, Lord Clyde's powerful protection in the submission of this claim on his behalf.

The officiating Adjutant General's brief reply was in contrast to the rolling periods of these communications, though it took nearly four months to compose it. In a letter of 27th March, 1860, he informed Colonel Baird Smith that "the Commander-in-Chief is unable to entertain this recommendation on account of the distance of time intervening between the application and the performance of the service."

However, Colonel Baird Smith, undeterred, again took up the cudgels on his subaltern's behalf, in the following letter, dated 17th April, 1860.

. . . I am sure that His Excellency will not object to receiving from me a brief explanation of the circumstances which created this delay, and should they seem to account fairly for it, I venture to hope that a claim, which on its own merits appears so powerful, may still be favourably considered.

2. From the 16th of September, 1857, the day on which the Delhi Magazine was recaptured, to the end of May, 1858, Lieutenant Thackeray was incessantly employed on service in the field, either in the operations in the Doab, preceding the Siege of Lucknow, or at the Siege itself, or in the subsequent campaign in Rohilcund and Oudh. It was not till the latter date that he became aware of Major Renny, of the Bengal Horse Artillery, having been recommended for the Victoria Cross for the same deed in which he had taken so prominent a part. . . . It will be evident, from an inspection of dates, that no time was then lost in bringing the case to notice so soon as it was complete in its details, and considering the unprecedented circumstances of the times, I respectfully submit that a little over two years is not an unreasonable delay in a case of this kind. No officer or soldier employed in the campaigns of 1857–58 has yet received any of his prize money, and if the delay does not invalidate claims to this, it seems hard that claims to honours capable of complete authentication should be invalidated by it, without any previous notice of such a consequence having been given that I am cognizant of. I would further observe that the British Government has admitted in the case of services in the Peninsula and in India, claims for honours after the lapse of times fully twenty times greater than in the present instance, and it is only a few days ago that I had to deliver a decoration of this class, which bore on its face that it was granted for services rendered between 1799 and 1826. Trusting

that His Excellency may be pleased to give to these reasons the weight they may deserve, I respectfully, but very earnestly, solicit a consideration of the claim of Lieutenant Thackeray on its own merits. The act in which he shared has already attracted the personal notice of His Royal Highness, the Commander-in-Chief, and the gracious consideration shown by His Royal Highness for the soldiers of Her Majesty's service engaged leads me to indulge a confident hope that the same consideration will be granted to an officer of Her Majesty's Indian Forces, who has proved himself to be so thoroughly deserving of it.*

The result of this appeal was the submission to the Government of India by the Commander-in-Chief in India, Sir Hugh Rose (Lord Strathnairn), of Lieut. Thackeray's name, together with several others, "for the honourable distinction of the Victoria Cross." This recommendation was agreed to by the Governor General in Council (Lord Canning), and forwarded to the India Office in October, 1860. A delay of less than a year will be recognized as nothing out of the common, by anyone conversant with the ways of the Bengali *babu*, and the impenetrable jungle of *Indian Army Regulations*, amended and interleaved, in which he lives and moves and has his being. But the end was not in sight.

"*Bis dat qui cito dat*" was not the motto of the War Office and India Office. Pall Mall and Whitehall now sat down to debate the question of recognition. It was another year and a half before the Secretary of State for India was able to inform the Governor General in Council that he fully concurred with some of the recommendations made in the letter of 8th October, 1860. The Commander-in-Chief, H.R.H. the Duke of Cambridge, gave his final decision in Lieut. Thackeray's favour, at an interview with the young officer, on his return to London on sick leave early in 1862. Throughout his forty years' tenure of the office of Commander-in-Chief, the Duke was always accessible to officers of the army, liked them to attend his levees, and won their confidence and affection by his bluff kindness. He believed in the personal touch between officers and the Horse Guards, which necessarily disappeared to a great extent when a Royal Commander-in-Chief was superseded by a more magisterial Army Council. He had the princely quality of never forgetting a

* It is of interest to note that there have been instances, in modern times, of a delay of half a century in conferring distinctions. In 1907, fifty years after the Mutiny, a gazette announced the posthumous award of the Victoria Cross to the relatives of Lieut. A. Lisle Phillips, of the 11th Bengal Infantry and 60th Rifles. In this connection a coincidence occurred in 1913, which is curious enough to be here recorded. I was staying with my father at Gracedieu Manor, Leicestershire, the former seat of the Lords of the Manor, the family of Phillips de Lisle (formerly Phillips), to which Ambrose Phillips had belonged. One day we walked to the top of a hill on which stood a conspicuous tower. Arrived there, we found an inscription, almost obliterated, which with difficulty we deciphered. It proved to be a monument to the memory of my father's old friend of nearly sixty years ago, commemorating the several acts for which he had been recommended for the V.C., in the last of which he was killed. —C.B.T.

Edward Thackeray

THE BLOWING IN OF THE KASHMIR GATE, DELHI, 14TH SEPTEMBER, 1857.

From the original drawing by Eyre Crowe, in the Royal Engineers Mess, Roorkee.

name or face. This was not the only time he met Thackeray, nor the only good turn he did him.

The award, in *The London Gazette* of 29th April, 1862, is in the following words:

"For cool intrepidity and characteristic daring in extinguishing a fire in the Delhi Magazine enclosure, on 16th September, 1857, under a close and heavy musketry fire from the enemy, at the imminent risk of his life from the explosion of combustible stores in the shed in which the fire occurred."

A letter from the Secretary of State for War, dated 17th July, 1862, directs the G.O.C., Dover District, to "take the earliest fitting opportunity of presenting to Lieut. Thackeray this Cross, with which Her Majesty deeply regrets not being able to decorate him Herself,* in such a public and formal manner as you may consider best adapted, to evince Her Majesty's sense of the noble daring displayed by him before the enemy, and to testify Her wish that a distinction in which the Officer and the Soldier may equally share, may be highly prized and sought after by all of whatever rank and degree in Her Majesty's naval and military services."

The Cross was accordingly presented to Lieut. Thackeray shortly afterwards, on a general parade of the troops of the Dover Garrison. The recipient used to declare that he found the ordeal on the Dover parade ground more trying than the affair of the Delhi Magazine enclosure.

* * * * * *

The blowing in of the Kashmir Gate by a few British and Indian soldiers holds an appeal to the imagination as stirring as any collective act of heroism in war, not only for its supreme daring but by its far-reaching influence on the operations of an army. Had it not been successful, the assault would probably have failed, for one of the three columns could not have effected a lodgment within the walls. A repulse at this stage would have had incalculable consequences throughout India. The often told story has been given already in one of Lieut. Thackeray's letters. But the words of the actual dispatch, written on the very day by the officer in charge, bring it home more vividly and impressively than any other description. No excuse is needed for presenting this memorable dispatch in full. (It will be noticed that the Chief Engineer's memorandum to Lieut. Home is dated 14th September. Lang's daring reconnaissance, when the breaches were reported practicable, only took place on the evening of the 13th. As the troops paraded at 3 a.m. on the 14th for the assault at dawn, the order must have reached Home less than three hours before they fell in. But under the able management of Captain Alex Taylor, Director of the Assault, and his Engineer Staff, every detail had been thought out beforehand, and all preparations had been made.)

* The death of the Prince Consort was still recent.

Memorandum for Lieutenant D. C. Home.

Lieutenant Home, with Lieutenant Salkeld and four European non-commissioned officers, each carrying a 25-lb. bag of powder, will accompany the covering party of Rifles that precedes the columns and will proceed to blow in the Cashmere Gate. The party will be accompanied by a bugler of the 52nd Regiment, and on the explosion causing a successful demolition, Lieutenant Home will cause the bugler to sound the regimental call, which will be a signal for the column to advance and storm the gateway.

If the demolition is not complete and the breach made quite passable, Lieutenant Home will at once send notice of the fact to Colonel Campbell, and will himself rejoin the column with his party, following the first column by the breach. If from any cause whatever no explosion should take place, intimation will at once be sent to the different divisions by Lieutenant Home.

(*Signed*) R. BAIRD SMITH,
Lieutenant-Colonel, Chief Engineer.

Dated Camp before Delhi, September 14th, 1857.

From Lieutenant D. C. Home to Lieutenant-Colonel R. Baird Smith, Chief Engineer.

SIR,

In accordance with your instructions, I have the honour to forward as detailed an account as possible of the proceedings of the party ordered to blow open the Cashmere Gate of the City of Delhi, on the morning of the 14th inst.

2. The covering party of the 60th Regiment Royal Rifles having advanced in skirmishing order from No. 2 Battery (left) at Ludlow Castle, the explosion party (as per margin [Lieut. Home (Engineers), Lieut. Salkeld (Engineers), 3 N.C.O. Sappers, 14 Native Sappers, 10 Punjab Pioneers]), provided with powder bags and ladders, proceeded to the front at the double, halting once under cover to enable stragglers to come up. On advancing again, Serjeants John Smith and Carmichael, and Madho Havildar, all of the Sappers, and myself, arrived at the Cashmere Gate, untouched, a short time in advance of the remainder of the party under Lieut. Salkeld, having found the palisade gate on the outside of ditch and the wicket of the Cashmere Gate open and three planks of the bridge across the ditch removed. As Serjeant Carmichael was laying his powder bag he was killed by a shot from the wicket. Havildar Madho was, I believe, also wounded about the same time.

3. Lieutenant Salkeld, carrying the slow match to light the charge, now came up with a portion of the remainder of the party, and with a view to enable him to shield himself as much as possible

from the fire from the wicket, which was very severe (and the advanced party having deposited the powder bags), I slipped down into the ditch. Lieutenant Salkeld, being wounded in the leg from the wicket, handed over the match to Corporal Burgess of the Sappers, who was mortally wounded while completing the operation. Havildar Tillok was at the same time wounded while assisting Corporal Burgess into the ditch; Sepoy Rambeth (*elsewhere Ram Heth*) was also killed at the same time. As I was assisting Lieutenant Salkeld into the ditch, I think he was wounded a second time.

4. The charge having exploded blew in the right (proper right) leaf of the gate, on which I caused the regimental call of the 52nd Regiment to be sounded as the signal for the advance of the storming party. As I was afraid that the bugle might not be heard, I caused the bugler to sound the call three times, after which the column advanced to the storm, and the gate was taken possession of by our troops.

5. I have now only to bring to your notice the gallant conduct of Lieutenant Salkeld, who was wounded while firing the charge; of Serjeant John Smith (Sappers and Miners), who arrived at the gate at the same time as myself; of Bugler Hawthorne, of the 52nd Regiment, who accompanied the party to give the signal for the advance, and who, under a heavy musketry fire, while Lieutenant Salkeld was lying wounded in the ditch, bound up his arm and leg with bandages, and exerted himself in every possible way to ease Lieutenant Salkeld; of Madho Havildar (Sappers and Miners), who arrived at the gate along with myself, and was wounded while placing the powder bags; of Tillok Havildar (Sappers and Miners), who was of Lieutenant Salkeld's party, and was wounded while assisting Corporal Burgess into the ditch; of Jahub Singh, Sepoy (Sappers and Miners), who was one of the party who came up with powder bags along with Lieutenant Salkeld; of Tooloo Subadar (Sappers and Miners), who was one of Lieutenant Salkeld's Jemadars. I regret exceedingly that Government has lost the services of Serjeant Carmichael and Corporal Burgess of the Sappers and Miners, who were killed before the fire from the wicket, two more gallant men than whom it is difficult to meet with.

6. I have now given as succinct and correct an account of our proceedings as the excitement and bustle of the moment would allow me to achieve, and I hope that the conduct of the whole detachment under my orders will meet with your approbation. After the gate was blown in, we ought to have advanced with the third assault column towards the Jumna Musjid, but we unluckily missed the column and only joined it in the Bank Compound.

I have the honour to be, etc.,

(*Signed*) D. C. HOME, *Lieutenant, Engineers.*

Extract from the Report of Lieutenant-Colonel Baird Smith, Chief Engineer, Delhi Force, to Major-General Wilson. (Dated September 17th, 1857.)

Par. 13. "The gallantry with which the explosion party under Lieutenants Home and Salkeld performed the desperate duty of blowing up the Cashmere Gate in broad daylight in face of the enemy, will, I feel sure, be held to justify me in making mention of it. . . . (Here follows an abbreviated account of the affair.)

"I feel certain that a single statement of this devoted and glorious deed will suffice to stamp it as one of the noblest on record in military history. Its perfect success contributed most materially to the brilliant result of the day, and Lieutenants Home and Salkeld with their gallant subordinates, European and native, will, I doubt not, receive the reward to which valour before the enemy so distinguished as theirs has entitled them. I have since heard that Lieutenant Salkeld is dead, but have not seen it in the returns myself."

"After the wounds that he received on September 14th," wrote his friend Thackeray, "Salkeld lingered in much suffering until October 11th, when he passed quietly away. He was beloved and admired by all who knew him." But he lived to know that his services had been rewarded with the highest honour in the British Army. He, with Home, Smith and the bugler, Hawthorne, was provisionally awarded the Cross by Major-General Archdell Wilson in the field.

Although Duncan Home remained untouched at the assault, and did further valuable service during the capture of the city, he was fated to meet his death in a tragic manner, even before his companion of the Kashmir Gate. He was attached to Greathed's column, and was left behind with Lieut. Arthur Lang, to destroy the defences of the Fort of Malaghur. The exploding of the mines was a very ordinary duty, from which no danger was to be apprehended. In fact, it kept the party amused for three days. On October 1st, only one mine remained to be exploded, and Home ran down with the port-fire himself, and ignited the slow match. Lang describes what happened in a letter to Home's brother, Lieut. Robert Home, Bengal Engineers. ". . . . Heaven only knows how, but instantaneously the mine sprang, to our horror! We rushed down . . . and in a hollow, some fifteen yards off, I found your poor brother's body. . . . He was a favourite with all in camp, brave and active, so very good-natured and always laughing. I am sure everyone will mourn him, as I do, most deeply. Poor fellow! Fancy his escaping untouched from the blowing in of the Cashmere Gate, when he and Salkeld earned the Victoria Cross, to meet his end in exploding mines before a deserted fort. It is not half an hour since the accident occurred."

Of the two British survivors of this famous exploit, Serjeant J. Smith, Bengal Sappers and Miners, and Bugler R. Hawthorne, 52nd Foot, the latter seems to have been something of a character in his regiment, now the Oxfordshire and Buckinghamshire Light Infantry. He died in 1879. Beyond the fact that the Serjeant afterwards received a commission, and wrote an account of the Kashmir Gate, quoted later, I have been unable to learn what became of Serjeant Smith. It was not until the Great War, sixty years later, that Indians became eligible for the Victoria Cross. But the two Indian survivors received the high honours and rewards which they had so splendidly earned.

The ditch has been filled up, but the great South Gateway, frowning and battered, still stands. A tablet was placed outside it by Lord Napier of Magdala, when Commander-in-Chief, to commemorate the heroism of those who took part in the action. The inscription speaks for itself.

ON THE 14TH SEPTEMBER, 1857, THE BRITISH FORCE STORMED DELHI. IT WAS AFTER SUNRISE ON THAT DAY THAT THE UNDERMENTIONED PARTY, ADVANCING FROM LUDLOW CASTLE IN THE FACE OF A HEAVY FIRE AND CROSSING THE BRIDGE WHICH HAD BEEN ALMOST TOTALLY DESTROYED, LODGED POWDER BAGS AGAINST AND BLEW IN THE RIGHT LEAF OF THIS GATE, THUS OPENING THE WAY FOR THE ASSAULTING COLUMN.

Lieutenant DUNCAN HOME, Bengal Engineers.
Lieutenant PHILIP SALKELD, Bengal Engineers (mortally wounded).
Serjeant JOHN SMITH, Bengal Sappers and Miners.
Serjeant A. B. CARMICHAEL, Bengal Sappers and Miners (killed).
Corporal F. BURGESS, Bengal Sappers and Miners (killed).
Bugler HAWTHORNE, 52nd Foot.
Soobadar TOOLA RAM, Bengal Sappers and Miners.
Jemadar BIS RAM, Bengal Sappers and Miners.
Havildar MADHOO, Bengal Sappers and Miners (wounded).
Havildar TILLOK SINGH, Bengal Sappers and Miners (mortally wounded).
Sepoy RAM HETH, Bengal Sappers and Miners (killed).

THIS MEMORIAL IS PLACED HERE AS A TRIBUTE OF RESPECT TO THOSE GALLANT SOLDIERS BY GENERAL LORD NAPIER OF MAGDALA, COLONEL, ROYAL ENGINEERS, AND COMMANDER-IN-CHIEF IN INDIA,
1876.

* * * * * * *

The demolition of the Kashmir Gate is one of these memorable incidents in war of which the exact details are doubtful. The accounts are in some respects conflicting. It is not without historical importance, and it may have a more than academic interest to the Corps of Royal Engineers, that the evidence should be sifted. The apparent discrepancies can be narrowed down by a careful comparison of all the available material. The only two descriptions by eye-witnesses are contained in Lieut. Home's official dispatch, quoted above, and in a narrative written by Serjeant J. Smith, which is given at length in an Appendix to Volume III of Sir John Kaye's *History of the Sepoy War*. There are many other accounts by officers who were present at the Assault, or contained in the several histories, but these two must be regarded as the most reliable.

The memorial tablet gives the names of five Indians who took part in the affair. These brave men merit equal recognition with their British comrades for their splendid gallantry, though their names are less well remembered. The names given in the several records differ somewhat, which is partly accounted for by the variations in spelling. Home names five Indian officers and other ranks, as does the Memorial, but one name differs. (Smith only names one Indian, Havildar Madhoo.) That of Jahub Singh, mentioned by Home, does not appear on the tablet. On the other hand, Home does not name Jemadar Bis Ram. It may be that he was not in full possession of all the facts at the moment of writing his dispatch. Another source of information is General Order 579, of March, 1858, by the Governor General in Council, wherein certain rewards and promotions were gazetted to a number of Indian officers and men of the Corps of Sappers and Miners "in special recognition of the conspicuous gallantry displayed by them in the demolition of the Kashmir Gate of the Fort of Delhi on the 14th September, 1857, as well as for good service on other occasions." Subadar Toola is the only one among them whose name is mentioned both by Lieut. Home and on the tablet. Jemadar Bis Ram's is on the tablet only. Two of the others were killed on 14th September, and Havildar Madhoo may have died, or, like Home, been killed between that date and the General Order of March, 1858—unless he can be identified with Havildar "Nunda," in the *Gazette*, awarded the Third Class Order of Merit and promoted to Jemadar. Subadar Toola received the First Class Order of Merit and Second Class Order of British India, with the title of Bahadoor. Jemadar Bis Ram was awarded the Second Class Order of Merit, Second Class British India, and promoted Subadar with the title of Bahadoor. All these honours carried with them the more tangible reward of grants of money or land. This *Gazette* is divided into two lists, the first with 16 names of all ranks, the second with 17. Unfortunately there is no means of distinguishing the different services thus honoured.

The first list would seem to refer to the whole Siege of Delhi, including the Kashmir Gate, the second to the "other occasions."* It is possible that among the names are those of Indian soldiers who did good, if less conspicuous, service at the Kashmir Gate. Perhaps the regimental archives of King George's Own Bengal Sappers and Miners, to which Corps alone the honour redounds, could throw more light on the whole affair, unsurpassed as it was in daring, and brilliantly crowned with success.

* * * * * * *

So ends the story, recorded in these and previous pages, of those deeds of valour of seventy-four years ago. After Delhi, the Royal Engineers began to arrive from England, and fought with their comrades of the Bengal Engineers at Lucknow. The last survivor, General Sir Richard Harrison, Colonel Commandant R.E., died on the 25th September, 1931. Sir Edward Thackeray, the writer of the subaltern's letters which have appeared in previous numbers of this *Journal*, who died in 1927 at the age of ninety-one, was the last of the Mutiny V.C.s, and the last of the thirty-two Bengal Engineers who sat round the converted billiard table at the Sapper Mess on the Ridge at Delhi.

* * * * * * *

(Concluded.)

NOTE.

A memoir of Sir Edward Thackeray appeared in *The R.E. Journal* of June, 1928, the principal points in which may be briefly recapitulated. After holding various appointments in the Public and Military Works Departments in India, he commanded the Bengal Sappers and Miners in the Second Afghan War, 1879–80, being severely wounded when in command of the post at Jugdulluck Kotal in the Khyber Pass. Completing his command in 1886, he was appointed C.B. the same year, and retired in 1888 with the rank of Colonel. He became a Knight of Grace of the Order of St. John of Jerusalem, and was Chief Commissioner of the St. John Ambulance Brigade from 1892 to 1897, when he was created K.C.B. (Civil) for his services. He was the author of several military and biographical works, and was a frequent contributor to *The R.E. Journal*. Sir Edward lived for nearly thirty years at Bordighera, and received the two war medals, and was mentioned in dispatches for his services in Italy during the Great War, when he was over eighty. He died in 1927.

* Much valuable information is contained in a little book, *Deeds of Valour* (of the Indian soldier, 1837–1859), compiled by P. P. Hypher, and printed at the *Simla Times* press. A second volume is to bring it up to date, including the Great War.

ADDENDUM.

The names of the officers, all of the Bengal Engineers, who accompanied the assaulting columns at the capture of Delhi, on 14th September, 1857, should have been included in the account of the operation in Part III. As already mentioned, Engineer officers held a specially responsible position in all siege operations in those days, somewhat analogous to officers of the General Staff. At an assault they led the columns, and very junior officers thus found themselves in the coveted post of honour. They were :—

Director of the Assault : Captain Alex Taylor.
No. 1 Column, under Brigadier-General J. Nicholson, also directing No. 2 (died of wounds) : Lieuts. A. Lang, Medley,* and Brigham* (Assistant Engineer).
No. 2 Column, under Brig.-General Jones* : Lieuts. Greathed,* Hovenden* and Pemberton.*
No. 3 Column, under Colonel Campbell* : Lieuts. Home,*† Salkeld*† and Tandy (killed).
No. 4 Column, under Major Reid* : Lieuts. Maunsell* and Tennant.*
Reserve, under Brig.-General Longfield : Lieuts. Ward and Thackeray.† Took part in the capture, but after the actual assault.

Out of these 14 Engineer officers, 2 were killed and 8 wounded at the assault. Most of the remainder were wounded on other occasions, and one, Home, V.C., accidentally killed, a fortnight later. A few wounded or sick in camp returned to duty after the assault on account of the number of casualties. Captain Taylor had to prohibit Engineer officers from leading parties during the last days of street fighting.

In addition Colonel Baird Smith, Chief Engineer, already wounded, was accidentally injured by a fall in Delhi, and Captain G. Chesney, Brigade Major of Engineers, was wounded.

Of the 5 column commanders, one, Nicholson, was killed and 4 were wounded.

* Wounded on the day of the assault.
† V.C.s.

C.B.T.

ERRATUM.

It was incorrectly stated at the end of Part V that the battle of Bareilly, in May, 1858, was the last of Edward Thackeray's services in the Mutiny. After a short sick leave in India, he took part, under Brigadier (afterwards General Sir George) Barker, in the autumn campaign in Oudh, including the crushing defeat of the rebels at Sandela, near Lucknow, and the capture of Bewar. He left no letters or other record of this campaign.

REPAIRS TO THE BARGE PIER AT SHOEBURYNESS.

By BREVET MAJOR A. MINNIS, R.E.

ALTHOUGH the construction and maintenance of reinforced concrete structures subject to the action of sea water are not tasks likely to be met with often by sappers, it seems probable that a description of the particular method recently employed in reconditioning the Barge Pier at Shoeburyness will be of interest to many and of use to some.

The special feature of the work was the repair of decayed reinforced concrete by means of the "Cement Gun" (Photo 1, Figs. 2a, 2b, and 3). The process, which is known as "Guniting," is of American origin, and has been introduced into England only recently; the job here described being one of very few of its kind to be done in this country, and the first for the War Department. Because of its special character this process is given most attention in what follows; the remainder of the work being dealt with only so far as is necessary to complete the picture of a job which was of absorbing interest to those who did it.

ORIGINAL CONSTRUCTION OF THE PIER.

The pier is Y-shaped in plan, and is 365′ long overall. From the shore end it runs out to 275′ at 25′ width, carrying two standard-gauge rail tracks; then widening out on its further 90′ of length to 95′ and carrying three tracks (Fig. 6).

It was built primarily as a railroad pier, to take rolling stock out over deep water where vessels carrying heavy W.D. stores (guns up to 8″, ammunition, machinery, cement, ballast, etc.) could be unloaded and loaded directly to and from railway trucks by crane.

The use of the pier by road vehicles was not, apparently, considered likely (it was built 20 years ago, in horse-drawn transport days), because only a rather *kutcha* 3″ timber decking was provided; the principal members of the structure being designed practically solely for the purpose of carrying the rail tracks.

The substructure consists of 38 reinforced-concrete pile bents, spaced roughly at 7′ and 10′ centres, on the wide and narrow parts of the pier respectively. These bents consist of 12″ x 12″ and 14″ x 14″ R.C. piles braced horizontally and diagonally, and capped by 25″ x 12″ R.C. transoms. These transoms carry the R.C. railbearers, which are continuous T beams cast with the transoms.

the tops of transoms and railbearers being flush. A 15″ x 5″ pitch-pine stringer, strapped to the railbearers (see Fig. 1 (a) and (b)), ran the full length of each rail and formed, incidentally, a fixing for the deck chesses.

It would appear that the transoms and railbearers were poured in forms secured to the piles, which had previously had their reinforcing steel bared at their caps, in order to incorporate their bars with those of the transoms.

Owing, no doubt, to the difficulty of driving piles to exact positions on a beach exposed to rough weather, few of the piles were actually driven in the spots intended. Consequently, few of the transoms are straight in plan; or at right angles to the centre line of the pier, and no two neighbours are parallel with each other.

Although the spacing between bents on the parallel part of the pier was intended to be 10′ centre to centre of transoms, it varies between 9′ 4″ and 10′ 6″. These irregularities, whilst of little consequence to the stability of the pier, or to the construction of it as originally built (with its timber deck), added considerably to the difficulty and expense of the repair work which is described later, and which included a reinforced concrete deck.

The pier is furnished with a fixed 20-ton crane at its head for dealing with the heaviest loads, and a travelling 5-ton crane is used as an auxiliary. The fixed crane is carried on four groups, each of six 12″ x 12″ R.C. piles—a group under each leg. These pile groups are tied together by four pairs of R.S.J. set in the concrete block cappings of each group. These crane supports are quite independent of the main structure, a precaution, evidently, against unequal settlement and the possibility of movement of the crane mass causing damage to the pier itself. Care was taken to keep this condition of isolation when the new R.C. deck was poured.

The remainder of the pier furniture, such as railings, ladders, fenders, bollards, stairways, etc., require no description; the only feature of which particular care had to be taken when laying the R.C. deck being the provision of a water pipe and cable duct. A 2″ water pipe supplies water for the fixed crane and for fire-fighting, and cable for lighting and telephone at the pier head are provided.

CONDITION PRIOR TO REPAIR.

For several years past signs of decay of the structure had been noticed, especially of the R.C. railbearers. By the middle of 1928 this decay had become so pronounced that serious doubts as to the safety of the railbearers was felt, and in places timber strutting was resorted to, pending the preparation of a scheme for permanent repair. The cause of the trouble was rusting of the steel reinforcement, and the whole of the structure above a height of about four feet below

mean high-water level was affected in varying degrees; the deterioration, generally speaking, increasing with the height.

Examination of the piles below beach level and up to about 11′ below deck level showed them to be quite sound, but as higher levels were investigated damage was found to have occurred in increasing amounts. The damage showed itself in the form of patches of rust on the face of the work, and as cracks in the concrete which defined the positions of the reinforcing bars very clearly; in many places the steel had rusted and swollen to such an extent as to burst the concrete covering off completely (Photo 3).

The concrete cover to the steel had never been sufficient to give reasonable protection against atmospheric action. It was nowhere more than 1″, was usually about $\frac{1}{4}$″, and in quite a lot of places there was never any cover at all.

(These last occurred always on horizontal members, usually the railbearers, and were due to the use of hoop-steel binding as shear stirrups. When a beam was poured, workmen pouring the concrete into the form inevitably rammed down a stirrup occasionally, so that no room for concrete between form and stirrup was left.)

Where the structure was constantly wet, the pores of the concrete being always full of water, very little rusting had taken place; but the parts "between wind and water" had suffered severely. Sea water had left behind sufficient salt to keep the steel moist by hygroscopic action without excluding air, and an ideal condition for oxidization had existed.

Where rapid draining off of water took place, such as on the vertical faces of piles, comparatively little salt deposit was left, and deterioration had been slow; but, roughly, in proportion with the length of time of exposure to the air.

On the underside of horizontal faces, where water hangs until it dries out, the action had gone furthest. Such cases were the undersides of transoms and railbearers, and damage to the latter had been aggravated by excessive deflection under load.

Photo 3 shows a typical case of damage, but the worst cases, the undersides of certain railbearers, could not, unfortunately, be photographed owing to their position underneath the deck. There were many places where the rotten concrete and steel could be picked off by hand.

Calculations showed the theoretical strength of the pile-bent members to be well on the safe side for any possible loading, even after liberal deductions on account of deterioration had been made.

The transoms, which were 25″ x 12″ overall, with an effective depth of 23$\frac{1}{2}$″, and reinforced by top and bottom sets of three 1$\frac{1}{4}$″ round bars each, had nowhere an equivalent span of more than 2′.

They appear to have been designed, not so much as beams, as to provide a high degree of fixation to the top of the piles; and the

number and strength of these piles, with their bracings, were sufficient to make the bents safe under axle loads of 100 tons without stressing the materials above normal "working" allowances.

The railbearers, by comparison, were weak.

They had never, even when in perfect condition, been much more than barely strong enough for the 17-ton axle loads brought on by normal traffic-working, and the occasional use of a 10-ton travelling crane, with axle loads of 20 and 30 tons, must have caused stresses seriously in excess of those intended by the designer.

Looking at the pier as a whole, it seems that the designer had taken traffic loads into consideration only when working out the railbearers. He appears to have purposely made the substructure grossly overstrong in order to give stiffness against buffeting by any heavy craft which might happen to be moored to the pier during rough weather. If so, he had made a curious oversight by leaving the end piles of the bents and outside bracings without immediate protection against the impact of craft coming alongside.

One of these members was always the first part of the pier to take the bump. Being joined to the main structure at transom and ledger levels only, it was made to act for the moment as a beam, and was subjected to a heavy and suddenly applied load.

It was neither suitably designed nor nearly massive enough for such duty, and the later provision of elm fenders, strapped to the faces of the piles, proved to be only a partial safeguard. Several of these members were broken from time to time, and new ones were cast in their places. The repair of such a broken pile by guniting, and the measures taken to prevent a recurrence of the trouble, are described later.

The condition of the pier before repair work was commenced may be briefly summarized as follows :—

The substructure (piles, transoms and bracings) was not so seriously damaged as to give cause for immediate alarm ; but it had definitely entered on a process of decay which, once started, continues at a rapidly increasing rate.

The railbearers were in such an extremely bad state that it was astonishing that they had not long ago failed under load. It was certain that their remaining sound materials had been severely overstressed in developing the resistance moment demanded by the loads imposed, and the fact that no actual failure had occurred speaks volumes for the tenacity of reinforced concrete.

The timber decking and railstringers were generally rotten.

REPAIRS NECESSARY.

Repair work on an extensive scale was required, for the purposes of making the pier safe for traffic, and to prevent further decay.

Railbearers.—First in order of urgency came the railbearers. They required thorough repair or replacement.

Deck.—As a consequence of any work to be done to the railbearers, the timber deck would have to be taken up; and as a great deal of it was rotten a new deck of some kind would be necessary.

Rails.—Owing to the rotting of the timber stringers under the rails, a travelling crane had been derailed about ten years ago, and had taken a header into the sea. (Luckily for the driver, who was imprisoned in the cab, the accident happened on a neap tide.) Although the stringers had been renewed, they had since rotted away again. Something better than timber was shown to be necessary as a bed for the rails, and a provision of a guard rail was desirable.

Substructure.—Some preventive measures against further decay were required, though not so urgently as in the case of the railbearers.

Repair Scheme.

The examination upon which the foregoing remarks were based was carried out early in 1930. Nearly two years before this the necessity for repairs had been recognized and a scheme for the replacement of the R.C. railbearers by steel girders and the provision of guard rails had been partly prepared.

It was proposed to replace or renew the timber deck, but no repair work to the reinforced concrete parts of the pier was contemplated.

Owing to the irregular spacing of the transoms mentioned earlier, the preparation of detailed drawings of the girders had presented difficulties to a badly understaffed local drawing office, and the scheme hung fire. When, under pressure from the Chief Engineer, the problem was reviewed early last year, objections to this scheme were made on the grounds that:—

1. Steel girders (as was evident from the state of the R.S.J.s joining the pile groups under the fixed crane) would have a very short life in this situation. They would be very expensive in first cost, and in periodical painting; and some parts of them would be quite inaccessible for painting in any case.
2. The R.C. substructure could not be ignored much longer, owing to the decay which had started, and which in places was well advanced.
3. It was considered that the R.C. railbearers were not beyond hope of repair.

The proposals now put forward (and which were adopted) and the reasons on which they were based will be described as briefly as possible. It was decided to repair the R.C. parts of the pier, and to replace the old timber deck by a deck of reinforced concrete.

Methods of Repair of R.C. Work.

From time to time, as occasional outside members of the pile bents were broken by blows from vessels, they had been replaced by chipping away the old concrete and casting new concrete round the exposed steel, using timber shuttering.

This method, whilst successful for occasional replacements, was obviously out of the question when the repair of the whole pier was involved. To tackle the whole pier would have required a forest of timber shuttering; and if only a few members were renewed at a time to enable shuttering to be used several times over, the job would have been interminable. Waste of timber would have been inevitable, and the work would have been extremely expensive.

Rendering over bad places was out of the question also—it had been tried in places and was a failure. The method adopted was the only one which required no shuttering and which could be relied upon to give a dense cover to the reinforcing steel of the members.

Guniting.

By using a machine called a cement gun, fine concrete was sprayed on to the existing work. This fine concrete, or cement mortar, called "Gunite," when sprayed from the nozzle of the cement gun, sticks itself to the surface upon which it is directed without the use of any shuttering or other support, except a steel mesh which is fixed to the old work by means of dowels. Guniting is particularly useful on such a job as this, because it can be applied to vertical or inclined surfaces, and can be shot upwards on to the undersides of beams, soffits of lintels, etc.

The mechanism of the cement gun is illustrated in vertical and horizontal sections by Figs. 2 (a) and 2 (b).

The business part of the machine is the lower tank, which is here shown charged, as when working, with a dry 1 to 3 cement-sand mix. This lower tank is kept under a pressure of about 40 lb. per square inch by a separate air-compressor; and it is by this air pressure that the mix is blown through the outlet valve, along a hose, and ejected through a nozzle (illustrated in Fig. 3), by which it is directed on to the work. That is the main idea of the machine; and the remainder of the mechanism is merely contributory to continuous and even delivery of this dry mix to the nozzle.

For instance, it will be understood that, if an attempt were made to blow the mix from the tank by air pressure alone, by opening the outlet valve, the released air would simply cut its way through the heap; and, after the first small quantity of mix had been blown out, and a clear passage made, no more would follow.

In order to prevent this, and to keep up an even feed to the outlet, a distributing cone, called the Distributor in Fig. 2 (a), having pockets in its lower edge, is slowly revolved by means of an air-driven

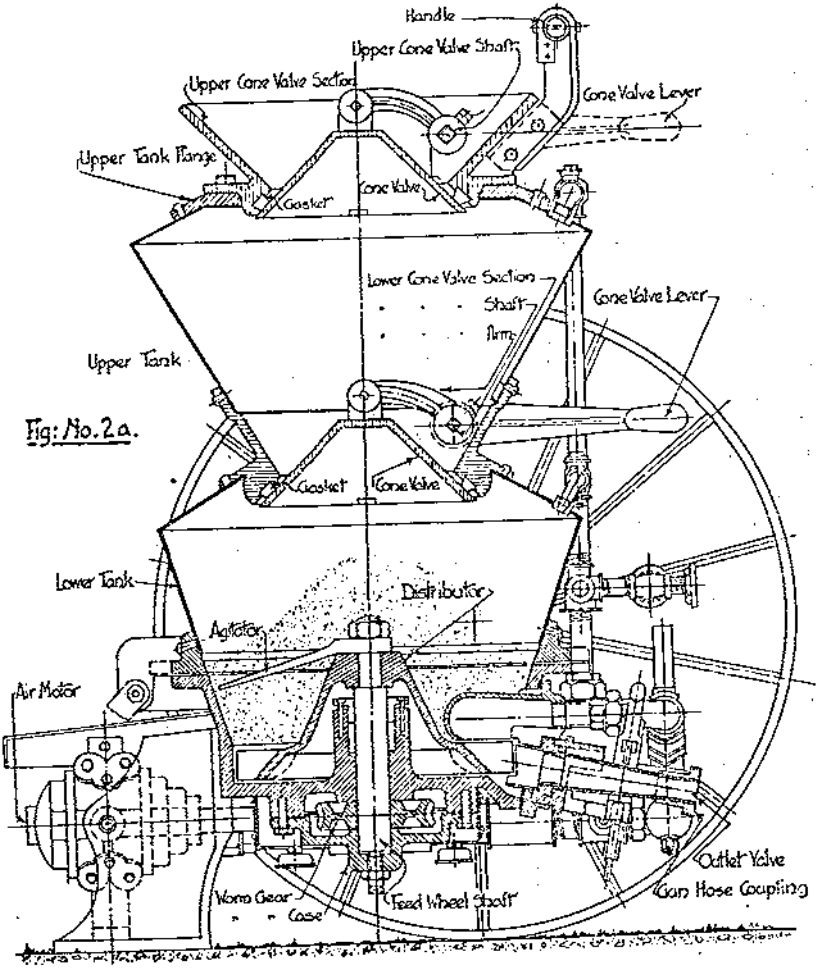


Fig: No. 2a.

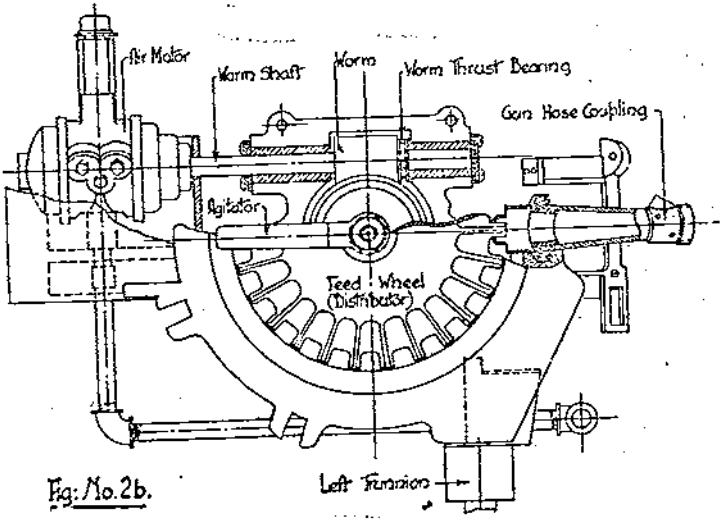


Fig: No. 2b.

motor. By this means, the outlet is supplied with pocketfuls of mix at intervals so regular and frequent as to keep a constant supply in the track of the air blast. To keep the heap of mix on the move, it is prevented from packing together by the Agitator (a plain steel arm bolted to the top of the distributor), which travels round with the distributor and breaks up the heap.

Continuity of delivery is further provided for by the upper tank, which is a pressure-equalizing device exactly similar in principle to the well-known method used in caisson-sinking.

When the lower tank requires a fresh charge of mix, the upper cone valve is opened, the upper tank charged with mix, the valve closed, and the tank then brought up to the same air pressure as that in the lower tank. The lower cone valve is then opened and the mix dropped into the lower tank. This lower cone valve is now closed, the air pressure in the upper tank released, and the whole operation is repeated as long as work continues.

When the dry mix, blown out of the outlet valve and along the hose, arrives at the breech end of the nozzle, it receives the water necessary to convert it into concrete. The water is delivered by a separate hose, under pressure, to the back of an annular ring in the breech end of the nozzle. This ring is pierced with holes through which fine jets are forced into the cement-sand stream, making an intimately mixed and wetted mixture of fine concrete.

The nozzle is illustrated in section by Fig. 3, which shows also the water-regulating cock by which the nozzleman controls the water content of the gunite as shooting goes on.

This cement-sand-water mixture, called gunite, is directed by the nozzle and is shot with considerable force on to the work, where it sticks. That is all there is to it ; and the process is called guniting.

The resulting concrete is extremely densely consolidated, and is a perfect mix, for the reasons which follow.

Consolidation follows from the high velocity with which the concrete is thrown on to the work. As it is shot it is consolidated by its impetus, and by the following material sprayed at it and into it as building up of thickness goes on.

The perfect mix, both as to grading of the sand and water content is, after the first cement-sand mixing, automatic.

The sand used is carefully graded and mixed on a mixing board (dry) with the cement. This mixing requires care, and special care must be taken to see that too large a proportion of very fine sand is not used. The *too coarse* grains are automatically rejected in course of guniting, their relatively large mass causing them to bounce off the face of the work to waste. For good work to be ensured this " rebound," as it is called, must always occur ; if it does not, there is evidence that there is likely to be insufficient coarse stuff in the sand for good grading.

This point possibly requires some further explanation.

For the work in hand and the pressure used, there will be an optimum large size of sand grain which can be used. If this can be found, finer grades can be mixed with it, as in normal sand grading for cement mortar work.

Guniting finds this optimum coarsest grade automatically by rejecting anything bigger by rebound; the only precaution necessary

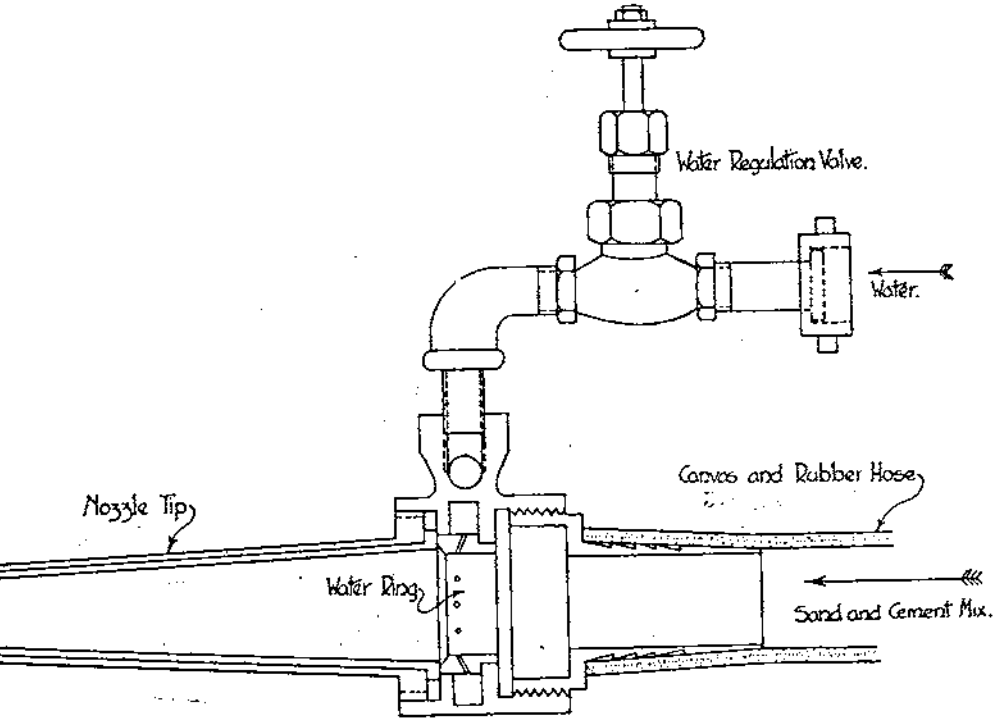


Fig: No: 3. Section of Nozzle.

being to make sure that the grading-down commences from a grade coarser than the optimum.

As regards correctness of the water content, nothing could be simpler. The admission of water to the nozzle is controlled by the "nozzleman" (the man actually shooting the gunite), by means of a control cock. If he uses too little water the gunite will show dry strips or dust and in extreme cases will be too floury and dry to stick; if too much, it will not stick because it will be too sloppy to hold up its own weight, and will flow off.

When the mixture is correct the gunite shows a uniform greasy-looking surface, easily recognized by the nozzleman.

By the middle of April the scheme for the repair of the R.C. parts of the pier by guniting, and the construction of a new R.C. deck with tramrails, was sanctioned.

R.E. work at Shoeburyness is normally done by directly employed labour, but, as guniting required trained personnel and special equipment which were not available, it was decided to let out this portion of the work to contract by a specialist firm. All work in preparation for the specialists, and the construction of the new deck, were done by directly employed labour, under R.E. supervision.

As it seemed likely that a cement gun would be a very useful machine for future use on general work on the ranges, the opportunity was taken of having men trained in its use by inserting a special clause in the contract. This clause provided for the training of two W.D. men by the contractor, their wages being paid by the W.D. The arrangement worked very well. The contractor had the full and free use of the services of two intelligent men, who soon became sufficiently expert to be entrusted with the working of one of the machines actually employed on the job; and at the same time their intimate acquaintance with every stage of the work was of great value to the R.E. supervisory staff.

Tenders were invited by the Contracts Department at the War Office, and the contract was let early in July to the Concrete Proofing Co., Ltd., 96, Victoria Street, S.W.1, who brought plant to the site by the 14th July. The specialists' jobs included in the terms of the contract were as follows:—

The whole of the reinforced concrete substructure to a depth of 4 feet below mean high-water mark was to be reconditioned by:—

(1) Chipping off all decayed concrete, and cleaning the exposed steel of all scale and rust.

(2) Attaching to the surface of the cleaned work a steel mesh, made up of 8-gauge wire, by means of dowels at 3′ intervals. These dowels were 4″ wire nails, cemented into holes drilled in the concrete to half their depth, and clenched over the mesh. In the case of piles and braces, the mesh was wrapped completely round the member, but was placed only on two sides and the soffit of the railbearers.

(3) Shooting on gunite, layer by layer, until sufficient thickness was built up to provide a 1½″ thick cover over the mesh.

As the pier was required for traffic, only one side could be tackled at once, leaving one rail track and sufficient deck space for handling stores intact. This restriction was an unavoidable but serious hindrance all through the job, as may be imagined.

Progress.

A bald statement follows, which shows how progress with guniting was made.

Work was started immediately on the east side, the railway and old timber decking being first taken up by W.D. labour, and the contractors' man started on the work of chipping away rotten concrete from the piles, bracings, transoms, railbearers and side beams. The central beam, which runs from the shore and to the point where the pier begins to widen, was not touched.

It had nowhere suffered any damage, partly due to its having never been subjected to any load worth mentioning, but chiefly because its reinforcing steel had been given a reasonable thickness of concrete protection.

When the repair scheme was mooted it had not been the intention to repair the side beams; but to cut them out and allow the new deck to carry itself. Once chipping started, however, these side beams were found to be in sufficiently good order to make guniting (which the contractor agreed to carry out as an extra at a rate cheaper than that charged for the other work) worth while.

The principal consideration leading to this decision was that the side beams, although not necessary as deck supports, served as longitudinal bracing to the pile bents, and their retention as such made it possible to use the free-moving deck slabs described later.

Their retention also allowed of a further modification in the deck slab design, in that longitudinal reinforcement of the outside deck edges could be dispensed with.

By the 25th July sufficient clearing of dud concrete and steel, and placing of mesh, had been done to provide work for one gun, and shooting started at the shore end.

By the 8th August a second gun started work on the sea end. Progress was rapid. By the middle of September the whole of the guniting on the east side and most of the middle portion on the wide (sea) end was done. This represented nearly two-thirds of the whole job.

It had been the intention to follow up the contractor by W.D. labour laying the new deck, but owing to delay in placing the contract for the supply of the special rails this was not possible.

As the contractors were working to a time limit they could not be held up, and it was therefore necessary to lay a temporary rail track and timber deck on the completed east side for traffic working.

This, and the stripping of the west side deck and track was therefore done (by D.E.L.*), and on the 19th September a gun started shooting at the shore end.

On the 10th October the second gun, which had been engaged

* Directly Employed Labour.

meanwhile on finishing off the middle of the wide part of the pier, started shooting at the sea end of the west side.

By the 7th November guniting was practically finished, though the contractors did not leave the job until the 20th, as certain parts of the work, of which more will be said later, were not passed as satisfactory.

Progress throughout, though variable, had been extremely good, an average of 220 square feet per gun per 9-hour day having been kept up. The work ran a very smooth course up to the last few weeks, when bad weather interfered. Differences of opinion between the contractors and the R.E. staff cropped up from time to time, but they were easily and amicably settled.

Two matters which caused some argument are worth mention here. One related to the after-treatment of the gunite and the other to admixtures in the gunite, before shooting, with the object of making it set more quickly.

As the whole cause of the trouble with the old structure had been the oxidization of the steel, due to poor cover, care was taken to make as certain as was humanly possible that the cover provided by the repair work should be perfectly watertight.

To do this an adequate thickness of the densest concrete possible was the first essential. Anyone who has seen guniting work will agree that the density of this material is as nearly ideal as can be imagined.

But, as even gunite is Portland cement concrete, and therefore must shrink on setting, it must, however closely consolidated, be to some extent porous, fine though the pores may be. In order to be sure that everything possible had been done to make the cover to the steel impervious, it was proposed to apply a dressing to the finished work to make sure that the pores were filled.

For this purpose P.84 grade sodium silicate was recommended in the report sent forward in March, but as it was the intention to apply the dressing by D.E.L., no mention of it was made in the terms of contract. (A short note on the action and methods of use of sodium silicate will not be out of place here. Sodium silicate, when applied as a surface dressing to concrete, is absorbed into the pores, and (following combination with the free lime which is always present after cement has set), forms a hard, dense layer by the formation of calcium silicate and the precipitation of silica within the pores.)

The concrete, in effect, is case-hardened, and the principal use of the treatment is for hardening purposes and to prevent dusting, waterproofing being almost an incidental effect. In this case, of course, the waterproofing action was of prime importance.

Because of its action, resulting in filling of the pores with a hard, insoluble rock, coupled with its prevention of leaching-out of free lime by making use of it, this method of waterproofing the

gunite gave most promise of permanence under all conditions of service.

"Silicating" was commenced as soon as a sufficient area of guniting was finished to make it worth while to employ a man and an air-compressor. (A six to one solution was applied by means of a paint-spraying pistol.)

The contractors demurred, on the grounds that such after-treatment of their work had not been contemplated by them. As they were bound to guarantee their job for twelve months after completion, they required assurances, either that silicating would not be done until their guarantee period had elapsed (which, of course, would be useless, as all free lime would by then have leached out), or that no harm would result from the treatment. They had been alarmed by the appearance on the finished work of certain white patches.

They suggested other means of waterproofing, which met with objections from the R.E. staff. After some discussion it was agreed to accept the opinion of the makers of the cement used on the job.

They endorsed the use of sodium silicate completely; going so far as to recommend, in addition to after-treatment, mixing it with the water used in guniting, in order to be quite certain that there would be sufficient *within* the gunite to take up all the free lime available; instead of relying on such shallow penetration as could be expected into material so dense as gunite.

With the full approval of the contractors this was done, but after a short time surface treatment only was reverted to.

Mixing with the water fed to the gun had proved to be very expensive, and caused delay in work by clogging the water-feed jets of the nozzle at frequent intervals.

The white patches again appeared in places, and caused accusations against the silicate, until it was pointed out that places where silicate had not been used also sported the decoration.

These white patches were diagnosed by the cement manufacturers' chemist as a quite harmless substance due to carbonization of extremely fine particles of cement, which would disappear in a short time. They did, in fact, disappear, and their occurrence stopped with the next consignment of cement used.

Another discussion, which led to an interesting innovation, arose out of the contractors' request to be allowed to use a proprietary admixture with the mixing water in order to quicken-up setting of the gunite; the object being to make longer use of the time between tides by carrying on shooting to within two hours of submersion.

As proprietory setting-hasteners are suspect, being usually composed chiefly of calcium chloride (which, though an excellent quickener for concrete, has a corrosive effect on steel, and is therefore bad for reinforced concrete), permission to use the preparation was

not given. At the request of the contractors the opinion of the cement manufacturers was again asked for.

They refused to recommend any admixture as being both an effective hastener and harmless. They suggested that the mixing water should be heated; the idea being to give the chemical action of setting a start by presenting the mix with some heat which it would otherwise have to produce itself. Arrangements were made to supply hot water by using an old steam locomotive as a boiler.

It was not possible to run the loco on to the only rail track on the pier, so it was placed on a siding on shore, with the consequence that such a long run of pipe was required at the seaward end that the water lost most of its heat by the time it arrived at the shooting nozzle. On the other hand, the nozzleman on the inshore gun objected because the water was uncomfortably hot!

Taking one consideration with another, the use of hot water for guniting was not very successful; but it was a great success later when used on the deck construction.

The cement used was "Vitocrete," a rapid-hardening cement of first-class quality manufactured at the Holborough Works (on the Medway), of the "Red Triangle" group.

The service backing up this cement was of special value.

Whenever a difference of opinion arose, or information about anything connected with cement and its reactions to various influences was needed, the manufacturer's technical and research department placed their special knowledge and laboratory freely at the disposal of the contractors and the R.E. staff.

This department took a keen interest in the job, and often formed an extremely valuable third party in various discussions which arose in connection with the work.

Steel Mesh.

According to the usual practice in gunite work 3" x 3" square mesh of 8-gauge hard-drawn steel wire, made by the B.R.C. Co., was used as support to the gunite.

Reconstruction of Pile.

The pile on the extreme south-western corner, which was always the first to take the impact of craft berthing on the western side of the pier, had to be entirely reconstructed.

It did not show any special damage until chipping off of the decayed concrete in preparation for guniting commenced. As soon as a pneumatic chisel commenced work on it, it fell to pieces, leaving the four bars, with their binding, standing as shown in Photo 5.

It had been shattered into small pieces by craft bumping into it; and the bits had evidently been simply strung like so many beads on the steel. It was reconstructed entirely by guniting.

On two adjacent sides timber shuttering was fixed, after wrapping with mesh, as shown in Photo 6, and gunite was shot, layer by layer, into the right-angled V thus made until the whole pile was built up, as shown in Photo 7.

The simplicity of the operation made possible by the cement gun may be best realized by thinking of the difficulty of pouring a pile into a four-sided form in the usual way of column construction, with the transom in place above to interfere. It would have been extremely difficult to ram concrete placed in such a form, and almost impossible to finish decently to the transom at the top.

General Remarks on the Guniting Work.

It has been remarked that the work proceeded very smoothly, and there is very little incident to write about, but certain features of the work are worth remarking upon.

One was the appalling waste of material in a job of this kind.

Photos 4, 8 and 9, showing nozzlemen at work shooting the gunite, give an idea of the spray-form in which the material is projected, but unfortunately do not show clearly the rebound which is taking place continually. Nor do they show what happens in a high wind, when the gunite is blown about.

It happened quite often that a nozzleman, balanced rather precariously on scaffolding slung from above, missed a pile or brace completely when a gust of wind upset him, or shifted his feed hose, or blew the spray of gunite to one side.

There were hundreds of times when the nozzle had to be turned into the beach to waste until the right mixture came through, and not a few whilst the nozzleman's pipe or cigarette was lighted.

The contractors expected to lose 30% of their material; and it is probable that their expectations were more than realized.

The pier, which was in an exposed position, and consisted of a large number of narrow members, was a job particularly liable to waste; and this should be specially noticed. An indoor job, or one consisting of large areas, is, by comparison, very economical. The contractors carried out repairs to the facing of a sea wall near the pier (see Photos 11 and 12) by placing a patch of gunite on mesh 63′ long by 4′ 8″ deep, and on this job lost very little material during shooting.

It required a bag of cement to about a square yard of work covered on the whole pier job, so that this particular type of work in such a situation is extravagant. It should be understood that both progress and quantities of materials vary enormously with conditions.

Both are affected by weather conditions (especially the strength of wind), scaffolding and nature of surface treated. In favourable circumstances progress may easily be made at twice the rate possible in bad conditions, and might show a saving of 50% of materials.

Appearance of Work and "Flash" Coating.

The general method of carrying out guniting has already been described, but a few remarks on finishing are worth recording.

As has been described, gunite is built up layer by layer. The first coat (or two or three as may be required) is shot according to the filling necessary, no particular care being taken to finish to an even surface. When this work is set the "Flashcoat" is applied.

It is of the same material as the others and is applied in the same way, but its chief duty is to smooth out unevenness on the lower surface; and it is usually much thinner (about a quarter to half-an-inch thick) than the lower coats.

Gunite is so dense, and so perfectly consolidated that it is difficult to make any impression in it with one's finger a few seconds after it is applied, and any process of "floating off," as the term is generally understood in concrete work, is out of the question.

It can be smoothed off by hard trowelling, but not without some danger of disturbing its internal structure unless done immediately after shooting, because it hardens very quickly.

For this reason it is normally finished by the application of the flashcoat only, and nothing is done to the surface after the shooting ends. It will, therefore, be understood that a perfectly flat surface and sharp arrises are almost impossible to obtain, even if they were desired; hence the bolsterlike appearance of the finished pier members shown in the photographs.

They are like that because the process of guniting leaves them like that, and not, I regret to say, because (as one visitor to the work remarked, in a pleasing effort to find something complimentary to say) "a few officers of the Corps have the artistic taste to avoid hard, straight lines sometimes." Where straight lines are required, screeds are fixed to the work and the nozzlemen take special care to shoot up to the lines set by them.

Photo 8 shows shooting going on between these screeds, or shooting strips. This was done only on the outside piles in order to give a regular appearance to the pier as a whole. Photo 10 shows the typical finish of these outside piles and, for contrast, the normal appearance of gunited work is shown in Photo 2.

Faults.

The contractors carried out the work very well, and the remarks which follow are not written with the object of depreciating them in any way, but only because without mention of such faults as were noticed the experience gained by the officers engaged on the work could not be passed on to others. Almost the only other faults were due to the flashcoat shooting.

Towards the end of the work several cases occurred of flashcoating falling off. The contractors attributed it to the cold, wet weather

experienced as the season advanced towards winter, and this no doubt was the chief cause of the trouble.

Setting was naturally slower under these conditions than it had been in the summer, and the flashcoat did not have time to harden before it was washed by choppy water on the rising tides.

These places were re-shot, not without considerable difficulty in one or two cases, and made good.

In May of this year a thorough examination of the pier was made, with the objects of finding how it had fared after a winter's weather, and what, if any, maintenance work should be demanded of the contractors under their guarantee.

The examination consisted of a careful scrutiny of all the gunite work, and the whole of the area was tested by rapping with a hammer.

The following defects were found:—

1. Rust spots were noticed at places on the face of the work.

These were found to be due to stray ends of the binding wire (by which sheets of mesh were secured together) having been left sticking out when gunite was shot. These have been cut out and the gunite made good. As oversights of this kind are bound to occur where many hundreds of such bits of wire are used, it seems that the small additional cost of stainless steel wire would be justified in future work of this sort.

2. Some of the flashcoating which had given trouble during shooting, in the cold weather, was found to be still defective; showing that shooting had still, in spite of previous failures, been carried out to within too short a time before immersion by rising tides.

3. A few places were found where the upper faces of diagonal braces, and the crutches between them and other members were covered with a soft, sugary coating of poor concrete instead of with a gunite flashcoat. This was found to be accumulation of rebound which had fallen from members being gunited at a higher level, and had set to form a loosely-bound coating.

4. A few places were found where hammer-rapping gave a hollow sound. These places were attacked by smart hammering, and in every case it was found that the flashcoat had lifted slightly off the lower work, forming an independent shell which was broken off by the hammer with a little trouble. A quotation from the report of the inspection follows, in which reasons for this defect are discussed.

"Underneath this displaced flashcoating a grey slime was found, of which samples were sent away for analysis; and sample pieces of the flashcoating which had been knocked off were sent to be tested for watertightness.

" The analysis of the slime was as follows :—

Silica and insoluble residue	47·20%
Ferric oxide and alumina	11·30%
Calcium oxide	21·08%
Magnesia	5·18%
Sulphuric anhydride	7·32%
Loss (water and CO_2)	7·92%
	100·00%

" From this analysis it is certain that sea water gained access through the flashcoat.

" Tests of samples of the flashcoat, however, showed them to be perfectly impervious.

" The explanation of these apparently contradictory results is, in my opinion, as follows :—

" The flashcoat is thin and, in the case of work such as the final coat on a pile, is in an especially unfavourable situation if shot in one operation all round the pile. As it shrinks during and after setting, considerable tensile stress must be set up, as happens when a steel tyre is ' shrunk on ' by a wheelwright.

" There must, therefore, be a likelihood of cracks developing by tearing apart of the flashcoat, and such shrinkage cracks would be most likely to occur at the corners.

" These cracks would provide access to sea water, though the flashcoat itself, apart from the cracks, would be perfectly sound and impervious.

" The slime would then be produced from action of sea water on the 7% or so of lime in free condition (termed ' free lime ') which is always present after cement has set.

" The action of sulphate of magnesia and alumina in sea water on ' set ' cement results in the formation of calcium sulpho-aluminate, which crystallizes with a large amount of water and a consequent increase in bulk.

" Once sea water gained admittance into the shrinkage cracks, which I suggest to have occurred after all-round shooting, the swelling following the formation of this new substance would cause further opening, and more sea water would find access to the underside of the flashcoating.

" The chemical action would proceed progressively as more and more contact between free lime and sea water was established.

" Because of the protection afforded by the flashcoating, the resulting product would not, as normally happens, be washed away ; and its swelling would cause the flashcoating to be separated from the undercoats, and eventually to spall off.

"The likelihood of the occurrence of these shrinkage cracks had been foreseen (as a result of which the use of sodium silicate was adopted), and had been discussed with the contractors, with the consequence that all-round shooting was in general avoided. I am of the opinion that the cases here discussed were due to relaxation of supervision of this point.

"To that extent only I consider that the contractors were, in part, at fault; but the principal fault lies in the specification of the work.

"In the light of the experience gained on this job, I suggest that flashcoating be omitted from future specifications.

"This experience has convinced me that flashcoating is unnecessary and useless; and that it is likely to cause needless misgivings about the soundness of the repair work generally.

"Its value as a protective coat, compared with the heavier undercoats, is very poor; it is almost certain, owing to its thinness, to suffer from shrinkage cracks; and its appearance is not so much better than that of the lower coats as to justify its use.

"Future specifications for work of this nature should provide for building-up coats of gunite to be applied to within not less than $\frac{1}{4}$" below the steel mesh. A heavy final coat should then take off from this level, should be not less than $1\frac{1}{4}$" thick, and should not be shot so as to encircle a pile or beam in one operation.

"This final coat would thus take off from a sound key on the steel mesh, and would be safeguarded from serious shrinkage cracks by the isolation of small areas afforded by the mesh. The microscopic shrinkage cracks which would possibly occur would be easily and effectually sealed by early treatment with sodium silicate.

"I have gone into the matter of this defective flashcoating in detail because I consider it necessary to alter the specification for future work. As this somewhat lengthy report may give a false impression of the seriousness of the faults found in the work on the Barge Pier job, I would again point out that the whole of the repair job, with the exception of the flashcoat, is perfectly sound—and that the flashcoat found to be defective represents only 0·1% of the whole area."

Reinforced Concrete Deck.

Calculations of the strength of the railbearers had shown that they would not be strong enough to take the 30-ton axle load of the 10-ton crane without overstressing the materials, even if they could be restored to their original condition.

In many cases complete restoration was not done, the reinforcement having been considerably reduced by rusting. It was essential, therefore, that the new deck should be capable of relieving these old railbearers of a considerable part of their load.

Fig:No.4a.

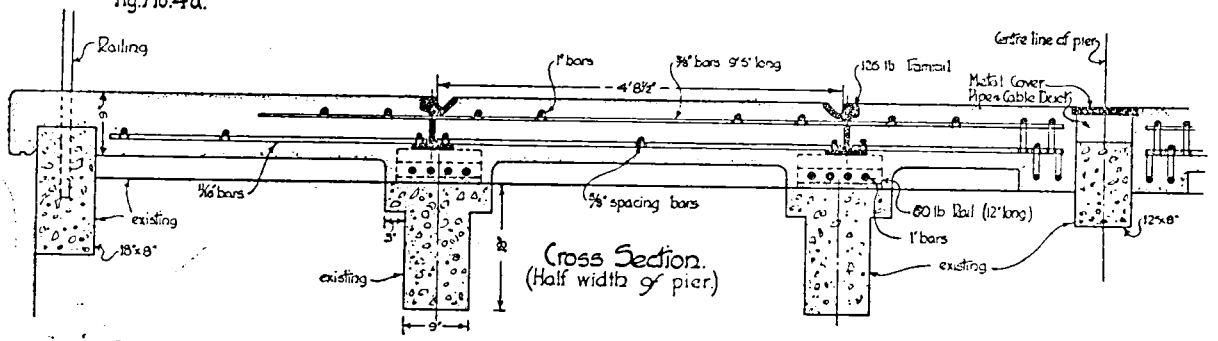
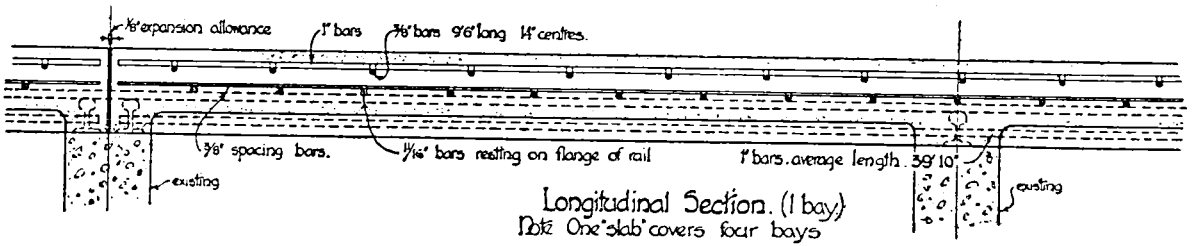


Fig:No:4b.



Shoeburyness. Barge Pier

Scale.

Sections of New Reinforced Concrete Decking.

Feb. 27th 31.

Check rails had been shown to be necessary, in addition to load rails. In order to avoid the clumsy arrangement of twin rails everywhere, it was decided to use a tramrail, thus combining check and load rail in one. As the rails had to be embodied in the concrete, expansion allowances could not be made unless the deck were made in independent slabs, so that the rails of each slab could be completely detached from those in front and behind.

The running treads of the rails, and their grooves, being exposed to the sun, and the remainder of the rail embedded in concrete, an expansion allowance of $\frac{1}{8}$" was allowed between rail ends. No allowance was made between the ends of the concrete slabs (the end of slabs already set forming the end moulds for new slabs), expansion of the concrete being automatically provided for by setting shrinkage.

Rails running the whole length of each slab were used, thus enabling full advantage to be taken of the strength of the rail itself.

The deck was, therefore, constructed in units, each containing its own rails, and covering four spans between transoms.

As the distances between transom centres varied considerably, each rail had to be carefully cut to length from the centre of one transom to the centre of the fifth transom away, the span of the slab unit being continuous across the three inside transoms of each group of five. The length of each slab was thus roughly 40', and its width (on the straight part of the pier) 13', covering half the width of the pier.

The length was governed by the maximum length of rail obtainable, and the desire to take full advantage of continuity of span.

The shape and size of the slab units varied with the situation on the pier, and with transom distances, no two rails being of the same length, but that illustrated in Figs. 4 (a) and 4 (b) is typical of all.

Each unit is quite separate from adjacent units, and is not joined to the substructure anywhere, except to the centre transom of each group of five covered.

All the substructure was carefully smoothed off and given two thick coats of tar in order to give a greasy surface on which the slab would be free to slide from its centre outwards, the central anchorage being provided to prevent bodily movement of the slab by creep.

The great thickness of the slab is due to the necessity of providing ample cover to the reinforcing steel on the underside, made evident by experience of the old structure. Everywhere a full 2" of concrete cover is given. The level of the top of the slab was governed by the old rail level, which was adhered to in order to avoid alterations to the approach from the shore.

Over each railbearer the slab is deepened to 11", forming a T beam in which is incorporated the 126-lb. tramrail; and as the slab span is continuous this T beam is doubly reinforced.

In order to make as full use as possible of the strength of this rail

(which has an inertia moment of 84-inch units), the amount and position of the reinforcing steel were arranged so that the N.A. of the T beam, and the centroid of the rail, are at the same depth from the top of the slab. The actual laying of the R.C. deck was a simple matter, but was laborious, due to the irregular spacing of the transoms, and the uneven vertical surfaces left by guniting.

These factors ruled out completely any hope of repetition work in shuttering, and made progress depend entirely on carpenters, who had to build up the shuttering afresh and fit it to suit every new slab. There was consequently a lot of cutting to waste of timber.

The general arrangement of the shuttering is shown in Figs. 5 (a) and 5 (b).

The procedure in laying a slab was as follows :—

The top surfaces of transoms and railbearers were first smoothed off and coated with tar ; and the centre transom was drilled to allow an anchor bolt to be hooked round its bared reinforcing steel.

The tramrails were then placed in position, resting on short lengths of 60-lb. rail (placed on each transom), which were drilled to allow the lower four 1″ reinforcing rods to be threaded through them. These rail blocks thus served the double purpose of supporting the rail to its correct level (after in most cases packing up from the transom by shims to make up irregularities in level of the old concrete), and of holding the reinforcement in position. The transverse rods were then placed, resting on the flanges of the rails.

The upper main reinforcement of four 1″ bars was secured in position by binding to ⅜″ rods threaded through holes specially drilled through the webs of the rails. The concrete was then poured from tip-trucks run on a Decauville track, which was laid on sleepers spanning the tramrails (see Fig. 6, which shows the general arrangement of mixing plant and transport).

The concrete was mixed in a petrol-driven mixer on shore, hot water being used. The mix was 1 to 5 cement and Thames ballast, screened through a ¾″ mesh. The hot water caused a great speeding up of setting. Using ordinary Portland cement as supplied on W.D. contract, a slab poured between the starting time of 7.45 a.m. and about 11.30 a.m. was already well on to setting by the middle of the afternoon, and was hard enough to walk on the following morning, even in the coldest weather. Frost was not allowed to interfere with progress.

One slab was poured in very severe weather, but, by using water which was nearly boiling, and by covering with tarpaulins and manure, it was still quite warm the following morning and well set. The average contents of slabs was about 20 cubic yards of concrete, and the average rate of pouring was 8 cubic yards per hour.

The laying of the deck slabs proceeded without incident until the

Fig: No. 5a.

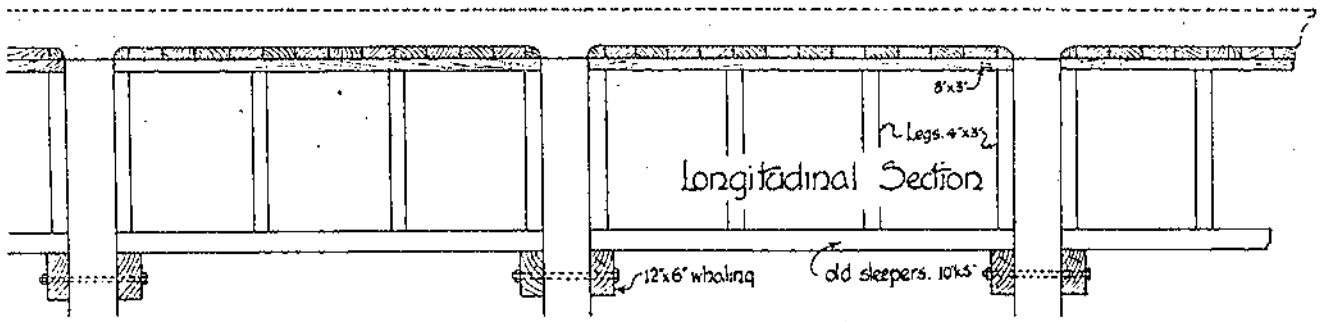
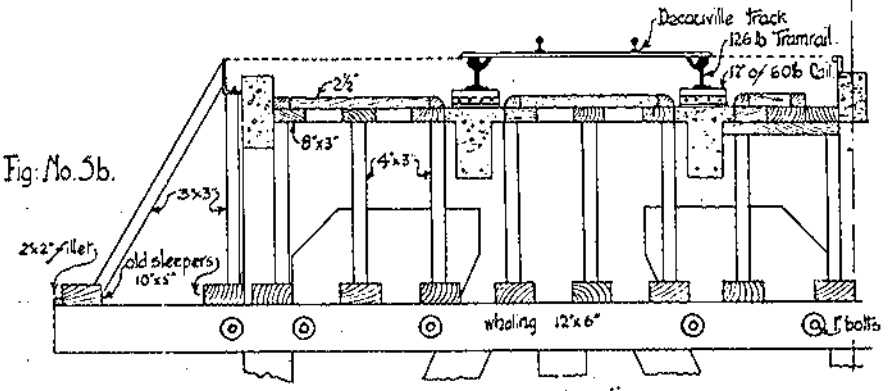


Fig: No. 5b.



Shoeburyness Barge Pier.
Details of Shuttering for Deck.

9th March, when an abnormally high tide, aggravated by a bitterly cold easterly gale, caused trouble.

A slab had been poured and was still soft when the tide reached its height, about three feet below deck level. The gale drove waves over the pier, washing out most of the green concrete, and taking away a good deal of the shuttering underneath the slab. The slab had to be recast completely.

This incident was the only setback in the race against time (the job had to be completed before the end of the financial year), and the whole of the deck, commenced on the 11th November last, was completed and open for traffic by the end of March.

Rails.

To complete this account of the laying of the R.C. deck, a few remarks on the rails used are necessary.

Because the rails are set within the R.C. deck, renewal of worn out parts must be a difficult and expensive matter.

In order to avoid the necessity of frequent renewals, the switches and crossings were made of Hadfield's "Era" manganese steel, a material which has been used for such parts in tramway systems during the past 30 years.

This steel has a useful life of from seven to ten times that of ordinary rail steel, and the parts made of it should outlast the mild steel rails used on the straight. It is not anticipated that any rail renewals will be necessary within 30 years.

The switches are enclosed in cast steel boxes, which have 2½" drain holes through which water and grit are discharged through the deck into the sea. The switch itself is a pinless tongue which is easily removed for greasing.

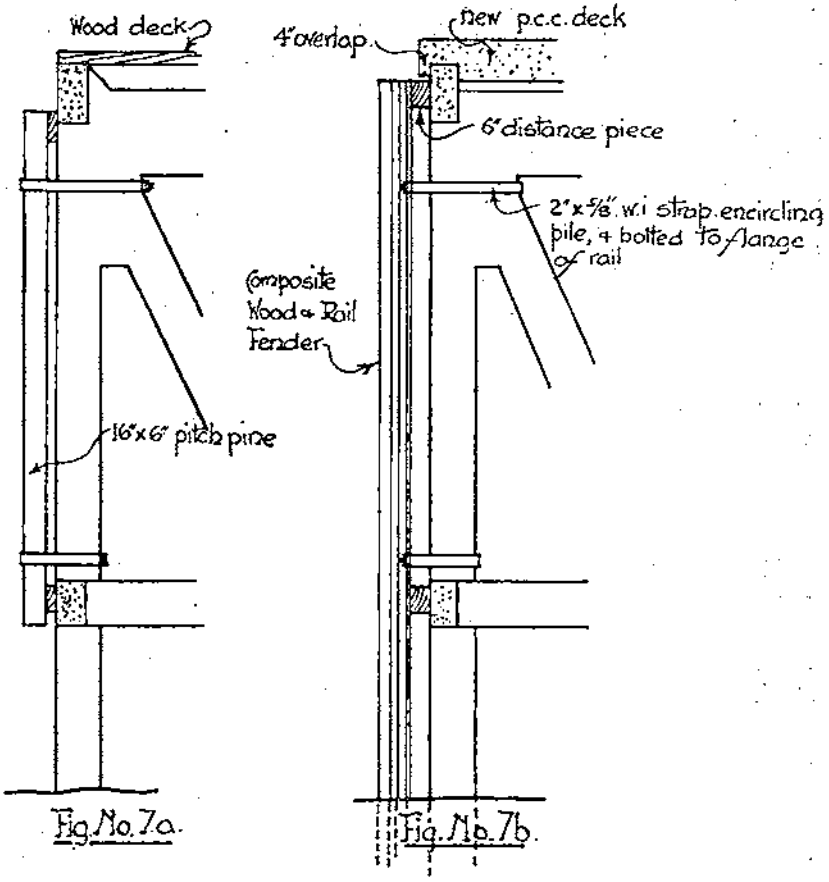
The whole of the rail system was made by Messrs. Hadfields, Ltd., of Sheffield, from measurements given by the R.E. Staff at Shoeburyness. There being no two rails of similar length, because of the odd shapes of the transoms, and it being essential that every joint should have a centre bearing on a transom, great care both in measurement on the job and in fitting of the work was required.

The makers laid out the system at their works and numbered each part, their work being so accurate as to make fitting together on the job a very simple matter.

Fender Piles.

In order to avoid in future the breakage of outside piles by the impact of craft, it was first proposed to erect a heavy triangular-piled dolphin at the two seaward corners of the pier, on which incoming vessels would bump before touching the pier itself.

This raised objections from the master of the principal W.D. vessel using the pier, who said that such dolphins would make the


Wood deck
16"x6" pitch pine
Fig. No. 7a.
4" overlap
new p.c.c. deck
6" distance piece
2"x 5/8" w.i strap encircling pile, & bolted to flange of rail
Composite Wood & Rail Fender
Fig. No. 7b.
Old.
New.
Shoeburyness. Barge Pier.
Fenders.

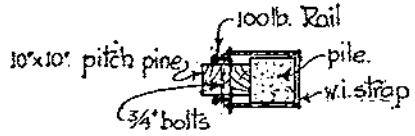

100lb. Rail
10"x10" pitch pine
pile.
w.i. strap
3/4" bolts

Fig. No. 7c.

task of coming alongside very difficult, owing to the set of the current at some stages of the tide.

The temporary expedient of re-using the old 16" x 6" fenders was made, but with the precaution of blocking them out from the faces of the piles by fixing packings behind them at transom and ledger levels. See Fig. 7 (a).

These fenders thus stand 2" clear of the faces of the piles, and soften the blow on the piles to the extent that it is not until a fender has deflected this amount that any effect of the bump is felt by the pile. That this precaution was necessary is shown by the fact that several of these fenders have been broken already.

As these fenders are broken they are being replaced by a pile-cum-fender built up of two 100-lb. rails with a hardwood flitch bolted between them; driven 10' into the beach and packed out from the pile faces in a manner similar to that used when refixing the old elm fenders. See Fig. 7 (b) and 7 (c).

CONCLUSION.

The pier as now reconstructed is capable of carrying loads far in excess of those for which it was originally designed. All the travelling cranes in use on the ranges may be used with safety on the pier. Having, also, a greater thickness of protective concrete over the steel, and that of a much denser quality than the concrete of which it was first built, its probable life is longer than when it was originally built.

The cement gun process has justified itself to a degree greater than was anticipated, and it might well be used more frequently in situations where the use of shuttering or rendering might be difficult, or doubtful in effect.

It is possible that further small patches of flashcoating may show defects, but as it is likely that a cement gun will be purchased for general R.E. work at Shoeburyness and elsewhere, their repair will be an easy matter, though whether the flashcoat is maintained or not, is a matter affecting only the appearance of the pier and not the effectiveness of the repair job.

Shoeburyness. Barge Pier.
Organization

Fig: No: 6.

Scale.

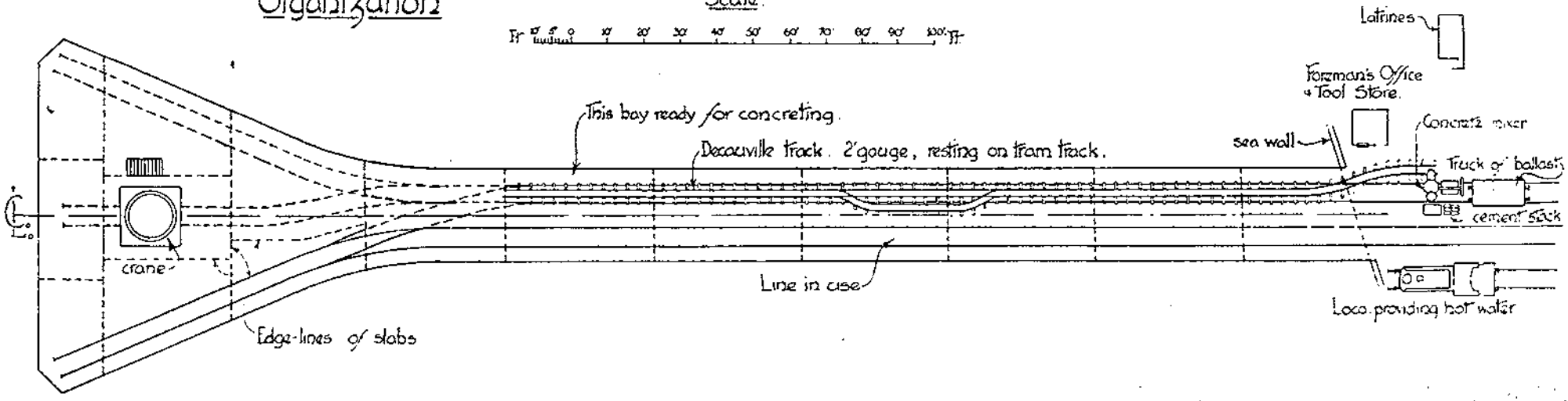


Fig: No: 1a.

Cross Section thro' Head of Pier.

Scale.

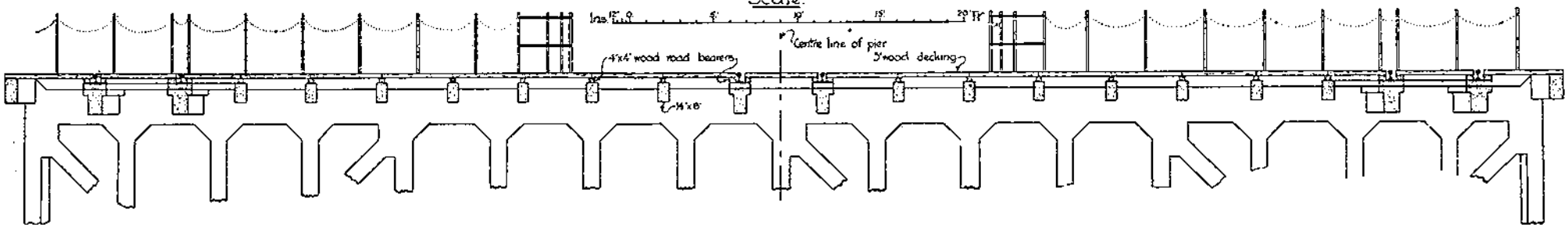
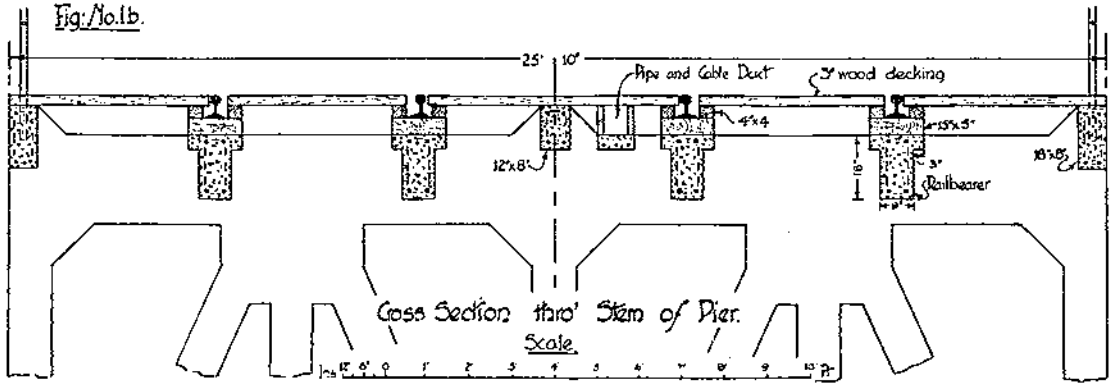


Fig: No: 1b.



Cross Section thro' Stem of Pier.

Scale.

Shoeburyness. Barge Pier.

Sections of Old Timber Decking.

Photo 1.—Cement-gun.

Photo 2.—Photograph showing typical appearance of gunite work.

Photo 3.—Rail-bearers. Concrete bursting by pressure of rusting reinforcing bars.

Photo 4.—Shooting gunite.

Repairs to the barge pier at Shoeburyness 1-4

Photo 5.—Pile Reconstruction.
First Stage.—Pile after broken concrete had been knocked off reinforcing bars by pneumatic hammer.

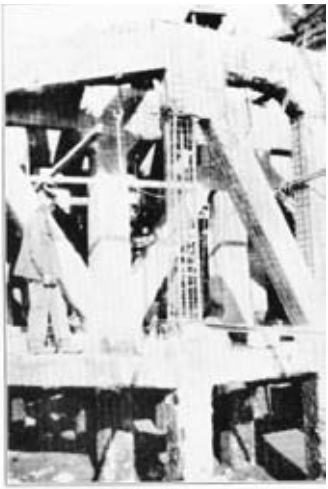


Photo 6.—Pile Reconstruction.
Second Stage.—Pile after mesh had been fixed.

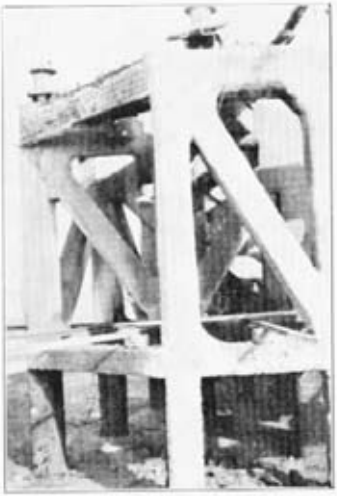


Photo 7.—Pile Reconstruction.
Third Stage.—Pile built up by gunniting.

Photo 8.—Shooting to screeds.

Repairs to the barge pier at Shoeburyness 5-8

Photo 9.—Shooting gunite.

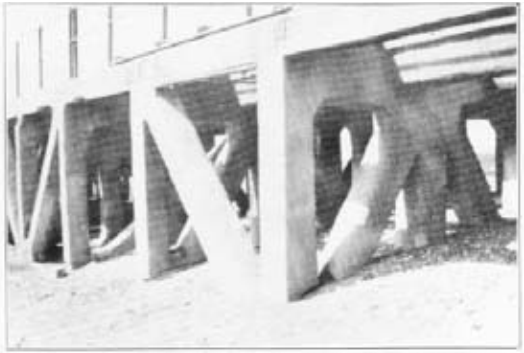
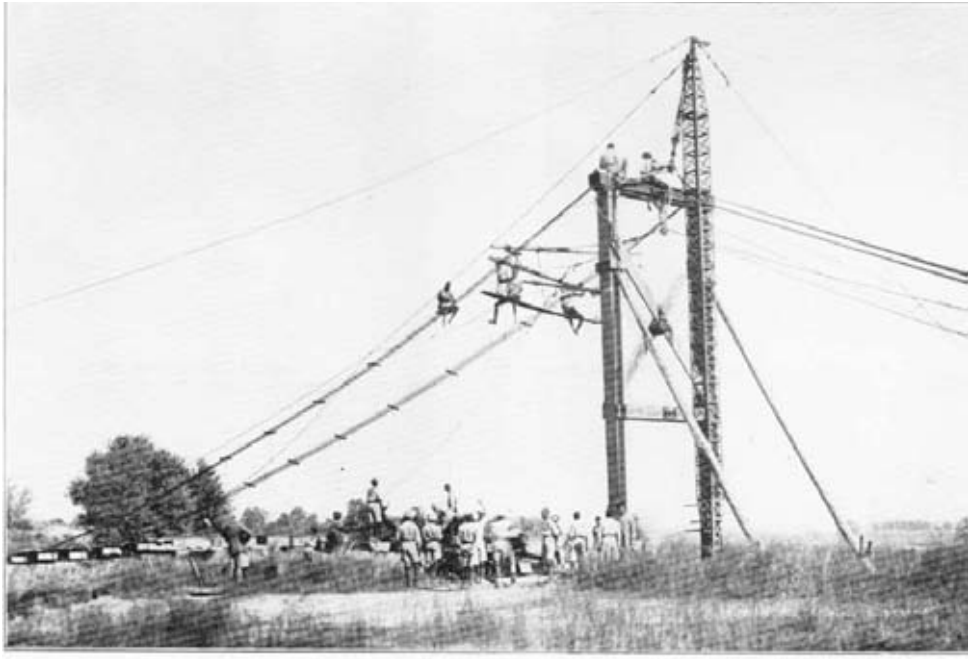


Photo 10.—Finished appearance of outside piles shot to screeds.

Photo 11.—Sea-wall before repair by guniting.

Photo 12.—Sea-wall after guniting.

Repairs to the barge pier at Shoeburyness 9-12.



A 43-ft. derrick in use.

Further notes on the Roorkee pattern steel crib 1

FURTHER NOTES ON THE ROORKEE PATTERN STEEL CRIB.

By LIEUT.-COLONEL G. LE Q. MARTEL, D.S.O., M.C., *p.s.c.*, R.E.

IN September, 1930, an article appeared in *The R.E. Journal* describing the Roorkee pattern steel cribs and their employment. They have now had considerable use and undergone many trials at Roorkee, and the photographs show the component parts and also two of the many types of trestle that can be erected very rapidly with them. The previous article does not appear to have raised very much interest at home—perhaps the idea is too deeply embedded that India can produce no new ideas—nevertheless, there appear to be many possibilities in using light skeleton steelwork for field engineering. The days when trees were cut down on the spot and adzed into 12" x 12" timber for bridge building (and in fact nearly all improvisation methods), are over, and if material must be sent up it is far better and more economical to use light steelwork than heavy timbers; especially in the tropics, where the life of timber is limited by many causes. It is difficult to cut our ideas away from heavy timbers and dogs and spikes, but the fact remains that these ideas are often out of date, and there is no reason why we should not use light skeleton steelwork for field engineering such as we see used every day for constructional work in London.

As regards bridging we now have at home three types of bridge. The light type with folding boats for loads up to 5—6 tons and used mainly for rafting; the medium bridge for 8—9 tons and the heavy bridge up to 16 tons. At one time it seemed as though the heavy bridge would be the main type of bridge for the Army, because, although the whole of the rest of the field army can cross on a medium bridge, the medium tanks were rising from 12 to 16 tons and required a heavy bridge. The trend is now towards lighter machines, and it seems probable that the medium bridge will cover all our requirements, leaving the lighter type of equipment for assaulting troops and weapons; incidentally it might be suggested that light steel boats should be used instead of the plywood folding boats in this equipment, because the latter can hardly be expected to last long in the tropics; a light steel boat would be just as light and handy as a folding boat and there seem to be few military advantages in the latter.

Now the pre-War pontoon equipment was limited to loads of the

5—6 ton category, and with this equipment we used the old Weldon trestle, which served its purpose well. If there was a shortage of pontoons the trestles could be used instead near the banks, and they also served for the construction of tidal ramps. If the river bottom was insecure, one or both legs would sink and the transom could be rapidly adjusted.

After the War we went one step farther and produced the medium steel trestle. The design was not very scientific (I was myself responsible for the main features in the design), but it served its purpose, though in practice the sudden sinking of one leg under load on an insecure footing was disquieting with loads up to 8—9 tons.

The next step was the present heavy trestle, which is an excellent design (carried out mainly by Captain R. D. Davies). Both these steel trestles are intended to be used in much the same way as the Weldon was used in the past, and it is here that it is reasonable to suggest that we may be making an error in principle.

First of all it is very doubtful if a tidal ramp could be constructed with trestles for heavy or even medium loads. The action of the tide causes scour round the legs and the feet of the trestles move and they lean at awkward angles. With the lighter loads this does not matter very much; the transoms can be adjusted, and in any case the additional stresses produced by these lighter loads owing to sudden movements of the trestles are not nearly as serious as with medium or heavy loads.

Provided we have sufficient pontoons for the floating portion of the bridge, the main use for trestles in bridging should be for dry gaps and for the approach down a bank to a point where there is sufficient water to float the pontoons. For dry gaps a height of trestle far in excess of the present design of steel trestle is often needed, and for the approach over rocks or shallow water to the pontoon only a low trestle is usually needed. The present design of steel trestle appears to fall between these two; it is not high enough for many dry gaps and it is unnecessarily high for the approaches over rocks or shallow water to the pontoons.

It is therefore suggested that some design of steel skeleton work such as these steel cribs might be preferable for general use with medium and heavy loads. They can be erected just as quickly, can be built to any height, and provide a secure foundation. If this view was accepted we might then return to a really light and handy steel trestle, built on scientific lines, for the 5—6 ton loads, or largely reduce the weight of the present steel trestle for the 8—9 ton loads.

In addition to being used as trestles and for water towers and other similar purposes, it was suggested in the last article that these steel cribs should make a useful derrick when joined end to end with a special taper section added at each end. This has now been tried

FURTHER EXPERIMENTS IN VIBRO-CONCRETE PILING IN THE NORTH-WEST FRONTIER PROVINCE.

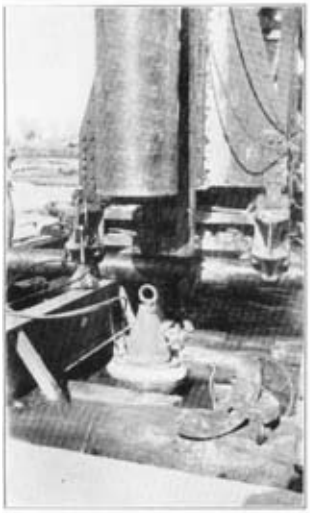


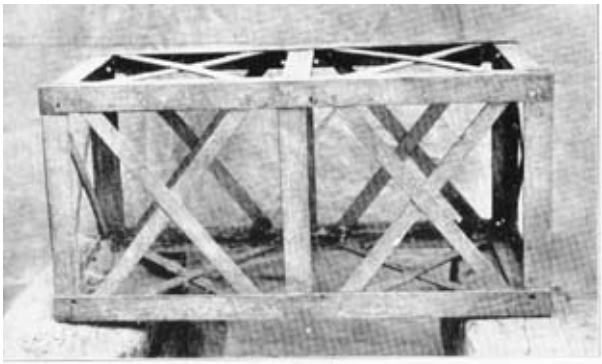
Photo 1.

Photo 2.

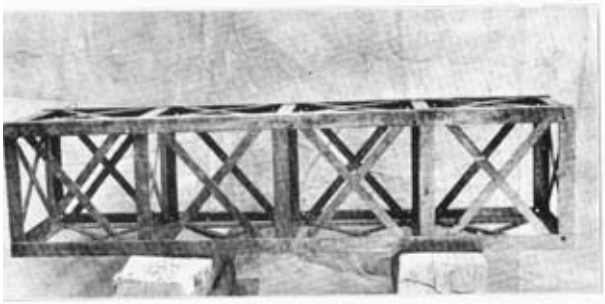
Photo 3.

Photo 4.

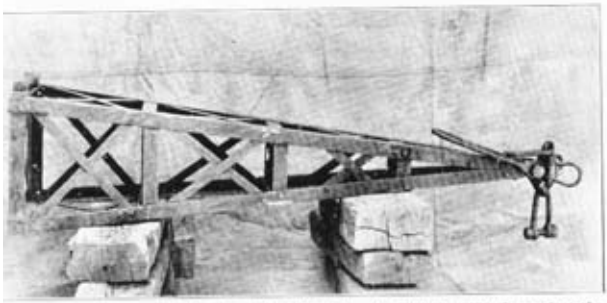
Further experiments in vibro-concrete 1-4.



The 3-ft. crib.



The 6-ft. crib.



he taper section used at the top of the derrick. A similar section is used at the lower end, and stands on a ball mounting.

Further notes on the Roorkee pattern steel crib 2

out by Captain J. C. F. Holland with his company at Roorkee, and I am indebted to him for the photograph, which shows the derrick in action, and the following brief account of the work.

The derrick was used for the erection of a 280-ft. suspension bridge. If more steel cribs had been available they would have been used for the construction of the trestles, as well as for the derrick; as it was, the trestles had to be made of 30-ft. lengths of 15" x 15" timber, groundsills and capsills being of the same material. The derrick consisted of five of the 6-ft. cribs joined end to end with the special taper sections at each end. The photographs show the design of these taper sections. The total length was roughly 43 ft. and the weight 1,400 lb.

Both trestles were erected from the one derrick, which was placed on the centre line of the bridge and 3 ft. from the near trestle. The trestles only weighed 2 tons each, so the derrick was not tested to its maximum safe thrust, which should be about 8 to 10 tons, but even for the stresses produced in this case, if a timber derrick had been used, it would have weighed at least a ton. A long, heavy timber derrick is often very difficult to transport to the site, whereas the steel cribs which weigh less than 200 lb. each can be assembled at the site.

In building such a bridge, a comparison of the transport required for the two types of material is interesting. A total of 32 of the steel cribs can be carried in a three-ton lorry. Of these 30 would be sufficient for the construction of the two trestles, whereas the timber for these trestles would weigh almost twice as much and 15" x 15" timber in 30-ft. lengths needs some special type of transport.

In the construction of this bridge the one prominent fact was the great labour involved in getting to the site the large timbers for the trestles, compared with the ease of transporting and assembling the materials for the derrick.

THE PRINCIPLES OF COMBINED OPERATIONS.

By BRIGADIER W. G. S. DOBBIE, C.B., C.M.G., D.S.O., *p.s.c.*

1. GENERAL REMARKS.

1. In any war in which the Empire may be engaged, in the future as in the past, Sea Power must play a very important part. It is not too much to say that in nearly every case it will be, ultimately at any rate, the decisive factor. In any case, and at all stages, it will be an invaluable weapon, and it would be criminal folly not to make the fullest use of it. But we shall not be able to do so unless we study and master the principles underlying its application.

Frequently in the past victory has attended our arms owing to the fact that we have appreciated the value of sea power more clearly than our enemies have done. But there is, perhaps, nowadays a tendency to suppose that the altered conditions of to-day (*e.g.*, the advent of the Air Arm), have affected the validity of this old-established principle. This fallacious idea constitutes a definite danger and calls for careful study of the subject on the part of all persons concerned with the defence of the Empire.

2. Sea power may be used to our advantage in three ways :—

(*a*) By ensuring the uninterrupted flow of all necessary supplies to the various portions of the Empire.
(*b*) By interrupting the enemy's supplies from overseas.
(*c*) By threatening him or attacking him at any place on his seaboard that we may choose.

3. Combined operations may be necessary to put any of the above into effect. (*a*) and (*b*) may at first sight appear to be matters for the Navy alone, but in reality the Navy cannot carry out its functions without the assistance of the Army, as history has shown over and over again. The Fleet cannot function without safe harbours conveniently situated for the theatre of its operations. The necessary harbours may have to be seized and in any case protected. It is true that in the Great War the Navy in some cases provided their own protection on land, notably at Scapa Flow and St. Helena. But the circumstances then were exceptional, as the Army was so fully employed in the main theatre that it was unable to spare men or material for the defence of these additional harbours. But usually this duty will fall upon the Army, and will in some cases require a

military undertaking of considerable magnitude, involving at the outset a difficult and tricky combined operation.

4. It might also be desired to seize some enemy territory on which to establish an air base within effective range of vital objectives, or, again, to establish a military base with a view to aggressive military action. But for whatever purpose we use our sea power, *i.e.*, whether for subsequent naval, military or air operations, a combined operation of some sort will be necessary, and for this reason the principles should be studied. If we have to confine ourselves to landings at places where we need expect no opposition, our choice will be very much restricted, and we will not turn to best advantage the weapon placed in our hands by our sea power. But if we are prepared to consider landings at any place on the enemy's seaboard, and despite any opposition which may be encountered, we will be using our sea power to the full and will be keeping the enemy guessing, and we will be forcing him to make numerous detachments with all their attendant disadvantages. But such landings are difficult operations of war, and require much previous study before they can be made possible. However, in view of the great strategic advantages which may be gained, the study of this difficult subject is well worth while, and is, indeed, incumbent on all the three Services.

II. The Underlying Principles Governing the Successful Conduct of Combined Operations.

5. If a combined operation (*e.g.*, a landing on enemy coast line) is to have a reasonable chance of success, the element of surprise is all-important. This can only be achieved if the strictest secrecy in preparation is observed and the greatest rapidity in execution is assured by careful and methodical foresight.

As regards secrecy, it is of three kinds :—

(*a*) Secrecy as to the fact that the expedition is contemplated at all.
(*b*) Secrecy as to the proposed place of landing.
(*c*) Secrecy as to the time.

(*a*) is, of course, far the best of the three, but in view of the considerable preparations required is very difficult to attain. But much can be done in this direction if care is taken to prevent irresponsible and light-hearted acts by one or other of the fighting Services.

In the case of the Dardanelles untold harm was done by the original naval attack, which drew the attention of the Turks to the fact that we were much interested in that part of the world. It is, of course, acknowledged that in this case a combined operation was not at that time contemplated. But the fact remains that the naval action infinitely increased the difficulties of the Army when it was

later decided to put it ashore. In those days there were only two independent fighting Services. Now there are three, and this will not render a premature disclosure of our intention any less likely. It points to the necessity of a central authority which will be able to control the action of all three Services, so as to conform to the general plan.

6. Although preparations may not be hid, it is in some cases possible to turn this fact to our advantage, by playing on the enemy's fears and causing them to make detachments, when we have actually no intention of making a landing. Both we and the Germans did this to the other with some success in the War.

We may even go so far, perhaps, as to adopt second degree methods, and to induce the enemy to think that our preparations are so obvious that they are clearly intended to deceive him into imagining that we intend to attack when actually we have no such intention, and so on *ad infinitum*.

7. Secrecy as to place must be insisted on, even when the fact that we propose to effect a landing cannot be hidden. This can be achieved by allowing no attention to be drawn to the place selected by premature reconnaissance by sea or air (unless our warships and aircraft have been regularly operating in the vicinity—in that case their sudden disappearance might rouse the enemy's suspicions), and by making reconnaissances at other places where a landing is not intended. In this connection, the principle should be followed that a secret should only be disclosed to those persons who need to know it, and to no one else. It is, therefore, unnecessary to inform all of those concerned in the reconnaissances above mentioned that their reconnaissance is really a blind. It will be much more realistic if they think it is the real thing and so the more likely to deceive the enemy.

8. Secrecy about the place selected is, however, not always possible to ensure. It will frequently occur that the choice of possible landing places is so restricted that there will be little doubt in the enemy's mind where the landing, if attempted, will be made. As a preliminary to a big military expedition it will obviously have to be within reasonable distance of some organized harbour, which will be required as base for the main force. In such a case secrecy as to the time and date of landing is of absolutely vital importance. The time chosen need not be confided beforehand but to very few.

9. Historical examples illustrative of the above points are not wanting.

At the Dardanelles in the original landing at Anzac and Helles, the secret of the fact, place and time of landing was not preserved, and the great difficulty we had in forcing our way ashore is directly attributable to this cause.

At Suvla, however, the secret was well kept, and the actual landing

presented little or no difficulty. Difficulties occurred later, but were due to entirely different causes.

10. Another essential element for success is forethought.

In view of the necessity of ensuring surprise, and of the speed at which operations once commenced will have to be carried through, it will not be feasible to make elaborate plans on the spot. The plans must, so far as is possible, be thought out beforehand and the probable requirements anticipated. In many respects it is possible to go into greater detail in the plan of a landing operation than in others. The scope of the operation in its initial phase is limited, and particular units have well-defined and comparatively simple tasks to carry out. Forethought can do wonders in this respect, and the learning of its part by each unit can be effected in comfortable conditions, and not under fire.

11. One of the main difficulties in combined operations is that each service is working with and is in a special degree dependent upon the other two Services, whose work, customs and methods are to some extent unfamiliar. This will especially be the case between the Navy and the Army. Normally we each have to do a job which is quite independent of the other Service, but here we are suddenly brought into such intimate contact that we have to carry out one of the most delicate operations of war in the closest co-operation with each other.

Moreover, we are each doing something for which we were not primarily intended. The Navy is organized, designed and trained for fighting warships on blue water. Its very guns and ammunition are by no means ideal for dealing with hostile troops on land, and, although the ships can carry a certain amount of ammunition more suitable for this purpose, yet this will be limited in quantity, as they must always maintain a sufficiency of proper naval ammunition to enable them to carry out their true role against enemy ships. The flat trajectory of the gun, moreover, is a drawback that can hardly be overcome, as was shown in the Dardanelles campaign.

The Army, moreover, is designed to move and have its being on shore. Put it into boats and it is out of its element. A great feeling of helplessness is likely to pervade the military force in these circumstances, to say nothing of sea-sickness.

All this proves that the more each Service can sympathetically understand the possibilities and limitations of the other, the more likely it will be that a good plan will be made; and the more practice each Service can have in the abnormal tasks that will fall to its lot, the higher will be its confidence and its morale when the time comes to put the plan into execution, and the greater the probability of success.

III. THE MAKING OF THE PLAN.

12. It may now be helpful to discuss a landing operation of a particular type, under the following headings :—

(*a*) Plan.
(*b*) Preparation.
(*c*) Execution.

We will imagine that a military expedition of some size has been decided on against a hostile country, and that the approach is to be by sea.

Such an expedition will obviously require an organized port for a base, and the acquisition of such a port will become the first main objective. It may be assumed that the port selected is defended by Coast Artillery and that a direct attack on it from the sea would, even if possible, be costly, difficult and tedious, thus giving the enemy time to mass his troops to resist our attack. It is, therefore, decided to attack and capture the port from the land side and to this end to land a military force of a suitable size at some convenient point on the coast with the object of—

(*a*) Establishing itself ashore.
(*b*) Seizing the port.
(*c*) Enabling the rest of the expedition to land at the port.

13. The choice of the landing place will now be considered.

The military will select a certain locality as being suitable to their needs, *i.e.*,

(*a*) At a suitable distance from the port (not too far and not too near) and with a possible line of approach to it—water supply, etc.
(*b*) Not likely to give the enemy strong positions on which to oppose the landing or delay the subsequent advance on the port.
(*c*) Enemy's positions can be dealt with by guns of supporting ships.
(*d*) Suitable bridgehead positions for the covering force to seize and hold.
(*e*) Place in the area from which our aircraft can operate.

14. The naval staff now consider this locality from the naval point of view, and will decide whether it is feasible in the following respects :—

(*a*) Suitability of beaches—depth of water—currents, etc.
(*b*) The distance the transports will have to lie from the shore.
(*c*) The positions of covering warships.
(*d*) Effect of bad weather, etc., etc.

It may be necessary to modify or even discard the military general proposals, but it will, of course, be understood that the Army being the predominant partner in this case, the other two Services will naturally consider themselves the servants of the Army for the time being, and do their very best to meet the Army's requirements.

15. Having then decided in general terms on the place of landing, the next point to decide is the strength of the landing force.

This will be divided into two parts—

(*a*) The covering force.
(*b*) The remainder.

The former is, of course, the more important of the two, as it may have to land in face of opposition—a difficult and hazardous operation at all times.

The strength of the covering force will depend *inter alia* on :—

(*a*) The expected strength of the enemy.
(*b*) The position it will have to seize and hold as a bridgehead.
(*c*) The length of time it will have to hold this until supported by the remainder of the force.

16. The composition of the force will also have to be decided.

The following are some of the considerations which will dictate the composition :—

(*a*) Cavalry would be most useful for exploiting surprise and seizing important tactical localities inland, but they certainly could not be carried in the first flight, and their transport to the beach and subsequent supply present considerable difficulties.

In fact it may be assumed that with the covering force horses must be reduced to an absolute minimum.

So one can expect at most only a very small force of cavalry with the covering force, and that not with the first flight. The size of the force of cavalry which it will be possible to allot will prevent it being of much use for offensive purposes, and it would therefore be employed for reconnaissance and intercommunication.

(*b*) *Artillery.* Some artillery support can in the first instance be given by the guns of warships, but as the infantry progress inland this will become less and less effective owing to the flat trajectory of the naval guns, and mobile land guns or howitzers will be needed.

If it were not for the difficulty in landing and supplying horses in the initial stages, it is probable that light artillery (3·7" howitzers on pack) would be the most suitable weapon. Failing that, some form of tractor-drawn artillery will probably be the most satisfactory, provided the nature of

the country and the landing facilities admit of it. But it may well be necessary to accept the disadvantages of horses and detail 3·7″ howitzers on pack to the covering force.

(*c*) *Engineers.* A good sized force of this arm will be required for the following purposes—

(a) Communications and removal of obstacles.

(b) Water supply.

(c) Improving landing facilities on the beach. Some should land with the first flight.

(*d*) *Infantry.* The strength depends on the opposition to be expected and the extent of the bridgehead to be secured.

(*e*) *Tanks.* These would be invaluable especially if machine-gun opposition is likely to be encountered at the moment of disembarkation. It is desirable that in these circumstances tanks should be the first to go ashore. But this presupposes a suitable form of lighter to convey the tanks ashore, and this does not exist. There is no doubt that if this difficulty were overcome tanks would be eminently suited to this role. But if this is not possible, they could no doubt be put on shore after the leading troops have cleared the beaches, and would be of the greatest value in later phases, especially if the enemy are likely to produce tanks.

During the War in 1917 this difficulty of landing tanks in the face of opposition was overcome by the Bacon Pontoon (see *R.E. Journal*, June, 1924, page 190), but the circumstances under which it was to be used were very exceptional and not likely to obtain in other landing operations.

(*f*) Supplies and ammunition must be put on shore, and medical arrangements made for dealing with wounded.

(*g*) It might be desirable that cyclists should be landed with the first flight. It must, however, be remembered that it is not every terrain which would suit them. In Gallipoli, for instance, they would have been of no use. Moreover, there are no cyclist units in the British Army now. So that if a cyclist unit were required it would have to be extemporized. But subject to these considerations, in suitable circumstances there is no doubt that they would be of the greatest value and take the place of the cavalry, which are not likely to be available, as we have seen.

(*h*) As regards aircraft, these will have to operate, to start with, from carriers until arrangements can be made for them to come ashore. They obviously cannot land with the covering force.

17. Having decided on the strength and composition of the covering force, it is necessary to consider and decide—

(*a*) the places at which the component parts go ashore, and (*b*) the order in which they go ashore.

The greater the number of landing-places selected for the leading troops the greater the chance of surprise, since the enemy cannot watch everywhere, and an advance from one beach may ease the opposition at another. There is, however, a drawback to the multiplication of the number of landing-places, since it dissipates a force and renders control more difficult. A balance must consequently be held between the two conflicting considerations. It is suggested, however, that it would be wiser to err in favour of the former than of the latter, since the difficulty of control can to some extent be overcome by careful forethought and rehearsal.

The decision as to the place and order of landing of the various units will, of course, affect the way in which the various vessels carrying the landing force from the advanced sea base are loaded. Here naval considerations have to be taken into account, and it may be necessary on account of these to modify the military requirements.

Thus we see that in order to arrive at the number, class and size of the ships to be procured for the expedition, it is necessary to work backwards from the tactical plan for the covering force landing on the enemy's coast.

18. Having settled the details of the covering force, similar, though less complicated considerations will be necessary for the remainder of the subsidiary landing force.

The fighting troops must be landed without any delay as soon as the covering force has established itself ashore. Time is now all-important, since not only will the covering force require support, but the whole force must move as rapidly as possible to seize the port before the enemy can recover from his surprise and bring up his reserves.

In this force it will be necessary to make provision for administrative units and personnel who will be required not only to serve the force advancing on the port but also, when the latter has been seized, to make the necessary preparations for the arrival of the main force.

19. The choice of the time at which the first flight should reach the shore is bound up with many considerations both tactical and naval. The choice lies between—

(*a*) Complete darkness.
(*b*) Dawn.
(*c*) Broad daylight.

In (*a*) and to a lesser extent in (*b*), the approach of the flotilla is less likely to be observed, and the chance of a tactical surprise

correspondingly increased. Further, even if complete surprise is not achieved, the hostile machine-gun fire will probably be less effective. But the naval difficulties in carrying out a landing at this time are very considerable. Without elaborate preliminary preparations (which conditions of secrecy may rule out) it is possible that mistakes may be made and that the troops may not be landed at the places intended. If that should occur considerable confusion and delay would inevitably result.

Landing in daylight, of course, does away with many of the naval difficulties, and the actual process of disembarkation if unopposed is likely to be much quicker.

If there is opposition the covering fire from ships is likely to be more effective against such targets as may be visible. But on the other hand the enemy's observers will give early warning of the approach of the expedition, enabling preparations to be made for its reception. Even if troops cannot be brought up to resist the actual landing they can probably be disposed so as to dispute the subsequent advance, and aircraft may be able to attack the landing force before it is clear of the boats. In other words the advantages of surprise are lost or greatly discounted, and, as has already been pointed out, surprise is the most important condition of success in an enterprise of this nature, and, generally speaking, it is obvious that in spite of some advantages a landing in unobscured daylight will, if opposed, be a very hazardous and costly proceeding and would rarely be justifiable.

Finally, in considering the time of landing, it must be remembered that the state of the tide is a very important factor, since the first flight will probably require to land on the rising tide.

20. The possibility of the use of smoke to cover the landing of the first flight must now be considered. To some extent it can take the place of darkness, and has most of the advantages of the latter without all the disadvantages.

It has, however, certain special drawbacks peculiar to itself. These latter may be enumerated as follows :—

(*a*) It is dependent on the strength and direction of the wind.
(*b*) It can only be maintained for a limited period.

Smoke may be produced by the following means :—

(*a*) Smoke shells.
(*b*) Aeroplanes.
(*c*) Small naval craft.

(*a*) need not be considered as warships do not normally carry smoke shells, and in any case this means is not in the circumstances very convenient, since the positions to be screened may be uncomfortably

close to where the troops will be landing, and the fall of the large naval shells might incommode the troops.

(*b*) Experiments have been carried out with considerable success in dropping smoke screens from aeroplanes. These screens are quickly and accurately laid, are very thick while they last and can be repeated as required.

(*c*) was often carried out in the War for naval purposes, and was quite efficient. It is obvious, however, that they can only be used to cover a landing where there is an on-shore wind. The strength of the wind is also of great importance, as it must neither be too strong nor too weak. Thus the restrictions regarding the use by this means of smoke are considerable, and there can be no certainty that the conditions prevailing will allow the smoke screen to be produced by this means at all.

The formation of the smoke screen by aeroplane is somewhat less dependent on the weather conditions, and that from smoke shell still less again.

If satisfactory arrangements for a smoke screen can be made many of the disadvantages of a daylight landing cease to apply, though it must be noted that the grave drawback of loss of strategical surprise referred to above will still obtain.

21. Special arrangements for anti-aircraft defence must be made in the plan.

The best anti-aircraft defence is by means of aircraft, but it must be realized that the invading aircraft are at first likely to be working at a great disadvantage in comparison with the aircraft on the other side. The former will most likely have to operate from carriers, while the latter enjoy the advantages of a land aerodrome. Even if the attackers have been able to seize an island conveniently situated, the facilities established there can only be of an extemporized order, while if preparations are made beforehand the element of surprise is lost. The chances of having a well-equipped aerodrome within easy operating distance of the point of attack will be remote.

It can be assumed then that the number of aircraft available in the first stage will be strictly limited, and it is probable that this number will be mostly required for reconnaissance purposes and will not be available for fighting.

In any case the amount of protection which our aircraft will be able to afford to the first flight against hostile aircraft will be meagre, and other means of protection will be needed.

22. So far as the military force is concerned, the anti-aircraft problem may be divided into three stages :—

(*a*) When the troops are on board ship.
(*b*) When they are being ferried to the shore.
(*c*) When they are on shore.

(*a*) is the entire responsibility of the Navy, and so, strictly speaking, is (*b*). But this is the time when the danger to the troops is the greatest, and it is desirable that the efforts of the Navy should be supplemented by the troops themselves.

Any air attack against the tows is likely to be delivered from a low height, and the aeroplanes will be within easy small-arm range. Arrangements must be made in consequence for small-arm fire to be instantly forthcoming from the tows in the event of air attack. Anti-aircraft light automatics should be mounted in the tows and operated by military or naval personnel as most convenient, while some of the troops in each boat should be detailed to use their rifles against hostile aircraft. The volume of fire thus generated is bound, at any rate, to affect the accuracy of the hostile attack and is likely to inflict loss on the enemy. It is, moreover, better for men who are being attacked from the air to fire back rather than sit passively hoping they will not be hit.

23. It is realized that in some quarters the effect of an air attack is valued at so high a figure that it is considered that, unless the attacking force has virtual command of the air, a landing in the face of hostile air attack will be impossible. It has been shown that the landing force is most unlikely to enjoy that position, as in the air they will be at a disadvantage to start with. Are we then to assume that the landing cannot be carried out on this account? It is suggested that our answer must be "no." We are getting more and more confidence in our preventive measures, and we must ensure that they will become more efficient still. We must also remember that, if the general plan has been well laid, provision will have been made for mystifying and misleading the enemy, and this will, it is hoped, affect the numbers of aircraft available to resist the actual landing, as well as their employment.

When once the troops have got ashore, they become less and less a target for aircraft. But immediate steps must be taken to protect the beaches from air attack, and, to this end, A.A. light automatics must be set up at convenient places without delay.

24. Of the points to be embodied in the plan we have still to consider the following:—

(*a*) Reserve for the covering force.
(*b*) Intercommunication and position of headquarters.
(*c*) Administrative arrangements.

As regards the reserve, it may either be landed at a pre-arranged place immediately the leading waves have gone ashore, or it may be kept afloat and put ashore at a time and place required by the developing situation. There are pros and cons for each method. The former is simpler. Everyone knows where the reserve is, and

this will probably be the best plan if the chances of serious resistance to the actual landing are not very great.

If the landing-places are mutually cut off from each other, or if the likelihood of a successful landing at all places is slight, it may be preferable to keep the reserve afloat, so that the commander of the covering force may use his reserve to influence a situation which he cannot foresee. But in this case it must be borne in mind that the landing of the reserve may be very difficult. The enemy will have been thoroughly aroused and his artillery and aircraft may be able to inflict much loss on the reserve as it approaches the selected beach. The smoke which perhaps was used to cover the approach of the first flight may no longer be available and altogether the approach to the shore may become a highly unpleasant trip. In any case, it will probably be useless to use the reserve to force a landing at a place where the leading troops have failed to gain a footing ashore.

25. The position of H.Q. for the covering force is to a great extent bound up with that of the reserve, since the two should be adjacent to each other. It is, of course, undesirable that the H.Q. should become involved in a dog fight on the beach, but if it is possible to decide beforehand where and when the H.Q. will be established ashore, the problem of communication is enormously simplified. This problem is at best a remarkably difficult and complex one.

(*a*) The three Services have to be kept in constant and intimate touch.

(*b*) The covering force commander has to be in touch with his subordinates, superiors, and colleagues of the other Services at all times, *i.e.*, whether he or they or some of them are ashore or afloat.

The importance of this matter cannot be too clearly recognized, and it is hardly too much to say that the whole success of the operation may depend on a successful solution of the intercommunication difficulties. However great these difficulties may be, they *must* be overcome.

It is also necessary to provide more than one means of communication, so that if one fails, as is very likely to be the case, touch may still be maintained.

26. Last, but by no means least, there are the administrative problems. Of these, water may be so important as to be almost decisive, as it was at Suvla. The site of a suitable water supply may, in fact, become the chief tactical objective of the covering force.

Then there is the problem of the evacuation of wounded. Are the wounded of the first flight to be sent back in the boats which are required to bring ashore reserves as soon as possible? If so, they are apt to cause delay, when time is precious. If not, special arrangements must be made for their evacuation.

Supplies and ammunition present difficult problems. If for any reason, *e.g.*, change of weather, presence of enemy submarines, etc., the covering force has to be left isolated for a time, reserves of all kinds of foods, water, ammunition, engineer material, medical comforts, etc., must be available for them. These must, therefore, be landed at the earliest moment, so as to make sure that they will be available if required.

IV. THE PREPARATION FOR THE LANDING.

27. So much for the plan. We can now pass on to the preparation.

This will chiefly consist of rehearsing such parts as can be rehearsed, and in making sure that every sub-unit and, indeed, every man, knows what is required of it or him. If it is possible to do so, it is very helpful to make a model of the various beaches, so that the men may see with their eyes their immediate objectives as soon as they have landed. The more this can be done the better, as it will eliminate confusion at a time when that would be most dangerous.

A note of warning, however, must be sounded. This method is excellent if the troops are actually put ashore exactly where they expect to be. But if there is any chance of a mistake occurring owing to darkness, currents, etc., and of the troops not landing where they expected (as occurred in Gallipoli) they must be prepared to act independently of their model practice and deal with the situation as they actually find it. They must, therefore, be taught the principles governing their action as well as the special details.

The preparation of the model, however, may present great difficulties, especially if previous reconnaissance by air or sea is forbidden, and this, as has already been shown, will usually be the case.

28. Then practice in boatwork and in rapid disembarkation is important. It is astonishing how this operation can be speeded up with practice. The naval personnel and the military units who will be associated on the day of landing should carry out their practice together, so that they get to know each other and have confidence in each other.

Practice in intercommunication between the Services must also be arranged, and especially in connection with the direction of the artillery fire of the ships detailed to support the troops ashore. This is an exceptionally difficult matter, but it is of the utmost importance. Instances are not wanting of the most unfortunate results arising out of unsatisfactory communication between the forward troops on shore and the supporting ships, and these instances will, no doubt, recur in the future unless the most meticulous care is taken in the arrangement of intercommunication services.

29. It is not necessary to do more than mention the necessity of organizing the necessary naval and military personnel at the place where the responsibility of the former ends and that of the latter begins. It is perhaps permissible to remind ourselves that the success of the landing largely depends on the harmonious working of the two parties, and everything which will tend to this harmonious working should be done. The longer the personnel of these two parties can have to get to know each other personally before the actual landing, the more likely is their co-operation to be harmonious and effective.

V. The Execution of the Plan.

30. The plan has now been made, the troops have had it explained to them, and they have rehearsed and practised their parts as much as possible. All that can be done beforehand by forethought and care to make the operation a success has been done. It now remains to carry it out.

If one thing in the execution of the plan is more essential than another, it is the determination to succeed coupled with the most vigorous action. These qualities are necessary in any operation of war, but they are superlatively so in the type of operation under review. A study of the operations at Suvla makes this abundantly clear, as the lack of these qualities in some cases deprived us of success.

It is probable that at any rate some degree of surprise will have been achieved if the plan has been well laid. The enemy will, it is hoped, be uncertain where the attack will come, and will consequently not be able to commit his force until he knows. The opposition to start with is likely to be provided only by a screen of observation troops, and this opposition should be overcome without undue difficulty. There will then be a brief respite until the enemy's reserve can be brought into the picture—and it is of vital importance that this respite shall be made full use of. During this period it will be possible, in all probability, to secure tactical features without opposition, which later could only be secured as the result of bitter fighting. The determination to push on regardless of everything and to secure these features without delay must be impressed on all from the top to the bottom. That is the chief requirement.

31. How can this be assured? History shows that there are many difficulties to overcome. The troops are weary, they are disorganized, units are mixed up, they have run out of water, etc., etc. These difficulties can to some extent be met by the care bestowed on the planning and preparation beforehand, but success will be won chiefly by instilling the right spirit into the troops beforehand, and making them understand down to the last private that the success of the operation and their own security depend on their taking full

advantage of the lull that is likely to occur immediately after the landing. Officers and N.C.O.s will be called upon to display the highest qualities of leadership at this time.

32. Having secured the desired tactical localities, immediate steps must be taken to prepare them for defence. Machine-guns must be handled boldly so as to cover the approaches to these places; guns, as soon as ashore, must be posted with the same object, and communication established with the covering warships so that the fire of the latter in support of the troops ashore may be suitably controlled. But equally important is the landing of reserves. These must land practically on the tail of the first flight, provided there are enough boats for the purpose. The presence of an organized and fairly fresh body of troops in the early stages will give an impulse which may be badly needed and will produce results out of all proportion to their strength—and therefore every effort must be made to make them forthcoming when required.

33. It is also important to keep the beaches as clear as possible after the first flight has landed. These beaches are likely to become targets for hostile guns and aircraft, and are thus apt to be decidedly unhealthy. Every boatload when landed must immediately clear the beach.

Some personnel required for handling stores must, of course, stay there, but their numbers should not be increased by a single unnecessary man.

34. As more troops are disembarked, ground should be seized further and further afield, subject, of course, to due consideration for the security of the advanced detachments. The force landing behind the covering force will want elbow room in order to prepare for its own role, *i.e.*, the advance on and the capture of the adjacent hostile port.

The plan for this advance must be made and put into execution as soon as possible. The enemy must be given the minimum of respite in which to organize his defence or prepare a heavy counter-attack. A good deal of the plan can be thought out beforehand, but it cannot be put into final shape until the covering force has got ashore. The positions secured by the covering force, and the ascertained positions, strength and morale of the enemy will, of course, affect the plan.

35. No mention has, so far, been made of the use of gas, but the possibility must not be overlooked that the enemy might see fit to use a persistent form of gas to protect his port by denying certain lines of approach to an invader, or of restricting the number of places where landings could be attempted.

Early information on such a matter would be of vital importance, since such action on the enemy's part would profoundly affect the plan of operation, and in all cases where such a possibility exists, the plan must be capable of adaptation in order to deal with it.

The chief safeguard against this eventuality is obviously secrecy as to our plans. The enemy is not likely to impregnate a large area of his territory with mustard gas—unless he has reason to suppose it will be of real value. Secrecy as to the intention of landing somewhere is, of course, highly desirable, but secrecy as to the actual place of landing is essential.

36. The desirability of appointing a supreme commander for an expedition of this sort, who will control generally the actions of the three Services, has already been hinted at. The question is one of the greatest difficulty, but it is none the less an extremely important one, and one which must be faced. History is full of proofs of the importance of such an appointment, and perhaps the military are more interested in its materialization than the other two Services, since any adverse consequences arising from the lack of a supreme commander usually fall on the Army. Now that there are three Services instead of two, the matter is all the more important.

37. In the foregoing paragraphs an attempt has been made to indicate the factors which influence the preparation of the plan by the responsible authorities. No attempt has been made to enlarge upon these various points, though each must be studied carefully by all who may be concerned in this most difficult operation.

To sum up :—

In a combined operation such as a landing on an enemy's coast, the following are the essential requirements :—

(*a*) One supreme commander.
(*b*) Surprise. Complete if possible, but at any rate partial.
(*c*) A complete and sympathetic understanding between the three Services.
(*d*) Foresight and meticulous care in the preparation of the plan.
(*e*) The utmost dash, vigour and boldness in its execution.
(*f*) The greatest care in all administrative preparations, on which the whole success of the venture may well depend.

THE TRANSATLANTIC VENTURE.

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

THE year 1931 brought forth the first race for small yachts between America and the British Isles. As a result of great labour from the few, and immense goodwill from the whole Corps—though at least one Gunner insisted on subscribing too—*Ilex* managed to take part in this historic venture. Her passage was a good one—almost exactly 21 days—but on handicap she only ran into seventh place out of a field of ten. This seemed little enough reward for the months of preparation, hours of sheet trimming and crystal gazing involved; but seventh in such a crack fleet is a fair success which well bears careful analysis. *Ilex* was, in the event, best British boat; also she came within forty minutes of *Landfall*, the 70-ton favourite, and she beat *Water Gypsy*, both yachts designed specially for the race. She did just as well as the winds permitted her, and they were unkind to all the Gulf Stream voyagers.

The whole venture was remarkable for the way in which it roused enthusiasm both at home and abroad.

The first official statement of the intention to race *Ilex* back from America was made by General Sir Bindon Blood at the Headquarter Mess dinner to the present Master General of the Ordnance; General Sir Aylmer Hunter-Weston gave the crew fund a vigorous clap on the back at the Corps dinner a little later. So that it was soon seen that *Ilex* could be fitted out with the best gear procurable. All serving Sapper officers and all associate members of the Royal Engineer Yacht Club were asked to subscribe to the *Ilex* Atlantic Race Fund; a short letter in the *Supplement* started a Crew Fund. The response was overwhelming. From every Sapper station in the world the replies came rumbling in, until the main fund reached just under £1,000—almost twice the amount appealed for. One associate member, a Territorial Sapper, gave £100 marked, "Not to be scaled down." The foreign stations, who might be thought too far away to be interested, replied to such purpose that the first Indian mail alone brought in over £100! The crew fund, almost entirely through the efforts of retired R.E. officers, rose up to £140 and paid over half the liner fares of the Atlantic crew. Indeed, the principal committee burden in the crew fund lay in writing tactful replies to the many eminent retired Sappers who wrote fierce letters complaining that they had received no appeal for help to either fund.

No official Yacht Club request for crew fund subscriptions was, in fact, ever sent out, as the committee felt that the Corps was doing enough by its golden largesse to the *Ilex* Fund. Retired Sappers, however, thought differently, one of them to the tune of £50.

With such a backing, the Yacht Club committee set heartily to work upon the fitting out. Dennis Hunt had been busy all winter collecting advice from every side, and in the late spring, *Ilex*, auxiliary yawl, went over to Burnham and slowly, painfully slowly, peeled off her cruising kit, emerging from the Crouch at Whitsuntide as *Ilex*, ocean racing cutter, R.E.Y.C., stripped for the fight. It will surprise no yachtsman to hear that, her mind intent upon the Atlantic greybeards, she sat heavily upon Foulness on the way out and stayed there, high and dry, for almost the full twelve hours' range of tide. No doubt she regarded the resulting fines as her own personal gift to this race fund about which she heard so much exciting chatter.

1. The Fitting Out.

The burden of fitting out fell on Dennis Hunt, who was to be skipper during the race, and the two secretaries, Bennett and Francis. They all had to work at top speed from the word "go," and right up to the start of the race at Newport, Rhode Island, the toil of splicing, tackle reeving, carpentry and painting continued.

The main changes carried out on *Ilex* this season were:—

(*a*) *Mizzen discarded.* It never was very useful, and the Trans-Atlantic Race Rules gave no allowance for yawls. A samson post was fitted in place of the mizzen mast, which, in desperate emergency, was to be used for towing a sea anchor astern. Fortunately the sea anchor, a fearsome monster of leather, canvas, and iron, spent a life of ease in the fo'c'sle throughout the race.

(*b*) *Panelling removed from saloon and extra pipe cots installed there.* This settled the old relentless struggle between the man occupying the weather bunk, μ and g.

(*c*) *Squaresail gear and raffees made.* The squareyard, lent by *Jolie Brise*, was arranged to slide up the forestay. The squaresail was made with a removable bonnet on the foot. Raffees are triangular sails which set between squareyard and topmast head. We found very little use for the whole of this gear during the race. When laced together the raffees made an admirable mainmast spinnaker, and we carried them so for two days, hoisted on the jib halliards.

(*d*) *Skylights completely redesigned to take ventilators, and decks recaulked.* This was a great success: we had far more air and less water below than ever before.

(*e*) *Roller reefing gear fitted to mainsail.* This worked perfectly. One wound the handle and shut off the surplus wind.

(*f*) *A host of details, including gear to change jibs and jib topsails from the foredeck.* The final designs worked very well indeed and saved many a wetting. Laurent Giles made out the original design on the Whitsun cruise—a most useful guest to sail with. Extra water tanks were fitted, for *Ilex* had to carry 30 gallons per man.

Dennis Hunt was the moving spirit in most of these changes, and the squaresail was the only disappointment, though in harder weather we might have been very glad of it. He also arranged the victualling so carefully that the Newport bread (and one of Dougal's eggs) was the only food that failed to stand the weather. Meat and bacon were carefully salted down at Southampton, and nearly all other food was put aboard in tins or bottles.

The crew was selected from well-known performers in the ocean races, and most of the original choices were able to come. All the crew had sailed with the skipper in former years. Carter, the paid hand, was held back by a stern voice from the hearth, and so Carington Smith volunteered to cook. This offer was quickly accepted, and we had cooking such as we had never had on board before. Fresh bread appeared almost daily, cooked in a biscuit-tin oven perched upon a gimballed primus stove, and magnificent meals were served throughout the race. At the last moment, H. A. Macdonald was able to come, and so the crew total rose up to eight. This late addition made great rents in the store calculations—it was rather like adding an extra foot to the width in a bridge project—but it made a far better crew for working the ship in any weather.

The final crew was organized, officially and unofficially, as:—

Lieut. D. N. B. Hunt. Skipper, navigator, wireless operator, caterer, and diver.

Our Watch.
- Captain W. G. Fryer. Mate, sails, megaphone man.
- Lieut. M. T. L. Wilkinson. Well-known helmsman, entertainer.
- 2nd-Lieut. T. P. Brown. Bosun, sails.

The Other Watch.
- Lieut. H. A. Macdonald. Mate and ship's band.
- Lieut. H. S. Francis. Chips, plumber, assistant navigator, surgeon, movietone man, and Old Moore.
- Lieut. J. de V. Hunt. Noted helmsman, ship's white mouse, and Young Moore.

Lieut. H. Carington Smith. *Chef*, interpreter, and wireless operator (thoroughly bad).

All were warned to prepare for a cold race, to practise their special trades, and to get their teeth overhauled. Even in May, the skipper was showing signs of the American influence to which he later fell an

easy prey; and the early "Q" orders were full of the rival argot—swell shore gear—don't wear knickers—real rubber pants. We all had monkish duffle coats for use on night watch, and those blue jerseys, which smack so strongly of the sea, for general wear.

Originally, it had been intended to ship *Ilex* from Tilbury, but suddenly this was changed: she was to sail from Southampton on *Berengaria*. Francis and Bennett had a fierce battle to get her ready in time for this unforeseen passage, but at last *Ilex* left the cradle at Upnor for the first stage of her great adventure.

The beat down Channel was unpleasant, and the roller reefing gear came in for much energetic winding. Off the Owers, *Ilex* was hove to for five hours, and the new hollow gaff was strained at the jaws, not, however, too badly for a quick repair at Southampton, where Nicholsons were waiting to put in some high-speed work. Mast, rigging, and ballast had to be removed before hoisting her aboard *Berengaria*.

There was a frantic struggle, and *Ilex* lay at last ready to be hoisted into her newly-made cradle on the liner's foredeck. The huge harbour crane, lifting up to 150 tons, can be hired for £50 an hour; and so *Ilex*, stripped of everything, was brought up to try her luck with *Berengaria's* own crane, guaranteed to lift up to 15 tons. Nervously she came up off the water with the crane man casting an anxious eye on the dial. The hand ran up—10 . . . 15 . . . 18 . . . 19 tons, and stuck at that while *Ilex* came aboard. A good effort. Then on the 13th June, the liner set sail for New York with four Sappers in her state cabins and a narrow white hull on the foredeck. The send-off was a hearty one and various speeches, to which Dennis Hunt replied, marked the occasion. *Ilex* left many friends at Southampton. Mr. C. E. Nicholson, the designer, presented her with a hollow topmast just before she sailed, Ratsey's did all their work for her at cost price, and the Cunard Co. pared down all fares to half size. The *Ilex* crew were well employed on the crossing to America, and made many feet of wrinkles for chafing gear. The skipper took an intensive course on wireless work from the operators on board.

The Stay in America.

Ilex reached New York on June 19th, only 15 days before the start. She landed in the sea with a great splash, and was towed up to Glenwood Landing, 20 miles from New York, for fitting out. There, Dennis Hunt, Francis, Macdonald and T. P. Brown had to labour with the re-rigging and fitting out, for the rest of the crew was still in England. Under a hot sun they finished all this with Fyffe's yard to help. The late arrivals avoided this labour, but one, at least, only at the expense of his manly reputation. An extra lifebelt had to be brought out for *Ilex* and Fryer, bringing this up the gangway as his

personal life preserver, met with many scornful looks from the rest of the passengers, who felt willing to show greater faith in Cunard.

Fryer, John Hunt, and Wilkinson were due to arrive at New York within less than a week before the start of the race. Glenwood Landing is about 150 miles from Newport, Rhode Island. It therefore became necessary for *Ilex* to set sail as soon as these three had joined ship. They were, however, given a quick glance at America, and picked up a few scraps of New World learning: "Flats fixed" is not, it seems, an estate agent's notice, but refers to tire (*sic*) troubles; while at the New York Y.C. a commuter is a fast motor-launch which ferries its master daily between business and pleasure.

Paul Hammond, owner of *Landfall*, had given us the use of his car and chauffeur in New York. This was a great help, and with Wilks, the last to arrive, aboard, we drove away from the docks, determined to show him New York in a morning. We made a great start. One porter addressed Wilks as "Doc," and Fryer scored a "Cap" from a taxi driver, even without wearing his yachting hat. Then, within a minute of leaving the dockside, we passed a dead horse lying unattended in the middle of a wide road. America, wild and raw, we felt. And we were still looking at it, when, with a deafening crash, we hit a lorry just by Wilks' head. We bounced off and went on. This, we thought, was giving Wilks very good value for his short morning in New York, and looked out of the windows for some further American thrill, hoping that, perhaps, the skipper, long since steeped in the spirit of the country, might have turned up to complete the show—for by this time he had taken to a speckled Panama and patent leather shoes. But we looked in vain. Some hasty shopping, and a drive down Broadway, completed our tour, and, bound for the *Ilex*, we crossed over to Long Island. We were doing a comfortable fifty past desolate car cemeteries, when a notice, "Parkway Drive. $1 entrance," supported by a wooden bar across the road, came in sight. Filled with the wild west spirit, Jack, the chauffeur, merely crowded on another ten m.p.h.; and only as we reached the bar did the keeper whip it back in hasty recognition of our season ticket. We shot away at a nimble seventy for the rest of Parkway Drive, for this, it seems, is a road specially built for speeding.

At Glenwood Landing, we saw a strange white cutter, square-yard aloft, moored in the sparkling inlet. The sun was hot, and we rowed aboard with leisurely strokes; Maurice Chandler, an American friend of the skipper's, came with us to do a little piloting up Long Island Sound. There was much stowing to be done, and it was not until 4 p.m. that we cast off from our buoy and beat slowly down the inlet to the skirl of Dougal's bagpipes. It was the most pleasant of starts: gentle breeze, hot sun, fair tide. Green parkland stretched down to the water's edge, with, here and there, stately country houses

cooling themselves in the shade of tall clustering trees. Here live some of the Four Hundred, and already the returning commuters were dashing by with angry buzzes. We turned up the Sound for Newport, but scarcely made more than four knots. New York still showed up on the clear horizon as a grey mass of tall rectangles.

Slowly night came down and we hugged the Long Island shore to keep clear of the night steamer traffic. It was a still moonlight night with only a faint off-shore ripple to keep us moving. Dawn came on a clear sky, and we spent a gentle day struggling with the spinnaker, and fumbling with the squaresail. A motor-boat, *Foto*, came up and trained cameras at us from all angles. " The eyes of the Press," our pilot told us ; and the news immediately made us all act like stage sailormen. It was soon clear that Newport (R.I.) was a long time ahead of us, and we made for New London to drop the pilot who, it seemed, was due to argue a case on the morrow. We reached the mouth of the River Thames by tea-time and ran up to the anchorage with a fair wind, pursued by two motor-boats vying for our custom at the yachts stores ashore. The Harvard–Yale boat race is rowed on the Thames at New London, but there were only a few steam-yachts moored off the city when we dropped anchor there. We slept soundly, turning in early, for the tide was due to ebb at 4.30 a.m. Dougal woke up in time, and we made sail in the lightest of airs well before sun-up. It was a matter of floating down tide ; and we floated into a nearby steam-yacht almost as soon as our anchor came aboard. Its bowsprit, indeed, with an excess of *gaucherie*, was nosing its way into our rigging in a most determined fashion, until T.P. rushed nimbly up the shrouds and beat it off from there. After this all went well, and we slipped out into the Sound, passing the curious red brick villa, built in the middle of the estuary, which seems to do coastguard duty there. The wind freshened as the day grew older, and we were soon heeling well over, beating through the race for Newport. As we cleared the Sound, larger rollers came in, it grew colder, and the skipper came up to test the jib gear in the fresh breeze. This worked fairly well and we all practised setting jib from the foredeck. Narragansett Bay and Rhode Island turned up ahead in the late afternoon, and, trying our new duffle coats, we finally made the Newport Harbour entrance well after dark. Tea was dismal, puffed wheat figuring as the chief item. Even Brother John, steering gloomily in the gentle rain, had shown no interest in it after the first handful had blown away so surprisingly. He was, no doubt, still brooding on his recent wetting during jib practice. We groped our way to a berth in the harbour close to *Landfall*, discernible in the blackness with the aid of our Aldis lamp.

Thursday, July 2nd, was a clear sunny morning, and the crew was early on deck, bathing and gossiping. They saw a large land-locked

harbour, dotted about with all kinds of yachts lying comfortably to their moorings in the sparkling water. Near at hand, the low shore gave straight on to the rolling green lawns of some famous villas. Most of the other ocean racers could be seen: *Landfall*, *Dorade*, *Mistress*, *Skäl*, *Water Gypsy*, *Amber Jack II*, bulging with wrinkles, and *Highland Light*, with her odd bumpkin frame. The Ida Lewis Yacht Club, named after the Grace Darling of the States, was well within hail, and motor-launches ran past us busily on their way to the huge harbour. One of them stopped alongside to pay a call, giving us an opening hail of, "Colonel Hunt aboard?" We brought out all the Hunts we had, and found that we were being hailed by George Roosevelt with an offer of his launch whenever we wanted it. The splicing gangs set to work after breakfast, sitting about the deck feeling rather overclad in a pair of shorts. A shore party did some quick dressing, hoisted Flag N, and waited. As arranged, over came the motor-launch from *Mistress*, and away shot our shore party at a rich speed, lolling back in the stern sheets like commuters. Carington Smith joined *Ilex* from Canada that evening, complete with bread machine, and the crew was now complete.

The official race dinner was brought off on Thursday night. The Mayor of Newport, in a speech, gave out his gossip about *Ilex*—"An Old Timer, they tell me, handed down among the Royal Engineers from generation to generation." Drink was provided.

Friday was another scorching day, and the splicing gangs were again hard at it. In the afternoon, most of our crew went to an "At Home" on the *Aloha*, a superb barque owned by Mr. Arthur Curtiss James, Commodore of the New York Yacht Club. Most of the ocean racers were there: *Landfall's* crew turned up in red Arcachon trousers and blue coats, and spent much of their time clambering up the tall masts. The papers reported this party as: "The crew of the British entry *Ilex*, were to be seen from afar swarming along the upper yards clad in their picturesque uniforms of double-breasted blue coats and red trousers (they are all officers of the Royal Engineers regiment)." The Sapper Foreign Legion at play, no doubt!

THE START.

A few odd fireworks heralded the morning of the race—Independence Day. We felt that perhaps a few black rockets should be a Briton's gift to the gaiety. By 10 a.m. *Ilex* had got rid of all "swell shore gear," was full up with fresh water, and still stowing the fresh food. Somehow it all got packed away, and by 10.30 a.m., with movietones and cameras clicking on all sides, we made sail. There was some mist and a faint easterly breeze, but our friend *Mother Goose* gave us a tow out to the start. A few good luck telegrams came aboard just before we left—one from the Royal Canadian Engineers. The race

was due to start at noon, and all the starters were cruising within reach of Brenton Reef Light Vessel, which marked one end of the starting line. A huge fleet of small yachts collected to see us start, for the mist was slowly clearing. There were two unofficial starters: *Wander Bird*, too big to enter, and *Ahto*, too small. We sailed alongside *Landfall*, and Paul Hammond threw over a pair of "red Arcachon pants" for Dennis Hunt; we flung back a fairy godmother wand, but it splashed into the water.

The ten-minute gun went, and we hauled up the long hoist jib topsail in stops. There was a faint easterly breeze with a longswell, which made *Aloha*, the 300-ton barque, roll ponderously along in the midst of the fleet of sightseers. We felt it a little hard that we should have to start such a long race with a light headwind, but hoped that it would favour the cutters. Everything was ready, sun shining, ship loaded down with food and water, and general gaiety aboard. "Bang!" went the starting gun, at 1 p.m. Eastern Summer Time. We had made a bad start, gathering way very slowly in the light air; and we crossed the line just after *Landfall*, last but one. We were very well up to windward of the fleet, but the lee end of the line seemed nearer England, and so we were little benefited by this. *Landfall* and *Highland Light* drew away ahead and soon disappeared in the haze. *Dorade* seemed to be keeping rather to the north, but the rest of the fleet was obviously bound for the Nantucket Light Vessel. *Ilex* did not get going very well, and was feeling the absence of her jackyarder, left in England as being too expensive on handicap. Just for a moment it seemed as if we might have difficulty in defeating the fleet of keen spectators sailing out to sea beside us, and comfortably to windward: it looked as if we might suffer the indignity of the fireman, hurrying to the clang of the village fire bell, and unable to outdistance his attendant swarm of small boys, keen observers of his brave outfit. But we did some careful sheet trimming and started hauling up on *Amber Jack*, the long handicap yacht. The wind veered a point, and we set the yankee jib and the balloon staysail. By lunch-time, we broke up into watches and settled down to ocean race routine, breaking the seals on our drink lockers to mark the occasion. *Amber Jack* was now close ahead; and when the skipper showed them a bottle of whisky, they broke off an attempt to luff us and made signals of pleasure. A good throw sent our present aboard, and we went on. *Mother Goose* came up to say good-bye, and we threw another bottle into the eager baskets held out over the bulwarks. She hooted a final farewell and turned back for America. *Aloha* passed on her return journey flying the signal T.D.L., "Wishing you a pleasant voyage." Then at last we were left alone with the racing fleet, doing a gentle three knots on a warm calm sea. Three into three thousand seemed to give 40 days. We all looked anxious when Herby spilt some water from the deck breakers.

THE RACE.

Although loaded down with gear and stores, *Ilex* had been very carefully trimmed to keep weight out of the bows. The deck amidships was crowded with gear. The dinghy held two crates of fruit, and covered the anchor lashed on deck below it. Then there were four canvas breakers—very tender passengers—holding Macdonald's extra water supply, and a clutter of spars, spare topmast, spinnaker boom, squareyard. The food was hidden in the bilges and the sail locker, keeping the heavy weights as low down as possible. Sails were kept forrard.

The great circle from Newport, Rhode Island, to the Scillies goes so far north as to pass through Newfoundland, and it had been the original intention of the skipper to go by Cape Race and the shortest route. The currents off Newfoundland are, however, not favourable, and wind charts show that a southerly route should find better winds. The Gulf Stream, too, flows at anything from five to forty miles a day. Former races and the fastest sailing ship passages have been won by taking the Gulf Stream route. In addition, icebergs and heavy fog discourage sailing around Cape Race. For these reasons, all the racers but *Dorade* took the Gulf Stream route, and ran in calm weather for most of the first week. It would have been too much of a gamble for *Ilex* to go by Cape Race. In the event, *Dorade* crossed in 17 days, and beat all comers by three days: she was just as likely to have lost by the same amount. And so we kept with the fleet and went by the Gulf Stream, changing to a great circle course when it was taking us too far out of our way. *Atlantic* won the race to Keil in 1904 on very much the same route as *Ilex* took.

July 4th. The afternoon of the start found the fleet making for Nantucket Light Vessel with a light S.W. breeze blowing them along with all their reaching canvas set. At dusk we were doing five knots and catching up *Maitenes* and *Skäl*. *Amber Jack* fell behind very slowly. It was easy sailing without much sail changing to do. The watch on deck did a great deal of bag o' wrinkle making, and fixed up chafing gear. During the whole of the race we kept Norwegian watches, and found them much pleasanter, as they give far fewer changes. Watches were changed at midnight, 4 a.m., 8 a.m., 1 p.m. and 7 p.m. After nightfall it grew calmer still.

July 5th. Light fog came down just after midnight, and with scarcely any steerage way we could do little but listen to the distant motors of rum runners. Once the moonlight showed us *Amber Jack* sailing back home, for in that feeble air it scarcely mattered which way the vessel pointed. *Maitenes* was within five cables of us most of the night. The morning watch worked hard in the mist with spinnaker and balloon jib, and when the mist lifted at six o'clock, *Maitenes* and *Amber Jack* were well astern, with *Wander Bird* abeam.

A light northerly wind kept heading us throughout the day, and from mid-day onwards we were close hauled; but *Maitenes* pulled up, and by noon was a mile up to windward. She passed close beside us and took a chronometer check from us, shouted across the calm sea. The wireless set (two-valve) lent us by Marconi's, was working well, and we easily heard the time signal from Rugby (Eng.). By 3 p.m. Nantucket Light Vessel was on the port beam, distant 5 miles, with *Maitenes* close beside it. *Amber Jack* and *Wander Bird* were astern. We logged 81 miles at noon—not a promising day's run.

At the close of a sunny afternoon the wind veered, and we replaced the yankee with the longhoist jib topsail once more. It was a dark calm night, and the helmsman, bent forward peering intently into the binnacle, looked like an old-time crystal gazer.—"I see a rich blue ship scudding along . . . red trousers . . . *Landfall.*"

Some Mother Carey's chickens kept chirruping at the deck watch from the gloom behind the main sheet. The wind veered more and we went about on to the starboard tack, when, suddenly, among the chirruping we heard a hoarse cough. The Aldis lamp picked up *Maitenes* close up to windward on the other tack. There was no time for side lights—we were saving our paraffin and so, no doubt, was she—and we shone the lamp on our sails to show which way we were heading. *Maitenes* crossed thirty yards astern of us in the blackness, and we shouted a good night: it was to be a crowded ocean after all, it seemed.

Monday, July 6th. Fog came up with the moon, and in the dim light an unknown cutter crossed ahead. We sailed all day close hauled on the starboard tack, losing on *Maitenes*, who had to pick up a great deal of ground lost during the early morning. The noon log gave us a day's run of 124 miles, and the sea temperature went up from 59° F to 61° F. A high noon sun sight worked out at Lat. 40° 15′ N.—our farthest south in the race. At sunset the wind died away to a light free breeze, and the stars came out for our best night at sea.

Tuesday, July 7th. A late moon rose in a clear sky to find *Ilex* doing a silent five knots over a smooth sea. The middle watch felt pleasantly warm and a bucket of sea water gave 69° F! The cry, "Gulf Stream," went up, and we all lay back to watch it do its work. Before breakfast the sea was up to 77° F, and even the cook came up, pale and sleepy, to feel it. We expected great things from the Gulf Stream. In 1928 *Pinta* took forty miles in 24 hours from it! Some of us would have shown no surprise had *Ilex* been flung about, like a canoe in the rapids, by the eager current; and one helmsman who reported seeing flocks of parrots was almost believed. Tropical, this Gulf Stream. The longhoist was sagging, and Handy Billy was brought up from the sail locker to deal with it; but a second attempt by Wilks alone beat Handy Billy to such purpose that the chain tail on the halliard broke a link and let the whole sail down.

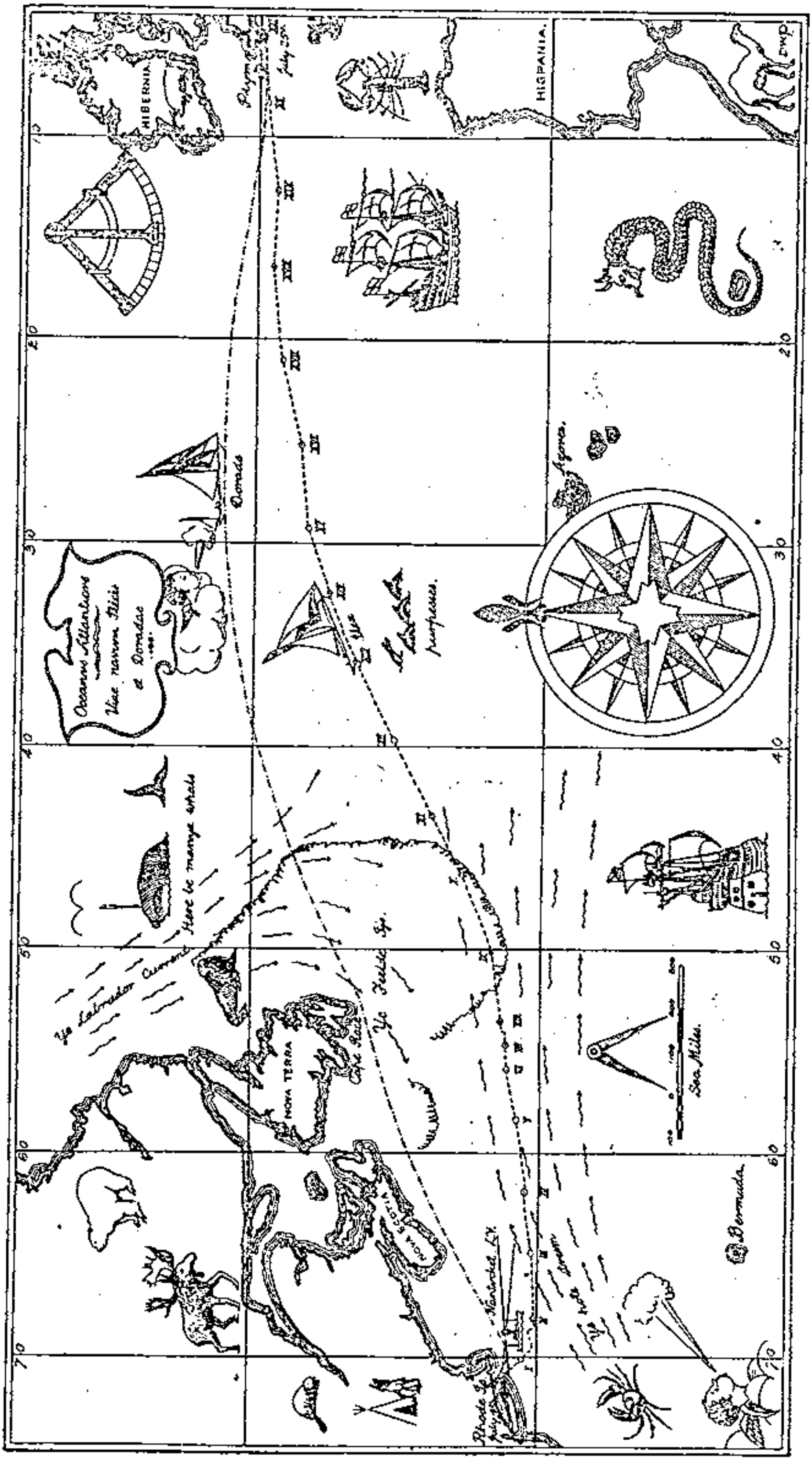
We did about six knots most of the day in a really hot sun. Fryer lost the canvas bucket overboard in a washing palaver on the fore-deck, but, after some nimble sewing and carpentry, another rose up to take its place. Long rollers were coming in from the open sea, which was fairly steep for such a gentle breeze.

The day's run was 140 miles, and the skipper's evening sight gave us a boost of only seven miles from the Stream. An ugly dark sky came up at sunset to offset the effects of the superb dinner the cook had produced, and by 9 p.m. the longhoist had been down and up again.

Wednesday, July 8th. A dark, gloomy night of light wind and drizzle turned into a rainy, squally dawn. The long hoist came down for the first squall and by 6 a.m. the jib-headed topsail had been up and down three times. Indeed, by the time we had set it, it was nearly always time to wrench it down. This was so annoying, that we left it up for what looked like a less active squall then piling up to windward. Down came the rain and wind in fiercer gusts than ever before. We luffed up *Ilex* for the worst, which were really quite nasty, blowing hard with drenching rain and raising a steep, uneasy sea. But we kept up the jib header through it all, and, as the wind steadied down to a hard breeze, bore away and then ran up the medium jib topsail.

Ilex fairly pounded along. The watch below sent up a message that the ship seemed to be sinking fast; but on deck, when the sun came out soon after breakfast, it was very pleasant. With so much sail up and a fairly high beam sea running, *Ilex* took aboard some large samples, and the thermal navigation experts got quite good readings in the scuppers (74°F). Everyone felt that this was the first chance of forcing the pace we had had, and that we must take it. The skipper saw a flying-fish this morning, and Portuguese men-of-war, mauve and pink, were to be seen on all sides. Typical Gulf Stream weather, we felt, but it was very little fun in the watch below. The motion was very unfriendly, and from this day onwards we used the word "beads" to describe a keen desire for fresh air, accompanied by a pallid brow glistening with beads of sweat. However, Neptune be thanked, we managed to last out the race without the motion claiming anything more deadly than beads; though washing-up in the lively fo'c'sle was sometimes a great trial. Herby seemed to be quite unaffected by the weather and turned out exciting meals whatever seas were running. He came up and did a little steering after tea, and the breeze, which had died down to longhoist strength, brought up some merry little squalls. We were getting much better at gauging these now, and managed to leave up the longhoist for most of them. The day's run came to 144 miles.

After dinner, the squalls blew harder and it grew blacker up to windward. After running off for several, we handed the longhoist


HIBERNIA
HISPANIA
NOVA TERRA
NOVA SCOTIA
Dorade
Azores
Sea Miles
Bermuda
Ye Labrador Current
Here be manye whales

at dusk. We did eight knots for the first time and it was beautifully warm. By 10 p.m. the squalls were quite fierce, with heavy rain and brilliant phosphorescent displays. In the intervals of struggling with the tiller and sheets, the deck watch put in some very fine bathing in the warm rain. The ship was dashing ahead quite fast when the waves would permit her, and only the watch below felt that *Ilex* was overdoing it. The crashing and shouting was slightly lessened by wearing ear plugs of cotton wool, but sleeping was uphill work.

Thursday, July 9th. The middle watch came on deck in the midst of a squall. *Ilex* was dashing ahead into pitch blackness with rain beating down and lee rail awash. Every now and then we hit a sea, but nothing really big came aboard. The squalls were too violent for the topsail, however, and we handed it when they showed no signs of abating. For six hours of that night we met half-hourly rain squalls, and as soon as one had left us, we could see another up-to windward, getting ready to pounce down upon us. *Ilex* averaged just under eight knots throughout that night, and by noon had logged 176 miles more. By 3 a.m. we could see up to windward a clear sky, and were able to laugh at the black squalls still passing across our stern. The jib header went aloft at breakfast time, and with the sun coming out just after, we set the baby jib topsail, which brought up the speed to eight knots once more, though *Ilex* heeled well over under it. After lunch we put on the ship's clock one hour, and Francis, as ship's doctor, opened the surgery, which was soon full of panel patients suffering from sunburn and cooking scalds. The wind was falling lighter and after tea the medium took the place of the baby jib topsail. It fell lighter still and the balloon jib went up. An evening sight on the pole star put our latitude up to 41° 4′ N. The crew was in superb form, feeling that *Ilex* had got the most out of the recent blow; and few of us envied the carpet snakes who must have been putting in such good work at the R.E. Ball on this evening.

Friday, July 10th. Just after midnight the wind died right away to a faint following calm. We set the spinnaker and just kept steerage way. At dawn *Ilex* did quite 30 yards astern, and so we started beating with the balloon jib, main, and jib header. The morning watch set a new record by doing 1·1 miles in four hours of hard sail-trimming. Weird phosphorescent fish could be seen below *Ilex* in the first light; and we were marvelling at a large, spotted snake which was to be seen swimming and twisting beneath us, when the skipper came up and dived in for the first bathe of the race. We told him of our natural history notes when he came out, but it seemed to disturb him little. We also saw several luminous eyeballs, and what seemed to be floating false teeth. After breakfast, a faint ripple ruffled the glassy sea, and for most of the day we went

ahead at two knots with light reaching sails set—balloon jib and staysail with jib header and main. At 10 a.m., with much excitement, we spotted a funnel on the horizon. It came nearer and turned out to be an American cargo steamer, *Annington City*. She came near enough for us to exchange shouts, promised to report us, and told us that a large white two-masted yacht was about 50 miles ahead. We took this to be *Landfall* seen in a half-light. It was stiflingly hot all day, and bare feet met with a rough welcome from the deck. White hats and dark glasses, recent purchases in the States, were standard wear, with Wilks adding tone to the vessel with his rich Panama (reduced to seven bucks as the man despaired of finding another head to fit it). The U.S. liner *President Harding*, eastward bound, came up just before lunch, promised to report, and gave us the news that she had passed no other yachts. A wag on the liner added, " You're last," to explain this news.

The afternoon seemed to be hotter still, with little change of the faint southerly air. We held a victrola concert on the foredeck. General bathing at tea-time, followed by spinnaker drill in variety after dinner, ended a slack day. It was a clear starlit night with what Young Moore assured us were typical doldrum clouds in the distance. He may have been right for even Dougal's pipes failed to fetch a breeze. The log gave us a run of only 90 miles up to noon.

Saturday, July 11th. A week out, another hot calm day, with bathing as the great attraction. A nautilus was drifting close to the ship, and the skipper swam out to play with it. These things sting, it seems ; and this one stung well, forcing a wild howl from the skipper at his first touch, and causing much merriment aboard. Bathing was the only diversion of the afternoon and we all dived right under *Ilex* as she barely kept steerage way. Once the skipper made a stealthy attempt to seize two gulls which were asleep on the water about fifty yards away, but they woke up whenever he swam near. The night wind was fluky, and a look-out with a torch sat on the foredeck to watch the sails. The day's run was 59 miles. The whole week had only netted 815 miles and we were still west of Cape Race !

SECOND WEEK.

Sunday, July 12th. T.P.'s birthday and another day of glassy calm. The night had been oppressive; and the watch below, stretched out on the saloon bunks, bearded and almost naked, looked like early Christians asleep in the catacombs. Several times we went below to light the candles and laugh at their archaic appearance. The skylights were folded back and, when daylight came, the morning watch passed a merry couple of hours waking up the crew by prodding with a pole from on deck. Even Herby, a persistent sleeper and the first to be called, got up in five minutes under this treatment. But

the morning watch, 4 to 8, was always quite pleasant. Watch began only just before first light, so that dawn and sunrise filled up the first two hours, and rid one of the earnest crystal gazing which fell to the earlier middle watch. From six onwards there was the excitement of rousing the cook and seeing the vessel slowly waking up. Indeed the rousing of Herby was far more the opening of day for the watch on deck than any sunrise, and one watched the clock with great care to see that this important function was not delayed a minute. To-day we piled up T.P.'s pillow—he was getting an extra watch below on account of the lack of wind and his birthday—with a gay mixture of oranges, sweets, and seaweed, as a birthday gift from his friends on watch.

The balloon jib was up most of the morning; but, with a fresh wind after lunch, we found that it was upsetting the flow of air behind the main. A change to the yankee put on over a knot, although the wind was still light and only slightly ahead of the beam. This was one of the many times when a speed log would have made our judgment more certain. For close-hauled work in really calm weather the balloon jib and balloon staysail, when carefully sheeted, gave by far the best results; but a breath stronger than a light air upset them completely, and we had to return to the longhoist at once.

A Spanish steamer, *Manuel Arnus*, came close to us at mid-day swarming with passengers, and taking a heavy list as she passed, every deck crammed with white faces. We flew the usual signal asking her to report us, and waved a blue ensign.

It was a dismal day's bag—42 miles on the log; but we felt that any ship out of the Gulf Stream must be far worse off in such calm weather. Even so, we only got a push of about nine miles from the current that day. Sea temperature 72°F. It was odd that the watch below spent all their spare moments reading books on sailing about this time. One cannot, it seems, get too much of it.

Monday, July 13th. A fresh, southerly breeze blew all night and we made seven knots on a calm sea with a late moon lighting up the gloomy middle watch. The day's run came to 146 miles plus an extra 18 from the Gulf Stream, and the sea water fell to 69°F. Lunch was a cheerful meal to celebrate the end of the first 1,000 miles. Herby was doing some marvellous cooking, and it was no surprise when Wilks was seen to have a wild nightmare while we were still washing up the breakfast things. To-day we turned up on the great circle course for the Scillies, in search of some brave westerlies.

Tuesday, July 14th. After some headsail drill during the night, varied by idle flashing of the torch into the depths to watch the resulting phosphorescent glow all around, a light following breeze came up at dawn and we set the spinnaker. A large school of whales passed close beside us and the rearguard gave a great leap out of the water

for our benefit: the rest steamed lazily westwards in two columns line ahead, puffing out spray at regular intervals. We were still in the Gulf Stream (72°F was taken at noon), and for the next two days all the bad weather came up from the lee quarter. This was a great surprise, but it was so, and whenever a black cloud gathered there we got ready for squall drill. Squall drill works like this: (i) Black cloud gathers down to leeward: cries for soap from the deck watch: (ii) First drops arrive with increase of wind: wild undressing and flinging of clothes and dark glasses down the hatch: (iii) Warm, heavy rain falls: energetic washing with much scrambling for the mainsail, and dinghy cover, pools of fresh water: (iv) Dark cloud moves up to windward: energetic drying and cries for shorts, hats and glasses. The wind first played this odd trick at change of watch, and the new watch was actually persuaded to hunt out oilies after an anxious glance at the black mass up to windward. Day's run, 154 miles. Stream boost of 15 miles.

Wednesday, July 15th. The middle watch had to gybe ship as the wind backed, and the morning watch had to hand the spinnaker when the wind backed still more. All day there were odd rain squalls from the lee with short sunny weather sandwiched between them. Chips seized his moment to varnish most of the deckwork, and *Ilex* was soon untouchable aft; he himself, bearded, burnt a dark brown, and clad in the shortest of linen pants, looked very like an untouchable, too, as he sat down at his work. A large school of dolphins—we saw ten in the air at once—came and played around the ship. Day's run, 140 miles. Stream boost, 18 miles. Sea temperature, 66°F. Clock went on an hour.

The south-west wind was steadily blowing up and at nightfall we set the medium jib topsail and 1st jib in place of the balloon jib. To-day we saw our last flying-fish.

Thursday, July 16th. During the night it blew still stronger and as a result of some hard work on the helm John Hunt took the hourly record with 8·9 knots just after midnight. After that we handed the jib header and still did 8·4 knots in a bigger sea. At dawn the rising wind and sea forced us to hand the jib topsail and roll down one reef as the sea was getting confused. The roller reefing gear worked perfectly and saved us much time on the old method. Although we were by no means dead before the breeze, the seas often threw *Ilex* round almost to gybing point and made the helmsman heave all he knew on the tiller to bring her back. It was a welcome dawn, for the blend of black night and rough seas put crystal gazing out of count and the helmsman had to steer by watching the sails, feeling the motion, and anticipating each wild rush up to windward, relying for direction upon the compass readings chanted out to him by another hand.

The worst rain squall came down upon *Ilex* just before breakfast,

and for a time she was surging about so fiercely as to be out of control. Careering down its front like an expert surf-rider, *Ilex* rode ahead on every wave, getting faster and faster until at last the wave passed her and she sank back into the trough to await the next. In one startling burst of speed, Wilks managed to beat one wave; but it came on again grander than ever and left us behind like the rest. We put in another quick reef for this squall to give the helmsman more control; but as soon as the new watch took over they managed to shake out all reefs and even hoisted the squaresail, too! This was a great moment; but, with full main and squaresail, *Ilex* only made 7·7 knots. We wanted much more wind to make the squaresail worth while and all day the wind grew lighter.

After lunch, topsail and raffees went aloft, and the skipper set the baby jib topsail tight to the mainmast head to stop the heavy roll. By tea time the spinnaker was clearly due and so we regretfully hauled the squareyard down the forestay and packed it away, never again to be used. A very lumpy sea kept on dipping both booms, until at nightfall a slight change of wind raised the cry of "Down spinnaker," and we reset the balloon jib. We were clear of the Gulf Stream now, having logged another 175 miles on our great circle course. It had been an energetic twenty-four hours, but it had brought us over the half-way mark and we were well clear of the Grand Banks. It was just as we were reeling off the magic 1,500th mile on the log that we saw a dead shark wallowing in the troubled water like the mid-Atlantic mark buoy we had almost been expecting. Francis, energetic as ever, spent most of his spare time to-day doing camera man as *Ilex* put forth some of her more dashing surf riding. There followed a dismal night of fog with crystal gazing as the only distraction for watch on deck.

Friday, July 17th, to Monday, July 20th. For the next four days we saw nothing but fog and grey haze all around. It was great circle sailing as most of us imagined it—fog, long, high seas—but the brave westerlies were not with us at any time and we never got more than strong following winds. Day runs were 153, 126, 179 and 154 miles. It was all monotonous, unexciting, weary work. Each day was like the last, grey and dull with a long, high sea running. At times we gybed, and for a long time we ran with the raffees, laced together, set as a mainmast spinnaker; for quite often it was too strong a breeze for the large spinnaker. One morning, just after dawn, the skipper came up to try to set the large spinnaker, with the result that he and Wilks were very nearly pulled off the bows as they hung on to the sheet. At last they hauled it in, but *Ilex* merely stood on end and seemed to be going much slower than before. The night fog was so thick that a look-out had to sit up in the bows, watching the bowsprit driving ahead into the dense greyness. The helmsman could see nothing but a dark, eerie edge of fog close around and, just

below, the unending swirl aft of the restless sea. There was no horizon, no sky; and the ship seemed to be gliding and wallowing down an eternal hill of dreams to some dark port of limbo far below.

By day it was better. There was usually more sheet trimming to do, though there was little applause when the daily task of "changing the nips" fell due. Herby was excelling himself at cooking. Fresh bread appeared daily, wonderful stuff made in his special bread machine and cooked over a primus, in an oven knocked together by Chips (one night watch) out of an old biscuit tin. One evening we heard Big Ben, and on Saturday we changed the binnacle to give the crystal gazers a better light. The 2,000 mark we celebrated with a victrola concert, listening in to 10,000 Old Elks marching past at Seattle, and some caviare. There were many delicacies of this kind on board, but it was long before the sleepers connected up the restless teeth of the deck watch with those stealthy movements below decks, which seemed so much a part of *Ilex's* night life.

The secret was let out to Wilks, who slept next to the food lockers, and heard a dim figure whispering in a disappointed tone, "What! Only two slabs in a tin!" For no food is out of place to the well-known gourmands who make up night watches; and chocolate, bullseyes, rum, ginger snaps, barley sugar and sandwiches all meet with the same ravenous reception. We now had enough spare water to give up the rugged practice of cleaning teeth in sea water.

On Monday night, with much relief, we saw the moon.

Tuesday, July 21st. At last the grey days had gone, for it was a bright, starry morning with brilliant phosphorescence and dolphins frolicking about the bows. The wind freshened throughout the day and the keen record-holders began to look worried, for the wind was a point abaft the beam and it seemed certain that we should notch at least nine knots. Sail was slowly reduced, but only when *Ilex* was obviously overpowered. By noon both T.P. and Wilks had beaten John Hunt's record of 8·9 knots, Wilks having a 9·15 and T.P. a 9. But it blew stronger still, and after lunch, although the yankee had been replaced by the baby jib topsail and 1st jib, John Hunt again notched another 9·15 to make him equal top. *Ilex* was now surging along with each wave at the bravest pace, shooting off spray the whole way down the lee rail and swinging the boom into the water in a crescendo of excitement. The watch on deck was so occupied with the surging, and wondering how long the topmast would stand it, that the cook, popping out of the forehatch, was the first to see a large liner dead astern. It turned out to be the *Olympic* and she agreed to report us. The sea grew fiercer every hour, but so did the wind; and at nightfall, under jib, balloon staysail, and main, Wilks notched the record—a dashing 9·3 knots. We tried to keep her going at that for another hour, but the seas,

grown up to roaring greybeards, came aboard; and at 10 p.m. we rolled down two reefs and handed the balloon staysail, having averaged over nine knots since noon. It was rough and wet the whole night long, the pronounced heel and the crashing of waves on deck bringing cotton wool once more into play for the watch below. *Ilex* had every reason for three reefs, but all night she was kept hard at it, though sometimes she charged into waves that shook her from end to end. The day's run was 177 miles.

Wednesday, July 22nd. The wind slackened off very slowly, and kept the watches busy crowding on sail. The sea was still very high, and the dolphins were amusing themselves by waiting until a greybeard had reared up to break and then jumping out of the vertical green water wall just before it crashed down. Two squalls came up at mid-day, making us hand the spinnaker, and twice we gybed; but dinner was the real event of the day. Though long, lumpy seas were running, Herby gave us our best ocean racing meal.

MENU.

Cocktails and Canape Caviare.
Grapefruit.
Chicken Soup.
Roast Chicken and Asparagus.
Corn on the Cob.
Omelette au Rhum.
Coffee and Port.

The day's run was 202 miles, noon to noon, our record since we have had her.

Thursday, July 23rd. A fluky, fresh wind kept us all night at work on the spinnaker and sheets. All booms were lazy guyed, with vangs set up fore and aft to hold the gaff; so that any wind change called for a great deal of trimming. The forenoon watch held a sail stopping and stitching bee which brought the canvas up to date. We heard this evening that *Landfall* and *Highland Light* had just finished. There was a quick rush at the chart and we found that we could beat *Landfall* by averaging 7·5 knots. At the time we were doing six, but the barometer was falling and so we made out a score card. By 11 p.m. we were doing eight knots and going up fast on bogey. The keen sail-trimmers were hard at work letting out inches here and taking them in there. At sunset we passed through a fleet of French trawlers working on the 100-fathom line, and seized the chance to air some strident French. At the end of such a long passage it was quite exciting for the crew to see some rough proof that the skipper had not, after all, missed Europe altogether. Day's run, 145 miles.

Friday, July 24th. A tantalizing day. The south-west wind blew fresher still, and the barometer kept tumbling down all through the

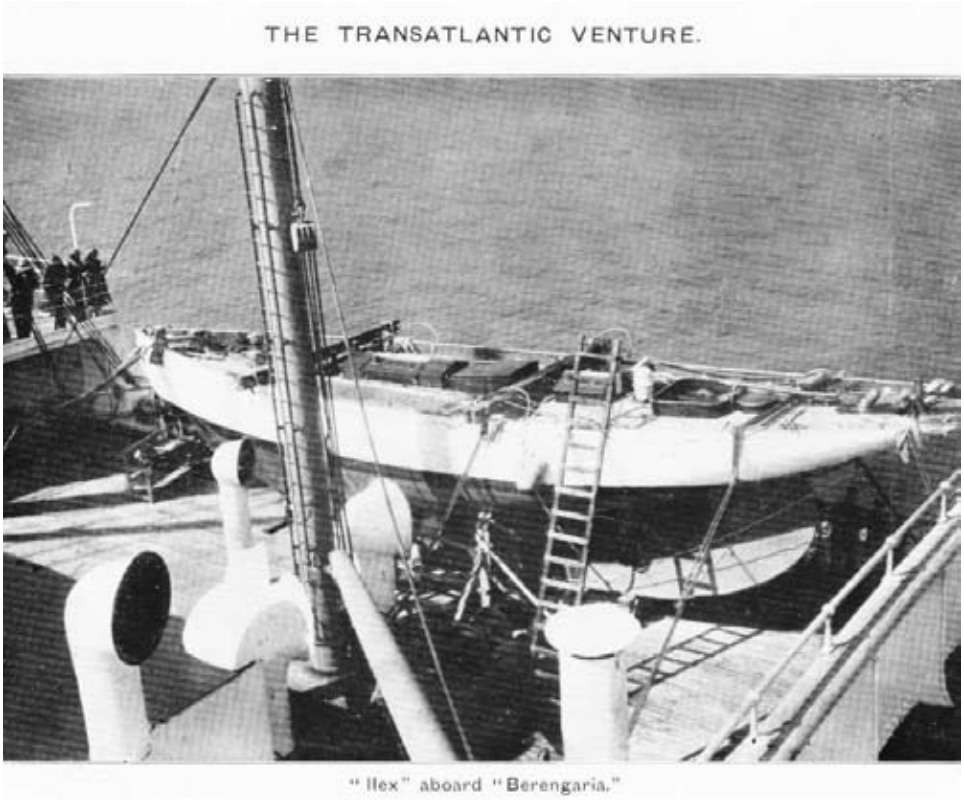
dark hours. There seemed every chance of beating *Landfall*, and each fresh drop of the glass was greeted with the heartiest applause. Our speed crept up and up, and at daybreak we were doing 9·1 knots under all reaching canvas. Thick, black clouds hurried past overhead, but the seas were not yet either steep or breaking. Only a long, ponderous swell, borne of the whole broad Atlantic piling up against the mainland shelf, sent us surging ahead in grand bursts of speed. At breakfast time we were 8½ miles up on bogey, and seemed to have a chance of second prize. But the wind now began to misbehave, backing and blowing up until we were doing 9·2 knots under plain sail at a heel that kept the lee rigging screws foaming through the water like submarine periscopes. Green seas came aboard—we caught a large garfish in the lee scuppers—and at last we could hold it no more without reefing. At noon we rolled in 1½ reefs, but soon followed that up by snugging down to 2nd jib, staysail, and fully reefed main; for it was now blowing a gale which persisted for the whole six hours of the afternoon watch. Slowly our speed sank down and by 3 p.m. we could not hold our course, as the steep and breaking beam seas sometimes swept right across the deck, heeling her over to a fantastic angle. The deck watch lay under the lee of the dinghy to avoid the drenching rain and spray, cursing the luck which brought us such weather when we were hoping to make our landfall. Visibility was down to under half a mile, and here we were driving down upon the Scillies with nothing but dead reckoning to guide us for the past twenty-four hours. Had we been just a little further ahead we could have run before the wind at great pace without fear of bumping the Scillies. As it was, we had to make a great deal of easting by fighting the ever-increasing beam sea. The skipper invented a nervous method of doing this with success; though once, Fryer, sitting low down in the cockpit, suddenly vanished from view beneath a keen greybeard which came aboard on the quarter and almost floated him out. The drill was to turn *Ilex* up to a reaching course and hold her there while she gathered speed and fairly bounded along. The seas were big and she could sometimes hold such a course for nearly a hundred yards. But soon a monstrous greybeard would come roaring along to put an end to such impertinence, forcing the helmsman to run her off before the menace. Once or twice we held the reach too long and the resulting crash made the watch below quite sure the ship must be going down. Cooking was quite impossible, and Herby came on deck to give his oilies an airing and watch the fun. The jib handling gear worked very well and we changed headsails from the foredeck without any difficulty in the worst of it. On a foul afternoon like this it is still the little discomforts which annoy the most, and we all grew infuriated with the unceasing downpour and the high-pitched howl of the wind in the rigging. The gale reached its full strength as the afternoon watch

came on deck, and blew throughout the watch. At 7 p.m. it stopped suddenly, as if cut off by a knife; and *Ilex* was left a-wallowing in the heavy sea, flinging about the new watch as they strove to pile on more canvas.

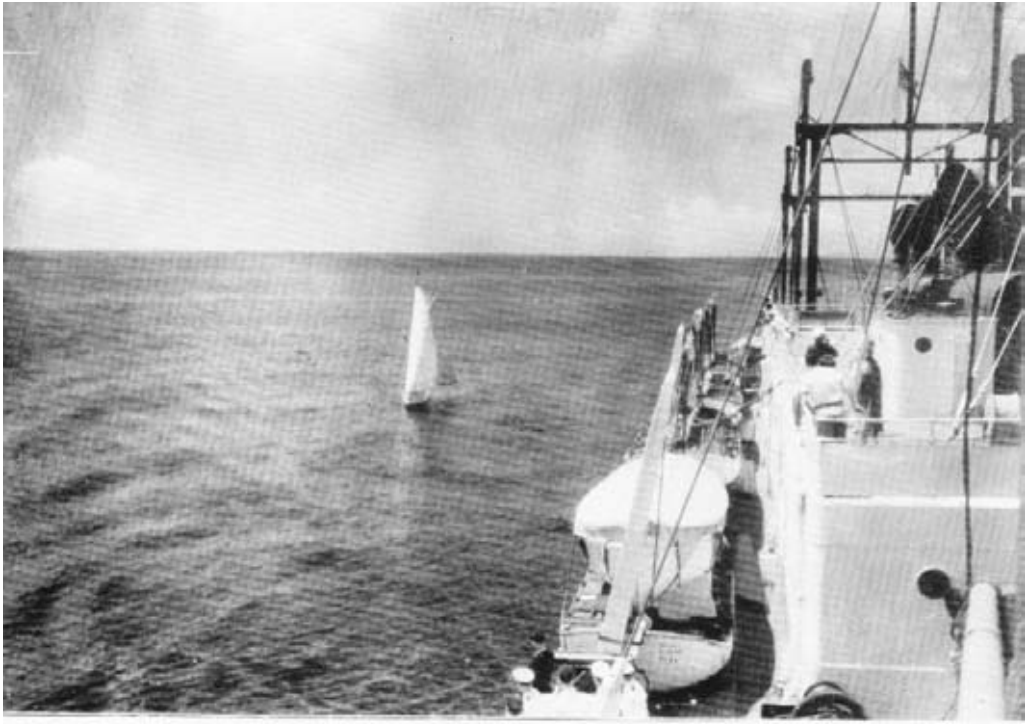
At dusk John Hunt viewed the Bishops Light on the port beam exactly where the skipper had been expecting it. We also heard that *Dorade* had won the race, and our spirits fell. In addition we were fast losing on bogey owing to lack of wind. Day's run, 185 miles.

Saturday, July 25th. Soon after midnight we gybed to run nearer to the Lizard, which was looming up on the port bow. In the light breeze, dark and drizzle, this was no easy matter, especially as the balloon jib had wound itself round the stay so tightly as to be immovable. The seas were very lumpy and we suffered many winch bites as we staggered about the decks carrying out the gybe. Even at 5 a.m. we could still have beaten *Landfall* by doing 8½ knots; but the wind refused to play, and we came up to Plymouth breakwater at less than eight to lose on bogey by 44 minutes. We crossed the finishing line at noon just 3 weeks and 25 seconds after the starting gun at Newport R.I. We saw that there were many of the racing fleet already at anchor before us; only *Amber Jack, Lismore* and *Maitenes* seemed to be missing. *Lismore* had lost a topmast. *Maitenes* came in next day, too late to beat us on handicap, but carrying off the special prize for the longest day's run. *Amber Jack* arrived in time to take third prize, and we saved our time on *Water Gypsy* to get seventh in a very close finish. In a field of thoroughbreds, on the course she took, it was the best *Ilex* could do. Corrected finishing times:—

				H.	M.	S.
Dorade ..	.. Mr. W. Stephens	.. July	19th	19	46	6
Skäl ..	.. Mr. P. L. Rhodes	.. ,,	23rd	1	30	47
Amber Jack	.. Mr. P. D. Rust	.. ,,	23rd	2	31	31
Mistress ..	.. Mr. G. E. Roosevelt	.. ,,	23rd	7	27	29
Highland Light	.. Mr. Dudley Woolfe	.. ,,	23rd	9	40	–
Landfall ..	.. Mr. Paul Hammond	.. ,,	23rd	16	2	19
Ilex ..	.. R.E.Y.C. ..	.. ,,	23rd	16	46	24
Water Gypsy	.. Mr. W. MacMillan	.. ,,	23rd	17	19	28
Maitenes II.	.. Lieut. W. B. Luard	.. ,,	23rd	23	36	9
Lismore ..	.. Mr. W. Roos ..	.. ,,	27th	3	23	4

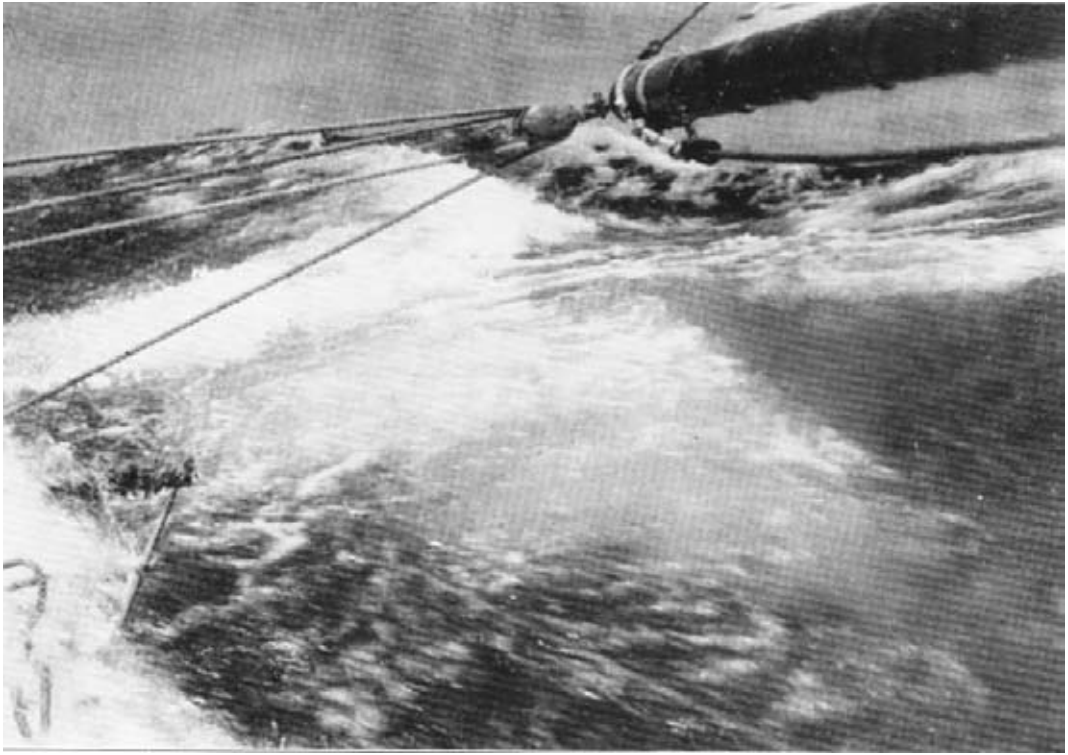


Ilex aboard Berengaria.



"Ilex" five days out in the Gulf Stream, passing liner.

Ilex five days out in the Gulf Stream.



Surging along, lee rail awash.

The skipper trying for a nine.

One on the foredeck: ten days out.

One on the foredeck ten days out.

*FURTHER EXPERIMENTS IN VIBRO-CONCRETE PILING IN THE NORTH-WEST FRONTIER PROVINCE.**

By COLONEL C. H. HASWELL, C.I.E.

DURING the last six months, experiments have been carried out to endeavour to find a method of driving a vibro-concrete pile through running water.

For those who do not understand the vibro-concrete piling system, the principle is briefly as follows:—A hollow steel tube, 16 inch internal diameter, to the end of which is fixed a removable cast-iron shoe, is driven into the ground to the required depth by means of a steam hammer and the latest form of pile-driving machinery. The hollow steel tube is then filled with steel reinforcement and cement concrete, links are fitted to lugs on the outside of the steel tube, the action of the hammer is reversed, and the tube withdrawn.

The automatic action of the hammer withdraws the tube 1½ inches and hits it back one inch, thus vibrating and at the same time ramming the concrete into the place where the tube was. The C.I. shoe is left behind. By this means, a green reinforced concrete pile is left in the ground which will take a load up to 60 tons, according to the set of the tube.

This form of pile can be put into ground through which no pre-cast pile could be driven, owing to the very heavy blow against which the steel tube will stand up.

This method is safe for dry or waterlogged ground or for dry river beds, but is useless where water is flowing in the river beds.

Where the water is shallow, artificial islands can be made by means of a ring of boulders in wire crates and river silt, and the pile driven through the island.

But there are occasions when islands cannot be formed, and the method now adopted and the experiments which have led up to this method and enabled a vibro-concrete pile to be driven through 10 ft. of water running with a velocity of 12 ft. per second, will now be explained.

The first requirement was some form of casing which could be driven into the river bed into which the concrete could be rammed on the withdrawal of the tube, and which would protect the green concrete from running water until it had properly set. A thin sheet-steel circular casing with stakes attached to it was first tried without

* See *R.E. Journal*, September, 1930, page 468, for previous article.

success, as the steel casing could not be driven into the boulder river bed without buckling, and could not be kept steady or vertical.

Captain M. R. Jefferis, M.C., R.E., worked at various ideas for some months, and eventually invented the ring shoe, which has been patented. The original idea has now been elaborated and has resulted in complete success.

It is now possible to increase the diameter of the 16-inch pile up to 24 inches at any point below ground according to the length of casing used.

The advantages of this are :—

(i) The pile is given extra strength just where it is required at nullah bed level.
(ii) The pile cast *in situ* can be moulded through running water.
(iii) A cast-iron or steel casing can be provided for the upper portion of the pile, protecting it against wear by erosion and giving it any additional strength required with absolute surety.

The results achieved have been worked up to by definite steps, and it is interesting to see how experiments have led to improvements, until the final method has been adopted as standard.

When putting a cast *in situ* pile through running water, the first necessity is to have some form of casing to hold up the concrete and protect it from the water.

The first attempt to drive a thin sheet-steel casing failed for three reasons :—

(i) It could not be driven into a boulder bed because the bottom of the thin sheets buckled.
(ii) The withdrawal of the tube pulled out the casing.
(iii) It let the water through and washed out the concrete.

It was necessary to form a hole into which the casing could be driven deep enough to withstand the withdrawal of the tube and firm enough to allow the ramming of the concrete.

This led to the invention of the ring shoe.

The ring shoe is a hollow cast-iron ring shaped thus :

of which the inside diameter is the same as the outside diameter of the main pile shoe, and the outside diameter about one inch greater than the diameter of the sheet-steel casing.

By means of this cast-iron ring a hole is made in the ground of larger diameter than the casing, and the casing follows the shoe down.

The ordinary pile shoe and the ring shoe are driven by means of a cast-iron driving ring which sits on both shoes and takes them down together.

When the ring shoe is down to the required depth, the tube is withdrawn and the driving ring removed by a cable attached to the ring in the centre. The vibro tube is replaced through the ring shoe on to the ordinary pile shoe, which is then driven on to the extreme depth of the tube.

The diagram on page 680 shows the parts used very clearly.

To make sure that the casing goes down correctly a wooden centring frame is used, which fits between the vibro tube and the steel casing. This is used during the whole of the operations, being removed when the driving ring is extracted and being replaced before the lower shoe is driven on past the ring shoe.

A great many piles have been driven with sheet-steel casings, but there were some failures, and the results were not always satisfactory for the following reasons, which have now been overcome :—

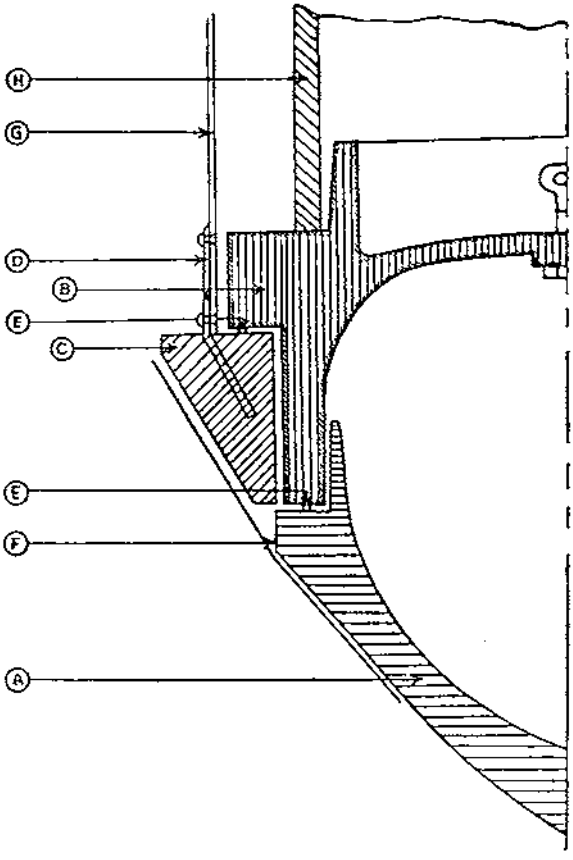
(i) The casings being of thin sheet-steel were apt to get misshapen.
(ii) Some casings pulled out of the ring shoe due to the cold short in the casting.
(iii) The limitations of the thin sheet-steel of which the casings are made are that they will deteriorate rapidly in water and cannot be considered to give protection to the concrete against erosion or extra strength to the concrete at the junction of the solid and the moving river bed.
(iv) Though light from the point of view of transport they are very easily damaged by rough handling.

In order to prevent distortion and to add weight to help the driving, the British Steel Piling Company produced a solid-drawn steel tube which could fit on the outside of the thin steel casing, and which could be withdrawn after the concrete was rammed in the casing, but this was not satisfactory.

The problem was now solved and at the Nagoman Bridge (*Photo* 10) five ring shoe piles with 16-ft. casings were driven through 7 feet of water, flowing at about 12 ft. per second, 3 feet of boulders in rope crates, and 5 feet of solid boulder bed. These conditions may be taken as the worst obtainable, but with the methods adopted by Captain Jefferis, no great difficulties were experienced. One pile failed owing to the ring shoe breaking up, due to faulty casting, but another pile was driven alongside.

The thin steel casings were not quite satisfactory for the reason that, though they gave a certain amount of protection to the concrete against erosion, they did not add any strength to the pile, and the life of the steel in water was so very limited.

Cast-iron casings would be preferable, being heavier, having



A. The ordinary cast-iron shoe pile.

B. The driving ring. This is fitted with a hook to enable it to be withdrawn. The internal diameter of the lower skirt is slightly less than that of the drawn-steel vibro tube, so as to ensure that the tube when lowered through the ring shoe will find the lower shoe accurately centred.

C. The ring shoe. This is of cast-iron and is weaker than the lower shoe. It is therefore hit with a half blow of the hammer where possible, as it may break under a full blow.

D. Ring 4¼ inches deep of 3/16-inch sheet-steel, burnt into the ring shoe when cast. To this is attached the sheet-steel casing.

E. Soft copper rings made up of 3/8-inch bar wrapped with hemp and placed between the driving ring, the ring shoe, and the pile shoe. This helps to make the joint waterproof and softens the blow of the hammer.

F. Lower cone made of 1/16-inch sheet iron. This is packed with bitumen between the cone and the shoe and is required so that the casing may be dry up to the time the tube is removed. Without the cone there is a likelihood of silt being blown in by the water pressure and interfering with the seating of the vibro tube on the lower shoe. When piles are being driven through water this cone has to be attached to the casing so as to hold the lower shoe in position whilst being lowered through the water. For this purpose 3-inch by 1/16-inch strips are riveted on to the cone and set screwed into the casing.

G. The casing, made of 1/8-inch sheet-steel, riveted and electro-welded so as to make it watertight. This is riveted to the sheet ring burnt into the ring shoe.

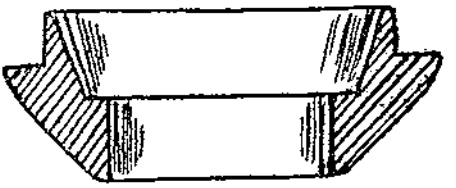
H. The vibro drawn-steel tube.

greater strength due to the thickness of metal, and having a longer life.

The Bengal Iron Company were approached, and they agreed to cast 24-inch external diameter pipes 11 ft. long, with 3/4-inch thickness of metal.

Captain Jefferis now set to work to evolve a method of driving them.

The ring shoe was cast with a skirt all round, over which the cast-iron casing could sit.



It would not be safe to drive the casing with the hammer, as, being cast-iron, it might fracture under the blow.

Two wire ropes are threaded through the driving ring, one on each side, forming two long loops. The two ends of each loop are firmly fixed to the driving ring, the length of the loops being shorter than the C.I. casing. On the two loops are fitted eye bolts, which are threaded through a solid steel distance ring piece, divided into two. The distance ring keeps the vibro tube properly centred in the C.I. casing. The wire loops are drawn tight by nuts against the distance ring.

When the blow of the hammer comes on the driving ring, the shock is taken on the wire ropes. The hole is made in the ground by the ring shoe, and the wire ropes draw the casing down. The object of the skirt on the ring shoe is now obvious, as the casing lags a little behind the ring shoe. The blow does not come direct on the casing, and there is very little chance of a fracture.

It is almost impossible to make the joints watertight, but there is a danger of silt getting in and preventing the proper seating of the tubes.

To avoid this, the outer casing is filled with water, which is kept under a head by a small force pump. Water is, therefore, always flowing from the inside to the outside, and this keeps all joints clear of silt.

When the outer casing has been driven to the full depth of 11 ft. the driving ring and wire ropes are removed, the vibro tube is centred on the inner shoe, and the pile driven through the ring shoe to the full depth of the tube.

There will be some water in the tube, and this must first be removed by means of a baler with a flap valve in the bottom. There will also be water between the vibro tube and the outer casing. This will be

pushed out by the concrete as it rises from below, and will not in any way weaken the pile.

Photo No. 1 shows the assembled shoes in position and the casing waiting to go on.

Photo No. 2 shows the vibro tube lowered and centred on the driving ring and the casing being lowered.

Photo No. 3 shows the complete assembly ready for driving.

Photo No. 4 shows the casing driven to the full depth of the 11 ft. and the vibro tube to the full depth of 30 ft.

Photo No. 5 shows the completed pile bent with the shuttering ready for laying the ground transom, connecting the two piles.

Photo No. 6 shows the 24-inch thick reinforced concrete piers in course of construction.

Photo No. 7 shows the various parts, the pile shoe, ring shoe, driving ring, wire ropes, distance ring and C.I. casing.

Photo No. 8 shows the main parts on the site of the work.

Photo No. 9 shows the plant as used on the Khiali Bridge.

The piles are connected by a heavily reinforced ground sill, and on this sill a solid reinforced concrete pier is built up. Trestle legs were used in the first designs, but as the rivers, when in flood, bring down heavy logs, the piers are now made solid.

The bridge is divided into sections of about 200 feet. The R.S. joists are then joined up on the bank into a continuous girder for this length, by plating, riveting and electro-welding. The welding is done by a portable electro-welding plant on the site of the work. Rollers are placed on the top of the piers and the girders launched out over them, the rollers being removed when the girders are in position.

By using a continuous girder for the whole length of the section, the weight of steel is reduced, and the rigidity of the structure increased.

The flooring consists of a reinforced p.c. concrete slab. Two concrete T beams are cast with the slab on each bay to act as bracing to the girders.

The road surface consists of a $2\frac{3}{4}$-inch slab of concrete treated with Colas, or with Surfastal filled with bitumen grouted gravel.

For the expansion joints, Captain Jefferis has designed a very ingenious device which has no moving parts, has lateral stiffness and yet allows all movement necessary.

The design is as shown on page 683.

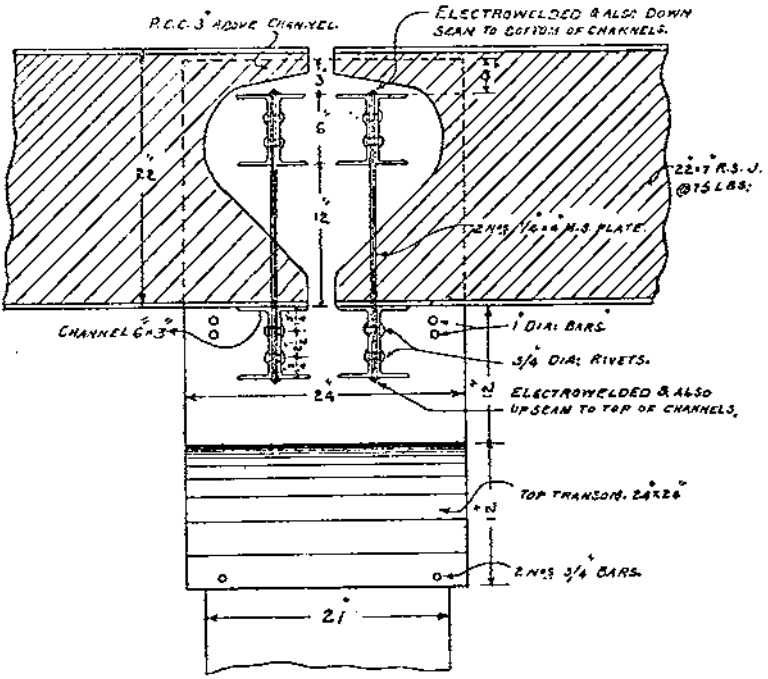
So many successful bridge foundations have been put in that it may be safely stated that the problem has now been solved.

The costly and difficult shoring and dewatering of open foundations

can now be avoided, and the vibro pile can be driven just as easily through water and a waterlogged bed as through a dry river bed.

A boulder river bed presents no difficulties. As a rule any obstruction in the way of large boulders are pushed aside by the heavy tube. If a large boulder too big to be moved is met, a heavy charge can be placed at the bottom of the tube, the vibro tube removed, the charge exploded, and a new shoe driven through the shattered remains of the old one.

An interesting point came to notice during the piling of the foundations of the Gulabad Bridge across a branch of the Kabul River.



In one bent the set of the piles came down to one inch per blow of the hammer, which showed that the pile shoe was probably in a pocket of soft sand.

The vibro tube was filled with concrete, the tube withdrawn 4 or 5 feet, and re-driven 3 or 4 feet. This process was repeated several times until about 20 c.ft. of concrete had been rammed into the hole. The ordinary pile was then completed, thus forming a massive mushroom head at the nose of the pile.

Ten days afterwards the piling plant was brought back and the finished pile hit first with half blows and finally with full blows of the hammer. The pile did not move a fraction of an inch, but began to splinter on the top. This proved that it would carry the full load for which it was designed.

The usual system now adopted is to carry a pier on two ring shoe piles with C.I. casings.

The height limit for single row pile bents is about 25 feet from maximum scour depth to the underside of girder level.

In cases where greater heights are needed and spans over 40 feet are necessary, bunches of piles are put in at 3 ft. to 4 ft. centres. These are connected by a heavy reinforced concrete slab, and on this slab the ordinary stone or concrete pier can be constructed.

For bridges across canals where engineers now have to wait for the canal to be closed, this system of bridging is ideal. The bridge can be constructed while the canal is running, and the pile foundations driven through the water.

If a ring shoe has to go down more than 11 ft., it is possible to use an extension piece, as the casings have a socket into which a second tube can be fitted.

There are two important factors in vibro pile bridging, cost and *time*, and up to the present no system has come to light which can in any way compete.

The following data may be interesting to Engineers :—

Haro River Bridge.—Hazara Grand Trunk Road.
A dry boulder bed subject to sudden floods.
980 ft. long. 18 ft. roadway.
Cost Rs. 150/- per ft. run. *Time*, 4 months.

Maksud Bridge.
A shaly bed with large boulders. Waterlogged.
360 ft. long. 18 ft. roadway.
Cost Rs. 154/- per ft. run. *Time*, 2 months 5 days.

Adozai Bridge.—Kabul River.
Permanent water from 4 to 10 ft. deep. Heavy boulder bed.
760 ft. long. 18 ft. roadway.
Cost, Rs. 200/- per ft. run. *Time*, 3½ months.

The N.W. Railway are about to start experiments on vibro pile foundations for a minor railway bridge, and it will be interesting to see the results.

For permanent bridging behind a force in the field it will be possible to guarantee at least 10 feet of completed bridge per day, which could be increased if work is carried on with double shifts and if steel troughing is used for the decking instead of concrete slabs.

The piling plant weighs 15 tons, and is now being mounted on a caterpillar track to make it possible to move it across country.

FURTHER EXPERIMENTS IN VIBRO-CONCRETE PILING IN THE NORTH-WEST FRONTIER PROVINCE.

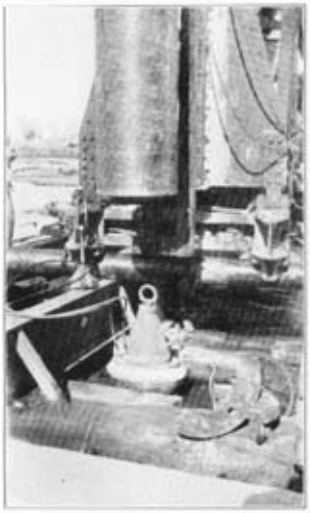


Photo 1.

Photo 2.

Photo 3.

Photo 4.

Further experiments in vibro-concrete 1-4.

Photo 5.

Photo 6.

Photo 7.

Photo 8.

Further experiments in vibro-concrete 5-8

Photo 9.—The Vibro Piling Plant working on the Khiali Bridge.

Further experiments in vibro-concrete 9.

Photo 10.—The Nagoman Bridge completed.

THE PRINCIPLES AND PRACTICE OF LUBRICATION AS APPLIED TO MOTOR VEHICLES.

By CAPTAIN S. G. GALPIN, R.E.

THE President of the Institution of Automobile Engineers, in the paper read before the Institution in November, 1928, referred to lubricating oil as " the only material of construction used in a motor car, in which its main property, namely, viscosity, may vary 20 to 1 over a temperature range of 140° F."

It might equally well be said that no other material used in the construction of motor cars is subject to such adverse conditions of working relative to its main property.

The Principles of Lubrication.

Lubrication is the interposition of a viscous substance between two rigid surfaces, acted upon by forces tending to bring them together, and possessing relative motion. The load and speed play an all-important part in the friction of a bearing, and lubrication falls into two main classifications according to the relation of the friction to load or speed.

These are : (*a*) Boundary lubrication, and (*b*) Viscous lubrication.

(*a*) Boundary lubrication occurs in heavily loaded bearings at low speeds (below the region of 2 feet per second or so peripheral speed). The critical speed depends upon the oil used. Under conditions of boundary lubrication the speed is insufficient for a true oil film to be drawn between the bearing surfaces. A film only a few molecules in thickness is present. Metallic contact and wear occur in places, and the friction is proportional to the load and dependent on the nature of the bearing surfaces. In fact, it follows the law of dry friction ($F = \mu P$) except that, the value of the coefficient μ is modified by the " oiliness " of the oil. The friction is entirely independent of the speed until the critical speed is reached.

In the motor vehicle, boundary lubrication exists chiefly in the chassis bearings, *e.g.*, spring shackle bearings, swivel pin bearings, and all greased points, but—and the significance of the fact has only recently been realized—it always occurs in any bearing working below the critical speed; that is to say, it exists in all the engine bearings at the time of starting and stopping and also between all reciprocating parts of the engine at the limits of the motion.

(*b*) Once the critical speed is reached, provided there is an abundant supply of oil, a film of considerable thickness is drawn into the bearing. This phenomenon of film formation was first discovered by Beauchamp Tower in 1884, and it appears to rest upon the viscosity of the oil in relation to Bernouillis' theorem. The kinetic energy of the oil layers near the moving surface is transformed into pressure as these layers are slowed up by those adjacent to the stationary surface. When the sum of oil pressures equals the load, the bearing surfaces part, and an oil film of the order of 5,000 molecules in thickness is formed and maintained. The oil film then supports the load and the bearing surfaces adjust their relative inclination under conditions of responsive equilibrium.

The friction of viscous lubrication follows the law of viscous resistance.

$$F = \frac{\eta VA}{t}.$$

Where η = viscosity, V = relative velocity of bearing surfaces, A = contact area, and t = thickness of oil film. A glance at this equation seems to indicate that viscous friction is independent of the load. This is true provided that the viscosity remains constant. Actually the viscosity of oils increases within limits with increasing pressure, and decreases very markedly with temperature rise. Since both the oil pressure and temperature in the bearing are determined to a great extent by the load, changes of load do produce variations in the bearing friction.

The coefficients of viscous friction in journal bearings have been determined practically. Expressed in relation to the load on the bearing they are usually in the neighbourhood of ·001. The coefficients of boundary friction are of a higher order and range from ·01 to over 0·1.

In many journal bearings it may be assumed that the increase of load with speed is insignificant compared with the increase of temperature. For such conditions a considerable decrease of viscosity and consequently of bearing friction is to be expected with increase of speed. This is found to be so in practice.

From various tests which have been undertaken it has been found that, in viscous lubrication, temperature is the controlling factor in the load capacity of a bearing. With a given oil, and a given load and speed, there is a critical temperature at which the oil film breaks and wear and abrasion of the surfaces rapidly follow.

Engine Lubrication.

In the paper referred to at the beginning of this article the President pointed out that, up to that time, scientific research had confined itself mainly to normal running conditions, whereas nearly all the

wear and damage to engine bearings occur at the two extremes of the speed range. In his search for increasing efficiency and reliability the engine manufacturer demands an oil forming a strong film (*i.e.*, that has a high viscosity) at high temperatures. Though different oils possess but slightly varying viscosities at high temperatures, their viscosities at atmospheric temperature may well vary by more than 200%, and, unfortunately, the most suitable oils at high temperatures are so viscous at ordinary temperatures that the mechanical efficiency of the engine is greatly impaired. This has been well demonstrated by a test carried out on a 30 cwt. car engine. The petrol consumption at a mean oil temperature of 100° F. was 50% more than the consumption at a mean oil temperature of 150° F. Admittedly, at the lower temperature the thermal efficiency of the engine would be slightly decreased, but this could only account for a fraction of the extra petrol consumption. The rest was due to the relatively high viscous friction in the bearings and cylinders.

It is too much to hope that an oil of constant viscosity at all temperatures will ever be forthcoming and the high viscosity of oil at low temperatures must therefore remain a necessary evil. The suggestion of artificially heating the oil by the exhaust gases for winter running has been seriously considered, but the most urgent problem lies in the inefficiency of lubrication at starting. It has been shown that a cold start may mean that 9 or 10 minutes elapse before the oil film in the bearings and cylinders is fully formed. Cases have been known of a few attempts to start from cold, followed by a wait of twenty-four hours, causing the pistons to rust solid in the cylinders.

Experiments in priming the cylinder walls with oil have been tried with considerable success. The Daimler range of engines has a gallery pipe running the whole length of the engine. This pipe is connected to the main oil supply when the starter pedal is depressed, and it feeds oil through holes in the sleeves on to each connecting rod, whence it is thrown on to the cylinder walls. Another method adopted is the cutting of a bleed hole in the shoulder of the big end, which registers with the oil hole in the crank pin once per revolution. The size of bleed requires some experiment with each engine for the best results. If bleeding is overdone violent smoking occurs when the engine is warmed up.

Investigation into oil film formation has shown that a compounded oil (mineral and vegetable) tends to quicker film formation than a pure mineral oil.

Turning for a moment to the conditions under which oil is required to work in many petrol engines we see a substance, whose efficiency depends essentially on its being kept cool, clean, and pure, deposited at the bottom of a hot crankcase to which any dirt, metal chips, petrol, and water naturally gravitate. In splash lubrication, the oil is freely mixed with oxygen and any products of combustion

which may leak past the piston rings. Under the piston head the oil is subjected to sufficient heat to carbonize it. Such conditions are definitely adverse. Any solid matter which passes the oil filter tends to abrade the bearings. Petrol causes dilution and loss of viscosity. Excessive oxidation and water cause sludging and stickiness.

The last few years have called for many improvements, of which dry sump lubrication combined with really efficient oil filtration is probably the most outstanding. Oil cooling has become a necessity in high duty engines such as those in long-distance chars-a-bancs, where the oil temperatures in the bearings closely approach the mushing point of the white metal itself (about 400° F.). The " stream-line " filter, also known as the Hele Shaw filter, has proved extremely efficient in removing all dirt and water from the oil, restoring its colour and even improving its lubricating properties. Oil rectifiers are fitted to a few American cars. This device removes diluted petrol from the oil by fractional distillation, returning the recovered petrol to the engine for consumption. The scraper ring with drain holes behind it has led to economy by controlling the amount of oil on the cylinder walls and thus preventing loss by the pumping action of the piston rings. Last but not least the essential features of oil film formation are now understood by most manufacturers and the indiscriminate cutting of oil grooves, usually in places where the oil film pressure is most required, is fortunately on the wane.

Chassis Lubrication.

Despite all advertisements to the contrary chassis lubrication is still far from ideal. The trouble lies in (*a*) the character of the lubricant and (*b*) the human element. Of late years oil-tight gearboxes and back axles have dispensed with the necessity of using grease for the transmission bearings. The oil splash system is usually found quite effective for such bearings, and the transmission now requires even less attention from the owner than the engine as regards lubrication. This is as it should be.

The number of points on the chassis requiring lubrication is still large, however. Most of these points are exposed to water and dirt. They are " open " bearings and it is impossible to keep grease in them for long. Water in particular is capable of driving grease out of a bearing and then rusting the bearing solid. The so-called waterproof greases now being marketed are an attempt to remedy this defect, but their value is not yet proved. Ordinary greases are a mixture of oil and soap (usually calcium soap). The majority are too acid in nature and cause pitting of the bearing surfaces. Slight acidity is an advantage in that the grease holds to the metal and therefore minimizes wear.

The human element, however, will always remain the chief obstacle

to chassis point lubrication. Too much work is entailed, and for this reason several automatic or semi-automatic systems have been evolved. Mr. H. W. Pitt, in a paper read before the I.A.E. in 1929, classified these as follows:—(1) The continuous flow, including capillary tube and gravity flow systems; (2) The automatic feed, including engine-operated pump, vibration pump, and exhaust heat expansion systems; and (3) The intermittent flow, including hand pump, foot pump, or mechanical pump.

Of these No. (3), although requiring some work from the owner, appears to be the most satisfactory at present, as it gives very accurate control and allows a lubricant definitely suited to chassis bearings to be used, an advantage denied to any system connected directly to the engine lubrication. An essential feature of lubricating a number of "open" bearings seems to be selectivity in the sense that one and only one bearing is fed at a time, because the attempted lubrication of all bearings simultaneously inevitably means that the loose bearing is over lubricated at the expense of the tight bearing. The Bosch system is of the intermittent flow type and is selective.

The direction of progress appears to lie in the elimination of lubricated bearings from the chassis. Rubber bearings are proving successful where small movement only is required. Bronze graphite bearings are good for light loads. It is interesting that, in the Austin Twelve-Six car, Silentbloc bearings are used for all the spring shackles, and the number of greasing points in the chassis has been reduced to eight. When such improvements have reached their limit it may be possible to make the few remaining lubricated bearings totally enclosed, and circulate suitable oil through them by automatic mechanical means. At present, however, such a system would require radical alterations to conventional chassis design.

A word must be added in favour of graphite. Acheson or colloidal graphite was discovered by Dr. Acheson in 1906. In this highly divided form graphite will remain suspended in many ordinary lubricating oils, and its addition in small quantities to suitable engine oils has proved advantageous both under normal running conditions and more particularly for "running in" engines. It is also useful in heavily stressed bearings and in the form of graphite grease is definitely the best lubricant for leaf springs.

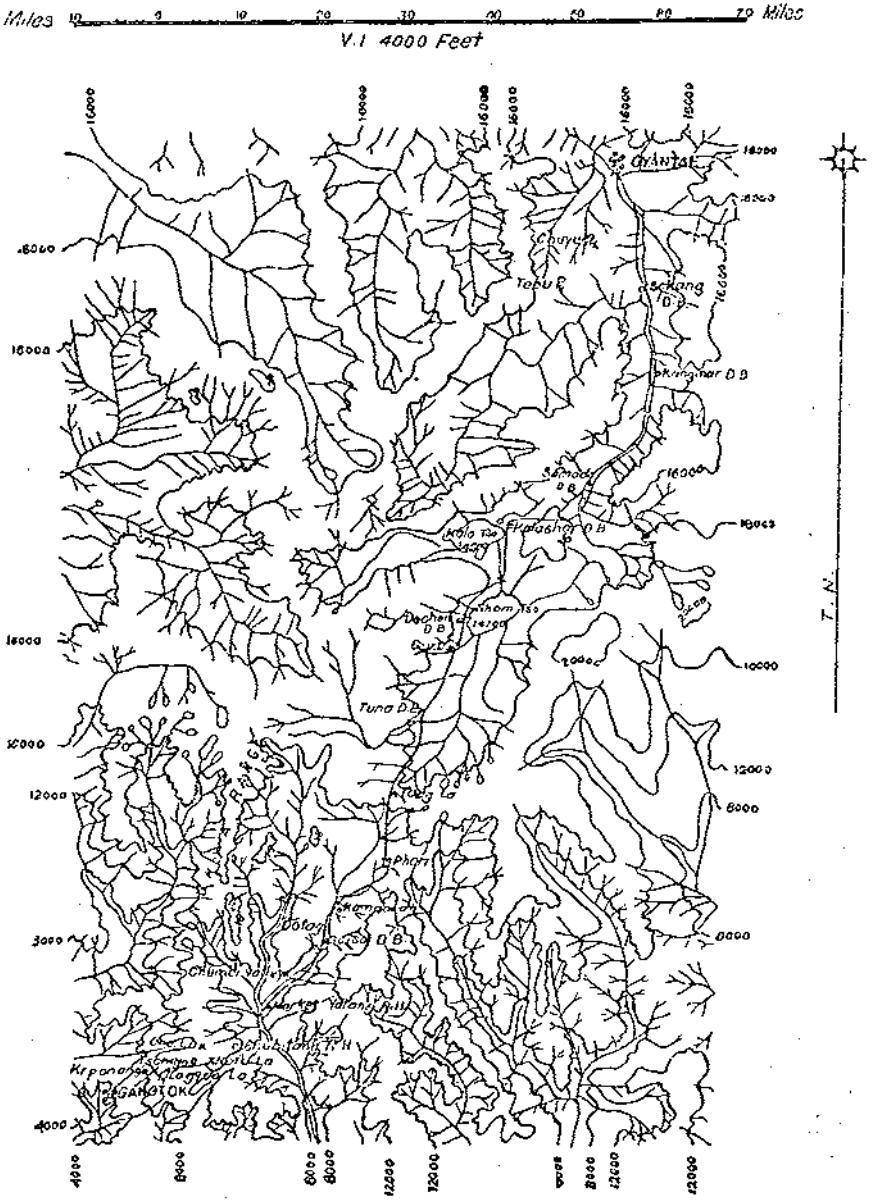
TWO SAPPER SUBALTERNS IN TIBET.

By LIEUTENANT L. T. GROVE, R.E.

FOR various reasons, chief being the powerful religious antipathy of its governing authorities to western ideas, and the consequent restrictions imposed, Tibet is seldom visited by army officers. For this reason an account of the tour of two Sapper subalterns in the autumn of 1930 may be of some interest. The tour was made in connection with an inspection of the fort at Gyantse, and it came about in an unusual way. Up to 1927 all government buildings in Tibet were run by the Public Works Department, being included in the Sikkim district. About two years ago Sikkim suffered from a number of landslips, and the hill roads were continually getting blocked. Eventually the State Engineer found himself so busy at home that he was unable to make his usual biennial visit to Tibet. Faced with the alternative of providing another executive engineer or making some fresh arrangement, the government of India adopted the latter course, and handed over responsibility for the upkeep of all the Tibet buildings to the British Trade Agent. As junior officers in the Political Department, even to-day, are not expected to be experts on engineer services, he was allotted two native sub-overseers to take charge of the work. This was in 1928. By 1930 the condition of some of the buildings had become so alarming that the B.T.A. applied to Simla for an R.E. officer to go up and inspect them. The application reached Roorkee just before the writers of this article were setting off on two months' leave to the hills. So it was decided that, although only one officer had been called for, the two projects should be combined and Gyantse, not Spiti, became the objective of our trip.

Gyantse, which is the headquarters of the B.T.A., is situated at the head of the trade route into Tibet. Any foreigner wishing to enter the country must use this route, and no one may on any account go beyond Gyantse without special permission from Lhasa, which is practically never given. Further down the route is Yatang, only 16 miles from the border. From here there are two routes into Sikkim, and thence to British India. That generally used by traders crosses the border by the Jelap La and leads straight to railhead at Kalimpong. The more usual route for travellers crosses by the Nathu La and leads to Gangtok, the capital of Sikkim. British representatives in Tibet are the British Trade Agent and his immediate superior, the Political Officer in Sikkim, who visits Tibet annually.

ROUTE TO GYANTSE



The former in practice has little to do with trade, acting more in the capacity of vice-consul. His title survives from 1904, when as a result of the military mission to Lhasa, Great Britain was allowed to keep one trade representative in Tibet. He remains still the only British official resident in Tibet, though he is allowed a bodyguard by virtue of his position. For this purpose there is one company of Indian infantry, with two British officers, the majority stationed in Gyantse, with only a small detachment at Yatang. The Political Officer usually visits the country for two months every summer, staying either at Gyantse or Yatang.

Our particular object was to inspect and report on the condition of Gyantse fort. Various other jobs materialized as we went along. Thus we were asked further to inspect all *dak* bungalows along our route; and on our way back we were set the task of reconnoitring a third route across the border from Yatang into Sikkim as an alternative to the two already in existence. In consideration of this we were given permission to shoot along the trade route, a great piece of luck, as this privilege is almost always restricted to the political officials and members of Gyantse Garrison.

On August 20th we started our journey at Gangtok. The capital of Sikkim is situated along the tops of a ridge 6,000 feet above the sea. Along the valley below flows the river Tista, noted for having the wettest river basin in India. It has an annual rainfall of 160 inches, spread fairly evenly over about ten months of the year, so that it may fairly be said that it is usually raining at Gangtok. We spent seven days in Sikkim, and every one of them was wet. This was the more disappointing as some of the views are said to be very fine, and in particular, Kinchenjunga is clearly visible from the Residency grounds. Our only glimpse of this famous view was obtained by rising very early on our last morning, when we just had time to see the snows before the clouds came down for the day. As a result of this heavy rainfall there is very thick, dark undergrowth on all the hillsides, in which large numbers of butterflies, but comparatively few birds, are in evidence. Practically all game has been driven from the jungles by swarms of leeches. These leeches are everywhere, and a short excursion through the undergrowth is sure to collect two or three. They go through a shirt or stockings with ease, and only drop off of their own accord when thoroughly gorged. There are two correct methods of removing a leech. The first is to burn it off with a match or cigarette, the second to put salt on its tail. A third method, which is generally employed in practice, is to remove it with the fingers. But sometimes the animal leaves its head behind, and this may lead to blood poisoning. The cowherds of north Sikkim have a habit of eating leeches. They first allow them to fatten on the heads and faces of the unfortunate cows. When properly matured, the best ones are picked off and dropped straight

into boiling water. The result is a ready-made sausage, which may be as much as three inches long. It does not sound an appetising meal, but ten or twelve such " sausages " must be amply sustaining.

From Gangtok to Yatang is forty-three miles. On the Sikkim side of the border there is a well-made mountain road, mostly about nine feet wide, surfaced with hand-packed stone. Handrails are being put up at all difficult places, and it will soon be possible to drive native carts the whole way. Eventually it may develop into a motor road. The chief drawbacks at present are a great shortage of culverts, which appear to be almost unknown, and frequent landslides, which still give a lot of trouble. It is because of these landslides that the Political Officer is trying to find an alternative route for traders. Twenty-seven miles from Gangtok the road crosses the Dongkya range by the Nathu La (14,300 feet). This is the boundary of Tibet. The final ascent from Sikkim is steep, and the road goes up in a series of sharp zig-zags. The last ten miles of this road pass through some of the rhododendron forests for which Sikkim is famous. The southern slopes of all hills between 11,000 and 13,000 feet are covered with the shrubs, and in spring they must be a marvellous sight. Once over the Nathu La the road changes abruptly. There is a saying that in Tibet the greater the distance from Lhasa the less trouble is taken over anything, and this route is a good example. From the summit, the path—for it is no more than that—leads down over half a mile of natural boulders which may once have been the bed of a stream. It then follows the hillside, varying in width from two to eight feet, and in surface from boulders to sand, corduroy and mud. It finally plunges 2,000 feet down a hillside which is almost a precipice into the valley of the Amo Chu. However, as if to make up for the bad going, the weather on the Tibetan side seems to improve at once, and the views are delightful. At the bottom of the hill the road turns up the Amo Chu valley, and in three miles reaches Yatang.

Yatang is situated just where the Chumbi river runs into the Amo Chu, and, although at an altitude of over 10,000 feet, it possesses a climate very similar to England. Vegetables and flowers grow in profusion, and the valley is a pretty sight. We particularly noticed how the butterflies changed from all the tropical varieties of Sikkim to many of the familiar English species. The Camberwell Beauty was much in evidence, as also were the more homely cabbage whites. The latter had almost completely destroyed a whole bed of cabbages in the B.T.A.'s garden.

There is a fair-sized bazaar, though the inhabitants are not pure Tibetans. In fact, the Chumbi valley as a whole approximates much more closely to Sikkim than Tibet. The Amo Chu enters Bhutan close below Yatang, and perhaps one day a road will be built down its valley leading straight into British India.

It was here that we found our first job of work, owing to an earthquake which had occurred the previous June. Most of the buildings have walls two feet thick of so-called dressed stone in mud mortar.

Dressed stone only means that the outer face is clipped clean so as to give a nice appearance. There is no attempt to square up the stone as a whole. The treatment of cracks is simple. If small, they are filled with cement or lime mortar. If the sub-overseer thinks they are too big for this treatment he submits an estimate for a new wall. In this case the sub-overseer appeared to have guessed right in every case, so there was no more to be done.

Here too we had our first chance of *shikar* after leaving the leech-infested jungles of Sikkim. Gooral, serow and black bear are all to be found in the hills round Yatang. As we did not want to stay long we only tried for the latter by the local method of prowling round the buckwheat crops with torch and rifle an hour or two after dark. In this we were unsuccessful. The buckwheat was nearly over, and the bear just at this time were not coming down from the hills. After four days in Yatang we left on our way to Gyantse.

The distance from Yatang to Gyantse is 132 miles, divided into ten stages. There are good *dak* bungalows at every stage. A peculiarity of all Tibetan *dak* bungalows is that they have the servants' quarters in the form of a square compound in front of the bungalow. The main object of this arrangement is to screen the bungalow as far as possible from the wind, a most important point, and one which perhaps justifies the necessity of having to put up with all the nuisances of Tibetan family life outside the front door. This wind is a most formidable proposition. Once on the main plateau of Tibet at a height of 14,000 feet or more, hardly a day passes without it. It appears to get up generally at about ten o'clock in the morning, always from the south, and frequently it rises almost to a gale. Ordinary cosmetics seem of little use, and anyone who intends to travel in these parts had better be prepared to lose the skin of his nose and face several times in a month. Transport is all by pack pony or mule, officers and servants riding on ponies. Walking over these plains is very fatiguing, and dull, and no Tibetan of rank ever does it.

It is quite easy to do double stages all the way, and five days from Yatang to Gyantse represents no more than good going. Those stationed in Gyantse usually take four, while the record for the course is said to be three days from Gyantse to Siliguri—about 230 miles. This was done just after the War by a contractor who thought the police were after him. In our case there was no such inducement to speed, and we spent three days on the way trying to shoot first burrhel and then gazelle—in both cases without success. Eventually we reached Gyantse on September 5th at 9 p.m., finishing up with a treble stage of forty-three miles.

Gyantse lies in the middle of a large plain entirely surrounded by hills, which run up to 16,000 feet. The town itself is at an elevation of 13,000 feet. It consists of the Dzong, or native fort, perched on the summit of an isolated and precipitous hill, the bazaar, and a monastery. There is also another monastery within three miles at Tsechen.

Gyantse was the scene of considerable military activity in 1904. A detachment of the British mission to Tibet had remained at Changlo, a farmhouse, just outside Gyantse, while the main force went back towards Sikkim to secure its communications. This detachment was treacherously attacked by a large force of Tibetans from Shigatse and besieged for two months. It was then relieved by a column from Yatang under General Macdonald, R.E., who proceeded to attack, take and sack the Dzong as a deterrent to further treachery. The only government buildings are the *dak* bungalow and the fort.

The fort was built in 1911 as the headquarters of the B.T.A. For some reasons it was decided that it must be capable of withstanding a siege: hence its queer construction and its name. Roughly rectangular in shape, it is divided up into separate courtyards, variously allotted to the B.T.A., officers and men of the garrison, servants, followers, etc. In order to avoid windows in the perimeter wall all ground-floor rooms in the outside blocks are used as store-rooms. The roof is flat and provided with a loopholed parapet. Both roof and upper floor consist of *arka*—a local substitute for lime concrete—carried on slate with timber purlins and rafters. All walls are two feet thick: lower story of stone in mud and quite sound: upper story of mud brick and less reliable. The whole building is covered outside with mud plaster, which, besides its dreary aspect, serves only to hide defective workmanship and any subsequent damage. Most of the quarters are in the upper story, and are reached by external wooden staircases and verandahs. It was the condition of these verandahs and staircases which in the first place had led to our being called in. Certainly they justified extreme measures. All the woodwork was rotten. Probably it had been green when the fort was built, and much of it had scarcely been touched since then. Some of the steps were positively dangerous, and many of the verandahs certainly looked it. The rest of the fort was not in as bad a condition as at first seemed likely. Once the depressing effect of the mud plaster had worn off, the walls beneath turned out to be unexpectedly sound. The majority of the internal woodwork, too, had lasted surprisingly well. Our attention was drawn to cases where the ceiling beams appeared to be sagging unhappily under the weight of the roof above. But this was really quite in keeping with the rest of the fort. Nowhere were straight lines much in evidence. Probably these beams had taken up a permanent set

within a year or two of their erection, and if necessary they would maintain it unchanged for many years to come. The timber was sound enough. Briefly, then, our recommendations took the following form :—

1. All verandahs and staircases to be rebuilt.
2. Mud plaster to be removed and all walls cement pointed. If necessary this work to be spread over several years.
3. The mud brick walls to be pulled down and gradually replaced by stone ones.
4. A regular system of annual maintenance to be adopted.
5. A proper timber yard to be started, so that all timber is seasoned before use.

With the collection of these recommendations into a proper report and the inclusion of appropriate drawings and estimates, our main task was at an end, and we were free to turn our attention to lighter things.

Tibet is probably one of the finest big game countries in the world. But the shooting restrictions are very severe, and no one is allowed to go more than a few miles to either side of the trade route. This narrows down the possibilities of game to gazelle, burrhel, and ovis ammon. The time of year further restricted the list, because the ammon all leave this vicinity and go further west for the summer months. Thus we were left to pursue gazelle and burrhel, with about a fortnight available for actual shooting. Major Burrard in *Hill Shooting in the Himalayas* gives the distribution of gazelle as " widely distributed through Tibet on open plains above 13,000 feet." This seems to be the case, though a rider might be added for the summer months (July to September), " except where they are driven away by the grazing." At this time of year there are yaks and mules grazing all over the plains and foothills, and the wild animals are driven off many of their usual grounds. Our experience with gazelle was limited practically to two areas—the plains round Kala and Gyantse. The former is a great open plain about eight miles long by three broad—almost dead flat. Gyantse plain is smaller and thickly populated, so that the gazelle retire into the broad side nullahs which open off the central plain. The habits of the species in the two places are curiously different. At Kala they stay right out in the middle of the plain, both for grazing and also when lying down in the middle of the day. Here they are easy to spot but very difficult to approach. Except when alarmed they take little notice of a man or horse more than three hundred yards away. But any attempt to come within that distance makes them uneasy, and they start to move off at once. Like chinkara, it is possible to get fairly close by " ringing," *i.e.*, walking so as to pass always about two hundred yards to one side, and we got two heads by this method.

Even then they are such a small target and the shot has to be taken so quickly, before they move off, that it calls for very accurate shooting. We also tried stalking them, but found it almost impossible to get within sporting range without being spotted. Their eyesight is wonderful, and the country all in their favour. It may be noted that their sense of smell appears to be nil. Thus where the country permits of a covered approach they are not difficult to stalk. This is the case near Gyantse, where they seem to feed early and late, like the wild sheep, and lie up in small side nullahs during the day. It makes them harder to find, but once located it is generally a simple matter to stalk them over the ridge from an adjoining nullah and so get a shot which may be anything from 50 to 300 yards. In order to cover more ground we borrowed ponies from the mounted infantry section of the B.T.A.'s bodyguard, and so covered from fifteen to twenty miles a day. Yet in three days' shooting we saw only two shootable heads, both of which we were lucky enough to secure. One in particular fell to a galloping shot at 200 yards—an amazing fluke. Both at Kala and Gyantse there were plenty of does about, and they were generally easier to approach than the bucks. The latter seemed to favour small bands of four or five, of which all or only one might be bucks. Our largest head, a fine 13¼-in., was a lone buck flushed in the middle of Kala plain, while the biggest herd we saw consisted of fourteen does. In fact, although we saw four separate herds of ten or more, there was not a single male in any of them. At Gyantse we got the curious impression that animals which looked big in the distance always turned out to be does. However, this was not confirmed at Kala, and so it was probably just an optical delusion. We never shot a doe, and so had no means of putting it to the test. We also found great difficulty in judging heads. When the animal is lying down with only his horns showing above the grass, he frequently looks huge. Then when he gets up and his whole head is visible, the reverse is sometimes the case. It is essential to view the head from the side, as the shape of the horns makes it impossible to tell anything when viewed in perspective. Also the buck usually tilts his head slightly back, which makes it harder still. The best of our own heads all had a good spread at the tips, but it is unlikely that the spread can really give any true indication of length. In fact, after trying for nine days we had still failed to discover any reliable principle to follow.

Besides gazelle there are plenty of burrhel in this part of the country, though they have the reputation of running small. In Rowland Ward's *Records of Big Game* the world's record burrhel is described as having been shot near Gyantse in 1904, but nothing big has been shot there for a long time. Our most interesting experiences were all connected with the weather. In August and September we met with no success at all. In fact, we scarcely saw a burrhel in

these months. Moreover, the clouds were generally so low and the weather so uncertain, that it seemed very doubtful whether it would be worth trying seriously at all at this time of the year. Then at the beginning of October we camped for four days and tried the nullahs south of Phari. The weather improved, and no snow had fallen, so that we could cover a good area in a day. The first day we saw only two small herds. Next day we covered almost the same ground and saw two large herds, one of which was obviously a fresh one and yielded a twenty-four-inch head—the best we got. Encouraged by this we took the same route again on the third day, and this time we saw one huge herd of about two hundred, besides two small ones. After that we tried a fresh place and again found plenty of game. It seemed that the burrhel had just started to come down from their retreats in the mountains, and every day they were coming in increasing numbers into their usual nullahs. Where they had been before we could never discover. These hills are none of them very high, and their upper slopes are rocky and bare—not the sort of country where one would expect to find burrhel. However, it is certain that they were not in the nullahs, so presumably they must have been up in the hill tops somewhere.

This last day almost ended in disaster. We had selected two parallel nullahs opening off the trade route, and our intention was to follow up one of them for about five miles, then cross over the ridge and come back down the other. Guides are practically unobtainable in many places in Tibet, so we relied on a quarter-inch map and an intelligent coolie to see us through. The latter led us along a jungle path—we had started below the tree line—and all went well until we were on our way back down the second nullah. It was getting late, and we had become reconciled to a return in the dark when suddenly the path fizzled out altogether. This was a serious problem. The banks on either side of the stream rose steeply, and were covered with dense undergrowth. Moreover, the timber was mostly rotten, and the ground rocky and treacherous. However, there was nothing for it but to try and force a passage, and hope to pick up another track farther on. To make matters worse, it was now quite dark, and like most of their kind our guides were useless in a crisis. In fact we were soon to lose them altogether. It was when we had climbed up the hillside in the hope of finding a clearer way and were crossing a rocky slope. The second coolie somehow slipped and hurt his knee. It was nothing serious, but it probably hurt him a bit, and he promptly sat down and cried like a child. Nothing we could do would induce him to move, so eventually we lit a fire, and left the two of them together to wait for daylight. It was now 10 p.m. The rest of the night was like a bad dream. Loaded with all our equipment we slowly worked our way downstream; sometimes wading in the edge of the water until the current became too strong,

and sometimes forcing our way through the bamboo thickets above. Towards dawn our progress became so slow that we climbed to the top of the ridge to take our bearings. Here we received the final blow. Instead of finding the trade route below us within easy reach as we expected, there was nothing but a succession of valleys and ridge tops to be seen. Of that day's journey there is little enough to be said. Our painful progress continued for another twelve hours, until we finally reached the Agency at Yatang at 7 p.m. We had left Gantsa just 36½ hours before, and had had no food since our tiffin six hours after the start. The cause of the trouble turned out to be a simple mistake in map reading. We had gone up our second nullah instead of our first, and so by crossing the ridge we got into a completely fresh one which proved to be five miles longer than either of the others. In this sort of thickly-wooded country, which has only been very approximately surveyed, such a mistake is easily made, and it serves to emphasize the importance of taking a proper guide in unknown country. We also came to realize in no uncertain manner the importance of the iron ration which we had left behind.

So ended our shooting for the trip. At Yatang we spent a couple of days resting before setting out on the last lap, which was to be a reconnaissance of an alternative route into Sikkim over the Chu La. There was supposed to have been an old route which had been in use thirty years ago, and there is still a track which is used by yaks during the summer months. It leaves the main trade route at Chumbi, where we were fortunately able to pick up a small boy who undertook to act as guide. At first the ascent was easy—almost better, in fact, than the corresponding section of the trade route. Then, as we were nearing the Chu La pass the ground got very rocky, and to make matters worse it began to snow. Soon we were properly enveloped in a snowstorm, and our guide, perhaps wisely, decided to make for home. Thus we again found ourselves among strange hills, with our confidence badly shaken, trusting to the map and an official *Route Book*. The position would not have been so bad if we could have spotted any landmarks, but with visibility limited to about fifty yards this was out of the question. However, whether by luck or good management, we managed to keep the right route until within three miles of Changu bungalow, our first day's objective. Then, when almost within sight of home, we took the wrong track, and it was dark before the mistake could be rectified. So we were faced with another climb through virgin jungle—this time straight up a hillside covered with dense rhododendron scrub. Moreover, we had no moon to help us, and to make matters worse the undergrowth was all soaking wet. However, fortune favoured us, and we emerged at the top of the climb to see the lights of Changu four hundred yards below, and a search party just setting out. Thus the first day's work was done, after twelve hours' steady going in fog and snow without

a single halt. Truly we must have seen the Sikkim weather at its very worst.

After one day in Changu we set out to complete the second stage of the journey. Referring again to the map it looked as though we had only to follow a simple-looking route mostly "along the contour," to Karponang, where we should join the main trade route to Gangtok. But here again the quarter-inch map proved deceptive. The path for the most part led us straight across a succession of steep-sided nullahs, alternately rising and falling sharply. Much of this section was over rocks, and it soon became evident that it would be useless for any practical form of transport. The general gradient continued to rise steadily until the path had attained a height of 13,500 feet or 3,500 feet above Karponang, which was only about three miles away. Then it suddenly plunged downwards and wound through the trees, disappearing at intervals, until it joined the trade route a few miles above Karponang. Again it was only due to our guide that we were able to follow it at all. That evening we walked (in pouring rain) to Gangtok, whence we had started just fifty-six days before.

This completes the story of our trip. Little has been said about the people of the country with whom we came in contact. Between Gangtok and Phari they are mostly a glorious mixture of Nepali, Lepcha, Tibetan, and Sikkimese, speaking various dialects and exhibiting no marked national characteristics. Beyond Phari both the country and the inhabitants suddenly alter, and become typical of true Tibet. The people are delightfully cheerful and willing and always ready to help when they understand what is required. They are mainly agricultural, and each village normally supports itself, and very often its attendant monastery as well. These monasteries are everywhere, and the monks exercise an absolute control over the country. It is the custom of one son out of every family to enter a monastery to serve an apprenticeship. At the end of this course it rests with him whether he will stay on as a qualified lama or return to his village; but few of them elect to return. Such a system is essentially oriental, and it is because the spread of western ideas must inevitably weaken their position that the lamas are so bitterly opposed to allowing visitors into the country. The religion they practise is a depraved form of Buddhism, and the peasants carry out their worship very largely by means of prayer wheels and prayer flags. The former is like a baby's rattle which can be swung round in one hand. Inside are stuffed many hundred pieces of paper, on each of which a prayer is supposed to be written, and every time the "wheel" is rotated all these prayers ascend to heaven. The prayer flags again are streamers of cloth or paper, on which the prayer is written, attached to poles, trees, etc. In this case the wind, by stirring the flags, causes an endless sequence of prayers to ascend. By now it is

Left.
Pack transport.

Right.
A Tibetan woman wearing her national headdress.

Left.
Three typical villagers.

Right.
Our Permanent Staff.
Cook (Mohamedan),
Bearer (Tibetan),
Orderly (Hindoo).

Two Sapper subalterns in Tibet 1-4

The Dzong or native fort.

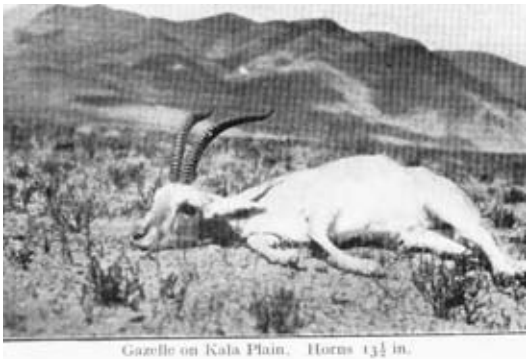
Officers' quarters in the British Trade Agency.

Two Sapper subalterns in Tibet 5-6

Mt. Chumalhari—the sacred mountain of Tibet.

Yatang Bazaar, with prayer flags all along one side of the street.

Two Sapper subalterns in Tibet 7-8



Gazelle on Kala Plain. Horns 13½ in.

Gazelle country near Gyantse.

24-in. barrhel shot at 16,000 feet.

Two Sapper subalterns in Tibet 9-11

the spirit so much more than the letter which counts, that many of these flags are no more than bits of old rag or paper quite innocent of any writing, strung up anywhere where they can catch the breeze. One other form of *poojah* which serves still to emphasize the simplicity of these people is the manufacture of sunshine. This is done by means of a rude water-wheel turning a crank with a block of wood at the end. This block is thereby worked to and fro in a small wooden trough, and gradually pounds itself to very fine sawdust—the sunshine. Each block is replaced the instant it is worn out, so that the manufacture of sunshine never ceases so long as the stream is running. We saw three of these machines all working together, and it is only fair to say that there was not a cloud in the sky at the time.

In winter all the villagers hibernate. There is no wood to be had on the higher plateaux, which are all well above the tree line, and yak dung—the only available fuel—only just suffices for cooking. Consequently the inhabitants collect in their houses, and as it gets colder they simply put on more clothes and remain well wrapped up until the spring. Then they gradually discard the surplus garments until they get back to their working clothes and it is time to go out into the fields again. Crime is almost unknown, and litigation is reduced to a minimum. The latter is perhaps due to a widespread custom among local magistrates of giving both plaintiff and defendant a hundred lashes before even hearing the case. What a lot of senseless litigation would be saved if this system could be more widely adopted.

Tibet, indeed, possesses few of the amenities of civilization. Yet in spite of this—or can it be because of this—it wears an atmosphere of cheerfulness which is hard to find in some more modern countries. Its inaccessibility and the restrictions placed on travellers make it a difficult place to visit. Yet the travelling is comfortable and still quite cheap. And anyone who is prepared to spend the time and trouble to organize the trip will certainly find it a delightful and interesting experience.

BRIDGING ON THE CHITRAL ROAD, WITH SPECIAL REFERENCE TO THE N.W.R. PORTABLE TYPE STEEL BRIDGE.

By LIEUTENANT W. F. ANDERSON, R.E.

A. INTRODUCTORY.

OWING to the replacement of animal transport by M.T. throughout India, the normal method of transport by pack mule from Dargai to Drosh could not be used, owing to a shortage of mules.

Instead, A.T. carts were used from Dargai to Dir, and then the mules, converted from draught to pack, made a double journey over the Lowari Pass (10,500 ft.) from Dir to Drosh, a distance of 35 miles.

To enable A.T. carts to reach Dir, the following work had to be done on the road in 1930 :—

(*a*) General widening from 8′ to 10′ and cutting out of hairpin corners ; (*b*) Construction of two bridges of 112′ and 72′ span over the Panjkora and Usherai Rivers to replace the old bridges washed away by the floods of August, 1929.

In view of future developments it was decided that these new bridges should be built to take M.T.

B. THE BRIDGING PROBLEM IN CHITRAL AND DIR.

The difficulties in the way of making these M.T. bridges are several :—

(1) *Lack of skilled labour of every kind.* The states of Chitral and Dir do not breed cunning workers in wood, stone or metal ; anyone of even third-class skill must be imported from India at double wages. Even with this lure, the Indian does not come readily, probably owing to the long journey on foot, and the Dir Pathan's reputation for disliking strangers.

The employment of Sappers and Miners on this type of work is, of course, a most excellent solution to the problem from the point of view of the M.E.S., and one much used in Chitral, where a Section is permanently posted, and probably does bridging work for the M.E.S. for nine months out of every twelve.

But it frequently happens that after floods more work arises than

the Section can cope with, and the cost of sending Companies from India is very great, besides which they often cannot be spared.

(2) *Distance from Railhead.* The road starts at railhead at Dargai, and it is 120 miles to Drosh, 145 to Chitral and 231 miles to the Shandur, where it crosses into Gilgit territory.

(3) *Bad Communications.* These distances do not look very formidable until one realizes that it is a pack road, that 13 miles represent an average stage for a day, and that 3s. 6d. per 80-lb. load per stage is the cost of freightage to Drosh, so that it costs £40 to bring a ton of bridging material up to Drosh at the moment. A similar distance by road in India would cost about £5 per ton.

Thus all bridge parts required from India must be repacked at railhead in the form of camel or mule loads, and from considerations of cost must be as few and light as possible.

C. Types of Bridge used in the Past.

With the idea of using local materials to the full, most bridges on this road are :—

(*a*) Spans up to 40 ft. Timber beams, or framed trestles.
(*b*) Spans up to 60 ft. Timber girders.
(*c*) Spans 60 ft. to 300 ft. Suspension bridges with timber girder stiffening.

In the heavier design now required for M.T. :

(*a*) Spans up to 40 ft. Timber is the obvious material to use, and a bridge to take any type of lorry can be designed.
(*b*) Spans up to 60 ft. Timber girders to take lorries are quite feasible. From an M.E.S. point of view, the only disadvantages of this type are the difficulty of getting skilled labour for construction, and its comparatively short life. 30 years is all that can be expected.
(*c*) Spans 60 to 300 ft. form the real bridging problem. Stiffened suspension bridges as permanent bridges for M.T. have several disadvantages :—(1) They require really skilled labour to erect ; (2) They impose great strains on the stiffening girders, which need renewing after 20 years, even with pack transport ; (3) There is considerable risk of damage by fire or earthquake to this type of bridge. Three years ago a bridge at Shishi in Chitral caught fire and was reduced to cables and ashes.

The Station Board, not being able to fix the guilt on anyone in particular, returned the rather ingenious theory that " in the opinion of this Board, the fire was caused by the self-ignition of mule dung which had accumulated on the bridge."

D. THE N.W.R. PORTABLE TYPE STEEL BRIDGE AS A SOLUTION.

This bridge, designed by the N.W.R. Bridge Engineer specially for use on the frontier, will take a single 8-ton load or two 5-ton loads over a clear span of 104', or over a span of 192' as a continuous girder with two intermediate supports.

Some of the points in its favour are :—

(1) It is capable of being carried on camel transport. The heaviest unit is a channel 8' long, 167 lb. in weight, which is a perfectly possible side load for a camel.

(2) It is extremely simple to erect. The bridge consists of two Warren girders, arranged as a trough or a deck span as required. Top and bottom boom, diagonals, and cross members are all interchangeable, as are all gusset plates. Either rivets, or bolts and nuts, can be used for assembling : the bridge is really Meccano on a large scale.

(3) It is adaptable to a large variety of gaps. Any number of 8-ft. bays can be ordered, *i.e.*, 88', 96', 104', 112', etc.

Supports can be put at any panel point in the bridge, and trestles 16' high can be made out of the bridge units themselves.

(4) Launching can be done with a minimum of gear. The cross members of the bridge can be assembled to make derricks, and the diagonals spiked down to the decking sleepers to make a slipway. No launching rollers are necessary.

(5) Units are all made from very common standard sections. This enables the cost to be kept down, and, should need arise, a large amount of this bridge could be made at short notice.

The cost of this bridge at railhead is about £8 per ft. run, or £21 per ton.

E. ACCOUNT OF ERECTION OF N.W.R. PORTABLE TYPE STEEL BRIDGES OVER THE USHERAI AND PANJKORA RIVERS.

Usherai. See Photos Nos. 1 to 6.

This was a 72' span deck type, across a gorge about 80' deep, and replaced an unstiffened suspension bridge, which, although 20' above normal water level, was topped and half washed away in the 1929 floods.

The chief difficulty was the limited space for erection, making it impossible to assemble more than five of the nine bays before pulling out.

Girders were launched singly, so as to keep the hauling gear light and to enable the cross members to be used as derricks and slipways.

Erection and launching were carried out by a gang of 12 men supplied by the N.W.R., assisted by about 30 local Pathans.

Time taken, 30 working days.

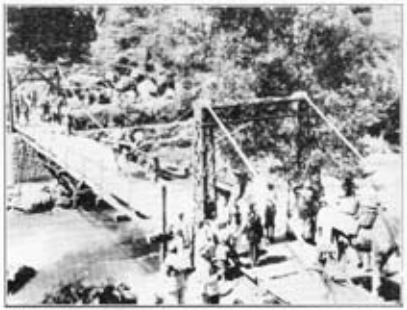


Photo 1.—Portable Type Bridge parts as packed for camel transport, crossing the old Usherai bridge.

Photo 2.—View showing the railway gang at work assembling the first girder.

Photo 3.—The first girder very nearly across.

Photo 4.—View from above as derrick was being raised into position.

Photo 5.—The Usherai bridge finished except for decking and painting.

Photo 7.—Temporary suspension bridge at Chutiatan erected by K.G.O. Bengal S. & M. in autumn, 1929.

Bridging on the Chitral Road at Usherai and Chutiatan 1-7.

Photo 8.—Abutments of old bridge washed away by flood of August 28, 1929.

Photo 9.—The permanent bridge at Chutiatan just about to be launched.

Photo 10.—General view, showing permanent and temporary bridges both in position.

Photo 11.—Both girders over, derricks being dismantled for cross members.

Photo 12.—Bridge parts being unloaded at Chutiatan.

Photo 13.—A rather premature attempt to use the road for motor traffic.

Bridging on the Chitral Road at Usherai and Chutiatan 8-13

Chutiatan (over the Panjkora River). See Photos Nos. 7 to 13.

This was a 112′ deck type span, 70′ above water level.

This is the longest span yet attempted with this type of bridge, originally designed as a 104′ maximum span. The extra bay was added at the expense of being able to take a single 5-ton load only.

The method of assembly and launch was identical with that used at Usherai, except that extra side guys were put on to the girders to keep them vertical during launch, a very necessary precaution, as a heel of more than 10 degrees from the vertical would have seriously strained the girder.

Time taken 30 working days, which was a considerable improvement in efficiency. This was partly due to the fact that the Pathan nearer Dir is rather less woolly; to the end, however, it was risky to tell them to put on or screw up a nut; like all Indians, they had the thread-crossing complex born in them.

The whole job was looked upon with some wonder; on seeing the 56′ derrick assembled at Chutiatan, one of the local Pathans said he thought it looked quite a good beam, but he did not think that it would reach across!

The cost of these bridges at railhead worked out at £8 per ft. run, the cost of transporting to the site came to about another £8 per ft. run, and the erection cost £3 per ft. run.

Abutments at Usherai cost £450 and at Chutiatan £900.

F. Uses of this Type of Bridge for Military Purposes.

The long times taken to erect these bridges at Usherai and Chutiatan do not do justice to the design. This bridge really is extremely quick and simple to erect.

The N.W.R. gang was very small, the sites were rather awkward, and the local labour very much so. The method of launch, too, was more economical of launching gear than of time.

Sappers and Miners would quickly train to doing this work at great speed, and it would probably be within the scope of Pioneers.

If ever a situation arose in which it was required to push a motor road through a hill country at short notice, this type of bridge might well have great uses.

REPORT ON CONCEALMENT FROM THE AIR.

By MAJOR B. C. DENING, M.C., R.E.
(Q.V.O. Madras Sappers and Miners).

1. During the visit of "X" Flight, 28th (A.C.) Squadron, to Bangalore early in December, facilities were available for photography from the air. It was decided accordingly to carry out certain experiments, especially in view of the reports on the experiments in concealment from the air carried out at Aldershot and Egypt in 1929.

2.—OBJECT OF THE EXPERIMENTS.

The object of the experiments was partly to provide photographs with which instruction could be imparted and partly to test out how far, under Indian conditions, with the materials likely to be readily available, concealment from the air was possible. It was also desired to ascertain the importance of height. Objects were therefore photographed vertically, respectively at 1,000 ft. and 3,000 to 4,000 ft. They were further photographed obliquely, and some were taken respectively at 09.00 and 15.00 hours to show effect of time of day on shadow concealment. It was also desired to have photographs to emphasize the need for concealment of troops.

3.—CONDITIONS OF THE EXPERIMENTS.

The photographs were taken in brilliant sunshine, all of them over the S. and M. field works ground. This area suffers from many excavations of different dates, mainly filled in. The surface is, therefore, irregular and aids camouflage. On the other hand, with the exception of an occasional tree and patches of heather-like growth, the ground is bright bare earth in which every scratch should show.

4.—CONCEALMENT OF FIELD DEFENCE AND CAMOUFLAGE.

The Prismatic Compass sketch shows the field works that were laid out.

A. Shelter with Camouflage.

At point A was an open excavation, 6′ by 10′ 6″ deep, containing an elephant shelter. Camouflage was erected over it in the form of an adaptation of wire netting cover, *vide M.F.W.* (*All Arms*, 1925), pl. 195. As an experiment, half an elephant shelter only was erected in excavation to ascertain difference in shadow. The camouflage appears to have failed as no smaller mesh wire netting than ½″ was available, and efforts to increase density of cover at centre by additional layers of this mesh wire netting proved to be

ineffective. Photo 71 V shows this point A taken at 1,000 ft., and 74 V shows it at 4,000 ft. In both cases camouflage has failed to hide the shadow in the excavation, and there is no doubt about the presence of some work, and a camouflaged work at that, as shadows have been interfered with (compared with trenches alongside).

B. and C. Shelters.

At B and C it was desired to ascertain, given a trench system, whether elephant shelters could be concealed merely by covering over with earth. At point B was an uncovered shelter in an open pit. At C the shelter was covered over, as was one trench leading to it. Photo 71 V, taken at 1,000 ft., shows that shelter C is given away by the uncovered trench entering it. If both trenches entering the shelter had been covered, the shelter might have escaped attention, particularly if the earth thrown up were evened off all round to throw no shadow. Photo 74 V shows that at 4,000 ft. the chances of non-detection are reasonable for a covered shelter.

D and G. M.G. Emplacements.

At D was an open M.G. emplacement uncamouflaged. At G the same emplacement was camouflaged, having over the complete excavation a form of " meat-cover," made out of a frame of 4" by 2" timber, covered with wire netting threaded with strips of sandbags and brushwood.

Photo 71 V shows D plainly at 1,000 ft. On 74 V at 4,000 ft. it is doubtful whether even the expert with magnifying glass would pick out this emplacement unless guided to it by other information. On 73 V, taken at 3,000 ft. but later in the day, D is definitely invisible.

Unfortunately, no photo of G was taken at 1,000 ft. On 72 V and 74 V, at 3,000 to 4,000 ft. without information from other sources, point G cannot be identified as an emplacement, though on 73 V the emplacement G is definitely visible. Comparing D with G on 73 V, the camouflaged emplacement at G is far more obvious than the uncamouflaged one at D. On 74 V, taken 3 hours earlier and 1,000 ft. higher, almost the reverse is the case. On the oblique 9 P at 500 ft. with other information G might be noticed.

E, F, I, J. Section Posts.

A group of four section posts, E, F, I, J, with the initial obstacle O and P, was constructed to represent a platoon-defended locality facing south.

Post E.—This was dug half under a small bushy tree and half was crudely camouflaged with rectangular frames of wire netting threaded with canvas, supplemented by branches of bushes. 71 V shows that even at 1,000 ft. the part under the tree and its shadow is totally invisible while the crude camouflage appears as such. As regards the greater heights, on 74 V, at 4,000 ft. taken at 09.00 hours, the camouflage is also visible. On 73 V, taken two hours later, the

camouflage is still visible. On 72 V, taken at 15.00 hours, the shadow of the tree has moved across over the camouflage and the whole section post is invisible.

Post I.—An attempt was made to camouflage this post with wire-netting fixed upon a bamboo framework and laced as before with canvas and brushwood. This failed entirely to hide the deep shadow of the trench at all hours of the day at all heights up to 4,000 ft.

Posts F and J.—These were dug without camouflage for purpose of comparison with posts E and J.

O and P. Wire Entanglements.

Double apron fence and French wire entanglement are invisible at 3,000 ft. No photo at 1,000 ft. was taken of these. Wire probably would only be visible if erected in broad bands and possibly only after rusting.

M and N. Bridges.

Bridges were constructed over a nullah at M and N, that at M being camouflaged by a framework of bamboo, supporting wire netting laced with brushwood and sandbags.

The oblique 6 P at 500 ft. shows the camouflage plainly. Both on this photo and on the verticals 73 V and 74 V the camouflage is shown to be quite ineffective.

5.—CONCEALMENT OF TROOPS IN OPEN.

(Photos 73 V and 75 V.)

Taken at 11.00 hours 75 V shows 100 men on track ST halted, in fours. The bright spot at the head of the column was an open map. At rear were two bullock carts, each drawn by two bullocks, the rear bullocks being white.

73 V was taken five minutes later. The men dispersed into parties, as shown on sketch to E, V, F, W and T. At E the men were in a trench, while an attempt was made to conceal the bullock carts under the shadow of a small tree. One cart is shown protruding. At V men lay in heather, at F they stood in open trench with bayonets fixed, at W they stood in shadow of a nullah, at T they lay on the track. This pair of photos shows that men dispersed and lying so as to throw no shadow are indiscernible at 3,000 ft., but that transport in the open is difficult to hide. Intelligent use of roadside trees might, however, at the halt, enable a whole column to escape notice.

CONCLUSIONS.

6.—EFFECT OF HEIGHT.

See Photos 71 V and 74 V. These show that while at 1,000 ft. concealment is very difficult, at 3,000 to 4,000 ft. there is some

chance of success (note point D, for instance). At the same time, under shadow, total concealment at any height is obtained (*e.g.*, point E, part under tree). The need for good air defence arrangements to keep enemy machines up high in an area in which important field work construction is going on (*e.g.*, prior to an offensive) is apparent.

7.—Effect of Time of Day.

See Photos 74 V, taken at 09.00 hours, 73 V taken 11.00 hours, and 72 V taken 15.00 hours. These show that, apart from the change in shadow protection (*e.g.*, over trench E), a point in the open, such as C or D, or camouflage as at G, is more conspicuous at some hours than others. It is, however, difficult to see how to take advantage of this knowledge, except that perhaps air defence measures could be accentuated during the hours of greatest shadow, *e.g.*, bright mornings and evenings.

8.—Importance of Information from Other Sources in Detecting Camouflage.

From this group of photographs, the importance of aiding camouflage by denying the enemy sources of information supplementary to his air photography is apparent. Such sources may be activity, *e.g.*, movement or firing near the camouflaged point, visible to ground or air observers, disclosures by tracks leading to the point or disclosures by prisoners (examples: M.G. at D on Photo 74 V and G on 72 V, 74 V and oblique 9 P).

9.—The Prospects of Concealment.

(*a*) *Natural.*

These experiments confirm that concealment obtained from natural conditions is greatly superior to any obtainable from artificial conditions. Particularly in tropical countries in which bright sunshine is the rule, the use of the resultant deep shadows offers great opportunities. A tree becomes as important a consideration as the field of fire in siting a post. Nullahs, sunken roads, deep banks or walls become increasingly important, and slits for one or two men or for M.G.s would appear far preferable to the standard section posts (*e.g.* on photos attached a platoon locality employing the nullah GN and its branches could have been held without being detected). Except when facing an enemy short of aircraft, guns and M.G.s, or when it is the intention rapidly to connect up the first trenches into a continuous system, the digging of standard section posts away from the protection of some natural cover would appear to be exposing the occupants to destruction.

(*b*) *Artificial Concealment.*

This group of experiments shows that at least in bright tropical sunshine, artificial cover is of very little value. The only work which was successfully camouflaged was an elephant shelter C on 73 V, successful because it was sunk below ground level and so threw no shadow with its covering, and because it was covered all over with earth which rapidly dried to the same colour as the surrounding ground. Points E on 71 V and M on oblique 6 P show that crude camouflage is worse than useless. Deep shadow as caused by a pit or trench cannot be hidden except by roofing with some material of thick, continuous texture, *e.g.*, A on 71 V and I on 73 V were covered but the shadow showed through. A sufficient covering (as at C, referred to above) necessitates the use of heavier materials as a rule, which cannot be supplied on sufficient scale.

(*c*) *Concealment of Bridging.*

The cutting of the outline of the banks and bed which any bridging involves makes concealed bridging very difficult (see M and N in 73 V and 74 V). Similarly, tracks or approaches to the site give a bridge away. With the need of surprise attacks by A.F.V.s across obstacles, however, this is a matter of great importance. Surprise could be achieved by bringing up materials in such a way as to show no tracks, by concealing materials in the shadow of the banks and erecting bridges during darkness immediately before use. Where an obstacle is shrouded from bank to bank by shadows of trees on the banks a bridge may remain undetected even in daylight.

Future Development.

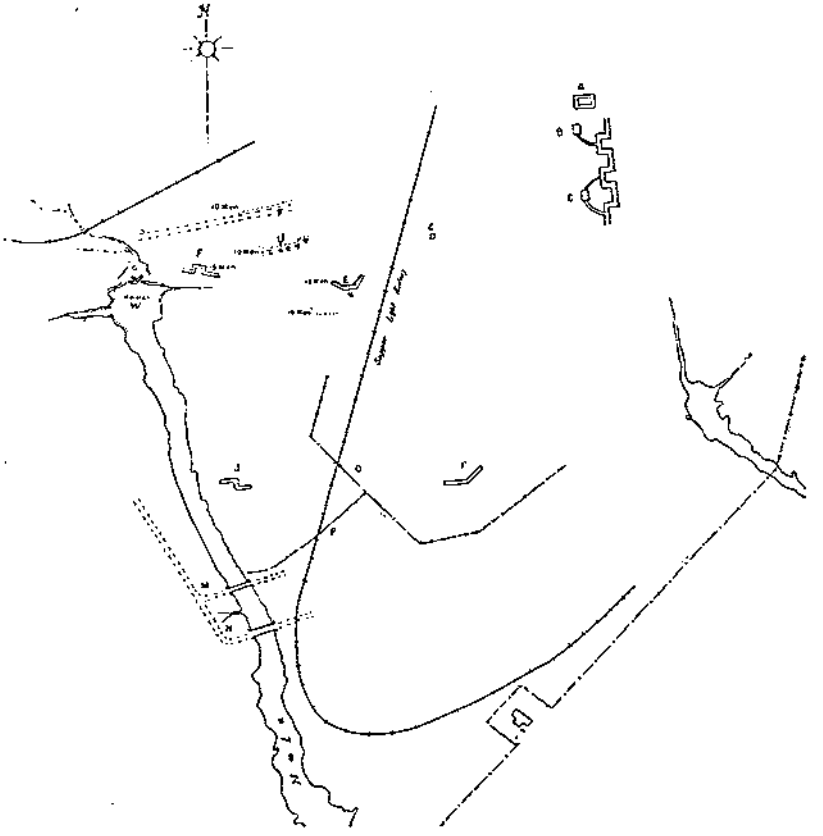
Two factors affect the future possibilities of concealment from the air. The first is the undoubted improvement being made in cameras and lenses which may result in far more information becoming apparent on photographs. The second is the parallel improvement being made in air defence arrangements which will force aircraft to a far greater height. These factors counteract one another. Only by periodic experiment will it be possible to ascertain the existing powers of aeroplane photography.

10.—General Conclusion.

The general conclusion arrived at from these experiments is that, in India, the disadvantages of continuous bright sunshine and good visibility compared with European conditions are balanced to a certain degree by the more pronounced shadows obtained. Further, in Southern India, there is no leafless season. Prospects of concealment are, therefore, by no means poor. The need for using natural cover far more than artificial camouflage is emphasized.

REPORT ON CONCEALMENT FROM THE AIR.

PRISMATIC COMPASS SKETCH.



REFERENCE.

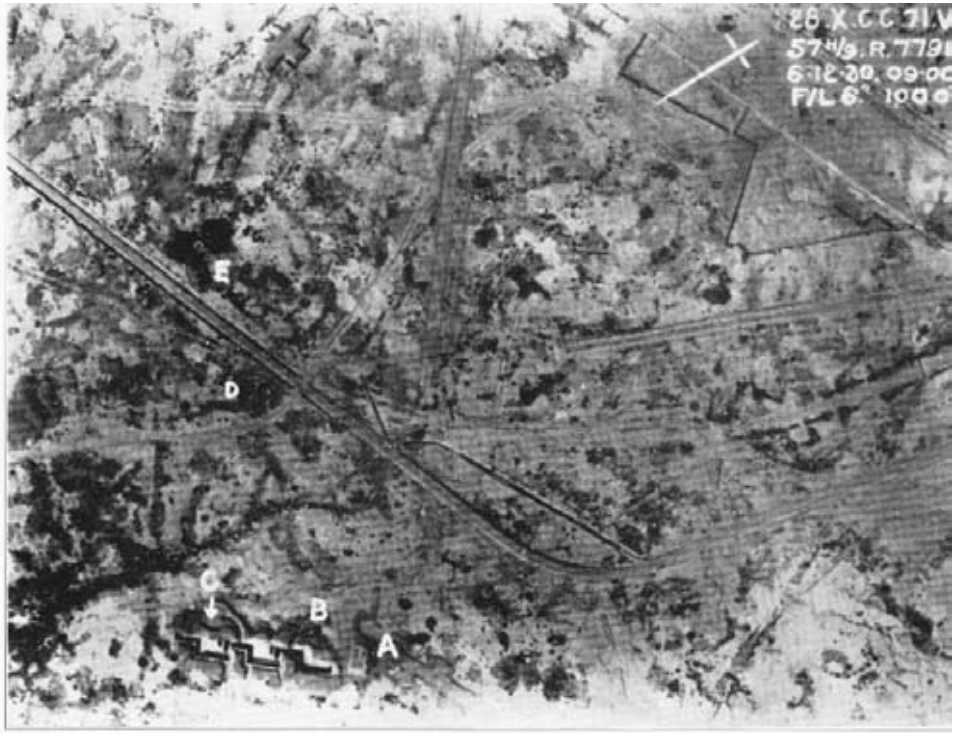
A Shelter with camouflage.
B Shelter without camouflage.
C Shelter covered with earth.
D M.G. emplacement without camouflage.
E Section post under tree.
F Section post without camouflage.
G M.G. emplacement with camouflage.
I Section post with camouflage.
J Section post newly dug.
M Bridge with camouflage and track.
N Bridge with track without camouflage.
O D.A. fence with knife rest.
P French wire

Oblique Photo 6.P., taken at 500 feet.

Oblique photo 6P.

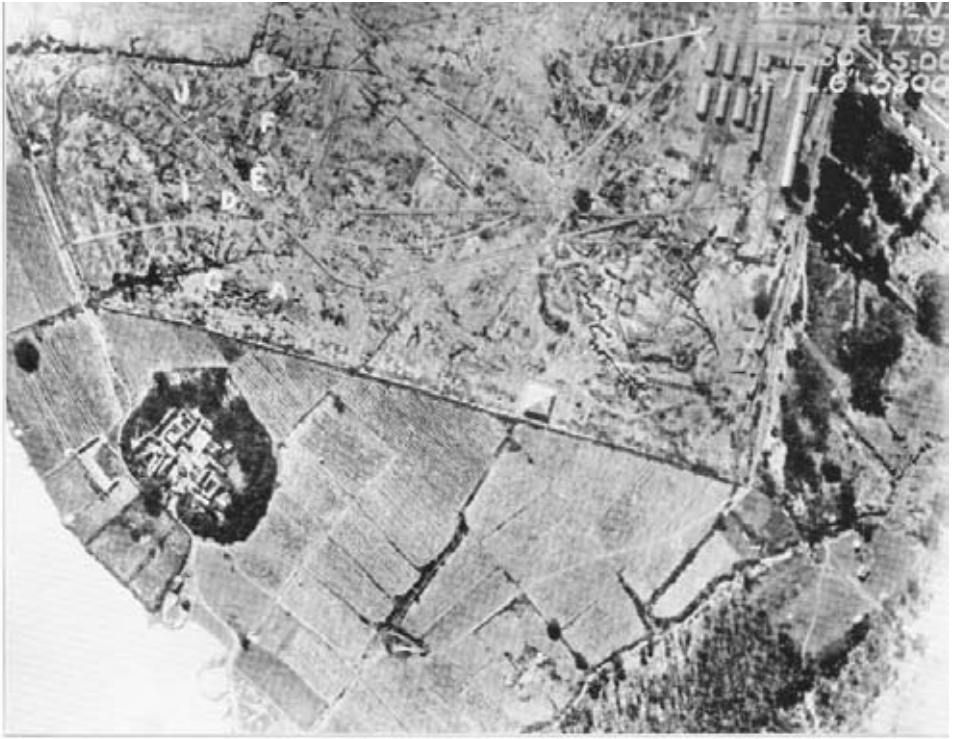
Oblique Photo 9.P., taken at 500 feet.

Oblique photo 9P.



Vertical Photo 71 V., taken at 1,000 feet.

Vertical photo 71V



Vertical Photo 72 V., taken at 3,500 feet.

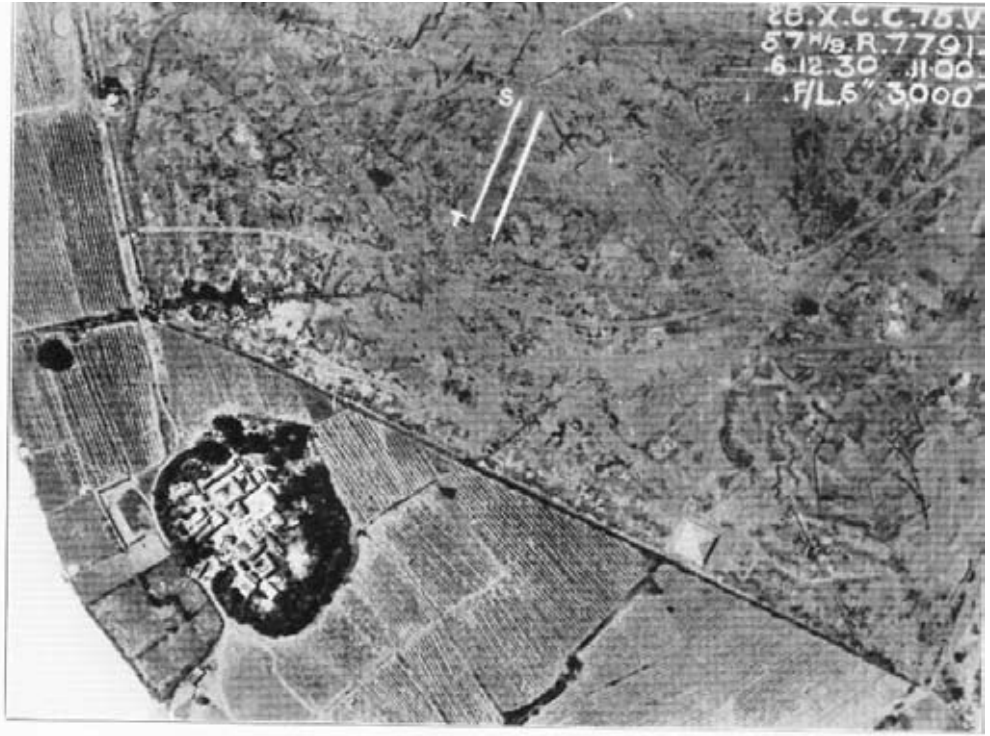
Vertical photo 72V

Vertical Photo 73 V., taken at 3,000 feet.

Vertical photo 73V

Vertical Photo 74 V., taken at 4,000 feet.

Vertical photo 74V



Vertical Photo 75 V., taken at 3,000 feet.

Vertical photo 75V

AN "F" PROJECT.

By LIEUTENANT A. E. M. WALTER, R.E.

THE reconstruction of Hogmoor Bridge, near Longmoor, was a typical example of an "F" project, though not carried out under the same conditions. The bridge carries the line over Hogmoor Pond, and is built of 30-foot spans of R.S.J.s carried on pile piers. Two of these spans had previously been demolished.

Firstly, the project will be briefly outlined and then its solution traced. The problems which arose and the methods of dealing with them will be emphasized.

THE PROJECT.

1. *Gap to be bridged*—60′ clear span.
2. *Load*—Waddell Class 30 load, *i.e.*, 1·72 tons per foot run (see M.E. Vol. VIII, Table Q).
3. *Bridge to be used*—A Class "A" Warren Girder Portable Road Bridge (deck span) strengthened to take railway loads was to be used. This bridge was lying built up in the yard at Longmoor.
4. *Machinery Available*—A 5-ton Steam Crane could be used for loading stores only in the yard. Locos and rolling stock were available for carrying stores as required.
5. *Stores Available*—12″ x 12″ timber and any P.W. material as required.
6. *Labour*—One section of the 10th (Railway) Company, approximately 1 N.C.O. and 29 O.R.s. (In practice, there were seldom more than 1 N.C.O. and 21 O.R.s.)

General—Work started on September 8th, 1930. Working hours, 7.0 a.m. to 1.30 p.m. All stores were in the yard at Longmoor. Bridge site is about 2 miles from Longmoor.

SOLUTION OF PROJECT.

The quickest and clearest way of showing the solution to the project will be to follow the work through as it progressed, emphasizing the problems. Photo 1 shows the gap and the start of the work on the three crib piers. The Warren Girder was to be carried on the two abutment piers.

Problem I. How to launch the girder. The Cantilever method could not be used, as no counterweight was available. Hauler and

preventer tackle could not be used. As can be seen from Photo 1, only one span of bridge existed beyond the gap, and then came a further gap between the bridge and the far bank. The bottom of the pond is sandy. It was discovered from simple tests that the back guy of a derrick (when used with hauler tackle) when anchored to this one span beyond the gap would have drawn the piles out. Hence hauler and preventer tackle could not be used.

Solution I. Two abutment (permanent) crib piers and a central crib pier (falsework) (see Photos 2 and 3) were built up to rail level. Four 36′ 75-lb. rails were launched over these cribs and fished up (Photos 2 and 3). The Warren Girder was then to be pushed over the gap on these rails by a loco.

Problem II. The stumps of the demolished pile pier in the middle of the gap protruded a few inches out of the water. How to build the central crib pier over these stumps ?

Solution II. Only two tiers of this central crib pier were built on shore, with gaps left to fit the pier over the pile stumps. The crib was then floated out and lifted by men swimming in the water over the pile stumps. The first five tiers of this central crib were dogged. Above that height the pier was built up without dogging the sleepers.

The abutment piers were only dogged to the height they would be when the girder was finally in position (see Photo 12). The sleepers were not dogged above this height, as they were functioning as falsework. These piers were built to a height of five tiers on shore, floated out and sunk under their own weight later as more tiers were built up. While the work was proceeding at the bridge site, a small party was at work unbolting the Warren Girder in the yard at Longmoor. The girder was split into five sections. The sections were loaded in pairs on to rectanks by the 5-ton crane (Photo 4) and taken to the bridge site.

Problem III. How to off-load the girder sections on to the existing bridge. It must be remembered from the setting of the project that the 5-ton crane was only available in the yard, and could not be taken to the bridge site.

Solution III (Photo 5) shows how each section of the girder was off-loaded from the rectanks. 12″ x 12″ timbers were built up under the buffers to support them. Ramps of four 36′ 75-lb. rails were built as shown and each section hauled off its rectank with 2-2 tackle, a 2″ cordage wound a couple of times round a sleeper being used as a preventer tackle. As each section came off the ramp, short lengths of old piping were placed underneath to act as rollers. Photo 6 shows the complete girder being bolted up preparatory to launching. Note the sleeper lashed to the back end, to enable the loco to push the girder over the gap.

As stated above, the original intention had been to push the girder over with a loco. At the last minute, in order to try and make the

Photo 1.—The gap.

Photo 2.—The three crib piers.

Photo 3.—Rails to carry girder over the gap.

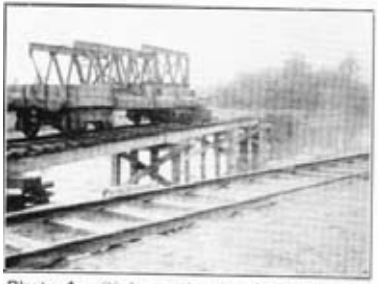


Photo 4.—Girder sections at the bridge site.

Photo 5.—Girder section being off-loaded from a rectank.

Photo 6.—Complete girder being bolted up.

An 'F' project 1-6.

Photo 7.—The start of launching the girder.

Photo 8.—The girder across the gap.

Photo 9.—Rails de-launched.

Photo 10.—The girder after a jack had slipped.

Photo 11.—Track being laid.

Photo 12.—Bridge completed and under load.

An 'F' project 7-12.

A MINING STORY.

(From *Military Memoirs of a Confederate*, and *The Long Arm of Lee.*)

TOWARDS the end of June, 1864, Brig.-General E. P. Alexander (Chief of the Artillery, I. Corps, Army of Northern Virginia), noticed signs opposite the Elliott Salient in the Petersburg Lines which at first led him to expect to see the parapets of zig-zag approaches shortly appear from the ground. Several days passed and nothing happened and, on the 30th June, he became convinced that the real Federal activities were underground. On his way back he happened to be slightly wounded by a sharpshooter, so that it was only on the next day that he went to General Lee's headquarters, where he reported his belief that the Federals were mining.

There happened to be at that moment with General Lee an English war correspondent, Mr. Lawley. He asked General Alexander how far it would be necessary for the Federals to tunnel to get under the Confederate works at Elliott Salient. General Alexander answered that the distance was about 500 feet. Mr. Lawley replied, somewhat pompously, that the largest military tunnel or gallery which had ever been run was at the siege of Delhi, and that it had not exceeded 400 feet, it having been found impossible to ventilate for any greater distance. Thereupon General Alexander curtly remarked that there were many Pennsylvania miners in General Meade's Army, and that mere military precedents would not deter them from making the attempt.

* * * * *

Actually, against the advice of all the military engineers at Federal H.Q., the gallery had been begun on the 27th June by Lieut.-Colonel Pleasants of the 48th Pennsylvania Regt., a coal-miner, who saw the opportunity which the situation offered. The celebrated mine (loaded with the, then, record charge of 8,000 lb. of powder) was blown on the 30th July, the gallery being 511 feet long, with two branch galleries at the end, each 37 feet long. Another competent civilian critic was thus demolished.

V.L.

MEMOIRS.

GENERAL SIR RICHARD HARRISON, G.C.B., C.M.G., COLONEL COMMANDANT, R.E.

(Reprinted by permission from *The Times*.)

GENERAL SIR RICHARD HARRISON, Colonel Commandant R.E., who died on Friday at his home at Brixham, Devon, at the age of 94, was a Mutiny veteran, and a soldier who filled many important appointments in the field and at home.

The second son of the Rev. B. J. Harrison, he was born on May 26th, 1837. He was sent to Harrow in 1850 to the house of Rev. G. T. Warner, West Acre, and played in the Football XI in 1854. He was not destined for the Army, but in March, 1855, as the result of the casualties in the Crimea, the War Office began granting direct commissions to public school boys. Dr. Vaughan, then headmaster of Harrow, recommended Harrison, who, after a course at Woolwich Arsenal, was gazetted to the Royal Engineers on July 31st, 1855.

Within a few months of joining, Harrison was sent out to the Near East, but the Crimean campaign was over, so that he did not go farther than Scutari and did not qualify for the war medal. Next year, however, he was dispatched to India. Though he did not arrive in time to take part in Sir Colin Campbell's march from Cawnpore to the relief of Outram and Havelock at Lucknow, he was at Alambagh when the British troops, too weak in numbers to inflict a crushing defeat on the rebels, retired, bringing away the surviving women and children. Outram with 4,000 men then remained at Alambagh to hold the rebels in check, while Campbell fell back upon Cawnpore. The rebels made strenuous efforts to capture Alambagh. But Outram's boldness in sallying out in full force was largely based on his confidence in the security of his defensive works, and for his share in the construction of these defences Harrison received the warm commendation of Lothian Nicholson and of Outram himself.

Under Outram's command Harrison next took part in the ultimate capture of Lucknow. Afterwards he served throughout the campaign in Rohilkund and was with Campbell when he captured Fort Rooyah, dispersed another body of rebels at Allegunge, defeated the Ghazis at Bareilly, and drove them across the Gogra. In the final operations, by which Campbell and Hope Grant cleared the rebels from Oudh, Harrison also took part. Then again in 1859, during the Trans-Gogra campaign, he was with Lord Clyde's column as staff officer to the C.R.E. . . .

Before the close of 1859 Harrison was once more in the field with Sir Hope Grant's expedition to China, where he took part in the siege

Lieut. Richard Harrison, R.E.

(Taken at Chatham, 1861.)

Richard Harrison 1861

General Sir Richard Harrison, G.C.B., C M.G., Colonel Commandant R.E.

(*As Inspector-General of Fortifications, November*, 1902.)

General Sir Richard Harrison, GCB, CMG, Colonel Commandant RE 1902

and capture of Taku Forts. In these operations his comradeship with Major Garnet Wolseley, begun at Alambagh, became a life-long friendship. In the advance on Peking Harrison was attached to the Q.M.G.'s staff, and for his services was recommended for a brevet majority. During two years' service in Canada, he travelled in the United States at the opening of the Civil War, and, though he saw no fighting, he came near to being hanged as a spy.

He returned to Chatham in 1861, and from 1876–79 was at Aldershot with the R.E. Train.

While at Aldershot in 1874, after promotion to brevet lieutenant-colonel, he failed, largely owing to domestic trouble, to pass into the Staff College. Next year, however, he succeeded in the examination, and after two months' practical training was granted the certificate without passing through the College. In the meantime he became known to the Duke of Cambridge, whose approval was a great assistance to him. In 1877 he won the gold medal of the Royal Engineers Institute for an essay dealing with the work of engineers in war.

Among the reinforcements sent to Africa to retrieve the destruction of the small British force at Isandlwhana, in Zululand, in January, 1879, was the 30th Field Company, R.E., which Harrison had joined at Aldershot as O.C. on mobilization. Soon after arriving at Durban, he was transferred to the H.Q. Staff as Assistant Quarter-master-General, and in that capacity was responsible for intelligence work. For this duty he was allotted a very small staff, which included the young Prince Imperial of France, who, while thus employed, was surprised and killed by the Zulus. In the end, Harrison emerged from the affair without loss of reputation, and after the defeat of the Zulus at Ulundi, took the place of Colonel Evelyn Wood for a few weeks as commander of the Flying Column. Soon afterwards he was entrusted with the reconnaissance of Sekukuni's stronghold, and finally became commandant of the troops employed in the Transvaal during the suppression of that chieftain.

In June, 1880, he received the appointment of C.R.E., Aldershot, soon to be changed to that of the A.Q.M.G. As a result both of his friendship with Wolseley and his lectures dealing with preparation for war, he was, in July, 1882, appointed A.A.G. to General Earle, who had been selected to command the communications in Sir Garnet Wolseley's forthcoming Egyptian expedition. Harrison was present at the action of El Magfar, also later, but as a spectator only, at Tel-el-Kebir. He was again nominated, in 1884, to go out to Egypt as A.A.G. on Lord Wolseley's staff in the attempt to relieve Gordon, but while in charge of the line of communications beyond Wady Halfa he was invalided home. Shortly after, he returned to his appointment of A.A. and Q.M.G. at Aldershot, but went on half pay in February, 1886. In the summer he received command of the

Royal Engineers in the South Eastern District, but was soon transferred to the like appointment at Aldershot, where he remained until promoted Major-General in July, 1888.

In June, 1889, Sir Richard Harrison received his first general officer's appointment, that of Governor of the Royal Military Academy. He had not been a cadet there, but he filled the post with success. In April, 1890, he accepted the command of the Western District, and for more than five years was a hospitable and popular occupant of Government House, Devonport. He was promoted Lieutenant-General in 1893, and full General in May, 1895. In 1897 he served temporarily as Quartermaster-General at the War Office, pending the arrival of Sir George White from India, and in the summer of 1898 was appointed Inspector-General of Fortifications and member of the joint Naval and Military Committee of Defence. He completed his full five years' tenure of this office, and then retired after 49 years' service. He contested Mid-Devon in January, 1904, as a tariff-reformer.

Sir Richard Harrison was created C.B. in 1879, C.M.G. in 1882, K.C.B. in 1889, and G.C.B. in 1903. He was a Colonel Commandant R.E., and Hon. Colonel of the South Midland Divisional R.E., and the Devonshire Territorial R.E. He published in 1897 *The Officer's Memorandum Book in Peace and War*, and, in 1908, his autobiography entitled *Recollections of a Life in the British Army*. He married in 1870 Amy, daughter of Lieutenant-Colonel J. Doyle O'Brien, and had one son and three daughters.

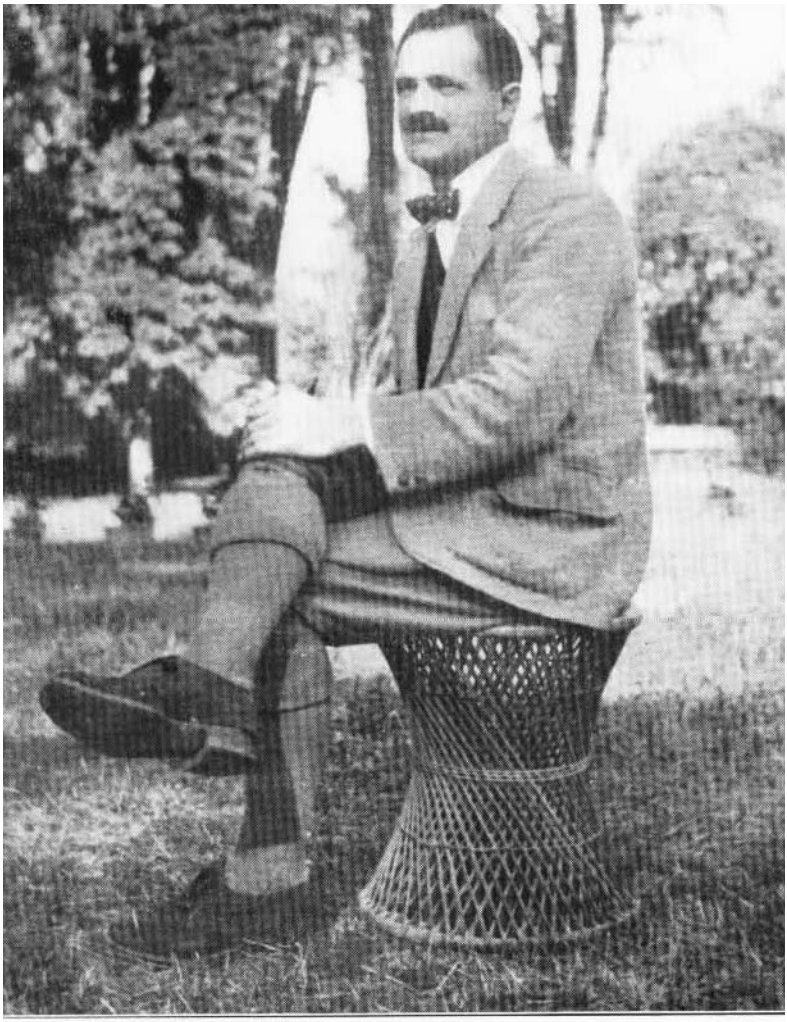
After retirement Sir Richard Harrison continued his activities in Corps matters, with which he kept in close touch. He was the originator of the R.E. Corps Committee, and was chairman of it from 1907 till 1922, when failing health at the age of 85 compelled his resignation.

He also originated unofficially the "Representative Colonel Commandant," about 1906–7, and filled the position himself until 1922.

Sir Richard Harrison had always been interested in the formation of a R.E. Museum. In 1880, on his motion, a Sub-Committee was formed to deal with the question, which underwent various vicissitudes for many years. After the South African War, when the want was again felt of some place in which to exhibit the trophies and relics of the Corps, the Colonels Commandant discussed at a meeting in 1904 the possibility of providing a Corps Museum.

Eventually in 1908, a Committee with Sir Richard Harrison as President was appointed to formulate a concrete scheme. As a result of the work of this Committee, the present Museum was formed in the old Model Room.

In these and other matters Sir Richard continued to render valuable services to the Corps.



Lieut.-Colonel Henry Treise Morshead, D.S.O., R.E.

Henry Morshead.

LIEUTENANT-COLONEL HENRY TREISE MORSHEAD, D.S.O., R.E.

HENRY TREISE MORSHEAD was born in 1882, the eldest of the seven children of Reginald Morshead, *J.P.*, of Hurlditch Court, Tavistock, owner of Lamerton on the borders of Cornwall and Devon, and a wrangler of St. John's College, Cambridge. His mother belonged to the Gloucestershire family of Sperling. The Morshead family had been settled in Cornwall for many generations, and the branch to which the subject of this memoir belonged was cadet of the Morsheads of Tregaddick, near Bodmin. Sir Warwick Morshead of Tregaddick, third and last baronet, died in 1905. The youngest of the seven children of Reginald Morshead is Mr. O. F. Morshead, D.S.O., M.C., Librarian at Windsor Castle. A younger brother of Reginald was Frederic, a distinguished housemaster at Winchester whose name is still associated with the house. Frederic was a noted climber in his day, and among his feats was the ascent of Mont Blanc in record time. Henry went to Winchester to his uncle's house, but apparently his taste for climbing was inherited for he never climbed with his uncle and, as far as is known, never went in for high climbing till his ascent of Kamet with Kellas in 1920.

Morshead was a typical West Countryman: small and dark, well-built and lithe. His energy was unbounded, and he had the resourcefulness and the quickness of decision essential for an explorer. When in his company the writer always felt that the men who went adventuring with Drake from the West Country ports must have been cast in this mould. Blessed with an impregnable digestion and indifferent to personal comfort, he would assimilate any fare that came his way, or if no food at all was available he would do without it—and without water either, if need be. He was hard as nails and always in perfect condition; this was attained not by any fads or dramatic exertions, but by common sense in the regimen of life. It was always a pleasure to see his well-knit body stripped for swimming, or in shorts and shirt-sleeves swinging along the path and over the hills. By no means averse to society and organized games, he probably got his greatest pleasure in breaking away from the conventions of station life in India and "taking to the hill." During the years when Morshead spent the hot weathers at the Survey Headquarters at Mussoorie, the writer used to accompany him in week-end tramps of seventy or eighty miles over the hills, and has lively recollections of watching him swinging along, sometimes—in uninhabited stretches—in his shirt-tails and carrying his shorts to avoid a threatened chafe!

From Winchester he passed direct into the Royal Military Academy at Woolwich, passing in low and passing out high, an incident not uncommon in candidates entering straight from a school and not from a crammer's. He passed out high enough to be able to choose Engineers, and his record at Woolwich and Chatham was a foretaste of his subsequent career. Though blessed with good brains and judgment his academic distinction was but moderate; the Fowke Medal awarded to him was, typically, "for a young officer who has distinguished himself in the School of Construction."

After leaving Chatham he was posted to India in 1904 and stayed there for ten years, with only occasional leave home. Like many young sappers in those days, he was appointed to the Military Works Department; during these years he led a life of routine, during which he acquired a knowledge of the land, the people and the languages, that was later to contribute greatly to his success as an explorer.

A man of Morshead's character would not long be content with a life of routine, however useful, and the lure of adventure inevitably drew him to the Survey of India, in which life in the open was a certainty, adventure a probability, and high adventure in the form of exploration a reasonable possibility. To a sapper there was yet another incentive in that the world-wide repute of the Survey of India, both for scientific research and for exploration, was largely due to the work of the officers of the Royal Engineers who formed the bulk of the gazetted officers of that Department. It was, therefore, in the order of things that Morshead joined the Survey of India in 1906; the first few years were spent in acquiring the technique of the science of modern surveying and the art of getting on with the people and over the ground.

The first opportunity of out-of-the-way work came in 1911, when he was detailed as a member of the Mishmi Mission Survey Detachment. The story of this adventure has been told in the pages of this journal (January, 1915) by Captain (now Colonel) Gunter. It is a record of rain and mist in the valleys, and snow, mist and intense cold on the hill tops; the summing up being twenty-one clear days in four months! To get the necessary views the parties had to climb difficult hills and not infrequently had to descend *re infecta* owing to the weather. Add to the climate dangerous tracks, broken bridges and deserting coolies and some idea can be formed of the conditions in which an unknown country was added to the map. In these exertions and hardships Morshead took a leading part, and an estimate of his work can be formed from the following extract from the official report:—

> "The whole area under survey was triangulated by Captain Morshead, and he fixed peaks on the entire main watershed except those portions north and east of the Dri River and north of the Tangon River. This is a record for one observer without help of

any sort from recorder or computer under such trying weather conditions as prevailed throughout. . . . Captain Morshead completed the computations of almost every triangulated point within a few hours of the observations having been made and sent the results to the plane-tablers long before the latter required them. As most of the computations were carried out while camped in snow and under very trying conditions, it can be realized what a fine record Captain Morshead has to show for his season's work."

Henry Morshead had found his life's work.

The survey of the Mishmi country came to an end in 1913, but Morshead stayed behind to try, in company with Captain Bailey of the Foreign and Political Department, to discover the connection between the Tsang-po of Thibet and the Bramaputra of Assam. An entertaining account by Morshead of this exploration appeared in *The R.E. Journal* for January, 1921. In this account the difficulties and dangers are made light of, but otherwise the account is a full one of the exploration of one of the few important blank spaces remaining in the world. It was a fine effort; two Europeans plunging into an unexplored region with nothing to support them save knowledge, determination and courtesy. Once again Morshead was thoroughly in his element, and his share in the expedition was rewarded by the Macgregor Medal.

When the Great War broke out, Morshead was at home on leave. He was promptly shipped out to India on the *Dongola* of unhappy memory, and on arrival there was—promptly shipped home again! There he was posted to the Field Company R.E. of the 16th (South Irish) Division. Owing to political causes this Division was slow in recruiting, so in 1915 the R.E. unit was incorporated in the Guards Division near St. Omer, and took part in the battle of Loos in September. In 1916 he was promoted Major and commanded the R.E., 46th Division. While in France and Belgium he was wounded and received two mentions in dispatches and the D.S.O. In 1919 he was transferred to India and immediately took part in the Third Afghan War, and later on in the same year was with the Mohmand Field Force. Early in 1920 he served with the Waziristan Field Force. For these services on the north-west frontier of India he received the Indian General Service Medal with three clasps, and ended five years' continuous active service. A fine record. He then rejoined the Survey of India.

As a sort of relaxation, apparently, from the hardships and dangers of field service, he joined Dr. Kellas in the autumn of 1920 in an attempt on Mount Kamet. An account of this journey was contributed by Morshead to *The R.E. Journal* of April, 1921; this account is short and lays no stress on his own hardships and exertions, while great admiration is expressed for the leader of the expedition. The party reached the great height of 23,500 feet, and it was

apparently only through lack of technical knowledge in this special field that the attempt was not successful. However, the experience and confidence gained in this expedition undoubtedly inspired him to further adventures in the direction of high climbing.

In 1921 he accompanied the first (reconnaissance) expedition to Mount Everest as Officer Surveyor, and in that capacity surveyed 12,000 square miles of new country and reached a height of 22,000 feet. In 1922 he accompanied the second Everest Expedition and reached 25,000 feet, but owing to frostbite and temporary sickness was unable to accompany the party next day, when it reached a point two thousand feet higher. An account by him of these two expeditions appeared in *The R.E. Journal* for September, 1923, but, as usual, his personal hardships are only lightly referred to. An estimate of these hardships can be formed from Brig.-General Bruce's book, *The Assault on Mount Everest*, 1922, from which one extract may be quoted :—

> "As a *tour de force* it stands, in my opinion, by itself. It was the most terrific exertion, carried out during unfavourable weather and in face of that dreadful west wind. . . . It was a tremendous effort unparalleled in the history of mountain exploration, but it gave immense confidence to all that the mountain was not unconquerable."

The severity of the exposure is shown by the fact that Morshead, in spite of his hard condition, was frostbitten, and some months later had to undergo amputation of the top joint of three fingers of the right hand. He told the writer that in his opinion the frostbite was due to unsuitable clothing ; he received permission to accompany the expedition so late that there was no time to get proper kit from home, and he had to set off with what could be found in the Darjeeling bazaar. Characteristically, he considered the damage to his hand a smaller loss than the failure to reach the summit. This injury prevented him from taking part in the third Everest expedition in 1924, a great disappointment, but he found an outlet for his craving for adventure in accompanying the party that, in 1927, made the first crossing of Edge Island in Spitsbergen. This was probably the first time that the Survey of India was represented within the Arctic Circle !

Morshead was appointed a Deputy Superintendent of the Survey of India in 1921, and a Superintendent in 1926. In 1928 he was promoted Lieutenant-Colonel. He was appointed Director of the Burma Circle, with headquarters at Maymyo, near Mandalay, and it was there he met his death in May, 1931, at the age of forty-eight ; he was found dead from gunshot in the woods near Maymyo, having met his end while out for a morning ride.

In 1917 he married his second cousin, Evelyn Templer, daughter of

Mr. Henry Widdicombe. They were much to each other, and only a week before his death, he wrote to the author of this memoir, giving news of himself and his family, the letter implying a great happiness in life. He leaves four sons and one daughter, all under twelve years of age. The responsibilities of the widow may be partly lightened by the knowledge that if heredity counts for anything—as we know it does—then the children of such parents will not fail in the race of life.

In conclusion, it may be profitable to sum up what this Royal Engineer officer accomplished in rather less than thirty years of adult life :—

The Mishmi Survey, 1911 to 1913.
Exploration with Bailey of the Tsang-po in 1913.
During the Great War five years' continuous active service on the Western Front and on the North-West Frontier of India.
Attempt with Kellas on Kamet in 1920.
First Everest expedition, 1921.
Second Everest expedition, 1922.
Spitsbergen, 1927.

And so, all too young, passes a faithful friend and a very gallant gentleman, leaving to the Corps, the army and all who love high endeavour, a shining example of the motto, "*Quo Fas et Gloria ducunt.*"

W.H.O.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE ROYAL ARMY SERVICE CORPS.

A HISTORY OF TRANSPORT AND SUPPLY IN THE BRITISH ARMY.

In two Volumes. Vol. I by JOHN FORTESCUE, LL.D., D.LITT. Vol. II by Colonel R. H. BEADON, C.B.E., *p.s.c.*, late R.A.S.C., with an Introduction by JOHN FORTESCUE.

(Cambridge University Press, 1930–31. Price 21s.)

The Royal Army Service Corps is to be congratulated on inviting Sir John Fortescue to write the History of the Corps and persuading him to undertake a work covering such a wide field and involving so much labour and research. It is not surprising that he found it necessary to entrust the major portion of the second volume to Colonel Beadon, an officer of the Corps who is well qualified to describe its development since the South African War and the important and successful part it played in the various theatres of the Great War. Together they have produced a work which as the standard book on the development of Supply and Transport in the Army will be of immense and lasting value to the British Nation.

No one is better qualified than the author of the *History of the British Army* to write of the many campaigns in which that army has taken part, and no other military writer has at his fingers' ends the profound knowledge of his subject which enables him to confine the historical portion of the book to the essentials which affect the "ancient" history of the service of Supply and Transport and at the same time produce a thoroughly readable volume.

Volume I is, in fact, a "short history" of the British Army from its infancy as Cromwell's "New Model" to the South African War of 1899–1902, a date which may be taken as that of its rebirth.

Volume II contains an Introduction by Sir John Fortescue covering briefly the history of the service as a Corps and giving generous tribute to some of those to whom it owes so much, particularly Major-General S. S. Long and Lieut.-General Sir Crofton Atkins, who bore the brunt of the work at the War Office during the Great War. This recognition of the outstanding qualities of Major-General Long is more than overdue: like most forceful men he made enemies, and he received no recognition from the Government for his invaluable services. Others to whom the Corps owes much are mentioned in various portions of the book, but the names of General Sir Redvers Buller—the Father of the Army Service Corps—Lieut.-General Sir F. T. Clayton, Brigadier-General J. R. C. Paul, Major-General C. E. Heath, and General Sir John Cowans, Quartermaster-General of the Forces from 1912 to 1919, are familiar to all, while those of Major-General Sir W. G. B. Boyce, Major-General Sir E. E. Carter, Major-General Sir R. Ford and Colonel H. G. Burrard are well known to those who served in France.

Colonel Beadon takes up the pen to describe in detail the building up of the vast organization which contributed so largely to victory in 1918. He includes a particularly interesting chapter on the development of Mechanical Transport, and

goes on to deal with the activities of the Corps in each theatre of the Great War and its aftermath in Mesopotamia and Russia.

The British nation has always had to pay heavily for its wars, and the reasons are not far to seek. The voluntary system may have advantages, but it has many drawbacks, and one of its worst features is that the people and its representatives forget, or ignore, what happened last time. Unfortunately the profiteers have a long memory, and do not forget, or they very quickly pick up the threads dropped by their forbears. Cromwell's "New Model" was a far more efficient fighting machine than anything that had come before it, but even his administrative system was crude, and whatever success he achieved in the Civil War at home was more than discounted by the disastrous—Sir John writes disgraceful—failure of his buccaneering expedition to capture St. Domingo. True that Jamaica was captured, but the expeditionary force of 6,000 men—a rabble though it was—was practically annihilated by starvation and disease due to the bad food provided by the Victuallers of the Navy and the absence of any medical arrangements. There was some improvement in the Supply arrangements during Marlborough's campaigns. He had broken down the system of sedentary warfare which up to his time was in vogue on the Continent of Europe and his rapid movements necessitated a mobile army which could march and fight. It could do neither in a country denuded by the enemy of supplies and transport unless it could carry its food and move its guns and ammunition. Both the system of supply and the amount of army transport were therefore improved and augmented. He it was who initiated the system of contracts for the provision of bread to the troops in the field.

But it was not till Sir Arthur Wellesley, afterwards Duke of Wellington, had to undertake the reorganization of the forces in Mysore in 1803–1805 that supply and especially transport received that personal attention of the commander in the field, which is necessary to make successful war. The shortcomings of the Indian Commissariat, to remedy which Wellesley in his limited sphere did so much, were however —in the words of Sir John Fortescue—unblushingly uncorrected more than sixty years after the Battle of Assaye. Wellesley realized that a force of 20,000 men with 50,000 followers, as at Seringapatam, or a force of 31,000 men with 150,000 followers, as later in Madras, was useless for offensive purposes. He also realized that trained personnel, officers and drivers, were necessary if transport oxen were not to die in thousands through neglect. His letters, like Marlborough's, are full of his anxieties on the subject, as also the urgent need of money to pay for supplies, and the hire of transport, and provide for the pay of the fighting men, and thus ensure discipline. The Crimea and the Indian Mutiny were, nevertheless, to prove that the nation had forgotten all about the systems that these great generals had taken such pains to create and organize.

"The forty years," writes Sir John Fortescue, "which followed upon Waterloo "were amongst the most dismal of the Army's history. The nation, as Lord Liver- "pool, the Prime Minister, said was peace-mad, and the soldiers who had saved it "were cursed as plagues." Politicians scented militarism in the most trivial acts of the soldier, and denounced such acts as a military conspiracy to enslave England.

"Englishmen," continues Sir John, "are never quite so great as during the con- "tinuance of a dangerous war, never quite so silly as when it has come to an end. "Yet a new Empire had been won and an army was necessary to guard and con- "solidate it; but the country would never provide money enough to pay for a "sufficient force. The army was shamefully overworked and underpaid. . . . "When the combatant branches were so badly treated it is no surprise to find that "the Wagon Train, an ancestor of the R.A.S.C., was a constant target for the shafts "of false economists in Parliament. Officers of experience pleaded that some "nucleus should at least be preserved for expansion in the case of war; but the "answer of the ignorant was that surely soldiers were not needed to drive wagons." Accordingly, the Wagon Train was swept away in 1833–4, and the Commissariat, the

other ancestor, dropped back into its old groove of accountancy under the direct control of a civil department, the Treasury, which knew nothing about war, and always thought of the Army not in terms of living men, but of pounds, shillings and pence. The strange thing was that during these forty years after Waterloo, wars of greater or less scale never ceased in some part of the Empire. The starvation of the troops and animals in the Crimea and the disasters of the Indian Mutiny were both due to the same cause, neglect on the part of the Government to maintain an adequate army with adequate ancillary services. The China War of 1864 served further to draw attention to what was already apparent after the Mutiny, the difficulties which attend the separation of transport and supply, and the fact that the Military Train was organized and officered on wrong lines.

One would have imagined that the successful campaigns of the Germans in 1863, 1866 and 1870—short though they were—would have kept the British Government alive to the necessity of keeping up a proper establishment of officers and men trained for transport and supply duties, but though the Cardwell reforms did something for the Army, it was not till 1888, when Sir Redvers Buller was successful in getting the supply and transport service recognized as a homogeneous corps, the "Army Service Corps," that the cardinal principles were at last accepted, viz., that the man responsible for the wagon must also be responsible for the load, that the man responsible must be a trained military man and not a civilian, and that drivers are as important as beasts.

Thanks to Sir Redvers Buller there was at last some hope that in the next war the failures of previous wars would not recur. It may be mentioned here that load tables, a modern invention so it was thought, owe their origin to a little pamphlet printed at Philadelphia in 1766, in which Bouquet included the tables he had worked out for the exact amount of transport required for an expedition he had led against the Indians together with the load of each wagon and each pack horse, somewhat in the style of our Mobilization Tables of to-day. Sir Redvers had been shown a copy of this valuable pamphlet—it now commands a fancy price—by Sir John Fortescue.

In the Egyptian Campaigns of the decade following the creation of the A.S.C. in 1888, the personality of Sir Herbert Kitchener and the fact that it was the Egyptian Army that was fighting prevented the new organization being tried out. Transport and Supply were under different heads, but they were in a way united in the person of the C.-in-C., without whose orders not a ration could be moved.

It was the South African War of 1899 which was to give the A.S.C., as a Corps, its baptism of fire, and with Sir Redvers Buller in supreme command it could not have made its *début* under better auspices. What happened after that "Black December" of 1899, is not very clear. The authors hold that Lord Kitchener or Lord Roberts, or both, were responsible for upsetting the organization of the Corps, and assert that the decision had already been made before they landed in South Africa. In February, 1900, an order was issued by Lord Kitchener that "the whole of the 2nd Line Trans-" port (the words are the authors') and all the rest of the transport—Ammunition "Columns, Ammunition Parks, R.E. Units and Supply Columns" were to be swept into a common pool to lie at disposal for any purpose. Whatever may have happened to other units, the reviewer can definitely state that R.E. Field Companies were not denuded of all their transport. They were still left in charge and command of the mule teams and native drivers for their Tyler Carts, technical vehicles, and pontoon and trestle wagons. The baggage and supply wagons of all units were organized in Transport Columns, but the same wagons and teams were sent to the unit each day, and returned when unloaded to the Transport Column camp for the night, or longer if units were halted. Owing to the deficiency in A.S.C. personnel the Transport Columns were commanded by officers of all arms—in the case of "Plumer's Column," by a distinguished Guards officer who had been Transport Officer of his battalion and proved to be a most excellent Column Transport Officer. The authors, no doubt, would say that whatever advantage Lord Kitchener gained by

his drastic order—it was not accepted without a good deal of grousing by battalion commanders who liked to have control of their company wagons—might equally well have been attained without upsetting the whole organization, and that the possibility of the temporary withdrawal from units of their 2nd Line Transport had been foreseen and would have been carried out whenever circumstances demanded. But there is no doubt that there had been wasteful employment, or allotment, of some of the transport, especially in the case of sedentary units and garrisons on the L.-of-C., and as there was a shortage of transport and trained A.S.C. personnel for the rapidly increasing army, something had to be done, and done quickly, to make full use of whatever transport was in existence, whether it was the 2nd Line of combatant units or the Ammunition and Supply Columns and Parks. The protest raised by the authors of the *History of the R.A.S.C.* cannot be taken objection to, but for them to write that neither Lord Roberts, nor Lord Kitchener—not to mention that very able officer Sir William Nicholson—knew anything about the organization of transport, is open to question. Unfortunately they go farther, and though they are—or were—in the fashion when they belittle the qualities of the man who saved the Empire by his far-sighted policy on mobilization, they overstate their case by having another thrust at him—below the belt, for he is dead—when they go on to state that he was responsible for ordering the troops destined for Gallipoli to proceed without any transport whatever, on the grounds that the distance between the beaches and the trenches was so short that transport was not required. Whatever instructions Lord Kitchener gave had to be interpreted into orders by his administrative subordinates, as well as the General Staff, at the W.O. or at the Front, and interpreted with common sense.

Lord Kitchener may have made mistakes, for all men are human. No man was more human than K. of K. if he was approached and treated as a human being, and not as an ogre.

Except for this blemish the book is good reading. Every Staff officer should read and digest the lessons it teaches. Is it too much to hope that the politicians will also glance at it, especially the concluding paragraphs of Sir John Fortescue's appeal on behalf of the Corps in the Introduction to the second volume? His words are well timed at the present moment, when peace-mad economists are once again meddling with the future of all Britain's armed forces, and when, if we are called upon to defend our honour, we shall in all probability have "to take it lying down," on land, or sea, or in the air.

The folding maps at the end of each volume are ample in number and clear—though the thinness of the paper is unfortunate; there is a good index, and the price is reasonable.

H.B-W.

DÉFENSE DE LA POSITION FORTIFIÉE DE NAMUR 1914.

État-Major Général de l'Armée. Section de l'Historique.

(Bruxelles, Institute Cartographique Militaire, 80 francs.)

This is the official account of the siege of Namur in August, 1914, compiled by the Historical Section of the Belgian General Staff. It is a substantial volume of nearly 800 pages, including many documents, accompanied by a case of maps. Beginning with a description of the forts and armaments, and the role the fortress was expected to play, there follow chapters on mobilization, the putting of the fortress into a state of defence, a day by day narrative of events, ending with the successful escape of the 4th Division and the mobile troops.

The compilers are at pains to show the difference between the defence by General Michel and the better-known defence of Liége by General Leman. The conditions at the two places were very different. The Germans tried to take Liége by assault

with six small columns. Having failed, they brought up their battering train. At Namur they did nothing until, under protection of covering troops, the heavy guns were in position; when these had made the forts untenable, they took possession. Hence they were not detained so long as at Liége. But it is justly claimed that, with the help of the fortress, one Belgian division with the help of three French battalions and some fortress troops kept seven German divisions from the Battles of the Frontier. General Michel, finding his forts were being destroyed and the German armies closing in round the fortress, so that only a corridor to the south remained open, decided to withdraw the mobile troops. None too soon, for they lost nearly a thousand men killed in fighting their way through to join the French.

Two plans show the effects of the bombardment on Fort Cognelée, and there are tables giving the German artillery employed, the rounds fired and the number of hits, their distribution, and the effects on the concrete and armour. Designed to resist 21-cm. shell, the forts naturally could not stand up to the larger calibres employed. "The resistance of some forts was shortened and compromised by the vitiation of the air occasioned by the explosion of the German projectiles." The guns of the defence, being inside the forts and damaged with them, could do little to keep the enemy off, in fact the attacking artillery was beyond their range.

J.E.E.

LECTURES ON *F.S.R. II.*

By MAJOR-GENERAL J. F. C. FULLER.

(Sifton Praed & Co. 7s. 6d.)

Quotation from General Fuller's preface to his own book will best explain his purpose in presenting this series of lectures to the military community. He writes, "... when in command of an infantry brigade I found that the *Field Service* "*Regulations* were read for purposes of examination, but consistently neglected in "the field, especially if action were in any way hurried. The reason for this was no "doubt due to lack of professional interest, but also in part to the extreme dullness "of the book, especially when read by a lukewarm soldier. Nevertheless, I do "think, seeing how unimaginative the normal British officer is, that over-condensa-"tion defeats its end by presenting such a host of facts that the mind of the reader "becomes bewildered and weary. To overcome this disadvantage, which is a real "one, I gave the officers of my brigade a series of lectures on *F.S.R., Vol. II*, not so "much from an historical point of view as an explanatory one. ..."

In order to bring the unimaginative officer on friendly reading terms with our thus maligned Manual of Operations, General Fuller takes him chapter by chapter through its contents, examining, explaining, amplifying and occasionally criticizing. It would be surprising to find dullness in any work of our author's, and this book is no exception. His treatment of the doctrine of *F.S.R. II* is always interesting and instructive, and there is sufficient of controversial matter to satisfy the argumentative and stimulate the unimaginative. The diagrams, the majority purely geometrical with the object of "expressing a tactical idea," illustrate a variety of subjects ranging from Alexander's Anti-Scythian Tactics to Anti-Tank Trenches.

Such criticism as General Fuller makes is not intended to belittle *F.S.R.*, which he believes to be a sound manual, but to assist those who will some day have to re-write it. He joins issue most severely in regard to the unbalanced consideration of cavalry and tanks in trench warfare, contending that experience and trial have so far advanced conviction that the latter arm deserves at least as much emphasis as the former. The author's conviction in the future of mechanization and motorization finds expression in the advocacy of motor-car guerilla action. The soldier of some sort in some sort of a motor-car, organized to seek information, harass flanks, communications and vitals, so finding employment for some of that vast number of i.c.-engined vehicles,

which modern civil life has brought into use. It may be recollected that motor guerillas in some such form, found by naval personnel, were in action alongside our cavalry in Belgium in October, 1914.

Reference is made to the *Manual of Armoured and Mechanized Formations*, which General Fuller also dubs a dull work and would convert to the brighter *F.S.R.* faith as *F.S.R. Vol. III.* Here he has been forestalled as the "Purple Primer" is already in its second issue, providing ample distraction for the open and flexible mind.

In the sphere of field engineering the author is in agreement with the teaching of *F.S.R.*, emphasizing the importance of bringing the engineer element into every battle plan. He is insistent upon the principle that engineers should not be employed upon any work which the other arms can carry out for themselves, and when development from field defence to protracted defence is entailed the entire planning of the defensive system should be an engineer responsibility. Perhaps some readers may take exception to the statement that "strictly speaking the Royal Engineers are not fighting troops."

These lectures should prove of great assistance to officers of all arms in fulfilling their duties as soldiers to study and practise their profession.

H.J.D.C.

TOPOGRAPHY IN THE TROPICAL FOREST BELT BY TRAVERSE AND ANEROID.

ORDNANCE SURVEY TRAINING SERIES No. 2.

(Ordnance Survey Office, Southampton. Price 2s. 6d. net.)

If this series of pamphlets, issued by the Director General of the Ordnance Survey, is to carry on to numbers four or five or more, their rightful fate is undoubtedly to be bound together in book form and to be issued as a supplement to that more than excellent book, *The Text Book of Topographical Surveying*.

No. 2 of this series has now appeared, and may be said to rival even No. 1 in interest, clearness, and essential "practical" advice. As the title implies, this pamphlet does not attempt to deal with all forms of traverses. Geodetic or primary traverses are not even touched upon; the tacheometer and subtense bar find no place in it; but control and detail traverses using tapes and compasses, and that peculiarly interesting West African invention, the rope and sound traverse, are described in much detail and every sort of hint given as to their execution and record. The pamphlet contains an introduction, short but very much to the point, a general description of compass traverses; extracts from Gold Coast technical instructions; a couple of pages describing similar topographical method in Malaya, copied from a recent *R.E. Journal*; and finally a complete series of specimen forms recommended for use in traverse work. There is also an example of a barometer wave chart for four consecutive days in September, which indeed bears out the author's words in the introduction that "air pressure in our tropical colonies, though subject to a regular daily variation, is relatively (to England) reliable."

As regards rope and sound traverses the following most interesting points come to light in the pamphlet. (*a*) That two surveyors rarely differ by more than two degrees when taking a bearing on to a sound. (*b*) That so great is the diurnal variation of the barometer that it is essential that surveyors, even on a minor traverse, should be in a position to determine standard time to within two or three minutes. To this end even native surveyors have been trained to observe the sun's altitude with a clinometer and by means of a table prepared for the latitude concerned, to compute their watch error on standard time.

Finally must be quoted a remark in the introduction which fairly deserves to be called a surveyor's epigram. It is "Surveying may, indeed, be said to be a perpetual struggle between man's inventiveness and the necessity for traverse."

P.K.B.

A SUMMARY OF THE STRATEGY AND TACTICS OF THE EGYPT AND PALESTINE CAMPAIGN, WITH DETAILS OF THE 1917–18 OPERATIONS ILLUSTRATING THE PRINCIPLES OF WAR.

By LT.-COL. A. KEARSEY, D.S.O., O.B.E.

(Gale & Polden, Ltd., Aldershot. 3s. 3d., including postage.)

This very moderately priced publication (three shillings net) is Col. Kearsey's Second and Revised Edition of his *Summary and Diary* of the course of the "Great War" Campaign in Egypt and Palestine and his Illustrations of the Principles of War from actions and events of that period. The author has obviously determined to provide for the student of military history who is limited in study time, for he has covered the field of operations in 93 steps (or pages), yet within that compass there are a very careful and comprehensive abstract of the campaign and numerous illustrations of the methods of applying the Principles of War.

Col. Kearsey has based his work on the *Official History* of the Military Operations in this Eastern theatre, with reference to certain other books which treat of war and policy in the sphere of the Suez Canal. His summary of the strategy and tactics is therefore accurate and logical and presented in clear and balanced form, though criticism may perhaps be directed against the lack of paragraph headings. For quick reference some marginal assistance, particularly in regard to dates, is recommended. The compressed nature of the Summary does not permit of more than the briefest reference to contemporary events in other theatres of war, and the operations against the Senussi in the Western Desert are also treated very shortly.

The Diary is headed "The Palestine Campaign," and contains an accurate list of important events, day by day, from the date of Turkey's mobilization in 1914, to the signing of the Armistice with Turkey on 31st October, 1918.

The author deals with the Principles of War in different sequence from that adopted by the writers of *Field Service Regulations, Vol. II (Operations)*, 1929, and introduces, or perhaps re-introduces, an eighth Principle, namely, "Maintenance of the Aim in War." That apart, the illustrations given should prove helpful to the student in training his mind to grasp the essential lessons of war histories and to apply the Principles of War correctly to the testing situations of training and reality.

One other point of criticism is made. The maps, though adequate and conveniently incorporated in the book, should be re-inforced by another covering the whole field of operations in the Campaign and showing the important topographical features. The Western Desert area is not represented on any map in the copy under review.

Here is, then, a useful work on the Egypt and Palestine Campaign, and it is specially recommended to the student, who having previously studied a more discursive account of these operations, such as the *Official History*, requires a handy work of reference to the course of events and the lessons to be learnt from them.

H.J.D.C.

THE MAHDI OF ALLAH.

A DRAMA OF THE SUDAN.

By RICHARD A. BERMANN.

(Putnam, London and New York. Price 16s.)

(*Translated from the German by Robin John.*)

Herr Bermann, an Austrian author and traveller, visited the Sudan in 1929 and collected information about the Mahdi (1844–1885). His book in manuscript was read by Sir Rudolph Slatin and Sir Reginald Wingate, who helped him with suggestions and corrections. In a short preface Mr. Winston Churchill writes that the author "has thrown a running commentary of light on a strange and sinister figure "which fell like a distant shadow across my generation in the eighties."

The sub-title " A drama of the Sudan," well describes the book, which is not a formal biography, nor a study like Strachey's *The End of General Gordon*, but a drama of twenty-one scenic chapters interesting and delightful, but almost as difficult to summarize as Shakespeare's *Hamlet*.

In addition to the twenty-one chapters there are thirty-two pages of extracts from Herr Bermann's journal—two sketch maps—and a short chronological table—but there is no index or table of contents, so I have compiled a list of titles of the twenty-one chapters with a short description of each.

The Mahdi, whose personal name was Mohammed Ahmed, was born at Dongola about 1844. In early life he joined the Dervish order whose head was Sheik Mohammed Sherif. About 1871 the Sheik held a great ceremony in Khartoum. The Mahdi publicly protested against the debauchery and worldly pleasures in the ceremony sanctioned by the Sheik. The Sheik was very angry and dismissed him from the order. The Mahdi then caused himself to be placed under " The Yoke," the murderous cross of torture used by Arab slave drivers, and sat down at the door of the Sheik's house. The Sheik cursed him as a traitor, saying " Be off with you—you are not forgiven."

The Mahdi then retired to Abba Island in the Nile, about 150 miles above Khartoum, and lived there as a hermit dreaming and reading the Koran and travelling about as a mendicant for nearly ten years, his fame as a " holy man " continually increasing.

The Mahdi was an idealist, not a warrior. His defiance of the Sheik, his master, in 1871, his protest against debauchery and worldly pleasures, his sufferings under " The Yoke " show that he had courage. He was a devout Moslem—" Poverty and Holy War " were both essentials of his creed. But his real life and joy were asceticism and the study of the Koran. " Plain living and high thinking " were his daily bread. " Holy War " was not his line.

At last in 1880 among other pilgrims to the Mahdi's cave appeared *Abdullahi*, a Baggara Arab of the Taaisha tribe, of no prestige or visible power, an uneducated man walking with a donkey to carry his luggage. This man (described in Herr Bermann's chapter as " The Friend ") was received by the Mahdi as a disciple and announced to his new master, " Thou art the expected Mahdi." Abdullahi was a sort of miniature John the Baptist—and in a short time he persuaded the Mahdi to proclaim publicly, " I am the expected Mahdi ! " After that all was plain sailing. The Mahdi went on thinking and proclaiming. Abdullahi organized physical victory. From 1881–1885 the Sudanese were in active rebellion against the Turkish and Egyptian authorities, their nominal rulers. In November, 1882, troops sent from Khartoum were mopped up. In February, 1883, the town of El Obeid was captured, and in November, 1883, the Hicks expedition was destroyed. Finally, on the 26th January, 1885, Khartoum fell and Gordon was killed. Abdullahi, the Khalifa, was then appointed " Commander of the Faithful," and on June 22nd, 1885, the Mahdi died.

In Japan, before the revolution in 1867, the Mikado was a nonentity behind a screen. The Shogun ran the show. In the Sudan, 1881–1885, Abdullahi ran the show (and as Khalifa kept on running it till 1898), but the Mahdi was not at all a nonentity. Abdullahi had consecrated him—other expectant Mahdis had dried up. The Mahdi was the " Holy Man " revered by most Sudanese. He inspired revolt against Pashas. He was seen and heard by large crowds who hung on his eloquence. He was gracious to visitors. His smile was famous and his voice a most musical organ specially effective in its rhythmic roll of Arabic words. But from Abdullahi's point of view the Mahdi was evidently a valuable stage property to be moved about the wilderness like the Ark of the Covenant. During 1881–1885 the Mahdi, though severely prohibiting alcohol and tobacco, indulged in large meals and kept a large harem. He became very fat and he died at the early age of 41. The strain of 1881–1885 was too much for him.

Gordon died only six months before the Mahdi, and it is difficult to avoid comparing the two characters. Both men were idealists, both indifferent to riches and to

the many more subtle means of "getting on"—both were constant and deep students of their respective Scriptures—and Gordon with his wide sympathies would have agreed that the Mahdi was "trying to do his duty."

But there is also a complete difference. Gordon was both Saint and Warrior. In the Mahdi machine two separate functionaries were necessary. One man to proclaim truth—the other to make war. To Lord Wolseley, Gordon was "our greatest hero since Nelson." In the Crimea—in China—and in the Sudan he was always "a man of action." Herr Bermann's chapter "The Hero" describes Gordon riding ahead of his escort into a camp of 10,000 rebels and by his personality compelling them to do exactly what he told them in his "angry and abominable Scotch Arabic."

The combination of saint and warrior, though most picturesque to the "general reader," is naturally a bit puzzling to students. Gordon's religion transcended creeds. "The letter killeth—the spirit giveth life" was one of his favourite texts. His sister, Miss Gordon, said that if her brother wrote down his real religious views some people would call him atheist, infidel, etc. In his writings can be traced a continual struggle in his mind between his "love of power" and his desire to destroy in himself that "love of power."

In 1880, when Gordon passed through Hong Kong, he happened to meet Dr. Eitel, then acting as private secretary to the Governor. Eitel asked Gordon "Colonel, what has been your leading motive in life?"—Gordon replied instanter "Love of power."

In 1884, January 11th (only a week before he left London for Khartoum) Gordon stopped with Prebendary Barnes at Exeter. They went to see Sir Samuel Baker, living near Newton Abbot. Baker met them at the station, and while driving to his house "... Baker pressed on Gordon the expediency of his again going to the Sudan "as Governor-General. Gordon was silent, but his eyes flashed and an eager expres-"sion passed over his face as he looked at his host. Late at night when we had "retired he came to my room and said in a soft voice, 'You saw me to-day?'—"'You mean in the carriage?' 'Yes, you saw *me*—that was myself—the self I "want to get rid of.'"

Gordon was conscious of his "love of power," and if he had not enjoyed its exercise he would have been inhuman. But he was even more conscious that love of power for its own sake was bad.

Into the swamps and deserts of the Sudan, into the atrocities of the slave trade, into the corruption and incompetence of Turkish and Egyptian Pashas—into the well-intentioned but inevitably bewildered counsels of real patriotic statesmen—Gordon, a heavenly fiery body, as if from another universe, was projected across the "eighties of our generation" trailing a cloud of glory still visible to survivors and students, but leaving also a cloud of confusion so that, as Mr. Churchill writes, "One day a Gibbon will summarize England's work in Egypt—and discover splendid material for a ruthless and unrestricted pen. It is too close for the final word."

In 1902 (seventeen years after the death of Gordon) many great men and many passions of the "eighties" had passed away. On the 18th July a replica of Onslow Ford's statue of Gordon on a camel (erected temporarily in Trafalgar Square prior to its transmission to Khartoum) was unveiled by H.R.H. the Duke of Cambridge, then 82 years of age.

H.R.H., who had first known Gordon as a boy of ten in Corfu, and had followed his career, proceeded: "He was a very peculiar man with splendid qualities and great "power of dealing with men who had not entered much into the world. He was a very "unselfish man. When I said good-bye to him he had the conviction that he would "be perfectly successful in the curious undertaking which he said he would face "without anybody to assist or help him. I am gratified that we have here the great "man who has just returned from South Africa, who I am sure is delighted to be "present under such circumstances as the unveiling of a monument to an old friend "(as I believe I may call him) who has left this world crowned with honour and "glory."

Lord Kitchener followed : " I shall be very pleased to see this statue placed on the " banks of the Nile at Khartoum, where I am sure it will be an object lesson to both " the natives and the Europeans of a man who led a blameless life—put duty before " himself, and died happily for his country." D.M.

LIST OF THE TWENTY-ONE CHAPTERS.

Title. *Contents.*

1. THE TOWN.—Description of Khartoum.
2. THE YOKE.—The Mahdi, then a young dervish, defied his Sheik and is expelled from the order.
3. THE ISLAND.—The Mahdi retired to Abba and lived there 10 years as an ascetic hermit.
4. THE STORK.—Gordon's thoughts in 1874 on his work in the Equatorial provinces.
5. THE BOWL.—The Sheik wanted the Mahdi back in his order, but the Mahdi declined.
6. THE HERO.—Gordon rides alone into a camp of rebels in Darpur, 1877.
7. THE FRIEND.—Abdullahi (afterwards the Khalifa), recognizes the Mahdi as the true Mahdi, 1880.
8. THE VISION.—The Mahdi announces publicly, " I am the expected Mahdi."
9. THE WARNING.—The Governor of Khartoum tries to capture the Mahdi by diplomacy, 1881.
10. The FLIGHT.—The Governor sent a small force to capture the Mahdi. They were killed or converted. The Mahdi moved to Mount Gadir in Darnuba.
11. THE MOUNTAIN.—The Governor sent 6,000 troops against the Mahdi. They were all killed or converted.
12. THE MESSENGER.—The Genaissi Sheik of Jerhbub sent the Mahdi a messenger, who reported " This is not the expected Mahdi."
13. THE BATTLE.—Hicks' Army annihilated, November, 1883.
14. THE TREE.—Mahdi's camp at Rahad-Slatin and Ohrwaldd captured.
15. THE COSTUME.—Mahdi sent a dervish dress to Gordon, who threw the dress on the ground and stamped on it before the public assembly.
16. THE PILGRIM.—Olivier Pain, a French journalist, visited the Mahdi, was put in irons and could not get a cigarette.
17. THE PROOF.—Gordon's thoughts, January 17th, 1885.
18. THE HEAD.—Capture of Khartoum and death of Gordon, January 26th, 1885.
19. THE VICTORY.—Sack of Khartoum, massacre of inhabitants. Abdullahi appointed " Commander of the Faithful."
20. THE PULPIT.—Mahdi's last sermon.
21. THE ANGEL.—Death of Mahdi, June 22nd, 1885.

CHRONOLOGY.

MAHDI.

1844. Born at Dongola.
1871. Defied the Sheik of his dervish order.
1871–80. Lived at Abba as an ascetic hermit.
1880. Proclaimed himself as " The expected Mahdi."
1881–85. The Mahdi got Abdullahi to make "The Holy War."
1885, June 22nd. The Mahdi died at Omdurman.

GORDON.

1833. Born at Woolwich.
1855. Crimea. 1860–64, China.
1874–76. Governor, Equatorial Africa.
1877–79. Governor of all Sudan.
1884, Feb. 18th–1885, Jan. 26th. At Khartoum.
1885, Jan. 26th. Killed at Khartoum.

THE DUKE.

By PHILIP GUEDALLA.

(Hodder & Stoughton, 25s. net.)

(Reprinted by permission from *The Times Literary Supplement.*)

In all our annals there is no figure of the importance of Wellington, our second soldier, who stands so much in need of a new and really thorough biography except, curiously enough, our first soldier, Marlborough. And if Wellington is second to Marlborough as a soldier, his importance in general, when we consider his political achievements and his social influence as well as his military career, is greater. His place in the military hierarchy has, moreover, a new significance if it is recalled that, while we breed great leaders of men in plenty, we do not breed very freely great military genius. Amid the group of those who, while not Hannibals or Napoleons may be counted the most favoured children of Mars, and who number about twenty or thirty, Britain can claim only Wellington and Marlborough. Some might add Cromwell to the band, but his place is doubtful; if we make the claim on behalf of British blood rather than Britain, we shall probably have better warrant for Robert E. Lee. France may say that she put the same number into the field at once when Condé, Turenne and Luxembourg went to the wars.

Wellington has, as he remarked, been "much exposed to authors" during his own lifetime and ever since. His conversations have been recorded by Stanhope, Croker, Creevey and others; his dispatches have been published; his correspondence has been salved in great bulk; he has been given a place in countless memoirs written by the critical and the unfriendly as well as by the admiring; his political secrets have been pretty fully revealed. He has had biographers, too, of merit, though, in Mr. Guedalla's words, "when Waterloo is passed, they nearly always falter." Still, there is no question about it, he is very much in need of a new biography. It has been known for some time that Mr. Guedalla was at work upon one and that he was having put at his disposal much unpublished and a good deal of unconsulted material. Many people must have felt curiosity as to the result, some perhaps a little nervousness; for Mr. Guedalla did not seem an ideal choice, on the one hand, and, on the other, was so popular a writer as to be certain to influence very strongly this generation's conception of his subject—"what he says, goes," and might go too far.

The doubters will find that their fears, anyhow their worst fears, were groundless, and that their favourable anticipations have been fulfilled. The book is a good book. It is, to begin with, well proportioned. Each phase—India, Dublin, the Napoleonic Wars, subsequent political life and old age—gets its reasonable and appropriate share of the narrative. Scholarship is satisfied by a list of authorities to which reference is made by means of marginal numbers, the best possible method of annotation, which neither fills half-pages of the text with footnotes nor embeds numerals or letters in the narrative. So much for the framework. The picture of the man is clear and brilliant; we see him standing out against the background of his age and career. Most of those we have already are in the same relation to it as a portrait in the flat to a portrait viewed through a stereoscope. The portrait is, of course, not necessarily true in detail; but, if we complain of the drawing here and there, we feel none the less that it teaches us to know more of the living Wellington than we knew before. Some will hold that its chief fault lies in its tenderness to his character. It certainly gives us a kindlier and more warm-hearted man than was to be expected. We hear a great deal of the Duke's abruptness, of his gruffness, of his laconicism, of the grimness of his humour; but little of the hardness of which many, including his own brother, have borne witness. We hear of the sovereign, always kept loose for a needy veteran, but not of the serjeant who wrote of the death of the Duke of York and Wellington's succession as Commander-in-Chief: "Every individual in the Service is attached to the Duke of York and looks up to him in the light of a father and a friend. The Duke of Wellington will not be to the Army what the Duke of York has been." The

name of Norman Ramsay, which always chills the heart, does not appear in the index. Wellington's relations with women are skated over if not bowdlerized. On the other hand, it must be admitted that Mr. Guedalla shows again and again how often Wellington's coldness was a mask, and again and again—especially after his days of warfare were over—depicts him, faithfully and with full backing of authority, as kindly, thoughtful, happy in the companionship of old friends, yet happier in that of children, even gay.

The Duke, however, is more than a portrait. It is in the modern style, and certainly not nearly long enough to describe and explain in detail the events of one of the fullest lives in British history. Yet it is very much longer, more thorough and more careful than the romantic sketches to which we have of late grown accustomed. It may be said that if any biography now requires and has unquestionable scope for the old-fashioned three volumes, it is that of Wellington; but the seekers will not find much that is essential omitted here. Mr. Guedalla makes "no pretence to supplement the military historians," but he has visited Spain and Portugal frequently and has made detailed studies of the ground of some of the outstanding battles and sieges of the Peninsular War. Catholic Emancipation, Reform and Repeal, above all the long and largely successful struggle for peace in Europe, are described not only sympathetically and vividly, but obviously by a pen which knows its way amid these subjects. In short, Mr. Guedalla has made a brave attempt to combine in one cover a historical work and a popular work.

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Wellington was almost as successful in politics as in warfare. Those who think of him as a politician only in the guise of the defeated opponent of Reform are completely mistaken in their estimation of his career; for that was almost his only serious reverse. Probably few of them realize how thorough was his apprenticeship to statecraft and administration. It is one of the chief merits of the balance and proportion which have been praised in this book that it brings this out so clearly. It shows with equal clarity, however, that he was not, in the usual sense, a many-sided man. His mind had not, like Napoleon's, a whole series of compartments—but those of Napoleon's were all connected, let us not forget—for the review of all his problems. With Wellington everything entered by the same door into the same chamber. That chamber was not even very lofty; but it was very well equipped and orderly. He brought to politics and war the same qualities: a quick eye which saw the situation as it was and not merely as he would have liked to persuade himself it was; good nerves—which failed him once, at Seringapatam, and never again; an immense fund of common sense, which sometimes appears to descend to platitude but never misses the essential; an almost unique lack of the dangerous sort of obstinacy that prevents retreat (he retreated constantly throughout his career, and never without justification); foresight; and just enough imagination to afford him always a pretty good notion of what was "on the other side of the hill." There is nothing happier in Mr. Guedalla's book than his comparisons of Wellington's strategy when in office or opposition after the Napoleonic Wars and that which he displayed in the Peninsula. It may, indeed, be said that we are shown that strategy in action throughout his whole career. There is, of course, one difference. He was more at home in the field than in the council-chamber, and he failed to inspire his followers and colleagues in the latter to quite the same extent as his generals and troops in the former.

Like Napoleon and the Archduke Charles, who were of the same age as himself, Wellington had early experience of command, but not like them of high command. By 1795 the Archduke was at the head of an army; Bonaparte was only a divisional commander, and was thus outpaced, though he took the lead very decisively in Italy the following year. Wellington was only a battalion commander, who for a time had a brigade under his orders in the campaign in Flanders. Then he returned from war to politics, while Napoleon went forward to the heights of his extraordinary career.

That is not to say that Wellington's time was wasted when he sat in the Irish Parliament, looked for a place, and rose to answer Grattan in defence of the administration. When he had his chance again in the field his rise was swift enough. He was "Satrap of Mysore" and in command of the Company's forces there at thirty; was a major-general and victor of Assaye and Argaum at thirty-four. Yet then comes another interlude of politics, stranger still, considering the times and the position he had won. There was now no Irish Parliament, and he entered the British House of Commons in 1806, becoming Chief Secretary for Ireland next year. How many of those who have studied his career recall that he was Chief Secretary when he went out with the Danish expedition and quietly resumed work on his return; was Chief Secretary when he won the Battle of Vimiero, and again went back to his desk at the Castle when the Board of Inquiry into the Convention of Cintra had finished its labours? When he went out to the Peninsula for the second time he was pretty fully equipped. He had learned, in Ireland as well as in India, very useful lessons in administration; he had studied to his profit the problems of transportation in war; and he had met the French in battle and defeated them.

Mr. Guedalla's account of the Peninsular War is as informative as he well could make it in the space he has allowed himself. The retreat to the Lines of Torres Vedras is well described and explained; but that is perhaps the one incident of the war which every British schoolboy understands. Wellington's subsequent strategy is sometimes lost sight of in a cloud of words. Mr. Guedalla gives us its essence in the simplest terms:—

"The French occupation of Spain hung by one precarious chain—the great road "from Bayonne to Madrid. If that were snapped their armies must recoil from every "province, since they could not maintain themselves with a British force across the road "to France. If it were threatened they must all come swarming north to safety. . . . "He must be free to move decorously out of Portugal and to re-enter it at will; and "this privilege would not be his unless he held the gates. So Badajoz and Ciudad "Rodrigo must be his first objective; and, these once secured, he might make "his decisive thrust towards the road to Paris."

Thus, if there is no detail, the main outline of the campaign is sketched, and is ever borne in mind. And when we come to the battles we are told enough to realize that Wellington really was a military genius, not merely a wary defensive fighter commanding troops of unmatched steadiness, as some of his opponents have alleged. Yet Mr. Guedalla never fully analyses his genius to discover wherein it differs from the very greatest. It appears to differ in two respects, in height and in breadth. When we consider the strategy of Napoleon's First Italian Campaign, of the Marengo Campaign and of the Ulm-Austerlitz Campaign, we feel ourselves in the presence of military genius at its highest. When we consider his knowledge and employment of all arms, his skill in every circumstance, in every *terrain*, in every branch of tactics, we acknowledge military genius at its broadest and most universal. Mr. Guedalla remarks that Wellington was not at his best either in the conduct of sieges or in pursuit. There is surely more to be said than that, especially of the latter, which is of such vast importance in war. It can most fairly be said in the words of our most accomplished soldier since Wellington's day. Wolseley wrote in his *Soldier's Pocket Book*:—"In all our battles against Napoleon's troops . . . we have shown ourselves incapable of reaping the benefit of victory. Wellington won many battles, but never delivered any very crushing blow to his opponent, because he failed to pursue." Otherwise one can only praise this section of the book. The Waterloo Campaign is less convincing, though the fashion in which the accounts of eye-witnesses are handled is vivid and arresting. One would imagine that Napoleon's preference for a frontal attack to a flanking attack was due only to overweening confidence. Surely it is obvious that the Emperor needed not only to win a victory, but to win an absolutely decisive victory, and by sundown.

While not denying warm admiration to Mr. Guedalla's outline of Wellington's

military career, we have found in it a good deal to criticize. In the last half of the book—it is nearly a half and it covers not so much less than half the Duke's life—there is very much less. Once again, it may fairly be called only an outline; for at any rate the first thirty years after Waterloo were filled for Wellington with unceasing activity and with problems even more complex than those he had solved in the Peninsula. He enters the maze of British and international politics; and if the general structure of that can be described, the countless turns and blind alleys cannot. On the Continent he watched over defeated France, with no particular affection but with a firm determination to allow her to rehabilitate herself and stand upon her feet again, and worked everywhere to prevent new wars or to limit those which could not be avoided. At home he was Master-General of the Ordnance, Commander-in-Chief in 1826, and Prime Minister two years later. More than any other man he, the Irish Tory Protestant, was responsible for Catholic Emancipation, extorted from an unwilling and obstinate King and forced through a reluctant House of Lords. He was first in the fight against the Reform Bill, and the first of his party to see that blind opposition would no longer suffice. He fought it to the end, but that was because, as Mr. Guedalla remarks, his own supporters failed him when he attempted to pursue "his old strategy of retreat—the deft withdrawal to the next position in rear, which "would keep safe men in office and leave dangerous characters in Opposition." He pursued that strategy in his seventy-seventh year over Repeal. He was no free trader and did his best to persuade his leader, Sir Robert Peel, to modify his measures; when he failed in that he persuaded his colleagues to support the Prime Minister. Peel had the confidence of King, Parliament and country; he represented a *government*, which was "of more importance than any measure or particular law"; therefore he must be backed up. Of all this and more we have here only the broad lines, but they are firm and bold.

Yet in the end we return to our original impression. Soldier and statesman are good enough, but it is the man who remains with us. The final scene, when occupations are past and only the man remains, is particularly impressive, though the pomposity of the funeral comes as an anti-climax to the dignity of the last days at Walmer. Mr. Guedalla's work will not wholly fill the space that has been waiting for a complete biography of Wellington, but it will certainly merit a place on the same shelf. Few, even amongst those who think they know Wellington best, but will feel that something more has been suggested to them when they set down this book.

THE ELEMENTS OF IMPERIAL DEFENCE.

By A. G. Boycott, B.A.

(Gale & Polden, Ltd., price 12s. 6d.)

When one picks up a book with this title in a familiar red binding it is pardonable if one says to oneself, "Here is something for the instruction of the young officer; we have our invaluable Cole, standby of examiner and candidate; is this something new, something better? Are we to scrap our trusted friend or does this book contain valuable new matter to be read in conjunction with Cole?" It is indeed impossible to read Mr. Boycott's book without making a comparison with the Army's standard work on Imperial defence, for a reference to the index will show that the ground covered by Mr. Boycott is almost identical with that in Captain Cole's work; the chapters have, in the majority of cases, similar titles, though the sequence is not identical, whilst the substance is remarkably similar. The difference lies in the emphasis laid in Mr. Boycott's book on the air aspects of Imperial Defence; the development of air routes, the composition of air forces and considerations governing the employment of aircraft in the defence of the Empire receive particular attention. It is perhaps natural, therefore, to find that the Treaty with Iraq negotiated by Sir

Francis Humphreys in 1930, and the abortive treaty with Egypt, are printed in the book *in extenso*, together with the attendant notes and letters exchanged between the respective negotiators. Both these diplomatic instruments, needless to say, profoundly affect the situation in the Middle East, an area in which air forces are peculiarly interested. Indeed, from internal evidence, from the somewhat inaccurate references to the military forces and army organization, which will be noted below, from the extensive knowledge of air forces and the somewhat dogmatic assertions of doctrines by no means universally accepted as to the employment of these forces, it would not be surprising to learn that the writer is in close touch with the air service. Before commenting on the strategical passages it will be well to discuss the value of this book in so far as it deals with ascertainable facts rather than theories.

The book commences with a brief description, practically a précis, of the history of the British Empire, which serves as a useful background for the details which follow. Chapter II deals with the political organization of the British Empire, and in placing this subject at the commencement of the book the author is possibly more logical than in following the arrangement adopted by Captain Cole. This chapter has useful appendices dealing amongst other matters with the system of mandates and the report of the Inter-Imperial Relations Committee, of which a verbatim extract is printed. Chapter III deals with defence organization, and includes several appendices, extracts from the report of a Committee on National Defence (1923) and Cabinet conclusions thereon. The subsequent chapters deal with the material resources of the Empire, the Dominions and India, in detail, communications in the various sea areas, and communications by cable and wireless, adding little to the comparable chapters in Captain Cole's geography. There is a long chapter on the Middle East, and finally one entitled the "Defence Services of the British Empire," including further appendices from the report of the committee referred to above. Why this chapter should be detached from Chapter III is difficult to understand, the one should follow logically upon the other.

So much for the general arrangement. As regards the matter contained in the book one must admit that there are three faults which go far towards making it impossible to recommend it as an authoritative guide to the younger members of the Services. First of all many important statements of fact are inaccurate or misleading; in the second place the grammar is frequently below the standard one has a right to expect in a work of an educational description. Thirdly, as has already been pointed out, much of the strategical doctrine cannot be accepted without question.

Examples of the first type of fault are numerous. The following are amongst the more glaring cases:

(*a*) On page 17 the author states: "Because Germany, by the possession of the greatest land forces in Europe and of a navy second only to that of Great Britain, had upset the balance of power and gravely threatened British security by the violation of Belgium, Great Britain was compelled to declare war. . ." Now, it will be apparent to all who are old enough to remember the tense days of early August in 1914 or who have read with insight the more trustworthy histories of that time, that this is a most inaccurate summary of the causes which led to the declaration of war by Great Britain. It is true that naval and military officers and some statesmen were fully alive to the German military menace, but Great Britain as a nation declared war simply and solely because we had guaranteed the integrity of Belgium, our honour was at stake, Germany had committed an act of gross international injustice and Britain was at pains to right a grievous wrong. That was the outlook of Parliament, the first and foremost thought of the men who rushed to the colours. Had Germany not violated her treaty obligations we should not have declared war at that time, though we should undoubtedly have been driven to do so later on, as were the United States.

(*b*) On page 18 it is stated that the alliance with Japan was abandoned " in deference to the wishes of certain of the Dominions." This, of course, is sheer nonsense. As is well known the abandonment of the Japanese alliance was the price we had to pay to obtain the United States signature to a treaty limiting what would inevitably have become a ruinous race in armament construction.

(*c*) On page 22 is a table in which is set out the general scheme of Imperial Government. In this table the responsibility for the local defence of India is shown to rest upon Great Britain. This is misleading. Although certain aspects of high policy in the defence of India are matters upon which the Cabinet in Great Britain and Parliament are the ultimate arbiters, yet the Governor-General-in-Council and the Commander-in-Chief in India are in their respective spheres mainly responsible for deciding upon the military measures necessary to meet the situations which from time to time arise in maintaining peace on the frontiers and within the borders of India.

(*d*) On page 53 it is stated that there are three assistant secretaries to the Committee of Imperial Defence. There are, of course, five: one from each service, one representing the India Office and one civil service assistant secretary.

(*e*) On page 56 is a paragraph dealing with the organization of the commands; the military reader will recognize that the table of the organization of the Aldershot Command is a curious and inadequate representation of the staff of the command, whilst the following sub-paragraph with its reference to the " services " of the Adjutant-General and Quartermaster-General points either to ignorance of service nomenclature or slipshod writing which should be out of place in a work of this description.

(*f*) On page 99 we find the remarkable statement that " in the case of the British Commonwealth upon the white peoples alone so far has rested the main burden of defence, though the coloured races were enrolled for non-combatant labour services during the last war and would be so called upon again." Oh! shades of Neuve Chapelle, of Mesopotamia and Palestine.

The above are but a few of the more precious flowers culled from the garden of ignorance. We may add one or two incorrect numerical statements.

(i) On page 105 we read " the ratio of whites outside Great Britain to those in Great Britain is about the same (*i.e.*, 1 to 8). Actually the figures are (in millions) 18·25 to 48, or approximately 1 : 2·67.

(ii) On page 210 the British forces stationed in Khartoum are stated to be one British regiment and one squadron R.A.F. There are two British regiments in the Sudan.

(iii) On page 245 the British troops in Egypt are said to include eight battalions. There are, of course, six battalions only in Egypt.

(iv) Elsewhere the distribution of regular divisions in commands at home is wrong.

It is clear that a book from which so considerable a list of errors (and these but a proportion) can be compiled will require drastic revision before it can be considered authoritative or a suitable guide for examination candidates.

Reference has been made above to grammatical errors. Not only do we find such unhappy constructions as " aim to secure," " has been followed with a consequential enlargement," " The importance of efficient means of inter-communication . . . is of such paramount importance," and so on, but the author uses certain unusual and irritating phrases, evidence of misplaced literary snobbery. Of such phrases two typical examples are the use of the terms " the General War " and " compression-ignition engine " for " the Great War " and " internal-combustion engine " respectively.

In many other respects the book contains slipshod work. For example, it would be reasonable to expect that in describing the various colonies similar details would be

given in each case. We find, however, that in one case the composition of the defence forces is given in full, in another air units only are mentioned, and the uninformed reader would not be aware that Palestine has a garrison of two regular battalions of infantry or that a considerable body of troops, the Trans-Jordan Frontier Force, is stationed in that area to assist the R.A.F. in preventing raids over the frontier, or again, that Somaliland is not only a rest station for the R.A.F. but is defended by the Somaliland Camel Corps.

It may be added that some of the tables in the book are not easily to be followed ; they suffer from illogical arrangement.

In discussing the third point on which criticism must be directed, namely, the prominence given to certain aspects of the use of air forces, we are admittedly treading on contentious and delicate ground. It will be sufficient to show the type of exaggerated statement which may mislead the less well-informed student and, for the rest, to remark that such matters as the value to be given to air forces in the protection of very long seaboards, the nature of the menace to be anticipated from air attack against defended ports and war vessels, the limitation of aircraft in attacking merchant vessels without transgressing the laws of war, and so on, are all matters which require highly technical enquiry and the most detailed knowledge of the many factors involved before any useful opinions can be given. Dogmatic assertion and uninformed criticism of the type so frequently to be found in the Press should never be taken at their face value.

The first obviously exaggerated statement which calls for notice is to be found on page 123, Section 5, Defence of the United Kingdom. It is said that " the dangers of offensive action by aircraft have now become the first dangers that the country would have to face in *any* future war " (italics are mine). A moment's reflection will show what nonsense this is. There are only two important military powers in the world, France and Germany, able from the point of view of distance alone of carrying out an air offensive against Great Britain. Neither Italy, Russia, Japan, the U.S.A., or other important power could by any possible means carry out any such offensive against this country.

Again on page 255 we find that " two bomber squadrons and two sections of armoured cars are a guarantee of order in Baghdad and the near-by cities." Order in Baghdad and any other city is guaranteed by the police and Iraq military forces, possibly assisted by armoured cars, though the latter have, it is understood, certain limitations in street fighting. Bomber squadrons, as experience in Palestine conclusively proved, have no power whatever to exercise any control over disorders in towns, a duty which must inevitably fall in the last resort on military forces.

To sum up one's impression of Mr. Boycott's book, it must be said that whilst covering in the main identically the same ground as Cole's military geography, there is a certain amount of useful additional information not to be found in the latter ; nevertheless the work will require drastic revision both as to facts, figures and theories before it can be safely recommended to less experienced officers as a suitable guide for either promotion or staff college examinations. *Quant à moi, donnez-moi mon brave Cole.* R.L.B.

PLANNING FOR GOOD ACOUSTICS.

By HOPE BAGENAL and ALEX. WOOD.

(Methuen. 22s. 6d. net.)

(Reprinted by permission from *The Times Literary Supplement.*)

A book on acoustics, with its formidable diagrams and equations, does not, at a glance, promise much to the imagination, but it is only necessary to read the preface to this one to be persuaded of the contrary. Take this passage :—

" In church design the Gothic revival has restored the medieval church form and

" with it inevitably the acoustics suitable for the Mass rather than for the pulpit. . . . " The inappropriate religious building can render religion unintelligible. A building " operates gradually but certainly upon the activities produced within it and operates " largely through acoustics."

To anybody convinced of the simple truth of Francis Thompson's " Thou can'st not stir a flower Without troubling of a star," convinced of the inevitable relations between one thing and another, so that you cannot change any factor in the artistic problem—form, substance or application—without having to readjust all the others, this passage will be, as the saying is, " nuts and figs." Every work of art is, indeed, a recovered equilibrium, the " peace of God " that follows acceptance of the nature of things. Oppose any single consequence, and the design refuses to balance.

The idea of the close connection between sound and form is, of course, not new. In their *The Acoustics of Buildings*, published in 1927, Dr. Davis and Dr. Kaye pointed out that the characteristic features of church choral music and intoned liturgy were developed from the form and materials of the medieval church building; Lancashire vowels are visible upon Lancashire lips; and when Mr. Lansbury was being abused for his inoffensive bathing shelters by the Serpentine every sensitive person must have wondered why no musician commented upon the brutal misunderstanding of bells which ravaged another quarter of Hyde Park. Shaken down from the lacework of a spire in Belgium the carillon has its charm, but the authentic voice of bells from an English tower is, and must be, in change-ringing. There is as close a connection between sound and form, here, as there is in the case of intoned liturgy.

The ideal auditorium would be like a bubble blown upon the sound to be produced in it. Architecture is not as easy as that, though Wren grasped the principle in his churches; and the object of this book is to work out practical applications of the principle as affected by circumstances—the purpose of the building, the nature of its materials, the nature and source of sound, the character of the ceremony or performance, and so forth. " Good acoustics," say the authors, " has always been more closely connected with intelligent design than is popularly supposed." That is true if by " intelligent " design we mean not only a grasp of the architectural conditions, but also a recognition of the time of day—as evidenced by a change in the form of worship or by the introduction of sound films, for examples. It is when these factors are taken into account that any attempt to limit the " utility " of architecture becomes ridiculous. A building that fails to adapt itself to the subtlest requirements of what is done in it is to that extent bad architecture. As the authors show, some of the changes in requirement are more subtle than might be evident, even to a person who had grasped the general principle of the connection between sound and form. Instances quoted are the change from the Gregorian to the Ambrosian—let alone the Anglican !—chant; the change from Italian to Wagnerian opera; and, perhaps most striking of all, the substitution of German for Latin words in the music of Bach. " Medieval Latin, as we have seen, provides a beautiful series of tones for a church with a long reverberation. German, on the other hand, while retaining a grand series of open vowels, has in addition a great number of contrasting consonants." Bach appears to have been sensitive to acoustics, and it is generally agreed that most of, perhaps all of, his larger works were composed for production in a particular church, that of St. Thomas, in Leipzig. That is an instance of the adaptation of sound to form, but it is clear from history that the contrary adaptation has been at work; and it is hardly an exaggeration to say that successful or " standard types of auditorium " have been designed upon a basis of sound—thus giving a new meaning to the legend of Arion.

Though, of necessity, a good deal of this book is highly technical, there is much in it —apart from the historical portion—to interest the general reader. Why, for instance, does a man sing in his bath? First, because the bath-room has bare walls usually tiled and no carpet or furniture—hence a long reverberation; second, the bath itself acts as a resonator, reinforcing the voice in a certain region of pitch; and, third, " the

falling water sets up a noise in a certain tonality which, selectively reinforced by the bath, may even act as a physical stimulus upon the anatomical resonators in the throat." In the same vein the authors note the spontaneous shouting of young children when wheeled under a railway arch, and, we might add, many grown-up people find it hard to resist the temptation to whistle or sing on deserted Tube platforms. An interesting suggestion is that of the " unifying tone effect of the church as an instrument," so that more than one tune could go on at the same time—bearing on the development of polyphonic music, which " depended upon human voices using the church as their major instrument." This tallies with an experience in the Mozarabic chapel of Toledo Cathedral more than twenty years ago, when, another mass being celebrated at the high altar at the same time, the organ harmonies suggested a " mean " between the intonations of the two celebrants, so that the two services were bound together in a garment of sound without conflict or confusion. Another odd sound experience which may be quoted as bearing on polyphony was on Brandon Hill, Bristol, on a Sunday morning, when the bells of many churches ascending produced a " complex " of sound in which a tune could be pitched in any key in perfect accord.

A useful feature in this book is a series of drawings of " auditory types " for different purposes—three-dimensional " graphs," so to speak, of the sound requirements. On the æsthetic aspect of these types the authors are extremely sound. The dogmatic statement that because they are useful therefore they are already beautiful will not do. " But they can be used to narrow the artistic problem to well-defined limits. If they have character, that character is a clue. In designing an auditorium an architect should recognize and use acoustic character as the basis of his idea." Summaries of practical points for council chambers, concert halls, theatres and churches are given, and these are translated into French, German, and Italian in an appendix.

SURVEY OF INDIA.

GEODETIC REPORT, VOL. VI—FROM 1ST OCTOBER, 1929, TO 30TH SEPTEMBER, 1930.

(Published under the direction of Brigadier R. H. THOMAS, D.S.O., Surveyor General of India.)

The Geodetic Report for 1929–30 has only recently been issued. One could hardly expect it much sooner considering the nature of the subjects dealt with and the amount of computations and consideration required for a report of this kind. These volumes form a most valuable series of scientific records, the importance of which to all investigators in the domain of geodesy cannot be exaggerated. They contain records of small earth movements which only the lapse of time will show up; it is, therefore, very necessary that they should be continued and that their high standard of excellency should be maintained.

Observations for variation of longitude at Dehra Dun have been continued. It is hoped, when continued long enough, they may throw some light on continental drift which so far has not been proved. The enquiry is a difficult one, as there are so many possible sources of error to be guarded against—notably the behaviour of levels, always an uncertain quantity, and then there is the question of time. This has been improved by the acquisition of a *Shortt Clock* and further precautions to guard against variations of temperature are to be adopted. Observations for variation of latitude have also been started and will come under regular investigation. They are to be carried out with the zenith telescope. Those concerned with this intriguing subject will await the results with interest. The best means of measuring small angles in connection with the extension of the Hunter Short Base has been under investigation, and the best method of doing this has been arrived at. This is of general interest, as any surveyor may be called upon to measure a base for triangulation purposes or make use of the Hunter Base for subtense traversing. The essence of the method is

that the repetition reading of the angle should be made by swinging the telescope always in the *same* direction and not backwards and forwards, as is the usual practice. Another matter of general interest is that the tests of the Paulin aneroid barometer have given good results.

Tables showing the predicted and actual times and heights of high and low water in the Tide Tables issued by the Survey of India for Indian and adjacent ports indicate that the usual high standard of accuracy has been maintained.

Observations for gravity were made by Major Glennie at 21 stations in the Central India Plateau, spaced fairly evenly about 60 miles apart. The Cambridge apparatus was employed. He " is striving to get the gravity anomalies freed from the effects of deep-seated causes so that they may supplement geological enquiries. If he fails to carry everyone with him, this enquiry still retains considerable value in so far that it has brought geological facts into direct comparison with geological results."

The report says " gravity observations have now brought irrefutable confirmation of the existence of Burrard's Hidden Range, which was at first inferred from rather scanty deflection data."

The Principal Triangulation has been in progress in Burma. It was found necessary to re-observe certain triangles, on which the Wild theodolite was employed last season, showing errors of as much as 3".

The Levelling Party has been employing new Invar staves for high precision levelling, and they have been compared with the results obtained using the old wooden staves. The conclusion is that the wooden staves are precise enough where large differences of level do not occur, but if great precision be required, with considerable difference of level, Invar must be used. The records of levelling carried out over a period of 70 years show that the alluvial plains of Bengal are rising at the rate of 0·050 ft. per annum, a total rise of about 3 feet in the period, relative to Calcutta. Tidal records indicate that Calcutta is not sinking, so that the country farther north must be rising. This is the explanation given for circuit errors which have been found greater than can be accounted for by errors of precise levelling.

A supplement to the report (which will also be published separately) contains a list of all known deflections of the plumb-line which have been observed in India and adjacent countries. There is also included a table of the results of observations at all gravity stations. It is intended to keep these tables up to date so that gravity data may be available in a concise form.

H.L.C.

THE PURIFICATION AND DISPOSAL OF SEWAGE.

(By C. J. NURSE, A.M.I.C.E.)

(Crosby, Lockwood & Son. Price 4s. 6d.)

It would be interesting to know what section of the public Mr. Nurse had in view when he produced this book.

He states in his preface that " existing books do not meet the requirements of the many people who to-day find it necessary or useful to be generally informed on the sewage question. The mass of complicated detail which is usually included renders them of greater value as books of reference for qualified Sanitarians than as a convenient source of information for the lay men."

One wonders whether it is true that there are really so many people with this curious taste in light literature as to justify Mr. Nurse in condemning the inclusion of just those practical details which make our present text-books valuable.

It must be admitted that a reader who already possesses some knowledge of the subject will derive considerable interest from this book, but he will probably wonder why the author has not been true to his principles and substituted a fuller description of the Bio-Aeration system (with a paragraph on Hartley's Spiral flow type of

Activated Sludge treatment), for the "complicated details" of chemical analysis with which he closes.

The style is very readable and the presentation clear, while the illustrations are of sufficient value to make one wish there were some more of them.

In general, the book, though not written for this purpose, might form a useful complement to W.D. *Drainage Manual.*

A.D.C.

BOOKS FOR GENERAL READING.

Recommended by Brig.-General Sir James E. Edmonds:—

THE MAN WHO MADE GOLD (Arrowsmith). By Hilaire Belloc.

Provokes many a good laugh.

PORTRAITS AND APPRECIATIONS (Hodder & Stoughton). By Viscount D'Abernon.

Twenty-three first-hand portraits of British and foreign celebrities. An appreciation of the French and German character. The portrait of Mr. Ramsay MacDonald is of special interest.

A MARRIAGE TO INDIA (Hutchinson). By Frieda Hauswirth (Mrs. Sarangadhar Das).

India from within. By a Swiss girl, educated in America, who married, and lived eleven years with, a Hindu.

ENGLISHMEN AT REST AND PLAY. Some Phases of English Leisure. 1558–1714 (Clarendon Press). By Members of Wadham College.

An interesting account of how the Englishman ate, drank and spent his time in the period Queen Elizabeth to Queen Anne.

Recommended by Major-General Sir Hugh Bruce-Williams:—

IN THE HIGHLANDS. By Seton Gordon.

Recommended by Lieut. H. I. Pocock, R.E.:—

1. POLITICAL HISTORY.
   "STRESEMAN" (in R.E. Library). By A. Vallentin, translated by E. Sutton.
2. TECHNICAL (BOILERS).
   "MODERN STEAM BOILERS" (in R.E. Library). By E. Pull.
3. TECHNICAL (ELECTRICAL).
   "J. AND P. SWITCHGEAR BOOK" (in R.E. Library). By Johnson and Phillips.

Books recommended by Major J. B. H. Doyle, O.B.E., *R.E.:—*

CIVIL ENGINEERING DESIGN. By Arthur A. Fordham. (R.E. Library, B/7, 320/34.)

To quote the preface: "Typical designs worked out in detail are of inestimable value to the engineering student to enable him to appreciate the practical applications and limitations of the theory of engineering."

This book gives several such designs. Detail varies, thought and calculation are necessary to follow them, and the author's aim appears to be to teach methods of tackling the problems with which he deals and not universal solutions.

ENGINEERING ECONOMICS. By T. H. Burnham. (R.E. Library, C/2, 280/49A.)

An armchair summary of economics, business organization and industrial psychology for the production engineer. Uneven in detail, but easily read and worth reading by any engineer who has no time to study those subjects in detail.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1931. TOME II.—NOS. 1 TO 3 INCLUSIVE.)

Pages d'Histoire de l'Armée Belge au cours de la Guerre 1914-1918.—*Le 20e de Ligne à la Bataille de la Crête des Flandres.* This article is contributed to No. 1 of the *Bulletin* by Major Willems; it is practically a reprint of a chapter from the Regimental History of the Belgian 20e Régiment de Ligne—"Vu et Vécu." Towards the end of September, 1918, the Army under King Albert, consisting of the Belgian Army, the British Second Army and the French VII Corps, was directed to drive the enemy from the heights stretching along the line Clercken-Standenberg-Passchendaele-Zonnebeke, with the ultimate object of advancing the Entente line towards Zarren. The 20e de Ligne was at this time under the Belgian 10th Division, which formed part of and was on the left of the "Groupement Nord" commanded by Lieut.-Gen. Bernheim, who was directed to seize a position on the line Zarren-Stampkot. Major Willems briefly sets out the outline of the general plan of operations, he further reproduces the Orders issued to the 20e de Ligne, and gives a detailed account of the operations which resulted in the occupation by this unit of a position immediately S.W. of the Zarren-Dixmude road. The lessons to be learnt from these operations are finally summarized by him.

Un Aspect du Problème de la Sécurité.—La Sanction Militaire de la Société des Nations.—Les Accords de Locarno. This article is contributed to No. 1 by Major Dendal; he deals briefly with the controversy which has taken place in relation to the necessity for "Sanctions." The nature of the "Sanctions" contemplated by the League of Nations, viz., the (1) *sanction morale;* (2) *sanction économique;* and (3) *sanction armée,* are indicated; the circumstances in which it may be necessary for the League to call to aid these "Sanctions" are examined—it is recognized that war is still possible under certain conditions, commonly referred to as: *Les fissures du Pacte;* the several documents containing the agreement reached at Locarno in October, 1925, are briefly dealt with; the matters involved in the application of the *sanction armée* are analysed at some length. In conclusion, Major Dendal points out that the "Sanctions" can alone prove effective if all States are prepared to abandon a part of their sovereign rights and place themselves unreservedly in the hands of the League of Nations; in other words, the League must possess an absolute and unchallengeable right to issue commands to the adherent States, and these States must be ready and willing implicitly to obey all such commands immediately and without question. He thinks that much progress has been made towards the realization of the aims of the League, but matters have not yet reached a stage at which Nations are willing to submit themselves to the complete domination of the League where questions of vital importance to their safety are concerned.

L'Équipment du fantassin. This article is contributed to No. 1 by Major Deharchies, who discusses therein the question of decreasing the "load" which the infantry soldier has to carry on the march. He points out that the introduction of mechanically propelled vehicles has had the effect of practically doubling the carrying capacity of regimental transport wagons, and, further, that there is now not the same danger, as in the days of horse-transport, of a failure on the part of supply columns punctually to meet the immediate needs of the soldier when on the march. Major Deharchies

shows in tabular form the reductions which, he thinks, could be made in the " loads " carried by various ranks of the Belgian infantry, if advantage were to be taken of the increased carrying capacity of mechanized regimental wagons.

Notes sur l'artillerie belge de 1830 à nos jours. The concluding article on this subject by Capt.-Comdt. Lambinon appears in No. 1, it contains an account of the Belgian Artillery and of its armament in November, 1918. It is stated that by November, 1914, owing to the heavy losses of guns in the opening phase of the Great War, the armament of the Belgian Artillery had been reduced to 200 " 75 " field pieces. The steps taken during the War to deal with the situation resulted in a great increase in this arm ; at the date of the Armistice, there were in the Belgian Army 20 Artillery Regiments, which had in their charge, in addition to an ample supply of anti-aircraft guns and trench mortars, approximately 540 guns of various types and 260 heavy and light howitzers.

Le Système défensif de la Belgique. This subject is dealt with by Col. Michem in Nos. 2 and 3 of the *Bulletin;* the article is based largely on official records, viz., *Les Annales Parlementaires,* the Report of the *Commission d'Études du Système Défensif* and the *Comple rendu de la Commission Mixte de* 1928. In No. 2, the general considerations bearing on the defence of Belgium are briefly set out ; an historical review is given of the development of the Belgian defensive system since 1816 ; the role of the Belgian fortresses and the part which they played on the outbreak of the War in 1914 are briefly sketched ; and an extract is given from the evidence of Lieut.-Gen. Galet, Chief of the Belgian General Staff, before the *Commission Mixte de* 1928, wherein he reviews the influence of the geographical position of Belgium on the strategical plans of the neighbouring States. In No. 3, Col. Michem examines the special features of the two principal defensive systems which have been advocated for the solution of the problem under consideration, viz., (1) the system advocated by Lieut.-Gen. Hellebaut, whose plan of defence entails the construction of a continuous line of permanent fortifications along the whole frontier—the so-called " système de l'organisation du champ de bataille frontière " ; and (2) the system of permanently fortified areas recommended by the *Commission d'Études du Système Défensif* which has been adopted by the Belgian Government—the so-called " système des regions fortifiées permanentes." Details in relation to both these systems are given in the original article.

Col. Michem points out that a small country like Belgium could neither meet the expenditure which would be involved in the construction of the works to defend a continuously fortified front of the magnitude which would have to be dealt with on the " Hellebaut system "—the length of the frontier from Antwerp to Luxembourg is approximately 200 miles—nor could it maintain an army of the size required effectively to man the works on a front of this extent. He further condemns the " Hellebaut system " on the ground that it is not a proper solution of the problem in question ; he makes the apposite remark : *A vouloir être fort sur une telle longueur de frontière, on est faible partout.*

The defensive system which has been sanctioned will comprise : (A) A series of *ouvrages d'arrêt* on the line Bastogne-Arlon, along the western frontier of the Grand Duchy of Luxemburg, with the necessary clearings, etc. ; (B) the Meuse Defences, which will consist of (1) the fortified position of Liege, and (2) the fortified position of Namur ; and (C) the Scheldt Defences, which will consist of (1) the fortified position of Antwerp, and (2) a bridgehead at Ghent.

Emploi des chars de combat dans la contre-attaque. This article, which is contributed anonymously to No. 2, consists of the solution of a War Game exercise set recently by the Inspector-General of Infantry ; the details of the scheme ; the Orders assumed to have been necessary ; and the action taken thereon are all set out.

Emploi des Mortiers 7·6. This article is contributed to No. 2 by Capt.-Comdt. De Smedt ; it contains the solutions of problems relating to the employment of trench-mortars in certain defined cases.

Quelques considérations sur l'examen des aptitudes pour la répartition dans les unités d'infanterie. This subject is dealt with by Capt.-Comdt. Leseul in Nos. 2 and 3 of the *Bulletin;* he describes certain measures which have been taken to give effect to the instructions contained in the Belgian Manual entitled *Les Directives pour l'Instruction des Troupes* (published in 1928). The object of these measures is to select individuals for particular duties by reason of their special fitness for the same. In No. 2 are set out the particulars of the "intelligence tests" devised in the Belgian *6e batterie d'infanterie;* the manner in which they were utilized; and the results obtained. Extracts are also given from the *Directives pour l'Instruction des Troupes* relating to the duties of the specialists of an infantry unit. The grouping of specialists in the various sub-units is discussed in No. 3.

Les opérations de l'Armée belge pendant la campagne 1914–1918. This article appears in No. 3; it is the first part of a summarized account of the operations of the Belgian Army during the period November 13th, 1917–February 7th, 1918. At this period, the Belgians were holding the portion of the front along the Nieuport-Furness Canal, and thence by Kloostermolen to Corverbeek. In December, 1917, an armistice had been arranged between the German and Russian Commanders, and negotiations had been commenced to settle the peace terms between the two Powers. Without awaiting the result of these negotiations, the German High Command had already in November, 1917, begun to transfer considerable forces from the Eastern to the Western Front. The defection of Russia necessitated a review of matters affecting the Entente Front. It then appeared that in order to utilize the Entente troops to the best advantage, it was desirable to adopt a defensive attitude in the early part of 1918, and to concentrate a general reserve in that part of the theatre whence it could be most effectively employed to counter the coming German offensive. It was agreed, in consequence, that a redistribution of troops should be carried out on the left of the Entente Front. This redistribution involved an extension of the front held by the Belgians; the moves which were carried out in connection therewith are described in the original article, which also contains particulars of the system of trenches in the neighbourhood of Merckem, and the operations which took place in this region shortly after the Belgians had taken over this sector from the French. Finally a brief account is given of the tactical developments which took place in 1917, and a reference is made to some of the *Instructions* issued by the Belgian General Staff in relation to the new methods of warfare.

Le D.L.O. dans la marche d'approche. This subject is dealt with in No. 3 by Lieut.-Col. Dony. Amendments have recently been made in the Belgian *Règlement Tactique de l'Artillerie,* and new editions of the *Instruction sur la Liaison et le Transmission* and the *Service en Campagne* have also been published during the past few months. Col. Dony calls attention to the instructions contained in the new service Manuals in relation to the composition and functions of the "Détachement de Liaison" and the "Détachement d'Observation." The composition of the "détachement de liaison d'artillerie" is set out in the *Instruction sur la Liaison et les Transmission;* it is also provided therein that in certain circumstances "observers" (N.C.O.s) are to be attached to this detachment, which is then to be called "détachement de liaison et d'observation" (abbreviated D.L.O.). Matters affecting the employment of the detachment last mentioned (the D.L.O.), in the case where opposing forces are about to come into contact, are briefly discussed.

Un cas concret d'organisation des feux aux avant-postes couvrant une position défensive. This article is contributed to No. 3 by Capt. Gerard, who discusses his subject in the light of the instructions contained in the Belgian Service Manuals: for this purpose, a definite scheme is set and worked out in detail.

L'emploi du peloton et de la compagnie au leur échelon en défensive. This article is contributed anonymously to No. 3; the subject is discussed in the light of the instructions contained in the Belgian *Instruction provisoire sur l'emploi des grandes unités* and the *Règlement de l'Infanterie au Combat.* The fundamental principles upon which

the Belgian defensive tactics are based are set out, and the various measures to be adopted to give effect to the official instructions on the subject are examined in detail in the original article.

W.A.J.O'M.

THE MILITARY ENGINEER.

(*September—October*, 1931.)—Experiments extending over several years have been conducted by the Chemical Warfare School to test the effect of smoke upon the efficiency of rifle fire. A large number of officers of varying skill have fired a test course with the following results:—With no smoke on the range 49 % of hits; with smoke on the target 16 %; with smoke on the firing point 5 %. The deduction is made that smoke on the enemy's line gives one's own men a three-to-one superiority, but the difficulty of maintaining the necessary strength of smoke is fully realized. Temperature, wind, terrain and surface features all affect the dilution.

The application of the principles of camouflage to the concealment of Coast Defences is considered, and the conclusion reached that camouflage, though expensive, must be done thoroughly or not at all.

Details are given of the spinning of the cables of the bridge now being erected across the Hudson from Fort Lee to Washington Heights. The spinning machinery, fastenings, and the methods of adjustment and compacting are described and illustrated. This bridge has a span of 3,500 feet, and is eventually to have 8 lanes of motor traffic on the upper deck and 4 rapid transit lines on the lower. The four suspension cables are each 3 feet in diameter, and weigh over a ton per foot. The anchorage on the New York side is a block of concrete containing 110,000 cubic yards This prodigious structure was due to be opened in 1932, but has already been opened, ahead of schedule.

The manœuvres of the First Cavalry Division afforded an opportunity of testing the reorganized Engineer Squadron, formerly the Mounted Battalion. It now consists of H.Q., a motorized H.Q. and Service Troop, and 3 Troops, two motorized and one mounted. In the motorized Troops motor transport is provided for all the personnel. The mounted Troop consists of 2 pack Platoons. As the terrain selected was a desert region near El Paso, it is not surprising that the water situation dominated the whole exercise. The conclusions of an officer who was present throughout strike a familiar note:—"It was seen that the Unit Engineer in exercises of this kind, as in actual war, must maintain constant contact with the officers of the General Staff in order that he may be thoroughly apprised of impending action. There is a tendency in peace-time manœuvres for staff officers to overlook the wartime importance of the engineer arm, because in peace the occasion for the employment of the engineers upon the routes of communication does not often arise. Manœuvres are in general planned for areas where roads and bridges are adequate, or, if not, the necessary repairs are ordered prior to the commencement of the manœuvres, in order that the purely combatant features may not be slowed up by delays which will, however, occur in time of war, when enemy action against our routes of communication becomes a factor of first importance. For this reason the unit engineer must be vigilant for opportunities to employ his engineer force in a tactically sound manner even though the work be only hypothetical. He must suggest the inclusion of engineer missions in the field orders of the unit, and must do what he can to combat the tendency to employ engineers only to guard the trains, bury the dead, and repair the barbed wire fences."

The demolition by dynamite of a 90-ft. high brick water-tower gave the officer in charge *un mauvais quart d'heure*. Having tested his blasting machine (exploder) through the coiled leads, and having tested each detonator with a circuit detector, he had the leads run out and in the presence of a number of movie and talkie operators gave the order to fire. Nothing happened. He examined the connections,

while ominous chunks of mortar dropped at intervals from the two gaping cracks which had been opened up by a preliminary charge. He tested again and had another failure. Finally it was found that the leads had become kinked in the process of running out, and the fault lay in them. They were replaced by others, after which the tower was successfully felled to the satisfaction of all save some pigeons who had made it their home and who had not taken advantage of the "notice to quit" in the form of the preliminary charge.

The tables of organization of the Army Topographic Battalion have been issued, and show that it is designed primarily for the rapid execution of mapping projects by means of air-photo surveying. It consists of H.Q., a H.Q. and Service Company, a Reproduction Company and 2 Surveying Companies. The total strength is 26 officers and 572 other ranks.

A Surveying Company is organized primarily to establish the control, upon which to base all mapping. It also executes such terrestrial surveying as may be required. The company consists of H.Q., a control platoon, and a topography and drafting platoon. The control platoon includes a horizontal control section and a vertical control section. This platoon executes horizontal control by triangulation, using towers or searchlight beams, and vertical control by "spirit levels" or trigonometric levelling. The other platoon is used principally for making terrestrial surveys in connection with the identification of triangulation points when the air-photo method is used, and for making surveys by ordinary methods when for any reason the use of air-photos is impracticable.

The Reproduction Company includes a lithographic platoon and a photo-mapping platoon. The former is organized into sections for drafting, photographic work, preparation of plates, and the operation of lithographic presses. The photo-mapping platoon is one of the most novel features of the new organization. It comprises 3 identical sections for the purpose of continuous 24-hour work in making maps from air-photos. All reproduction processes will be by lithography. Equipment will include steel towers and possibly searchlights for use in executing primary control. A liberal allotment of motor transport is made.

It is interesting to learn that the S.M.E.'s counterpart—the Engineer School at Fort Humphreys—has "gone Hollywood." The first production, "The Combat Engineer Company," has just been released, and while not being a nickel thriller it is said to be packed with absorbing interest. "You could take the children!"

The actual work depicted is incidental to the main theme, which is troop leadership and the technique of command. The scenario-writer seems to have accomplished the difficult task of weaving into an otherwise prosaic lesson a thread of almost romantic interest in the way of a continuous story of the Company Commander leading his men upon a succession of engineering missions, each coming in its logical order. I hope that our quota system will not prevent us from seeing this Company Commander "very much the typical soldier, hat off, blouse undone, hair dishevelled," but who, when occasion demands, is scrupulously exact and correct in his person, his relations with his subordinates, and his general military bearing.

That films are no use unless they are good is realized. The movie public, which of course includes every actual and potential soldier, is accustomed to cinematography of high excellence and has little patience with films of poor quality. And there's the rub! For good lighting is essential, and the fog of peace (as we know it in England) militates against clear pictures.

I.S.O.P.

REVUE DU GÉNIE MILITAIRE.

(*June*, 1931.)—There is an article describing the most important works carried out by the engineers during 1930 under the heading of roads and paths, bridges, railways, transmissional, miscellaneous, with numerous illustrations. The works included a

Pigeaud bridge, 70 metres long, constructed at Fenoyrolcs in Tarn et Garonne by the 7th Regiment, to replace a bridge washed away by a flood, and a ferro-concrete roof of a barrack at Beyrouth made by the 33rd Battalion.

The second part of the article entitled " Practical Advice to a Director of Engineers " includes many useful hints.

The continuation of the article on Permanent Fortification deals with the construction of protective works for armament and personnel in considerable detail.

There is a highly technical note on the loss of energy in power cables by Captain Allard.

(*July*, 1931.)—This number contains a note on the international colonial exhibition so far as the Génie are represented therein.

There is a continuation of the article on Permanent Fortification dealing with casemates, water supply, etc., and with the siting of permanent works.

An article by Captain Guittonneau describes the work carried out by the 32nd Battalion of Génie to remedy the damage caused by floods in Algeria in the winter of 1930–31. The works included two long pile bridges over the Chéliff at Charron and Orléansville to replace permanent bridges which had been severely damaged.

There is a short article by Reserve Captain Briancourt on the Tarring of Roads.

A.H.B.

HEERESTECHNIK.

(*November*, 1930, *continued.*)—*The Technical War-Equipment of the German Army before the Great War.* The National Archives are preparing in several volumes a work intended to show the nature, development and extent of Germany's production of war-material during the Great War. It is entitled *War Equipment and War Economics.* Such a work is looked upon as an indispensable adjunct to the volumes dealing with operations in the War History proper. It will be published by E. S. Mittler and Son, Berlin; and the first volume, complete with documents, tables, charts, etc., in a separate cover, price 60 marks (£3), appeared before the end of 1930. This first volume, as a necessary introduction, deals with the military, economic and financial equipment of Germany from the foundation of the German Empire to the outbreak of the Great War (1871–1914), and forms the subject of this article. The writer endeavours to characterize the contents, to show in what directions development principally took place, what its objects were, and to what degree they were attained. He deplores at the same time that the authors with intent have avoided going into the political and parliamentary factors which influenced development, since many a mistake and many an omission are thus hard to explain, and there is a tendency to throw the blame on the military authorities who were not at all, or only partially, at fault. The course of development traced in this volume also shows how in Germany—as indeed elsewhere—the experiences of the Russo-Japanese war were ignored, a phenomenon never clearly understood, and inadequately explained by showing how little results fitted in with the views of European armies.—(*To be concluded.*)

The German Railways in the War. While the official volume on the German Field Railways, produced by the National Archives, deals principally with the utilization of the railways in connection with strategic and tactical operations, this work is concerned in the first place with the performances of the home railways. It is written by the President of the National Railways Directorate at Treves, Dr. Sarter, and has been produced by the Carnegie Foundation for International Peace.

The two publications are thus complementary, and show to how great an extent not only operations but also the economic situation of a country are influenced by the railways. Major Kretschmann, who writes the article, says that Dr. Sarter's book clearly brings out the decisive importance of railways.

Germany's railway problem differed from that of the other great powers engaged, in that, owing to the occupation of enemy territory, there was an increase of about 40% in the length of line controlled. The home railways and those of the occupied territories thus became, for the purposes of war-conduct and war-industry, a unity of which the backbone was the home network. Of three-quarters of a million railway personnel nearly 300,000 had to be transferred out of the fatherland. In spite of the weakening consequent on this transfer of personnel, and on the transfer of much rolling-stock (*e.g.*, in 1918 field railways took over 5,215 locomotives), the home network fulfilled all requirements up to the second half of 1916. Then, however, serious difficulties began to occur, culminating eventually in only 100 demobilization trains being dealt with in a day, where four years earlier during the advance march the daily total had reached 1,210 trains, a falling off of nearly 92%.

During the whole War, Germany had suffered through not having her railways under unified control. What Bismarck had failed to bring about after the Franco-Prussian War, and what not even strenuous and repeated efforts during the Great War had been able to effect, came to pass in the troublous post-War times, viz., the unification of all the German State Railways.

Another interesting point to which Major Kretschmann draws attention is the effect the War had upon the different national systems. Countries with privately-owned railways (France, England, the U.S.A.) tended towards State control, so as to obtain a greater respect for the public interests on their railways, run generally on motives purely capitalistic. While, on the other hand, the countries with State-owned railways tried to a greater or less degree to free themselves from State and Finance control so as to work more on business and commercial principles. This mutual *rapprochement* has taken materially from the importance originally attaching to the question of State *versus* private ownership of railways in war.

(*December*, 1930.)—*Telephony by Directed Beams.*—The series of articles on this subject collected from the experts by Capt. Löwenstein is brought to a close in this number by "Trials with directed short electric waves" by Professor Krüger, Director of the Physical Institute at Greifswald University, and by Dr. Michelssen's "Telephony by means of the shortest directed Hertzian waves." Both articles refer to trials instigated by Capt. Löwenstein, and carried out in the first instance by Professor Krüger with the assistance of the Telefunken Company, and in the second by the Telefunken, to which Dr. Michelssen belongs. These trials form the latest development of the attempts started during the War by the German War Ministry, the object of which was to obtain a practicable system of directed ray telephony for use in the field.

Professor Krüger refers to the initial difficulties in obtaining reflectors, which alone would make directional telegraphy and telephony possible. With the aid of transmitter-valves, including one with a specially small capacity anode, wave-lengths were reduced to a few metres. Reflectors with ordinary reflection for these wave-lengths would have been too large and unwieldy. Recourse was had, therefore, to a kind of reflector, which, as it turned out, had already been tried by Braun, viz., a resonance-reflector, *i.e.*, a parabolic cylinder-reflector, the surface of which is formed of wires stretched 10 to 20 cm. apart and parallel to the axis of the cylinder. The length of the wires was such as to be in resonance with the oscillations, *i.e.*, they had to be half the length of the wave. By earthing them it was possible to reduce them to a quarter of the wave. The reception-reflector was built on similar lines, but with a longitudinally movable wire in the mirror-axis connected with an amplifier. Evidently these short waves were heavily damped by the earth, for successful reception had not been carried out at more than 1 km. when the end of the War stopped the trials.

Dr. Michelssen continues the story. Since that time, however, the short wave has come into its own, so that by far the greater number of the long-range wireless traffic stations of the world at present use short waves; the distant effect of which depends

upon their being conducted by the Heaviside Layer, occurring about 100 km. from the earth's surface. Waves shorter than 8 metres are not suitable for long-range working, since their radiation normally does not return from the Heaviside Layer. The phenomena of space and surface-radiation, as with the waves of commercial wireless, no longer hold good. The radiation of these wave-lengths below 8 metres is straight, like that of light. Hence Dr. Schröter has called them "quasi-optic." Directed and sharply defined radiation, which is necessary for short-range wireless telephony, can be obtained more easily as the wave-length decreases. Thus these quasi-optic rays are suitable for telephony in the field. They can be produced down to a wave-length of 3·5 cm., but two factors impose a limit. The ionization of the air by the sun causes a great falling-off in radiation-strength, and comparatively fine layers of moisture also absorb radiation. Thus atmospheric conditions limit the practical use of the shortest wireless waves to those from 10 cm. upwards. It is with these "decimetre" waves that the Telefunken Coy. has been carrying out exhaustive trials during the last few years. The method of producing them, with questions incidental thereto, has been dealt with fully by E. H. Hollman in 1928 *Annals of Physics*, 86, p. 129 *et seq.* The best known method of production is that of Barkhausen and Kurz, which is naturally a return to spark and the classic use of a Hertzian oscillator. The latter is placed at the focus of a reflector to which it radiates as a di-pole antenna. Instead of the alternator used by Ludenia for feeding the oscillator Professor Esau and Busse used valves for ordinary undamped fairly H.F. oscillations. They were thus able with 300,000 sparks a second to radiate energy at 50 watts on a 30-cm. wave. Performance can also be increased by the use of suitable material at the poles. Aluminium, though inferior to silver as a conductor, proved to be 50 times better as a radiator, owing apparently to the formation of a layer of aluminium oxide which covers the surface of the poles.

The trains of heavily damped oscillations radiated from a di-pole antenna are suitable for telegraphy only; but if the aerial is fed with undamped H.F. oscillations, speech-modulation is easily imposed in the usual way.

For reception a crystal detector is the simplest means, directly connected with the reception di-poles, which lie in the focus of the reflector. The L.F. oscillations can then be taken off by H.F. chokes being built in close to the resonator. Barkhausen and Kurz, however, use a valve-detector instead of the crystal, connected between the poles, one to anode and one to grid. The valve thus acts as a detector, L.F. oscillations being taken off in the anode-circuit and led to amplification.

With these arrangements, telephony has been easily worked at a distance of 20 km. on a 40-cm. wave with only a few watts power, and entirely unaffected by atmospheric conditions.

Summing up shortly, the problem was to create a simply directed, invisible means of telephony and telegraphy, suitable for use in the field. It has been found that both infra-red and short Hertzian waves, not below 10 cm. long, are suitable. For the solution of the task the following were necessary:—

(1) The design of a transmitter of infra-red rays, capable of modulation.
(2) The creation of a detector of infra-red rays, with the least possible inertia.
(3) The development of telephone-circuits for the shortest wave spark transmitters of sufficient energy.
(4) The creation of a valve-detector arrangement for decimetre-waves.

As regards sharpness of direction the infra-red telephony radiator is still considerably superior to the short-wave wireless sender. On the other hand, as regards the penetration of very thick wet mist the superiority of the electric waves is well established. Their range is limited only by the earth's curvature.

Capt. Löwenstein concludes that, based upon these trials by the Telefunken Coy., it should be possible in the next few years to produce practicable directed beam telephony for military purposes.

The Technical War Equipment of the German Army before the Great War (concluded). Relates how Germany in the race with France for an improved field gun, lamentably backed the wrong horse by breaking off the trials with barrel-recoil, and thus could only put up their field gun 96, a much inferior weapon, against the famous French "seventy-five." There was then nothing left for the Germans to do but to convert their gun to barrel-recoil as quickly as possible. This conversion took five years, even with the added stimulus of the Morocco crisis. The light field howitzer (one of the few examples of profiting by the unfortunate experiences of other people), adopted by the German Army after the failure of the Russian field guns against the Turks' field defences at Plevna, was also converted to barrel-recoil.

Here General Schwarte, who writes the article, thinks another mistake was made. Although the reconstructed light field howitzer, excepting only as regards range, was a universally acknowledged success, the Treasury opposed re-armament, and in 1914 not more than one-quarter of the Regular Field Artillery and none of the Reserve Field Artillery had been re-armed. This mistake was felt more and more as the Reserve divisions came into the line in increasing numbers.

The writer then deals at some length with the heavy artillery, and in turn, but very shortly, with infantry close-fighting weapons, engineer equipment, aviation equipment, anti-aircraft equipment—there was none—signals, motor-transport, travelling field ovens and cookers, and field railways.

It is very clear that the reviewer has laid no such restraint upon himself with regard to mentioning political factors, as did the authors of the book he is reviewing. And indeed it is questionable whether anyone could give an approximately true account of the development of army equipment, in Germany or elsewhere, without showing again and again the effect of financial restraint or even of Treasury veto. Similarly external politics also have a bearing on armaments, when competition takes place with a foreign power, or under threat of war.

The accumulative effect of making a summary of this nature is so great that General Schwarte ends with a sigh. He takes the deficiencies, the errors of omission and commission disclosed by Vol. I of "War Equipment and War Economics" as proof positive that Germany could not have been thinking of war.

British Mining Activity in the Great War. Taken almost exclusively from Major-General R. N. Harvey's article in *The R.E. Journal*, December, 1929. The writer contests nothing in that article, and apart from extracting information, quotes only to approve. Finally, he goes even farther than saying that in every future European war mining formations will be necessary, for he foresees an extension of mining methods in the making of C.T.s (Russian sap) and of small shelters, which will make every infantryman a miner.

(*January*, 1931.)—*Questions of Passive Air Defence.* 1. *A New Directional Hearer*, by Dr. von Hofe. Taken from the *Zeitschrift für Instrumenthunde*, published by Julius Springer, Berlin. Germany may, as the introduction states, be specially interested in passive air defence questions owing to active air defence not being permitted, but there is no power which is not eager to obtain the very earliest information of the approach of hostile aircraft. Directional hearers of various makes, from a simple paraboloid with microphone at the focus to instruments based on time or phase-difference, were produced during the War not only in Germany, but elsewhere, especially in England, France and America. In war also was the origin of that brilliant invention, the hot-wire microphone, the idea of which occurred to an R.E. officer as he lay in bed and heard slight whistling sounds produced in small holes in the canvas sides of his Armstrong hut in correspondence with the reports of distant guns. Latterly a new idea occurred to an Austrian artillery officer, Capt. Maurer, of an arrangement which would greatly increase the accuracy of directional hearing. He tried it out with Professor Haschek, and then gave the design and manufacture of the instrument over to the well-known instrument makers, Goerz. The increase of accuracy is obtained by causing sounds which come from the right

to be heard only by the right ear, sounds from the left only by the left ear, while a sound coming from directly in front is heard by both ears. This is done by means of two paraboloids as receivers and two ellipsoids as conductors of the waves received. Each pair of curves has a focus in common. Sound-waves coming from the left are reflected by the left paraboloid into its connected ellipsoid. Sound-waves coming from the left into the right paraboloid are reflected outwards, so do not reach the right ellipsoid and the right ear is not affected. The sum of the paths of all waves through the conductor being constant makes for great purity of tone.

A diagram shows that the complete instrument consists of a horizontal system and a vertical system combined. In this there are four paraboloid receivers of similar pattern, but two of the ellipsoids are shown as having a right-angled bend in the middle.

The remainder of the article treats the subject mathematically.

Air Notes. Very high praise is accorded to Italy for the first trans-ocean flight of a closed squadron. That such an achievement could not be arrived at without loss was certainly taken into account. That the losses were not greater was due to systematic training for years for such flights; thus in 1928 a flight was carried out over the Western Mediterranean by 61 light hydroplanes over 3,000 km. This was followed in 1929, by a tour over the Eastern Mediterranean and the Black Sea, 5,000 km. long, carried out by 35 heavy hydroplanes. A third effort was 10,000 km. over Europe and Africa by 12 heavy bomber hydroplanes.

In Russia, the Commissary for War, Woroschilow, announced that in 1930 no less than 87 new aeroplanes were taken over by the Army, having been provided by voluntary subscriptions of the population. Associations, etc., making such gifts were allowed to give their names to the aeroplanes. Woroschilow said they would be used in defence against the intended attack of the capitalist powers on Russia.

Belgium is ordering aeroplanes from English firms out of all proportion, *Heerestechnik* thinks, with the size of the country—45 Foxes in the summer and 45 Fireflies in November.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1931.)—Colonel Loizeau completes *Succès stratégiques, succès tactiques* in this number. His object is clearly to show how Schlieffen drew up a sound plan, how Moltke, Falkenhayn and Ludendorff all failed in their execution, and how Foch was eventually successful. Colonel Loizeau sets out his arguments very clearly and makes it quite plain that there is always a tendency for tactical successes to distract the commander from his strategical idea. On the other hand, Foch had time at the end of the War and could have carried on, if necessary, in 1919. Ludendorff had only the first part of the summer of 1918 and time was definitely against him. Near though he was to success, one cannot help wondering whether he could have really succeeded. It is possible that the German army itself, although parts of it were still excellent, was not still in a condition to carry operations through till the British or French were finally defeated, quite apart from Ludendorff's actual methods.

Contre-Amiral Castex has an article entitled *Les objectifs géographiques*. It deals both with military, as well as naval conditions. The writer points out how, in history, naval commanders have fluctuated between Nelson's method of making for the enemy's main forces and the method of attacking a "geographical objective" quite apart from the situation and intentions of the enemy. Under certain conditions geography may provide an importance to an objective, as illustrated by the Dardanelles in 1914–15; but it is never sound to concentrate on geography apart from other conditions. The article is of considerable length and Admiral Castex goes into the situation in many wars. He finishes with a discussion of so-called "limited"

wars and points out that many people think that in a war like the Russo-Japanese, geography decides entirely where the main action is to be fought. The writer, however, disagrees with this theory and points out that one never knows when a war will cease to be limited and that geography cannot take the place of naval or military conditions.

In *Le premier généralissime des armées russes*, Général Danilov completes his description of the Russian operations while Nicholas was still in command. The Russian forces had two objects, first to help out their allies and second to be still in a good position to carry on fighting. General Danilov, who was first quartermaster-general of the Russian army, claims with justice that the first object was fulfilled, but that the second was doubtful. There is no doubt that the German troops increased very considerably on the Russian front during the early stages of the War. On the other hand, practically all the German operations were successful, owing to a series of circumstances which are now well-known but which were not realized at the time.

Chef de bataillon Delmas has an article entitled *La guerre sur le plan de réalités* in this number. This discusses the developments which the last war produced and how they are to be faced in the future. There is no special interest to us in this article, but the writer's last words point towards the usual enemy that France has always had on her eastern frontier.

Le Maréchal Macdonald et la défense du Bas-Rhin, by Capitaine Regnault, begins in this number. The period 1813–14, when Napoleon was being driven back into France, is described. Macdonald was put in command of the defences of the Rhine and his efforts to maintain his position are shown. The article has no particular interest for us except in showing that some of Napoleon's commanders fell a long way short of the Emperor himself.

(*August*, 1931.)—Lieutenant-Colonel Desmazes has a short article on *La défense de la position fortifiée de Namur en août*, 1914. Early in the Great War there was a general impression that the defence of Namur was by no means as glorious as that of Liège. This book, published by the Belgian General Staff and reviewed here by Lieutenant-Colonel Desmazes, corrects this view and describes how Namur was as important to the Allies as Liège and how it was defended by the Belgians. (See page 727 of this journal.)

Lieutenant-Colonel Pugens begins *Du rôle joué par le terrain à la bataille des Ardennes* in this number. The French realized that the Germans would advance through the Ardennes, even if they broke the neutrality of Belgium, and General Langle de Cary, commanding the 4th Army, had the task of attacking their left. Even though he studied the ground, he did not seem to realize how terribly difficult offensive operations would be. General de Lanrezac, who was to command the 5th Army, had also reconnoitred the area and expressed himself most forcibly on the prospects of an attack. He said that they might attack into the woods but that they would never come out of them. A further advantage held by the Germans was that better routes existed for them, from north-east to south-west, than for the French from south to north. The writer is very much against the actions carried out by General Langle de Cary and General Ruffey, on his right, and completes the instalment by saying that the French forces were approaching an action "partly unexpected, unprovided for and impossible to conduct."

Les tentatives de manœuvres d'aile après la bataille de la Marne, by Lieutenant-Colonel Variot, is a description of the French effort to turn the German right flank in 1914. Although General Joffre's intention of using Manoury's Army was correct, he failed to crush Von Klück owing to the slowness of action of the French troops. Colonel Variot points out that a single commander, with the one object in view, was required first of all. Until General Castelnau appeared on the scene, no such commander was available, and by the time he arrived the chance had gone. The article gives a very detailed description of the operations of Manoury's army, but is not of

particular interest to us apart from the description of the causes leading to the partial failure of the French counter-attack.

Yves Gylden has an interesting article entitled *La cryptographie militaire des Puissances Centrales*. He is a Swede, who has made a thorough study of the subject of cryptography, and who has published his views in this number. Apparently the Germans had not the same pre-war experience of cryptography as either the French or the British, as was demonstrated by the French and British cryptographers in 1914. The writer discusses the Russian use of clear by wireless in 1914, which made Ludendorff's orders so much easier, and points out how the Austrians took advantage of the Russian mistakes in their own wireless. He then considers the subject, not only with the Great Powers, but also in countries like Serbia, etc. The whole article is distinctly interesting to anyone who is keen on cryptography.

Capitaine Regnault completes *Macdonald et la défense du Bas-Rhin* in this number. The rather complicated operations in Holland and to the south of it are described. The instalment is rather too detailed to be interesting to the Englishman. One cannot help wishing to hear more about Napoleon himself and not so much about his officers.

Lieutenant-Colonel Larcher begins *Le 1er corps de la Belgique à la Marne* in this number. This Corps was expecting, towards the end of August, 1914, to attack, not to retire. On the 28th it received orders splitting it up, but the chief of staff succeeded in prevailing on the Army Staff to cancel these orders, to everyone's relief. The instalment is completed with the Corps preparing to counter-attack the Germans with the cavalry already in action.

(*September*, 1931.)—Général Fangeron begins *La recherche de la décision* in this number. This instalment refers to the beginning of the Great War, when the Germans were acting on Schlieffen's plan, as modified by Moltke. It is very difficult to take an unbiassed view of Moltke and Joffre, the two commanders. The writer considers that although the French were too keen on the offensive, they were at least controlled by Joffre, who visited his armies regularly; the Germans were hardly controlled at all by Moltke, who stayed at G.H.Q. throughout. This is very likely true, but the original operations of the French nearly brought about a great disaster, and one cannot help wondering whether it was Joffre's control, or the actions of Lanrezac, in the 5th Army, which prevented the disaster. Was not the real difficulty, which the Germans failed to overcome, that the task they undertook was really too big for any army?

Du rôle joué par le terrain à la bataille des Ardennes is completed by Lieutenant-Colonel Pugens. In the last instalment he concludes by saying that the action would be "partly unexpected, unprovided for and impossible to conduct." Here he explains how each of these were true and how the French failed completely to give the Germans a setback in this difficult area. To anyone knowing the Ardennes it seems remarkable that the French should have considered the area as one for attack. If they had prepared it for defence, far better results would have been achieved.

Capitaine Seive has a short article entitled *L'aviation en guerre de montagne* in this number. There has been more than one article of this type, which is always interesting to the Englishman on account of the great use now made of aircraft on the north-west frontier of India. The writer describes the difficulties of mountain flying, how the weather affects the use of aircraft, and particularly how few landing-grounds there are. This leads him on to explain how particularly important it is for airmen to be trained in this special form of flying. The article is illustrated by very effective air photographs taken in the Alps.

In continuing *Le 1er corps de la Belgique à la Marne*, Lieutenant-Colonel Larcher describes how this Corps moved up to counter-attack the Germans. The latter were pressing heavily on the 3rd and 10th Corps, while General d'Espérey prepared to relieve them with his counter-attack. For some time the troops of the 1st Division were forced to wait under heavy shell fire, but on the afternoon of the 29th August,

the two Divisions, together with troops collected by d'Espérey from either flank, moved forward with great enthusiasm. The instalment, which gives very considerable detail throughout, closes as the Divisions are advancing on Hill 150 north of Bretagne.

R.C. has an interesting and important article entitled *Intérêts russes et japonaises en Mandchourie* in this number. The writer, after describing the early history of Manchuria, explains how it was that Russia and Japan went to war in 1905. He then considers the points at issue between Japan and China and points out how Russia has again become involved. There is no space here to go into any details, but to anyone interested the article is well worth reading, more particularly in view of the recent Japanese action since the article was written. There is no doubt that Manchuria provides the easiest outlet for the Japanese and is rich in all kinds of raw material. Whether Japan is right or wrong morally, the presence of Bolshevik Russia and a possibly Bolshevik China in this country are bound to cause considerable trouble. The League of Nations are now dealing with the present friction between Japan and China, but there is little doubt that Japan will not give up what she now holds.

H.A.J.P.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*November–December*, 1930, *continued.*)—*The Importance of the Training of Morale in the Modern Army.* Capt. Fechner thinks that the good spirit and the reliability of the troops has always been taken too much for granted. Experience in war and in the troublous times of the revolution after the War have shown the value of morale, and caused soldiers to think about how morale can be trained. He defines the soldierly spirit as the sum of the moral factors which alone guarantee that the individual will act as demanded by the conditions of the modern combat. Since the origin of the moral factors lies not in his military education, but in the sphere of the will, moral training is necessary to bring out the soldier's moral qualities. This is the more necessary in order to counteract modern tendencies, materialism and lack of national feeling, a lack of understanding of the idea of authority, and international pacifism. Then also there is to be combated the false teaching of peace which invariably elevates mere knowledge above soldierly spirit, forgetful of war's teaching, which puts the latter first. Capt. Fechner's list of means by which morale may be trained is: (1) Instruction, (2) Example of the leader, (3) Relationship between leader and man, (4) Nature of and spirit animating military service. It will be noticed that (2) (3) and (4) have always existed without any specific instruction in morale: and doubt may be permitted whether human beings are capable of devising any system of instruction in morale worthy of the priority accorded.

Modern War Aeroplanes. Capt. Ritter, late of the German General Staff, follows up his "Problems of a Modern Air Power" (*vide R.E. Journal*, September, 1931, p. 558) with another admirable article, well illustrated and covering 40 magazine pages. He classifies aeroplanes by types and tasks, and, according to these, points out the guiding principles underlying present construction and future development. His immediate object is to give the reader a picture, based upon principles, of the composition of modern air-fleets and an idea of their value from the standpoint of the military and technical expert. He hopes thereby to help to create public opinion.

Capt. Ritter is an enthusiastic exponent of the Independent Air Force school. By the state, at that time, of technical development, by the stationary nature of the War, and by their spectacular successes, he explains the position of prominence, in the estimation both of the public and of the airmen themselves, attained by the Fighter, as compared with the Bomber and the Co-operation machines (Reconnaissance and Observation). These war ideas, arising from factors at that time decisive, must not be accepted as our guide. The idea of air forces being purely auxiliary to land and

sea forces is now, through the facts of technical development, long since out-of-date, and no longer to be found except in France and in second and third-class powers whose officers have been trained in the French school. From this point of view there can never be credited to the air arm, as the ideal to be striven for, the capability of exercising a direct and effective influence upon the course of a war in the grand style and as a political act.

After such clear statements of his views, Capt. Ritter's order of classification comes as no surprise. He takes first aeroplanes suitable for Independent Air Force purposes and places them in order of importance: (*a*) Bombers of all sizes, including the 'planes necessary for their offensive or defensive combat, and also machines requisite for the strategic distant reconnaissance of suitable targets for bombing; (*b*) 'Planes for co-operation in land and sea-fighting; (*c*) Fighters. The bombers are sub-divided into heavy, medium and light. Types are: "the only heavy bomber as regards load and range which is worthy of the name," the Italian Caproni 90 PB; heavy night-bombers, Handley Page Hinaidi, Vickers Virginia X, and three French types, also not star-performers, the Dyle Bacalan 10, the old Farman Goliath, and the 0·25 Bn 4 type of Lioré and Olivier. Medium bombers are the Sidestrand Mark III of Boulton and Paul, and three French types, considerably inferior to it in speed, but not in range, the Amiot 122-B3, the Blériot 127 and the Potez 35. In the fast and light class, which is specifically British, are the Fairey III F, the Fairey Fox, Hawker Hart and Hawker Harrier.

Turning to the Fighters, Capt. Ritter selects as prototype of the future "flying destroyer" or "air-cruiser" the Blériot 127, the Potez 35, and the Swedish A.B. Flygindustri K 37, all of which are also suitable for long-range reconnaissance and for bombing tasks up to a load of half a ton.

The second main category consists of aeroplanes necessary as auxiliary to land and sea forces. Here the author has compiled a list, not claimed as exhaustive, of nineteen types. As regards the army alone he reduces them to: (*a*) Reconnaissance and Observation machines, (*b*) Bombers and Battle 'Planes, (*c*) Fighters. In class (*a*) he awards the palm to the Armstrong Whitworth Atlas and the Avro Antelope, mentioning also the Westland Wapiti, the Bréguet 19 and the Potez 25–A 2. Capt. Ritter thinks that the Dyle et Bacalan D.B. 20, introduced for taking part with the infantry in ground fighting, should be the prototype of this class, which, apart from more powerful engines, somewhat improved performance and greater constructional strength, differs "heartily little" from its predecessors of the Great War.

The types chosen in class (*c*) are the Hawker Hornet, the Morane-Saulnier 222–C 1, and the Swedish A.B. Flygindustri K 47, which is a two-seater.

The whole article, with its interesting quotations from the *Coast Artillery Journal*, the *R.U.S.I. Journal* and the *R.A.F. Quarterly*, and Grey's excellent photographs, is to be regarded as a fitting appendix to *Luftflotten* (*vide R.E. Journal*, March, 1929, p. 140).

(*January–February*, 1931.)—*The first Battles against the Italians*, by the late Colonel Veith. In the Austrian *Official History of the War* reference is made frequently to a manuscript by Col. Veith preserved in the War Archives in Vienna. The work in question was produced for publication in America, but the matter fell through. Some years before his death Col. Veith presented his manuscript to the Archives to be at the disposal of the Director, Glaise-Horstenau, preferably for publication. This account was drawn upon by the compilers of the war history, and the quotations from it in that work awakened so much interest in the original, and caused so many requests for further information, that the *Mitteilungen* has decided to start publishing extracts. They claim charm for these writings as being those of an eye-witness, and on the same grounds claim indulgence for more plain speaking and soldierly language than is usual in a scientific work. The first instalment deals with the first two battles on the

Isonzo. The style is popular, and the treatment quite unofficial. It is easy to understand how the compilers of the *Official History* must have turned eagerly to this racy account for quotations with which to lighten their own products.

The author gives more than one case of the use of stage armies. The Austrians were at the beginning so weak on the Carinthia front, that for some time a battalion of the Landsturm spent its time travelling daily by train from Oberdrauburg down the valley of the Drau to Villach, and thence up the parallel valley of the Gail to Hermagor, where it detrained and marched up the valley under Italian observation. During the night it used to take a very short cut over the mountains to Oberdrauburg, where it was ready to entrain again for the next round trip.

The story is also told of the Austrian artillery officer who had to perform the melancholy duty of shooting up the home of his ancestors near Gorizia, as it had, unfortunately for him, been chosen as an Italian headquarters. Under similar circumstances near Ypres a Belgian artillery officer is reported to have been overheard saying " I bet that one went into the billiard-room."

About Gorlice. Under this title Major-General Kerchnawe reviews the second double number of the second volume of the Austrian *Official History of the War*. The title must be taken as meaning, not only concerning Gorlice, or Mackensen's great break-through battle in Galicia early in May, 1915, but also round and about Gorlice, since the volume deals also with facts, figures and measures connected with Italy's immediately succeeding entry into the War. There can hardly have been many who foresaw that Italy would actually take sides against her allies, but there is evidence here that many did not believe that she would fight on their side, when and if the time ever came. Prominent among doubters was Count Schlieffen, whose remark, " What an illusion ! " when hearing in 1905 of the diplomats' ideas on the subject, has become historic.

Gen. Kerchnawe considers the success at Gorlice a proof of what the Central Powers were capable of, given only that superiority which in all pre-War calculations had been laid down as essential. Their tragic fate and their real mistake were that, although it was possible, they did not bring this superiority to bear from the beginning.

The English-Belgian plans before the Great War for an advance march against Germany. The title of this article appearing in German in a patriotic Austrian magazine can hardly fail to suggest to the English reader that he has once more before him an article whitewashing Germany. Notorious examples of this process endeavour to show that England and France *would* have done what Germany *did* do ; and so on. Here, however, we find with pleased surprise, nothing of the sort. Major Hosse (late of the German General Staff) has made a study of the *Conventions Anglo-Belges* captured by the Germans in 1914, and surrendered by them in 1919, but not before the precaution had been taken of having them photographed. This agreement was made in 1906 between the British and Belgian War Offices, and only permitted by our Foreign Office as " an exchange of ideas, quite provisional and unbinding." It gave in some detail provisional arrangements for the transport of a British army to the neighbourhood east of Brussels, with as an alternative a move to the north of Namur. The agreement was cancelled a year later, as it was feared that there would be insufficient time after the violation of Belgium by German troops for a British army to reach Belgium, and it was on this supposition of previous German invasion that the agreement alone rested. The Anglo-Belgian Conventions were then replaced by an Anglo-French agreement embodying the arrangements for the provisional landing and advance march of a British force ; as actually took place seven years later.

If any of the *Gott strafe England* school survive they will be disappointed that Major Hosse has found nothing against England, but everything in her defence. The *Mitteilungen* and its reviewer deserve both our thanks and our congratulations upon this example of their rising superior to other considerations while chasing truth.

Foreign Politics and Military Power, by Lieut.-Col. Regele. The fundamental connection exists between these two, that all the actions of foreign politics have real value only when behind them is real power. This military power again must be equal to dealing with all the situations arising from international alliances, or from international crises. Starting from these propositions the author takes the simplest solution of the problem of bringing into harmony foreign policy and the conduct of war, viz., the combination of foreign minister and commander in the same person. He gives an imposing list of examples:—Cæsar, Cromwell, Gustavus Adolphus, Eugène, Marlborough, Frederick the Great, Washington, Napoleon, Bernadotte, Kemal Pasha. It is obvious that as soon as the offices are divided, the possibility arises for severe conflict between statesmen and general, and of this history bears testimony on numerous occasions. The cause of such conflicts lies in the absolute inseparability of the two spheres and in false ideas of their mutual relationship. The conduct of foreign affairs and the conduct of war are both arts, requiring skill to be added as a crown to knowledge. The soldier and the statesman must know something of each other's arts, so as to ensure harmonious co-operation. Col. Regele points out that England is the first country to take a practical step towards the solution of this burning question in starting the Imperial Defence College, "a road which all nations in one way or another must follow."

The Care of Tradition in the Old Army and in the Army of to-day. An article written by General Kerchnawe as an introduction to a review by Colonel Schubert of an admirable publication, *The Care of Tradition in the Federal Army—through centuries of Austrian soldiering*. This work contains 130 pages, 10 in. x 14 in., with nearly 500 illustrations. It is sold by the *M. Mitteilungen*, Wien I, Stubenring 1, at the quite nominal price of 2 Austrian schillings, or, say, 1s. 2d. in English money, for a 7s. 6d. book: postage extra.

The story of its origin is shortly this:—The Austro-Hungarian Empire, lineal descendant of that Ostmark created in 803 by Charlemagne to defend the eastern boundary of his possessions, took the field in 1914 with sixty divisions. That empire disappeared from the map on October 30th, 1918, and its army ceased to exist at the same time. After the Armistice a people's army was formed, having no connection with the old army. The Treaty of St. Germain abolished conscription in Austria and limited the army to 30,000 men (6 brigades). Under the Austrian Constitution Act the People's Army was abolished and a new Federal Army was formed. This army was the creation of the Minister for Military Affairs, Vaugoin, who, against much opposition, made an army which would prove a reliable instrument for the use of the Government. He wisely started to weld it on to the old Austrian army by reviving the names of certain regiments, whence followed at once *liaison* with Old Comrades' Associations, the keeping of regimental anniversaries, etc. The War Archives and the War Museum assist in the good work, to further which is also the object of the handsome volume under review.

Modern Armies, by Colonel von Wittich. As an introduction to a statement of the present army conditions prevailing country by country, this first instalment of the article deals shortly with—armies and the conduct of war in the last 150 years; armies and the conduct of war at the present day; armies and state-constitution; armies and revolution; and armies under restrictions. The notes under these five sub-heads provide the historical background necessary to throw the remainder into relief. The first and second are general; in the remaining sub-heads examples are chosen, France and Russia for armies as affected by revolutions, Germany and Austria for armies under restrictions, while England is selected for showing the connection between army and state-constitution. For this purpose the author starts with a quotation from Chambrey's *Les deux derniers chapitres de ma philosophie de la guerre*, which was used in a pamphlet of L. von Ranke, dated 1836, "one of the best and cleverest political studies in the German language." Chambrey, on the subject

Des institutions militaires dans leurs rapports avec les constitutions politiques et avec les institutions civiles, likens the British army to Parliament before the Reform Bill. The aristocracy, which filled both Houses, gave its consent yearly to the army's maintenance. As it was in the aristocracy's interest to maintain the existing order of things they arranged it so that the officers' posts remained in their hands. The private soldier, on the other hand, was enlisted and kept in subordination by a combination of good will, through better wages and greater care, than any other European army enjoys, and the strictest discipline.

Col. von Wittich's comment is "How comparatively little the British army has changed since! English conservatism, which, for centuries until quite recently, has been so characteristic of the constitutional life of this island-power, expresses itself clearly in the steadfastness of English army institutions." Even the drastic measures necessitated by the Great War have proved to be only an episode in the life of the British army. Macaulay, himself for two years Minister for War, is quoted as the classical representative of the Englishman's opinion of army service as being a voluntary performance with which the public is in general but little concerned. This strongly marked conservatism has, on the other hand, proved no obstacle to the development of the British army in its keeping for its purpose abreast of the times. "In many branches, especially as regards a utilization, worthy of imitation, of the achievements of a highly developed standard of technics, the British army to-day must be named with those in a leading position."

Changes in the British Empire since the War, and the great alterations, which started at the same time, in British constitutional and party life, all doubtless point to the commencement of a new era. It is not easy to foresee the extent of these developments, hence it is unwise to prophesy their possible reactions on the character of the army.

"The English example shows perhaps most clearly, that holding fast to what has been proved and has grown familiar, combined with a watchful sense, that looks ahead, for every sound progress, is a very good way of meeting both those changes which constantly become necessary in an army, and also unexpected exceptional demands." —(*To be continued.*)

Civil War and Communism in China. Under this title General von Mierka, who had some years of experience in the Far East, gives a résumé of the more important events in China during 1930. The story thus continues from where it left off on p. 187, *R.E. Journal*, March, 1931, with the National Government (Kuomintang) in Nanking still unable to maintain their authority. Feng-yu-hsiang, the "Christian" general, had returned from banishment and induced the "model" governor, Yen-si-shan, to join him against the Government. Operations against Feng, and against revolting generals in the south near Canton, bound the National armies (troops of the Nanking Government) to such an extent that the Russians were able to obtain in full their demands concerning the E. Chinese Railway, which had been confiscated by the Chinese. The Russians by regaining the administration of this railway were able to resume the Communistic propaganda for which they had used it before: but a greater result was a considerable strengthening of the Communist elements, noticeably in South China, which had catastrophal effects.

At the beginning of March the rebels, Feng and Yen, demanded the dismissal of Chang-kai-shek, President of the Central Government and Commander-in-chief of its armies. They also established, at least on paper, a counter-government in Peking. Thus the years-old struggle for the unification of China resolved itself once more into North *v.* South. Both parties tried but without success to win over the Governor of Manchuria, Chang-su-liang, the son of the great Chang-so-lin, who had been assassinated.

As in all the campaigns hitherto the three great railways which traverse China decided this time also the theatre of war, thus about 16 divisions of Government troops

occupied the Hankow-Peking railway and, facing west, opposed 12 divisions under Feng based on the Singan railway. A further Government force of 10 divisions occupied the Nanking-Peking railway as far as Tsinanfu and facing north opposed 12 divisions under Yen. The Government had 5 more divisions on the Kiauchao-Tsinanfu railway. It will be noted from this short description that Chang-kai-shek's army was on interior lines. Nevertheless, Feng was allowed to attack first. This he did early in April, and with great success, capturing the Peking railway at Chengtan, and occupying the Singan railway to 200 km. E. of Kaifeng. A considerable portion of the Government troops he had cut off to the north went over to him. Meanwhile Yen had confined himself to confiscating the customs of Tientsin. This was a good move; especially as he avoided touching the portion which was earmarked for the repayment of loans to the Powers. Chang-kai-skek drew back before Feng, when he had a stroke of ill-luck. He was threatened in rear by three divisions of Chang-fai-kwat's (the Ironsides), who, driven into Hupe the year before, now reappeared and captured Changsha, on the railway between Hankow and Canton. This threat so hampered the Government forces that operations against Feng had to be suspended; but a month later, in July, with the aid of troops from Canton who had remained true to the Central Government, Chang-kai-shek decisively defeated the Ironsides, who retreated to their home-provinces, scrapping on the way with forces out of Yunnan and Kwantung, who had gone over to the Government. The seven divisions thus set free were used partly to attack Feng, but without success, and partly to attack Yen, whom they drove north, but the Communists in the south developed such activity that Chang-kai-shek had to stop this drive and sent troops south once more. A Red corps took Changsha at the end of July and plundered it. They also made the mistake of firing on an American gunboat and killing five men. It is natural that an incident of this nature puts back the whole movement towards abolishing foreign privileges. Chang-kai-shek had to send troops to protect Hankow, the next place threatened. As it was important to carry on the good work in the north he decided eventually to buy off the Reds, and this accomplished and Changsha evacuated by them, he hurried the troops back to continue the offensive against Yen in Shantung. By the middle of August the Government had taken Tsinanfu and its important railway junction.

Feng tried too late to help his ally, but could not avert this defeat, which was largely ascribed to the use of bombers. The effect of this aerial bombardment was so great that Chang-kai-shek could have followed into Peking, but that Chang-su-liang arrived from Manchuria early in September and occupied Tientsin. He thereupon transferred his attention to Feng, whom he defeated at Chengchow, driving him off the Peking railway, back along the Singan railway, and even across the Hoangho into defensive positions.

Except for the increase of strength to the Reds, with whom the issue will have yet to be fought, 1930 brought no great change, and certainly no advance to a settlement.

Military Policy in 1930. There is a great improvement this year in Colonel Paschek's method of reviewing events, changes and policies of the various powers. Instead of a chronicle, which must give rather a headline and staccato effect, he has written a narrative showing the connection of events with the past, mutual relationships and the trend of development. He finds us still living in the fermenting transitional period following the unnatural first liquidation of the Great War, and does not dare to say that 1930 showed much signs of starting a new era.

The notes start with Great Britain, whose centuries-old mastery of the sea was brought to an end by the Naval Disarmament Conference in April. In the autumn Col. Paschek sees in the many concessions by the Dominions in favour of unity a triumph of the old Anglo-Saxon imperialism. He finishes well with the idea of a Coalition Government.—*(To be continued.)*

Fire and its Application. Written by Major-General Büttner, with reference to

the section on Fire in the new Austrian Combat regulations. Exception is taken at the outset, to the use of the word " regulations " as being inapplicable to anything as fluid as the combat. It is hoped that this is only the writer's way of saying that the letter killeth, while the spirit giveth life ; but he carries it farther still when he says that the fight cannot be subjected to a set form. Of fire General Büttner says that it is the most important means of creating the foundations which guarantee success to the aggressive spirit. This definition tallies very little with what is said in our own *Field Service Regulations* on the object of fire, and on the factors making for success in the attack. Perhaps, however, it explains the author's objection to regulations. He wishes to emphasize the importance of the spirit animating the attack.

F.A.I.

CORRESPONDENCE.

NOTES ON THE PONTOON BRIDGE PARK, R.A.S.C.

Royal Engineer Office,
The Castle,
Dover.

The Editor, *The R.E. Journal.*

SIR,

Major Kerrich says in his interesting article on the Pontoon Park that his suggested standard approach road might be " drawn like other R.E. stores from the Corps dump." I wonder what Major Kerrich visualizes when he speaks of a Corps dump. The official definition of " dumps " from the *Field Service Pocket Book* is " Small collections of supplies, stores or ammunition accumulated temporarily for some particular purpose."

There will be no Corps R.E. dumps as we knew them in the Great War. Such things as are collected into dumps will be only for some specific purpose and for a very short period.

Unless we get back to position warfare, which we are led to believe is unthinkable, we shall have to rely on our parks for everything we want in a hurry and there is a very definite limit to their capacity owing to the transport problem.

I am, Sir,
Yours faithfully,
H. A. BAKER,
Captain, R.E.

TANK *v.* TANK.—A CORRECTION.

The Secretary, The Institution of Royal Engineers, Chatham.

DEAR SIR,

With reference to my article, "Tank *v.* Tank," which appeared in *The Royal Engineers Journal* of June last, Lieut.-General J. Talbot Hobbs, A.M.F., who at the date of the observation in question was in command of the 5th Australian Division, has been good enough to point out an error. In it I said:

> "The Australians broke before them [the German Tanks] just as the Germans had done at the battle of Cambrai, and the Australians are probably the staunchest offensive infantry in the world."

This is incorrect; it was not the Australians who were attacked, but units of the 8th Division which had relieved them on April 22nd.

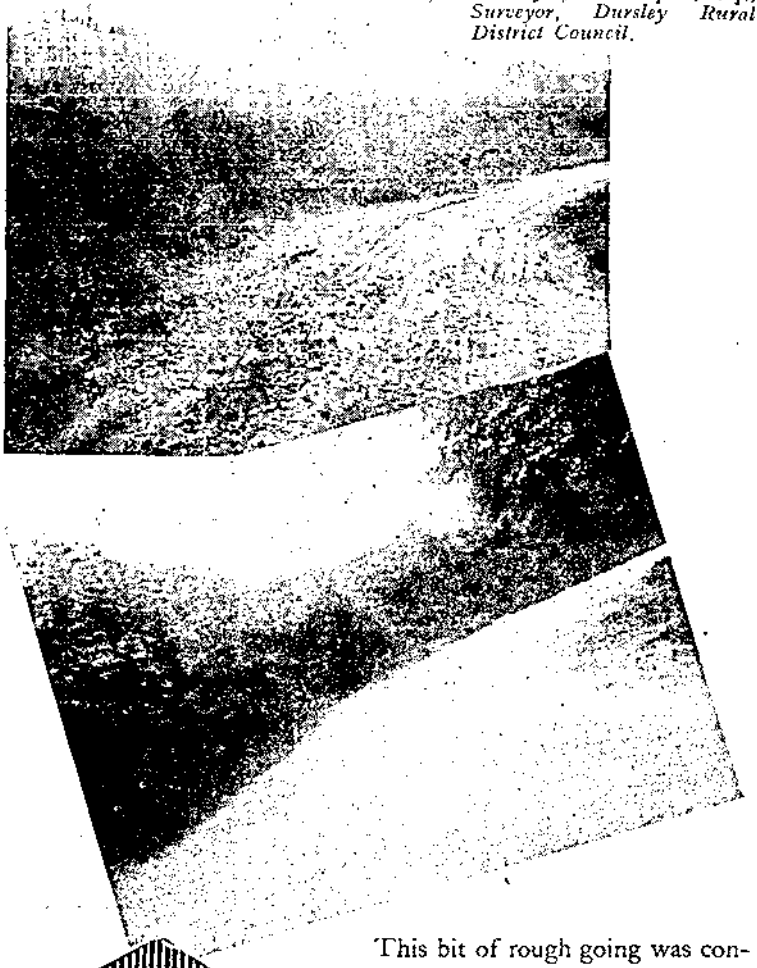
Yours faithfully,

J. F. C. FULLER,

Major-General.

[The correction has been verified, and it is regretted that the original statement was not.—EDITOR.]

Dursley R.D.C. Photos by courtesy of L. V. Apter, Esq., Surveyor, Dursley Rural District Council.



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