THE ROYAL ENGINEERS JOURNAL—MARCH 1962
VOL LXXVI No 1

THE ROYAL ENGINEERS JOURNAL

Vol LXXVI MARCH 1962 No 1

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The Comprehensive Insurance

Policy for Life Happiness

by THE REDUCED SCHOOLS FEE PLANS

The ordinary Educational Endowment Assurance Policy does not normally take into consideration the peculiar difficulties and the varying conditions of each parent.

The following scheme has been produced for parents to consider. There is no obligation for them to undertake the plan, but it is recommended that they should consult Colonel Finch (retired), of Messrs. Harold B. Finch & Co. Ltd., a Qualified Insurance Broker, in order to see what assistance he can provide to meet each individual parent's requirements. It is equally applicable to either girl or boy or both.

Under normal circumstances where parents are of an average age and the plan is initiated at the birth of the child, a sum approximating to his fees at a Public or other School can be provided, guaranteed and secured against the death of the parent, at a cost making a saving of several hundred pounds on the average normal fees.

Should a parent be so unfortunate as to die during the child's infancy, then a maintenance income, as well as a sum towards the cost of education, becomes available immediately.

Unfortunately education is expensive. A Public School Education is costly and whilst it is possible for a child to attain a high standard of education for less than £200 a year, many Public School fees are in the region of £300 and upwards, as can be seen by the few examples listed, which are only as an indication and not necessarily correct to-day. Parents are, however, recommended to register the baby at the selected school as soon as possible in order to avoid finding no vacancies available.

We have for consideration the following schemes:—

A. The Monthly Payment Endowment Policy Plans.

These plans permit the individual needs and circumstances of each parent to be considered. They are flexible and do not bind parents to use the policies for payment of fees at any particular School if, for any reason, the child should not enter the School. The examples given later in this brochure are designed to show only the general principles; a fully personal plan will be sent to parents who use the attached enquiry form, without placing them under any obligation.

A and B plans recommended would achieve a spread of payments over long periods and, in special cases, it might be possible to start off with a lower premium during the first few years.

EXAMPLES of Reduced School Fees Schemes A and B.

These have purposely been made simple, but the actual plans can be arranged to include more than one child, e.g. whole families can be included. Existing Life Policies can be taken into account and the addition of subsequent children is simple to arrange.

Plan A.—The intention is to send a boy, who is not yet one year old, to a Preparatory School at say £240 p.a. when he is eight years old for five years, and then to a Public School at say £309 p.a. for five years.

10 years' education at fees normally payable in those 10 years, would cost ... **£2,745**

Under the plan, the cost, spread over 17 years, after allowing for the maximum tax reliefs and allowances (current rates) would cost about £111 per annum until the boy goes to the Preparatory School and would gradually increase each year to about £173 in his last School year, i.e. **starting at £11 4s. 2d. per month.** (Not taking into account the allowance for Officers of the Services.)

Total cost would be about — Net **£2,238**

Total saving about **£655**

If the father died, the plan would pay the sum assured towards the fees in one lump, and £100 yearly from the date of death for the boy's maintenance.

Plan B.—The intention is to send a boy, who is not yet one year old, to a Public School in his thirteenth year for five years, independent arrangements being made for his schooling prior to entry.

5 years at a Public School at approximately £309 per annum, normally payable in those 5 years, would cost	**£1,545**
Under the plan the cost, spread over 17 years, after allowing for the maximum tax reliefs and allowances (current rates), would cost about £64 per annum until the boy starts at a Public School and would gradually increase each year to about £89 in his last year, i.e. **starting at £6 8s. 5d. per month.** (Not taking into account allowance for Officers of the Services.)	
Total cost would be about — Net	**£1,172**
Total saving about	**£463**

If the father died, the plan would pay the sum assured towards the fees in one lump, and £100 yearly from the date of death for the boy's maintenance.

In these examples it has been reckoned that the father's age is 30. The annual outlay on the plans varies chiefly with the age of the boy—the younger he is the lower the outlay each year.

Plan C. The Single lump sum Payment Scheme.

By which the total amount of fees is aggregated together to purchase an annuity certain policy through a trust fund with a bank of your choosing. As a result of considerable research and knowledge of taxation, this is able to produce a saving to parents in some cases of several hundred pounds as compared to schemes where the lump sum is paid to the school direct. Each case is dealt with according to its requirements.

We enclose herewith a list of approximate fees for boys' Public Schools, which we hope will be helpful to you with regard to our Reduced School Fees Plan.

Ampleforth	£330	Aldenham	£345	Bedford	£285
Beaumont	£330	Blundell's	£345	Bradfield	£360
Bromsgrove	£345	Canford	£399	Charterhouse	£390
Cranleigh	£345	Downside	£429	Eton	£460
Fettes	£315	Haileybury	£390	Epsom	£345
Harrow	£462	Lancing	£396	St. Edwards	£342
Malvern	£375	Marlborough	£417	Loretto	£360
Oundle	£435	Radley	£381	Mill Hill	£387
Rugby	£439	Sedbergh	£339	Repton	£410
Shrewsbury	£360	Stowe	£405	Sherborne	£336
Tonbridge	£330	Trent	£324	Taunton	£282
Westminster	£408	Wellington	£375	Uppingham	£360
Worksop	£320	Wycliffe	£315	Winchester	£453

Girls' Schools

Cheltenham	£324	Queen Anne's, Berks	£312	Skellfield, Thirsk	£279
Harrogate	£348	Roedean	£387	St. Audries	£297
Lowther	£360	R.N. School, Haslemere	£300	St. Leonard's	£360
Malvern	£366	Royal School, Bath	£315	The Mount, York	£348
Overstone	£309	Sherborne	£360	Westonbirt	£375
Penrhos	£324			Wycombe Abbey	£410
Queen Margaret's	£291				

To Officers of Her Majesty's Forces specially competitive terms covering all contingencies and hazards of Service life in peace and war are available and allowance can be made for the Service grants.

ENQUIRY FORM

Will you please fill in this form and send it to Colonel Finch,
C/o. HAROLD B. FINCH & CO. LTD., "REVESBY," HUTTON ROAD, ASH VALE Nr. ALDERSHOT, HANTS.

Parent's Name ....

Parent's Address ....

....

Telephone No...

Profession...

Date of Birth of Parent............................

Each Child or Children's Name(s)	....	....	....
Date(s) of Birth	....	....	....
Date(s) of Entrance to Preparatory School	....	....	....
Fees of Preparatory School	....	....	....

Name of Public School ....

Date(s) of Entrance to Public School	....	....	....
Fees of Public School	....	....	....
Date(s) of Leaving School	....	....	....

Since we try to employ all existing means available, it will assist if you please state Provisions already made:

(a) Insurances already taken, giving detail in full, Name of Company, Sum assured, Date of Maturity.

....

....

(b) By other means ....

(c) Any other information ....

Signed...

Date ....

To: Col. H. B. Finch, M.C., (Retd.)
"Revesby," Hutton Road, Ash Vale, Aldershot.

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ASH VALE, ALDERSHOT.

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MARCH, 1962

Captain Charles William Pasley RE

150 Years of the School of Military Engineering

By Lieut-Colonel E. E. N. Sandeman, RE, OBE (Retd)

On 23 April 1812, by Royal Warrant issued by the Prince Regent on behalf of King George III, an Establishment was authorized for the instruction of the Corps of Royal Military Artificers, Sappers and Miners and the Junior Officers of the Corps of Royal Engineers in military fieldworks. This Royal Engineer Establishment was later to be renamed the School of Military Engineering, which is now about to celebrate its 150th birthday.

From the time of the Norman Conquest there have been in this country military engineers permanently employed by the Crown, but in the early days there were no schools of instruction for their professional education; indeed many had to learn their job in the hard school of active service. It was not until 1683 that a Royal Warrant laid down the specific duties and qualifications required by military engineer officers employed under the Board of Ordnance, but the Warrant made no practical provision for their instruction. A few selected cadets, or young engineer officers, were from time to time sent to Europe to visit fortifications and report upon them, but it was not until 1741 that the Royal Military Academy was established at Woolwich for the training of potential artillery and engineer officers. There was, however, at first no entrance examination nor were age limits set and the standard of instruction was not very high. Furthermore, after leaving the Academy, officers received no additional courses of instruction to fit them as engineer officers.

Until the formation of the Soldier Artificers at Gibraltar in 1772 and the Corps of Royal Military Artificers in 1787 there had been no peacetime other rank military engineers, and moreover even after the raising of these two Corps the privates in them were principally tradesmen and they received no special training in fieldworks nor in offensive siege operations. However, in 1809 Captain C. W. Pasley, RE, as a result of his experience of operations in the Low Countries where he had been severely wounded, began actively to stress the need for instructing junior engineer officers in their duties in the field and for "forming a well-instructed and well-disciplined body of Engineer soldiers diligently exercised in all operations of a siege, particularly military mining, and also in the formation of military bridges." He pointed out that the Gentlemen Cadets at Woolwich were not even taught the elements of siege operations and that junior Royal Engineer officers were "sent on active service without ever having seen a fascine or a gabion, without the smallest knowledge of the military passage of rivers, of military mining or of any other operation of a siege, excepting that what they might pick up from French writers." Two years later, whilst in command of a Company of Royal Military Artificers at Plymouth, he began diligently to put his ideas into practice.

Early in the Peninsular War the Duke of Wellington realized the need for employing the Corps of Royal Military Artificers in a combat engineer role and for Royal Engineer Officers being permanently attached to Companies of Royal Military Artificers. He suggested a change of name to Royal Sappers and Miners and he requested that six companies, after instruction in the art of siege warfare, be sent out to him. Finally on 7 April 1812 he wrote a forceful letter to Lord Liverpool saying, "storming a breach, or attacking a place by escalade, is an operation of a very different description from fighting a general action. In the latter every man, generally speaking, has an equal chance, but in the former the officers, the bravest and best of the non-commissioned officers and soldiers, go first. The loss falls upon these; and five minutes after the breach is carried women and children might enter it instead of men . . . great losses would be avoided, and, in my opinion, time gained in every siege, if we had the properly trained people to carry it on . . . I earnestly recommend to your Lordship to have a Corps of Sappers and Miners formed without loss of time. . . ."

This letter had its effect. On 23 April 1812 an establishment was authorized for the instruction of other ranks of the Royal Military Artificers and junior officers of the Royal Engineers in the duties of sapping, mining and other military fieldworks. Four months later, on 4 August 1812, the Royal Military Artificers were formally renamed the Corps of Royal Military Artificers or Sappers and Miners and the title was shortened on 5 March 1813 to Royal Sappers and Miners. Pasley's system of instruction was accepted as a basis of instruction for the newly authorized Royal Engineer Establishment, and he was selected to be its first Director with the rank of Major—a rank for which he had to fight although authorized in the Warrant.

On 2 May 1812 Pasley received orders at Plymouth to march with a detachment of men to Chatham, the place selected for setting up the Royal Engineer Establishment. Ten days later he was there living in the Royal Artillery Mess, his men being quartered in St Mary's Barracks and at Upnor. On 28 October 1812 Pasley issued his first orders for the new Establishment in which he stated his aims and laid down rules for the classification of instructors, details for the various courses of fieldworks and the times of parade.

Chatham in Pasley's day was a strongly fortified naval dockyard town. The defences were of a permanent nature designed to be garrisoned by some 7,000 men. The fortifications included deep, wide ditches, batteries, bastions, sally-ports, drawbridges—all excellent material for the instruction in the art of siege warfare. Ample land for fieldwork training at Upnor already belonged to the Board of Ordnance. Rochester Bridge then had many narrow spans and the water at certain times of the tide rushing between the piers made navigation hazardous and provided just those risks Pasley considered excellent for realistic pontoon training.

The first unit trained at the Royal Engineer Establishment sent to join Wellington's Army of the Peninsula was the 2nd Coy/2 Bn Royal Sappers and Miners. The unit distinguished itself at the storming of San Sebastian in 1813 and its men were nicknamed "Pasley's Cadets".

Pasley's method of instruction was quite revolutionary. At that time very few soldiers could either read or write and it was considered that to educate the soldier and to teach the NCOs to carry out fieldworks on their own

In the Name and on the Behalf of His Majesty.

George P. R.

WHEREAS you have represented unto Us, that it would tend much to the Advantage of Our Service if a general System were established for the Instruction of Our Corps of Royal Military Artificers, Sappers and Miners, as well as the Junior Officers of Our Corps of Royal Engineers in the Duties of Sapping, Mining, and other Military Field Works. We, in the Name and on the Behalf of His Majesty, do hereby approve of the annexed Establishment which you have stated to be necessary for conducting the Business of the proposed Instruction, and do authorize you to fix upon such Stations as you may consider most advantageous for carrying on the extensive Practice there to be performed.—Our further Will and Pleasure is, that you or Our Master General of Our Ordnance, for the Time being, do from time to time select from our Corps of Royal Engineers, such Officers as from their Zeal and Abilities you may deem most competent to fill the Appointments of Director and Assistant Director, for the Purposes aforesaid; And whereas the Appointment and Duties of Director are of much Importance, requiring a considerable Portion of Ability and Exertion on the Part of the Officer who may be entrusted therewith; We are moreover pleased, in Order to give due Weight and Authority to such Officer, to grant to him the Rank of Major in Our Army, from the Date of his Nomination, to that Trust, provided he shall not have previously attained the said Rank; And We do also direct that you do cause the Amount of the aforesaid Establishment, together with the Expence of Materials, Tools, and other Articles required for the Operations to be carried on, to be inserted in the Ordnance Estimates, to be from time to time presented to Parliament; and for so doing, this shall be as well unto you as to the Commissioners for Auditing the Public Accounts of the United Kingdom, and to all other Our Officers and Ministers herein concerned a sufficient Warrant.

Given at Our Court, at Carlton House, this Twenty-third Day of April, 1812, in the Fifty-second Year of Our Reign.

By the Command of His Royal Highness the Prince Regent, in the Name and on the Behalf of His Majesty.

(Signed) R. RYDER.

To our Right Trusty and well-beloved Councillor, Henry Lord Mulgrave, Master General of our Ordnance.

Warrant for an Establishment for the Instruction of the Corps of Royal Military Artificers, Sappers and Miners, and the Junior Officers of the Corps of Royal Engineers in Military Field Works.

Entd. Kings Warrant Book No. 11 fo. 234

Photograph of the original Royal Warrant, granted by the Prince Regent on behalf of King George III, for the formation of the Royal Engineer Establishment.

responsibility would be a waste of time and might even make them conceited and insubordinate.

Those initially under instruction at the Establishment consisted of Royal Engineer officers on first commissioning from the Royal Military Academy and batches of recruits from the Royal Sapper and Miner Depot, then at Woolwich, and NCOs and men from the Royal Sapper and Miner Service Companies. In 1815 East India Company engineer officers, after passing through their Seminary at Addiscombe, came to the Establishment to be trained with the young Royal Engineer officers, and in 1817 batches of recruits for East India Company Engineers came also for six months training before being posted as NCOs to the Company's Indian Sapper and Miner Corps.

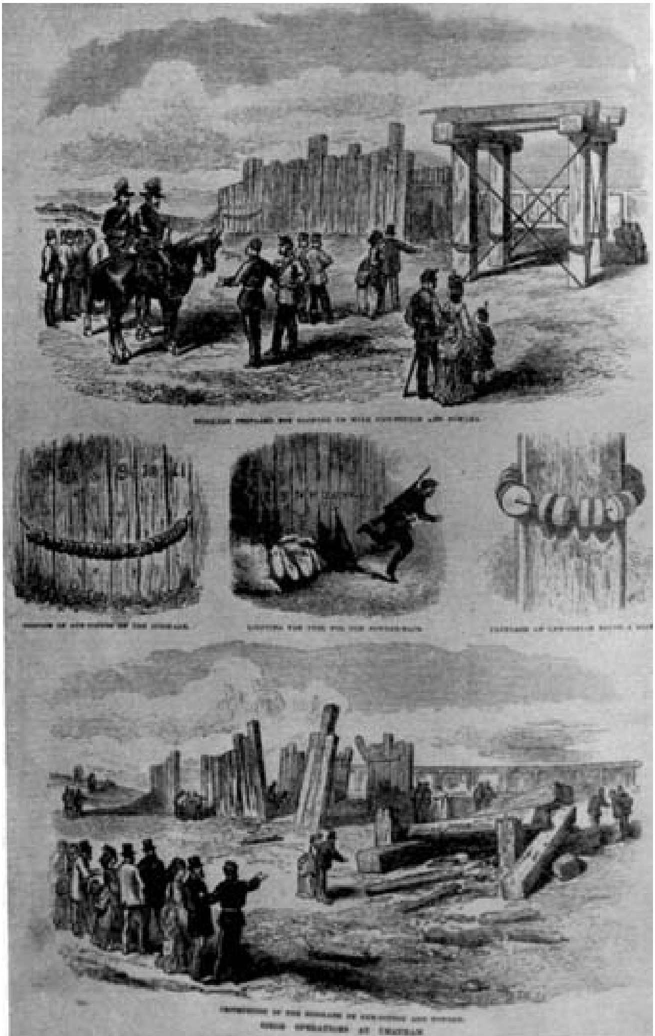
In 1833 Pasley, who was a great showman, organized the first of a series of demonstrations of siege operations on the Lines at Chatham in which all arms of the garrison took part. One of these early demonstrations was described by Charles Dickens in his *Pickwick Papers*, first published in 1836. Pasley, who was represented as the dashing Colonel Bulder, greatly impressed Mr. Pickwick, as did the "astounding evolutions" carried out that day. The annual RE Demonstrations of today have not yet achieved such immortality.

Pontooning took place from the Gun Wharf, despite attempts by those in authority to limit this form of training to the relatively still waters of St Mary's Creek. From 1833, and for some years afterwards, the Sappers constructed each year a pontoon bridge across the Medway in the presence of the Infantry of the Garrison and of the Cavalry from Maidstone, who afterwards crossed the bridge.

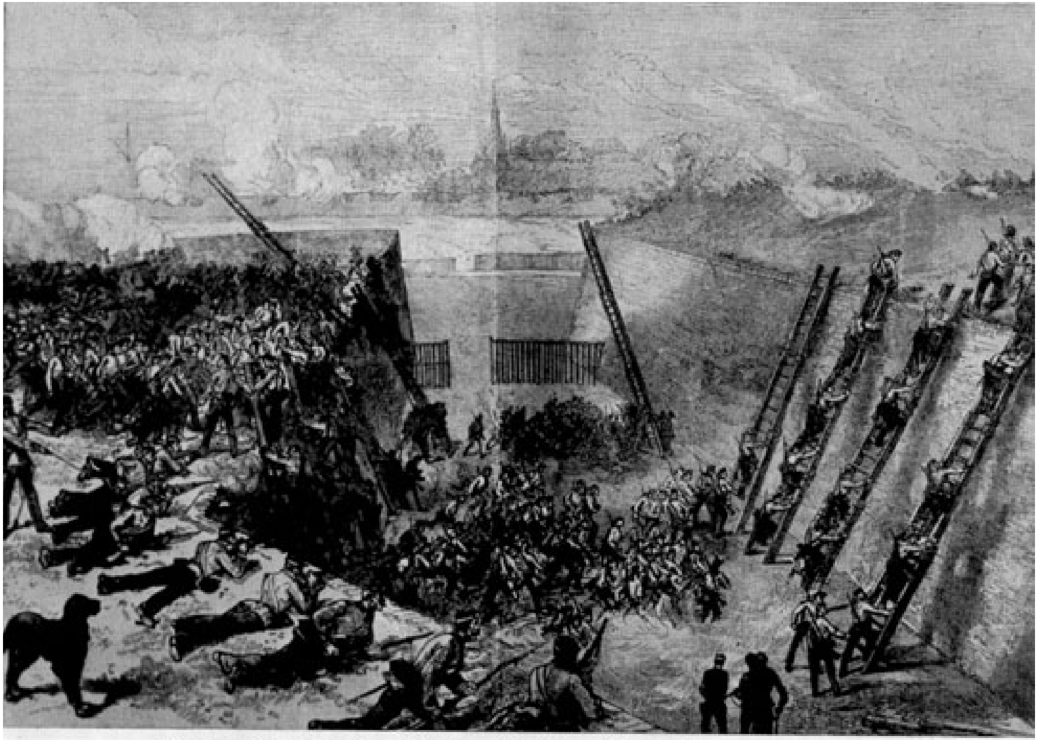
In February 1825 Pasley carried out some of his first experiments in firing explosives under water with fuzes, and between 1838 and 1843 he superintended parties from the Establishment removing several wrecks from navigation channels. The most notable of these were the brig *William*, sunk off Tilbury Fort, the schooner *Glenmorgan*, also wrecked in the Thames, and the line-of-battle ship HMS *Royal George* sunk at Spithead. For his work in the Thames Pasley received the Freedom of the City of London and from the experience gained in salvage work the art of working under water was developed. Diving became a recognized Corps trade, and the science of submarine mining began to be studied at the Royal Engineer Establishment.

The RE Establishment was formed initially as a Fieldworks School, and the syllabus of instruction included the practical operations of a siege in the field, sapping and mining, escalading, the passage of a ditch (or moat), practice with hand grenades, bridging and pontooning. Theoretical training ranged from instructing other ranks in the "three Rs" and geometry to teaching officers the art of fortification and siege warfare. Later, however, instruction in chemistry, electricity and military telegraphy was also taught in the Fieldworks School.

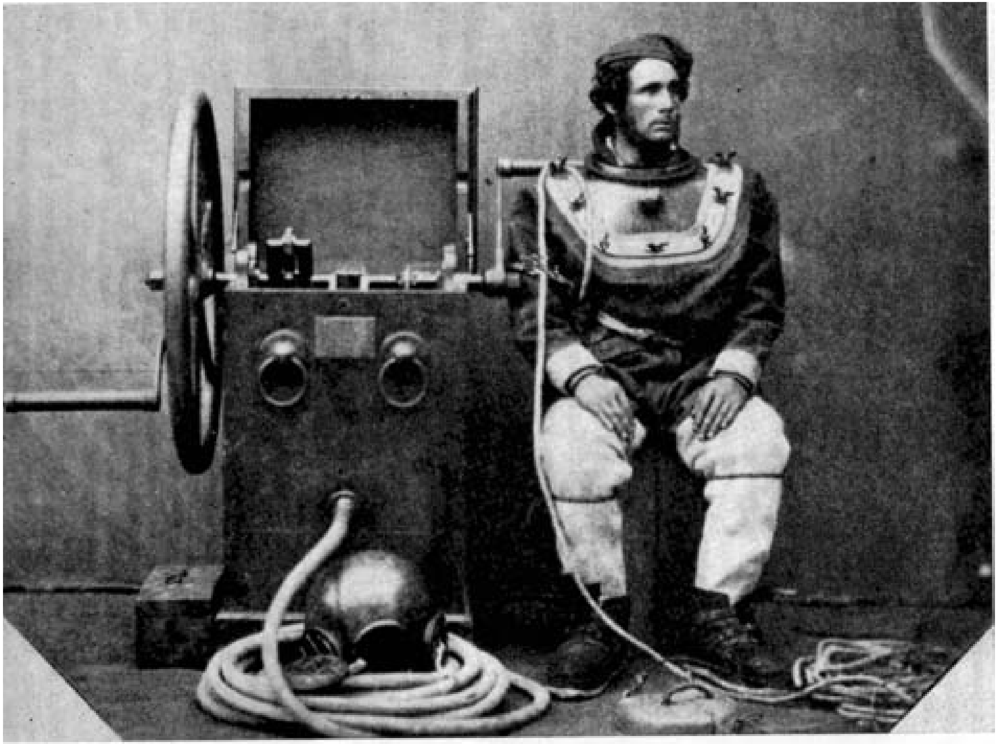
Prior to 1792 the Royal Engineers had been responsible, under the Board of Ordnance, for barrack construction and maintenance. In that year, however, a Civil Barrack Department was charged with that task which it carried out until 1822 when it was decided that the responsibility for Works Services should revert to the Royal Engineers. To prepare the Corps for this a School of Construction and Estimating was added to the Royal Engineer Establishment in 1825. Instruction was initially limited to officers, but later extended



Siege operations at Chatham in 1871. The demolition of a stockade.
(From *The Illustrated London News*, 11 November 1871)



Siege operations at Chatham 1871 (From *The Illustrated London News*, 4 November 1871).



RE diver 1859.

150 Years Of The School Of Military

to include the training of NCOs in the duties of Military Foremen of Works and Clerk of Works, and to train infantry NCOs in the supervision and maintenance of sanitary appliances in barracks. The ever versatile Pasley produced his famous instructional textbook entitled: *Outline of a Course of Practical Architecture compiled for the Junior Officers of the Royal Engineers.* Instruction soon also covered all the various branches of civil engineering in connexion with buildings, water supply, sanitation and roads. Pasley was to achieve even further fame by his chance discovery of a method of producing a high grade cement manufactured from chalk and Medway clay from which has sprung the Portland Cement industry which still flourishes today on the banks of Chatham's River.

For many years prior to 1833 Cadets at Woolwich qualifying for commissions in the Royal Engineers had been sent to Wales for training in survey. This, however, had not proved satisfactory and in 1833 a School of Survey was set up as part of the Royal Engineer Establishment. It is of interest to note that a Corps of Royal Military Surveyors had existed from 1800 to 1817, before the Survey School at Chatham had been started, and that the first three Survey Companies of the Royal Sappers and Miners were raised during the years 1824 and 1825 for the survey of Ireland.

At the close of 1841, Pasley, now a Major-General, left the Royal Engineer Establishment after being its Director for almost thirty years. During his time the scope of the Establishment had increased enormously and it had achieved international fame. It had also produced a host of brilliant military engineers renowned for their outstanding work in many far-flung countries of the world.

Pasley was succeeded by Lieut-Colonel Sir Frederick Smith who, after completing his appointment sat as a Member of Parliament for Chatham in 1852 and from 1857 to 1864.

The third Director was Lieut-Colonel Harry Jones who, whilst at Chatham, made the Army "pick and shovel minded" enough to send infantry officers and men on fieldwork courses at the Royal Engineer Establishment. He later became the CRE of the British forces during the investment of Sebastopol during the Crimean War.

In 1855 Colonel H. Sandham became Director. It was a most appropriate choice. He had previously served as Brigade Major of the Royal Sappers and Miners Depot at Woolwich and he, as Director of the Royal Engineer Establishment, was responsible for accommodating the Depot at Chatham on its move from Woolwich in January 1856. He was also Director when the Corps of Royal Sappers and Miners was absorbed into the Corps of Royal Engineers on 17 October 1856 and Chatham became the Headquarters of the Corps as we now know it.

The uniform for the amalgamated Corps Regimental Brass and Reed Band was designed personally by the Prince Consort. It was somewhat striking. It consisted of a black bearskin head-dress, white tunic with bright blue facings and ornate gold trappings and scarlet trousers. The more practical scarlet tunic and black trousers were, however, adopted in 1873.

The amalgamation of the Depot with the Royal Engineer Establishment necessitated several changes. The Brigade Major of the Depot became an AAG, and a Commanding Officer of the RE Battalion was appointed in 1857. The instructional staff of the establishment was increased and four main schools were established, namely the Fieldworks, Construction, Survey and

Special Schools. The latter dealing with all subjects not covered by the other schools.

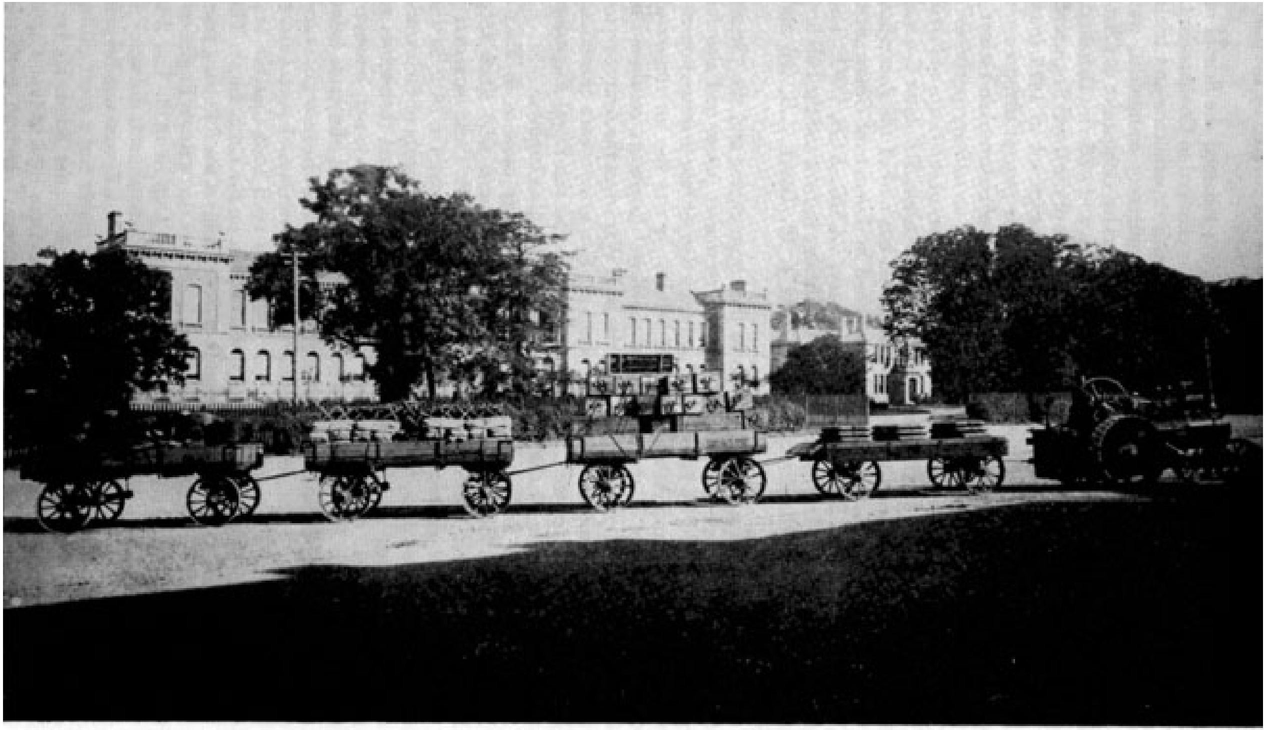
In 1869 the Royal Engineer Establishment was renamed the School of Military Engineering and the title of Director was changed to Commandant. The Royal Engineers Committee, which dealt with experiments and trials connected with the development of military engineering equipment, was placed under the Commandant. The Depot and Service Companies at Chatham were in 1889 grouped into a Training Battalion and a Service Battalion, and Brompton Barracks became the undisputed home of the Royal Engineers.

The Royal Engineers Institute was officially recognized in 1875 (now known as the Institution of Royal Engineers) for "the general advancement of Military Science and for promoting the acquisition of historical and scientific knowledge in relation to engineering as applied to military purposes". The Institute had its origins in the Professional Papers of the Corps of Royal Engineers, started in 1837 by Lieutenant W. T. Denison, RE (later Colonel Sir William Denison, one time Governor of Madras and of the Australian Colonies). The Institute building was designed by Lieutenant Ommanney, RE, later to become Sir Montague Ommanney, GCMG, KCB, DSO. The foundation stone was laid by the Duke of Cambridge in 1872 and the building was erected under the direction of Colonel J. W. Lovell, CB, RE and completed in 1874.

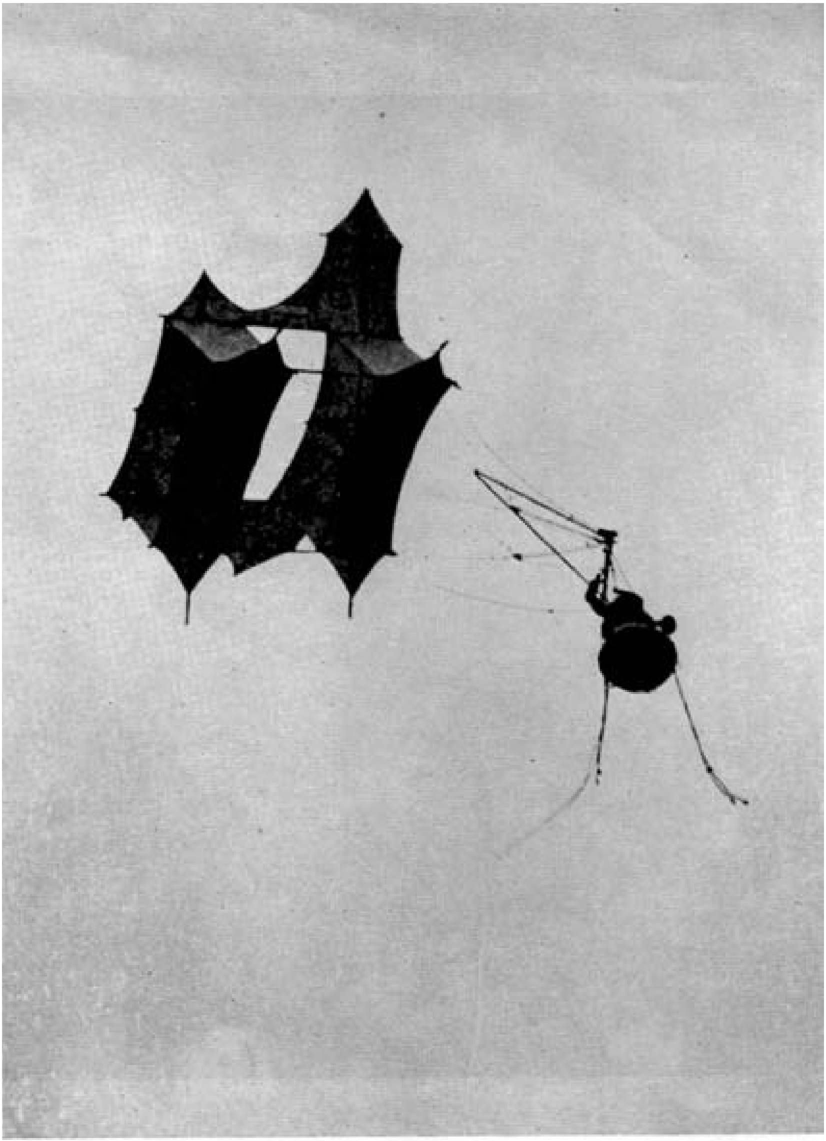
In 1870 instruction was first given in the steam engine and the "Steam Sapper" was developed for use as a mobile source of power and also for pulling a train of vehicles behind it. The Steam Sapper was first used operationally in the Second Ashanti War of 1873–4. It was the forerunner of mechanical transport in the Army, and the Royal Engineers continued to operate this type of transport until after the Boer War when the Army Service Corps became responsible for its operation. For many years thereafter, however, ASC drivers were trained at Chatham and the Royal Engineers remained responsible for the repair of the steam traction engines.

In 1882 an RE Balloon Establishment and Factory came to St Mary's Barracks and the following year the Submarine Miners, who since 1873 had been living on a hulk in the Medway, also moved into those barracks.

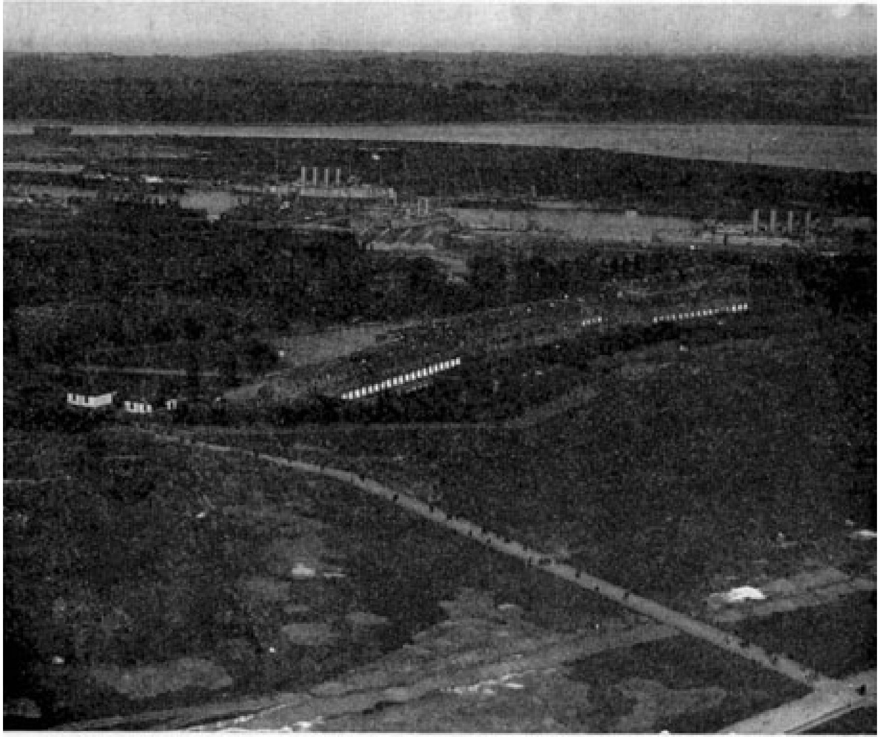
Royal Engineer officers, when they first came to Chatham in 1812, as was the custom in those days, hunted with the neighbouring packs of foxhounds and went shooting. As a summer diversion they interested themselves in sailing and by 1815 this had become a popular sport. It was not, however, until 1846 that the Royal Engineer Boat Club was formed, the name being changed ten years later to the Royal Engineer Yacht Club. In 1860 games and athletics became popular and soon afterwards other ranks took part. Cricket had been popular for many years but it was not until 1863 that the first Corps cricket pitch was constructed and fenced in on the Great Lines. The Tennis Club was started in the grounds of Fort Amherst the following year. Association football began to flourish to such a degree that a Royal Engineers' team from Chatham won the Football Association Cup in 1875. The first Corps rugby team was formed in 1886. Successive Commandants did much to further these sporting activities. Major F. A. Marindin RE, who was Brigade Major from 1866 to 1874, was an all-round games player and a great enthusiast, and it was he who initiated the present RE Games Fund. He later became Sir Francis Marindin, KCMG, and he was from 1874 to 1890 Chairman of the Football Association. In 1875 Sir George Trevelyan wrote this



"RE Steam Sapper" and road transport train 1877

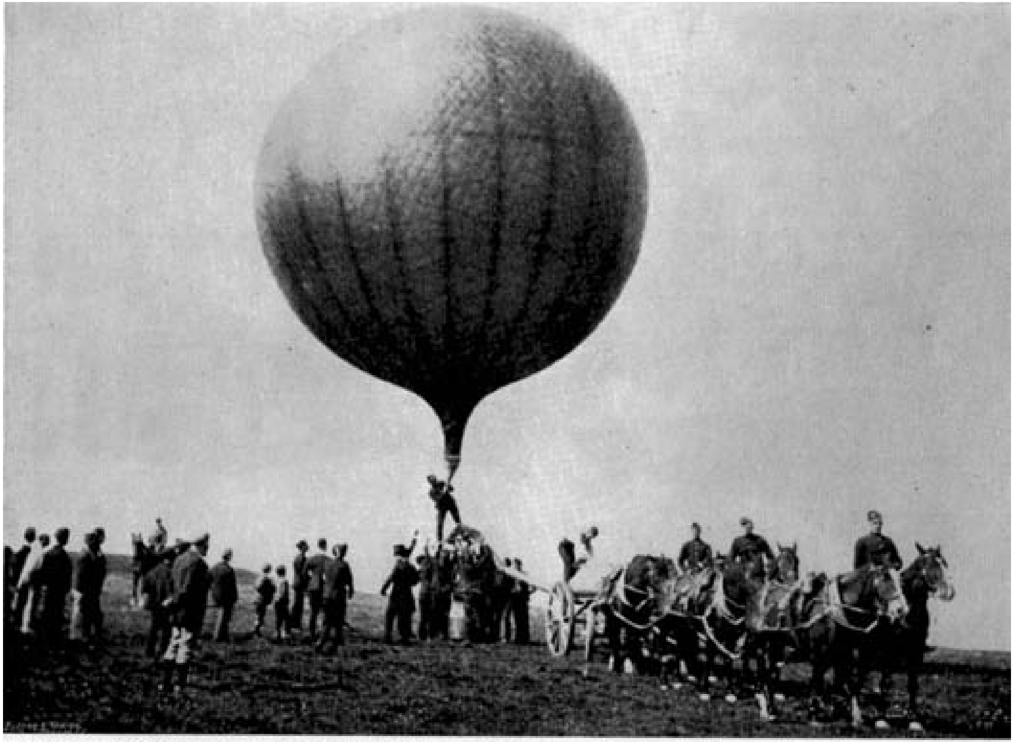


RE man-carrying kite 1904.

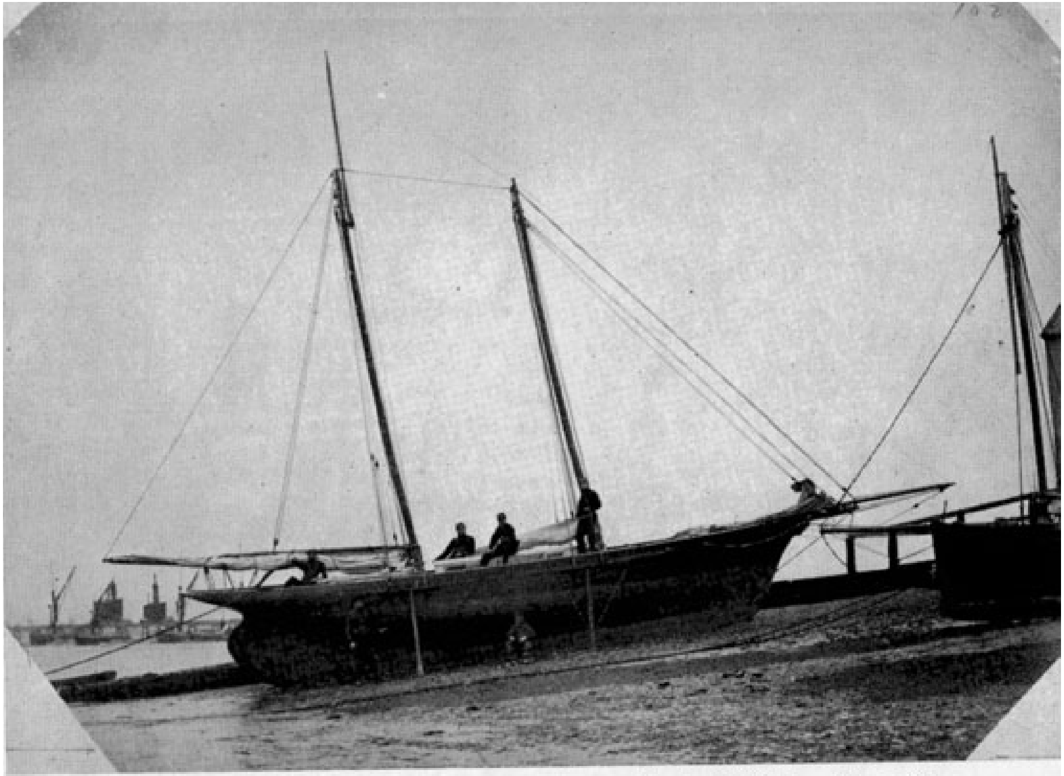


An early air photograph taken in 1904 from a man-carrying RE kite at a height of 300 ft. The camera exposure was 1/400 seconds. The negative was developed at the SME Photographic School.

RE observation balloon 1898. Captain B. R. Ward, RE, is in the car of the balloon. The Sapper seated on the ring of the rigging operates the gas valve.



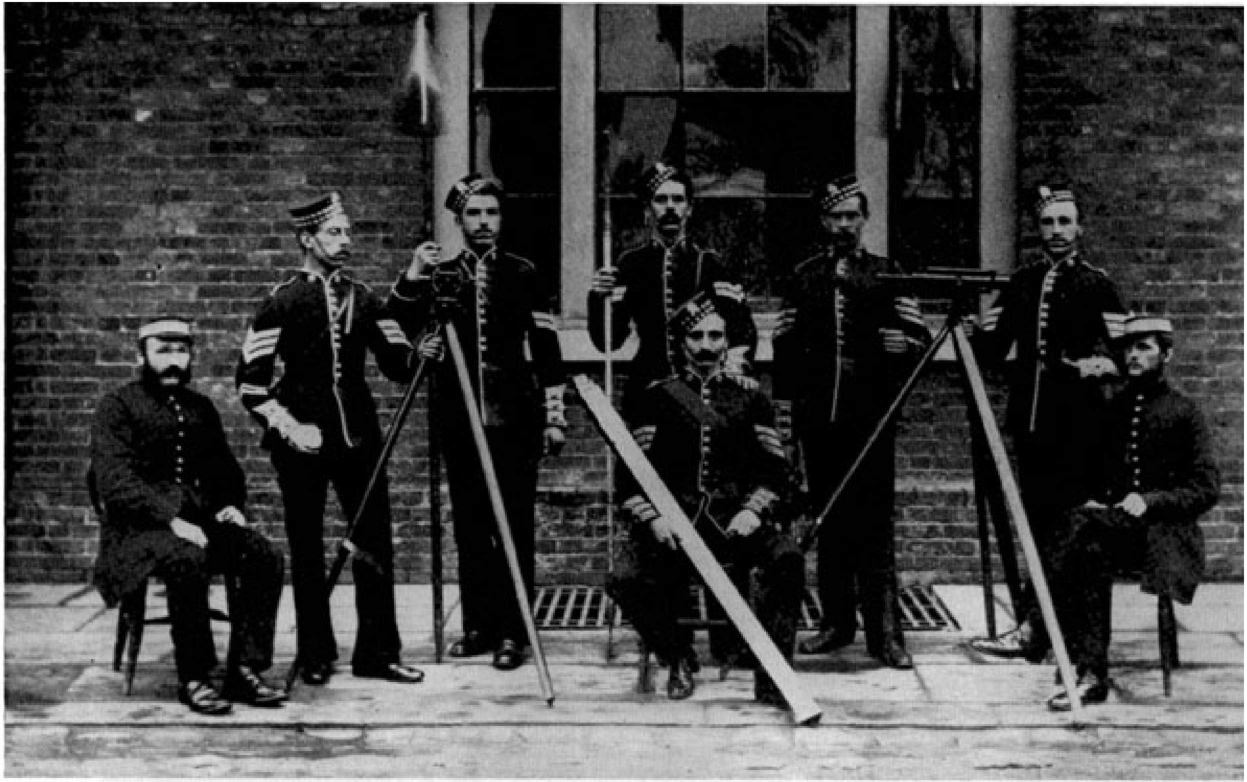
RE Balloon 1896. The balloon in the picture has just been filled with gas from ten cylinders carried on the waggon drawn by a six-horse team. The deflated balloon is carried on a four-horsed waggon. A similar waggon carries the balloon cable, winch and telephone line. A Steam Sapper was often used to pull the waggons in place of the horse teams.



The first Sapper yacht, the 12-ton schooner *Violet*, owned by the REYC from 1865 to 1883.

Royal Engineers Chatham FA Cup winning team 1875.
Lieut H. L. Mulholland (12th man) Lieut G. C. P. Onslow Lieut H. E. Rawson Lieut A. L. Mein Lieut C. V. Wingfield-Stafford
Lieut R. M. Ruck Major W. Merriman (Capt and goalkeeper) Lieut H. W. Renny-Tailyour Lieut P. G. Von Donop
Lieut G. H. Sim Lieut G. T. Jones

Cricket. The RE Officers v the Gentlemen of England 1875.



All Arms Survey Class 1871.

All Arms Signalling Class 1874.

RE Telegraphists 1875. Note the RE Boys employed as learner telegraphists.

See-saw searchlight emplacement, St Mary's Barracks, Chatham 1891.

Meet of the Brompton Barracks Herring Hounds, 1906.
Captain A. Lloyd Owen (in frock coat), Captain C. E. P. Sankey (Master), Lieut P. N. Dunman and Lieut G. B. Pears. The original four beagles and the Staffordshire bull dog.

Opening meet, Mr Marsh's Hounds, 4 October 1928, Dean Farm, Luddesdown. The Master and his two whippers-in and 2nd Lieut F. M. Hill and 2nd Lieut J. H. S. Lacey with the hounds.

of the determination at Chatham to preserve a *mens sana in corpore sano*: "The Royal Engineers—the select of the select, everyone of whom, before he obtains his commission, runs the gauntlet of an almost endless series of intellectual contests for years together—could turn out the best football eleven in the kingdom and within the last twelve months gained a success at cricket absolutely unprecedented in the annals of the game. The match in question was against an eleven of the I Zingari; eight wickets of the Royal Engineers fell for an average of more than ninety runs a wicket, and this stupendous score was made against good bowling and excellent fielding".

Many new RE units were raised at Chatham for service in the South African War (1899–1902), and courses of instruction had temporarily to be shortened. After the war there was some talk of changing the location of the SME, but the pull of Chatham prevailed. The Commandant, however, ceased to be President of the RE Committee in 1905, and in that year too the responsibility for submarine mining was taken over by the Royal Navy. At that time almost one-third of the total RE manpower was engaged in that branch of the Corps. Submarine Mining Companies were, however, converted into Fortress Companies responsible for the operation of battery engine rooms and defence electric lights. The Construction School was expanded and the workshops modernized. The Electrical School block, designed by Major E. C. S. Moore, RE, was built and occupied by the Electrical and Fortification Schools in 1907. The Training Battalion remained in Brompton Barracks and the Service Battalion was accommodated in the North Square of Brompton Barracks, in Upper Chatham Barracks and in St Mary's Barracks.

In 1905 RE Records moved to Chatham and the Officer i/c RE Records was given certain command and training responsibilities. This, however, was found to be an impracticable system and two years later Records moved to Gravesend, to return again in 1910. The Service Battalion was renamed the Depot Battalion and the Commandant once more controlled both the Training and Depot Battalions in addition to his many tasks as "Headmaster" of the School of Military Engineering.

Sports and games continued to flourish. In 1906 Captain C. E. P. Sankey started a bobbery pack, known as the "Brompton Barracks Herring Hounds", that hunted a drag. The pack was, however, soon converted into a proper hare hunting pack and the RE Beagles were established. In 1907 the Royal Engineers won the Football Association Amateur Cup. Notable successes were achieved also in rowing and in tug-of-war contests.

An unprecedented load was thrown on the resources at Chatham at the outbreak of the First World War in 1914. The mobilization of Reservists proceeded smoothly enough, but the influx of volunteer recruits far exceeded expectations. They began to arrive at 200 a day and numbers rose to a peak of 900 in one day. The staff, though overwhelmed, did wonders and enabled just over 12,000 all ranks to parade in uniform on the Great Lines on 3 October 1914. These men had to be clothed, fed, trade tested when possible, given military and fieldworks training, and finally dispatched fully equipped to units at regular intervals. Barracks were supplemented by billets and tented camps. In 1916 the buildings in North Square, Brompton Barracks, were burnt down. The loss of accommodation was a disaster which was not made good until the Great Lines hutments became ready for occupation.

The Commandant had to move his offices from the north side of Brompton Barracks to the RE Institute Building, where they have since remained.

In the years following the Armistice in 1918 over 15,000 men were demobilized at Chatham. In 1919 a special RE Memorial Service was held in Rochester Cathedral, attended by the Duke of Connaught, representing the King, and Field Marshal Sir Douglas Haig.

The schools and training programmes were reorganized. The functions of the SME being then defined as: "The technical training of all ranks of the Regular Army, TA and Supplementary Reserve in military engineering, fieldworks, bridging, and in matters relating to the employment of engineers, and to the execution of works in peace and war; the tactical training of young officers on first commission; the training of RE soldiers in required trades, and those to fill specialist appointments, such as MFW; trade testing; the training of RE Boys as draughtsmen and the trade training of buglers in RE trades; the training of RE dismounted recruits; and the carrying out of experimental and research work in military engineering for the RE Board (until 1921 called the RE Committee, and after 1936 renamed the RE and Signals Board)."

Sports and games flourished again, especially in the 1920s when there was a large number of officers on Supplementary Courses at Chatham. In 1928 Lieutenant John Marsh, RE, started a pack of draghounds known as Mr Marsh's Hounds to which the present RE Draghounds, Chatham owe their origin. Great successes were achieved in ocean racing. The Training Battalion RE was runner-up in the Rugby Army Cup Tournaments of 1922, 1930 and 1931, and many officers undergoing their YO training at Chatham were awarded International Caps, Cambridge Blues and Army Caps. In Association Football the Training Battalion reached the final in the Army Cup in 1936/37 and the Depot Battalion reached the semi-final in 1923/24. The Corps fielded an almost invincible hockey side between the two world wars, star-studded with players who had been awarded International Caps, Cambridge Blues and Army caps. In the 1930s, due to the experience gained by Young Officers whilst up at Cambridge, there was a great resurgence in athletics. The Training Battalion won the Army Championship in both 1935 and in 1936, setting up five Army team records in both track and field events.

More serious times were ahead however, casting their shadow before them. From June 1939, in the atmosphere of impending war, security and passive air defence preparations were speeded up, and instructions were issued for the carrying of respirators and steel helmets, the wearing of eye-shields during air-raids, and for black-out at night. Members of the RE Band were trained as stretcher bearers. A few days before war was declared two companies of the Training Battalion left for Ripon to form 2 Militia Training Battalion RE. The remainder of the battalion went to Shorncliffe on the outbreak of war to form 1 Training Battalion RE. The Training Battalion RE was never to return to Chatham. The Depot Battalion expanded enormously with the influx of Reservists and it occupied, in addition to Kitchener Barracks, most of the accommodation in Brompton and St Mary's Barracks, and the huts near the Electrical School. In March 1941 the Depot was moved to Halifax. When the Battle of Britain started Chatham, as a naval base and dockyard town, was frequently attacked from the air. Indeed at one period the town was almost as much subject to air-raid warning Red as to All Clear.

Over one hundred bombs fell in the barrack area. Under such conditions it was difficult for the SME to carry out its proper training functions and in November 1940 it was moved to Ripon, leaving at Chatham only the Trades Training Wing, and the Printing and Survey Schools, the latter moving from Chatham in 1941. The Royal Navy occupied the accommodation left vacant, and 600 ratings were housed in the RE HQ Mess, the contents of which were either moved to Ripon or placed in storage at Tunbridge Wells. Pasley House, until it was bombed, was used as an Officers' Mess for the Trades Training Wing.

At Ripon, Deverell Lines and Harper Barracks, both hutted camps, were occupied and the following Schools were set up:—

Fieldworks and Bridging
Electrical and Mechanical
Construction
Assault Engineer 1941–6
Bomb Disposal 1941–6
Plants, Roads and Airfields 1946–9

and a variety of courses, to meet changing operational requirements, were run in each school. There were also courses and demonstrations for senior officers.

Despite post-war schemes to locate the SME away from Chatham, the School of Military Engineering returned to its traditional home in October 1948 after an eight-year sojourn in Yorkshire.

The RE Depot returned to Chatham in 1959 but the descendants of the old TBRE have never come back to their place of birth.

The SME now consists of a Headquarters, a Publications Section and a stores organization, and two Training Groups each supported by an administrative regiment. The Technical Training Group comprises the Construction School, which is responsible for other rank trades training other than combat engineers, signals and plant operators, and the Engineer Planning School responsible for teaching engineer designs and planning mostly to officers. The Combat Engineer Group consists of the Field Engineer School, which teaches combat engineering to officers and other ranks, a Tactical School and a Plants, Roads and Airfield School. The Depot Regiment, accommodated in Brompton Barracks, gives administrative support to the Technical Training Group and 12 SME Regiment, located in Gordon Barracks, provides similar support for the Combat Engineering Group.

The SME is, therefore, the centre of all Royal Engineer activities and training except for other rank recruit and MT training, now carried out at Aldershot, and for such specialist training, also given elsewhere, for the Survey, Transportation and Movement Control, Bomb Disposal and Postal branches of the Corps.

The SME has never been stagnant. It has constantly grown and adapted itself to ever changing requirements. New activities of the Corps have been developed and taught and old ones discarded. It holds many memories and famous memorials of the past, but it is constantly looking ahead. A scheme is now being studied for an impressive rebuilding programme on both sides of the River Medway worthy of the school's claim to be the centre of so many and varied Corps activities which should, were he still alive, satisfy even the demanding and exigent Pasley its celebrated founder.

DIRECTORS OF THE ROYAL ENGINEER ESTABLISHMENT

The rank given is that of the Director on first appointment. Subsequent rank attained and decorations are shown in brackets where applicable.

Major C. W. Pasley 1812–41
(General Sir Charles Pasley, KCB, FRS, DCL)

Lieut-Colonel Sir Frederick Smith, Kt, KH, FRS 1842–51
(General Sir Frederick Smith, Kt, KH, FRS)

Lieut-Colonel H. D. Jones 1851–55
(Whilst Director he was promoted Brigadier-General to command the British Land Forces in the Baltic, and he was subsequently sent as Major-General to the Crimea to relieve Sir John Burgoyne. He later became Lieut-General Sir Harry Jones, GCB)

Colonel H. Sandham 1855–60
(Lieut-General H. Sandham)

Colonel H. D. Harness 1860–65
(General Sir Henry Harness, KCB)

Colonel J. L. A. Simmons 1865–68
(Field Marshal Sir Lintorn Simmons, GCB, GCMG)

Colonel T. L. J. Gallwey 1868

On 17 August 1869 the title of the Royal Engineer Establishment was changed to the School of Military Engineering.

COMMANDANTS OF THE SCHOOL OF MILITARY ENGINEERING

Colonel T. L. J. Gallwey 1869–75
(Lieut-General Sir Thomas Gallwey, KCMG)

Colonel Sir John Stokes, KCB 1875–81
(Lieut-General Sir John Stokes, KCB)

Colonel Sir Andrew Clarke 1881–82
(Lieut-General the Hon Sir Andrew Clarke, GCMG, KCB, CIE)

Colonel E. C. A. Gordon 1882–85
(Major-General E. C. A. Gordon)

Colonel J. B. Edwards, CB 1885–88
(Lieut-General Sir James Edwards, KCMG, CB)

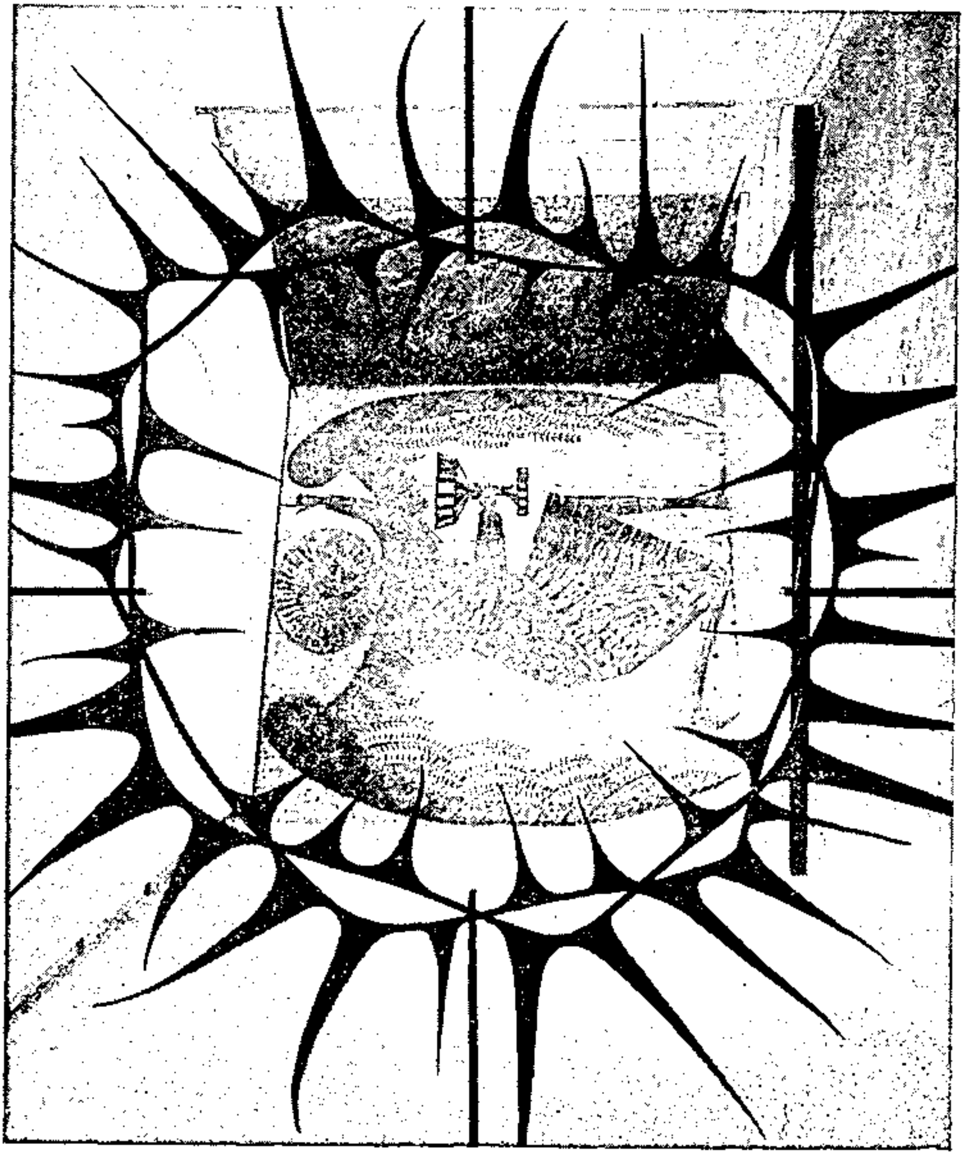
Colonel R. N. Dawson-Scott 1888–93
(General R. N. Dawson-Scott)

Major-General E. O. Hewett, CMG 1893–95

Colonel Sir John Ardagh, KCIE, CB 1895–96
(Major-General Sir John Ardagh, KCMG, KCIE, CB)

Colonel Sir Thomas Fraser, KCB, CMG 1896–1902
(Major-General Sir Thomas Fraser, KCB, CMG)

Major-General Sir Reginald Hart, VC, KCB, KCVO *(General Sir Reginald Hart, VC, KCB, KCVO)*	1902–05
Colonel H. W. Smith-Rewse, CVO *(Colonel H. W. Smith-Rewse, CB, CVO)*	1905–06
Colonel F. Rainsford-Hannay *(See below)*	1907–08
Colonel J. A. Ferrier, CB, DSO *(Major-General J. A. Ferrier, CB, DSO)*	1908–10
Colonel J. L. Irvine *(Colonel J. L. Irvine, CB)*	1910–11
Colonel J. E. Capper, CB *(Major-General Sir John Capper, KCB, KCVO)*	1911–14
Brigadier-General F. Rainsford-Hannay, CB *(Brigadier-General F. Rainsford-Hannay, CB, CMG)*	1914–17
Brigadier-General A. L. Schreiber, CB, CMG, DSO, ADC	1917–19
Major-General H. F. Thuillier, CB, CMG *(Major-General Sir Henry Thuillier, KCB, CMG)*	1919–23
Major-General P. G. Grant, CB, CMG *(Major-General Sir Philip Grant, KCB, CMG)*	1923–27
Major-General G. Walker, CB, CBE, DSO	1927–31
Major-General H. L. Pritchard, CB, CMG, DSO	1931–33
Major-General W. G. S. Dobbie, CB, CMG, DSO *(Lieut-General Sir William Dobbie, GCMG, KCB, DSO)*	1933–35
Major-General L. V. Bond, CB *(Lieut-General Sir Lionel Bond, KBE, CB)*	1935–39
Major-General R. P. Pakenham-Walsh, MC *(Major-General R. P. Pakenham-Walsh, CB, MC)*	June to Sept. 1939
Brigadier E. E. B. Mackintosh, DSO	1939–40
Brigadier R. Briggs, DSO, MC *(Brigadier R. Briggs, CBE, DSO, MC)*	June to Dec. 1940
Brigadier M. Luby, DSO, MC	1940–41
Brigadier N. A. Coxwell-Rogers, DSO, OBE *(Major-General N. A. Coxwell-Rogers, CB, CBE, DSO)*	1941–42
Brigadier D. Harrison, DSO *(Major-General D. Harrison, CB, DSO)*	1942–43
Brigadier H. T. S. King, OBE	1943–45
Brigadier B. T. Godfrey-Faussett, CB, DSO, OBE, MC, ADC	1945–48
Brigadier B. C. Davey, CBE *(Major-General B. C. Davey, CB, CBE)*	1948–51
Brigadier C. E. A. Browning, CBE, MC	1951–54
Brigadier H. C. W. Eking, CBE, DSO *(Major-General H. C. W. Eking, CB, CBE, DSO)*	1954–56
Brigadier G. W. Duke, CBE, DSO *(Major-General G. W. Duke, CB, CBE, DSO)*	1956–59
Brigadier E. F. Parker, OBE	1959



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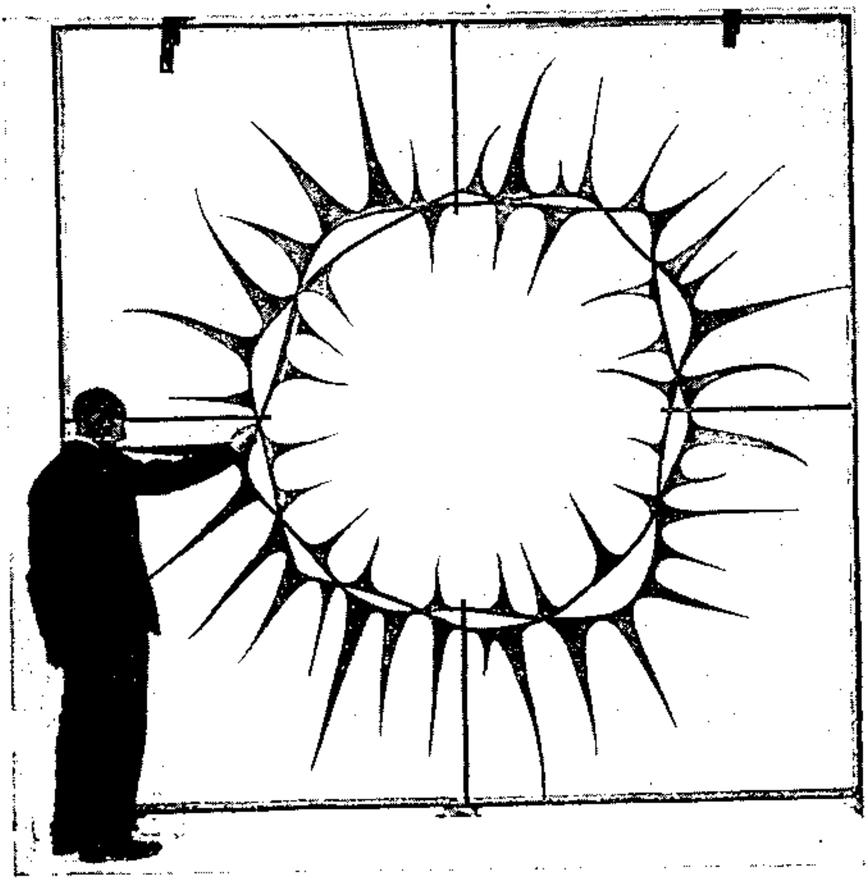
Coventry Cathedral Grille

THE accompanying photographs show a metal grille, representing the Crown of Thorns, designed by Sir Basil Spence, RA, RDI, PPRIBA, the Cathedral Architect, that is to be placed in Coventry Cathedral. The mosaic mural behind it was painted by Stephen Sykes and depicts The Angel appearing before Christ in the Garden of Gethsemane.



The grille was made in the Blacksmiths'and Welders' shops of the Trade Training Workshops, School of Military Engineering, Chatham by members of No 61/09 Higher Trades Training Welders Class, under the supervision of Mr K. F. Tinklin (Senior Instructor Metal Work) and Mr J. Ferrigan (Instructor). It was commenced in April and completed by the end of September 1961.

It consists, essentially, of a 10-ft square metal frame of 4 × 1-in material forming the main structure, to which is fixed, by means of four ¾ × 3-in support rods, the interlaced crown ring of ¾-in diameter metal. The thorns were each cut out of ¾-in plate, shaped and then welded to the crown ring by twelve runs of electric weld, forming a fillet with a smooth, oval section tapering to a point.

The total weight of the finished work was 6¼ cwts.

Sir Basil Spence, on accepting the grille expressed his admiration of the skill and workmanship with which it had been fabricated.

Bomb Disposal Silver Centrepiece

On 7 November 1961, a cocktail party was held in the RE Headquarter Mess, Chatham to inaugurate the silver centrepiece commemorating Bomb Disposal operations (1940–61). Early arrivals were able to see a few glimpses of the centrepiece on the BBC television programme "Town and Around". The centrepiece itself was displayed in the conservatory and the RE Band played in the dining-room. A number of the guests were visiting the Headquarter Mess for the first time and were full of admiration for the splendid and gracious setting for the party.

Guests included General Sir Frank and Lady Simpson, Major-General Sir Douglas and Lady Campbell, Major-General J. C. Walkey, Major-General and Mrs T. H. F. Foulkes, Mrs E. F. Parker, Brigadier and Mrs H. H. Bateman, Brigadier and Mrs J. H. D. Bennett, Brigadier and Mrs J. H. S. Lacey, Brigadier and Mrs G. J. Eaton-Mathews, Dr H. J. Gough, many officers of the Bomb Disposal Units AER and TA, and retired Bomb Disposal officers.

The Silversmith, Mr Marston Barrett, the artist, Mr Reginald Hill and the sculptor, Mr T. Bayley, were also present, and representatives of many subscribing firms.

During 1960 it became clear that the emphasis in Bomb Disposal was changing from the disposal of conventional bombs towards the disposal of guided weapons. Clearly the time had come to commemorate in some way the gallantry of all ranks of the Corps of Royal Engineers, who had distinguished themselves in this exceptionally hazardous and unpleasant form of warfare—the disposal of the unexploded bomb, commonly known as the UXB.

The UXB was a menace which had never been imagined prior to 1940. It might be unexploded by deliberate design of the enemy or by accident. Either way it was a hazard to morale, life and property, and had to be removed. Because the bombs buried themselves deep in the earth, under foundations, by railways, in factory floors and similar difficult places, only the Royal Engineers had the combination of Civil, Mechanical and explosive engineering knowledge to deal with them.

The cost was high, 246 officers and men lost their lives and to this must be added another 151 who were killed clearing our own minefields. Twelve George Crosses and countless other decorations were earned. The casualty ratio was nearly two killed to one wounded.

The Bomb Disposal Unit (UK) RE therefore decided to commemorate these operations by a silver centrepiece for its Officers Mess. A Committee was formed to raise funds and arrange for its design and completion. The members of the Silver Committee were:—

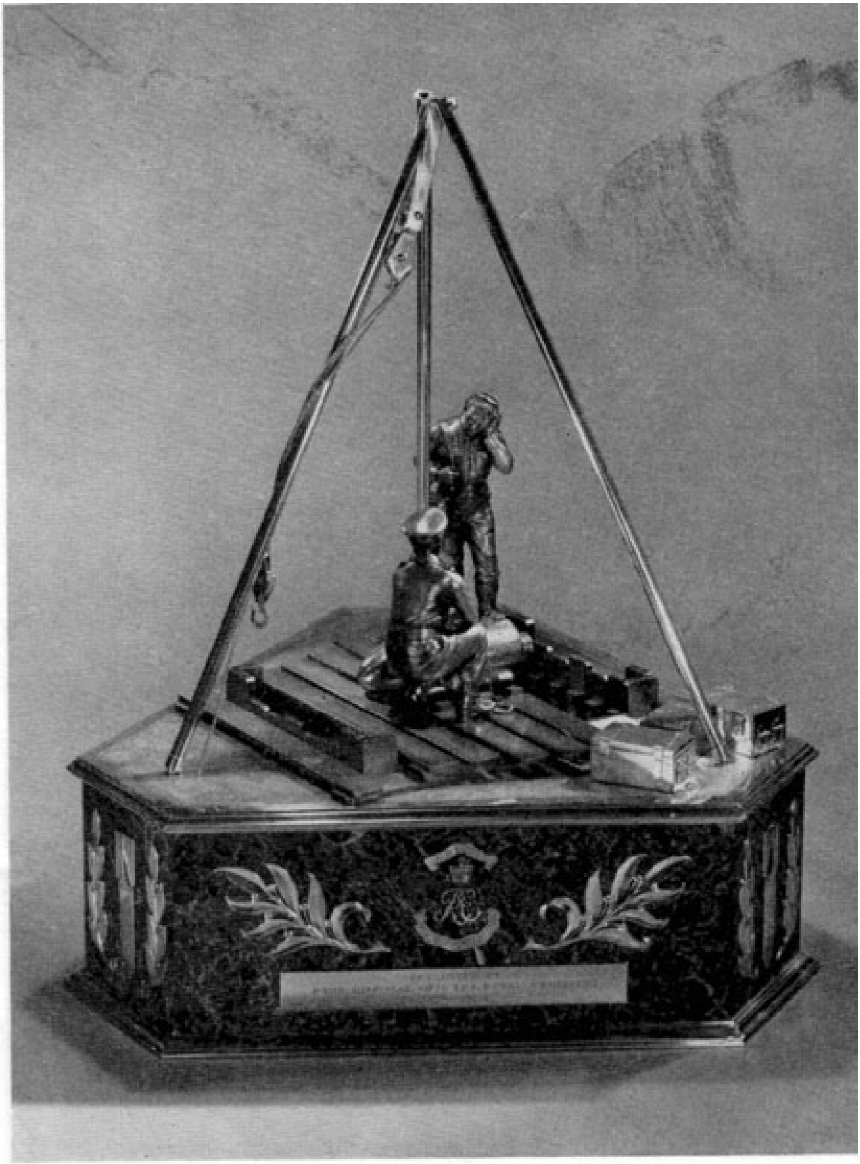
Chairman: Brigadier H. H. Bateman, CBE, DSO, MC (a war-time Director of Bomb Disposal).

Colonel W. G. Parker, MBE, GM, ERD (Hon Colonel, Bomb Disposal Regts (AER)).

Lieut-Colonel B. S. T. Archer, GC, OBE, ERD, RE (AER) (OC 142 (Bomb Disposal) Regt RE (AER)).

Lieut-Colonel J. H. Clark, MC, RE (OC Bomb Disposal Unit (UK) RE).

Secretaries: Major A. B. Hartley, MBE, GM, RE (until retirement). Major R. H. Hough, MBE, GM, RE.



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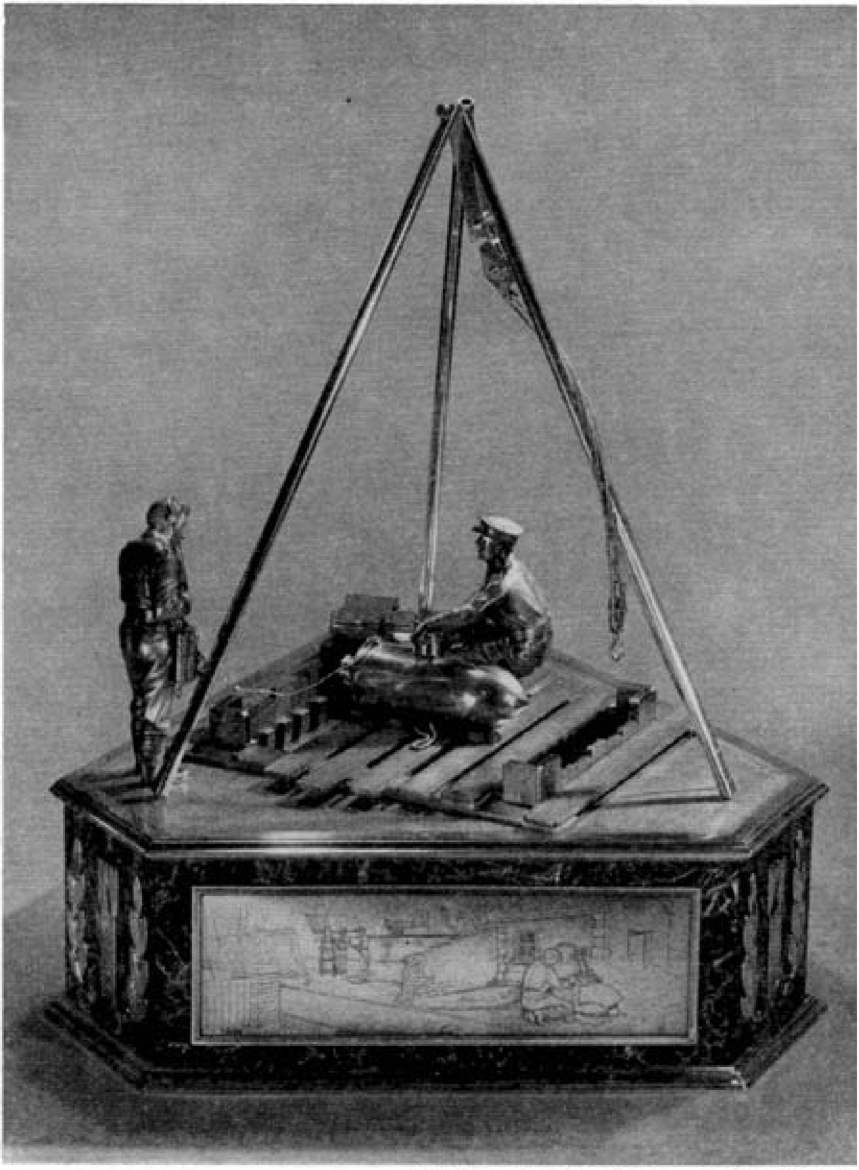
Bomb Disposal Silver Centrepiece 1



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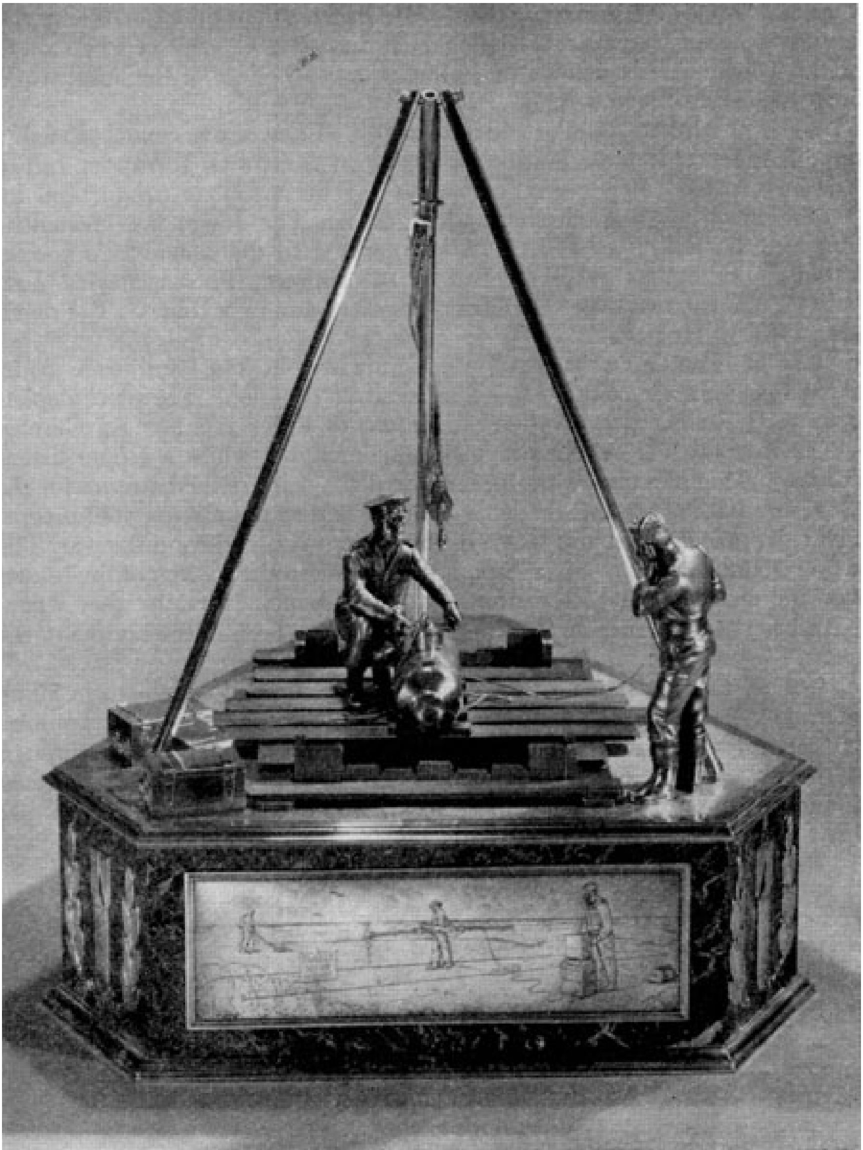
Bomb Disposal Silver Centrepiece 2



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Bomb Disposal Silver Centrepiece 3

Donations from serving and retired Bomb Disposal officers came in quickly, and a further donation came from the RE Corps Committee. However, these donations were not enough and the appeal was widened to firms and organizations, who had formed their own Auxiliary Bomb Disposal Units for their own protection, or who had benefited from the work of Bomb Disposal Squads RE in ridding them of UXBs from their premises. There was a most generous response, which enabled the Silver Committee to go ahead without financial restrictions in producing a centrepiece of the finest workmanship obtainable in Britain.

Marston Barrett, Jeweller and Silversmith, of Lewes was commissioned to produce the centrepiece, and it was made by Messrs C. J. Vander Ltd of Hatton Garden. They were responsible for the complete production, including silversmithing, chasing and engraving. The design was created by Reginald H. Hill, Esq, MSIA, NRD, according to the committee's specifications. The figures were modelled by the sculptor, Thomas Bayley, Esq, ARCA, and the two plates were hand-engraved and carved by G. T. Friend, Esq, OBE.

The base consists of Italian Verte Royale Marble. The hand-made model is made completely of hall-marked solid silver (London). The piece depicts a correctly timbered excavation on the top of which is a 500 Kg German UXB. An officer is handling a clockstopper magnet whilst a sapper listens for the ticking of a clockwork fuze. Around the pair are the batteries for the clockstopper magnet and the leads to these and to the electric stethoscope. Over the pair is a gyn and tackle of the pattern issued during the war. The detail is authentic, the only artistic licence being in the placing of the soldier and the clockstopper batteries so near to the bomb. In reality they would have been at a distance and the bomb would have been at the bottom of the shaft.

One of the panels on the base depicts the steaming-out of the main filling of a bomb, probably because the fuze could not be removed. In the background is a vertical Merryweather boiler which is feeding steam into the bomb through a spinner-jet. The other illustrated panel shows beach-mine clearance in progress. One man uses the early "Polish" mine-detector whilst others use the ERA mine-locator.

The third panel carries the monogram of the Corps of Royal Engineers.

Operation Hurricane Hattie

By Lieut-Colonel D. J. Willison, OBE, MC, RE
and Major J. A. Notley, MBE, RE

At midday on 3 November last 38 Corps Engineer Regiment received warning by telephone direct from the War Office that up to one field squadron was needed to fly to British Honduras the following day from airfields as far away from Ripon as London Airport and Lyneham. Reports of the hurricane disaster of 31 October in Central America had been appearing in the newspapers for several days. Without these, few of us would have had any clear idea where British Honduras lies. At Map "A" will be found a location map of the Caribbean.

A few historical notes may be of interest. The city of Belize was founded more than three hundred years ago by British pirates seeking an inaccessible place to establish their lair. Belize is thought to be a corruption from the name of the pirate chief captain preying on the Spanish Main at that time, a man called Willis. Since that time the city has grown gradually through the mangrove swamps surrounding it until in 1961 the population was 33,000. The total population of British Honduras is only about 90,000, largely negro or mixed blood with some Creoles and isolated communities of Carib and Mayan Indians. Logging has for several centuries been the backbone of the economy. Recent developments have included sugar cane plantations around Corozal in the north, citrus fruit planting in the Stann Creek valley and ranching around Cayo.

Hurricanes are by no means unknown in the territory. Belize was devastated in 1931 when 2,000 people lost their lives. Proposals were then made to move the capital well inland. These fell through because no road to Cayo then existed and the cost was high. Corozal was hit by hurricane Janet in 1955 and rebuilding had only just finished about the time Hurricane *Hattie* struck.

Effects of the Hurricane

Warning was given over the local radio about lunch time on 30 October that *Hattie* was approaching and would strike during the early hours of the following morning. A well thought out scheme existed for the people to gather for shelter in the most strongly built houses in the town. The PWD dispersed their plant and vehicles in the Cayo and Corozal areas together with key executives. Some people moved inland by car, a few guessing wrongly and choosing the Stann Creek valley to shelter in.

The hurricane struck about two o'clock in the morning and in Belize raged for nearly eight hours. Winds of up to 200 miles per hour were recorded. As it began to get light, up to twenty huge tidal waves about twelve feet high swept in from the sea. Belize and Stann Creek are both on the coast only a foot or two above sea level. These waves, therefore, swept right through the narrow streets at the level of the first floors of the houses, the vast majority of which are built on stilts. The wind and waves banked up the highest tide ever recorded. Both towns had about six feet of water in the streets until early afternoon. The receding tide left many inches of thick black mud over the debris hurled into the streets and houses by the force of wind and wave.

The area of major devastation is shown on Map "A". The eye of the hurricane passed over Mullins River Town and then roared inland over the Maya Mountains into Guatemala. The worst damage of all occurred to the rain forest; mahogany, santa maria and many choice hard and soft wood forest giants; over thousands of square miles the crowns of the great trees had been wrenched off and landscape never before seen by man laid bare. By contrast only 10 per cent of the orange and grapefruit trees in the Stann Creek valley were uprooted though the foliage and fruit were largely stripped off.

Because of the precautions taken late on 30 October casualties were small compared with 1931. In Belize only 180 were killed; 380 in the territory as a whole. All roads were blocked by debris and fallen trees. All vehicles and plant in the coastal area were drowned under seawater for many hours. Much PWD transport and plant had been caught because of a failure to obey orders by a local employee. The population as a whole were suffering from shock akin to shell shock which lasted for many days. Mass hysteria set in on 1 and 2 November, leading to mob looting of shops, clubs and even private homes.

A company group of the Royal Hampshires, the resident battalion in the Caribbean, has been stationed for some years at Belize Airport Camp. They moved into Belize and were rapidly joined by Battalion Headquarters and two companies from Jamaica. A small number of looters had to be shot before law and order could be restored. Commander Caribbean Area flew in from Jamaica and Senior Naval Officer West Indies from Bermuda to set up a Joint Headquarters. On 2 November they decided to ask for a second battalion, a field squadron and certain administrative units to be flown out from the United Kingdom. Priority was given for the sappers who accordingly were warned at midday 3 November to fly about one hundred men and 17,000 lb. of freight to British Honduras the following day. The First Battalion the Royal Worcestershire Regiment and certain minor administrative units were to follow.

The story is now taken up by Major Notley.

On 3 November, 12 Field Squadron RE stationed at Ripon was finishing its annual range course at Strensall. At 1400 hrs the Squadron was informed by Regimental Headquarters 38 Corps Engineer Regiment that it was required to fly 100 men with G1098 to British Honduras that night. I arrived at Squadron Headquarters at 1500 hrs to find the 2IC, the SSM, SQMS and Chief Clerk in conference sorting out who could go and what G1098 to take.

The troops arrived back from Strensall at 1600 hrs and I held an "O" group at 1615 hrs. There was very little information as to the squadron tasks, or the state of affairs in British Honduras. I decided to take as many tradesmen as possible and leave the administrative staff to a minimum. Three Clerks of Works from outside units, a plant foreman and five tradesmen of 15 Corps Field Park Squadron were allocated to the Squadron. The unit was split into two troops of about thirty-five, and Squadron HQ which included all the plant operators and specialists. The Squadron breakdown was four officers, twelve WOs and Sergeants and eighty-three Other Ranks.

Deciding on what G1098 to take was more difficult; the Squadron had been told that they had been allotted a freight aircraft which would take about ten tons of G1098. Finally six section kits, a large selection of tradesmen's tools, a set of compressor tools, recce kits, two demolition sets, a Johnson pump and water supply equipment, tentage, office equipment, cooking gear for three troops, and arms were taken. Four Seagulls with assault boats and four power saws were also supplied from outside sources. This proved to be very adequate for the tasks undertaken in British Honduras.

At 1800 hrs the Regimental QM issued KD to all those going, and immediately afterwards I briefed the Squadron as to what was happening.

Then began the task of sorting out the G1098, boxing, banding and painting it. Various items such as mosquito nets, light-weight blankets, AL 63, palludrin, Seagulls and assault boatswere delivered or collected. This was all loaded on to three tonners and left the Squadron at 0100 hrs on 4 November for London Airport, under the rear party officer. On arrival at London Airport he loaded it on to a DC7C, with the power saws and seven days' rations which were waiting there for him. It was not possible to get the assault boats into the DC7C but everything else was loaded and the aircraft left that afternoon. Some of the boxes, especially the section kits, weighed 400–500 lb and were difficult to load even with the mechanical equipment available.

Meanwhile numerous changes of plan had been taking place and I was told to go to Lyneham to catch an RAF Brittania at 0600 hrs on 4 November.

The CO was on his way to London before the flap started and he was not contacted until the evening of 3 November. He was later told to accompany the Squadron, to report on the situation in British Honduras and was to come on the same aircraft as myself.

I left Ripon at 2200 hrs on 3 November leaving the Squadron in the capable hands of my 2IC. I arrived at Lyneham at 0600 hrs on 4 November only to be told that they did not know of any aircraft going to British Honduras that morning; there was one going in the evening, but it was doubtful if I would get on it.

The CO meanwhile had been told before he left London that the aircraft was not leaving until the evening and he arranged with Movements for five seats to be reserved for Sappers. My SSM, the plant foreman and the stores sergeant were immediately dispatched from Ripon and all five of us eventually took off at 2100 hrs. We arrived in Jamaica at 1400 hrs local time on 5 November where we found our freight aircraft just about to leave for British Honduras.

The CO stopped in Jamaica to sort out policy with HQ Caribbean Area and I went to see if we could get on the freight aircraft. After some discussion with an officer who was acting as Movements Officer, three of us got aboard just as it was warming its engines. The stores sergeant was left behind to inform the CO what had happened.

Just off British Honduras the pilot asked if I had a map showing Stanley Airport as he had never been there before and had no maps. Luckily I had a JIB map and the aircraft made a safe landing.

With the help of a platoon of Royal Hampshires, the G1098 was unloaded on to the taxi strip. This would have proved quite impossible without a fork lift as the boxes were much too big and heavy to lower the 10 ft to the ground. Luckily the Americans had flown in a fork lift from Panama and this proved invaluable for the next two weeks.

Emergency Task Undertaken in British Honduras

The CO arrived from Jamaica soon after first light next morning to find that no transport could be allotted to the Sappers, to carry out a reconnaissance of Belize city some eight miles away, despite the frantic speed of movement all the way from UK. By Herculean efforts the military plant foreman managed to get going an extremely ancient car found abandoned in the camp. Enveloped in clouds of blue smoke the party set out mid-morning for Belize. Everywhere the big trees were down. Power lines sagged over the road in dangerous festoons. The Belize river beside the road was flooding over its banks. The main bridge over the mouth of this river was found to be intact; one great weight off the mind. Shortly afterwards a tipper was seen at work on the road which by this stage was under a foot of water; a most encouraging sign that the PWD had started functioning again. Almost immediately, the ancient car fell off the road into the swamp. A passing truck full of negro workers stopped and the latter lifted us bodily back on to the road. To our surprise they all spoke good English; a most welcome augury for future co-operation. A large saw mill and timber dump appeared; most of the cut planks could be seen sticking out of the mangrove swamp beyond the river, blown there by the force of the hurricane. Upturned boats littered the banks, some of them also amongst the trees. The City itself was an even worse sight. The main street had been cleared one way but still had many inches of muddy water swilling about over it. All side streets were blocked, some with houses in the middle of them. Some vehicles were moving about, mostly relief agencies, Guatemalan or US Army trucks. Police HQ in the centre of the town was reached at last; here were gathered together the Governor, the heads of the Civil Service, the Police themselves, an American Colonel, the HQ of the Royal Hampshires by that time in control of the city after subduing looting and imposing curfew; finally anyone who was seeking information or trying to offer help. The tower of Babel had nothing on the so-called operations room.

The most valuable contact made here was with the acting Director of Public Works, Douglas Manning. A visit to the PWD offices, workshops and stores yard showed the difficulties he was working under. Right on the seashore the full force of the tidal waves had wrecked the offices and workshops and gutted most of the stores. A Braithwaite water tank had been moved bodily off its plinth and washed over one hundred yards away to block completely the main approach road. Despite the appalling damage the PWD yard was humming with activity and it was clear that all remaining capacity which had not been destroyed or drowned was being set to work with a will. On the spot it was decided to set up a Joint Task Force. All stores and tools needed could be demanded on PWD who would issue, give local purchase authority, or buy from their agents in New Orleans. The Belize Club near by, very badly damaged and in need of re-roofing, was at once earmarked for the leading troop to arrive from UK to live in. This later became Squadron HQ. The only commodity which the PWD could not supply was transport. Much of their resources had been drowned; the remainder was being worked round the clock using their own drivers. The same situation applied to plant.

Much encouraged by this visit, the next vital point to be looked at was the port. Once again a scene of orderly activity was found. A naval commander had flown in several days previously to take over as Queen's Harbour

Master. With the aid of a frigate lying off-shore, a number of large flat topped lighters capable of discharging the heaviest types of plant or vehicle had been salvaged and put back into commission. Tugs and local craft were being rehabilitated. The quay was a mass of mud mixed with the debris of shedding and cargo caught on the wharf; but already gangs of local labour supervised by the Royal Hampshires were clearing sections of the dock area. The Navy were confident that the port could work up to 150 tons per day in the near future.

With the airfield intact, Naval technicians ashore helping with installation or repair of emergency generators, and a United States Army Engineer detachment running large field cookers and setting up a large water point in the city, it was clear by evening that transport to move stores from the docks and airfield and plant to clear debris was of first priority as against summoning more Sappers from UK.

On 7 November the Squadron 2IC, some plant operators and 1 Troop arrived from Jamaica. The next day the rest of the Squadron arrived; unfortunately their kitbags were left behind, and some of these did not arrive for three weeks, causing hardship to the Sappers.

The greatest problem was transport and every effort was now made to obtain some. The CO acquired a large American car so that he could get around and obtain the over-all picture of the damage, work out priorities of work and indent for plant and vehicles from Jamaica.

The Squadron was offered twelve "Marsh Buggies" by a local American oil company who said that they had all been seized up for twelve months but the Sappers were welcome to them. The military plant foreman immediately got together all the plant operators and fitters and after two days hard work got four "buggies" and trailers working. They carried men and stores to work, collected water, cleared garbage and at times carried officers on recces. The Squadron was allocated two 5-ton vehicles from Corozal which had not been hit by the hurricane. These two vehicles and their civilian crew stayed until the Squadron transport arrived and did an excellent job. The SSM acquired a civilian Landrover which had been drowned but was made to work after a fashion. This all took about five days and the Sappers continued to be very restricted in their work until transport and plant arrived from Jamaica on 23 November.

On 8 November a second hurricane warning was received just a week after *Hattie* had struck. Fortunately this storm turned northward into the Gulf of Mexico. The tail of it caused very heavy rain to fall in the mountains of Mexico. The resultant floods poured down into the Belize flood-plain to top up the very extensive flooding already existing. As a result the main road from Belize inland to Cayo was under 3 ft of water for several weeks thereafter. As an example of the rainfall associated with *Hattie*, the Belize river at Cayo, 70 miles by road inland, rose no less than 45 ft to touch the underside of the 500-ft suspension bridge in the centre of the town. Some communities up country were isolated for many days by the combined effects of flooding, and roads blocked by trees uprooted by the hurricane. The main role of the US Marine Corps helicopters flown in from the carrier *Antietam* was, therefore, food distribution to marooned towns and villages. Fortunately a great deal of plant existed up country in the hands of the Forestry Commission, private logging estates and the PWD. The re-opening of roads was undertaken as a joint enterprise without assistance from Belize.

The town of Stann Creek possessed few substantial buildings. Damage from wind and wave was therefore even more severe than in Belize. The Worcesters moved to the valley soon after their arrival and did a splendid job in organising the population to look after themselves. Commander 12 Engineer Group, who had arrived to take command of all Navy and Army forces in British Honduras, flew by helicopter with the CO to assess what assistance was needed. From the engineer aspect the priority task was to rebuild a jetty 3 miles south of the town to take lighters and local coastal craft alongside. Drinking water was being hauled by tractor from the citrus factory township of Pomona 12 miles away up the valley. A water point in Stann Creek town was, therefore, needed.

2 Troop officer and a strong section moved by road to Stann Creek, 106 miles by road from Belize, to take on these commitments assisted by local labour and a PWD tipper. This move they welcomed to escape from the foetid stench of Belize, for the Stann Creek valley, some twenty-five miles of orange and grapefruit groves, soon became scented for mile after mile with blossom. In striking contrast to the surrounding rain forest which was completely devastated by the wind, the ordered rows of citrus trees still stood, though stripped of foliage and fruit. New leaves and blossom appeared in a matter of weeks.

South of Stann Creek the coastal communities for some thirty miles had suffered grevious damage. Commander 12 Engineer Group therefore arranged for another section of 2 Troop to be embarked on the survey vessel HMS *Vidal*. The party took with them two small landing craft and supplies of food, corrugated iron and nails. They spent a fascinating week running in to beaches and up river mouths to bring succour to the needy. Their efforts were very much appreciated; on one occasion they were greeted on the beach by a cheering crowd waving Union Jacks.

On 8 November Tac Squadron HQ and one troop moved into the Belize Club. The SSM quickly made friends with local residents who very kindly allowed the officers and sergeants messes to move into two private houses which needed minor roof repairs.

1 Troop immediately got to work; they repaired half the roof on the Belize Club and started work on hospitals, government buildings and the power station in the town. With the aid of the three Clerks of Works they soon had new roofs on these buildings and the plumbing and electricity working. They also took over the water point from the American Engineers who had just finished erecting it. One sergeant and one sapper ran this until 11 December. A total of 600,000 gallons was issued during this time. The US Army Engineer detachment left, shortly followed by the RN Frigate so that all engineer work devolved upon 12 Field Squadron and the PWD.

On 10 November, 2 Troop moved to the Belize Club, leaving one section and the 2IC at Airport Camp. This section was responsible for the repair of the taxi strip which was breaking up through gross overloading. With no equipment except an old kitchen boiler to heat the tar, they repaired the strip day and night until the PWD got some equipment working. Then in a combined operation they relaid 100 yds of the strip using a 6-in layer of lean mix concrete, then tar spraying and blinding the surface. This held up very well and the PWD took over the airfield on 20 November.

2 Troop in Belize sent a section to help the Electricity Department to get the power lines repaired and a second section began work on repairing roofs.

Meanwhile the CO had been all over the country by helicopter and Land-rover, which he had swapped for his comfortable car, finding out the real extent of the damage, establishing contacts and allocating further tasks in agreement with the PWD.

Many countries bordering the Caribbean were most generous in sending building materials by sea to Belize. Within days of our arrival mountains of corrugated iron, nails, prefabricated huts and camp structures from Jamaica began to pour in through the port. The stores sergeant took charge of establishing a dump for this material and was then responsible for the detailed issues to the townsfolk for reroofing their own houses. So efficient were his methods that the First Minister was refused six bags of nails without the proper authority, but everyone received their fair share which was appreciated by the locals. The Squadron used a great deal of these stores, distributing them by "marsh buggy", in reroofing government quarters, an emergency RAF hospital, and the Fort George Hotel which soon became the joint Civil and Military HQ for the whole country.

On 16 November the rest of Squadron HQ moved into the Belize Club, and on 20 November the third section of 2 Troop moved in from the airfield.

On 17 November a section of 2 Troop, helped later by the section off HMS *Vidal*, took over repair work in Belize and continued this job in co-operation with the PWD until they returned to UK.

First Phase of Reconstruction

Concurrently with planning and organizing the emergency work outlined above, it was necessary to start thinking about temporary housing for the homeless in Belize and Stann Creek and about full clearance of all streets and demolished houses in these towns. For both tasks the key factor was early provision of plant, tippers and transport. The Sappers had no assets to start with. The PWD had insufficient to deal with so many pressing commitments. A joint demand was therefore prepared. This demand together with the transport needs of the Army as a whole in British Honduras was submitted by the Joint Command in Jamaica to Whitehall. In a miraculously short time approval in principle was received from both the Ministry of Defence and the Colonial Office. Purchasing off the peg started at once in Jamaica where the Army Works Organization excelled themselves. Within two weeks of the initial request, a ship laden with precious cargo appeared offshore.

The civil authorities reckoned that 5,000 people were homeless in Belize with a further 1,000 in Stann Creek. Within days of arrival, HE the Governor sent for the CO and asked him to go out and vet from the technical aspect a temporary township for Belize 16 miles inland on the Cayo road. This project had been sponsored by Mr George Price, the First Minister. Site layout and design were in the hands of a local American contractor. After a hazardous journey in a diesel 5 ton tipper during which the First Minister and the CO first loaded the vehicle with salvaged timber with their own fair hands and then helped to recover it after falling off the flooded road into the swamp, the site was reached. This was by no means ideal but offered the nearest savannah type country beyond the mangrove swamps to the town. It also lay on the first important road junction inland. The hut design was to provide family living-rooms 15 by 10 ft in continuous blocks, 300 ft long by 30 ft wide; sixty families to a block. Each pair of blocks were to be served by a communal kitchen and a combined "aquaprivy" block of ten showers and ten latrines. The first hut was already starting; the Forestry Commission had brought in large quantities of cut timber, and some Belize city workers assisted by a party of Jamaican forestry workers, under the Conservator of Forests, were at work. The PWD had not been consulted at any stage. In the circumstances, therefore, approval was given to the project and full co-operation was offered to assist in construction.

Next day the Clerk of Works Construction took over as assistant planner to the American engineer on site. A carpenter joined him to organize mass production of prefabricated members for hut construction with the aid of a circular saw brought from Airfield Camp.

On 16 November 1 Troop moved out to Milestone 16 to help in the construction of the temporary town, Hattieville. The town layout of huts, cookhouses and latrines had been planned in outline, but no plans had been made for water or electrical supply, drainage or sewage disposal. Plans were soon underway with the co-operation of the three Clerks of Works.

The troop spent just over three weeks on the site and in this time made a good start on the temporary township. Planning of water and electrical supply, sewage and drainage for the whole town was completed. One aquaprivy with ten showers and ten latrines was completed and another half finished. Plumbing for these two aquaprivies and two cookhouses was prefabricated. The main water supply pipe for half the town was laid, and 25 per cent of the sewage drains was completed. A water point 3 miles away was set up as a temporary water supply and was operated until 10 December. Five wells were dug with the help of PWD equipment and crew. The first four wells produced salt water, but the fifth produced excellent water at 5,000 gallons per hour 1½ miles from the town. A power station was built and two 33 KW generators were installed. Three living huts, three cookhouses and the police station were wired and connected to the power station.

Families began to move into Hattieville on 1 December and by the time the Sappers left there were eighty families living there.

Stores were a constant headache for these camps. At the start it was hoped that the American International Co-operation Administration would assist. A number of meetings were held by the CO with their local representatives but progress was slow and recourse had, therefore, to be made to PWD local requisitioning and ordering on Jamaica.

The troop tradesmen all had a chance to work at their trades, and it was found that Class III tradesmen were not skilled enough to do a job on their own; the fact that several of the Class II tradesmen were on upgrading courses or cadres was sharply felt. The Clerks of Works came in very useful here as first class tradesmen themselves.

Great efforts were made to get the PWD to take over the tasks from us when we left, but this proposal ran into every kind of difficulty and it was not until the day we left that Douglas Manning on his own initiative took over the water and electrical supply. The remainder of our work was vaguely taken over by the First Minister's American engineer advisor.

Another hazard was the choice of permanent sites for rebuilding Belize and Stann Creek well back from the sea coast. The First Minister set up a Committee to discuss the many aspects involved. The CO was invited to be a member. It rapidly became apparent that the temporary townships to house the homeless should be located near the new permanent sites so as to provide

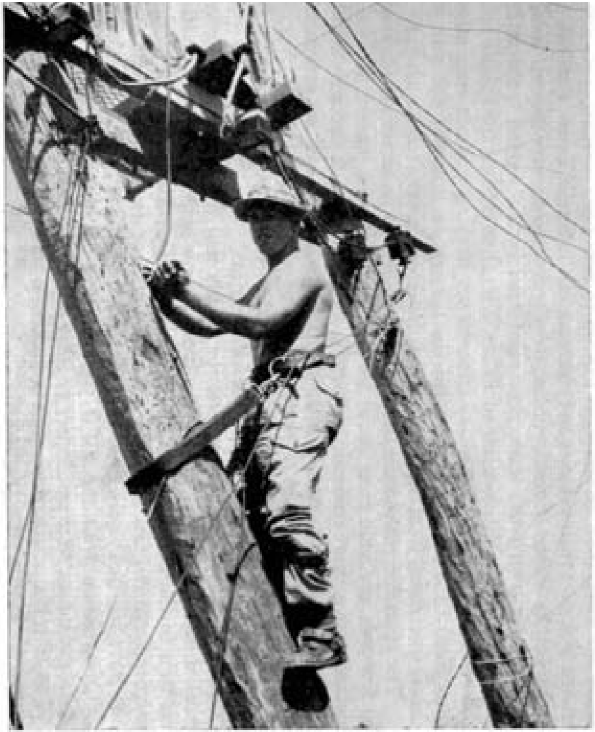


Photo 1. Assisting the Electricity Department in Belize to restore lights to the town.

Photo 2. Operating a Wisconsin pump at the water point at Stann Creek.

Operation Hurricane Hattie 1,2

work for the occupants. It was found that the new Belize could best be placed at least 30 miles and possibly 50 miles inland; the temporary township at milestone 16 was already too far advanced to allow re-location. At Stann Creek on the other hand, at the expense of some delay in starting the temporary township, it was found possible to reconcile all the conflicting interests in favour of a permanent solution immediately adjacent.

2 Troop Officer with his section remained in the Stann Creek area and took on work connected with the temporary township at Silkgrass Creek. Accommodation was in tents; some emergency camp structures were erected. A start was made on water and electricity supply.

On 28 November the CO left British Honduras after having fixed the withdrawal dates of the Squadron and having seen the arrival of the plant and vehicles he had asked for.

The Plant Foreman had not been idle during this period, apart from operating and keeping the "marsh buggies" on the road, his team had taken on the repair of PWD plant and vehicles. A workshops was built on the tennis courts at the Belize Club and drowned and broken down plant and vehicles were brought in for repair. Very soon the results of their labours were apparent as increasing numbers of rollers, concrete mixers, tippers, graders and traxcavators were seen being operated by the PWD.

Our plant was supposed to arrive in Belize on 18 November, but owing to an error of navigation the ship carrying it from Jamaica went aground 11 miles off Belize. Unloading began from here but was very slow; a grader came ashore on 22 November, six 5-ton vehicles on 23 November, eight tippers on 24 November, two traxcavators and two D 4s on 25 November.

On 27 November the plant and tippers, except for one traxcavator, were ready for work. The drivers who had up to now been working with their troops took over their vehicles and clearance of Cinderella Town, a suburb of Belize began. Masses of mud, rubble, trees and seaweed were moved. When this was completed the team, now reinforced by the second traxcavator, began to clear the main streets of Belize. The D 4s pushed the rubble into the centre of the street, the two traxcavators working towards each other then filled their buckets and loaded the tippers. In this way 250 tons of debris was moved from the streets and dumped outside the town each day.

The operation proved the necessity for Sappers to be extremely fit. With so few men available none could be spared off sick. In practice the only sickness was a short epidemic of "tonsilitis-cum-flu" which suddenly struck the Squadron. Twenty men went down with it, but medical officers descended in their hordes and within 48 hours every man was working again.

Flies, mosquitoes and snakes were all coped with without any loss of work, and the beautiful sunshine made everyone very fit.

There was little time for recreation in the first few weeks as the men worked from dawn to dusk, but later everyone saw something of the country on trips to the islands in our LCAs, or inland in vehicles. Several parties went to Cayo and saw some of the fantastic damage done to the forests, and one party was lucky enough to get into Mexico for the evening.

Co-operation with the PWD was excellent throughout, many of the British members were ex-Sappers and did everything they could to help us. All tasks in Belize were done after consultation with the PWD and they gave every assistance in procuring stores.

Photo 3. Operating a "marsh buggy" in Belize. In the background is the Belize Club which was used as the Squadron base in British Honduras.

Photo 4. Operating a D4 in Belize. Dozers were used to push the rubble on to the roads where it was picked up by traxcavators and put into tippers.

Operation Hurricane Hattie 3, 4

On 6 December the first ten men of the Squadron left for the UK, to be followed on 11 December by sixty more; the remainder left on 13 December. The 2IC was left behind to sort out the accounting in Jamaica and returned to UK on 19 December.

Conclusions

Operation Hurricane *Hattie* provided a really testing exercise for a unit of the strategic reserve. At the same time much constructive work was done to assist a country devastated by a natural catastrophe of terrifying proportions.

Much was learned about the technique of dispatching a composite squadron group in a matter of hours carrying with them a considerable quantity of freight.

On arrival, the principal lesson was the need to work through the local organization such as PWD rather than to attempt to set up a separate engineer organization. It is considered that this lesson is generally applicable to any cold or limited war operation on friendly territory. To design engineer reinforcements with complete success, the key must be good engineer intelligence and if possible prior liaison with the local engineer authority.

Detailed lessons included:—

(*a*) A Sapper recce party must be on the site of such a catastrophe as early as possible.

(*b*) Maximum information on Sapper tasks is required before Sapper units leave UK.

(*c*) Sappers must have their tools, some transport and plant if they are to be of any value. This can be achieved by flying it in, stockpiling, local purchase, or requisitioning. The last two were impractical in this case except for local purchase in Jamaica which took time.

(*d*) Helicopters are essential for quick engineer reconnaissance where communications are bad.

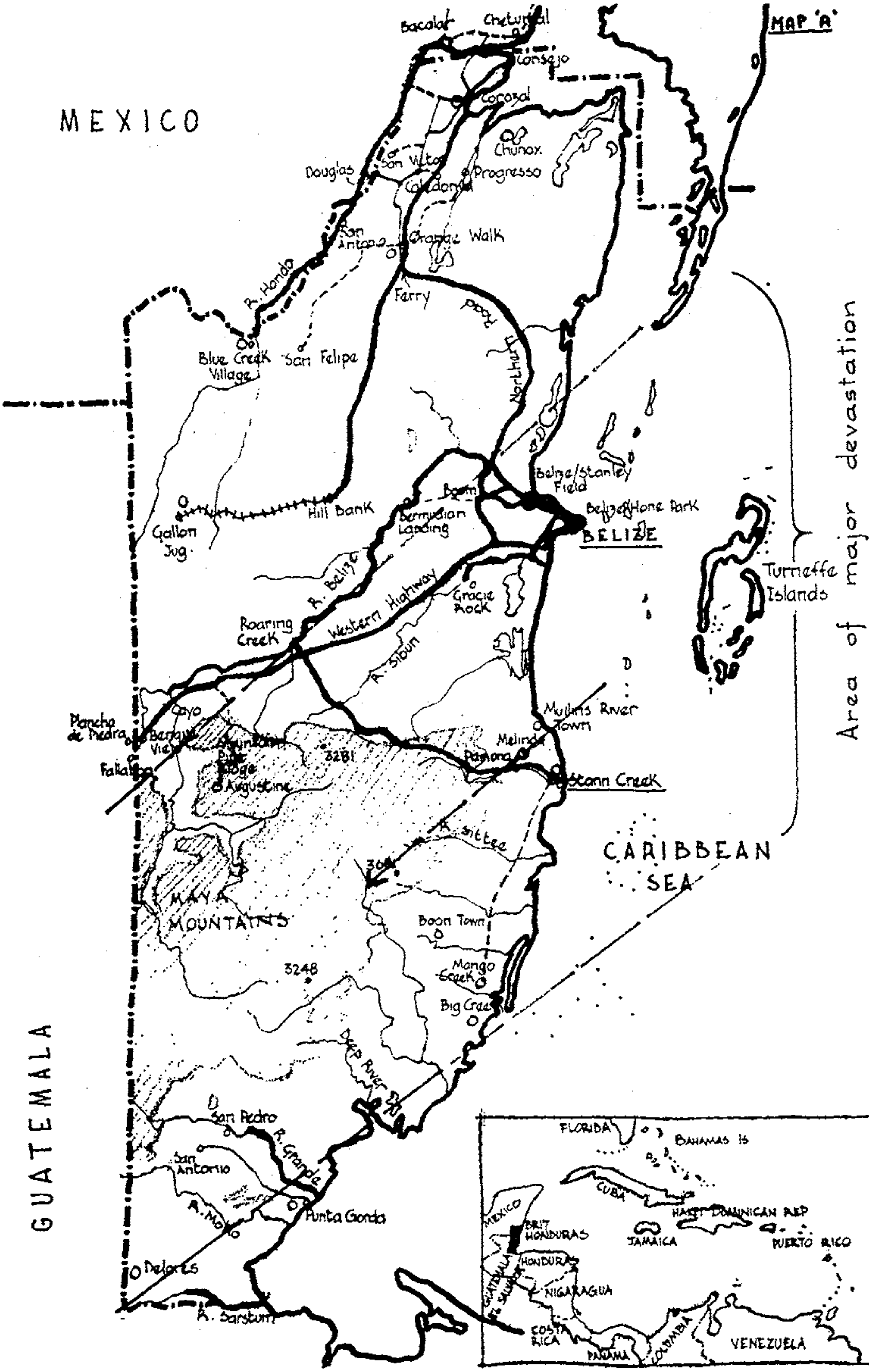
(*e*) An administrative element must be taken as peace time accounting is always required in such circumstances.

(*f*) A stock of empty light weight boxes should be held in squadrons for air movement. Boxes used for normal exercises and in the G1098 are too big and heavy. The maximum weight of any package should be 200 lb. Pioneer tools should be banded and not boxed for air freight.

(*g*) A good proportion of Class II and I tradesmen is essential for this type of operation, as Class III tradesmen cannot cope with some of the technical problems encountered.

(*h*) Although we were only given ten hours notice it is possible to move a squadron with its tools in this time, if a certain amount of pre-planning has been done.

Finally, the old lesson that Sappers must be mentally adapted to making bricks without straw was fully borne out on Operation Hurricane *Hattie*.



BRITISH HONDURAS -

Long Boots

By Brigadier K. B. S. Crawford

A View of Military Strategy for Young Soldiers

Operations unexpected by the enemy are,
when well executed, almost certain to
succeed, whatever be the odds.
John Fortescue, Dundonald.

It is a commonplace in the art of war that surprise is even more effective in strategy than in tactics.

Surprise consists largely in rapid and orderly movement, and the art of strategy lies as much in good marching and administration as in cleverness of manoeuvre. The supply plan must be foolproof, the vehicles durable and in good order, and the men as hard as nails. These are the secrets of good strategy. In bringing the enemy to battle one or more advantageous moves will occur to any commander of experience, but only a commander whose officers and men are thoroughly trained in overcoming difficulties of movement is able to put the bolder plans into effect. Other things being equal he will prove the most successful strategist.

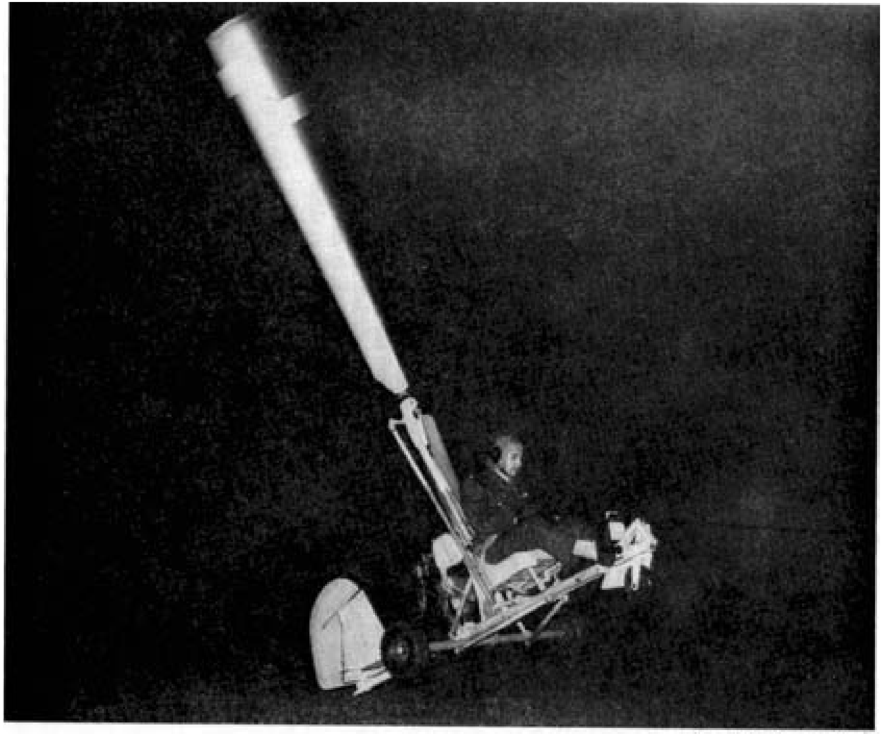
Napoleon's "Long Boots" were his greatest excellence in the art of war.

We are convinced that there are no rules of any kind for strategic manoeuvring; that no method, no general principle can determine the mode of action; but that superior energy, precision, order, obedience, intrepidity in the most special and trifling circumstances may find means to obtain for themselves signal advantages, and that therefore chiefly on those qualities will depend the victory in this sort of contest.
Clausewitz, On War.

The value of an army lies in its habits.
Maurois, Tragedy in France.

The quality of decision is like the well-timed swoop of a falcon which enables it to strike and destroy its victim. Though we have heard of stupid haste in war, cleverness has never been associated with long delays. Rapidity is the essence of war; take advantage of the enemy's unreadiness; attack when he is unprepared; appear when you are not expected.
General C. Willoughby, Manoeuvre in War.

The insistence upon precision, order, and obedience, upon habit, and upon the blood sports principle of catching something unawares, all suggest the Military Mind. If a young soldier finds march discipline exacting, and his routine work meticulously enforced, he may console himself with the thought that such things give him the temperament of victory, and that though victory may be arduous it is likely to be less costly, and bliss for the junior ranks, in comparison with defeat.



By permission of Chatham Observer

Photo 1. Pilot Training. Flying the machine as a kite (see text) gives valuable pilot training at negligable risk. The photograph shows the "tail down first" flare out landing typical of the gyrocopter. The flashlight photograph has caught the rotor at an unusual angle. The two projections at the blade end are the nose weight and the trim tab.

An Experimental Sapper Recce-copter

By MAJOR N. A. F. EDWARDS, RE

INTRODUCTION

IT IS generally thought by air-minded people that we do not make sufficient use of light aircraft at regimental or squadron levels. At present most of our light aircraft are operated, controlled and maintained by The Army Air Corps who are also responsible for pilot training. Whilst this centralization is the obvious solution in respect of fixed wing aircraft because of airfield requirements, etc, it would be most desirable if machines of the helicopter or Gyrocopter type could be operated and controlled by individual Corps down to at least regimental level.

Undoubtedly the high initial cost of machines and their subsequent maintenance, coupled with the cost of pilot training, has to date prohibited the wide distribution of this type of aircraft. It is as a partial solution to this problem in respect of RE that I suggest the wide usage of the light Gyrocopter as a Sapper reconnaisance machine that could be operated, controlled and maintained down to field squadron level.

A description of an experimental machine follows which, when fully developed, might be suitable for this purpose. I have built this aircraft at the SME Chatham over the last year and, although it is only a prototype, it has passed its initial flight test satisfactorily. Further experiments are continuing.

GENERAL CHARACTERISTICS

The basic configuration of the airframe has been modelled on an American gyroglider whilst the control system and the rotor head is similar in design to the German hydroglider which was towed by U-boats when surfaced for reconnaisance purposes.

The "Recce-copter", as I shall refer to it, is not a true helicopter but is best described as a "jump-start gyrocopter". The main characteristics of the gyrocopter are as follows:—

(*a*) It cannot hover nor climb in still air although it can perform these functions if there is a sufficient headwind.

(*b*) It requires a short take off run (dependent on wind conditions) but can land in virtually the same space as a helicopter.

(*c*) It cannot spin or stall, too tight a turn resulting only in a gradual loss of altitude.

(*d*) If the engine fails, the machine can effect a glide landing in autorotation similar to the conventional helicopter.

Horizontal thrust for the recce-copter is provided by a normal airscrew located behind the pilot and acting as a pusher. Both the blades and the tail boom fold, thus allowing the craft to be easily towed.

Courtesy of Soldier Magazine

Photo 2. Transportation. With the blades either removed or secured fore and aft the reece-copter can travel on the road under the power of its pusher propeller.

An Experimental Sapper Reece-Copter 2

The blades are also removable for alternative means of transport. The machine is fitted with a steerable nose wheel and foot brake and, with the blades removed or secured, it is capable of travelling under its own power on the road. When moving thus the craft travels under the power of its pusher propeller and does not rely on its wheels for traction. This allows it to negotiate surfaces which would normally prove difficult to wheeled vehicles.

The craft is fitted with Army radio communication, a 35 mm camera and an elementary recce sight. This latter fitting is a simple wire framework which when adjusted to suit the pilot allows ground linear measurements and ground areas to be read directly from the altimeter.

Construction

The machine is extremely simple in construction and consists only of three main basic units namely:—

(*a*) The airframe.
(*b*) The rotor and rotor head.
(*c*) The propeller and power unit.

The three units can be seen quite clearly in the accompanying photographs and do not need more than general description.

The airframe. The airframe has been built mainly from scrap material and consists of a mast, a tail boom and axle made from 2-in OD aluminium tube and a mainspar built up from 2-in aluminium channel sections. The various drag-braces and other supports are made from smaller aluminium tubes and angle sections. The airframe is of nut and bolt construction throughout and with the main landing wheels which are from a "go-kart", weighs about 90 lb. The rudder is conventional and is constructed from marine plywood.

The rotor and rotor head. The main rotor, which is a two-bladed affair and was by far the most difficult part of the whole construction, consists of two tapered steel spars to which are screwed the plywood main spars of each blade. Thin plywood skins are in turn glued to these and the whole is shaped and sanded to the final required airfoil. For good performance and to save work in the final tracking of the blades it was essential that the two blades be identical in both weight and shape. Much careful work was necessary to achieve this. The rotor head consists mainly of the axle for the rotor blades, the main bearing and the smaller control bearings. The main bearing is a heavy sealed double roller thrust bearing which will allow the axle passing through it both to revolve and to change direction of its axis up to 10 deg in any direction. This particular bearing will support a weight of 800 lb for 2,000 hrs whilst revolving at 500 rpm. The two blades are permanently set at negative pitch chordwise but have a precone angle of 4 deg spanwise. The rotor head was the only part of the whole machine that called for really accurate work.

The propeller and power unit. The propeller was one of the few items that I purchased ready made and is a conventional pusher type 45-in long and of 29-in pitch. It is made of birch. The actual power unit is a twin cylinder Triumph motor cycle engine giving about 35 bhp at 6,000 rpm and apart from a small cowling fitted to the carburettor (to offset propeller suction) is unmodified in any way. It is held into the airframe by the original plates that secured it to the police motor cycle from whence it came. The propeller at present is chain driven from the crankshaft and is "geared" to run at 3,500 rpm whilst the crankshaft is running at 5,800 rpm. The chain requires constant lubrication and as a result covers all and sundry with oil. I am in the process of changing to V-belt drive.

Controls. As the blades of the main rotor are of fixed pitch there is no need for the collective pitch lever found in conventional helicopters. There are, therefore, only two main controls, the rudder pedals and the cyclic stick. The rudder pedals control the rudder in the normal way and are only used to correct the path of the aircraft in yaw. The cyclic stick operates in the same way as the control stick in a fixed wing aircraft but with the usual pendulum effect characteristic of the helicopter. The engine throttle which is usually a twistgrip type mounted on the collective pitch lever is in this case a caliper lever and is located on the cyclic stick. Thus during normal flying only the feet and one hand are occupied. Located on the cyclic stick in addition to the throttle control are two electric switches, one is the engine ignition cut out and the other is a change over switch which, dependent on its position, feeds one of two electric generators into a common revolution counter on the instrument panel. When the switch is in the up position main rotor revs are shown and when in the down position propeller revs are indicated. These two switches can easily be operated with the thumb even whilst manipulating the engine throttle with the same hand. The engine mixture control is mounted on the engine and, although not normally required in flight, it can be reached by the pilot.

Instruments. There are only three instruments all of which are conventional. They are, airspeed indicator, altimeter and the dual purpose rev counter (rotor revs/prop revs).

Characteristics. Empty weight, 230 lb; payload, 270 lb (including pilot and fuel); gross weight, 500 lb (maximum rotor design weight 700 lb.); range, 60 miles (still air); road speed, 40 mph; air speed, 50 mph; rate of climb, 600 fpm and ceiling, 5,000 ft (not yet fully tested); engine 500 cc (Triumph twin approximately 35 bhp at 6,000 rpm); airscrew, McCullough pusher (29-in pitch); take off run, 300 ft (still air); take off run, 20 ft (15 mph headwind); landing run, 20 ft; rotor size, 10 ft 6 in long (each blade), 7 in chord, 0 deg pitch (chordwise), 4 deg precone angle (spanwise); rotor revs, maximum 450 rpm, normal 350 rpm; maximum rate of descent, 18 ft per sec; minimum glide angle, 15 deg.

Pilot Training

Flying the machine differs somewhat from flying both normal fixed wing aircraft and conventional helicopters, I believe, however, that a normally intelligent person with no previous flying experience could fly the recce-copter with reasonable confidence after about 15 hrs practice. A suggested phasing of pilot training is as follows:—

(i) General explanation of machine and its controls plus (if possible) a short dual flying session in a light aircraft of the Auster type in order to get the "feel" of rudder pedals and a normal control stick—2 hrs.

(ii) Taxi-ing the recce-copter under power but without the main rotor. Speeds of up to 20 mph should be achieved in order to get the "feel" of the throttle and rudder control—2 hrs.

(iii) Flying the machine as a gyro-glider (ie without power) towed behind a vehicle. A cable of about 60 ft in length is sufficient. It should not be necessary for the towing vehicle to travel at more than 20 mph in still air to get the

Courtesy of Soldier Magazine

Photo 3. Pilots eye view. The throttle caliper control and the two electric switches referred to in the text can be seen on the cyclic stick.

craft fully airborne. A number of short hops of only 3–5 ft altitude should be mastered before attempts to fly higher are made. When the trainee is reasonably confident more forward speed can be applied to allow small turns to be practiced. Flying the machine as a kite can also provide valuable pilot training but a site where the wind blows consistently at about 20 mph is required for this type of flying. A cable of 100 ft in length and capable of withstanding a pull of at least 1,000 lb is necessary to tether the machine to the ground—8 hrs.

(iv) Straight take offs and landings under power should now be attempted progressively. First take offs should be practiced under no wind conditions. Landings are made by flaring out. The actual landing speed being about 7 mph—3 hrs.

Total time 15 hrs.

Summary of Main Points

(*a*) The machine is easily constructed from readily available commercial materials.

(*b*) It does not require an expensive aircraft engine but operates with a standard motor cycle engine.

(*c*) It is nut and bolt construction throughout thus making for easy repairs and cannabilization in the field.

(*d*) It is not expensive to make and should not cost more than a normal motor cycle combination if made commercially.

Photo 4

Photo 5.

Towing. The removal of a single pin allows the tail boom to fold up giving adequate clearanc under the rudder to allow the nose to be raised for towing purposes. In the photographs th rotor blades have been removed and are stowed on the Landrover canopy frame. Reassemb ling the machine from this position can be done by one man in less than five minutes.

(*e*) It uses normal POL.
(*f*) It is easily towed or transported in the field.
(*g*) It can travel under its own power on the road for short distances.
(*h*) Maintenance problems are negligible.
(*i*) Pilot training is not difficult and could be done at regimental level.

To Conclude

It must be understood that this machine is experimental and could b vastly improved. Since starting it and installing the present engine I hav found a motor cycle engine giving a much better weight/bhp ratio. There ar also many alterations that could be made to reduce the weight and improv the machine's performance, etc. In spite of the aircraft's shortcomings however, I believe that it could form the basis for the development of simple and useful machine that could be completely operated, controlled an maintained at field squadron levels.

As an afterthought and for those who may wish to construct a simila machine for either experimental or amusement purposes it may help to know that my present effort has cost me about £68 in cash and approximately 76 hrs working time.

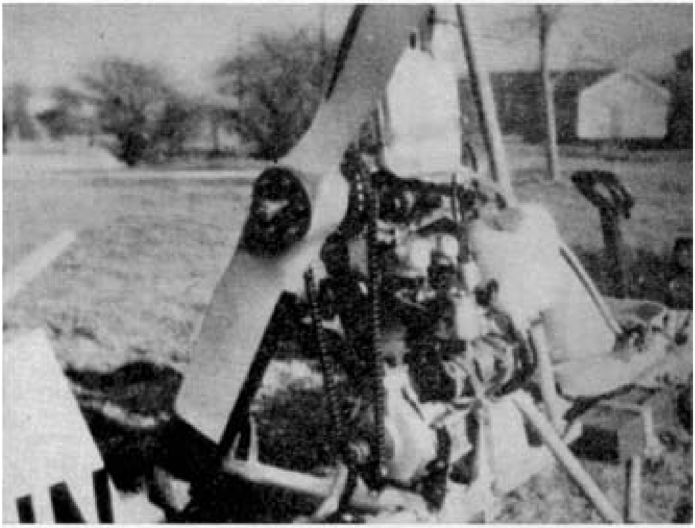


Photo 6. The power unit.

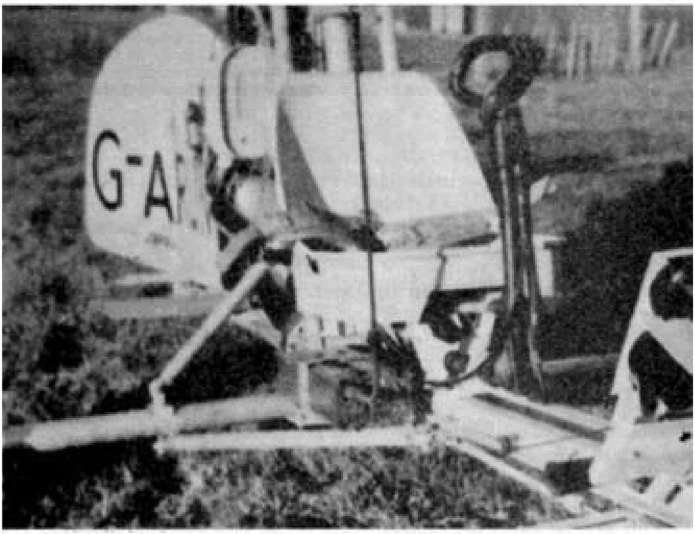


Photo 7. The radio installation.

An Experimental Sapper Reece-Copter 6 & 7

An Aspect of Mobility in the Forward Area

By COLONEL K. H. STEVENS, MBE, BA

INTRODUCTION

MODERN military publications, British as well as American, contain many articles dealing with the tactical mobility of the Army of the future. In these articles, the reader is constantly reminded that VTOL aircraft and amphibious tanks are realities of today while within the next ten years flying platforms and ground/air vehicles of all sorts will enable the soldier to move about the battlefield quickly and without regard to ground conditions. We are invited, indeed exhorted, to think in terms of these new developments, to project our minds a few years into the future when these and other more advanced military vehicles will be part of the normal equipment of the Army. We must do so, we are told, to enable a military doctrine to be evolved which will, in the test of war, make full use of the potentialities of these wonderful new machines.

It takes no great military genius to envisage the advantages that would accrue to an Army completely equipped with such vehicles. There would of course be much to be gained by the tactical commander who has the ability to launch a force quickly into the enemy's rear by going over rather than through his front. But to the ordinary officer and soldier, the main advantage can be summed up in one phrase—no more mud. There would be no more muddy vehicle parks and assembly areas from which it is a toss-up whether the vehicles will ever emerge; no more quagmire detours which can be kept open only by the addition of many tons of rubble a day; no more attacks bogging down in the bottomless mud of river banks. When these conditions threaten, the soldier of the future will simply take to the air. In these Elysian circumstances Sappers in the forward areas, it can be imagined, would be at a discount. One of our traditional tasks, that of enabling the Army to move, would then have disappeared.

How true is this vision of the future? To what extent will aerial vehicles be able to replace the earth-bound vehicles of today? It is the aim of this article to estimate the probable impact of these vhicles on the Royal Engineers of the future to see how much of their traditional task will remain. The time frame to be considered is 1970–80 when vehicles existing at present only on the drawing board will be in service and others, at present only dimly seen through the mists of the future, will be coming in. The background, where one is necessary, will be war in North West Europe since it will be there, if ever, that our future doctrines will be put to their severest test.

DISCUSSION

Let us first of all see what sort of vehicles we are likely to have and what their limitations are likely to be. For vertical take-off purposes jet engines are not very suitable. They have a low efficiency when used in this way and the effects of the soil erosion they cause might limit their use on certain types of soil. Ground/air vehicles will, therefore, probably be based mainly on the ducted fan principle in which air is sucked in at the top of the vehicle and forced out through the bottom by one or more large fans set in short ducts, with other smaller fans to assist stability. These vehicles may vary in their specifications from road vehicles which can fly to flying vehicles which can travel on roads. Their basic disadvantages are likely to be:—

(*a*) Their enormous power requirements. In a conventional aircraft most of the lift necessary to keep the aircraft in the air is obtained from the flow of air over the upper surface of its wings. Similarly a helicopter obtains much of its lift from the flow of air over the upper surface of its rotor blades. This source of lift is not available to an aerial vehicle operating on the ducted fan principle. It must obtain all its lift from the thrust of its fans. This has two important implications. Firstly the fuel requirements will be very large indeed. To keep something the size of a Ferret in the air will consume hundreds of gallons per hour. Secondly the motor required to keep a given machine in the air is likely to be necessarily so large that there will be little capacity remaining for payload. Therefore, at least until the advent of small nuclear power packs, which cannot yet be foreseen, it will not be possible to give aerial vehicles any worthwhile armour. Battle tanks, if required, will still be confined to the ground. Nor can such aerial vehicles be considered to be economic load carriers.

(*b*) Their complexity. It is obvious that when the ability to travel both on the ground and in the air is to be built into one machine the result will be complex. This has one certain, and one possible, repercussion. The cost of such machines will certainly be very high, and the degree of skill required to operate them may be of the order of that of an RAF pilot rather than that of a 3-tonner driver unless an even more expensive and complex "black box" is incorporated.

A word now about ground effect machines (GEMs), more popularly known as "hovercraft". These rely upon their proximity to the ground or water surface to obtain their lift. By means of their air cushion they attain a degree of efficiency, whether measured as a payload/gross weight ratio or in payload ton miles per horsepower hour, which is likely to be substantially superior to that of a helicopter and comparable to a transport aircraft of short or medium range. They have, however, major practical disadvantages particularly insofar as movement over land is concerned. These disadvantages need not be listed here. The GEM is so much in its early stages of development that it would be foolish to attempt to forecast to what extent these difficulties may eventually be overcome. Obviously open prairie country is ideally suited to their use and will demand no engineer work so long as obstacles are few and small. But as the terrain becomes more broken or more covered with vegetation, so the amount of engineer work necessary to enable GEMs to operate will increase until it exceeds that required to enable even wheels to move.

Developments along the lines described above are the principle ones which can be seen to offer promising results. The point which must now be emphasised is the probable cost of aerial vehicles and its effect upon the numbers likely to be provided for the Army. It has been estimated that the cost of improved mobility rises roughly in proportion to the square of the degree of improvement. This is due not only to the increasing complexity of these machines, which makes them intrinsically more expensive to manufacture, but also to high development costs particularly where there is no parallel civilian requirement and thus no civilian development effort from which we can benefit. So aerial vehicles are bound to be very expensive. The VTOL Rotodyne for example will cost over £1 million each. Their annual maintenance costs will also be high, possibly up to 50 per cent of their initial cost. There is a limit to the amount of public money which can regularly be spent on defence in peace without endangering the economy of the country. At present defence expenditure is running at about 7 per cent of the gross national product or rather over £1,500 million per year. There are many inescapable defence costs such as pay, movements, and accommodation for all three services which must come out of the £1,500 million. For 1961–2 the amount allocated for the purchase of Army equipment is £88 million. It is of course impossible to forecast with any degree of precision what the allocation is likely to be in the future but around about £100 million per year is a reasonable guess. There will be many competing demands upon this money for the purchase of other equipment all of which is tending to become more complex and more expensive. It is impossible to be precise about numbers but it will be apparent that, at the best, the Army will have to get along with many fewer ground/air vehicles than it could use.

Without attempting to estimate fuel requirements, let us not forget that a tremendous maintenance problem will arise. Modern RAF fighters already need quantities of fuel which are frighteningly large unless the airfields from which they are to operate are already well provided with delivery, storage and distribution means. If the Army too is to be equipped with machines which will multiply its fuel requirements many times, the logistic problem will be greatly increased. No doubt this problem will be solved but it is perhaps not too much to say that difficulty in meeting fuel demands in a remote area of operations will severely limit the number of aerial vehicles that can be employed even if the limiting factor is not initial cost.

What then is the answer? What proportion of the Army of the future is likely to be equipped with aerial vehicles and what will the rest of us travel in? It is suggested that aerial vehicles will probably be confined to the following:—

(*a*) Reconnaissance units and the reconnaissance elements of other fighting units.

(*b*) A very limited number of load-carrying units mainly for the tactical movement of infantry much as APC units were provided in the last war. These units would be available for re-supply missions when not required in their primary role.

(*c*) Limited numbers for intercommunication, VIP transport, etc.

This leaves much of the Army and most of its maintenance to travel on the ground in the forward areas. The only means available, which provide a reasonable measure of mobility, are wheels and tracks. There is apparently little prospect of any outstanding increase in the efficiency of either as cross-country agents, particularly in the case of tracks. A good deal of development is proceeding in the direction of wheeled vehicles with very large, low-pressure pneumatic tyres. These vehicles (the American GOER is the best known example) undoubtedly give increased cross-country performance on soft ground. But there are also inherent disadvantages. Another line of development is towards smaller wheeled, multi-axled vehicles. These will climb vertical obstacles of a height greater than the radius of their front wheels (the normal limit of a four-wheeled vehicle) but their general effectiveness in this respect is probably not as great as in the case of vehicles with larger wheels. They have other advantages however, including improved air-portability. Vehicles of both these types will have a cross-country performance approaching that of tracks but of course will cost much more. Their numbers too, may therefore, be limited for financial reasons.

One respect in which considerable improvement can be expected is in the amphibious qualities of both wheeled and tracked vehicles. Indeed the Ferret and the Saracen nearly float now. Much greater attention is likely to be paid to this capability in the design of future vehicles. Nevertheless, the fact that a vehicle can float does not mean that it can cross rivers without assistance. There will always be difficulties about getting in and out, unassisted, of any river but one with gently sloping banks. Such rivers are rare particularly in highly developed countries where they may be canalized. In any event there are likely to be only a very few places where unassisted crossing is possible and these, because of the large volume of water brought out of the river by amphibians as they emerge, are likely very quickly to become unusable. Naturally considerable development effort is going into overcoming this inherent weakness of amphibians but though some measure of self help may be possible in the future, there is no doubt that earth-bound vehicles will always require considerable engineer assistance in the assault crossing of normal European rivers.

Wheels will always find it quicker and more economical to travel on roads. For this reason alone roads are likely to be an attractive target for enemy attack. Unfortunately roads, whether constructed from scratch by modern road engineers or built on the alignment of ancient tracks, generally follow the best "going" available. This means that, when a road is blocked (e.g. by nuclear attack) so that a wide detour across country is necessary, vehicles will suffer not only from the loss of the smooth road surface but also because they are now forced to travel on wetter or steeper or at any rate less suitable ground for movement.

How large is this problem of bad "going"? How great a proportion of the earth's surface in those parts of the world where the Army may have to operate offers considerable opposition to wheeled and tracked movement off the roads? The answer to this question will influence many important matters such as the design of future vehicles. It will have a considerable bearing upon the order of battle of a force operating in any particular area. Unfortunately the subject of "ground mobility", as it is now called, has presented problems of such magnitude and complexity that up to the moment little progress has been made. It is still not possible to forecast within an acceptable time limit what the "going" may be like in any inaccessible area for any specified climatic conditions whether the answer is required in general terms for strategic purposes or in detail for use by a tactical commander.

This subject is now receiving active attention. The Military Engineering Experimental Establishment is working on a new approach, the details of which need not be set out here, which shows some promise that a trained observer will, from air photographs and by the use of a system for the storage and retrieval of data classified in terms of the physical environment to which they refer, be able quickly and accurately to assess the ground mobility in any given area for a given set of meteorological conditions. Much basic work remains to be done before it can be seen how successful this new approach will prove to be.

Those who have served in field units in BAOR will be aware that during many months of the year movement of tracks and particularly wheels over many areas of the country is impossible. Even in the summer there are areas which remain impassable while others notably the banks of rivers cause difficulty especially if there has been much rain. It is, therefore, reasonable to deduce that, though the advent of aerial vehicles and improvements in the cross-country performance of wheels and tracks may lessen the amount of engineer work necessary in any given area, some engineer support will continue to be required at least during the time frame under examination to enable the whole of the Army to move and to keep on moving.

The question is how much support. Let us list briefly some of the other factors which will influence the number of engineers employed on the task of maintaining and improving the Army's mobility.

Those factors which, together with the improvements in the mobility of future vehicles, tend to reduce the number of Sappers include:—

(*a*) A reduction in traffic density on roads due to greatly increased dispersion forced upon us by the nuclear threat. Roads will therefore break up less quickly.

(*b*) The probable short duration of any war. Existing roads may require little maintenance before the war is over.

(*c*) An increase in the amount and efficiency of engineer plant. More work is possible with fewer Sappers.

Factors which tend to increase the number of Sappers include:

(*d*) The same dispersion as in factor (*a*) above will enforce a greater degree of decentralization of Sapper effort than has been normal practice in the past. Divisional areas are likely to be some ten times or more than what they were in the last war. Over such distances, the effect of which may be enhanced by nuclear interdiction, timely Sapper support cannot be provided unless a considerable degree of decentralization is adopted. This will inevitably lead to some waste of effort.

(*e*) Dispersion will also increase each engineer unit's area of responsibility for route maintenance.

(*f*) Because of the need for dispersion many more routes will have to be opened and maintained. This will be particularly so in assault operations across obstacles when, because of the need for crossing on a broad front, the number of crossing places will have to be greatly increased and spread out.

(*g*) The vastly increased scale and extent of the damage caused by modern weapons.

To deduce the net effect of these influences upon the number of engineers in the order of battle of a force, one must assess how much weight to attach to each factor. This is the crux of the problem. With no experience of nuclear war to guide us, personal assessments will differ widely. Be that as it may, there is one further consideration. Engineer work must be viewed against a time scale as well as geographically. Though future vehicles with engineer assistance will be able to surmount obstacles more quickly, that does not mean that there can be a reduction in Sapper effort. On the contrary a forceful commander will wish to use this increased capability as a means of getting on more quickly. The next engineer problem will thus arise sooner. The necessary Sappers to deal with it expeditiously must be available, otherwise the commander will be unable to make full use of the improved mobility of his new vehicles. Thus, in the future as in the past, the Army will be able to move only as fast as the available engineers enable it to do. The writer submits that if the Royal Engineers are to play their full part in the mobile operations of the Army of the future, the proportion of Sappers in the order of battle of any force, provided for the task of maintaining and improving mobility, must be at least as high as if not higher than it has been heretofore.

Conclusion

We can, therefore, conclude as follows:—

(*a*) Though it is dangerous to attempt to forecast any further ahead, it is probable that in the period 1970–80 the number of aerial vehicles in the Army will, for financial and possibly logistic reasons, be far short of what the Army could usefully employ.

(*b*) A large proportion of the Army, both fighting units and maintenance transport, will continue to travel on wheels or tracks.

(*c*) Since there is not likely to be any great improvement in the cross-country performance of wheeled or tracked vehicles, some Sapper effort will continue to be required to get the bulk of the Army forward through those considerable areas of the globe where the going is no better than fairly bad.

(*d*) Though improvements in mobility will enable obstacles to be overcome more quickly than in the past, this merely means that the next engineer problem will arise more quickly. The demand for Sapper effort for this purpose will, therefore, be as great, or greater than ever, and the proportion of Royal Engineers in the forward area should be at least as high as heretofore.

inside faces of the main girders, to present a clean elevation and enhance the slenderness of the superstructure. Expansion has been provided for with roller-rocker bearings at each end of the bridge and at one end of the suspended span. There are rocker bearings at the other end of the suspended span and at both piers. The parapet is of welded steel panels, capped with a teak handrail.

The new bridge bears two bronze plaques, one of which records the history of the site, including the existence of the Bailey, and the other names the personalities and firms involved in the design, construction, etc, of the present bridge.

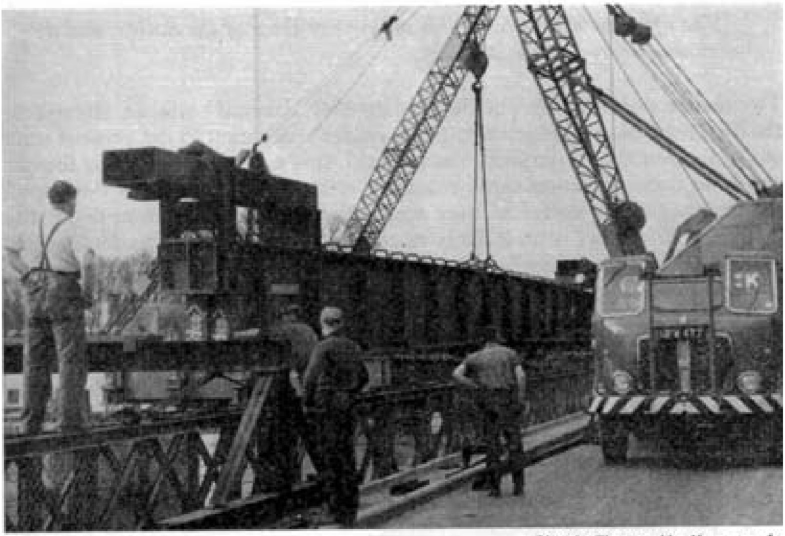
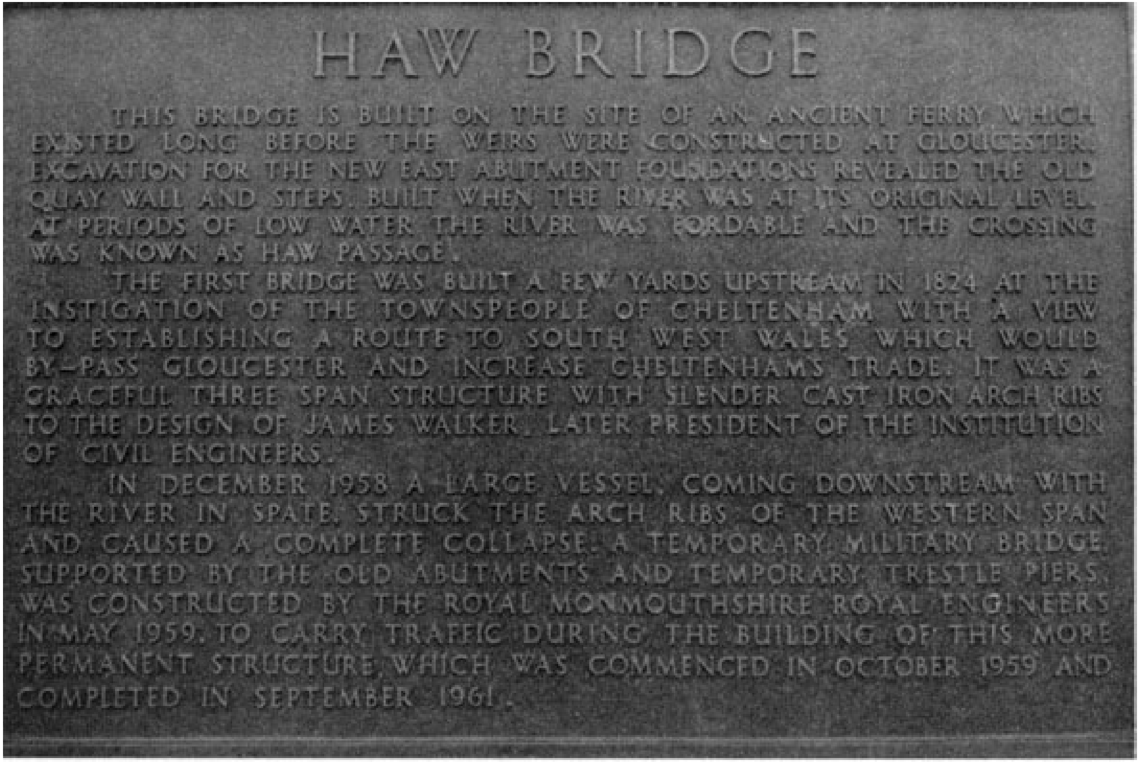


Photo by Gloucestershire Newspapers Lt

Launching centre spans from the temporary Bailey Bridge.

It is of interest to note that the estimated saving on the cost of the new bridge afforded by the temporary bridge immediately alongside the working site is slightly greater than the total charges for the Bailey and the construction of its three piled piers—quite apart from the benefit to through traffic which used the temporary bridge for two years. Not only could a single concrete batching plant, etc, be used for both abutments, but the Bailey was also used as a platform from which to launch the centre span members.



Plaque on New Haw Bridge. *Photo by South Wales Argus, Newport*

Haw Bridge 2

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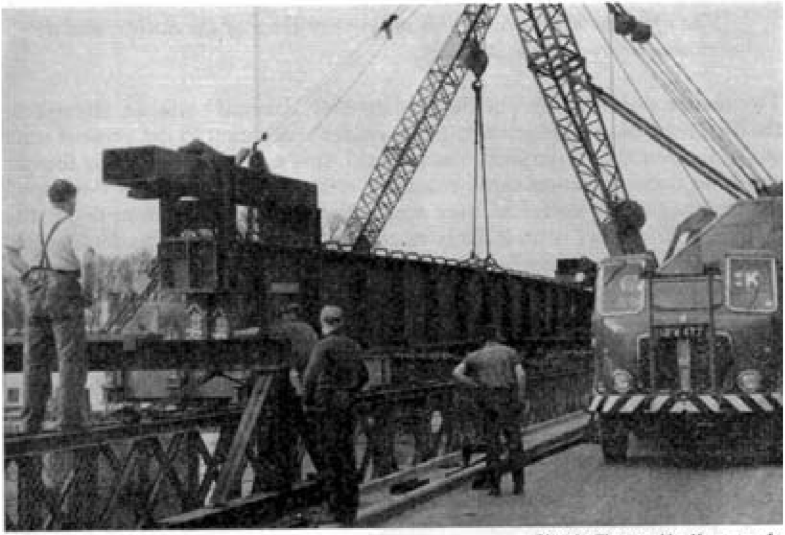

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More About Reactors

By Major A. A. T. Hiscock, RE, BSc(Eng)

The opinions expressed in this article are those of the author and do not necessarily reflect official policy.

The article published in the September 1961 *Journal* [1] was an attempt to clarify a confusing situation and bring reader's attention to the present state of the art over the whole small reactor field. It is my intention in this further article to concentrate on those reactor systems which have been developed sufficiently to offer useful military application on land. It is from these that the Royal Engineers is most likely to choose its reactors. I have deliberately ignored those scientifically fascinating, but technologically unattractive systems which have confused so much discussion and description of reactors.

The Essentially Useful Reactor Systems

As implied in my previous article there are only a few systems which offer a real possibility of useful and reasonably priced military hardware over the next fifteen years. These are:—

1. The pressurized water reactor.
2. The boiling water reactor.
3. The direct cycle gas-cooled reactor.

In addition, great strides are being made with direct conversion systems and it is just possible that these may also achieve useful status.

In my opinion any Royal Engineer officer now serving is highly unlikely to be directly and militarily involved during his service with reactors with sodium cooling, organic moderation or cooling, heavy water moderation or any permutation on combination of these, together with fast breeder or thermal breeder reactors. It is to be hoped of course, that at least some Sapper officers will have the opportunity of working on these and other types; as military hardware, however, they are almost certainly not at present a feasible proposition.

British or American Reactors

As I have also implied previously it is unlikely that in view of the close co-operation with the United States, we would develop small reactors ab initio. The United States has most generously made the greater part of its research and development information on small reactors available to the whole world. It is unnecessary for her closest Ally and the only other Western nation with a really substantial nuclear industry to go over the same ground again.

It is possible, therefore, that in due course we may take a reactor system which has been developed in the United States and, if necessary, adapt and manufacture it in the United Kingdom. This is approximately what is happening in the case of nuclear submarine propulsion.

There are in any case a number of British firms with links with those American firms actively engaged on small reactor projects and the technological know-how is readily available to them. In view of the financial losses incurred by some of the British nuclear consortia, no British firm is likely to embark willingly on work in the small reactor field without close links with a successful United States project. Many American and some British (e.g. Hawker Siddeley) have written off their losses and retired sharply from the nuclear field. I have not given a list here of British/US associations as these are liable to change rapidly and an incorrect list could cause embarrassment. However, it is useful to record that the following American firms are taking a leading part in development and construction of package reactors:—

ALCO Products Inc Martin Co Combustion Engineering	PWR & BWR
Aerojet General	GCR
Nuclear Development Corp (plus General Motors)	MILITARY "COMPACT REACTOR"

General Requirements of a Land Based Military Nuclear Power Programme

Before considering the details of actual reactors it is useful to consider the objectives of a land based military nuclear power programme and of the US Army Nuclear Power Programme (ANPP) in particular.[2]

The broad objective of the ANPP is the development of a range of stationary, portable and mobile plants with capacities ranging from several hundred to 40,000 KW. The programme includes:—

(*a*) Research and development of nuclear devices as primary heat sources in the generation of electrical and mechanical power.

(*b*) Research on and development of nuclear power plants for supplying power for heat and electricity.

(*c*) Provision of technical assistance to users of devices and plants developed.

(*d*) Selection and training of the necessary staff to accomplish research, development and field utilization of nuclear power.

Such a programme must also take the following into account:—

1. Increasing power and life of nuclear reactor cores.
2. Simplification and toughening of components.
3. Reduction of reactor operating staff and improvement of system reliability and safety.
4. Making plant operation as nearly unattended as possible.
5. Continued improvements in the mobility of plant and more simple means for dismantling and re-erection.
6. Reduction of on-site construction effort, time and costs.
7. Achievement of a high degree of standardization.
8. Reduction of initial and operating costs to a minimum.

There is little in this programme which is not present to a greater or lesser degree in any military development programme. There is a difference however in that the cost, both in money and in technological and scientific manpower required for nuclear development is much greater than in "conventional" military engineering development.

The Pressurized Water Reactor and its Development

The Pressurized Water Reactor (PWR) has developed to the stage of being a well-known and well-tried reactor system of proven safety. At the present time there are seven PWR systems either in operation or under design and development in the USANPP (see Appendix I) and it is hardly necessary to remind readers that upwards of fifty pressurized water reactors are either built or under construction for the US and other Navies.

There is a considerable support and development programme for the US Army PWR.[3] Some details of the first military nuclear power plant, SM-1 (formerly APPR-1) were published in the June 1958 *Journal* [4] and a description of PM2A published in WOI James' article in the December 1961 *Journal*.

Some technical characteristics of five reactors are reproduced below.[5] (See also Appendix I).

	SM1	SM1A	PM2A	SM2	PM1
Thermal Output MW	10	20	10	28	10.3
Core life MW year	15	15	8	28	18.7
Operating pressure psi	1,200	1,200	1,750	2,000	1,300
Operating temperature °F	440	434	509	515	483
Flow rate gpm	3,960	7,050	4,220	7,800	2,125
Coolant passes	1	1	1	2	1
Number of elements	45	45	37	45	6
Core loading (U^{235})Kg	22.4	22.4	19.5	36.2	28.3
Number of control rods	7	7	5	7	6
Power density KW/l	72	144	87	200	50
Total weight tons	2,500*	3,000*	310	—	225
Number of packages	N/A	N/A	27	N/A	16

*Exclusive of aggregate in concrete.

SM1 has been operating as the PWR prototype at Fort Belvoir since April 1957. It is used as a research and development facility and as a training medium for reactor operations and has provided a portion of the power for Fort Belvoir. Much valuable information has been derived from it. The first core was removed in the spring of 1960 after 16.4 MW year of operation, 9 per cent more than its design life of 15 MW year.

The SM1A is installed at Fort Greely, Alaska. Its design is largely a direct extrapolation from the SM1. The testing and operation of the plant is providing data on nuclear power plant applications in remote frigid areas, including operating costs, crew size and training requirements.

SM2 [6] was originally for Nike-Zeus but will no longer be used in this role. This also is an extrapolation from the SM1 but includes a major advance in core design, ie, two coolant passes so that the same size core gives a threefold power increase.

PM1 is an air transportable plant jointly financed by the US Atomic Energy Commission and US Air Force. Its core life is estimated at two years and it will permit the use of minimum operating staff (about fifteen men). It is also designed to permit re-location when necessary and it is hoped that this plant will lead to further improvement in portability of pressurized water reactors of this type. Incidentally the on-site construction time of SM1 was fifteen to eighteen months. That for PM1 about three months.

PM2A, which also draws heavily on the SM1 design is now installed at Camp Century, North Greenland. Those in the United Kingdom during 1961 may have seen the US Army film on this installation, which was reproduced twice on BBC Television. Operation of the PM2A is providing data on remote-site operational and construction techniques. The article describing PM2A, by WOI James, which appeared in the December 1961 *Journal*, gives a very full account of the project.

Boiling Water Plants

These are a logical step forward from the Pressurized Water Reactor and the first BWR in the US ANPP (SL1) was operational at the National Reactor Testing Station in December 1958. This reactor of 200 KWe, was designed and constructed for the purpose of investigating techniques associated with relatively small outputs at remote sites for military applications. It included a direct boiling water cycle and was light water moderated. Unfortunately a nuclear explosion occurred in SL1 in January 1961 in which three men, all of the US Forces, were killed. There have been prolonged investigations into the direct cause of the accident but the conclusions are even now only tentative. Nevertheless it was revealed that responsibility for operation of the reactor was somewhat diffuse and that difficulties with the operation of the control absorbers had occurred on a number of occasions and, although recorded in the log book, had not sufficiently alerted those in charge to the potential-danger of the situation.

PL1 is designed as a low power (200 KWe) reactor based on SL1. It will be transportable by air in ten packages.

The power of PL2 is higher at 1000 KW(e) and has similar design characteristics to PL1.

Data on all three plants is reproduced below.[15]

	SL1	PL1	PL2
Thermal output MW	3	3.6	8.2
Core life MW/year	6.3	30	30
Operating pressure psi	300	600	600
Operating temperature °F	422	489	489
Flow rate gph	9,020	11,794	25,980
Coolant passes	1	1	1
No of elements	40	24	24
Core loading U235 Kg	14	67	67
No of control rods	5	9	9
Power density KW/l	9.2	5.9	13.6
Total weight tons	250	84	101
No of packages	N/A	10	11

The Direct Cycle Gas Cooled Reactor

This is a most promising type of reactor for military use and the first working prototype, ML1 (Mobile Low Power Plant 1) went critical at the NRTS Idaho in March 1961, full power operation being achieved later in the year. This mobile reactor has been developed by the USAEC, the US Engineers and Aerojet-General Corp. It consists of a high temperature, gas-cooled, water-moderated reactor with a closed cycle gas turbine power plant. ML1 has an electrical generating capacity of 3–500 KW but there has already been a preliminary study within the US Army Cooled Reactor System Programme of a 1 MWe version.[7]

The ML1 plant consists [8] of two major skid-mounted power plant packages and a control cabskid as follows:—

1. The reactor skid. This includes reactor core, shielding, and reactor auxiliaries.

2. The power conversion skid. This includes turbine compressor set, recuperator, pre cooler, alternator and electrical switchgear.

3. The control cab skid. This includes the instrument and control console for remote plant start up and operation.

There is an addition auxiliary equipment consisting of:—

Make up water-treatment equipment	900 lb
Gas processing and make up equipment	4,000 lb
Drums of bulk chemical (boron)	1,300 lb

These are also skid mounted for ease of transport.

The reactor is of the heterogenous water moderated type fuelled by enriched uranium dioxide. The reactor heat is transferred to the working fluid (nitrogen) as it passes the elements. At the design condition of 100°F the coolant enters the reactor at a nominal 800°F and leaves at 1,200°F. The moderator is of demineralized water and surrounds the pressure tubes, flowing under forced convection counter current to the gas flow. An integral radiation shield surrounds the reactor as protection during shut down but during operation the core, shielding, and pressure vessel assembly are enclosed in a tank of borated water.

This borated water is of course drained when the reactor is moved.

Reactor control is effected by six semaphore type control blades near the core circumference.

The major components of the power conversion system are:—

Turbine-compressor set and reduction gear
Alternator and starting motor
Pre-cooler with fans
Recuperator
Switch gear and connecting pipes and valves.

The hot gas leaves the reactor at 1,200°F, expands in the turbine, passes through the low pressure side of the recuperator and through the air-cooled pre cooler, where the waste heat is rejected to atmosphere. After being compressed in the compressor the gas is preheated to about 800°F as it passes through the high pressure side of the recuperator and thence through the reactor to the turbine inlet, completing the cycle. The turbine work drives the direct-coupled compressor and alternator through a gear box.

It is hoped that the plant will eventually give a 50,000-hour life with 10,000 hours between overhaul. This has not been achieved so far.

It can be operated at full power within twelve hours of arrival on site.

It must not be expected that achievement of the order demanded for

ML1 is attained without difficulty and without great effort, nor that development ceases with the running of the prototype. There have, naturally, been many problems in both nuclear and conventional engineering and those interested in the details may refer to the semi-annual progress reports of the project [9] which are obtainable from the Office of Technical Services, Department of Commerce, Washington DC, USA.

Other Developments Including Direct Conversion

Even the ML1 is relatively large and it is attractive to look for an even smaller system which could be very easily transported and which could provide a propulsion power source for an overland train (perhaps in the Arctic or Antarctic) or for other vehicles. This is the thought behind the US Army Military Compact Reactor programme [10] which is aimed at providing a mobile nuclear power plant capable of operation while in motion at power levels up to about 3 MW (e). This reactor system is at an early stage of development.

There are at the moment two direct conversion systems receiving some publicity. These are systems in which nuclear heat is converted directly to electrical power.

The Martin Co has a Thermionic Direct Conversion reactor under development in three stages.[11]

60 KWe at	15/16 lb/KW
300 KWe at	6–8 lb/KW
2,000 KWe at	4 lb/KW

It is probably about 10 per cent efficient.

Westinghouse have designed a 3MW(e) boiling water moderated and cooled reactor with a thermoelectric power unit.[12] This is designed to operate for 1½ years at full power with a further six months at reduced power, at a depth of 2,000 fathoms without attention, operates at about 6–7 per cent efficiency and weighs 155 tons.

In addition there is a proposed 1 MW unattended version of the General Atomic TRIGA reactor of which few details have been released.

Reliability of Nuclear Power Plants and the Attainment of Unattended Operation

I have previously mentioned the unattended nuclear plant [1] and have pointed out that much of the inherent advantage of nuclear power can be lost by the complexity and size of support and maintenance facilities. This problem has naturally received much thought and I have drawn attention to the Oak Ridge Report "Feasibility of an unattended nuclear power plant".[13] A really comprehensive study of reliability is contained in a "Reliability study of equipment and components in nuclear power plants" by Gilbert Associates Inc, for Air Research and Development Command, USAF.[14]

This report reviews and analyses the operating experience at five US nuclear power plants, viz:—

Experimental Boiling Water Reactor	(EBWR)
Shippingport Atomic Power Station	(PWR)
SM1	
SL1	
Vallecitos Boiling Water Reactor	(VBWR)

It was found that the most significant area of trouble was the instrumentation and control, particularly in the nuclear portion of the plant. Among the more conventional apparatus, the turbine-generator, piping, electrical auxiliary equipment, instrument, controls, and valves accounted for many maintenance problems and failures.

The conclusions and recommendations of this report are so detailed and comprehensive that it would be impossible to present more than the briefest summary. The following important points, however, are made.

(*a*) Human error influences reliability all the way from material and design selection for a component up to its operation and maintenance. The report points out the importance of quality control or inspection during manufacture and I could quote many instances from my own experience where the normal commercial type of inspection has allowed components to arrive on site which are absolutely inacceptable for assembly into a nuclear installation. The project engineer and his staff in a nuclear installation must be extremely vigilant. Once the reactor has gone critical it is usually too late to correct faults. Of sixty-four cases of human error traced in the report, responsibility is allocated as follows:—

Design deficiency	8
Manufacturing error	26
Installation error	16
Maintenance error	5
Operating error	9

(*b*) Reliability is not compatible with a "least cost" design philosophy.

(*c*) Prototype plants must be built and then performance analysed.

The overall implication of the Gilbert Report is that achievement of desirable military reliability can be achieved by a long, and carefully planned and detailed programme directed to that end. It will not come by vaguely hoping that in due course faults will be discovered and eliminated. The further step, to unattended operation for periods of years is much more difficult and can best be achieved by starting from a well developed and reliable system and by its subsequent extreme simplication.

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[10] Reference (2) pages 261 and 267.
[11] *Nucleonics Week*, 12 October 1961.
[12] Ibid.
[13] USAEC Report ORNAL 2985, September 1960.
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[15] Reference (2) page 260.

Summary of the US Army Nuclear Power Programme

Designation	Type	Main Contractor	Remarks
SM1 Stationary Medium Power Plant 1	PWR	Alco	1855 KW (e). Port Belvoir, Va.
SM1A	PWR	Alco	1,640 KW (e) plus 38,000,000 BTU/hr of steam. At Fort Greely, Alaska
SM2	PWR	Alco	Originally for Nike-Zeus but not required and will be used for R and D and to complete design
PM1 Portable Medium Power Plant 1	PWR	Martin Co	For Sundance Wyo Air transportable in 16 cargo aircraft. (Air Force Project)
PM2A	PWR	Alco	1,500 KW (e) plus 1,000,000 BTU/hr of steam. A further development of SM1. At Camp Century Greenland
PM3A	PWR	Martin Co	Prepackaged 1,500 KW (e). Shipped to McMurdo Sound, October 1961 (Navy project)
SL1 Stationary Low Power Plant 1	BWR		Nuclear explosion occurred in this reactor, January 1961
PL1 Portable Low Power Plant 1 PL2	BWR BWR	}	Air transportable prepackaged versions of SL1
PL3	BWR or PWR	Alco	Byrd Station, Antartica
ML1 Mobile Low Power Plant 1	GCR	Aerojet-General	Gas-cooled closed cycle gas turbine 3–500 KW
ML1A	GCR		3–500 KW(e)
MM1 Mobile Medium Power Plant 1 (Military Compact Reactor)	MCR	Nuclear Development Corp and General Motors	2,000–3,000 KW (e) Capable of operation while in motion. Possible propulsion power source for overland train or other vehicle
MH1A Mobile High Power Plant 1A	PWR		Barge mounted for power supplying from off shore locations for inland use
SH1 Stationary High Power Plant 1	PWR		20 MW(e) for GUAM

Reconstruction Work on the Stratford-on-Avon Canal

By 2ND LIEUTENANT D. R. REEKS, BSC(ENG), RE

INTRODUCTION

EARLY in 1961 17 Port Regiment was told that the National Trust was re-opening the Stratford-on-Avon Canal. Upon investigation, 53 Port Squadron was invited to provide assistance with this task and 481 Port Maintenance Troop was given the job as a training project.

The Stratford-on-Avon Canal from Kingswood Junction near Lapworth, Warwickshire to Stratford-on-Avon has been derelict for some thirty years and strenuous efforts by the Inland Waterways Association just saved it from final abandonment. The National Trust on behalf of the IWA has taken a lease of the canal and aim to reopen it within three years using mainly volunteer labour. The first year's work commenced in March 1961 and the Canal Manager gave the unit one of the worst stretches of Canal in the first year's programme.

THE TASK

The task was to replace lock gates at Lock 30, dredge the pound between Locks 30 and 31 (approximately ¼ mile) and reconstruct completely Lock 31, the location being 2½ miles south of Lapworth and halfway between Birmingham and Stratford-on-Avon.

A reconnaissance showed that all lock gates would have to be replaced, and that the brickwork of the lock chamber walls at Lock 31 needed complete rebuilding, new sluices, or paddles to be fitted, and about three to four feet of mud to be dredged from the pound and the locks, representing over 2,000 tons. Access to the site was difficult and no machine could move on the tow-path owing to its limited width. There is a constant flow of water through the Canal, designed to allow for loss of water mainly due to working of the locks. The canal at this point was very badly overgrown and in many places nothing could be seen of the water due to the profuse growth of weed, and trees were growing out of the lock walls.

The Canal Manager asked that, as far as possible, all old material from the locks should be recovered and re-used, with the exception of lock gates and paddles.

SETTING UP CAMP

On 2 September the Advance Party moved to the camp site alongside Lock 31 and set up a tented camp. The Troop arrived on 3 September together with the majority of its equipment.

Tented workshops were set up, together with the machinery lorry, between the camp and the canal site, and electric lighting was installed throughout the camp and also, at one stage, at Lock 31. On the opposite side of the canal was a well-equipped pub, and between the camp and the pub was a well-sited bridge.

Work on Lock 31

On 5 September a temporary 40 ft Single Single Extra Widened Bailey Bridge was erected skewwise across the lock in order to move the 19 RB with grabs to the opposite side of the lock, so as to dredge the approach to the lock. At the same time the bricklayers erected their scaffolding in the lock chamber and began to cut out the old brickwork, necessary due to the bulging of the walls and the flourishing trees growing through them. Meanwhile, the shipwrights had started the erection and fitting of the upper lock gate. All gates were supplied ready made, but without fitted balance beam and metal fittings. The task of fitting the gates involved hanging the gate and fitting the top collar with its wedges until the gate was plumb. The balance beam was fitted to the gate and dowelled and strapped on. The quoins were painted with red mastic paint and with the combined energies of half a dozen men the gate was slammed, thus showing the high spots on the mating surfaces. The shipwrights then set to work with adzes and planes until, after further slamming, the gate fitted snugly to the quoins. The cill was then fitted up to the gate so that it too was watertight. Two new paddle starts, paddles and paddle gear sets were then fitted to the sluices. Having completed all the work on this gate the shipwrights gang moved up to Lock 30 and made ready to fit the new top gate there.

The bricklayers were meanwhile renewing the brickwork. Since the Canal Company requested that as many bricks as possible should be re-used, a great deal of brick cleaning was necessary. One problem that arose as a result of this policy was that, owing to age of the lock, about 150 years old, all bricks varied considerably in size. This meant that the bricks had to be sorted in order to produce level courses. The walls were rebuilt 4½ in thick with expanded metal ties inserted at frequent intervals. These walls were then backfilled with a wet mix concrete. Finally a coping of blue coping bricks and large stone blocks, recovered from the old walls, was laid.

Work on Pound 30–31

This pound, a quarter of a mile long linking Locks 30 and 31, was in a very bad state, being about four feet deep in mud and very overgrown with weeds and trees. The pound was drained shortly before starting the dredging.

As it was impossible to run the 19 RB along the towpath owing to its very limited width, it was necessary to cut down the adjacent hedge and operate from the adjoining field. Revetting, consisting of unserviceable scaffold tubes and Bailey chesses, was built up on the edge of the towpath and the mud and weeds dredged from the canal were dumped behind the revetting. However, it was found that there was more mud than could be put on the towpath and it was necessary to spread the rest on the field, using a Michigan 75A and bucket.

One problem that arose during the dredging was the fact that it was necessary to be extremely careful in using the grabs in order to avoid damaging the clay puddle which is the watertight lining of the canal.

Final clearance of the pound involved the cutting down and lopping of a large number of overhanging trees which obstructed the navigation.

After a period of about two months the Canal Company will remove the revetting on the canal bank and the mud will have dried out and be sufficiently stable for small vehicles to drive on.

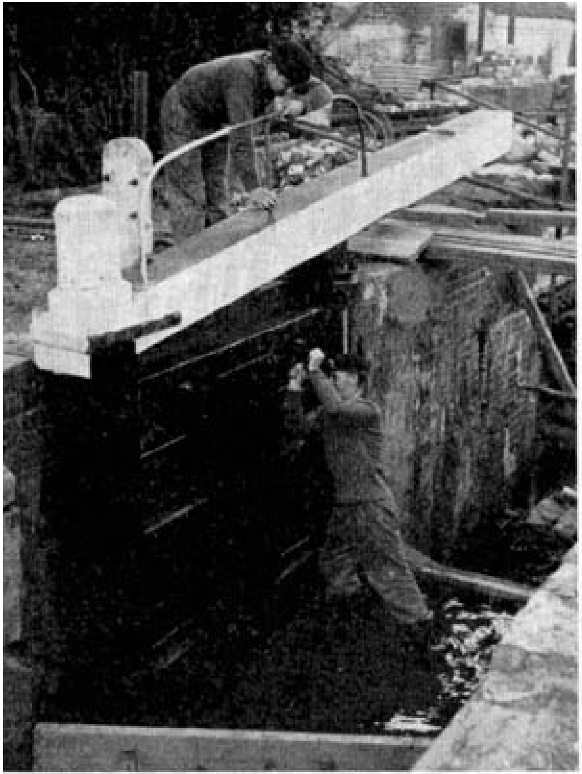


Photo 1. Final fitting of top gate, Lock 31.

Photo 2. Removal of old coping stones.

Reconstruction Work On The Strafford On Avon Canal 1,2

Photo 3. New lock walls back-filled with concrete.

(Courtesy of Birmingham Post & M

Photo 4. 19 RB dredging the pound.

Reconstruction Work On The Strafford On Avon Canal 3,4

Work on Lock 30

As time and labour were short it was only possible to do a limited amount of work on Lock 30. At the upper end of the lock, new quoins and cill liners were grouted in, a new gate was hung and fitted and new paddles, paddle starts and paddle gears were erected. The lock was also dredged.

Final Work on the Site

The only task that remained was the dredging of Lock 31. This was not done earlier because the 19RB was previously involved in dredging the pound, and the lock was in possession of the bricklayers. About five feet of mud, old tins, bottles, bicycle frames, bricks, prams and bedsteads were dredged from the lock, representing about 90 tons in all.

The Move from Camp

On 18 and 19 September the troop was employed in clearing the Canal and camp sites, and returned to Marchwood on 20 September.

Conclusion

The Advance Party went to Lowsonford on 2 September and the Troop returned to Marchwood on 20 September during which time one lock chamber had been almost rebuilt, three lock gates had been erected and fitted, five sets of paddle gear had been renewed, and about 2,000 tons of mud had been dredged and disposed of.

The Troop pulled well together and worked harder than it had probably worked before. As far as possible, the tradesmen were employed at their trades and all members of the Troop had the satisfaction of seeing the fruits of their labours. They left Marchwood as a collection of individuals and returned as an operational Troop.

We left our mark on the Canal in the form of a ceremonial stone, carved by our clerk who happened to be an ex-monumental mason. This stone was let into one of the lock walls and shows that 481 Port Maintenance Troop RE rebuilt the lock in September 1961.

We look forward to being represented at the reopening of the Canal when the reconstruction is completed in about two to three years time. The usual interest has been taken in the job by the Press, TV and population, and a set of pictures illustrating the project appeared in the *Motor Boat and Yachting*.

The Poor Man's Everest

By Lieutenant G. A. Hewish RE

Why the Article?

The Devizes to Westminster Canoe Race has been called the Poor Man's Everest and surely there are good grounds for the comparison. Who, after canoeing 125 miles and portaging a canoe around seventy-seven locks would not feel a sense of achievement in some ways comparable with that of an "Everest Conqueror"?

The Easter 1961 Devizes–Westminster Race has become a part of the vague past but canoeists all over Great Britain are now thinking of, and training for, the 1962 Race. It is this which prompts me to write my reflections of last year's Race, and I would like to think that in the process I may be able to convince a few readers that this, the longest canoe race in the world is a most worth-while event.

Why Devizes to Westminster?

The Race, now organized by the BCU, first took place in 1948 when a Devizes businessman offered £100 to the local Rover Scouts if they could canoe to London in less than 100 hours. The wager was won in a time of 96 hours. A veteran canoeist Frank Luzmore had the idea of making it an annual affair and he was in the winning team in 1949 with a time of 49 hours 32 minutes including a night stop.

The Race was thus established over this route and it is now a major event in the British Canoe Union Calendar. It is the longest and toughest canoe race in the world.

The event is officially recommended only to experienced canoeists but, with due respect to the powers that be, I feel that with a suitably stable canoe and adequate personal buoyancy the event is open to anyone wishing to exercise his spirit of adventure and to test his powers of endurance. Neither my partner, L/Corporal Hughes, nor I had sat a canoe more than half a dozen times before we "went along for the ride", the Race being open to all.

Who Enters?

I have already offered the opinion that the race is open to all, but in fact competitors fall into two basic groups. This is a statement borne out by race timings, since the winning time last year was little over 20½ hours and the slowest time 67 hours. Obviously, there are those canoeists, experienced and determined, who enter to win and the others, like myself, who enter for the experience and for the prolonged thrill of being part of such an event.

A quality, common to all that I met, was a genuine interest in canoeing and canoeists. As a beginner I was overwhelmed by the generous advice and offers of assistance and it seemed that the simple act of sitting in a canoe, regardless of motive or ability, made me "one of the family"—a very pleasant feeling.

Canoes and Canoes

Indeed there are canoes . . . and canoes! 1961 saw 117 crews start in a variety of canoes that defy written description.

They ranged from the sleek "racehorses" of the canoe world to the sturdy "carthorses" such as ours. Some had clips, bottles, watches, charts strapped on and presented a very workmanlike appearance while our large metal "L" plate and grinning mascot made quite a contrast! to say nothing of the fact that the canoe itself was only slightly smaller than a river barge.

Pre-race preparations were no problem to us. My partner and I simply stacked our canoe with the equipment that the race rules demanded and added a considerable amount of food for our own peace of mind—there was plenty of room! We then shook hands to clinch the deal; "We would reach Westminster".

Race rules stated that crews could enter the water at any time nominated by themselves between 0800 hours on the Friday and 1000 hours on Saturday —all canoes to be out of the water by 1000 hours on the Monday. From these simple facts awe inspiring calculations based on weather, wind and tide were made by the ardent canoeists and with an air of "Quod Erat Demonstrandum" these canoeing wonders bid for their start time.

It was a sympathetic starter who agreed to us paddling off at 0805 hours on Friday—a decision based entirely on the fact that it would give us the longest possible time to reach Westminster. Thus with some misgivings we committed ourselves to the task and the waters of the Kennet and Avon canal stretched way ahead. Small consolation could we gain from our "L" plate for it simply stated our true position—however—come what may. . . .

So This is It!

After 300 or 400 yards the whole thing seemed ridiculous—my shoulders ached and I was wreathed in vile smelling weeds slung from the canal by my No 1 and my hands were sore. The remaining 124¾ miles began to look a problem—a big problem.

Fifty-three miles and fifty-five locks along the Kennet and Avon Canal—through Reading's maze of waterways and out into the Majestic Thames. Seventy-two miles and twenty-two locks down the Thames and that was it—the County Hall, Westminster!

My reflections were interrupted by a sudden increased resistance to my paddle strokes, for with every stroke of the paddle we drove deeper into a sea of weeds and experienced our first regrets over the largeness of our canoe. Many were the amusing quips as more slender and business like canoes passed and left us grounding the bottom. These crews sympathized with us but, judging by the smell emitted from the disturbed canal bed, it did not share their emotions.

Even freedom from the shallows was not the end of trouble, because, as inexperienced canoeists without a rudder to assist us, we were proving quite successfully that our vessel was far happier veering from bank to bank rather than following the conventional method of movement—the straight line. Surprisingly 15 miles later at the first lock our initial aches and pains had left us. We experienced a sensation of "not quite pain" in the shoulders and tender hands. These symptons were to accompany us for the rest of our journey.

We had even forgotten our inglorious start and the comments of a certain local when we rammed the bank on a perfectly straight stretch of canal.

As time passed we became engrossed in the art of getting in and out of the canoe and practising the easiest way to carry our burden. The portages were now coming thick and fast and between some of the broken-down locks there was insufficient water to float a laden canoe. This meant running along the towpath with a line attached to bow and stern.

The pattern was set, the blisters on our hands forgotten, aches were accepted and we paddled and portaged, paddled and portaged in seemingly endless succession.

Night brought its fair share of complications and increased our tendency to gouge small holes out of the bank with our now much battered bow. To some the night and the cold brought about at least a temporary eclipse of their efforts. On one portage we passed a pill box with a dejected looking canoe lying outside and from the black interior a heavy aroma of whisky was carried to us on the night air.

Just short of Reading we ourselves came close to losing interest in the journey. Gaining confidence from the fact that on occasions the River Kennet joined forces with the canal and carried us along at about five knots we failed to notice the weed-strewn canal course and cruised around a corner of the river to find ourselves confronted by a low brick arch entrance to a mill, under which the river flowed at a tremendous pace. Frantic back paddling proved ineffective and it was the canoe, to which we had become attached in every sense of the word, that saved the day. Once more with unerring accuracy it drove its bows into the bank to which we clung, thankfully, then slowly made our way upstream to our lost canal.

Cold, wet and not too happy we reached Reading, just in time to be overtaken by a fleet of fast canoes. It was difficult to imagine that these fit-looking canoeists had just travelled the same part of the course that had left us so bedraggled. Each canoe boasted a bow wave that represented the power being applied to the paddles and we must have presented a sorry sight as our bow pointed sluggishly into the River Thames and we barely "raised a ripple".

The 1½-knot current of the River Thames was most welcome after the heavy going of the Kennet and Avon Canal. For most of the night our paddling was of the "sporadic variety", not accepted as an official style and all too slowly we moved towards our objective.

Dawn brought us new life and our numbed senses failed to take in the fact that we had been paddling for 22 hours without a meal. We gladly accepted our new found zest and made progress that had at times seemed impossible—we even overtook the odd team or two—a pleasant change.

Little stands out of that day's journey, we raced to catch the ebb tide at Teddington Lock and arrived at an unbelievable sprint pace at Westminster Bridge. The time was 10.16 pm, and as I tottered from the canoe, I realized that our trip had taken over 38 hours to complete—non stop.

So What

A shower and a good meal in the warm basement of the County Hall restored life to our numbed bodies and we discussed our experiences with some of the many crews that had arrived before us.

It was a happy group of canoeists, but all were very tired and soon many fell asleep thankfully amidst the muffled noise of more crews arriving and the non-stop hiss of the frying pan as more meals were prepared.

The Race was run and although humbled by the ability of the experts we shared with many others the pleasant feeling that we had "made it". We had enjoyed thrills, learnt a lot and it was an excellent introduction to canoeing.

The University of Sussex and the Brighton College of Technology

By MAJOR J. R. JOHNSON, RE, BSc(ENG), AMICE, AMISTRUCTE

IN recent years the inability of our Universities and Technical Colleges to cope with the ever-increasing national demand for technicians has been causing grave concern. To overcome this shortage, many new technical colleges have been planned and charters granted for seven new Universities. As an example of what it is hoped to achieve, the university population alone is to be increased from the present 100,000 students to 170,000 by 1970.

Two institutions which form a part of this higher educational plan are the University of Sussex, at Falmer, and the Brighton College of Technology, both of which are already under construction. Their design and construction is of interest not only from the point of view of being modern examples of college building, but also from the extensive use of pre-cast construction leading to considerable saving in erection time and labour.

THE UNIVERSITY OF SUSSEX

The architect for the University of Sussex is Sir Basil Spence, RA and the Consultant Engineers Ove Arup and Partners. The first phase of the project is the construction of the College House and Physics Laboratory Building, the general contractor for which is James Longley & Co, Ltd, and the structural sub-contractor Modular Concrete Co, Ltd.

An impression of the completed College House is shown in Photograph 1. This illustrates the skilful embodiment of modern architectural and structural design with the indefinable atmosphere of distinction of the older universities.

An interesting point in the design is that both the College House and the Physics Building are essentially open frames of pre-cast beams and column units, supporting pre-cast concrete vault or shell units which form a fireproof ceiling to each cell. Sections are filled in to provide accommodation or left void to serve as terraces, and the whole balanced and yet spacious effect that this gives is well illustrated.

A dominant feature of College House is the two storey Refectory, incorporating a dining gallery. Its rounded arch shell roof and all-glass end walls provide a focal point in the otherwise basically rectangular construction of the building.

Photograph 2 shows the grid construction of pre-cast units in more detail. The design is based on 10, 15, and 20-ft grids, and consists of a series of three-storey vaults. The main pre-cast beams (the largest of which weigh 7½ tons) span 40 ft and carry the pre-cast shell units of each vault. Intermediary beams act as stiffening ribs. All external beam faces have a rough, close-boarded finish.

An aid to rapid construction is the use of only three sizes of load-bearing columns on the contract; in the College House columns are mainly 17½ × 13-in, and in the Physics Building 17½ × 8½-in. The third size of column is 17½-in square. All columns will be finished with facing bricks.

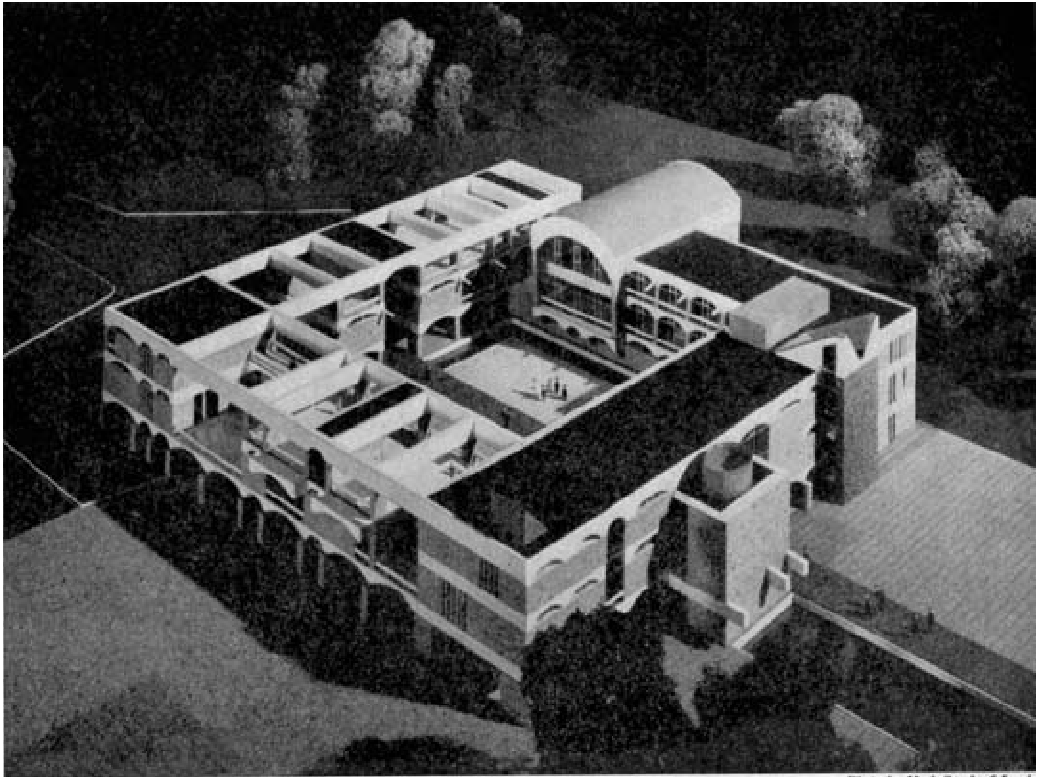


Photo by Henk Snoek of London

Photo 1. The College House, University of Sussex

The University Of Sussex and the Brighton College Of Technology 1

Photo by Donald Trezise of Brighton

Photo 2. Showing the erection of Main Frame and Vault Units in College House

The University Of Sussex and the Brighton College Of Technology 2

About 150 pre-cast units, using 2,700 cu ft of concrete, are being cast each week in the casting yard at Falmer, and it is this extensive use of pre-cast construction which is a primary factor in the scheduled completion of the structural contract after only ten months of work on site.

The pre-cast units are being erected by two Jules Weitz G.140 HV Telescopic tower cranes. These cranes, which have a basic height of just over 42 ft, are capable of rising to over 239 ft by means of telescopic tower sections, having a maximum lifting capacity of 10 tons at a rate of 33 ft per min on a 98 ft 6-in jib. When the crane is at its maximum height it requires 40 tons of ballast at the base of the slewing section.

The cranes have other unique features, in that they incorporate two and four fall block systems operated from the cabin, and also three-speed gear changes, capable of operation whilst there is a load on the hook.

As none of sufficient size was available in this country, the cranes had to be imported specially from France.

Brighton College of Technology

The Brighton College of Technology, when completed, will be the tallest building in Brighton, rising to a height of 161 ft. The College has been designed by P. Billington, ARIBA, AMPTI, Chief Architect to Brighton Corporation, under the supervision of D. J. Horne, MICE, Borough Engineer and Planning Officer, in association with the consulting architect Robert Matthew, Johnson-Marshall and Partners. The Consultant Engineers are Dixon Hurst and Partners, contractors Humphreys Limited, and the suppliers of structural units Pierhead Limited.

The main block consists of a ground floor, mezzanine, seven upper floors and a penthouse. Up to the first floor the construction will be in *in situ* reinforced concrete, but above this is precast except for stair wells and cill beams.

Again this affords an excellent example of the use of pre-cast units as there will be in all nearly 9,000 pre-cast units, including 556 prestressed, pre-tensioned beams, all of which will be cast on site by a team of only ten men.

The new University of Sussex and the Brighton College of Technology will, no doubt, make a valuable contribution to the output of our Universities and Technical Colleges, the expansion of which is becoming a matter of national urgency. Let us hope that those fortunate enough to enter their precincts in the future will find their aesthetic balance and exemplary design a source of inspiration in their efforts.

The Institution of Structural Engineers Joint Meeting with the Institution of Royal Engineers

THIS Joint Meeting was held in the Lecture Room of the Institution of Structural Engineers at 11 Upper Belgrave Street, London, SW1, on Thursday, 9 November 1961, Mr F. R. Bullen, BSc(Eng), MICE, the President of the Institution of Structural Engineers was in the Chair. With him on the platform was the President of the Institution of Royal Engineers, Major-General Sir A. Douglas Campbell, KBE, CB, DSO, MC, MA.

The Chairman extended a warm welcome to Sir Douglas Campbell who was fulfilling one of his last duties as President of the guest Institution, to Major-General T. H. F. Foulkes, OBE, MICE, MA, Engineer in Chief, the War Office, to Major-General D. C. T. Swan, CB, CBE, Sir Douglas Campbell's successor as President of the guest Institution, and to a large number of members of that Institution.

A paper by Brigadier H. A. T. Jarrett-Kerr, OBE, BA, Deputy Director, Military Engineering Experimental Establishment, entitled "The Development of Engineer Equipment for the Army", published in the September 1961 issue of the *RE Journal*, was presented and discussed.

In presenting his paper Brigadier Jarrett-Kerr said that he had tried to outline some of the factors affecting development of Engineer Equipment for the Army that were different from those affecting the normal run of commercial equipment. He did not propose to go into any great detail, but he would stress that the two factors that had the greatest influence were lightness and speed. These were complementary factors which must be satisfied by the best possible use of materials and the greatest ingenuity and mechanization that is compatible with cost and simplicity; they also accentuated the necessity for very thorough testing.

In illustrating these factors in his paper he had briefly mentioned some of the problems of development for a wide range of engineer equipment and plant wider, possibly, than that of direct interest to Members of the Institution of Structural Engineers. He would, however, try to remedy that by showing slides of bridging and structural, rather than mechanical, equipment.

He continued to say that in his paper, he had briefly mentioned the use of materials, and some may have felt there was insufficient emphasis on this, and that greater use should be made of new and exotic materials, such as reinforced or foamed plastics. In this respect, however, a word of warning was necessary. New materials take a long time to understand fully and to learn how to use economically; that is why at MEXE there was a Research Wing whose main responsibility was to find out their limitations, such as the effects of long-term storage and exposure to sunlight, creep properties, loss of strength in contact with water or petroleum products, and so forth. We had in fact developed a pontoon in plastic, reinforced with glass fibre, and its behaviour would be studied over a long period. It had not yet proved possible, however, to get its cost down below that of the light alloy pontoon with which it was being compared. He, therefore, strongly advocated a "feet-on-the-ground" approach to those problems and taking careful steps forward, each step being backed up by thorough research.

There was, nevertheless, a need for ingenuity. But here again there were serious bugbears looming ahead of the designer. Firstly there was the danger of complexity, and he supposed it was true to say that the most ingenious inventions invariably were those that were simple and made you gasp "why didn't I think of that". If they were complex they were inevitably costly both to make and to maintain, and they would give endless cause for trouble. The second bugbear was that the facts of nature, in this sphere at least, were hard and solid facts such as gravity, strength of materials, and the density of the medium which we employ. For example, there was no getting away from the fact he had learned as a boy that "a pint of clear water weighs a pound and a quarter", or in other terms that the displacement of a cubic foot of water would only support in buoyancy a weight of 62.5 lb. It would not support an armoured fighting vehicle.

Nevertheless designers must be imaginative and everyone always hoped for what had come to be known as a "break-through", indeed we should all be constantly on the look out for new ideas that may lead to one. Practical ideas however do not just drop out of the sky. Necessity may be the mother of invention, but her labour was often long and painful.

That thought led him to the difficult subject of the time scale of development, or "lead time" as it is often called. This was a continual source of grumbling in the services as elsewhere. In his paper he had set out all too briefly the process of development. The subject had been covered more fully in an article by Colonel E. W. L. Whitehorn, in the *RE Journal* of December 1952 entitled "The Development of a MEXE Machine". That article was still mainly relevant, despite some changes brought about by the abolition of the Ministry of Supply, and the transfer of MGOs Department to the War Office. But this apparently elaborate process was not the whole reason for the long time taken to introduce an equipment into Service.

He had referred in his paper to the risks that were incurred if short cuts were taken, risks which could result in endless trouble after the equipment came into service, or even in failure to achieve an acceptable equipment. Of course, with a conventional structure such as a hut, or with an equipment which was only a small advance on a previous one, the development time would be comparatively short. But any entirely new principle, or unconventional idea, was likely to take much longer to develop. Furthermore in peace-time it was normally worth while spending a fairly generous time on the early assessment and research stages, in order to make sure of starting off on the right lines. Development could often be bedevilled by some senior officer's bright idea, when the logic of the military requirement had not been properly thought out, whereas a careful appreciation might have shown before starting that the requirement, as stated, would not have been worth the cost. He, therefore, pleaded strongly for more thought, logical thought, and scientific thought—and we all had a part to play there.

After these introductory remarks Brigadier Jarrett-Kerr showed some slides of bridging equipment, including the Heavy Girder Bridge, the Heavy Ferry, the Heavy Floating Bridge, the Light Floating Bridge and the Gillois Amphibious Bridge, and of Bridge Testing Equipments. He pointed out how use had been made of light alloys, how speed of construction had been increased by reducing the number of component parts and the number of operations to be carried out when constructing a service equipment bridge, the use of mechanical aids, the maximum employment of pre-assembly away from the actual bridging site and how, in each case, construction followed a most carefully thought out "work studied" system.

Before opening a general discussion the Chairman thanked Brigadier Jarrett-Kerr for his excellent paper that had been most interesting both to the military and to the civilian engineer.

Mr O. Bondy, MIStructE, AMICE, in putting questions to the author, said that if it were not possible to give more information in reply he would understand.

With regard to the Heavy Girder Bridge, he asked if he were right to assume that the basic principles of the Bailey Bridge had been incorporated, and that the weight of the individual panels was about 1,500 lb, which was nearly three times as much as the original Bailey bridge panels; he believed they weighed 570 lb.

With the old Bailey bridge the members were in 10-ft units. Judging from some of the illustrations, however, they seemed to be much larger now.

He was interested to learn from the paper that the material used for the Heavy Girder Bridge was low-carbon manganese molybdenum and molybdenum boron steel. Was he right to assume that the steels would fall into the QT 28 and QT 35 categories of quenched and tempered steels, which, he gathered, had excellent welding qualities? Welding was, of course, one of the absolute necessities.

Next he asked whether any more tubes were being used in military engineering and whether advantage was taken of their ability to float.

In connexion with the description of the fuel storage tanks (p. 269), the author had pointed to the problem of leaking seams and had mentioned the special equipment which was developed by MEXE to test the seams. Mr Bondy asked if prefabricated steel tanks had been considered. He had heard of them some months ago when a British mission to Russia had described such tanks[1]; the welding had been done on the ground and the steel shell was wound on to the central drum.

The paper gave the impression that there had been a very marked expansion at MEXE. He had been privileged to spend some time there on the Bailey bridges during the war. It was particularly refreshing to learn of the developments since and he imagined that a tremendous amount of work had had to be done to achieve so much.

Lieut-Colonel G. W. Kirkland, MBE, MIStructE, MICE (Immediate Past President), as a member of both Institutions, associated himself with the Chairman's remarks regarding the pleasure he had derived from this occasion. As a member of the guest Institution and an ex-member of the Corps, he felt considerable pride in the quality of the paper.

He recalled taking his first bridging course at Moascar during the war in 1940, and it had been a very great pleasure. He was glad to see that the heavy girder bridge had now become fully fledged with concrete foundations, and he asked if this was a normal form of construction of the bank seats which normally formed part of military bridge requirements.

He had another question regarding the propulsion units for the pontoons

[1] *British Welding Journal, January 1961.*

which had been illustrated and inquired whether it was possible to transfer the propulsion unit from the pontoons to others or whether each of them was essentially an item of the pontoon equipment.

Mr Morris T. Shaw, also a Member of both Institutions, commenting on the reference on page 252 to the problem of "layer" corrosion on heat-treated high strength light alloys, said he used to be of the opinion that an aluminium alloy would not suffer corrosion. He had since then met this form of "rusting" and was glad to see that an answer seemed to have been found in coating by pure sprayed aluminium. He asked the author whether a high strength alloy had yet been developed which was corrosion resistant and did not need to be sprayed with aluminium.

Mr C. B. Stone, DSO, BSc, MIStructE, MICE, asked whether there had been any development in the launching of bridges from the ground, from some distance behind the river banks. There was an occasion during the war—he did not think it was the only one—in which it was extremely difficult to carry out the erection process on the banks, whereas it was possible to do the work some half mile back and then push the bridge forward on rollers.

During the war small diameter launching rollers were used, but he felt that larger diameter rollers would be more effective.

He wondered whether any possible use could be made of hovercraft in military engineering matters. If there were any possible use for them he would expect Sappers to be the very first in the field.

Brigadier H. Ewart Hopthrow, CBE, ERD, said that between the two wars the War Office designed a number of huts for use in war but because of scarcity of materials in 1939 they could not be used. The result was an immediate reversion to the Nissen hut, which became the principal form of personnel accommodation for the whole of the war.

The Romney shed designed in the War Office during the war was a real winner not only in use but as a design economical in materials and manufacture. He gathered from the paper that it is still in use.

He asked whether the difficulties of production in wartime had played any part in the design of the huts referred to in the paper, because one found that in war the users' requirements were nearly always completely submerged by problems of supply and manufacture.

Lieut-Colonel J. C. D. Montgomery, RE, MA, AMICE, quoted a sentence from page 245 of the paper that "there is another military aspect that allows fairly low factors of safety, in the case of bridging; the traffic crossing the bridge can be fairly closely controlled". He queried this, recalling having watched a bridge being heavily overloaded in Germany during the war although the traffic was being "carefully controlled" by American military policemen.

He emphasised that reliability was most essential from the military point of view and that reliability often meant simplicity of design. This requirement was emphasised by the fact that a piece of equipment was very often produced and put into storage for seven or eight years, before it was taken out for use. This led to the next important consideration that it must be properly packed and preserved otherwise it was bound to give trouble.

Lastly he sometimes felt that we strove for the absolute ideal; but it was so much better to have something actual than an ideal in somebody else's mind.

Dr J. G. Whitman, referring to the steels used for the Heavy Girder

Bridge, said that they had a yield point of 30 ton sq-in and were as weldable as the common structural high tensile steel—BS 968. The Cu 28 and Cu 35 steels that had been mentioned were used in the fully heat treated condition and this at present was not a process that could be applied to rolled sections because of the distortion which occurs at quenching. However, they did fall in the same strength bracket.

Layer corrosion did occur in one of the high tensile aluminium alloys used but metal spray with pure aluminium was an effective cure. A new alloy of similar properties was under development which did not suffer from this form of corrosion and it was hoped paint would give sufficient protection. The aluminium alloy used for the deck units of the Heavy Girder Bridge was the BS H30 alloy which was free from practically all forms of corrosive attack and required no protection.

Major J. McDowell, RE, suggested that repairability was an important factor in the design of military equipment. The scale of equipment to be carried for limited operations of war must necessarily be small. There are now fewer facilities in the form of Base Workshops and we must depend more on those workshops which are likely to be in the forward areas. These would not have the resources for complicated repair work. He pleaded for simplicity in design, even occasionally at the expense of lightness, in order to simplify repair.

Mr B. L. Clark, MIStructE, felt that he could not allow the opportunity to pass without throwing a few bouquets. Quite often military engineers had made, indirectly, wonderful contributions to engineering progress, and he wondered if they realized the extent to which many of the things they had been working on were used in the field of civil engineering. Many people had tried to make things which were similar to the Bailey bridge, but had so far failed. Military equipments such as box girder bridges, "V" and "L" trestles, had played their part in assisting the Civil Engineer. He asked whether, when studying problems in military engineering, they had considered making some of the equipment also useful in civil engineering.

He pointed out that at one time, under some conditions, the Bailey bridge did have a weakness in its sway brace system. For instance when long spans were placed on very high trestles and subject to high wind velocities, extra bracing had to be employed in the end bays. He appreciated that this was more the case of using the bridge under conditions for which it was not originally designed.

Bailey bridges had come on to the second-hand market and we did all sorts of things with them. About twelve years ago a large quantity of Bailey bridging was sold, and had since been sold several times, prices having gone up each time it was sold, certainly a true indication of its value to the construction industry.

Mr G. F. Hawker, AMIStructE, AMICE, asked whether the Royal Engineers had developed anything like the mobile high-lift shovels used for loading gravel, spoil and the like.

Stating that his military experience was confined to the Territorial Army, he expressed disappointment at the Army's apparent dislike of compressed-air tools. Every civil contractor relied heavily on such plant and he asked if the possibilities of lighter, versatile, air-operated equipment had been considered before the decision to change over to electric tools mentioned in the paper had been made.

Concerning fuel, he wondered why the Army had not long since changed from petrol to diesel, if only in view of the fire risk.

Finally, he would endorse a previous speaker's remarks concerning the quality of Bailey bridging. He had seen it extensively used for temporary works, and on one Scottish hydro-electric scheme he well remembered one such bridge being dismembered (he would not say "delaunched") by Irish labour wielding sledge hammers. Yet, despite its having been almost literally smashed apart, the components were re-assembled elsewhere faultlessly. He felt certain that no structure designed for civil use would tolerate such abuse.

Mr R. A. Foulkes of MEXE, commenting upon the reference in the paper to the long time scale in the development of military equipment, said that this was not peculiar to military engineering. The period of about eight years was common to vehicles, guns, aeroplanes and practically all the equipment that the Army used. The same thing applied in the American Army—and, doubtless, to all other armies. It was interesting that less than half this period was spent on design and development and rather more than half on production and testing.

Reference was also made to the factors of safety applied to military bridges and the military classification system to which all the bridge designs were subject. It was worth making the point that the average military load was much heavier than the average civil load, and that, therefore, military bridges could be designed with lower factors of safety than civil bridges.

With regard to the traffic closing up on military bridges, the problem was a little better now than formerly because regulations had been laid down by NATO which were accepted by most of the European countries.

Mr Bondy had referred to the failure of the fuel-tank seams, and Mr Foulkes remarked that rubber tanks were used because they were quicker to put up and much lighter to transport than steel tanks. The Army did, in fact, have steel tanks, but they were not popular. The problem of leaking seams had been almost solved now, although when the investigations started no one could foretell that a seam which behaved perfectly well when tested in air or in water would fail disastrously in petrol. This had been an interesting problem to solve.

Mr R. G. Biss, AMIStructE, referring to the aluminium decking for bridges, said it was evidently a plate which itself formed a wearing surface. In view of the fact that there were steep approach portions, he asked whether trouble had been experienced due to lack of adhesion for rubber tyred vehicles.

Mr B. L. Clark, MIStructE, taking up the point made by Mr Foulkes that the average military load was much more than the average civil load, said we had quite a lot of civil vehicles with 50-ton axle loads on two tyres, travelling at speeds up to 40 mph. These were often using Bailey bridges and were quite difficult machines to handle, with regard to the design of bridge deck systems. He asked if the military authorities ever had to consider that sort of axle load on two tyres, which he thought was far worse than on tracked vehicles.

Lieut-Colonel P. J. M. Pellereau, MA, AMIMechE, RE, remarked that the relegation of the Heavy Girder Bridge to the communications zone gave rise to the pleasing thought that something better was coming along. He asked if the author could say anything about what might be used in the future.

Mr G. B. Clarke, MIStructE, said he was much intrigued, when looking at the slides, by the hydraulic control equipment. In his experience of a few years ago, all sorts of troubles could arise, and he wondered whether they had now been overcome.

Another Associate Member, discussing the launching of bridges from behind the banks, recalled having seen during the war a pair of large tracks laid down on which to push a bridge by bulldozer. The tracks, however, often slewed sideways.

Having had the pleasure of building Twynham huts and re-erecting them, he said they looked as good when re-erected as when they were first erected. That was not the case, however, with the Nissen hut.

Mr J. B. Bayley, AMIStructE, commented on the 8-ft length of the bays of the Twynham hut (page 257) as being rather small, and said that perhaps the purpose was to ensure that the load was very small, for the huts might have to be used on soils having very low bearing capacity.

Brigadier Jarrett-Kerr, replying to the discussion, said he was thankful that some of the questions put to him had been answered by other speakers.

He was very glad to see Mr Bondy again, having met him during the war, when he was working on the Bailey Bridge. It was a fact that the principles of the Bailey Bridge had been incorporated in the Heavy Girder Bridge. The cross girders were now fixed at the base of the diagonals, not alongside the verticals. He was correct in saying that the weight of the individual panels was about 1,500 lb. The Heavy Girder Bridge was designed to be built by crane; it could, however, be built by hand, but that was quite a job.

The use of tubes had its good points. One of the difficulties in their use for the lighter forms of construction in which the Army was interested, however, was that they became very thin, and that was why they were not used so much now. Generally speaking, rolled steel sections were undoubtedly better. One of the advantages of using light alloys was that we could extrude sections to any convenient shapes to fit the design and that was a tremendous advantage.

The use of pre-fabricated steel tanks, the welding being done on the ground, seemed an interesting proposition. There had been trouble with the joints of the pre-fabricated tanks used at the moment.

In reply to Lieut-Colonel Kirkland's question concerning foundations, he said there were bank seats for certain bridges, using light alloy in one piece. As to the extravagance of having a separate outboard motor for each pontoon, he said they could not be transferred. They were used because each pontoon must manoeuvre into position, and the position where they entered the water and the site of the bridge, or ferry, which had to be built might be widely separated. He agreed that it was expensive, but that was one of the penalties that had to be paid in order to achieve speed in construction. The complication was there and it had to be faced.

The question by Mr Shaw concerning layer corrosion had been answered by Dr Whitman; the question on spraying had also been answered.

To Mr Stone's question about launching bridges from the ground some distance behind the banks, he replied that they were certainly thinking a lot, and they were very well aware of the difficulties of launching under cover. If you had to be under cover at the last moment you must have armour protection, and the answer was a tank launched bridge.

One of the troubles with hovercraft was that they were very expensive; there was also the fact that they were supported entirely by air of low pressure acting on the ground, so it was necessary to have fairly large machines to do the job. That gave rise to problems in close country, and at the moment he did not think they could be considered for use in such country. He felt sure however that they would come in for ship-to-shore work.

On the remarks of Brigadier Hopthrow, he agreed that the Romney and Marston sheds were still in use. There were production problems in peace as well as in war and MEXE had always to consider the availability of materials.

The question by Lieut-Colonel Montgomery on safety factors had been answered. Brigadier Jarrett-Kerr agreed that traffic over bridges was a problem; but we could not design a bridge for traffic which did not obey the rules.

He also endorsed Lieut-Colonel Montgomery's remark on reliability; Major McDowell had followed on by referring to repairability and simplicity. Whilst fully endorsing the plea for simplicity, because it was important, he pointed out that if we really required speed, as nowadays, simplicity was difficult to achieve. Nevertheless, the equipment must be reliable. He did not go all the way with Major McDowell on the question of repairability. His view was that in respect of equipment designed for forward use we did not want to think too much about repairability, other than a first aid repair. He agreed that it was not easy if materials could not be welded but, as Dr Whitman had pointed out, it was hoped to have in due course a light alloy which could be welded easily.

He was grateful for Mr Clark's remarks about the contribution of military engineers to civil engineering. He was afraid that military design could not always suit civil requirements, such as for high wind loads.

Axle loads had certainly presented a problem in the case of some of the wheeled vehicles that were being introduced into the service, and it had to be met.

In answer to Mr Hawker, he said that wheeled shovels had been introduced into the Army. About compressors, he agreed the paper gave the impression that they were not in favour. But he emphasised that they were still required for large scale projects, and there was no question of withdrawing them from service. On the whole high frequency electric tools were lighter than tools operated by compressed air, for field units.

He was glad Mr Foulkes had stressed the long period required for the development of equipment, and he pointed out, in support of his MEXE colleagues, that not only were there development and trial problems, but also they had to get the money first and then get the equipment into production.

As to the wearing surface of the ramps and aluminium decks of bridge roadways, mentioned by Mr Biss, there had not been much trouble experienced with them. The decks were ribbed to give adhesion.

He had been asked by Lieut-Colonel Pellereau whether anything better was coming into the Army in place of the Heavy Girder Bridge. Obviously they had always in mind more modern bridge equipment.

Coming to Mr Clarke's reference to the troubles arising in the use of hydraulic controls, he said they were very much concerned about it and were trying to instigate research, particularly into the problems of long-term storage. The packaging experts had said that, so long as each item was wrapped up, all would be well. But if equipment were taken to pieces and wrapped, it had to be put together again, which required time. Improvements in materials of seals might be effective.

Replying to Mr Bailey's question concerning the 8-ft bay lengths of the Twynham hut, he thought the reason for it was that they had to cater for fairly high snow and wind loads on that type of structure, probably higher than was normally required for civil use in this country, bearing in mind the use of that hut in many other parts of the world. Also some of the soils might have very low bearing capacity, and they must be able to put the hut down on the ground directly.

Finally he thanked the President and Council of the Institution of Structural Engineers for the honour of presenting the paper to this Joint Meeting.

The President, in turn, thanked Brigadier Jarrett-Kerr for his reply to the discussion.

It was appropriate, he continued, to say how honoured was the Institution of Structural Engineers by the presence of Major-General Sir Douglas Campbell in the Institution's hall, on the occasion of his last official duty as President of the Institution of Royal Engineers. All were grateful to him.

Major General Sir A. Douglas Campbell said he was very grateful for the kind things that had been said about him, and very grateful indeed to the Institution of Structural Engineers for having allowed this Joint Meeting to be held in the Institution's lovely Lecture Room. This was the second Joint Meeting they had had, and he hoped it would not be the last, for such meetings were of real value.

Many of the members of both Institutions had known each other in war conditions. Speaking for all Regular Officers of the Corps he said they had welcomed engineers from civil life then and welcomed them now, for their interest and knowledge was of great importance.

Engineers were really one band of brothers; and although life was becoming so complicated, there being more and more branches of engineering nowadays, the basic family feeling was still there. The evenings they spent together gave the opportunity to remind themselves of that.

His successor as President of the Institution of Royal Engineers, General Swan, had very kindly allowed him to remain in office for this occasion, and would take over the duties of that office on the following morning.

Correspondence

Colonel E. G. Gidley-Kitchin, OBE.
Challis House,
Sampford Peverell,
Near Tiverton, Devon.
28 December 1961.

The Editor,
RE Journal.

MAJOR-GENERAL J. S. LETHBRIDGE, CB, CBE, MC

Dear Sir,

As a footnote to the excellent obituary of Major-General "Tubby" Lethbridge in the December *Journal*, you might be interested to know that he had been offered and accepted the task of being the first organizer of the Community Council of Devon and was to take up his duties on 1 April this year. We were all very much looking forward to working with him knowing that he would lay an excellent foundation. Only at the last moment did he withdraw at his doctor's urgent advice. I think it shows how up to the end he was imbued with the desire to help to his utmost his fellow men and his native County.

Yours faithfully

(Sgd) E. G. Gidley-Kitchin.

Press and Public Relations Limited,
Ferguson House, 15–17 Marylebone Road,
London, NW1
8 December 1961.

The Editor,
Royal Engineers Journal.

ROCK TUNNELLING

Dear Sir,

Major Horne's paper, "Rock Tunnelling", published in the December 1961 *Journal*, was a masterly precis of a complicated subject. I should, however, like to add to his remarks about "mucking-out" methods.

It is, perhaps, of general interest to point out that crawler mounted as well as rail mounted Eimco shovels are available, powered either by compressed air or electricity. The crawler mounted machine offers great flexibility in operation and can be used for all types of tunnel driving and shaft sinking.

It dispenses with the necessity for running slide rails forward into the muck pits. Trackwork is simplified, and it is not necessary to pony skips to and from the mucker. Considerable savings in time, manpower and materials can be achieved, particularly in small tunnels.

The Eimco crawler base may be used to form a drill jumbo, carrying two or more drifters on airlegs. The manoeuvrability of such a jumbo together with its freedom from limitations imposed by track layout solves all problems of moving muck trains past when the jumbo is moved for blasting.

Yours faithfully,

(Sgd) A. Skinner, late Lieut RE.

Lieut-Colonel K. H. Tuson, MIMechE, MIEE.
Mackness and Shipley,
Consulting Engineers,
Parliament Mansions,
Abbey Orchard Street,
London, SW1.
11 January 1962.

The Editor,
RE Journal.

E & M ENGINEERING IN THE CORPS

Dear Sir,

Major McDowell's paper in the December 1961 *Journal* is strongly reminiscent of many discussions that took place in Messes and elsewhere between the Wars.

Interest in E & M Engineering was at a pretty low ebb between the Wars, and I am sorry to learn it has waned further, in spite of War experience. The situation will not change until senior officers of the Army and the Corps are persuaded that E & M officers are necessary and give them a fair cut at the senior appointments. The general attitude may be illustrated by the following:—

(1) As far as I know only two E & M trained officers have reached the rank of Major-General during the last 20 years. I do not admit that E & M trained officers are of lower calibre than their contemporaries, though they may be somewhat independently minded, as a result of dealing with natural laws which take little account of military rank.

(2) In 1944 AG7 could find no suitable employment for a Major who was a Chartered Electrical and a Chartered Mechanical Engineer, and allowed him to retire on an extremely feeble excuse.

(3) In an official report an officer was not recommended for transfer to REME on the ground that "he knew too much about electrical engineering".

As regards Major McDowell's comments on training, I would make these comments:—

(*a*) Too much time should not be spent at the SME on theory. A keen officer, who has been given the basic knowledge when a YO, will learn this for himself in the evenings.

(*b*) The separation of mechanical engineers from electrical engineers is not justified for Service purposes. It is necessary in the civilian world, but even there the separation is taken much too far and produces specialists with too narrow an outlook. All E & M officers should follow the same training equally divided between the two branches.

(*c*) Time in works and on test beds is essential. At one time I believe there was a theory that E & M "planners" need not know much about the "ironmongery".

Yours faithfully,

(Sgd) K. H. Tuson.

Major A. T. Tree, RE.
M.E.X.E.
Barrack Road, Christchurch, Hants.
19 January 1962.

The Editor,
RE Journal.

Dear Sir,

Major McDowell's article on E and M matters in the *RE Journal* of December 1961 is a timely reminder of the scope and importance of Electrical and Mechanical Engineering within the Corps, and must surely stimulate interest.

I feel, however, that a little amplification of his remarks on the proposal to standardize field power supplies at a frequency of 400 cps is necessary in order to provide an undistorted picture.

The chief reasons for the proposal are twofold:—

1. As Major McDowell says, the electronic equipment which is being used more and more in forward areas requires 400 cps power supplies and, in addition, Signals Plan Hobart also demands power supplies at this frequency.

Guided Weapon systems, electronic equipment, and communication equipment account for a large, and growing proportion of the power requirement in the Combat Zone; this power must be provided either by generation at 400 cps, which is the simplest and most economical method in terms of weight and physical size; or by generation at 50 cps with conversion to 400 cps which calls for an additional item of equipment and imposes penalties in terms of weight and physical dimensions.

2. Air-portability, and consequently weight reduction, is of paramount importance in the consideration of any equipment in the Combat Zone.

Conventional 50 cps alternator sets are limited to a maximum speed of rotation of 3,000 rpm, and because of this no further reduction in alternator weight or size is possible. The use of higher speeds of rotation would enable appreciable savings in weight to be made, but a higher frequency must be accepted. It is true that a 400 cps alternator running at 3,000 rpm will be heavier than its 50 counterpart, but the adoption of 400 cps as a standard frequency allows full advantage to be taken of high rotational speeds to achieve a significant reduction in weight of the alternators, and in some cases also prime movers, which in the case of gas turbines and high speed piston engines may in future have to be geared down to 50 cps alternators with a consequent penalty in weight.

The savings in weight which are made possible by a change from 50 cps to 400 cps power supplies, are by no means confined to the alternator. All electromagnetic devices, transformers for example, are reduced in size and weight, theoretically by a factor of 8, but in practice by a factor of about 6 due to constructional considerations, a significant reduction indeed in radio and communications equipment.

A wide range of 400 cps equipment and instruments are available and in normal production for the aircraft industry where the demand for small, light-weight and highly reliable equipment has for years dominated design, and where much of the development work in this field has already taken place.

The development of rectified AC electrical systems in fighting vehicles makes possible a plug-in power supply facility at 400 cps, it could be argued that this could be provided equally well at 50 cps, but the size and weight of the generator and transformer would make the system less attractive.

The proposed change to 400 cps power supplies increases flexibility in the field in that any consuming equipment can draw power from any alternator of suitable output. This would clearly not be possible if the greater part of the consuming equipment required power at 400 cps whilst most of the power supplies were 50 cps.

It must be stressed that the proposed change is limited to equipment in the Combat Zone and this may present organizational and logistic problems. The primary task is after all to get combat equipment to the place where it is wanted, at the time it is wanted and this demands compactness and light weight.

The use of combat equipment on civil supplies can be achieved only with the use of frequency changers, but developments in this field, particularly in the application of solid state devices are proceeding apace, so that already this factor presents no serious problems.

We cannot guarantee that the Combat Zone will be confined to areas where the British or American standard power supplies are available, and the question of the use of Civil Power Supplies must take into account the diversity of voltages and frequences which may be encountered, and the fact that a local power supply may not in any case be compatible with our present military equipment, the design of which is already penalized by the requirement that it shall be suitable for use on both British and American voltages and frequencies. Frequency and/or voltage changers may be necessary in any event, and solid state frequency changers can be designed to take account of a wide range of input voltages and frequencies, and to give an output of 400 cps.

There is, however, no suggestion that all installations at base or on the L of C should convert to 400 cps.

Finally let it be said that the proposed change to 400 cps is by no means put forward as the universal penacea for all ills. The problems consequent upon its implementation are of serious magnitude and are receiving very considerable attention. What is certain is that the proposal has great technical and operational merit, this has been acknowledged by all interested Arms of the Service, and it is deserving of the serious consideration it is now receiving.

At least let us keep up with modern thought, rather than apply a brake in the form of arguments about the aftermath and stalemate phases, which after all will be of little interest if we have lost out on the operational phases.

Yours faithfully,

(Sgd) A. T. Tree

Colonel J. R. Rawlence,
Ordnance Survey, Crabwood House,
Romsey Road, Maybush
Southampton.

The Editor,
Royal Engineers Journal.

25 October 1961.

Dear Sir,

ONE-INCH MAPS OF GREAT BRITAIN

Thank you for your letter of the 19th. You are right in thinking that the origin of military survey in Great Britain is linked with the Jacobites. We have the record of it in the Philosophical Transactions of the Royal Society for 1785 and an extract is quoted in a book I have here now. The account has the charm with which they wrote in those days and I cannot resist giving you some extracts:

". . . a body of infantry was encamped at Fort Augustus in 1747, . . . at which camp my much-respected friend, the late Lieut-General Watson, then Deputy Q.M.G. in N. Britain was officially employed. This officer, being himself an Engineer, active and indefatigable, a zealous promoter of every useful undertaking, and the warm and steady friend of the industrious, first conceived the idea of making a map of the Highlands. . . ."

"Although this work, which is still in manuscript, and in an unfinished state, possessed considerable merit, and perfectly answered the purpose for which it was originally intended; yet having been carried out with instruments of the common, or even inferior kind, and the sum allowed for it being inadequate to the execution of so great a design in the best manner, it is rather to be considered as a magnificent military sketch, than a very accurate map of a country."

(Written by Major-General William Roy, FRS, 1726–90, the distinguished Engineer officer and surveyor.)

The work went on until 1755 and eighty-four rolls of varying sizes are preserved in the King's Library in the British Museum.

But the Ordnance Survey dates from 1791, though conceived earlier.

Yours sincerely, (Sgd) J. R. Rawlence.

Major-General A. G. B. Buchanan, MICE.
4 Montacue Court, Folkestone.

The Editor,
RE Journal.

13 December 1961.

Dear Sir,

DEVELOPMENT OF ENGINEER EQUIPMENT

I was very interested in reading Brigadier Hopthrow's letter in the issue of December 1961, and it led me to look again at the hutting section of Brigadier Jarrett-Kerr's article. I happened to be DFW while the Romney Hut was designed by Lieut-Colonel Brown, manufactured, and tested.

From my own experience I would say that the Romney Hut was one of the oustanding successes of World War II. Both Ordnance and REME liked it, and it was used extensively in the big programme of accommodation ("Bolers") for the million-odd Americans in this country. It was first tried out in the field in the North African campaign, where it was highly commended.

I must confess, therefore, to a measure of surprise that this design has been so lightly scrapped. Not only did it employ only two components—tubular steel ribs and angle iron purlins—but its steel content only amounted to 6.65 lb per sq ft of floor area. I see that spans of 20 ft and 30 ft are now envisaged, whereas the Romney had one of 35 ft, but designs for 16 ft and 24 ft spans on the Romney principle, called Abbey and Tufton huts respectively, were actually prepared, and specimens were erected and tested satisfactorily by the Building Research Station. These two huts never went into production, as the end of the war was in sight, but the designs were put away for possible use in the future, and it would not be difficult to adopt them for the latest spans.

Brigadier Hopthrow's recollection of the Semi-Romney is not quite accurate. It is true that canvas was a difficulty but in fact by 24 July 1944, 139 huts were available in No 5 ESBD in Normandy. 21 Army Group considered them excellent.

Yours faithfully, (Sgd) A. G. B. Buchanan.

Memoirs

COLONEL SIR EDWARD LE BRETON, KT, MVO, DL, JP, GENTLEMAN AT ARMS

EDWARD PHILIP LE BRETON, the eldest son of Lieut-Colonel Edward Henry Le Breton of the Royal Irish Regiment, was born on 21 June 1883. He was educated at Radley and The Royal Military Academy, Woolwich and he was commissioned into the Royal Engineers in July 1901.

After completing his courses at Chatham he joined 7 Field Company at Aldershot in 1903 and after serving two years with that unit he returned to Chatham for an advanced course.

At the conclusion of the course Le Breton sailed for India where he was to have a long and distinguished connexion with the Bengal (1st KGO) Sappers and Miners, mostly with 5 Company in which unit he served almost continuously from 1906 to 1918, first as a Company Officer and from 1911 to 1918 as its Commander. His only temporary absence during that period from the Company was when he joined 9 Company Madras Sappers and Miners for the short but successful operations against the Afridi of the Bazar Valley beyond Peshawar in 1908.

In October 1911 he took 5 Company Bengal Sappers and Miners to Delhi to assist in the preparations for the Coronation Durbar. His unit was, however, diverted to the NW Frontier to form part of a peaceful mission to "show the flag" on the Chinese frontier and during the temporary absence of the Commander of the Mission, Le Breton carried out his duties.

His Company remained at Roorkee from the outbreak of the First World War until being sent to Aden in August 1915 where it soon became involved in active operations against the Turks, the first task allotted to it being to march to Makser and there construct defensive positions which had to be so sited as not to cut up either the golf course or the polo ground! Later, in the year, however, his Company was more seriously engaged and it had to cover the withdrawal of a column which had been operating against Waht, his Indian Sappers being best able to endure the extreme heat. In 1916 Le Breton's Company went with a small force sent to capture Jabir; in the final assault the infantry were checked and it was Le Breton and his Sappers who ultimately carried the place as a result of a successful bayonet charge. He was invalided home in October 1916 but he rejoined his Company in March the following year and he was soon engaged once again in further active operations during which he discovered artesian wells at Sheikh Othman and installed boring equipment.

In February 1918 he finally left 5 Company Bengal Sappers and Miners on promotion to Major as GSO II in the Intelligence Branch, GHQ Mesopotamia which appointment he held until the end of 1918 when, as a temporary Lieut-Colonel, he was appointed CRE 17 (Indian) Division. He returned home to a Works appointment at Gosport towards the end of 1919 and he retired on 17 August 1920.

**Colonel Sir Edward Le Breton Kt MVO DL JP,
Gentleman at Arms**

In that year he married Mary, second daughter of Captain E. H. B. Sawbridge of the 24th Regiment. They had one daughter.

After his retirement Le Breton took a most active part in local affairs, particularly in Dorset. He was High Sheriff 1933–4, he sat on the County Council for many years and from 1933 to 1946 he was Chairman of the County Education Committee. He became also a Deputy Lieutenant, a County Alderman and a Justice of the Peace. He was made an Honorary Colonel in the Territorial Army and he was Colonel of the Dorset Fortress RE from 1936 to 1947 and from 1942 until 1946 he was Commandant, the Dorset Army Cadet Force. In 1941 he was knighted for public services in the County.

He was a Member of the Company of Stationers and he was made a Freeman of the City of London. He also had the great honour of being for over twenty years one of Her Majesty's Body Guard of the Honourable Corps of Gentlemen-at-Arms from 1931 until 1953 when he was awarded the MVO.

He died on 16 December 1961 aged 79 years.

BRIGADIER-GENERAL F. G. FULLER, CB, CMG

Francis George Fuller, who died on 29 October 1961, aged 92 years, was the son of George Fuller, DSc, MICE. He was educated at Beaumont College and the Royal Military Academy, Woolwich and commissioned into the Royal Engineers on 17 February 1888.

After completing his Chatham courses Fuller was posted to India where he served from 1890 to 1895 in Military Works appointments at Meerut, Mhow and Quetta with a short tour of duty in Aden.

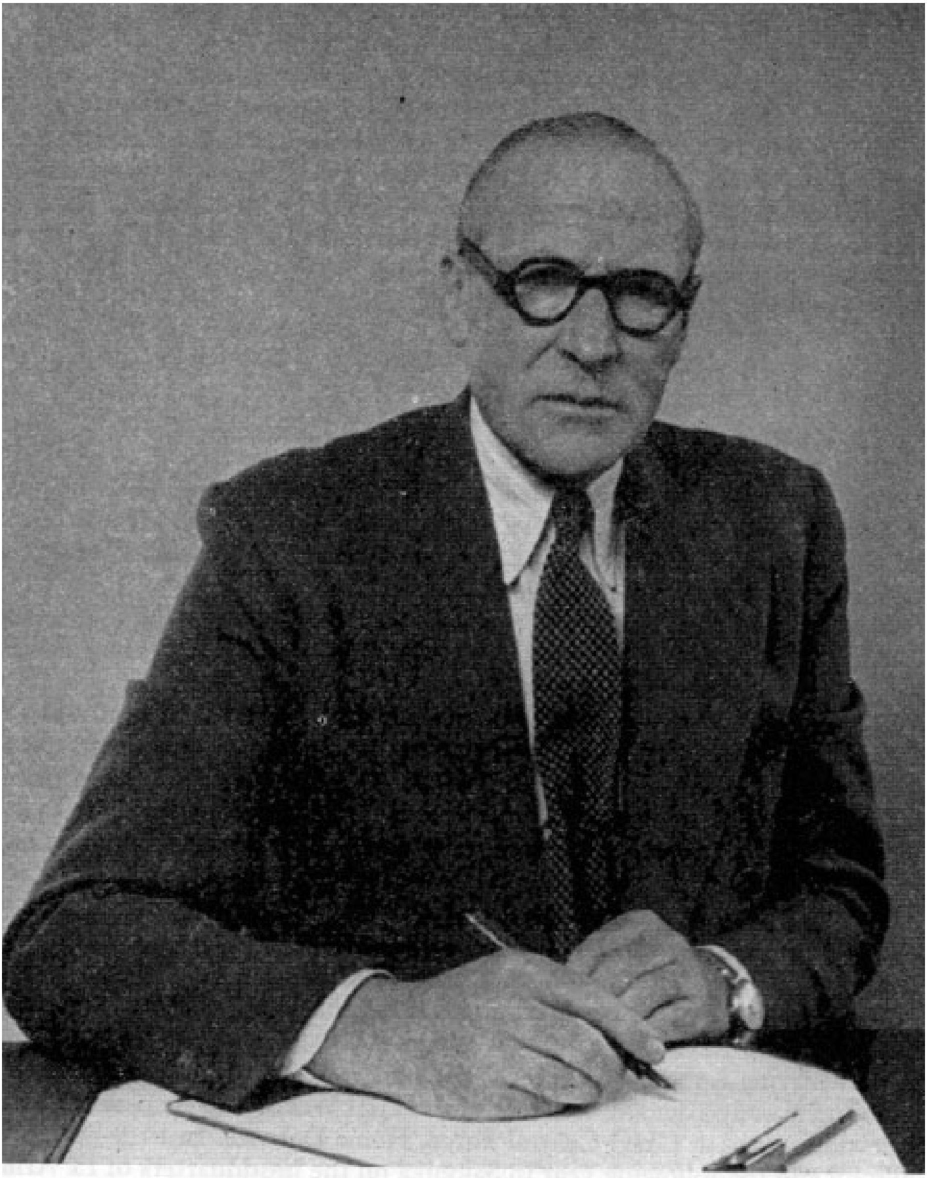
In July 1897 he was posted to 38 Field Company at Aldershot and the following year he was given command of 31 Fortress Company then serving at Chatham. He went with this unit to South Africa which on arrival there was converted into a Railway Company. Throughout the Boer War, Fuller was employed on railway work, on the staff, on railway construction and on the operation of Armoured Trains.

On being posted home in 1902 he spent two years in Ireland on the staff of the Chief Engineer. He passed into the Staff College, Camberley in February 1904, and after graduating from there in 1906 he became the first Commandant of the Railway Training Centre at Longmoor, consisting then of the 8th, 10th, and 53rd Railway Companies, RE.

After leaving Longmoor, Fuller spent some years in various staff appointments and shortly after the outbreak of the First World War he became a first grade staff officer at GHQ Central Force, Home Defence. In 1915 he was in Gallipoli and the following year in Salonika on the headquarters of IX Army and 27 Division respectively. He then became Brigadier General Staff, British Salonika Force and he subsequently held similar appointments in Turkey and in the Army of the Black Sea.

In 1921 he was made Chief Engineer Palestine and the following year he took up his last appointment namely that of Chief Engineer Southern Command. He retired in March 1926.

In 1910 he married Anesta Muriel, eldest daughter of the Most Reverend A. G. Edwards, one time Archbishop of Wales, by whom he had two sons. His wife died in 1934.



Brigadier FG Drew CBE

BRIGADIER F. G. DREW, CBE

FRANCIS GREVILLE DREW was born on 16 September 1892, the son of A. J. Drew, Esq FRCS, of Water Hall, Oxford. He was educated at Lynams, Oxford, Winchester College, and the RMA Woolwich, and he commissioned in the Royal Engineers on 23 December 1911. He completed his courses at the SME Chatham and attended the Army Signal School Aldershot early in 1914 before proceeding to India.

He was attached to the 2nd QVO (Madras) Sappers and Miners at Bangalore for a few months before going to Peshawar as a Garrison Engineer. Shortly after the outbreak of war he was sent to France where, in November 1914, he joined 21 Company Bombay Sappers and Miners which had been heavily engaged in the battle of Neuve Chapelle. He took part in the December operations on the Givenchy front, and he was mentioned in despatches in June 1915. Later he returned to India and in February 1916 he joined the Bengal Sappers and Miners at Roorkee. For a few months he was Corps Quartermaster there until appointed in November 1916 to 2 Company which was engaged in operations against the Mohmands near Peshawar. He took the Company back to Roorkee in February 1917, and in October that year, he went with the Company to join the Mesopotamia Expeditionary Force. In 1918 his Company built an elaborate suspension bridge at Akab across the River Adhaim to replace a pile bridge destroyed by floods.

In 1919, 2 Company took part in operations under 18 Division in South Kurdistan, and Drew was mentioned in despatches and awarded the OBE for his services. He also received a brevet majority.

During the Arab rising in June 1920 at Tel Afar, 40 miles west of Mosul, his Company was actively engaged in restoring law and order. This done, the Company left Mosul and returned to Roorkee in April 1921, still under Drew, who had commanded the unit for over three years without a break. After a long leave spent in England he returned to Roorkee and in April 1922 he became Adjutant of the Bengal Sappers and Miners.

In 1926 he entered the Staff College Quetta, and in 1928, having graduated, he returned to Roorkee as Assistant Superintendent of Instruction, becoming Superintendent of Instruction in 1929.

In January 1930 he was posted to London and soon afterwards became GSO II in the Military Intelligence Branch at the War Office, until he attended the Senior Officers' School at Sheerness in 1934. Later that year he went back to Roorkee to command the Training Battalion, and in April 1936 he became Commandant of the Bengal Sappers and Miners.

In April 1938 he was made GSO I, Western Command at Chester and, from the outbreak of war, he held successively the appointments of Brigadier GS Home Forces, Sub-Area Commander and Brigade Commander, Home Forces. In November 1941 he became GSO I Home Guard, and in September next year GSO I Northern Ireland District. In February 1944 he was appointed Colonel in the Directorate of Civil Affairs at the War Office, and promoted to Deputy Director in November 1945.

From October 1946 to 1951, he was Chief Administrator Eritrea, and for the period April–June 1948 he was Temporary Chief Administrator Somalia. He was awarded the CBE in 1950.

Whilst in India he sailed, played polo and shot. He was also keen on rowing, and latterly on golf and bridge.

In 1923 he married Sannie Frances, daughter of the late Charles Sands of the Indian Police. They had a son and a daughter. He died on 17 January 1962 in his seventieth year.

A brother officer writes this of him:

"Greville Drew was, physically, a large and powerful man but, by nature, he was gentle and courteous, humorous and generous, unfailingly helpful to others.

As Adjutant at Roorkee, when the new young entry of Regular Officers were joining the Sappers and Miners after the First World War, he unobtrusively gave them the full value of his experience, and he was always ready to assist them in difficulty.

It was Greville Drew, who initiated the removal of the outdated Indian Troops' Lines, and the building of modern barrack blocks for the Sappers. It was Greville Drew, who insisted on the provision of seven new hockey grounds, to encourage Indian soldiers to play games off duty, rather than wander idly about the streets.

As Commandant, before the Second World War, he was able to ensure the preparedness of the Bengal Sappers and Miners for the war, which he knew was coming. Drew's devotion to his profession was shown by his work at the Staff College and the Senior Officers' School, and in his various Staff and Command appointments.

But it will be as a Regimental Officer with Indian Troops that his memory will remain alive among so very many officers and men, British and Indian. The qualities he practised were sincerity and integrity, and these are virtues that soldiers appreciate more than transient brilliance.

All their sympathy will go to his wife, whose vivacity, cheerfulness, and hospitality was widespread, and who was a constant aid to him throughout his service."

BRIGADIER H. C. HAWTREY, CMG, DSO

Henry Courtney Hawtry, who died on 16 November 1961 aged 79 years, was born on 29 June 1882, the fifth son of the Reverend H. C. Hawtrey, Rector of Nursling, near Southampton.

He was educated at Uppingham and the Shop, being commissioned into the Royal Engineers on 18 August 1900. After his SME training he was posted to the 3rd Division Telegraph Battalion RE at Aldershot, a posting that had much to do with shaping his future career in the Army although his stay with the unit was only a short one.

His next posting took him to a Works appointment in Sierra Leone where he spent two years as a Divisional Officer.

In 1906 he joined 5 Field Company RE at the Curragh and moved with the unit later to Aldershot. At that time Hawtrey was an outstanding athlete, his greatest achievement being winning for Great Britain the 5 mile race in the 1906 Athenian Celebrations of the Olympic Games. He also equalled the native mile record of his day and won the London Athletes Club 10-mile championship.

In 1907, Hawtrey was posted to the 2nd Cable Telegraph Company RE at Limerick and two years later he became, with the rank of temporary Captain, Adjutant of the London District Telegraph Company RE.

He was posted to India in 1913 and shortly after the outbreak of the First World War, Captain Hawtrey became Assistant Director of Signals to the Indian Expeditionary Force sent to East Africa. He raised a local Signal Section for the raid on Bukoba and later the Z Division Signal Company of Sappers and Miners which did excellent work in the East African operations until the company was disbanded in 1917. Hawtrey himself was awarded the DSO and in 1917 he was made a Brevet Lieut-Colonel. In 1918, as Deputy Director of Signals, he was awarded the CMG.

After the Armistice, Hawtrey returned to India where he became Chief Signal Officer during the Third Afghan War of 1919. For distinguished services he was mentioned in despatches. In July 1920 he passed into the Staff College, Quetta and in December of that year he transferred to the newly-formed Royal Corps of Signals, in which Corps he subsequently served with great distinction. In 1925 he became Commandant of the Signal Training Centre in India and from 1926 to 1930 he was Signal Officer-in-Chief at Army Headquarters India. For the next four years, until his retirement in February 1934, he was Chief Signal Officer, Aldershot Command. He was ADC to King George V from 1931 to 1934.

In 1939, on the outbreak of the Second World War, he was re-employed until 1942 as Commander Tidworth Garrison and Marlborough District.

In 1907 he married Emily Mildred, eldest daughter of F. C. Gough, Esq, by whom he had two daughters. His wife died in 1960.

LIEUT-COLONEL H. G. BROWNLOW

Henry Guy Brownlow, who died suddenly at Hou Cottage, Alderton, Suffolk last September, was commissioned into the Corps in August 1924. Before the war he was Garrison Engineer in charge of the construction of the first 9.2-in battery built on Pulan Tekong. He became fluent in the Malay language and he was immensely popular with the Malays who looked upon him as the uncrowned King of Tekong Island.

During the war he was well known to a large number of Sapper officers as the compiler of the "Technical Instructions" issued first by Headquarters Home Forces and later by Headquarters 21 Army Group.

After the war, before his retirement in September 1950, he served in Egypt where he introduced a number of young soldiers to the delights and pleasures of bird watching. He was himself a great ornithologist and he took endless pains to instruct others in the fascinating mysteries of the study of bird life.

On his retirement he became a dynamic bird-conversationist. He was a member of the Royal Society for the Protection of Birds, and he was awarded the RSPB Silver Medal for his work on the bird reserves on Havergate Island during the floods of 1953. He was also a member of the British Ornithologists' Union, the Wild Fowl Trust, the British Trust for Ornithology and the Norfolk Naturalist Trust. In spite of indifferent health he was always active. He was seldom at his little Suffolk cottage. A friend paid him this tribute: "No grass ever grew under his restless feet and no unkind words came from a heart which was as warm and frank as his handshake. He will always be remembered by those who were lucky enough to be numbered amongst his friends."

Book Reviews

BRITAIN'S NEW TOWNS

By Major-General A. G. Duff, cb, obe, mc

(The Pall Mall Press Ltd. Price 10*s* 6*d*)

Up to 31 March 1961, the Treasury had made capital advances to the Development Corporations of the eleven new towns in England and Wales of over £220 million sterling. The project is therefore one of considerable material interest to the taxpayer: but, also, it is perhaps the most interesting and exciting social experiment to be launched in this country since the war.

The writer of this book, Major-General Alan Duff, was the General Manager of the Stevenage Development Corporation from its inception in 1947 until 1957. He writes therefore with authority and with a real knowledge of the problems which he, and his Corporation, had to tackle.

In the short space of a hundred pages, he has succeeded in describing the origin and purpose of the project; the task of planning a new community and the practical difficulties of carrying out the planned development so as to keep housing, industry, trade and amenities in balance at all times; the complications caused by having to deal with a Treasury, inclined to blow hot or cold according to variations in the financial temperature, and to reconcile the sometimes conflicting interests of the Development Corporation and the local authorities.

He has also given a most thoughtful account of the human problems involved in transplanting a young population accustomed to the bright lights and street corners of London and assimilating them into a new semi-rural community.

This book was published almost a year ago. It is however, timely now to draw attention to it, for the new towns are about to enter upon the second phase of their existence. On 1 October 1961, there was set up, by Order of Parliament, a Commission for the New Towns, which is to take over the assets and property, and the liabilities, of each Development Corporation as its town reaches its initial population target. On 31 March 1962, the Commission is due to take over from the Development Corporations of Hemel Hempstead and Crawley. This change will present many new problems; one of the most interesting and testing of which will be to maintain the excellent landlord and tenant relationship established by the Development Corporations.

This book is a most interesting and readable introduction to a fascinating subject, and it will make the reader wish to see for himself. Crawley—where your reviewer has been privileged to be Chairman of the Development Corporation for the last two years and which he ventures to think is not the least attractive of the new towns—lies close to the route between Chatham and Aldershot! The staff of the Development Corporation there have had over 3,000 visitors from fifty-seven different countries during the last year and are always ready to conduct a party of visitors round. Sappers will be specially welcome! N.C.D.B.

THE WAR AT SEA

Volume III—The Offensive—Part II

By Captain S. W. Roskill, DSC, RN

(Published by Her Majesty's Stationery Office, 1961. Price 45*s*)

During the recent revival of an old controversy, the writer of a letter to a London newspaper remarked on the good fortune of the Royal Navy in having Captain Roskill as its chief historian and of thereby being certain that the British official account of the maritime war would be accurate as to its facts and just in its conclusions. In these and indeed all other respects, Volume III, Part II of the *War at Sea* fully maintains the high standard of the three previous volumes and the author must be conscious that his now completed work will rank as one of the best histories of naval warfare that has ever been written.

Many books have already described the landings in Normandy yet perhaps no account, which is so clear and readable, has ever been brought into so small a compass. The reader will note that over 132,000 allied soldiers landed from the sea in the first 17 hours, which made the invasion by far the greatest ever made on a hostile shore. Another item worth remark is that the leading echelons were timed to leave their landing craft three to four hours before high water, at forty minutes after "nautical twilight" (begins when the rising sun is 12 degrees below the horizon). These timings gave the special teams of the Royal Navy and the Royal Engineers their best chance of clearing beach obstacles from the shallows.

As regards the vexed question of the landing in the south of France, Captain Roskill considers that, on the short term view, the enterprise was strategically profitable, in that the great port of Marseilles quickly became available for the use of the Allies and the newly formed French divisions became able, without vexatious delay, to play their part in the liberation of France. On the long term, however, he shared Mr Churchill's historical view, that the keys to the control of Central Europe were the estuary of the Scheldt in the north and the valley of the Danube on the south. As it fell out, the eighty-five days delay in getting the first convoy up the Scheldt wasted much of the advantage conferred by the lightening capture of Antwerp and the Riviera landing deprived the Army of Italy of formations, which might have made possible the invasion of the Danube valley.

Touching Antwerp, the lamented Admiral Ramsay vigorously disputed the contention of Field-Marshal Montgomery that "We could take the Ruhr without Antwerp". Yet with that great historian Chester Wilmot, alas now also dead, we do just that and advance convincingly on a shortened front to end the war in 1944. Captain Roskill quite properly sticks to his maritime warfare and hazards no comment on that thorny question.

The new volume goes on to describe in detail how the Navy gradually gained mastery of the sea lanes all the way from the Arctic, through home waters and the Atlantic, in the Mediterranean and right round Africa to the eastern limits of the Indian Ocean. By 1945 the U-boats, in small groups and sometimes singly, had perforce nearly all returned to German bases. From these, they did what they could to blockade the British Isles and the north coast of Europe, besides operating against the last of the Arctic convoys. Yet during this end phase, the normal south-west approach to Britain along the Channel was successfully re-opened and the remaining Arctic convoys got to Russia without losing a ship. Even the new Schnorkel type U-boats availed little, for the Germans hardly had time to discover how best to use them.

On 12 November 1944, Lancasters of Bomber Command left the Tirpitz with her superstructure resting on the bottom of Tromso fiord at an angle of 140 degrees to the vertical and thus destroyed the last of the German capital ships. The Admiralty could now send sufficient units to Ceylon to gain at long last command of the sea in the Far East and could also form a sizeable balanced fleet for fighting alongside the Americans in the Pacific. Thus by the spring of 1945 the East Indies fleet was assisting in the recapture of Rangoon and the British Pacific Fleet was taking part in the operations for the seizure of Okinawa and the final defeat of Japan.

Captain Roskill dovetails into his history a clear account of the masterly handling by the USA of the closing stages of the War in the Pacific. Their great Third and Fifth Fleets, especially the carrier elements thereof, in turn reduced the Japanese counterparts to impotence, whilst US submarines, aircraft and mines took such toll of Japanese shipping, that Japan eventually lacked the wherewithal to continue the struggle. The latter aspect of the conflict is a stark reminder that, if it had not been for the unceasing exertions of the Navy, the fate of Britain might have been precisely the same as that which overtook Japan. Moreover, the same threat to Britain's crowded existence would again loom up in any major war of the future. Despite this, discussions about Britain's complicated defence problems constantly fail to give priority to measures for safeguarding British shipping on the world's trade routes. Yet the task daily grows bigger and may be Britain, by herself, will be unable to repeat the triumphs of 1914–18 and 1939–45. The more reason for continuing the war-time alliance with the USA, whose massive power at sea is well revealed in the later chapters of this admirable book. B.T.W.

1962 YEARBOOK OF ASTRONOMY

Edited by DR J. G. PORTER

(Published by Eyre & Spottiswoode. Price 15*s*)

This Yearbook has been designed for the amateur interested in astronomy who has had difficulty in finding out what to look for and when.

It is divided into two parts. The first gives information about the planets month by month as well as eclipses, occultations, comets and meteor showers. It has twelve well drawn and clear star charts showing stars down to the fourth magnitude on which the positions of the planets can be plotted through the year.

The second has thirteen articles of topical interest, such as "Recent Rocket Research", "The Structure of the Galaxy", etc. It contains lists of Astronomical Societies, of recommended books and of a number of interesting telescopic objects.

The combination of these two parts in one volume has produced a book which should be of great value to all interested in astronomy. No other publication covers quite the same range. The book is excellently produced and the cost is very reasonable. We hope that this first Yearbook is but the first of a long line of succeeding annual numbers. K.M.P.

ASTRONOMICAL SPECTROSCOPY

By DR A. D. THACKERAY

(Published by Eyre and Spottiswoode. Price 18*s*)

This is the second volume of a new series edited by Colin A. Ronan and called "A Survey of Astronomy". The series of six volumes is designed to bridge the gap between elementary books on astronomy and the rather severe technical literature. Some elementary knowledge is assumed but mathematical formulae are sparingly used and are generally relegated to appendices or footnotes. Each volume is written by an expert in his specific field and is complete in itself.

Although Newton had investigated the nature of colour it was only in 1802 that Woollaston—closely followed by Fraunhofer—discovered the dark lines crossing the Sun's spectrum; later, similar lines were found in the spectra of bright stars. The significance of these lines was not appreciated until 1859 when Kirchoff identified sodium in the Sun and announced the three laws named after him.

Since then, in just over 100 years, astronomical progress has been amazing. Undoubtedly large telescopes and photography have helped in this, but, without the spectroscope, it is doubtful if any real progress would have been possible.

This book tells of the results of that 100 years and of the many successes the spectroscope has had in attacking otherwise insoluble problems. Three of the results described are perhaps outstanding.

Some stellar spectra show lines due to hydrogen only, others show lines due to other elements and yet others lines due to compounds such as titanium oxide. It was originally thought that there was a real difference in stellar composition but it is now considered that all stars have the same general composition, the main criterion for spectral difference being the effective temperature of the star's surface which may range from some 3,000° to 36,000°K. Spectral type depends on the surface temperature and there is not only a close relation between the spectral type, or temperature, and the intrinsic luminosity of a normal star but also between its mass and luminosity. To one side lie the dwarf stars of enormous density, and to the other the giants and supergiants with density less than that of air. The examination of a stellar spectrum will often allow the star's temperature, mass and intrinsic brightness to be estimated and its distance and diameter deduced. Naturally these figures are not exact but they have considerable statistical value.

The spectra of some double stars show a periodic doubling of the lines when one star in its orbit is moving towards, and the other away from, the earth. But some lines do not partake in this movement and are caused by clouds of gas lying in between the stars. Although their density is only about 1 hydrogen atom per cm^3, with a minute quantity of dust, the volume of interstellar space is so large that near the Sun their mass may equal that of the nearby stars.

All galaxies appear to be receding from the earth at speeds proportional to their distances. Recently, the 200-in telescope has located a galaxy with a recessional speed of 140,000 km per sec, nearly half the speed of light. The precise relation between velocity and distance is not known but the relative distances of the galaxies can be obtained with surprising accuracy from their measured recessions and a scale model be made of the Universe.

In a small compass and in a clear and lucid manner this book tells of the spectroscope's part in the progress of the last 100 years. It is not, however, a book to be dozed over on a Sunday afternoon. The argument is too closely knit and calls for all one's faculties to follow it. Nevertheless, the book is most successful in its object of providing a bridge between the elementary and the technical. It can be recommended for anyone who wishes to go deeper into spectroscopy than the average astronomical textbook; it has the further great advantage of being really up to date. The book is well printed and has fifty-five line drawings in a text of some 250 pages. Its price of 18*s* is most reasonable.

K.M.P.

STRUCTURE OF THE MOON'S SURFACE

By GILBERT FIELDER, FRAS

(Published by Pergamon Press. Price 50*s*)

Man has circled the Earth at 12,000 miles an hour; he has hit the Moon with a rocket and photographed its averted face, never before seen by man. It is inevitable that he should now set his sights on its conquest, but a round trip to the Moon—the journey is not worth making without a return half to the ticket—is probably further off in time than popular science would have us believe. But whether the journey is made this year, next year or some time, it is important that we should know as much as possible about the Moon's surface and the conditions there for man's very existence.

On the face of it the conditions are hostile. For fourteen of our days the Sun beats down on the Moon's surface unprotected by any atmosphere from γ-, X- and cosmic rays. The surface temperature rises rapidly to about +100°C and falls quickly as soon as the Sun sets to −100°C or lower. Radio observations show that just below the surface layer the temperature range is from some −50°C to −100°C. Light reflected from the Moon is only partially polarized; this fact, combined with the rapid changes in temperature noted above, shows that the surface layer is a poor conductor, is very thin and is probably a coarse powder. Only 7 per cent of the light falling on the Moon is reflected so it would seem that the surface might vary from something like brownish sand or granite in the bright areas to lava or basalt in the dark areas.

The surface is made up of dark areas (the so-called seas) and light areas which are mountain ranges, craters or bright rays. But, in addition, there are rilles or cracks in the surface, geological faults and low ridges similar to tide marks. A lattice pattern of ridges and valleys over the general surface can be detected.

All these things, and much more besides, are described in this somewhat encyclopaedic book which brings together observational data from the vast lunar literature. The author has generally confined himself to collating but not to giving his views upon the text. At the end of each chapter there are references to the relevant papers, extracts from many of which are given in the text.

The book is packed with information which is sometimes inadequately explained. For instance, it is stated that optical libration in latitude is due to the inclination of the moon's orbit and axis to the ecliptic. It is caused by the moon's equator not lying in the plane of its orbit and has nothing to do with the ecliptic. The magnitude—and therefore the importance—of the librations is not given. The parallactic and physical librations do not seem to be more than 1 and 4 minutes respectively whereas the optical librations are each about 7 degrees. Again, Fig 3–1–1 is a contour map of the moon's surface but the contour interval is not stated nor is there any explanation of the spot numbers, such as -56 ± 47. Further, to the left of and below the centre of the map the contours $+1000$, $+2000$ and $+3000$ coincide. The surface there should be a nearly vertical cliff which should be very prominent but none such is visible. The spatial distribution of craters is very important as it may help to decide between the meteoric or volcanic origin of craters. It is rather inadequately discussed in Chapter 13.

In spite of such faults the book should be most useful to the professional and amateur lunar specialist. Its value to the general reader is more doubtful. There is no general description of the moon's surface at the beginning on which the reader can hang the rest of the book, nor can he easily obtain the original papers where the text is too condensed or the explanation inadequate. K.M.P.

CORROSION SCIENCE

An International Journal of the Science of Corrosion and Protection of Metals

Volume 1, Number 1, August 1961

(Published by Pergamon Press Ltd in Great Britain. Price £7)

This is a new publication which contains papers on original research or critical reviews not previously published.

The issue reviewed contained five papers—two on stress corrosion cracks, one on anoidic characteristics of mild steel, one on attack by molten salts and metals and one on some effects of electrolyte motion during corrosion.

The journal appears to be aimed at the research engineer and the papers are reports of laboratory type experiments. However, with more and more equipment being made of metals and alloys, corrosion cracking and electrolytic action have to be guarded against and remedied, hence a publication of this type will keep the maintenance engineer abreast of modern thought and development on the subject. W.C.

AN INTRODUCTION TO DEEP FOUNDATIONS AND SHEET-PILING

By Donoran H. Lee, MICE, FASCE, MIMechE

(Published by Concrete Publications Ltd, 14 Dartmouth Street, London, SW1. Price 20s)

This is a revised and enlarged edition of the book which was first published in 1945. The chapter on bearing piles mentions bored piles, but I feel more material could be given here. In dealing with prestressed post tensioned piles the author consideres losses of 15 per cent but I think that it is generally agreed that 25 per cent is a more realistic figure.

The chapters on cofferdams deal in turn with the different types of cofferdam, their design, and different methods of dewatering. Four chapters are devoted to caissons and the problems connected with their use, including working in compressed air.

This makes a useful reference book for the engineer, if for no other reason, for its extensive bibliography. W.C.

REINFORCED CONCRETE DESIGNERS' HANDBOOK

(Sixth Edition)

By Chas. E. Reynolds, BSc(Eng), AMInstCE

(Published by Concrete Publication Ltd, 14 Dartmouth Street, SW1. Price 20*s*)

This well known book has been completely reprinted so that it does not suffer from the fault of most additions where parts are amended but the book is substantially the same as the editions that have gone before.

In this edition the tables and data are mainly based on CP 114/57 and CP 2007/60 and at the same time the symbol notation has been altered to conform to British Standards. This is obviously a step in the right direction and facilitates references to Codes of Practice without any ambiguity arising.

The layout of the book is slightly different from the previous edition. It is divided, as before, into two parts. Part I is shorter and more concise, the mathematics and notes relating to the tables being included at the appropriate place in Part II. The number of tables in Part II has been increased dealing more fully with bending-moment diagrams, panels spanning in two directions, moment distribution applied to continuous beams, and load factor methods of design.

My only criticism of this excellent book is that it does not deal with the calculation of the bending moments by ultimate methods for load factor design.

The *Reinforced Concrete Designers' Handbook* has been an essential part of any concrete designers library for many years and this new edition is well worth having.

W.C.

MOMENT DISTRIBUTION

By E. Lightfoot, MSc(Eng), PhDMIStructE, AMICE

(Published by E. & F. N. Spon Ltd. Price 67*s* 6*d*)

A student engineer is usually introduced to moment distribution as one of many methods of structural analysis. His introduction is necessarily simple and seldom developed to a full realization of the versatility of the method for the design of rigid-jointed structures. This lack of appreciation of the scope of moment distribution methods is all too often continued throughout an engineer's career. This book is the first comprehensive treatment of moment distribution to appear for many years, and should prove of immense value to the design engineer, both as a reference and guide to the analysis of many types of structures.

The author first considers the basic theory of moment distribution, and then goes on to consider its use and extension when applied to particular structural problems. Some typical subjects considered are haunched members (for which some excellent tables of stiffness coefficients, fixed end moments, etc, are produced), elastic foundations, elastic instability, arches, and cylindrical shells with domical roofs. Methods of solution of particular types of problems are given; in many cases these involve original methods evolved by the author. Where solution is best carried out by means of an electronic computer, using generalized slope deflection equations, the author is quick to point out the limitations and difficulties of analysis by moment distribution.

Although the actual behaviour of a structure, and hence the research analysis to explain it, may be complicated, the design method eventually devised must be kept as simple as possible. In such design, moment distribution will always serve a useful purpose, and in consequence, the practising engineer would be well advised to obtain this book.

J.R.J.

COMPUTER ANALYSES OF CYLINDRICAL SHELLS

By J. E. Gibson MSc(Maths), PhD, AMICE

(Spon's Civil Engineering Series. Price 84c)

In the *RE Journal* for June 1961 *The Design of Cylindrical Shell Roofs* by Dr Gibson was reviewed.

This present book carries on where the previous one left off. Using the University of Manchester "Mercury" Computer, design data for 286 shell roofs have been computed.

An engineer faced with the design of a shell roof can, by use of these excellent tables, obtain a workable design very easily.

Most varieties of shells are covered, single shells with edge beams, multi-shells with edge beams, multi-shells with prestressed edge beams, and a useful appendix giving multiplying factors for increased snow load is included.

Undoubtedly this is a highly specialized book but an engineer engaged in shell roof design cannot afford to be without it. W.C.

DESIGN AND CONSTRUCTION OF FOUNDATIONS

By G. P. Monning

(Concrete Publications Ltd. Price 24*s*)

It is difficult to write on foundations without either discussing in some detail the theory of soil mechanics and its ancilliary subjects, or else assuming the reader is *au fait* with these problems. In this book, the author dismisses soil mechanics, site investigation, load testing, and settlement in four short chapters, and in consequence fails to cover any of them adequately.

Most of this book, however, is concerned with the actual design and construction of foundations, and covers this extremely well. Eight chapters are devoted to practically every kind of foundation used, and some useful practical hints and worked examples are included. The chapters on RC and raft foundations are particularly good but those on driven-pile foundations, caissons, and submerged-site foundations, are somewhat less comprehensive.

Other chapters deal with structural loading, constructional operations and materials, and some design graphs and tables are included as an Appendix. Such information, although relevant, is better covered in certain other design manuals.

Despite the minor limitations mentioned, however, the book is well worth inclusion in any engineer's personal library as a guide and reference to the design of foundations, and is a useful addition to the well-known "Concrete Series". J.R.J.

SIX-FIGURE LOGARITHMS, ANTILOGARITHMS AND LOGARITHMIC TRIGONOMETRICAL FUNCTIONS

Fourth Revised Edition

By D. Attwood

(Published by Pergamon Press. Price 7*s* 6*d*)

This book has been prepared by Mr C. Attwood, the Principal of Apprentice Training of the Ford Motor Company Ltd, to meet the requirements of designers and other workers who need reliable tables for the solution of practical problems. It is a companion to *Six-figure Trigonometrical Tables and Formulea,* which volume, also published by Pergamon Press, gives natural values of the six trigonometrical functions.

The accuracy of the tables is stressed.

In addition to the normal logarithms, antilogarithms and logarithmic functions, it includes tables giving proportional parts in twelfths (5 seconds) and tenths (tenth of a minute). A page of the more usual mathematical constants is included giving number and logarithm values. Notes explain how hyperbolic logarithms may be obtained from logarithms to the base of 10, the use of linear interpolation to get functions of angles expressed in seconds or decimals of a minute, inverse linear interpolation and the use of Bessel's formula. A good bibliography is included.

The edition comprises 139 pages, well printed on good quality paper in a semi-stiff cardboard cover, is a handy pocket-size, and is well suited for field use. F.T.S.

Technical Notes

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review* for June 1961

"ENGINEERING DEVELOPMENTS IN THE USSR": These notes describe the use of wire mesh formwork in civil engineering construction. The mesh used varies from 0.04 ×0.04 to 0.6-to 0.6-in, the size most used being $\frac{1}{8}$ to $\frac{3}{16}$-in, and is mounted on a steel or timber framework supporting the mesh at about 12-in centres in both directions. The wire mesh formwork is used chiefly for making expansion and contraction joints, construction joints and for the reverse side of retaining walls and similar structures. Its weight is only 12½ to 20 per cent of that of conventional timber formwork and erection times are faster. The Russians claim that on their pricing the cost is reduced by 66 per cent. They also claim that the loss of cement paste through the mesh is acceptable and does not result in a weaker concrete near the contact surface since it is compensated by a reduction in the cement-water ratio due to filtration of water through the mesh. Joints made with mesh formwork have a strength 80–85 per cent of those made with conventional formwork which have had their contact surfaces subsequently hacked. However, if the mesh formwork is left in place, the strength of the joint is increased by 15 to 20 per cent.

"LETTER TO THE EDITOR, 'LIQUID-CONTAINING STRUCTURES', BY MAJOR W. COOK, RE": The writer of this letter is the Senior Instructor in the Design Wing of the Civil Engineering School, SME. He takes issue with J. D. Davies Esq, the author of an article in *Civil Engineering and Public Works Review* on design curves for singly reinforced slabs in liquid-containing structures, over his design convention, and suggests that the normal RC convention of basing design graphs for the values of Q (the moment of resistance factor) and r (steel ratio) on d_1, the depth of the centroid of the reinforcement, should be followed in the design of RC liquid-retaining structures. Major Cook develops this suggestion by calculations showing how a design graph for Q and r based on d_1 may be obtained, and concludes with a small example.

Notes from *Civil Engineering and Public Works Review* for September 1961

"A NEW METHOD OF STUDYING SEEPAGE THROUGH POROUS MEDIA", by Dr. Gabriel Matta. Basing his work on the relaxation method and depending on the similarity between the flow from the capillary tubes and the flow from porous media, the Author presents an experimental and automatic relaxation representing the porous media by a network of capillary tubes interconnected. This network is used to solve any two dimensional problem of seepage through porous media. He shows that this method combines all the advantages of the sand models, those of the electrical analogy and those of the relaxation. General solutions are obtainable even in the case of complex boundary conditions; the seepage line is given without any trial; the potential at any point is given by simple reading; and the capillary effect is fixed at will by the choice of liquid to be used. The Author considers that this method can replace, with advantage, the relaxation method whenever the latter is usable: homogeneous and isotropic, or heterogeneous and anistropic porous media. It can be used more generally to solve problems of irrotational flows or for flows having a very small Reynolds number. The problems of varying flow, for which the existing methods are very long, are solved rapidly and with sufficient accuracy by means of the capillary tubes.

"BENDING STRESSES IN THICK CURVED BEAMS", by A. Ormerod, Bsc, DIC, AMIMechE, Royal Military College of Science Shrivenham. The Author re-states the theory of the bending stresses in thick curved beams in a simple form which resembles closely the standard equation used for straight beams. In the new form the theory can be applied readily to thick curved beams bent in non-principal planes and to beams of composite construction. The Author includes a numerical example to illustrate his theory.

Notes from *Civil Engineering and Public Works Review* for October 1961.

"Note on Inhibiting Wave Impact": The note describes very briefly a system developed by an American Oil Company to provide protection for off-shore installations by breaking the impact of approaching waves. The device consists of bundles of vertical pipes closed at the upper end and separated between pontoons. The upper ends of the pipes are fitted with escape valves. Apart from these, there are no working parts, unlike the "Bubble Breakwater". The action of the pipes in holding the water until the trough of the wave has passed, breaks the rhythm of the waves.

"Note on Water Treatment and Clarification System": The note describes a new separator (called the Daynor) designed to remove suspended matter from liquids and produce a sediment-free water from sources containing high percentages of particles in suspension. The design of the separator is based on the hydro-cyclone principle; there are no moving parts whatever and, once installed, no adjustments are needed. Although the separator can successfully remove most of the suspended matter from raw water, smaller and lighter particles such as earth particles, mud or organic matter may be difficult to deal with. To overcome this problem the manufacturers have produced the Daynor clarifier which may be installed in series with a separator. A treatment unit consisting of separator and clarifier with attendant pipework, having a capacity of 40,000 gph, occupies less than 100 sq ft of floor space. The installation operates with a small head loss, is of robust construction, is automatic in operation and needs practically no attention when working. It is claimed to produce a water supply of constant quality irrespective of changes of turbidity in the raw water.

"The International Timber Engineering Conference": The first international conference on timber engineering was held in September at Southampton University, when twenty papers were presented covering engineering research and experience in Europe, North America and Asia. Abstracts of these papers are published in this edition and form a useful reference for anybody interested in the field of structural timber technology, which is of increasing importance.

Notes from *Civil Engineering and Public Works Review* for November 1961

"A Quick Way of Computing Channel Excavation": The method described in this article should help engineers faced with the task of determining the most economical and suitable cross section, slope and alignment of a channel which has to be routed through rough undulating country. It is often the case that field data is scant and time short, so it is essential to reduce the tedious and time-consuming work which would otherwise be spent on the running of numerous longitudinal sections and repetitive computations of excavation quantities. The method described enables one longitudinal section and the excavation quantity determined for a trial channel layout based upon it to form the basis of firmer and much shorter excavation computations for other possible channel designs. It is claimed that once the initial computation for the trial channel has been carried out further cases can be evaluated in about a tenth of the time.

"Note on Domestic Sewage System": The note describes briefly a new type of domestic sewage plant primarily designed for use in villages, institutions, caravan sites or similar small communities. As installed the complete unit measures 40 ft long by 8 ft wide by 10 ft deep and its capacity ranges from 2,000 to 30,000 gallons daily retention per single unit. The process is known as the "Oxigest" Sewage Treatment System and is essentially a long-period aerobic digestion activated-sludge system. It is claimed that installation takes only a matter of hours and that annual maintenance is low in cost and effort.

D.L.J.

THE MILITARY ENGINEER

November–December 1961

"Designing for Survival", by Arsham Amirikian. The author, who is the special structures consultant of the Bureau of Yards and Docks, Navy Department, discusses the means by which it is possible to provide some protection against the effects of H bomb explosions. He first of all tabulates the design criteria which should be accepted in the design of buildings to ensure a practicable degree of blast resistance without increasing the cost of construction. The suggestions deal in the main with the shape of the building and the principles which should guide the design of the framing. These protective measures are, in reality, strengthening devices intended to minimize the area of complete destruction in case of a nuclear explosion.

He then goes on to describe the family shelter and recommends the trench type which can be designed to withstand very high blast pressures and provide full protection against radiation. No design details are given but a chart is provided from which the strength of any given framing can be determined in terms of the basic blast overpressure.

While the trench type family shelters in back yards and gardens will protect the occupants of the houses concerned there is a need to provide shelters for the large numbers who will be at work or otherwise away from home should the attack take place in the daytime. His solution to this is to provide dual purpose shelters such as underground garages. He describes the work done in Sweden to carry out such a policy with illustrations of an underground garage and the subway in Stockholm to which emergency entrances have been made.

"Modern Engineering Education", by G. Brooks Earnest. The author has had a long experience of engineering teaching in US universities and he gives his views on the changes in the present system which are necessary to meet the conditions of today when, as he says, "military technology is renewing itself every five years". He asks for closer co-operation between professors of different subjects in formulating sequences of study on basic principles. He looks to advanced courses for undergraduates taking the form or membership of research teams which would provide the opportunity for bringing the principles he has learned to bear on a practical technological problem.

"Retaining Wall Stability by Electronic Computor", by Robert L. Renner and Charles E. Johnson. An account of the use which is being made of an IBM electronic computor for determining a stable and economical cross section of reinforced concrete retaining walls required in the project for the construction of six dams on the Missouri River. Considerable detail is given of the method of providing the in-put data.

"Army Field Nuclear Power Plant", by Captain Francis A. Wolak, Corps of Engineers. A short account of the installation of a nuclear power plant producing 4,000 KW at Fort Greely in Alaska. Some information about the plant is given but no details. There are good photographs.

"Photogrammetry in Missile Base Selection", by Rodney W. Johnson. This article gives a clear picture of the lay out of a missile base site with a summary of the factors which have to be taken into account when selecting a site. It goes on to describe in broad outline how photogrammetric methods should be used.

"Engineer Planning at Field Army Level", by Colonel William P. Jones Jnr, Corps of Engineers. An interesting article well illustrated on the planning carried out by the Chief Engineer's staff of the US Fifth Army in Italy.

"Hydroelectric Power for Alaska", by Colonel Christian Hanburger, Corps of Engineers. An examination of the water resources in Alaska for navigation, flood control, hydroelectric power, and related water uses has been in hand since 1948. This article describes in general terms the findings from the point of view of hydro-electric power but deals in more detail with the possibility of damming the Yukon River at Rampart Canyon and forming a lake larger in surface area than Lake Eerie which would enable a power installation capable of generating 4,760,000 KW to be constructed. The article describes the work of preparing the technical appreciation and discusses the advantages to be gained by carrying it out. There are good illustrations and a map.

"ANTARCTIC RUNWAYS AND ROADS", by Fred W. Doby. An article on the construction and maintenance of snow roads and runways for ski and wheeled aircraft at McMurdo Sound and on the Ross Ice Shelf in Antarctica. There is some technical detail which is informative and there are good illustrations.

"SACRAMENTO DEEP-WATER SHIP CANAL", by Major Arthur A. Becker, Corps of Engineers. A well illustrated article describing the design and execution of a project, which is still in hand, to construct a deep-water canal between Sacramento and San Francisco. The factors influencing the selection of the route, and details of the design and hydrographical problems associated with it are given.

"WIRE ROPE AS MAIN STRUCTURAL MEMBERS", by F. C. Livingstone. A new system of roof construction has been developed in Europe in which wire cables are used in place of heavier units to provide long spans free from obstructing columns. Named the Jawerth system after its Swedish inventor it is reported to provide strength, lightness and ease and speed of erection. This short note gives some details of methods of erection and materials of roof coverings and includes pictures of typical designs. J.S.W.S.

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, September 1961

ELECTRICAL INSTALLATIONS IN MODERN JET AIRCRAFT: The complexity of the installations built into modern aircraft is readily apparent to anyone who has seen a typical cockpit panel layout. The author of this paper seeks to outline the many applications which are similar to those used in other branches of industrial engineering, and to explain adaptations and special techniques necessitated by considerations of weight and space, and of aircraft environment. It is a pity that faulty grammar and misleading punctuation, combined with an apparent lack of proof reading, are likely to cause unnecessary confusion in the reader's mind.

TRENDS IN ENGINEERING TRAINING: Although based on Canadian conditions and requirements, this authoritative contribution by the Dean of Engineering, University of Saskatchewan, is well worth the attention of those interested in the education of engineers at university and post graduate levels.

The remaining papers in this issue are of specialist or academic interest. The titles are "*Combustion of gasoline during engine starting at low temperatures*", "*Non-linear control for distillation columns*", and "*Three dimensional photoelastic analysis of a diamond-head buttress dam*".

Notes from *The Engineering Journal of Canada*, October 1961

As usual, the October issue is devoted to the general subject of "Power in Canada", and is prefaced by a summary of developments in individual provinces and territories. The over-all picture is one of continual growth, though at a reduced rate of increase. With the completion of many hydro-electric installations, the past year has seen proportionally greater increases in thermal installations.

Nuclear power development is proceeding. The NPD project, too small to produce power on an economic basis, but designed to demonstrate technical aspects and to act as a test-bed for fuel performance, is expected to be in full operation during 1962. A larger nuclear station, at Douglas Point on Lake Huron, with a capacity of 200,000 kW, is scheduled to be in service in 1964/65.

LONG DISTANCE POWER TRANSMISSION: Two papers dealing with this general subject are inspired by the popular concept of providing plentiful electric power throughout Canada by developing her vast northern hydro resources. The paper entitled "*The hows, whys, and wherefores of EHV transmission*" should be read first. Short and clearly written, it summarizes the economic background of the problem, with special reference to the significance of extra high voltage transmission. The other paper, entitled "*Extra long distance DC transmission and system interconnection*" stresses the advantages of direct current transmission over considerable distances.

Both authors are agreed that economic considerations will govern the solution to the problem, that a power grid integrated with local utilities is unlikely to be worth consideration, that any technical development required will be achieved, and that, whatever system may be adopted, the cost of power to the consumer is unlikely to be reduced appreciably.

CARILLON FOUNDATION STUDIES: During the construction of the Carillon hydro-electric installation on the Ottawa River, excavation in the shale beds exposed soft altered zones which had not been discovered by extensive preliminary core drilling. To substantiate the design assumptions, *in situ* shear tests were carried out. These practical tests, which took fifteen weeks, are clearly described in the paper.

ECONOMIC DEVELOPMENT OF HYDRO-QUEBEC POWER RESOURCES: This is a most interesting statement of existing and projected power development in the Province of Quebec. The problem to be solved is the determination of the most economic sequence of development, to meet possible changes in a large number of variable factors. The correlation of the characteristics of existing and proposed plant, the variables to be considered, and the operating requirements to be met, is a vast exercise in trial and error, forming a typical task for a computer. The computer programme and methods of analysis are described, and the benefits derived from the establishment of a system "model" in the computer's memory are cogently established.

STRUCTURAL DESIGN OF TUNNELS FOR SOUTH SASKATCHEWAN RIVER DAM: A general description of this comprehensive project appeared in *The Engineering Journal of Canada* for May 1960 (see *RE Journal*, September 1960). The predominance of soft shale, which entailed unorthodox design of the huge earth dam, has posed a very difficult problem in the design and construction of five 20-ft diameter tunnels to be used, first, for river diversion and, later, as intakes to the power station. The solution was compounded of calculation, experience, and surmise. The peculiar swelling and squeezing properties of the soft shale could delay the exposure of any errors of judgment for several years.

SPEED REGULATION FOR HYDRAULIC TURBINES: This technical paper suggests a step-by-step procedure for designing the main elements of a hydro-electric station, and presents a method of reducing the basic calculations to a series of straightforward formulae.

ENGINEERING RESEARCH ON THE FISH AND POWER PROBLEM: The great rivers of British Columbia have an enormous potential for the development of hydro-electric power. It is calculated that the Fraser River system alone could provide some 10 million hp, to produce electrical energy at a substantially lower cost per kW than thermal or nuclear installations. These rivers are also vitally important to the fishery industry for migration and spawning.

Since the building of two major dams on the Columbia River cut off more than 1,000 miles of stream that were formerly available to salmon, a great deal has been learned about the upstream passage of fish to the spawning grounds, the design of fish ladders, and the safe passage of both adults and fingerlings on the downstream journey. This is a well arranged and interesting exposition of an unusual engineering problem.

Notes from *The Engineering Journal of Canada*, November 1961

THE INSPECTION, REPAIR, AND MAINTENANCE OF HIGHWAY BRIDGES IN LONDON, ONTARIO: This is a very clear and interesting account of what can happen to permanent bridges unless they are regularly inspected and maintained. Although the major defects described were largely attributable to wide extremes of temperature, and to the use of de-icing chemicals, there is a lot of practical information of value to any engineer. The primary causes of damage were seizing of expansion bearings and expansion joints, sometimes resulting in the displacement, and even instability, of abutments; the deterioration of concrete; and the corrosion of steelwork.

The discussion of precautions and remedial measures is always instructive, and the authors have certainly hammered home the importance of properly scheduled maintenance work.

WATERSHED RESOURCE VALUE: Following on the paper in the October issue, "*Engineering research on the fish and power problem*," this study of the management of salmon during migration and spawning shows that the development of both hydro-electric power and salmon production is practicable. Though dealing with a specialist and localized problem, the author has invested both facts and conclusions with considerable general interest.

WEAKNESS OF THE THEORY OF PLASTIC DESIGN: The argument about the validity of the plastic theory of design still rages (see Technical Notes, *RE Journals* of March, June, and December 1957, and June 1959.) The present paper is especially interesting because its author was at one time an advocate of the method, but is now severely critical of its practical limitations. He concedes that it has advantages in the case of simple structures where instability is not involved, but contends that, if there is any possibility of buckling, as is very often the case, the theory becomes unmanageably complex and unreliable. Those who appreciate good technical argument will enjoy this paper.

MARINE WASTE DISPOSAL: The problem of pollution of coastal waters by the discharge of sewage and chemical effluents is of some concern in this country. The technical presentation of this paper will be of interest primarily to sanitary engineers, but it contains a very comprehensive table of the factors to be considered in the design of marine waste dispersion systems. The author's choice of words, legitimate or coined, is sometimes distracting.

A SIMULATION OF THE ECONOMY OF BRITISH COLUMBIA: British Columbia is primarily a source of raw materials, and the economy depends upon a few large industries and foreign markets. This paper describes a method of checking the probable effect of developing secondary industries, and of predicting the outcome of particular forms of expansion. The method of analysis is laborious, and its numerical evalution is based upon statistical information, which is necessarily out of date. There is little doubt, however, that such analysis is a useful preliminary investigation.

USE OF AN ELECTRONIC ANALOG COMPUTER: This is a short and well illustrated description of the use of a computer for determining optimum settings of speed governors for hydro electric generating units, involving the solution of three simultaneous differential equations.

R.P.A.D.L.