THE ROYAL ENGINEERS JOURNAL—MARCH 1963 VOL LXXVII

# THE ROYAL ENGINEERS JOURNAL

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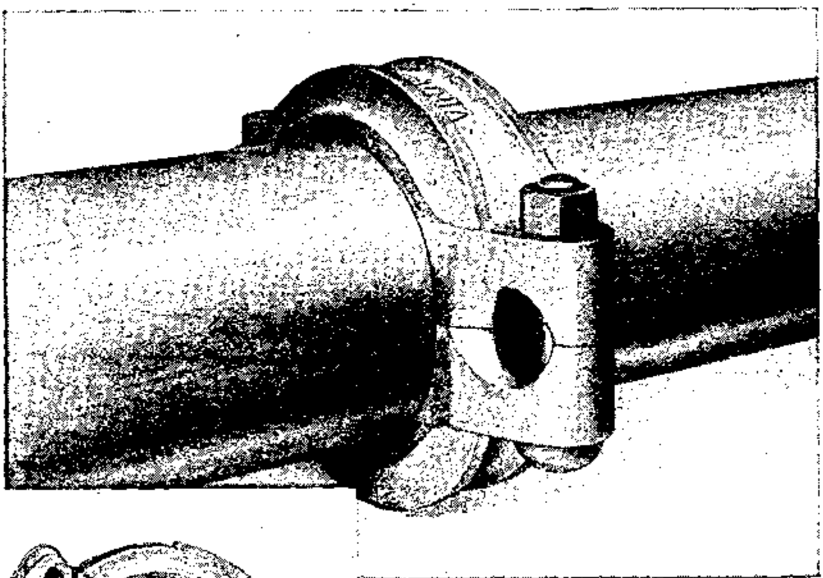

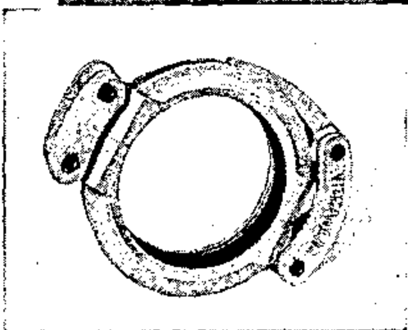

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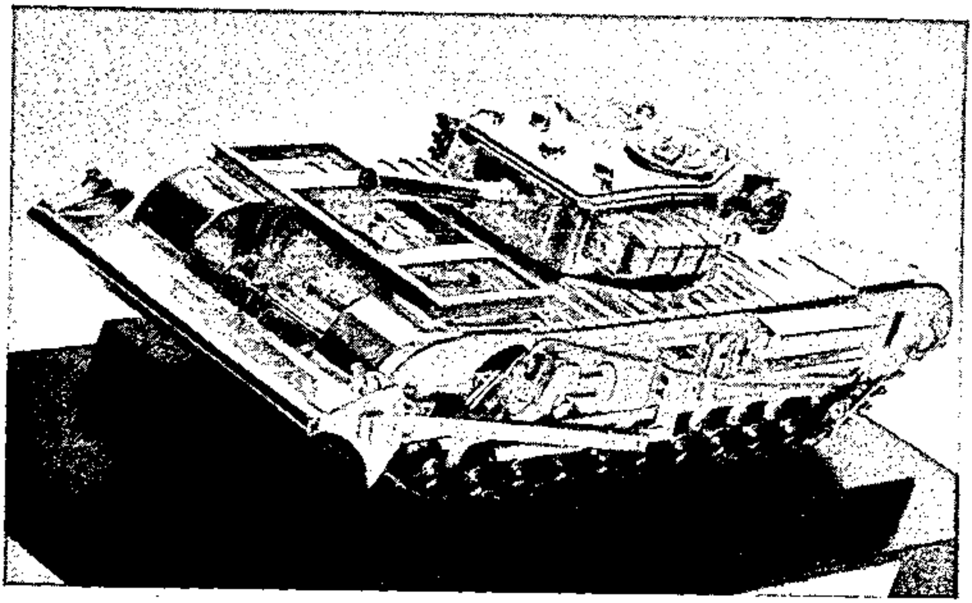

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THE ROYAL ENGINEERS JOURNAL

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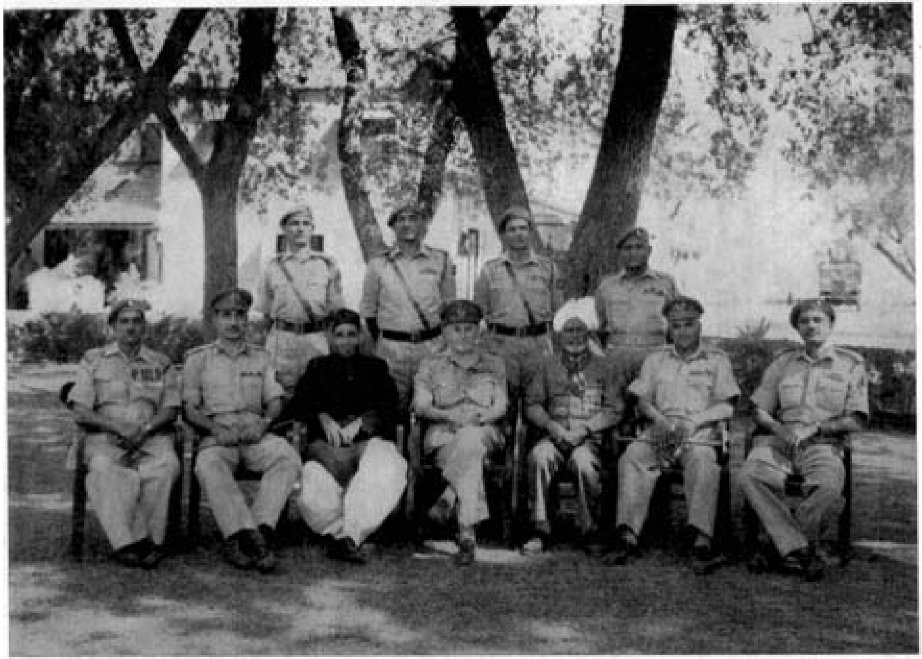
Lt Gen Sir Charles Richardson KCB, CBE, DSO, DGMT War Office
With the Sardars of 22 Fd Coy Royal Bombay Sappers & Miners at Engineer Centre Risalpur on 8 Oct 1962



*Sitting (L to R)*:—Hon Capt Shah Zaman (Retd), Maj-Gen Mohd Anwar Khan E-in-C, Sub Maj Imam Ali (Retd), Lt-Gen Sir Charles Richardson KCB, CBE, DSO, Sub Feroze Din OBI (Retd) Col Riaz Ul Haq Comdt Engr Centre, Hony Lt Shahinchi Khan TK I.

*Standing (L to R)*:—Sub Maj Abdullah Khan TK II, Sub Maj Adalat Khan TK II, Sub Maj Ghulam Sarwar, Hony Lt Mohd Hussain TK I.

**Bombay Sappers ad miners at Engineer**

# Presentation of Silver Candelabra to the Officers of the Pakistan Engineers

LIEUT-GENERAL Sir Charles Richardson, KCB, CBE, DSO, Director General of Military Training, recently visited Pakistan Army Training Establishments at the invitation of General Mohammed Musa, Commander-in-Chief of the Pakistan Army. On 8 October 1962 he and Lady Richardson were kindly invited by Major-General Mohammed Anwar Khan, the Chief Engineer Pakistan Army, to the Military College of Engineering and the Engineer Training Centre at Risalpur where they met several retired Viceroy's Commission Officers, many of whom had served with Lieut-General Richardson in the 'thirties who had been specially invited for the occasion.

In his capacity as a Colonel Commandant, Royal Engineers, Lieut-General Richardson presented on behalf of the Chief Royal Engineer and the Officers of the Corps of Royal Engineers a pair of silver candelabra to the Officers of the Pakistan Engineers. The presentation was made before a large gathering of officers and their wives in the Headquarter Mess. Major-General Mohammed Anwar Khan, the Chief Engineer, in welcoming his guests, said:

"I have great pleasure in announcing that we have amongst us today our distinguished guests Lieut-General Sir Charles and Lady Richardson. Sir Charles, who is now Director-General of Military Training in the War Office, is a distinguished Sapper Officer who has had memorable associations with us during pre-Independence days. It is, therefore, heartening to have him and Lady Richardson in the Pakistan Sapper home for the first time.

"22 Field Company was a distinguished unit of the Royal Bombay Sappers and Miners in many ways. Beside its military and athletic achievements it was the first Field Company to be 'Indianized', and it was during that time that Sir Charles served in the Company.

"If the passage of time does not affect the memory of relationships and associations developed amongst Sappers twenty-four years ago, I would like to ask Sir Charles whether he still remembers men like Swinhoe, Dinwiddie, Mackinlay, Wadia, Nanda and Bhagat.

"Our distinguished guest is not new to this area; I am sure that he must be feeling at home in the old haunt, particularly with Akora so close, except that in those days, bridges such as the Small Box Girders, Hamilton, Inglis, Everall and country boats held sway. We are very pleased indeed to have him with us today."

Major-General Anwar then presented Lady Richardson with a silver bracelet with the crest of the Pakistan Engineers and General Richardson with a shield with the Corps crest.

In his speech of thanks, General Richardson mentioned the very warm hospitality which he and his wife had received throughout their tour of Pakistan. He was most grateful to the Commander-in-Chief for giving him him the opportunity of returning after an interval of twenty-four years to the country where, as a young man, he had been given great opportunities and had learnt all his regimental soldiering. Throughout his visit, which included Quetta, Peshawar, Rawalpindi, Nowshera, Jhelum and Kakul, he had had many happy reminders of the close and genuine comradeship which, in those years, he had experienced with Sappers from the Punjab and the North West

**Presentations of silver Candelabra to the officers of the Pakistan Engineers**

Frontier, and with others who were now in India. He had learnt then to appreciate the great military qualities of the Pakistan people, qualities which he had later seen and admired in North Africa and Italy during the last war. Whatever the future development of war might be, the requirement of engineers grew no less either in size or in importance; he had noted with great interest the very large part which in peace-time the Pakistan Engineers were playing in many important national development projects.

The ties between the Pakistan Engineers and the Royal Engineers, based as they were on so many years of true comradeship in war and peace, were close and durable. He had been greatly impressed with the warmth of feeling which he had experienced throughout his tour, not only from senior officers, who shared memories of common service in the past, but also from the younger generation. The greatest welcome of all had come from the Pakistan Engineers.

The officers of the Royal Engineers had felt they would like to mark in some tangible way their deep appreciation of the ties which existed between the two Corps, and he had been deputed by the Chief Royal Engineer, General Sir Frank Simpson, GBE, KCB, DSO, DL, who had served for many years in the Royal Bombay Sappers and Miners, to present on behalf of officers of the Corps of Royal Engineers a pair of silver candelabra, which were inscribed as follows:

> "*Presented to the officers, Pakistan Engineers, as a token of abiding friendship and esteem between our two Corps.*"

Later, on 13 October, Major-General Anwar invited Lieut-General Richardson to a Pass-Off Parade at the Pakistan Military Academy, where he presented their Corps insignia to a group of newly commissioned Engineer officers. He presented to each officer his Second Lieutenant's badge of rank, Corps lanyard, cane and a book of Corps History from the time of the foundation of the Royal Bombay Sappers and Miners and 1 King George V's Own Bengal Sappers and Miners from which the present Engineers of the Pakistan Army stem.

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# New Silver Centrepiece for the 25th Corps Engineer Regiment

*By* Mess Members

On the occasion of a Regimental dinner night in the Officers' Mess of the Regiment in Roberts Barracks, Osnabruck, on 6 November 1962, the new silver centrepiece a Christmas Island Frigate Bird was formally "dined-in". The RE Band, Aldershot, played at dinner and the Garrison Commander with some members of his staff and his brigade group field squadron were guests.

This was not, however, the first occasion the new centrepiece had been present at dinner as during the previous week at a Corps guest night on the 1 November 1962 it took its place on the Headquarters Mess Tables with the Corps silver. It was then shown to the Chief Royal Engineer, General Sir Frank Simpson, the Representative Colonel Commandant, Major-General G. N. Tuck and other senior officers of the Corps, who had made its presentation to the Regiment possible.

This splendid silver centrepiece was made by Walker & Hall, Ltd., of Sheffield to a design originally conceived by 2nd Lieutenant G. Rowden RE of 37 Field Squadron in January 1961 and executed by Mr Hobson of Walker & Hall Ltd. The front and back of the plinth carry the silver motive of the Grapple to commemorate the Operation so named. Underneath the front Grapple is engraved:

"Presented to the
Officers Mess 25th Corps Engineer Regiment
by Officers of the Corps of Royal Engineers to commemorate the first decade
of the Regiment and its association with
Operation Grapple and Christmas Island".

On a third side is a plate carrying the designations and dates of the Squadrons that have served in the Regiment:—

FIELD SQUADRONS
OF THE REGIMENT

| | | |
|---|---|---|
| 37 Field Squadron | — | 27 November 1950 |
| 39 Field Squadron | — | 27 November 1950 |
| 50 Field Squadron | — | 27 November 1950 |
| 46 Field Park Squadron | — | 27 November 1950 to 27 September 1958 |

On the last side of the plinth is a summary of the history of the Regiment:—

HISTORY

| | |
|---|---|
| 3rd Divisional Engineers reformed as 25 Field Engineer Regiment at Maidstone | 27 November 1950 |
| Middle East | 1951–1955 |
| Suez | 1956 |
| Christmas Island | 1957–1958 |
| Reformed as 25 Corps Engineer Regiment at Maidstone | 27 September 1958 |
| BAOR Osnabruck | 1958 |

The Regiment stems from the original 3 Divisional Engineers and came into being on the re-formation of the division in 1950 as 25 Field Engineer Regiment. Comprising 37, 39 and 50 Field Squadrons and 46 Field

Park Squadron it was formed at Invicta Lines, Maidstone on 27 November 1950. The Regiment was trained with the Division as a strategic reserve or fire brigade ready to operate anywhere.

It was not long before 37 Field Squadron was flown out to the Middle East, shortly to be joined by the rest of the Regiment in Cyprus. By April 1952 the Regiment had moved on and was concentrated in the Canal Zone. During its time in the Middle East, detachments saw service in many places as far apart as Rhodesia, Kenya, Jordan, Greece, Cyprus, Cyrenaica, Tripoli and Iraq. The Engineers were never lacking employment and were fully occupied on building bridges, jetties, ranges and dealing with the eternal sand. The Regiment returned from the Canal Zone to Maidstone in January 1955. It remained there as part of 3 Division in the Strategic Reserve until once again 37 Field Squadron was sent to Cyprus to take part in the emergency.

By November 1956 the Regiment was involved in Operation "Musketeer". RHQ went straight out to Port Said, 37 Field Squadron moved on to Malta, whilst the 39 and 50 Field Squadrons were loaded into sea transport. The latter had not left the United Kingdom by the time the operation was over. The Regiment then reconcentrated in Maidstone where they remained training until they were selected to take part in the nuclear tests in the Pacific.

On 6 August 1957, at one week's notice the whole Regiment less the Field Park Squadron went to Christmas Island. There they were responsible for building laboratories, installing scientific equipment for the tests, maintaining the airfield and building emergency airstrips. After the tests they went on to lay the foundation for the permanent camp. In February 1958 they returned to Maidstone in a troopship which had brought out the families to meet them. On arrival at Maidstone the Regiment was under orders for service in BAOR. It was at this stage the Regiment became the 25 Corps Engineer Regiment saying good-bye to 46 Field Park Squadron, who went off to join 36 Regiment in Christmas Island. The Regiment moved out to Osnabruck to join 11 Engineer Group on 27 September 1958 where it has remained ever since.

The selection and production of the centrepiece took many months. In December 1960, the Officers' Mess Committee invited members of the Regiment to forward suggestions for an appropriate centrepiece. Sketches were submitted by a number of officers. Those considered but eventually discarded included a Heavy Ferry with 280 mm cannon, two designs suggesting the Pied Piper of Hamelin, a statue of General Gordon, and Le Bac and Le Pont Amphibie (Gillois units). After consultations with the Chief Engineer BAOR, Major-General I. H. F. Boyd and the CCRE 1 (BR) Corps, Brigadier T. H. Evill, it was decided to adopt the suggestion of a Christmas Island Frigate Bird mounted on a Grapple, as being simple and fitting.

Research suggests that in addition to hovering like a Guardian Hawk over His or Her Majesty's Frigates in the Pacific it was Captain Cook in 1777, who first observed the species on Christmas Island. Some claim that it is the highest flying of the sea birds, others that it is the fastest flying even faster than the albatross. Related to the gannet and the pelican, the bird is notable for the graceful way it soars in the air for hours, apparently without moving its wings. When spread, the long narrow wings measure 10 ft from

**New Silver Centrepiece 1**

**New Silver Centrepiece 2**

tip to tip. On land, however, they are awkward and almost helpless with very small legs. The male has an air sac, which lies along the throat and, when fully distended, is larger than the breast, looking like a red balloon. When deflated the sac is almost invisible beneath the plumage of the neck, but it is puffed out during courtship. The feathers are deep brown. From its habit of pursuing other birds, often much larger than itself, for food, the frigate bird was once called the man-of-war bird. Another name was hurricane bird, as its appearance over land, except at breeding time, meant that a hurricane was approaching.

A number of silversmiths were asked to tender, mostly in the United Kingdom, but one Dutch firm was also included. By January 1962 the various tenders complete with sketches had been short-listed to two, and certain amendments to the original conception had been made. The Frigate Bird and the Grapple were separated as two distinct motives. The Bird was to be mounted for stability on a sea-girt rock, and the Grapple would be mounted on the rosewood plinth. Research was carried out at the British Museum to ensure an authentic design. At the same time, the two firms were asked to tender for a number of miniature birds, which could be purchased by officers and senior NCOs of the Regiment, both past and present. The design of the miniature was different from the centrepiece, in that the wings were folded, and the air sac was shown inflated and was picked out in scarlet lacquer.

In April 1962, the Sheffield firm of Walker & Hall was selected as the final choice, subject to sufficient funds being available. In the meantime the Corps Committee was approached for a possible grant, and in July 1962, the Committee approved the design and made a most generous grant towards the cost. This enabled work to proceed, and Mr Hobson of Walker & Hall completed his design and finished the Frigate Bird by mid-October 1962. Officers of the Regiment were able to see the centrepiece during construction and advise on progress. The final design was 24 in high, with the wing-span also 24 in.

In conclusion it may be fitting to quote a verse from W. C. Bryant as appropriate to the centrepiece's symbolism:

"He who, from zone to zone,
Guides through the boundless sky thy certain flight,
In the long way that we must tread alone,
Will lead our steps aright."

# Developments in Structural Steel

*By* MAJOR J. C. PEACEY, RE, AMICE

## INTRODUCTION

SEVERAL articles have been published in the *RE Journal* over the past few years on developments in concrete, including prestressed concrete. On the other hand, little has been written about the developments which have taken place in structural steel. The steel industry has made vast steps forward in recent years, and steel remains a vigorous competitor of concrete and other forms of construction for bridges and the frames of buildings. This article covers briefly the history of structural steel, and then gives some information on the forms in which this versatile material is currently available.

## HISTORY

Before the Industrial Revolution, almost all construction was in timber, brick or stone. Cast iron was first used for structural work in the latter half of the eighteenth century, and the first iron bridge was built at Coalbrookdale in 1775. In 1784, Henry Cort invented a reverberatory puddling furnace which considerably simplified the manufacture of wrought iron; by the start of the nineteenth century this material was being produced and used widely. Steel was not manufactured in quantity until the 1860s. The Eads Bridge across the Mississippi at St Louis, which was opened in 1874, has many steel members, whilst the Forth railway bridge (1887) was the first to have its superstructure constructed entirely of steel. At about the same time the first skyscrapers were being built in America; from the start, almost all had a frame of structural steel. The Ritz hotel (1904) was the first large building in this country to have a steel skeleton.

*Early Rolling Mills.* Cort introduced grooved rolls for rolling sections of wrought iron in 1783. The output from the mills having these rolls grew enormously to satisfy the demands of the rapidly developing railways who needed large quantities of rails. The earlier rolls were manually powered, but by 1800 several manufacturers were driving their mills with steam engines; by 1859 joists were being rolled with depths of up to 18in. The stands of the first mills were only 2-high (see Fig 1) and were not reversible, but these were soon followed by 3-high stands and reversing mills, which avoided the need for the hot billet to be manhandled back to the other side of the rolls after each pass. Early practice was to hammer the hot metal in a forge until it was of a size to fit into the grooves for the forming passes, but this was superseded by cogging rolls which shaped the ingot mechanically. Figure 2 shows typical pairs of cogging and finishing rolls. Other developments which were introduced before the end of the nineteenth century were rollers on the mill bed, and manipulators to move the blooms around between passes through the rolls. The first steel beams to be rolled in this country were made at Dorman Long's Britannia Works in 1883, in mills which were not finally shut down until June 1962.

*Steel Production.* Until 1856, steel had only been produced on a relatively small scale, and it was reserved for such special applications as tools, springs and weapons; in that year, Bessemer invented his converter process, in which air is blown through molten iron to oxidize the impurities. Bessemer was dogged with early problems, the worst of which was that his process did not remove phosphorus, and this element made the steel unsuitable for forging or rolling. However, his method was quickly developed in some areas, and used where phosphorus-free ores were available, such as the hematites in Cumberland, or with imported ores.

In 1861 Siemens developed his open-hearth reverberatory furnace, using regenerative chambers to preheat the incoming fuel-gas and air from the heat of the exhaust gases; two years later such a furnace was used in France by Martin to produce steel. This process was slower but more accurate than Bessemer's, and larger quantities of metal could be handled at a time. As originally developed, this process was also incapable of removing phosphorus.

It was not until 1877 that Thomas and Gilchrist managed to solve the phosphorus problem. They lined furnaces with a basic refractory material, dolomite, instead of the acid siliceous compound which had been used before; they also added limestone to the melt which reacted with the phosphorus, forming a flux to contain the products of the reactions. The basic lining and flux were used first with the Bessemer process, and developed for the open hearth process a few years later. It was then possible to make steel relatively cheaply from all British pig irons, instead of only those made from hematite ores, and many more iron works gave up their puddling furnaces and started to make steel. Once these manufacturing processes became established on a large scale, the price of steel dropped, and it became an economically attractive material on a cost for strength basis; by about 1884, steel rails cost no more per ton than similar sections in wrought iron. Steel rails had been used for the first time at Crewe junction in 1861, and it was soon noticed that they compared most favourably in useful life with the wrought iron rails in use elsewhere. But for a long time the use of steel was limited to the railways and to shipbuilding; the latter took large amounts of plate and angle sections. In the structural field, steel was not accepted so readily; the major reasons were the difficulty of rolling suitable steel sections for joists, and the reluctance of the appropriate authorities to recognize the greater strength and reliability of steel over wrought iron, and to permit reasonable working stresses for it.

The President of the Institution of Mechanical Engineers said, in his address in 1885, "Now large quantities of rolled joists are produced at Middlesbrough. There appears to be no advantage in making them of steel, as in this material they are more difficult to get sound at the edges, less easy to straighten, and generally more costly to produce". These disadvantages have long since been overcome, and wrought iron is no longer used structurally. It is interesting to see in the same address that joists were quoted at £4 2*s* 0*d* a ton, which compares with today's price of around £40.

*Standardization.* The need to standardize sections was soon apparent. Every manufacturer had his own range of shapes and sizes for rolls, and architects and engineers frequently specified additional ones for different jobs. The *Dorman Long Handbook* of 1887 lists thirty-three joists, of which the largest was 20 in × 8 in × 100 lb, and all of which were available in three different weights; there were also large numbers of channels, angles, tees, bulbs and miscellaneous rolled sections, as well as some plated and compound combinations. The large variety of sections entailed high costs in making and stocking the necessary rolls, and in changing them over to suit different orders. In 1901 the Engineering Standards Committee was formed with the intention of looking into the problem, and of producing a list of standard sections to be used. This committee was the forerunner of the British Standards Institution, and their list of sections, published in 1903, was the first British Standard. Their job must have been well done, for there was little difference between their sections and those for the well known range of British Standard Beams which was not superseded until 1962. The largest joist was 24 in × 7½ in and the flanges had a taper of 8 deg.

*Universal Mills.* The rolling mills described above had horizontal rolls, one above another; one of their disadvantages was that it was difficult to work the metal into the tips of the flanges of joists, and pressure could not be applied as evenly to the flanges as to the webs; this tended to induce rolling stresses in the joists. Whilst this problem was not particularly serious with the narrow flanged joists suitable as beams, it did prevent the rolling of joists with wider flanges, more suitable for use as columns. A mill had been invented by Arrowsmith of Bilston in 1829 which entailed the simultaneous use of both horizontal and vertical rolls, and such a one was first used, in Germany, some nineteen years later. However, it was not until 1902 that Henry Grey, an Englishman, developed a satisfactory mill on this principle for rolling beams with large (and often parallel-sided) flanges; the first such mill was built under his direction at Differdange in Luxembourg, and more were later constructed in America and some European countries. In these "Universal" mills, as they are now called, the rolls are very much simpler than before, but more adjustments have to be made to bring the rolls closer together after each pass; this can, however, be controlled automatically. In Grey's mill the hot ingot was first passed through cogging rolls, and then given several passes through both a 2-high flange-upsetting stand and a universal stand (see Fig.3). It is now usual to have additional universal roughing stands between the cogging and the finishing ones. With these universal mills the whole section is shaped by direct rolling pressure, thus giving a sounder product. It is also possible to give a reasonable range of sections with less expenditure on rolls.

*1900–1950.* During the first half of the twentieth century, little spectacular progress was made in mill practice in this country, although many minor improvements were made in the machinery, with better gearing, and electric drives. In the steel manufacturing processes, furnace techniques were improved, and furnaces became larger. The Frodingham Iron Company installed the first tilting open-hearth furnace in 1901. Electric arc furnaces were developed, but due to the high operating costs were only used for making alloy steels. For much of this period the steel industry suffered heavily from foreign competition and poor trading conditions, so that resources were not available for large-scale modernization.

*Construction Methods.* For a long time fabricators made almost all their connections between steel members with rivets, or occasionally bolts. Massive structures were built up using innumerable rivets and it was common practice to have large plate or compound girders, and columns consisting of joists, plates, and angles riveted together. All this entailed considerable fabrication work, much of which had to be carried out on site. Columns were still designed in cast iron long after steel was the standard choice for beams, but they were eventually replaced by compound stanchions, often laced and battened together. Welding was not used to any extent for joining structural components until shortly before World War II.

*Design Stresses.* British engineers are renowned for conservatism and safety in their designs. The allowable stresses for steel have tended to be unduly low, and design loadings perhaps unnecessarily high. The design stresses used for bending were 6½ tons/in² in 1878, raised to 7½ in about 1890; in spite of the improvements in steel, they were no higher than 8 tons/in² until the outbreak of the last war, when they were raised to 10 tons/in² as an economy measure. Until 1948, all calculations were based on simple design, but in 1948 a new edition of BS 449 (the Use of Structural Steel in Building) was published, which approved the recommendations of the Steel Structures Research Committee (first formed in 1929) that "semi-rigid design" and "fully rigid design" should also be allowed. The report of the panel of this committee to inquire into welding in structural steelwork was published in 1937; the majority of their recommendations were also included in BS *449*: 1948.

## Post-War Developments

After the last World War, the steel industry set out on a massive programme of modernization, including the building of several completely new integrated steel works.

*Steel Making.* The major changes which have taken place recently in the manufacture of structural steel entail the use of "tonnage" oxygen (this is large quantities of the element in gaseous form). The oxygen is used in place of air, thus speeding up production, and improving the quality of the steel. The L.D. and Kaldo oxygen processes are used in converters similar to that originally developed by Bessemer, whilst the Ajax process is used in open-hearth furnaces. However, over 70 per cent of British steel is still produced by the traditional basic open-hearth process, either with or without tonnage oxygen.

A new High Yield Stress steel has been evolved and is available from manufacturers; this steel, which is detailed in BS *968*, has working stresses approximately 40 per cent superior to those of mild steel, and yet only costs about 10 per cent more; this comes down to about 6 per cent when calculated on the costs inclusive of fabrication. By using this steel it is possible to have lighter sections to carry a given load, thus reducing the dead weight of a structure. It is expected that before long this High Yield Stress steel will become the standard steel for all structural work; it is weldable, and is produced in both rolled sections and plate, making it ideal for large plate and box girders.

Several companies have recently installed plants for the continuous casting of steel, without the need to cast ingots and then roll them in cogging mills to produce the billets.

*Rolling Practice.* Almost all British manufacturers of structural steel have recently installed universal section mills for rolling a new standard range of beams and columns. The first company to do so was Dorman Long (Steel) Limited, who opened their new Lackenby Steel Works in 1958; this plant contains a mill which can roll sections up to 36 in deep.

*Connections.* Great improvements have been made in welding techniques, and welds are now generally accepted as giving perfectly satisfactory connections between steel members. For much fabrication work, welding has superseded riveting. Virtually all welding for structural work is carried out by the electric-arc process; recent developments include shielding the arc

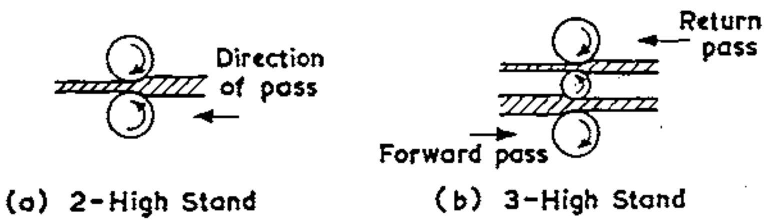



Fig 1.- Rolling Mills

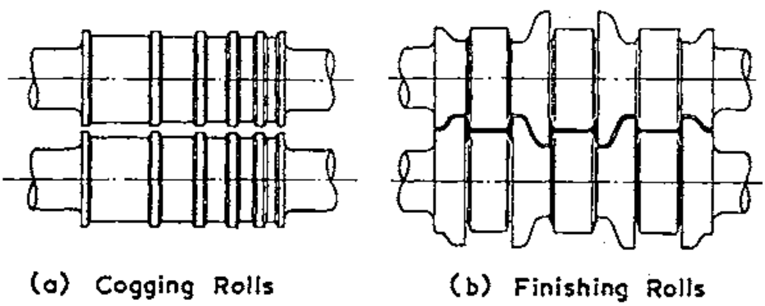



Fig 2.- Horizontal Mills

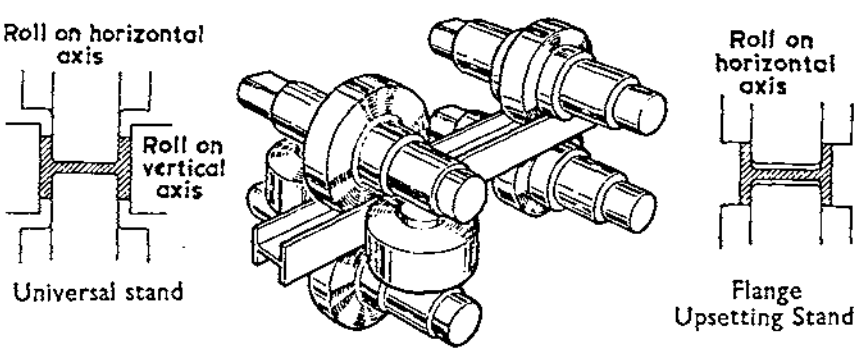



Fig 3.- Universal Mill

with a semi-inert gas such as carbon dioxide, and using a continuous uncoated electrode from a reel. Improved radiographic and ultrasonic inspection techniques have been introduced for the non-destructive testing of welds.

The High Strength Friction Grip bolt is a new form of fixing which is rapidly gaining in popularity for site connections. The members being joined are held so tightly together by the bolts that relative movement does not occur; the bolts rely on static friction between the members rather than their own shear strength. They have to be tightened to 90 per cent of a given proof load, and various proprietary methods have been invented to ensure that this is done correctly. Although more expensive than rivets, these bolts enable a reduction in total costs of site connections due to the simplicity of fastening them. The relative quietness of assembly is also a great advantage in built-up areas where the noise of riveting can become intolerable.

*Design.* The allowable stress in mild steel in bending has recently been increased to 10½ ton/in² for a beam with the compression flange restrained. The guaranteed yield stress for such steel (to BS 15) is 16 tons/in². The corresponding figures for the High Yield Stress steel to BS968 are 14½ ton/in² and 22 tons/in². These stresses are slightly reduced for sections where the thickness of metal is particularly high. The full details of allowable stresses are given in BS 449 and BS 153, Part 3B.

Structures which are to be welded must be designed as "fully rigid" to allow for the various support moments. One of the simplest ways of doing this design is by the "Plastic Theory" which considers the strength of the members at collapse; this theory is rapidly gaining popularity.

As well as allowing structures to be designed as "composite" where steel and concrete are used in conjunction, it is now permissible to consider any concrete casing over 2 in thick as adding to the strength of beams and columns; in many instances it is only necessary to increase the concrete cover required for fire protection by a small amount to take account of this concession.

## Structural Steel Today

*Hot Rolled Sections.* The British Standards Institution published a revised edition of BS 4, Part I, early in 1962. This gives details of structural steel sections, and has many changes from previous editions. The old range of BSBs has been made obsolete, and replaced by Universal Beams, Universal Columns, and Light Joists. Slight changes have also been made to the old channel and angle sections, the most important of which are that toe radii have been made much smaller; this gives squarer edges and simplifies preparation for welding.

Universal Beams (UBs) were first rolled in this country in 1958. These beams are more efficient than the old BSBs, having a better modulus to weight ratio. They are also available in a wider range of sizes, the largest being a 36 in × 16½ in × 260 lb which can be compared with the largest BSB which was 24 in × 7½ in × 95 lb. It is often possible to use a UB by itself where it would previously have been necessary to add plates to the flanges of a joist to give a section of sufficient modulus.

For each serial size (nominal depth × flange width) of UB there are two, three, or four, standard weights of section. (See Fig. 4.) These weights are given by varying the distance apart of the rolls; for this reason the actual dimensions do not normally agree with the nominal ones. The only constant dimensions in each serial size are the distance between flanges, and the distance from surface of web to tip of flange. UBs are available with either parallel or tapered (2 deg 52 min) flanges, and the properties of both are considered as being the same. The toes of the flanges are square, which simplifies welding. The earlier UBs all had relatively wide flanges, but ones with narrow flanges have recently been made available as well.

Universal Columns (UCs) are rolled in a similar manner to UBs. The largest is a nominal 14 in × 16 in × 426 lb (its actual overall dimensions are 18.69 in × 16.695 in, and the flanges are 3.033 in thick). UCs are much more efficient than the old BSBs in resisting bending about both principle axes as well as taking a high axial compressive load; the larger sections are big enough for it to be seldom necessary to add plates to increase the modulus; they therefore give great savings in fabrication costs. It is relatively easy to build up tall stanchions for buildings using UCs, and the splices are simplified when the same serial size is used all the way up, with heavier members for the lower sections. All UCs have parallel-sided flanges.

The series of Light Joists, of which there are only six, fills the requirement for sections smaller than the smallest UB (8 in × 5¼ in × 17 lb). They range between 3 in × 2 in × 4½ lb and 8 in × 4 in × 17 lb.

Broad Flange Beams were introduced as a temporary measure by some manufacturers before they had installed full universal mills; they are similar to UBs and UCs, but do not have as good a range of sizes. They will probably be obsolete before long.

Universal Bearing Piles have similar sections to UCs, but are generally lighter; the web and flange thicknesses are made the same. As their name implies, they are used in foundation work; they are able to withstand extremely hard driving, and have a large surface area to develop skin friction.

There have been no recent changes in the sections of steel sheet piling.

*Fabricated Sections.* Because of the high costs involved, fabrication is usually avoided if possible. UBs and UCs are able to support considerable loads without the need for additional flange plates. However, fabrication is unavoidable for really heavy loads, and is usually carried out by welding or, less frequently, by riveting. Box girders have become common for bridge work and plate girders have many applications; with both these it is possible to alter the thickness of metal over certain sections of a member where additional shear or bending strength is needed. One way in which welding can be reduced to a minimum in plate girders is by splitting a large UB or UC into two tee sections, and by welding a plate between them to increase the web depth.

A special form of fabrication is Castella construction (see Fig. 5), pioneered by the United Steel Coys Ltd. The web of a steel section is cut to a special castellated profile, and the parts are then welded together with the crests of the castellations in contact, thus increasing the depth of the section by 50 per cent with no increase in weight; the section modulus is increased by about 56 per cent. The web is left with large voids, but this is of no concern unless there are exceptionally high shear loads, and in these cases one or two spaces can be filled in over supports to resist the shear forces. Castellated beams are suitable where the loading is relatively light over long spans, so that a large depth of section is needed to resist bending and limit deflection. The majority of steel fabricators are equipped to produce Castella sections, and hold the apparatus for cutting to the correct profiles. As well as I-sections, the Castella principle can be used in making up special channels, zeds, tees etc; by cutting the profile obliquely, it is also possible to produce tapering sections. As a rough guide, Castella construction in a beam becomes economic where it can give a saving in weight of about 15 lb/ft run.

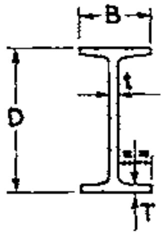
*Structural Tubes.* Whilst round sections are not very efficient in resisting bending, they are excellently suited to resist axial stresses. Because of this, they are frequently used in roof trusses and both two and three-dimensional frames. Tubes have the advantage of a good strength to weight ratio, and the surface area requiring painting is particularly low; they are joined together by direct welding between tubes, or by welding to special lugs, couplings, or flanges. The smaller sizes of tube, up to 4½ in dia, are usually rolled to shape from sheet and continuously welded, whilst larger ones, up to the maximum of 16 in dia, are seamless; all sizes are hot-rolled to their final dimensions and are available in several different thicknesses.

Round tubes are also suitable as bearing piles, and a range of helically welded tubes made from sheet steel is marketed; these are normally driven with an internal drop-hammer.

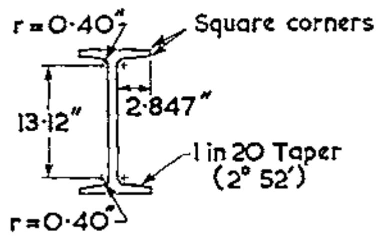
Rectangular Hollow Sections, which are tubes with a square or rectangular cross-section, are manufactured by Stewarts and Lloyds, the principal specialists in structural steel tubes. These sections have most of the advantages of round tubes and can also resist a certain amount of bending. They are very much easier for welding together than round tubes as they meet on straight lines, easily cut to profile, rather than the complicated curves associated with cylindrical sections. Rectangular Hollow Sections have a good appearance and are often left visible in such applications as balustrading and columns.

*Cold Formed Sections.* These are lengths of sheet steel which have been formed to the required shapes by cold rolling, or pressing. Almost any shape can be produced, of which some of the commonest are shown in Fig 6; the maximum sheet thickness is about 3/16 in. The sections are mostly used for roof trusses and light frames; they have the advantage that members can be built up from a large number of different sections, in such a way that the amount of steel at any position just matches its strength requirement. Members made from cold formed sections are light, and economical in steel, but have relatively high fabrication costs; they are therefore most suitable where large scale production is possible. Connections between sections are usually by spot welding or pop-riveting, whilst those between members are by welding or bolting. Open-web joists are often made from these sections, and are sold as ready-made units; these are frequently used in formwork for concrete.

*Preflex Beams.* The load-bearing capacity of steel beams can be improved, and the dead weight of composite steel-concrete structures reduced, by using Preflex beams. Steel beams are first stressed in a jig until the working stresses are reached; whilst held in this position, concrete is cast around the tension flanges, and allowed to harden. After several days, when the concrete has attained a reasonable strength, the beams are slowly released, thus putting the concrete into compression. The beams are erected into a structure in the normal way and the deck concrete placed. When the preflex beams are then loaded, the concrete around the tension flange assists the steel, and although its compressive stress is reduced, it is not put into tension.



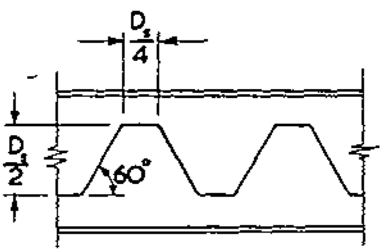

Variable Dimensions



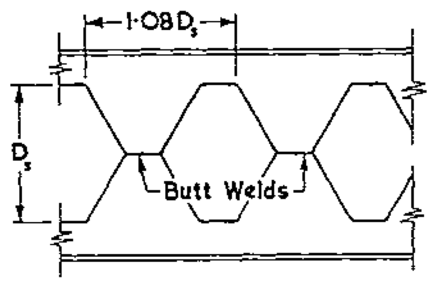

Fixed Dimensions

| Weight lb | D in | B in | T in | t in | A in² | Zxx in³ | Ixx in⁴ |
|---|---|---|---|---|---|---|---|
| 45 | 15.30 | 6.075 | .640 | .381 | 13.24 | 66.8 | 511.2 |
| 40 | 15.15 | 6.038 | .565 | .344 | 11.77 | 59.1 | 447.6 |
| 35 | 15.00 | 6.000 | .490 | .306 | 10.29 | 51.4 | 385.5 |

**Fig. 4.** Dimensions and Properties of Universal Beams with Serial Size 15 in × 6 in



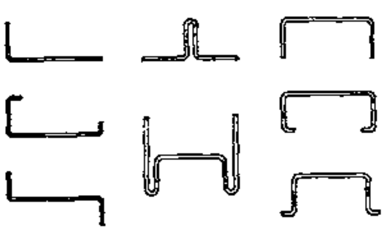

Cutting Profile



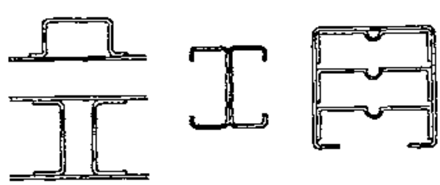

Reassembled Beam

$D_s$ = Serial depth of Universal Section
Overall depth = Actual depth of Universal Section + $\frac{D_s}{2}$

Fig 5.– Castella Construction



(a) Typical Basic Sections



(b) Typical Composite Sections

Fig 6.– Cold Formed Sections

## Steel in Other Countries

Developments similar to those which have occurred in this country have also taken place abroad; in some cases Britain has been the originator, but the lead has often, in recent years, come from America or the Continent of Europe. Almost every country has its own published standards; the larger countries have developed their own, whilst smaller nations have tended to copy British or American ones. On the Continent, additional standards for steel have been introduced by the European Coal and Steel Community. Copies of almost all national standards are held at the British Standards Institution's library.

*Nomenclature.* Many countries have their own way of describing steel sections. For instance, the USA nomenclature system consists of three elements: the overall depth; a letter descriptive of the type of section (I for narrow flanged beam, WF for wide flanged beam, C for channel); and the weight per ft run; e.g. 18 WF 60. In Germany the system is to give a number of descriptive letters (I for joists, P for parallel flanges, B for wide-flanges, E for European sections) followed by the flange breadth and overall depth in millimetres, e.g. IPE 240 × 4600.

## Military Applications

Structural steel has many advantages over other materials for use in the field; it is of course already used to a large extent in military equipments, particularly bridge components. The two uses of steel most applicable to the Royal Engineers are in the construction of bridges and buildings. Considering the improvised versions of these structures most common in war, there is plenty of scope for steel, particularly hot-rolled sections. RE units should be trained to make use of whatever steel they can acquire locally so reducing the amount to be imported. Great economies can be achieved by designing structures as continuous or rigid, and the majority of connections should, therefore, be by welding; it is thus necessary to have sufficient well-trained welders available.

*The Time Factor.* The greatest advantage of steel, and the one of most value to us, is the speed with which a structure can be built. This speed is due partly to the relative simplicity of the work required, and partly to the need to have much less temporary works than in, say, concrete construction. Furthermore, steel members can carry their load as soon as they are fixed. there is no need for ageing or curing before the working strength is achieved, nor is the work likely to be unduly delayed by adverse weather conditions which might prohibit concreting. Unless steel girders are to be cased in concrete for protection or added strength, there is no need for formwork, though any that is necessary can easily be suspended from the steel itself. Steel girders normally have symmetrical cross-sections, and can thus be launched directly from one end of a span with no problems over stress-reversals; concrete beams, even when prestressed, cannot be launched in the same way, but must always be supported at special points, an operation often entailing long-reach cranes. Steel members for a bridge, or parts of building structures, can often be prefabricated, thus allowing much work to be done under workshop conditions, and speeding up the work on site; this is especially advantageous when it is possible to standardize designs for a theatre to fill some requirement not met by normal equipment.

*Disadvantages*. There are naturally some disadvantages with steel, but they are not serious. The worst, which only applies when there is not sufficient steel already available locally, is the problem of the import tonnages involved. However, to give an equivalent strength of unit, there is not much difference between the weight of a steel section, and the weight of cement plus reinforcement for a concrete section. The corrosion of steel is seldom of any significance under military conditions, since it will take many years for strength to be lowered seriously, and no future war is expected to last for long; if necessary, steel containing a proportion of copper can be specified to reduce corrosion. The fire-protection of steel which has to be taken care of in large shops, offices, and blocks of flats is hardly applicable to military needs, where multi-storey buildings are unlikely. Holdings of steel in stores depots could become too large if the material was used indiscriminately, but this can be overcome by standardizing on certain lengths and sizes and working all designs to these; this may be uneconomic in design but would simplify work on the stores side.

*Identification*. Steel manufacturers do not put indelible marks on their products to show their quality. A number is painted on each order as it leaves the works, from which the consignee can identify it, but the paint soon wears off if left out in the open; further, if a length is cut in half, only one half retains the paintmarks. This presents a difficulty, as it is no good designing a structure as using a high quality steel, unless one can be sure that the right steel will be incorporated. There are considerable advantages in weight to be gained from using High Yield Stress steel, and it is therefore essential, for military purposes anyhow, that this steel should be readily identified. It is suggested that a simple colour code be devised, and an obvious mark in the appropriate colour be painted at each end of every length of steel to show its type; a similar process is already done with special steels for machining. Since it is virtually impossible to get a colour coding standardized on a world-wide basis, it would be useful if a simple kit could be available for identifying steels. As far as structural steels are concerned, the only important value which has to be found is the yield stress when subjected to tensile loading; all the necessary design stresses can be based on this one value. If a sample is cut from a length of an unknown steel section, it could be machined to some standard test dimensions in the lathe of an RE workshop lorry. All that would then be necessary would be a portable testing apparatus; this would be quite a small machine, limited to doing tensile tests on the specimens, and probably worked hydraulically by a hand pump. Such tests would give a sufficiently accurate guide to the permissible working stresses for a design in any unknown or locally acquired steel.

*Plastic Failure*. When a steel structure is made rigid it is considerably stronger than it would be if the same components were loosely pinned together. For a rigid structure to collapse, the various members must bend, and in bending they absorb energy. It is most unusual for structural steel to break when overloaded, and it normally deforms until it sheds its load, and then remains firm again. This principle was made use of in the wartime Anderson shelters, a simple device which saved many lives; it is also the basis of the Plastic Theory of design.

Rigid structures are ideal for resisting blast, and this makes them most useful where there is danger of nuclear attack. Some permanent deformation may occur, but there is unlikely to be complete collapse. When steel frames are used to prop up command posts, aid posts, and similar shelters, they should always be made as rigid as possible. The only quick way of achieving the necessary rigidity in improvised structures is by welding.

### Conclusions

Major advances have recently been made by the steel industry, and their products can be of great value to structural engineers as a whole, including military engineers. Steel is available in different qualities, including a new High Yield Stress variety; the range of shapes and sections has been greatly improved, so that large loads can be carried without the need for fabricating plated or compound units. Steel is competitive in cost with other materials, and has great military advantages in the speed with which it can be erected. It attains great strength when welded up to produce rigid structures, ideally suited for blast protection.

### Acknowledgements

The author wishes to thank Mr W. G. Willis, the Public Relations Officer of Dorman Long & Co Ltd, and Mr A. S. Babb of the Research & Development Department of the United Steel Companies Ltd, for assistance given in supplying information for the preparation of this article.

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"Universal Beams and their Applications" by S. Barlow and G. Foster; *Proceedings of Institution of Structural Engineers*, November 1957; Vol XXXV No. 11.

"The Development of Tubular Structures" by G. B. Godfrey; *Proceedings of Institution of Structural Engineers*, Fiftieth Anniversary Conference, October 1958.

"Cold Formed Sections" by W. Shearer Smith; *Proceedings of Institution of Structural Engineers*, Fiftieth Anniversary Conference, October 1958.

"Design of Steel Frames for Buildings" by J. F. Baker; *Proceedings of Institution of Structural Engineers*, Jubilee issue, July 1958.

"Construction of Steel-Framed Buildings" by Lewis E. Kent and G. W. Kirkland; *Proceedings of Institution of Structural Engineers*, Jubilee issue, July 1958.

### British Standards

Reference has been made in the text to several British Standards. All these are obtainable from the British Standards Institution, 2 Park Street, London, W.1. The following are the more important standards covering the subject matter of this article.

| | |
|---|---|
| BS4: Part 1: 1962 | Structural Steel Sections, Part 1: Hot rolled sections. |
| BS15: 1961 | Mild Steel for General Structural purposes. |
| BS153 in various Parts | Steel Girder Bridges—Materials, Loading, Stresses, Designs, etc. |

| | |
|---|---|
| BS449: 1959 | The Use of Structural Steel in Building. |
| + Addendum No 1 (1961) | The Use of Cold Formed Steel Sections in Building. |
| BS548: 1934 | High Tensile Structural Steel for Bridges etc. |
| BS968: 1962 | High Yield Stress (Welding Quality) Structural Steel. |
| BS1775: 1951 | Steel Tubes for Mechanical, Structural, and General Engineering Purposes. |
| BS1856: 1952 | General Requirements for the Metal-Arc Welding of Mild Steel. |
| BS2994: 1958 | Cold Rolled Steel Sections. |
| BS3139: Part 1: 1959 | High Strength Friction Grip Bolts in Structural Engineering, Part 1: General grade bolts. |
| BS3294: Part 1: 1960 | The Use of High Strength Friction Grip Bolts in Structural Steelwork, Part 1: General grade Bolts. |

# Farewell to Troopships

"*Who hath desired the Sea—the sight of salt water unbounded?*"
Kipling

*By* COLONEL R. C. GABRIEL

WHEN the Bibby liner *Oxfordshire* tied up at Southampton on 19 December 1962, trooping by sea came to an end. For several months she and the British India *Nevasa*, a very similar ship in many ways, had been the only two transports under Government Contract, and the latter had brought troops in for the last time only ten weeks earlier. Both occasions were marked by simple ceremonies at which were present the Directors of Movements of the three services.

*Oxfordshire*, the younger ship of the two, had not even completed six years' service, but strategic and economic reasons led to the decision to terminate sea trooping. The writing moreover had been "on the cabin wall" for the past five years, during which period the air trooping charter service has, like the RAF Transport Command Service to the Far East, steadily increased in frequency, comfort and efficiency. In the five and a half years between mid-1957 and December 1962 the trooping fleet had been run down from one of ten ships, totalling nearly 165,000 tons, to its final extinction.

The Corps of course has been intimately connected with all these ships through its Movement Control Service that has supplied many Embarkation Staff Officers and Port Staffs to assist passengers and to deal with their baggage. It was particularly associated with one vessel, the Ministry of Transport's *Empire Fowey*, operated by the P & O Line, for this ship had been adopted by the Royal Engineers, Singapore, in September 1954. A fine plaque, made in EBI Workshops there, was on the main 1st Class staircase,

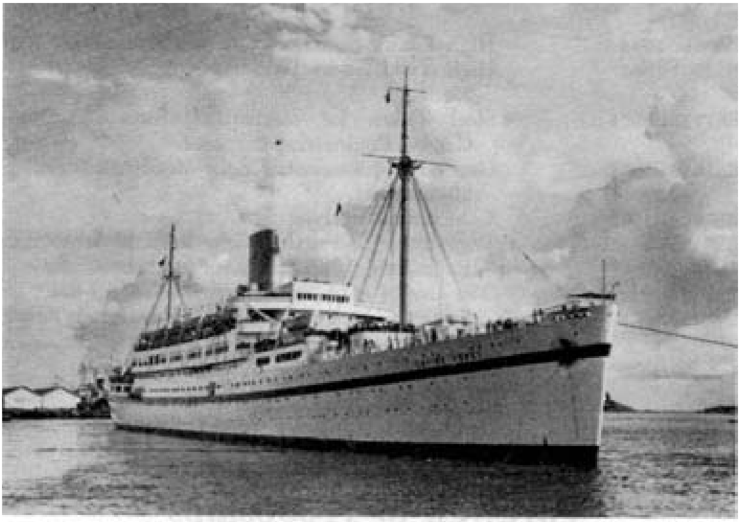


**Photo 1.** The *Empire Fowey* leaving Singapore. Though not identifiable in this picture the flag at the foremast yard is the Corps Flag.

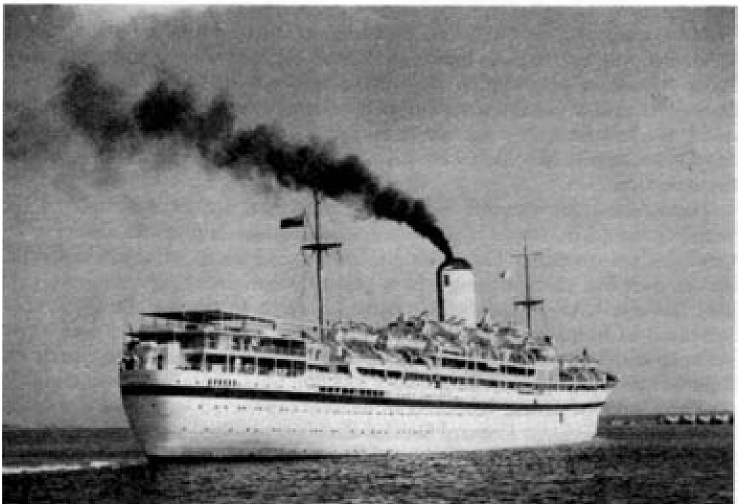


**Photo 2.** The BI *Nevasa* (III) heading down Southampton Water.

# Farewell to Troopships 1,2

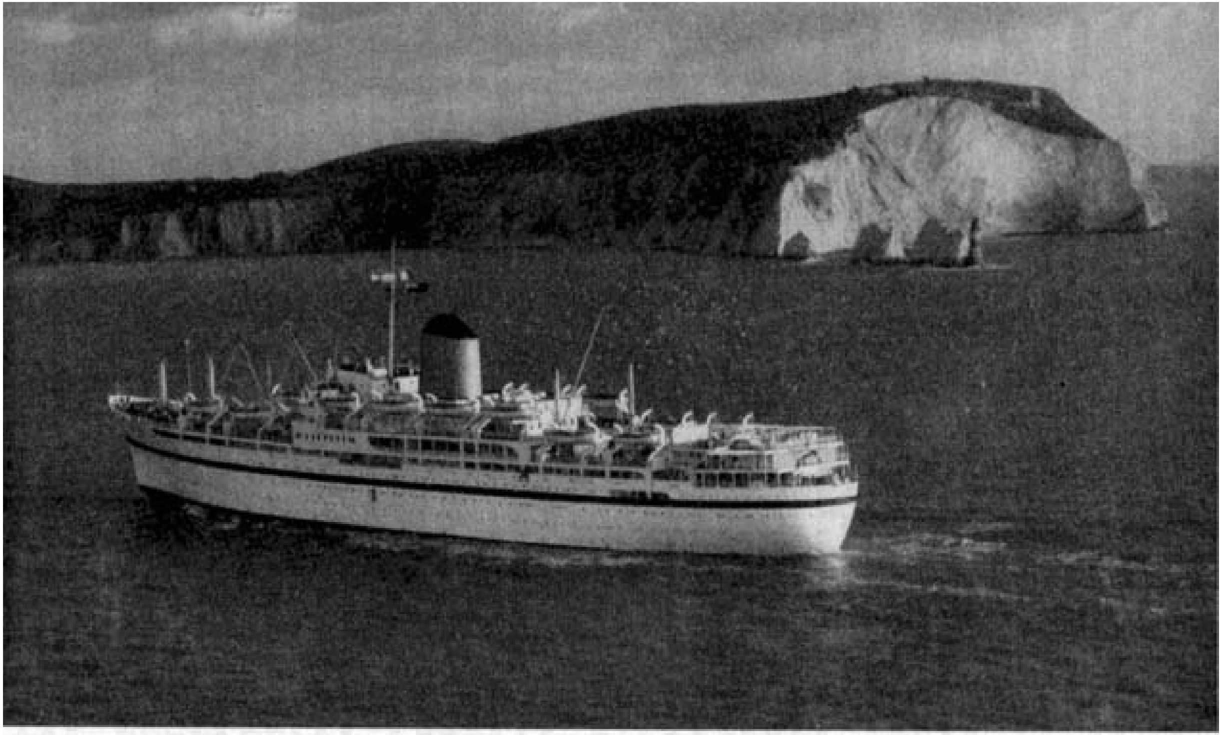


**Photo 3.** "They say there's a troopship . . .
. . . bound for old Blighty's shore"

*Daily Telegraph*

## Farewell to Troopships 3

and she used to wear the Corps Flag proudly at the foremast yard. She was, however, one of the first casualties in the great axing process, and she was sold early in 1960 to become the Pakistani Pan-Islamic Company's pilgrim ship *Safina-e-Hujjaj*. As such, she very rarely has to negotiate the Suez Canal, where, as a trooper, she used to rival the *Pasteur* in her propensity for going aground. Her German steering mechanism was always blamed; in pre-war days she used to be the North German Lloyd *Potsdam*.

The whole history of peace-time trooping is not without considerable interest, and for three-quarters of a century it was inextricably bound up with India and the British Army in India. Hence the important roles played by the P & O and BI Lines, two of the principal shipping companies serving the Sub-continent. Not only had both companies provided numerous transports for the many military expeditions of the last century in Middle and Far Eastern waters to Burma, China, the Sudan, East Africa and elsewhere, but these were the first two Companies to provide the first commercial troopers in peace-time; that was in the autumn of 1894 when the first BI *Dilwara*, a three-master, and the two larger P & O liners *Britannia* and *Victoria* sailed for India under Government contract. Previously Admiralty-owned *Serapis* class transports, a quintet of high sided white ships with sails and steam driven, specially built for the role, had for nearly thirty years been the only regular peace-time troopers. Some of them, such as the *Crocodile* and *Jumna* have been immortalized by Kipling. Prior to the introduction of these vessels troops had travelled in appalling discomfort in HM ships or, if to India, then as drafts in the rather more spacious East India Company merchantmen. Nevertheless, the initial popularity of the Admiralty transports quickly waned and even the Navy spurned their "lobster pots" as they used to be called.

The new commercial trooping service was, therefore, welcomed in 1894 and not only did the Army find it more economic but the troops themselves were much happier and more comfortable. The P & O soon found that their intermediate class ships, like the *Sicilia* and her sisters, were better suited for trooping than their express mail vessels and so, at the turn of the century, they built three new ships of this type named after the famous battles of *Assaye*, *Plassy* and *Sobraon*, for use as transports. The BI had the *Rewa* and *Rohilla* which were joined only just before the First World War (1914–1918) by their famous pair *Nevasa* and *Neuralia*. These became particularly well-known between the two World Wars, during both of which they served as Hospital Ships. Only *Nevasa* survived the Second World War, but she went to the breakers in 1948. Another well-known BI pair were the motor-ships *Dilwara* and *Dunera* of 1936–37. These were the first commercial ships to be designed specially for trooping, and they soon achieved great popularity. They are still in service today, the former as the China Navigation Company's pilgrim ship *Kuala Lumpur* and the latter as a Schools' Educational ship. The present *Nevasa* is in fact the third of that name and all three ships have carried large numbers of British and Indian troops in their time.

Of late, P & O's direct interest dwindled, in fact their last owned troopship was the *Ettrick*, a ship very similar to the *Dilwara* and *Dunera* and also built shortly before the Second World War although she did not survive it, but, since BI has from 1914 onwards been part of the P & O Group, their indirect interest has remained to the end.

The Bibby Line, the other company concerned to the very end, appeared on the scene for trooping long after the other companies, but in the forty-one years (less the last war period) since they started with their first *Derbyshire*, they have always provided some shipping on government charter for trooping. Their *Dorsetshire* and *Somersetshire* were a well-known pair in the years between the Wars; these two motorships had been constructed originally as freighters. *Lancashire* was another well-known one, with her exceptionally tall thin funnel and her four (later three) masts; while latterly the motor vessel *Devonshire*, very similar in size and design to the *Dilwara* and *Dunera*, supported the *Oxfordshire* in Bibby's trooping service. She, like *Dunera*, has become a schools' ship, now called *Devonia*, and sails under BI colours.

Unlike an earlier *Oxfordshire*, a graceful old four-master, the last of the troopships had been specially designed as such. Built on the Clyde at Fairfield's yard in 1957 she had a gross tonnage of 20,586 and was similar in many ways to the BI *Nevasa* (*III*) a 1956 product of Barclay Curle's Clyde yard. Each could carry in peace-time about 1,500 passengers including officers and a number of families, and normally made four round-trips to the Far East in a year. They were fast 17-knot vessels and took only twenty-two days for the passage to Singapore, but a Britannia aircraft of course can fly about 103 passengers to Singapore in a mere twenty-five hours, and to Hong Kong in twenty-seven and a half hours.

There are few who do not mourn the passing of the troopship era, almost a century since its inception, not only because of the restful comfort and acclimatization afforded during the voyage, but also because of the ability to move with all or most of one's baggage. Nowadays, in spite of express freight services provided by several cargo liner companies, military travellers must perforce be separated from the bulk of their kit for weeks on end.

Mention has been made of only the principal shipping companies involved in trooping over long periods in peace-time; there are many others that have provided ships for this purpose or operated Government-owned shipping after the end of a war. Examples are the Ellerman Lines, whose *City of Marseilles* was a regular trooper in the 'twenties, and the Cunard White Star under whose colours the *Georgic* made a number of trooping voyages, when not carrying migrants to Australia.

One happy feature is that the smart "trooping colours" will soon be seen again, for the new WD Logistic Ships (LSL), the first of which is at present under construction, will also be painted in the so-called "trooping colours" i.e. white with a broad blue band, red boot-topping and a yellow-buff funnel. Though Government-owned they will sail under the BI flag and, although primarily intended for the carriage of vehicles and stores, they will have accommodation for over 300 troops.

It was recently announced in the Press that the *Oxfordshire* has been chartered by the Fairline Shipping Corporation of Panama for a period of six years and will be used for carrying migrants to Australia. Structural alterations are in progress and like the *Fairsee* and *Fair Sky* she will presumably have a large V on her funnel (for Vlasov, the owner). As yet nothing is known of a new name.

# Keeping the Army in the Public Eye

*By* Lieut-Colonel D. J. Willison, OBE, MC, RE

Keeping the Army in the Public Eye—KAPE for short—conjures up a Giles Cartoon drawing of a huge guardsman in full regimentals surrounded by hordes of those inimitable children with protuberant eyes. For the last two years the Army has staged a series of visits to the cities and towns of this country with the declared aim of "KAPE". Even after two years there is still much argument about the purpose of such visits. Are they designed strictly to obtain recruits; the more, the sooner the better? Or is the object much longer term and all-embracing? Is it to project a favourable brand image for the Army in the minds of the bulk of the population? I believe the real purpose of the activity known as KAPE is the latter. Tattoos, the Royal Tournament and similar displays remind the public in the main of past glories on traditional lines. There remains a vast ignorance and apathy towards the Army of the 'sixties. The best way to lighten their darkness is to take the Army to the people as it really is, complete with modern arms, vehicles, equipment and techniques. Let them see the Army on their doorstep; let them handle the equipment, above all let them talk quietly and at leisure with the soldier of today. Such a policy is bound to have long term effects, including a satisfactory and continuing flow of keen recruits.

Colonel Clutterbuck in his article "Twice as many recruits", in the June 1962 edition of the *RE Journal* dismissed the technique of KAPE in fairly short order. In terms of immediate recruits it is true that measurable results are few. Yet it is difficult to imagine a youngster of 18 deciding on the spur of the moment by a chance visit to a "KAPE" unit display that he would then and there "go for a soldier". Only by taking the long view of recruiting trends over the next few years can a full assessment in numerical terms be made. Tours made by 38 Corps Engineer Regiment in 1961–62 were designed far more to create a favourable impression on the minds of all spectators, young and old alike—including Mum—than specifically to winkle out the odd recruit on the spot.

This Paper seeks to explain how 38 Corps Engineer Regiment set about its task in 1961–62 of Keeping the Army in the Public Eye; what lessons emerged in the process and what conclusions can be drawn for the future.

## Definition of the Aim

As laid down the the War Office, the aim for 1962 was to enable the younger members of the general public to see the Army training with modern equipment and to give them the opportunity of talking informally with regular soldiers, thus finding potential recruits who were thereafter to be handled by the Army Recruiting Staff. A grave limitation on the aim was that schools were to be excluded from the scheme unless Command Headquarters specifically requested such visits. This aim was clearly directed at the short-term problem of finding 165,000 soldiers by the end of 1962. The broader aspect of influencing the minds of the people of this country as a whole so that a continuing flow of keen young men wishing to join the Army is stimulated finds no place. The specific exclusion of visits to schools can only be assumed to stem in part from the vested interest of the Schools and

Youth Liaison Officers in teams of Lecturers. It is suggested that a major lesson for the future is that the aim needs broadening now that the short term other rank manpower crisis in the Army has been surmounted.

Certain specific ways of achieving the aim were also laid down. These included short demonstrations showing the unit operating in the field; civic ceremonies and social occasions including sports matches. The methods actually employed by 38 Corps Engineer Regiment are discussed in succeeding paragraphs.

## Planning a KAPE Tour

### *Basic Organization*

In early 1961, when first the plan for KAPE Tours was mooted, argument waxed fast and furious as to how to set about it. Where should units or sub-units go? At what strength—for how long—what equipment should they take—where would they live? The questions were legion; answers extremely hard to come by. Experience proved that the basic question of all to solve was into what sized groups should the Regiment break down for the Tour. Our solution was four Troop Groups of up to eighty all ranks including attached, with two squadron HQ each co-ordinating two Troops administratively.

### *Accommodation*

Geographically speaking, the area of operations split naturally into North-East England (and Scotland in 1961) for one squadron and North Midland Area and the West Riding of Yorkshire for the other. Accommodation for Troop Groups and Squadron Headquarters in these areas was the next hurdle to surmount. As a matter of principle, Troops engaged on KAPE tours must have good permanent accommodation with baths or showers if they are to turn out immaculate day after day for a whole fortnight. Territorial Army Drill Halls or disused hutted camps simply will not do. Large administrative overheads defeat all efforts to get maximum numbers of men on to the KAPE stands; a familiar hazard when organizing training.

A variety of solutions was found to the accommodation problem each year, including much help from certain RAF Stations. A radius of action from each firm base of up to 30 miles proved practicable. Greater distances were too much of a strain on the men at the end of a long day in the full glare of the public eye. This strain proved greater even than had been anticipated. Teams must be organized into shifts throughout the day and a tent or cover provided where meals can be eaten out of sight of the public.

### *Selection of Cities*

The selection of cities and towns in which to make an appearance was one of the most baffling problems to solve. Close liaison with the Army Recruiting Staff at Command and Area level was essential. Yet even with four teams operating simultaneously for two whole weeks, the numbers of cities and towns were far beyond our capacity to cover. The variables were so many; should well proven recruiting centres get the bulk of our effort; should we try and till virgin soil? Which cities were known to be hostile or at best apathetic to recruiting efforts? A typical case was Sheffield, a city believed to be indifferent at best, yet one in which the Regiment had built up a store of good-will when conducting emergency roof repairs after the great gales in February 1962. Where were Army and Special Royal Engineer

Recruiter centres to be found? Where was unemployment known to be a factor? What local fairs, agricultural shows etc. might clash? When was early closing day in each city; which cities could offer good central parks or squares on which a display could be staged?

The great need was for intelligence of every kind; once again a standard lesson from planning any military operation. A great mass of information had to be obtained and collated; by Regimental HQ from Command Headquarters' sources and by squadron commanders by ground reconnaissance. From all this data the final plan for each year emerged.

A major limitation on the numbers of cities to be tackled was the duration of stay in each. We got our answer to this one wrong in 1961 and by no means right in 1962. The key factor here is publicity to attract masses of people in a steady flow to the display site. This factor is considered further later in this paper. The lesson learned, by painful experience, was that in a large city it is necessary to put on a show for three consecutive days if full value for effort expended is to be forthcoming. The ideal solution is for the Lord Mayor to visit on the first day accompanied by local photographers and journalists. Publicity overnight leads to better attendance on the second day. If the show is good enough, word goes round on the local grape-vine on Day two, leading to yet better results on the third day. The only way to get really good attendance quicker is to have eye catching exhibits such as free fall parachutists, helicopters etc. as both a pre-publicity gimmick and attraction on the day.

*Co-operation with Area Recruiting Officers*

Having decided on the list of cities and towns to be visited, detailed planning should have been easy to complete through the agency of local Army Recruiting Officers. In several cases most valuable assistance was rendered, notably at Northampton and York. In the latter city the regular major concerned promised to arrange the site for the display, fix local publicity, talk to the local Press and have his recruiting caravan on site all day. All this was done and on the Sunday of the visit he and the whole of his all-arms recruiting staff were present for most of the day.

Such co-operation made life easy for the squadron and troop commanders concerned. It was not always thus. One Recruiting Officer made it clear on first contact that he considered KAPE a waste of time. He would give no help in arranging a display site in a large city in his area. On the first day of the show he would not even produce the local RE Special Recruiter on site; took him away during the course of the second day and as a great concession allowed him to attend full time on the third and last day. Many other Recruiting Officers fell between these two extremes. A typical case concerned an ARO who virtually forebad the Squadron Commander concerned to contact the Town Clerk of a big city direct in order to fix a display site. He promised to do it himself. When contacted six weeks later, he said he was finding things extremely difficult and that if we still wanted a site the only hope was to contact the Town Clerk ourselves. Valuable time had been lost; but a personal visit to the City Hall yielded the utmost co-operation and the immediate offer of two possible display sites. To give him his due, this ARO later accompanied the Lord Mayor on his visit to the Troop Team concerned in that city.

The lesson here is that intelligent and forward-thinking AROs welcomed the appearance of regular units in their areas. Those more wedded to past methods appeared to resent intrusion into their preserves.

*Detailed Reconnaissance*

The table at Annexure A shows the Regimental plan for 1962 in full detail together with some remarks on the results. A quick glance at the headings and one or two of the serials will give some measure of the quantity of detailed reconnaissance and liaison required to mount a two-week programme with four Troop Groups.

The burden fell entirely upon Squadron and Troop commanders. Expressed statistically, Squadron Commanders and their seconds in command spent about 17 officer days on reconnaissance; Troop Group Commanders spent up to 24 officer days before completing the plans for their fortnight tour.

Some of the reasons for this massive effort have been set out above. To produce even the outline plan required a mass of visits to Army Recruiting Officers, Territorial Army Group Commanders and staffs, Mayors, Town Clerks, Park Superintendents, Market Managers, Borough Engineers and Police. All these contacts were most instructive for the officers concerned; but time consuming. So far as site selection in each city or town was concerned, the most important individual was the Town Clerk. No site could be regarded as fixed until his approval in writing had been received after a meeting of the appropriate subcommittee of the City Council, an event usually held but once a month.

## FINANCE

Expenses fell into two main categories, entertainment and publicity. The total budget for the Regiment was just over £400 for both heads, scarcely a princely sum. A Troop Group could only expect about £50 for a fortnight on entertainment. This sum could not support any elaborate civic ceremonies or social occasions. Nor could a Troop hope to mount any worthwhile effort in the way of sports matches in a large city. In 1961 several cocktail parties in Territorial Army Drill Halls were staged. The conclusion was inescapable that though the city dignitaries and local Press enjoyed themselves, no potential recruits were to be found amongst their numbers. In 1962, therefore, entertainment was restricted to "on site" efforts only. Visiting Lord Mayors and Press were treated to sherry, usually in the privacy of the plush Army Recruiting Trailers now in service. The public were entertained to hot dogs and hamburgers cooked on the field kitchen exhibits which formed part of each Troop show. These exhibits were directed every bit as much at influencing Mum and the girl friend as at filling the stomachs of innumerable small boys—the recruits of tomorrow.

Accountancy, particularly in 1962, became a major headache. Those splendid men who seem to assume that every officer is a trifle short of financial probity had devised rules of such complexity that over 150 bills had to be cleared through the Command Pay Office for an expenditure of about £400. The only surprise is that no observations were received on the inordinate consumption of sausages.

Publicity eats money. Each year we could have done with double our allocation. Even then attendance was most variable as Annexure A shows. Publicity methods and expenditure are discussed below.

PUBLICITY

This is a subject of vast complexity; a successful solution is vital if all the blood, sweat, toil and tears of staging a KAPE tour is to have any tangible result. One lesson was learned early. The official Army Public Relations machine was unable to assist a single unit effort. The onus lay with the Regiment to initiate its own publicity campaign to cover twenty-six cities and towns.

The ideal solution would be for each year's KAPE effort throughout the country to be heralded by TV and newspaper publicity at National level. Individual officers approaching Mayors and Town Clerks would in this way find themselves dealing with minds generally receptive to the aim of their particular display.

Our method was to appoint an officer in each Squadron as a publicity officer with a small team to assist him. The principal weapon was the poster; large brightly coloured posters for boards and the sides of vehicles, small equally highly coloured ones for hanging cards. These posters proclaimed date, time and place of Troop displays to our own design filled in on standard Army Recruiting headed posters. Publicity teams visited shops, pubs, public buildings, restaurants, cinemas, public parks, football and cricket grounds etc. in each city to be visited well ahead of the date of appearance. Response in accepting these posters was most encouraging. We learned at an early stage that to rely on the Army Recruiting Organization for mass distribution of posters was insufficient; their usual ploy was to exhibit only on Territorial Army notice boards and other conventional Army hoardings.

Nearer the time, Scout cars, one-ton armoured and three-ton vehicles fitted with large display boards each side, like large self-propelled sandwich-men, toured the streets advertising our wares. Many cities ban loudspeakers. but in some cases loudspeakers mounted on scout cars were brought into play.

In every single case we found the local Press to be uniformly helpful. Good advance publicity came from feeding them "local boy" stories with photographs which they published free provided that the lad concerned was coming with the Troop team for that particular city. Classified advertisements we found useless. Most people do not read the small type. A number of 4-inch by 2-inch advertisements were paid for in local papers. It is difficult to judge how well these paid off. Local journalists were particularly good in covering mayoral visits and giving us free feature coverage on the second day of our stay in a big city.

In schools and clubs we found the latest editions of both Corps Recruiting pamphlets extremely valuable. Both are excellent, glossy publications which appeal to all who encounter them. Even in 1962 a number of school cadet forces had not received copies.

Great efforts were made to try and interest both television channels in our tours. ATV showed by far the most interest. In 1961 a cameraman spent a day in Ripon during the final rehearsals for the various Troop displays. Several minutes of most valuable publicity went out over the late Northern News that same night. In 1962 a similar visit had to be cancelled at the eleventh hour to our great regret; doubtless some juicy murder or scandal supervened. In 1962 BBC Steam Radio showed interest and put out an interview with the Regimental Public Relations Officer at lunch time on a Northern Events of the Week programme.

## Troop Displays

*Composition*

Each Troop Group was built up on the framework of a Field Troop or Troop of the Field Park Squadron. Some plant and a crane was added to each group. A detachment from 42 (GT) Company RASC provided transport to carry assault boats, light assault rafts, improvised bridging equipment and other gear allocated. The RE Band from Aldershot was routed round the various big cities to join Troop shows. The Corps Mobile Display Team was also allotted in 1962, though it met its Waterloo at South Shields where a ninety mile-an-hour gale shattered an excellent display and caused the Team to retire from the field of battle licking their wounds. Annexure A shows how these resources were allocated in 1962.

*Display Items*

We learnt quickly that traditional displays of inert vehicles and plant, masses of photographs and static stands of mines had little appeal. The real draw was action; something live happening or, better still, the chance to try a hand at something. Wherever a city offered a river front, assault boats and rafts were a certain draw. Simple combat engineer tasks by teams erecting an improvised bridge or derrick, repeated over and over again, were popular. Firing an electric detonator in a dustbin, thereby causing the lid to fly 10 ft in the air with a loud clang, never ceased to thrill. Stands for handling weapons and wireless equipment, all suitably chained to resist thieving fingers, were well patronized particularly by small boys.

In 1962 we put much more effort into exhibiting tradesmen actually working at their trade. Each tradesman's booth had working drawings of what was being made and specimens of completed work. Carpenters, bricklayers, welders, painters, fitters working on repair of items broken down during the tour; all these proved of great interest, not least to those visitors already engaged in apprentice training.


**Photo 1.** One corner of the Display at Nottingham showing a Regimental Poster in the foreground.


**Photo 2.** A never failing attraction for the young, provided security chains are available. A display site at Consett.

**Photo 3.** Potential tradesmen of the Royal Engineers.

**Keeping the army in the public eye 2 & 3**


**Photo 4.** These boys will remember the bang for many a day to come. A site in Hull.

# Keeping the army in the public eye 4

*Annexure A*

## KEEPING THE ARMY IN THE PUBLIC EYE

### NORTHERN COMMAND—TOUR BY 38 CORPS ENGINEER REGIMENT IN 1962

| Date | Town | Place of Demonstration | Timings of Demonstrations | Display Consisted of | Remarks |
|---|---|---|---|---|---|
| 12 Field Squadron *Group "A"*<br>19 June<br>20 June | Derby | Mark Eaton Park | 4 pm–7 pm | Static Display<br>Derrick Construction<br>Assault Boats<br>Raft Construction | Scout Car in Main Square. Fair attendance. Good site. Fair weather. |
| 21 June | Mansfield | Car Park Chesterfield Road | 12 pm–6.30 pm | Static Display<br>Band Performance | Band Beating Retreat at 6 pm. Fair attendance. Fair weather. Fair site. |
| 22 June<br>24 June | Nottingham | River Trent<br>Near Trent Bridge | 22 June 4 pm–7 pm<br>23 June 12 pm–7 pm<br>24 June 12 pm–7 pm | Static Display<br>Band Performance<br>Derrick Construction<br>Assault Boats and Raft Construction | Band in Square at lunch time 22–23 June. Beat retreat 6 pm. 23 June on Site. Good site, Fair weather. Very windy Sat. and Sun. Good attendance Sat. and Sun. Retreat popular. |
| 26 June<br>27 June | Doncaster | Market Square Car Park<br>Waterdale Car Park | 12–5.30 pm | Static Display<br>RE Mobile Display | RE Mobile Display damaged by gale at South Shields. Tour abandoned. Good crowds in both sites. Fair weather. Good site. |
| 29 June<br>30 June | Sheffield | Car Park on the Moor | 29/30 June<br>12–5.30 pm | Static Display<br>Derrick Construction<br>TA Band performance | Scout Car in front of Main Shopping Area. Poor crowds on Friday. Fair on Sat. Fair site. |
| 12 Field Squadron *Group "B"*<br>18 June to 20 June | Bradford | Peel Park | 4 pm–6 pm | Static Display<br>Assault Boats<br>Gainsborough Tractor<br>Machinery Lorry<br>Improvised Bridge Construction | Scout Car in front of Town Hall. Fair weather. Fair crowds. Reasonable site. |
| 22 June<br>24 June | Leeds | 22 Millgarth St. Car Park<br>23/24—Roundhay Park | 22 June–23 June<br>12–5.30 pm<br>24 June 12–7 pm | As for Bradford | |

*Annexure A*

## KEEPING THE ARMY IN THE PUBLIC EYE
## NORTHERN COMMAND—TOUR BY 38 CORPS ENGINEER REGIMENT IN 1962

| Date | Town | Place of Demonstration | Timings of Demonstrations | Display Consisted of | Remarks |
|---|---|---|---|---|---|
| 26 June<br>27 June | Corby | Town Square<br>Oundle School Demonstration | 12–5.30 pm | Static Display<br>Gainsborough Tractor<br>Improvised Bridge Construction<br>Machinery Lorry | *Corby*—Good site.<br>26 June Fair crowds.<br>Fair weather.<br>*Oundle*—Very good site.<br>27 June. 500 boys from seven schools. Very valuable. |
| 28 June | Peterborough | River Embankment | 4–7 pm | Static Display<br>Assault Boats<br>Gainsborough Tractor<br>Improvised Bridge Construction<br>Machinery Lorry | Good site.<br>Fair weather.<br>Fair crowd. |
| 29 June | Kettering | North Hall Street Car Park | 4–6 pm | Static Display<br>Gainsborough Tractor<br>Machinery Lorry<br>Improvised Bridge Construction | Good site.<br>Fair weather.<br>Fair crowd. |
| 30 June<br>1 July | Northampton | 30 June (Midsummer<br>1 July (Meadows | 30 June 12–7 pm<br>1 July 12–7 pm | Improvised Bridge Construction<br>Raft Construction<br>Gainsborough Tractor<br>Static Display<br>Machinery Lorry | Good site.<br>Fair weather.<br>Very good crowd. |
| 15 Field Park Squadron<br>*Group "A"*<br>19 June | Chester-le-Street | Market Square | 11 am–7 pm | Weapons Stand<br>Mine Warfare Stand<br>Wireless Stand<br>Demolition Stand<br>Tradesman Stand<br>RE Model<br>Corps Mobile Display<br>Display Boards<br>Sports Stand<br>Plant Stand | Good weather.<br>Very good attendance.<br>Made most welcome by Chairman of the Council and general public. |

*Annexure A*

## KEEPING THE ARMY IN THE PUBLIC EYE
## NORTHERN COMMAND—TOUR BY 38 CORPS ENGINEER REGIMENT IN 1962

| Date | Town | Place of Demonstration | Timings of Demonstrations | Display Consisted of | Remarks |
|---|---|---|---|---|---|
| 20 June | Consett | Market Square | 11 am–7 pm | as for Chester-le-Street | Good weather. Very good attendance. Made welcome by Mayor and general public. |
| 22 June | South Shields | Market Place | 11 am–6.30 pm | as for Chester-le-Street | Very good attendance. |
| 23 June<br>24 June | South Shields | Foreshore | 12–8 pm | as for Chester-le-Street in addition Plant Stand | Site abandoned on 24 June because of heavy gale damage |
| 25 June | Crook | Market Square | 11 am–7 pm | as for Chester-le-Street less Corps Mobile Display | Good weather.<br>Good attendance. |
| 26 June | Gateshead | Ellison Street<br>St Albans Street | 11 am–7 pm | as for Crook | Good weather—Band.<br>Very poor attendance. |
| 28 June | Newcastle | Cattle Market | 11 am–7 pm | as for Crook and in addition a small Plant Display. | Good weather—Band.<br>Very poor attendance. |
| 29 June | Newcastle | Leazes Park Car Park | 11 am–7 pm | as above | Abandoned. |
| 30 June<br>1 July | Whitley Bay<br>Whitley Bay | Band Stand Site | 12–8 pm | as for Crook and in addition a Plant Stand | Band played during afternoon and Beat Retreat. Excellent attendance both days. |
| 15 Field Park Squadron<br>*Group "B"*<br>19 June | Darlington | Market Square | 12–8 pm | Weapons Stand<br>Mine Warfare Stand<br>Wireless Stand<br>Demolition Stand<br>Tradesman Stand<br>Display Boards | Good site on Market Square. Good attendance. 1 Officer type recruit interested. |

KEEPING THE ARMY IN THE PUBLIC EYE

*Annexure A*

NORTHERN COMMAND—TOUR BY 38 CORPS ENGINEER REGIMENT IN 1962

| Date | Town | Place of Demonstration | Timings of Demonstrations | Display Consisted of | Remarks |
|---|---|---|---|---|---|
| | | | | Sports Stand<br>Machinery Lorry<br>Plant and Bridge Models<br>Circular Saw<br>Lighting Set | |
| 20 June<br>21 June | Stockton-on-Tees<br>Stockton-on-Tees | Brown's Bridge<br>High Street Recess | 11 am–7 pm<br>11 am–7 pm | as for Darlington | Too near Primary Schools. Too many young children. |
| 22 June<br>23 June | Middlesbrough | Albert Park | 2 pm–8.30 pm | as for Darlington and in addition:—<br>Water Crossing Equipment | Good site.<br>Good attendance. |
| 24 June | West Hartlepools<br>Seaton Carew | Public Swimming Bath Car Park | 11 am–8.30 pm | as for Darlington and in addition Plant Stand | Abandoned early pm due to high winds. |
| 25 June | Darlington | Feetham Field | 11 am–6 pm | as for Darlington | Not a good site.<br>Poor attendance. |
| 27 June | West Hartlepools | Fountain House Car Park | 11 am–6 pm | as for Darlington | Excellent attendance. |
| 30 June | Hull | Queens Gardens<br>Wright Street Car Park | 11 am–6 pm | as for Darlington | Fair attendance. |
| 1 July | York | St George s Field | 2 pm–8.30 pm | as for Darlington and in addition Light Raft | Band played and Beat Retreat. Very good attendance. |

*The Band*

This still has considerable drawing power as a last minute publicity draw. The ideal solution was found to be a combination of a band concert in the principal square of a city at lunch time, followed by a march to the display site and in the evening a Beating the Retreat ceremony. We were delighted to have the RE Band Aldershot with us in 1962. They provided exactly the right blend of military music and nothing was too much trouble for them.

*Timing*

This was one of the most intractable problems to solve. For how many hours should a display on a particular site keep open? We decided at an early stage to make our maximum effort on Saturday afternoons, Sundays and early closing days. On week days peak attendance could be hoped for over the lunch hour and just after closing time for shops and offices. Yet experience showed that a steady trickle of people could be expected at other times; unemployed, housewives, the ubiquitous children and so on. Some of these categories took a genuine interest and lack of mass custom allowed time to talk with them at length. Such talk was the essence of our method of getting people acquainted with the way of life of the Army of the 'sixties.

But despite our desires, the spirit being willing, yet the flesh was weak and forced on us a practical limit on hours of opening. Each Troop worked in two shifts on site. The strain on the individual sapper was severe, coping as he had to with a stream of people of all ages and both sexes; some interested, others viewing him and his particular wares with indifference; the children, often uninhibited and thrusting. A full day of rest per week proved essential for both men and equipment. Off-peak hours on site were tailored to find a reasonable balance between the conflicting factors outlined above.

## Conclusions

To surmount the short-term manpower crisis, particularly in the Corps of Royal Engineers in 1961–1962, it is certain that this massive effort by 38 Corps Engineer Regiment was worth while. However, the problem in succeeding years is now an Army rather than a Corps matter. The aim in future should be broadened to building up a favourable brand image of the Army of the 'sixties as an up to date force offering a thoroughly interesting and valuable career. By this means a steady flow of high quality recruits should be stimulated.

Our impression was overwhelming that there is a vast fund of well meaning but ill-informed goodwill towards the Army throughout the area in which we operated. The legacies of World War II and National Service are still with us. Ignorance of the All-Regular Army, its equipment, way of life and conditions of service is often abysmal. Taking the Army to the people, not in the arena at Earls Court or Edinburgh Castle but as close as possible to their homes, must remain of long term importance to the Army as a whole.

Keeping the Army in the Public Eye cannot be regarded as a strictly recruiting drive and results therefore measured statistically at the time. The influence exerted upon the minds of mum, dad, the girl-friend and even relatives and friends is just as important as the impact upon the mind of a potential recruit.

The scheme needs extending to allow displays on large school playing fields, university campi and any other place where potential officers as well as men are to be found.

It is essential that tours by regular units be fully integrated with the efforts of the Army Recruiting Organization, particularly at ground level. Local planning and organizing should be lifted off regular units and placed squarely on the shoulders of the Recruiting Organization.

A strong impression was gained in 1962 that city and town authorities and to some extent the public at large have been saturated with too many different "KAPE" touring teams, both large and small from all Arms of the Service. Far more impact on the public could have been made, certainly in the great industrial cities of the north, by fewer but larger KAPE shows put on by teams representing all Arms. In this way the load on the Recruiting Organization would be reduced, but the effect enhanced by the inclusion of "public eye" catching items such as helicopters to boost attendance.

Above all, well timed and directed publicity at National level is needed to put over the aim of such shows. Thereafter funds are needed for large scale local publicity. The end certainly justifies the means! The Corps, with its manifold attractions for potential recruits has nothing to fear from Keeping the Army in the Public Eye organized on an Army basis.

# Operation "Dominic"

*By* Lieut-Colonel J. D. Goodship, RE

## Introduction

1. At their meeting in Bermuda in late 1961 the President of the United States of America and the Prime Minister announced that as a result of the Russian Nuclear Tests which had been carried out in the summer of 1961, it might be necessary for the Americans to carry out a test series and the UK Government had agreed to make Christmas Island available to the United States Government as a test base. Shortly after this announcement a reconnaissance of the island was carried out by British and American representatives. The E-in-C on a routine visit to the island at this time was nearly caught up in the reconnaissance and his fortuitous presence in the area gave rise to some speculation. On 16 February 1962 a memorandum was signed between the two Governments allowing the United States the use of Christmas Island.

2. On 17 February, one day after the signing of the agreement, fifty American contractor's men arrived on the island ready to start work. They had no tools, equipment, bedding or food but this did not deter them. They were welcomed by and initially worked under the orders of OC 73 (Christmas Island) Squadron RE who provided them with British tools and equipment.

3. In order to cope with the increased requirement for production of water and electric power and to provide a liaison staff to work with the

American military and civilian forces the Garrison of Christmas Island was increased. A CRE together with a SO2 and E & MO, two Clerks of Works and about fifty Sapper tradesmen were dispatched from the UK and FARELF as reinforcements.

### Organization of US Task Force

4. A table showing how the Joint Task Force, which was set up by the Americans for the test programme, was organized is shown on page 42. There are a number of fundamental differences between the American organization and the organization set up for the Grapple series. In particular all engineering work was carried out by a civilian firm on behalf of the American Atomic Energy Commission as opposed to Military Engineers. This firm—Holmes & Narver—has constructed and operated the American test sites at Bikini, Eniwetok and Nevada and they have vast experience, not only of constructional engineering but of the general scientific requirements for a nuclear test series. Beyond their engineering responsibilities they also act as general contractors and arrange the feeding, accommodation and transport for all elements of the task force other than the United States Navy when afloat.

5. As opposed to the British organization, under which only one scientific body, AWRE, was concerned in the tests, there were four American scientific laboratories engaged in operation Dominic. Lawrence Radiation Laboratories (LRL) and Los Alamos Scientific Laboratory (LASL) were concerned with the design of the weapon systems whilst the Sandia Corporation was concerned with weapon engineering and Edgerton, Germeshausen and Grier Inc (EGG) were responsible for communications and electronics of the test series. The Task Force Commander and the contractors were often dealing with the conflicting requirements of three or four scientific bodies.

### General Condition of Facilities

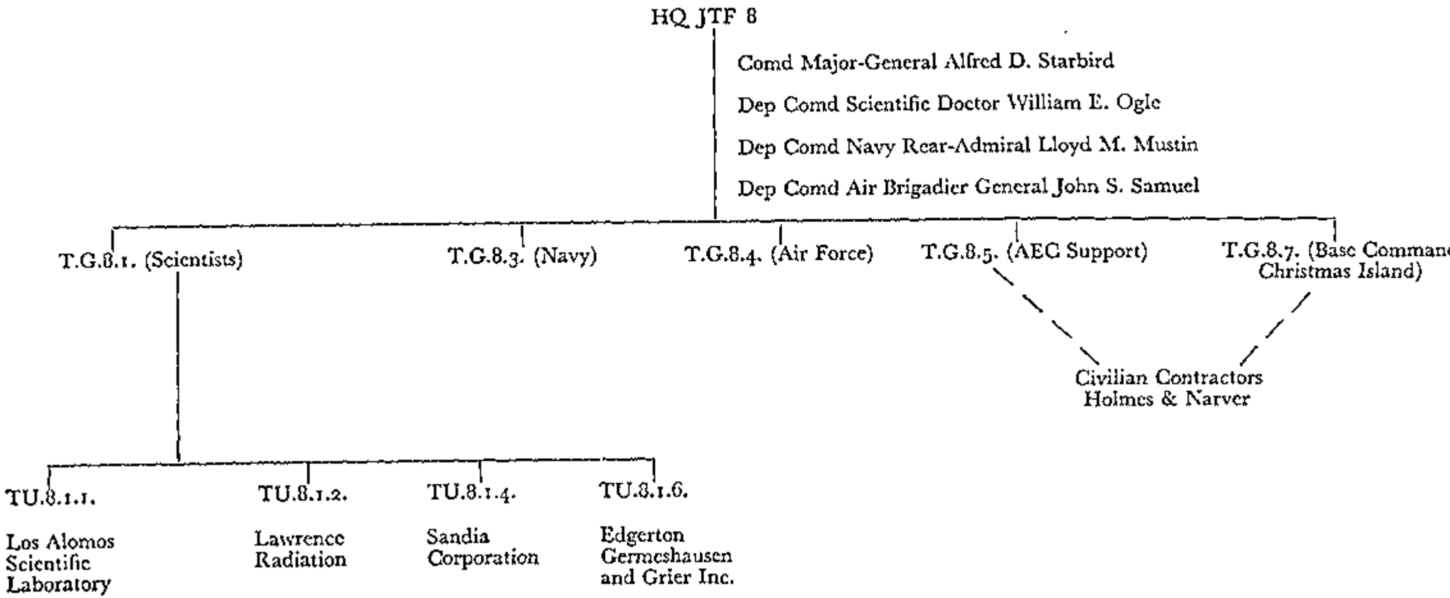
6. Since 1960 the British Garrison had withdrawn from the Main Camp and the facilities there had been put into a state of preservation. All that had been possible in the way of maintenance was occasional checks to ensure that the equipment and buildings had not deteriorated too far. The majority of the preservation of the equipment had been carried out by 17 Field Squadron in 1959 and the measure of the success of their work can be judged by the ease with which the camp was reactivated. Due, however, to the climate, most of the equipment stored in the open was in very poor shape as can be seen from the photograph on page 44. The Main Camp and Joint Operations Centre (JOC) area presented a sorry picture with fallen coconut palms and debris littered about. A photograph of the JOC area is shown on page. 44.

### RE Tasks

7. The American plans for the operation were to bring some four thousand scientists, military and contractor's men to the island and to accommodate them in the Main Camp and a smaller camp at their main scientific base at site "A". In addition to the re-activation of the camp and the construction of scientific sites they required to extend the hardstandings of the main airfield in order to cater for the numbers of aircraft which they would be basing on the island for the supply of the US forces and for the test programme. The initial target date for all work to be completed was 23 March, this was later put back by some three weeks.

ORGANIZATION OF US TASK FORCE

OPERATION DOMINIC




Note: There were other Task Groups under Command JTF 8 but these were concerned with the tests on Johnston Island.

8. RE tasks fell under four main headings:—

(*a*) Liaison with the Americans and approval of their plans.

(*b*) The re-activation and operation of three pumping stations providing water to the main camp.

(*c*) The re-activation of the generating stations providing power to the Main Camp and the JOC.

(*d*) The provision of such stores and equipment as were available on the island or could be obtained from the UK to the Americans.

*Water*

9. Fresh water for the Main Camp was provided from two water holes known as Banana and Bamboo. Water from these holes was drawn from underground lenses and it was most important to ensure that these limited sources of water were not over-pumped. A close check had to be kept at all times on their salinity. The two water holes were capable of producing some 50,000 gallons of water per day which with strict discipline should be adequate for approximately 2,500 men. To meet American requirements these natural sources required considerable augmentation with distillation plants. After initial difficulties in getting pumps to run and clearing out silted-up pipe lines the target figure of 50,000 gallons per day was reached by early March. However, most of the equipment was old and had remained in preservation for two years and there was a very heavy maintenance load in keeping the pumps running and attempting to match the rapidly rising consumption of water as the American strength built up. The provision of saline water for the Main Camp sewage system presented no major difficulties other than constant maintenance of pumps.

*Electricity*

10. The Main Camp power house contains six English Electric 300 KVA Generators. In order to retain a standby capacity and to allow for breakdowns the Americans were informed that the maximum capacity that would be available from this station would be 800 Kw. All six generators were depreserved and brought on line and this capacity was reached by mid-March. Considerable difficulty was experienced initially, due to exciters having become damp during the period of preservation. The power for the JOC was initially provided from its own power station containing three Dorman 60 KVA Generators but it was decided that because of the shortage of electricians (both British and American) to connect up the JOC area to the main camp generating station. This entailed laying approximately 1½ miles of underground cable and the erection of a new substation. The work was carried out by a Clerk of Works (E) and six Sappers in two days and reflects considerable credit on the men concerned. It also gained the admiration of the Americans who saw the work being carried out. However, assistance had to be provided in the form of an Hawaiian Japanese known as Sammy who became an honorary Sapper for two days and did the cable jointing.

*Liaison with the American Forces*

11. The American Forces before the arrival of General Starbird were under the command of a Colonel Hooper, a lean Texan cavalry man who had the task of co-ordinating the activities and requirements of the scientists, civilian contractors and American military forces. Each evening he held a co-ordinating conference with representatives from scientists, contractors

**Photo 1.** Part of the equipment preservation park.
(*see paragraph* 6)

**Photo 2.** View of JOC before rehabilitation.
(*see paragraph* 6)

**Operation Dominic 1,2**

and military units to air differences and sort out problems. I attended these meetings and thus got in on the ground floor. Even more essential I got my face known to the Americans on the island. In order to ensure close liaison HQ RE was set up in the Main Camp area next door to the offices of the American contractors Holmes & Narver and close to the office of the Resident Engineer of the Atomic Energy Commission who acted as the American Chief Engineer of the island. The most friendly relations were established at all working levels and in one case a joint office was set up where the Clerk of Works controlling the British water supply to the Main Camp and the American civilian supervisor of water facilities both worked.

*Provision of Stores*

12. When the British Garrison was reduced to a minimum holding strength the establishment allowed only one Corporal and one Sapper to look after all the Engineer Stores which had been left on the island. The Engineer Stores occupied an area of approximately 30 acres split between two main sites a mile apart and comprised stocks of some 6,000 different items varying from complete huts down to small electrical and water supply stores and spare parts for generators, etc. It had been impossible to check and maintain the stores. Whilst ledgers were held the stock figures did not necessarily reflect the true figure and the condition of the stores was often suspect. The photograph on page 46 gives an indication of the condition of stores left in the open. In order to cope with the flood of the American requirements an agreement was reached with the American Contractors that their tradesmen would visit the stores; select the items that they required; notify the Corporal what they wanted and then take them away. At the end of each day a consolidated list was made up and signed by the contractor's agent. This system relied on the absolute honesty of the American contractor's workmen and the British store-keeping staff. As far as can be judged it was never abused. Without it the Americans would never have been able to re-activate the island within the time space allowed.

## US Work

*Main Camp*

13. With the help and advice from RE the American contractors completely re-activated all the facilities in the Main Camp. This entailed the complete checking of the water supply system and the replacing of worn out ball-cocks, taps, etc. They took over the old cookhouse, cleaned and brought into operation the steam cooking system and installed some 500 tons capacity cold storage refrigeration. These were provided mainly in 5 and 10-ton units and operated by mobile generators.

14. In order to augment the water supply system the Americans brought in nine 600-gallon-per-hour and twelve 300-gallon-per-hour distillation units. A photograph of this plant which was erected and brought into use within six weeks of the arrival of the first unit is shown on page 46. When working at maximum capacity these units were capable of producing about 100,000 gallons per day of fresh water but due to breakdowns and difficulty with the inlet valves on the reef which were continually getting blocked they rarely achieved more than 30,000 gallons per day.

15. The electrical wiring in the huts was often a cause for alarm; it had become encrusted with damp coral dust blown in by the sea breeze. The best method of drying it out was to switch on the light and wait while a flicker of

**Photo 3.** Part of the Engineer Stores Area.
(*Ref paragraph* 12)

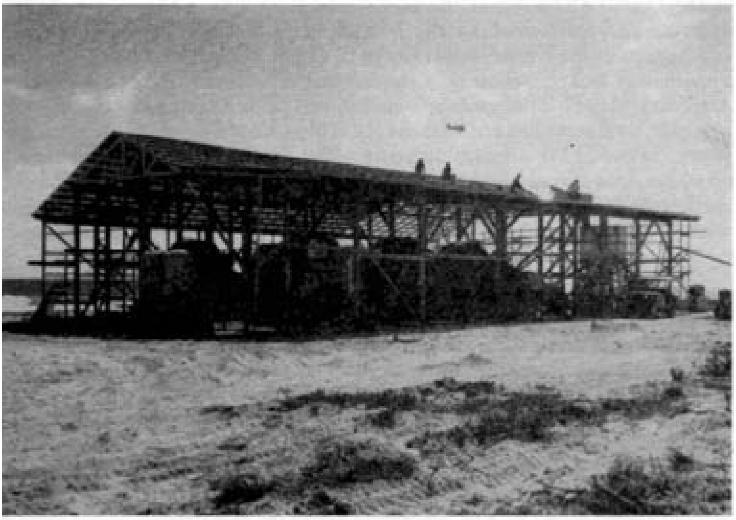


**Photo. 4.** American distillation plant. The building in course of completion.
(*Ref paragraph* 14)

blue flame ran up the flex. If this failed it was then necessary to rewire the hut.

16. When they had finally settled down the Americans started to instal a few luxuries in the Main Camp in the way of Ice-making Machines, and small electric heaters in all clothes cupboards to prevent clothes mildewing. From the early days they provided interior sprung mattresses for all ranks which proved a welcome change from the flock-filled variety issued by the British.

*"A" Site*

17. The Americans set up their main scientific base at "A" Site. This entailed the installation of some fifty scientific trailers and the construction of a 250-man camp. It required a power supply of .5 MW and for this purpose the Americans brought in two 750 KVA and one 1,000 KVA mobile generators. They also installed two 600-gallon-per-hour distillation plants to meet the water requirements of the staff living at the site.

*Roads*

18. Due to the excellent condition of the tarmac roads built by Royal Engineers during Grapple days, there was little requirement for road building by the Americans. However, they did construct a number of Coral Tracks connecting up the remoter scientific sites on the South of the island with the main road leading to "A" Site.

*Oil Pipe Lines*

19. In order to meet their requirements for aviation fuels the Americans laid a pipe line from the port area to a pillow tank farm at the main air field. This entailed the laying of some 13 miles of dual pipe line and the erection of a ship to shore line. It was an inter-service effort in that the ship to shore pipe line was laid and maintained by elements of a Construction Battalion of the United States Navy; the pumps and the pillow tanks were installed, operated and maintained by the United States Marines; the pipe line was laid by men of the United States Corps of Engineers specially flown out from Fort Belvoir and the whole organization was commanded by a United States Air Force Major! The operation was thwart with difficulties. These were, however, overcome but not without the loss of a number of nights sleep and worry, in particular on one occasion when the pipe line contained some 60,000 gallons of fuel which was spewing from most of the joints and flooding the island. It was even wondered at one time, whether the fuel in the line would ever reach the tank farm at the airfield.

*Airfield*

20. The main engineering work in operation Dominic was concentrated on the Airfield and entailed the preparation of two new hardstandings to take transport aircraft of MATS (Military Air Transport Service) and the search aircraft of the United States Navy as well as the resurfacing of the hardstandings and the runway through the aircraft decontamination area. In order to meet their original target date the Americans decided to prepare these hardstandings in compacted coral sealed with a cutback dressing. This construction proved inadequate in that the cutback bitumen did not penetrate the coral and merely formed a thin skin which tore off when the first aircraft taxied across it. The Americans relaid the two hardstandings and the decontamination area with cold mix of a coral aggregate which they mixed with a cutback bitumen using a grader to turn over the windrows before

laying the final surface. While this proved satisfactory, due to the poor grading of the aggregate a very uneven texture was achieved, and the hard-standing took a long time (ten days) to dry out before aircraft could be put on them. Eventually at the insistence of General Starbird the Americans re-activated the hot mix plant (Starmix 40), and used it for the construction of a helicopter pad. The American engineers subsequently admitted that they wished that they had used the hot mix initially as in spite of the work taking slightly longer it would have produced a very much higher standard of finish. In re-activating the hot mix plant the Americans were advised by an RE Officer and Sergeant who had operated it during the Grapple days. They were specially flown out from the UK at the Americans' request.

### US Test Programme

21. The United States test programme provided for the detonation of twenty-five nuclear devices in the vicinity of Christmas Island. This programme took place in a period of approximately ten weeks and at one stage three devices were detonated on consecutive days. In all their operations the Americans were most careful to ensure the complete safety of the British Garrison and the Gilbertese residents on the island. All British personnel were provided with special goggles to view the detonation and each outlying generating station or pumping house was provided with a separate radio receiver in order that those who worked there could hear the count down. In addition the Americans provided the normal loudspeaker broadcasts to keep everyone in the picture.

### Comments on the Operation

*American Organization*

22. While all work carried out by the American contractors was authorized by the Resident Engineer of AEC, he had no staff to ensure the work was up to specification. He also acted as the AEC agent on the ground and was swamped with a mass of other problems. In the rush to meet the target date some of the work carried out was most unsatisfactory and on occasions there was a difference of opinion as to how it should have been done. The contractor provided both the construction and design engineers and in the early days construction work was often completed before the design was formulated. In addition to these problems the Task Force Commander had no specific engineer adviser. In this case, however, he was a US Engineer Officer and on occasions he stepped in and made decisions on engineer problems himself. One could not help feeling that the presence of an American Chief Engineer and staff would have prevented many of the initial mistakes and would have provided more orderly solutions to their difficulties.

*Planning and Communications*

23. The team set up by Holmes & Narver for operation Dominic was recruited in great haste and while most of the top executives had worked together before, many of the foremen and junior grades were strangers to one another and often to the work. On some occasions there appeared to be a lack of planning and a subsequent failure to pass on orders to the man on the ground. One particular case stands out. The Americans wished to remove one or two lumps at the end of the runway and it was agreed that this could be done. The next thing that was known was when an enraged RAF Wing Commander (Flying) found a grader levelling off an area of some 500

yards at the end of his airfield thereby creating a dustbowl which was a hazard to aircraft when flying or if they should overshoot the runway. It appeared that someone had forgotten to tell the operator that it would be done by hand. This incident was settled amicably by the contractors filling in the dustbowl with lagoon mud and grading it to form an excellent overshoot area. But the extra work involved must have cost the US taxpayer a few thousand dollars.

*Financial Attitude*

24. If one was asked to name one factor which contributed above all else to the speed of the American operation the answer would be "their ability to buy time". To the American the one thing you cannot afford to waste is time and if the expenditure of money will avoid a hold up then there is no question of counting the cost. On many occasions a piece of equipment which had been delayed in shipment from America was purchased in Honolulu and flown in to Christmas Island rather than accept a possible hold up in their programme. An RE Officer and NCO were specially flown out from the UK to advise on the depreservation and operation of the asphalt plant in order to ensure that when the Americans wanted to use the plant there would be no delays due to their unfamiliarity with it. On the occasions when spares were urgently required for British plant and equipment all that was required was to mention the fact to the Resident Engineer of AEC and immediate authority for it to be flown out from the UK at American expense was given.

*Standard of American Tradesmen*

25. The American tradesmen on Christmas Island were highly paid (more than a Lieutenant-Colonel RE!) and first class at their trades. In particular there were a number of Hawaiian Japanese carpenters who were absolutely outstanding. The speed with which they constructed the shed housing the distillation units in the Main Camp was quite fantastic. The American plant mechanics managed to get several old items of British equipment running, including three Euclid tractors and scrapers. Anyone seeing the condition of this equipment which had been standing in the open for over two years would have said that such a feat was impossible. In addition to their efficiency the American workmen were some of the most cheerful and helpful individuals I have ever met. The Hawaiian guitar quartet which was formed of two Euclid operators, a carpenter and electrician was much in demand at evening entertainments and could earn a fortune at a London night club. An RE Officer was negotiating for the appointment as their UK agent but how far this got I don't know.

*General*

26. In a period of little more than two months the US Task Force re-activated Christmas Island as a Nuclear test base. In this time they brought in some 50,000 tons of stores by sea and 30,000 tons by air; they re-activated a camp which had lain idle for two years; erected a new scientific camp including the installation of 2.5 Mw of electric power and two distillation units and increased the hardstanding capacity of the airfield by over 50 per cent. This was a task that required drive, ingenuity and an immense organization. That there are one or two minor points of detail open to criticism is only natural but they should not be allowed to detract in any way from our admiration for the conduct and success of operation Dominic as a whole.

# Cheap Mobility

*By* Lieut-Colonel A. H. W. Sandes, RE

The *RE Journal* of September 1962 published a most interesting article on ground effect vehicles which discussed the possibility of developing (at huge cost) a scout vehicle with a cross-country performance akin to that of a horseman. This calls to mind an innovation of some eighty years ago, which at the time competed with cavalry rather well, to offer substantial improvement to the mobility of other arms. Its development affords some intriguing views of military attitudes towards new techniques of war, and a reminder that mobility need not always be expensive.

On 8 June 1888, Lieut-Colonel A. R. Savile, Professor of Tactics at the Royal Military College, Sandhurst, delivered a lecture to the RUSI, General the Right Hon. Viscount Wolsley, KP, GCB, then Adjutant General to the Forces, in the chair, on the subject of military cycling. Savile was an enthusiast who saw that the cycle could give the infantry a mobility considered by some of his contemporaries to be unnecessary if not ridiculous. He quoted "an officer who has distinguished himself and risen to high rank in our Army, who told me that he could not conceive any possible circumstances under which mobile infantry would be useful". This was possibly the voice of vested interest, for it was not long before trials were held on Salisbury Plain between a troop of cavalry and a body of cyclists to find out whether the latter could compete with horsemen across country. To the surprise of the cavalry the cyclists kept up with them, using the many paths and tracks which cover the Plain.

It appears that cycles were first put to military use by the Italian Army, for carrying dispatches on the manoeuvres of 1875. In Britain in 1881, a Colonel J. Sprot, writing in the *Cyclist*, suggested that orderlies be mounted on bicycles and that tricycles should be used for mounted infantry. It fell to a Colonel Tamplin of the Royal Sussex Regiment to employ military cyclists for the first time in Britain when he used them as scouts in 1885. This led to a comparison of the merits of the "penny farthing", whose rider could observe over hedge tops while on the move but was liable to descend without warning if his front wheel hit a stone, with those of the staid but lowly "safety bicycle". The "safety" was adopted, doubtless to the relief of scouts.

Colonels Savile and Tamplin must have impressed the War Office, for in December 1887 a committee was appointed under Savile to report on the specifications and manufacture of cycles clothing and equipment, and on the training of cycle units. Many kinds of cycle were examined. The tandem tricycle was judged to be fast and able to carry much baggage, while the modern troop carrying vehicle was foreshadowed by a multi-cycle made by Singer & Co. of Coventry, mounting ten to twelve riders with their kit, arms, and a large amount of ammunition. A single tricycle was thought by Savile to be "suitable in some respects for use by an officer, since it not only possesses the advantage of stable equilibrium, but the rider can halt without dismounting and turn about easily." Evidently officers were not too good at bicycling, and must be given a dignified mount midway between that of the swift but precarious scout and the multi-cycling ranks.

Royal Engineers must have been experimenting with cycles at this time, for in the manoeuvres of 1888 there appeared a machine called the Victoria Tandem, nicknamed "The Centipede" or "The Flying Sapper". It had six or eight pairs of wheels and carried sixteen men with a large tool box in tow. It seems to have been a failure, possibly proving too cumbersome, but the principle of the multi-cycle was approved by the War Office which in Army Orders of 1890 described a machine made in 4-wheel sections each seating 4 men, which could be connected to carry up to 12 men. Each section was 7½ feet long but only 39 inches wide, and the weight per man was 52 pounds. Other approved types were the tandem tricycle, 7 feet long and weighing 75 to 110 pounds; the single tricycle weighing 50 to 90 pounds; and the bicycle weighing 35 to 55 pounds. Pity the officer who had to ride a tricycle!

Sappers continued to show interest in cycling, for in 1900 the RE Committee approved a proposal to equip a cycle section of Volunteer Engineers for demolitions. Each man carried 26 lb of weapons and personal equipment, and 10 lb of tools and materials. Meanwhile the development of cycle mounted infantry progressed to the extent that in December 1908 the RUSI heard a lecture on "The Cycle in Warfare". A cycle unit of those days, despite its massive machines, could cover 80 miles a day on roads, or 60 miles on paths and tracks, and could carry three days' rations. Not a bad performance by comparison with present lorry mounted infantry.

The history of the London Cyclist Battalion relates that before 1914 the British Army was well to the fore in military cycling. Some curious aspects of the art are mentioned, such as the need for scouts "invariably" to hide their cycles under haystacks or in ponds of water, "preferably turgid". In contrast a distinguished staff officer at the War Office, who was responsible for military cycling, was urging that all riders in a unit on the march should use the same gear, so as to keep in step!

In 1915 an Army Cyclist Corps was formed, and a manual entitled *Cyclist Training* described the evolutions to be performed by cyclists and their duties towards their mounts. But mechanization had begun, and by 1935 there were no cyclist units in our Army, so that the use of these beautifully simple machines was relegated to the delivery of fairly urgent messages which did not justify a DR's time.

It was therefore a surprise to many when the Japanese made most effective use of cycle troops in the Malayan campaign.* The 5 and 18 Divisions each used about 500 trucks and 6,000 bicycles to move 13,000 to 16,000 men and Divisional weapons and equipment. The troops were given not more than two months cyclist training, but were capable of riding for twenty hours a day carrying up to 83 lb of kit plus personal weapons. The speed of the advance was little affected by our demolitions because the cycle troops were able to carry their cycles past the obstacle and continue pushing on while the road was repaired to take trucks. When the cyclists had to fight dismounted their machines were collected and brought forward after the battle by locally recruited civilian units. It is difficult to see how the Japanese could have achieved the astonishing feat of advancing 1,100 km in fifty-five days against superior forces had they not used cycle troops.

We should not then forget the cycle as a vehicle for lightly armed mobile troops. Unlike the horse it needs no stabling food or water and very little grooming, nor is it easily damaged or frightened by enemy action. Yet it can

* '*Singapore—the Japanese Version*' by Masanobu Tsuji.

go almost anywhere a horse can go and can of course take cover in haystacks and turgid ponds. Unlike its modern rivals, the lorry and the ground effect machine, it is very cheap, light, easily maintained, silent, uses no fuel, and can be lifted by its rider over most obstacles. It can reach the battle by parachute, and could be easily floated across rivers using polythene floatation bags. For troops landed from light aircraft it could offer a tactical radius of action of 80 miles a day for negligible weight and cost, while the exacting demands of engineer reconnaissance could be met by a high-speed machine such as the famous four-seater tandem formerly on hire in Cambridge, which can cruise effortlessly at no less than 25 mph and might again bear the name "Flying Sapper".

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# Short Leave in Kalimpong

*By* BRIGADIER G. MACLEOD ROSS, MC

TWO years ago Brigadier Bernard Ferguson revisited the Chindit country in north-east India. He wrote: Somewhere beyond Moirang, on the fringe of the Kuki country, I was enchanted to find by the roadside a memorial stone to a Kuki hunter.

> "In 1945 he became a Christian and
> in 1950 he died and lives with Jesus.
> Erected by his bereaved children for
> the price of rupees 300 and one pig."

To me this gives the essential flavour of the people who inhabit the north-eastern frontier of India. And so, with the brutality and devastation of war engulfing that part of the world today, I am constrained to look back in memory of some halcyon days spent in Kalimpong twenty years ago.

Kalimpong is the last Indian town on one of the best trade routes into Tibet and while it is not yet in the fighting line, it has only Bhutan between it and the 14,000 ft pass through which the Chinese hordes came so recently to threaten the Assam plain. The town lies wedged between the independent protected states of Sikkim and Bhutan with independent Nepal just round the corner of Sikkim to the west. While its elevation is only some 4,300 ft it is within 60 miles and in sight of such gorgeous snow eminences as Kinchenjunga (28,166 ft) and the lovely triangular peak of Chomo Lari (23,985 ft) the Queen of the Divine Hills.

The Darjeeling Mail of the East Bengal Railway leaves Calcutta at 9 pm and the 337 miles north to Siliguri are accomplished by 6.30 am. This is the end of the broad gauge line and you may now proceed either on the Darjeeling Himalayan railway metre gauge line or you can take a taxi and reach Kalimpong by road. From a scenic point of view the latter method is far the best, but you are at once disturbed to note that your driver is imbued with the same love of reckless speed which turns a trip up Chowringhee in Calcutta into such an exciting chariot race. Fourteen abreast is the usual formation up the broad Chowringhee but here the road deteriorates early into a one-way mountain track, so much so that at several sections you are stopped by a gate and a guard. Arriving at an even hour you may proceed but down traffic has the right of way on the odd hours. The drive gives some fine views along the deep precipitous banks of the Teesta river, a considerable tributary of the Brahmaputra and hereabouts, at the right season, clouds of butterflies of all colours of the rainbow are seen, most of them measuring 5 in across. There is little or no habitation until you arrive, shaken, on to a plateau where are situated the tea plantations in which tiny Gurkha women are plucking the top three leaves of each shoot of the bush and dropping them into a basket on their backs. Further on the steep hillsides disclose rough huts made of bamboo and thatched with corn stalks and if you look closely you would, in 1940, have seen some of these same tiny women knitting huge long wool socks for those whose business it then was to patrol the North Sea; a touching sight especially to an Englishman, because it was another example of the great loyalty which they have inspired in the many different jats which went to make up the Indian Army. These same Gurkha women were for the most part the wives of men who had retired on Army pensions from Gurkha regiments and who saw to it that every one of their small sons wore a pill box cap on the side of the head and saluted with precision. Having beaten par for the course you arrive somewhat breathless on the ridge which is Kalimpong and looking out over the canyon like gash of the Teesta valley to the north-west you are rewarded by the staggering beauty of Kinchenjunga's peak with its usual small cap-like wisp of cloud on top.

The bazaar collects one of the most cosmopolitan crowds to be seen anywhere in India, for here are gathered Tibetans, Mongolians, Chinese, Burmese, Lepchas, Bhutanese, Bengalis, Kabulis, Pathans and Europeans, all intent upon their various pursuits. You may even meet here the Powindah with his family on camelback whom you last saw some 1,500 miles to the north-west in Fort Sandeman, after making his way over the barren chrome-coloured passes from Afghanistan. Here he will gladly sell you the carpets he refused to offload from his camels in Baluchistan and if you investigate his economic philosophy you will discover that this is a way of life for him and while he may get the same price in the east as in the west, his transportation charges are virtually nil and anyway he enjoys the ride.

This is the centre of the Tibetan wool trade, at its height in the cold weather when the wool packs will not get wet. As you browse around the bazaar, noting the bags of atta and barley, the fruit, especially the oranges from nearby Sikkim, and stare in admiration at the salesmanship of the general merchant who is fitting an unsuspecting Mongolian with spectacles with plain lenses, the sound of cow bells strikes your ears and into the mass of people will come a long train of mules, yaks and dzos, usually led by a donkey with the bell and encouraged by wild looking muleteers in high felt Gilgit boots, long felt coats, the skirt tied up to the waist to form huge pockets and a fur or felt cap with wide ear flaps, all making their way to the wool godown with much yelling and laughter. That ascetic looking figure in the saffron robe is a lama from one of the Bhuddist monasteries which abound in the neighbourhood. These last are usually set on some small rise of ground, surrounded by 108 prayer wheels which must be passed on the right and spun with the hand, the wheels filled with repetitions of the all powerful formula: Hail! Jewel of the Lotus! There are statuesque chortens too, erected as a depository for relics or in memory of some saint, their form representing the five elements: A sphere on top for ether. A saucer below for air. Below these in succession and increasingly larger diameter are cones representing respectively fire, water and with earth at ground level. There are prayer flags, each with its wisp of cotton rag with the donor's name upon it. Inside the monastery you will be welcomed by the head lama and perhaps see some desiccated novices sitting on the floor intoning endlessly from the hundreds of good books which fill the walls. You may light a mutton-fat lamp but as you leave five to twenty rupees should be handed to the lama depending on the size of the monastery. Outside you are sure to meet the beggars, virtually hereditary and very numerous, they approach with the tongue sticking out of the mouth and it is as well to know that this peculiarity is a mark of respect and politeness.

Kalimpong is full of missions and the Mission Industries provide the unusual sight of small boys being taught to embroider butterflies on silk. This sounds a strange craft to us and it is to be hoped that a rapidly changing world will not catch up with them and outdate their calling for that of arms. But this is quite a normal skill for men in the east. I once met the man in Peking who had been the butterfly embroiderer to the Dowager Empress. All his life, until his eyes went, he embroidered butterflies, large and small, of every colour under the sun. You could buy them by the square foot.

A stern critic of reminiscence once said: Never mind the maps, tell us about the chaps. Kalimpong still reveres a number of names. In this respect it resembles other Indian towns. Not so long ago in Waziristan you could meet camel sowars who had marched with Roberts to Kandahar and would break into a smile at the mention of Roberts Sahib. But here it is Bailey who found the blue Tibetan poppy; Sherriff and Richardson, British officials; Younghusband, whose name will always be connected with Tibet; Graham, the Father of Kalimpong, who started the St Andrew's Homes for Anglo-Indians and encouraged the Government of India to make a hill station of Kalimpong. Some of these have long since removed themselves from the Himalayan scene, yet there remains one legendary figure, David Macdonald, who has spent all his life here or in Tibet and has been perhaps one of the most potent go-betweens the British have ever had with Tibet and the Dalai Lama. At 88 Macdonald still displays the physique and sturdiness of the Gurkha, for he is half Lepcha himself and married a Gurkha lady and has three daughters and two sons and while he no longer plays the strenuous game of tennis of yore, nor is he prepared himself to guide you on a tour of Sikkim and some of the loveliest scenery the eye can see, I can speak personally for the prowess of his daughters on the court. For sixteen years Macdonald was British Trade Agent at Gyantse and elsewhere. He was Younghusband's interpreter in 1904. He speaks and writes all the many dialects of Tibet; he has written several books on Tibet of which the *Land of the Lama* is one of the best and in a recent letter he tells me he has just completed a Tibetan-English dictionary. All these years he has been a close personal friend of the Dalai Lama, Ngawang Lobsang Thubeten Gyatsho. He told me how this came about. In 1909 the Dalai Lama was forced by the Chinese to flee Lhasa and sought refuge at the British Trade Agency at Gyantse, which is half-way between Lhasa and Kalimpong. Here Macdonald hid and disguised him until he could be spirited out to India. One day after some stirring sets of tennis, Macdonald took me around to his private quarters from the depths of which he unearthed some of the vast correspondence which he carried on with the Dalai Lama over forty years. In order to understand what is meant by correspondence in this part of the world you have to realize that the usual Tibetan letter is written on a piece of handmade paper a yard square. Court circles and etiquette demand that the floweriest ceremonial style be used. When addressing the Dalai Lama you might open with: To the pure toe-nails of Your Holiness, or To the Lotus foot-stool of the High Golden Throne. More space is left at the top than at the bottom of the letter if you are addressing your superior. Although these letters and notes from the Dalai Lama were not, for the most part, concerned with matters of state but rather, were more as we would send a short billet doux saying: Come to tea. It's not a party. Just you and I, nevertheless it was necessary that even these communications should follow the pattern of all others emanating from the holder of Indra's Sceptre and so they had appended a wide silk ribbon to which the huge seal was attached. The whole was then folded into a 9-in by 2-in packet, wrapped in a silk scarf and enclosed in a coarse paper and sealed again with wax. Such documents must be unique, more especially now that the Potala has probably been sacked by the Chinese. A bright blue ink was reserved for the sole use of the Dalai Lama and all matters requiring his decision had to be committed to writing. Below each query were the words: To be or not to be. The Dalia Lama would place a spot of ink above the course of his choice which makes one begin to wonder whether business would not proceed more speedily in Ottawa were such measures adopted, more especially now that all pretence of debate has disappeared.

In the few short weeks that I sat at his feet I was much impressed by Macdonald's physical and mental prowess and I could not help but remark the wonderful amalgam which the union of the blood of two Highland races had produced. The night before I left he gave a Tibetan dinner to which we had as guest the Tibetan envoy to China. The opening gambits involved the service and consumption of chang or barley beer from tall lengths of bamboo, sucked out with smaller bamboos for straws. Then followed some appetisers of dried fruits but the *pièce de résistance* was contained in four large bowls of stew in which you might meet such delicacies as sea slugs, shark's stomach, curried forcemeat, small birds, bamboo shoots, sea anemones and dried eels, the four bowls being endlessly refilled. The end of the meal was signalled by the arrival of small bowls of rice and so it will be understood that when I left next day to keep a rendezvous with a Sunderland flyingboat named Coriolanus 1,500 miles away in Karachi, I was not at the top of my form.

Since Tibet was overrun by the Chinese, Macdonald has spent all his energies succouring the refugees, some 1,000 of whom are in Kalimpong and Darjeeling and there is little doubt that he is and has always been one of the staunchest friends the people of Tibet have ever had. He writes: "Depon (general) Surkhang came to see me this morning. I told him I was praying that God will restore peace in Tibet. He wrote on a piece of paper: God will punish the Chinese." And so as we leave him in circumstances which may well bring his whole small world crashing about his head, let us say: Tashi deleg, which means: May you enjoy long life, prosperity and happiness, but I have little doubt that this sturdy combination of courage, humour, sympathy, steadfastness and loyalty will manage to survive somehow.

# Our Man in Old Trafford

*By* Lieut-Colonel D. E. Thackeray, RE

## Introduction

"Quite close to the cricket ground" they said. After ruminating at odd moments in the past as to what actually transpired behind the *RE List* pseudonym of "CO in UK" I was going to be allowed to find out. I hoped the rain cleared occasionally.

Further research was not helpful, assistance generally being given by those least qualified to do so. Geographical description ranged from locating the unit "alongside the Manchester United Football Club" to "next door to the coloured quarter you know". Both are vaguely applicable but not very relevant. With more expert knowledge we can fairly describe our main Drill Hall, built by subscription in 1903, as a hundred yards or so from Old Trafford Station, electrified in May 1931 but, sad to relate not noticeably since, Photo 1 shows the exterior frontage of this typical Drill Hall.

Many are called but few chosen. A relatively high proportion of those who are may now find themselves as Commanding Officers in the TA. These remarks are intended as a discursive if not helpful introduction to what may well be, for most regular officers, a new experience. At least they may encourage other TA COs to point out where I am wrong. They follow and complement the excellent article by Colonel Hamilton recently published in the *RE Journal* on the same subject.

Most Sapper news of the TA, is related to exploits which have publicity and news value. What happens on the other 363 days in the year? Does it work, and if so how do you work it? Let us examine one or two aspects.

## Permanent Staff

These come first because they are the backbone of the structure. The main requirements of the permanent staff members are enthusiasm and professional knowledge, plus an overdose of patience and philosophic adaptability. There will be many occasions on which the desire to change the order of priority of these essentials is almost overwhelming, but this must be resisted. In a regular unit the endeavour is perhaps to command, co-ordinate, and occasionally curse an end product out of difficult circumstances, shortages of manpower, and obsolescent material. In the TA one may amend this to coaxing, cajoling, and occasionally corrupting an end product out of unforeseen circumstances, negligible manpower and equipment that has been delivered to the wrong place. The reason that end results are possible is that if one can tap and organize the reserves of spirit and enthusiasm which actuate this all volunteer force a great deal can be done.

The aims of the permanent staff are laid down in numerous valuable booklets. Basically their purpose is to keep the unit running smoothly, and to ensure that instruction in training and administration make the unit as militarily effective as possible. This may be more difficult than it sounds since apart from the necessary qualification of attending annual camp the basic additional requirement for a volunteer is only thirty drills per year. This requirement has remained unchanged since the inception of the TA in 1907. It represents fifteen drill nights (2-hr. periods) or eight full days training or a combination of the two. The real minimum is thought by most experienced TA personnel to be nearer 100 drills a year, and of course many put in a great deal more time, consistently and conscientiously. Nevertheless there will be training periods, especially in areas of high employment where attendances may well be scanty. This produces two evils for the permanent staff. Firstly a very great deal of minor administration must be performed by them personally, and secondly there is an intangible but readily sensed lack of purposeful achievement if training is poorly attended. At all costs it is essential to point long term aims repeatedly, forcefully, and with purpose. If some concurrent improvements e.g. works services on the buildings, standard of inspection reports etc can be shown then a feeling of progress will be encouraged. The regular CO may find that he can and should spend considerable time on these aspects of his unit since the TA CO cannot often spare the time to pursue these matters in detail, and regular adjutants and QMs are not in a position to plan and progress such work except at the expense of other essentials. As we shall see later this may well involve the regular CO in considerable minor administrative effort, but as he is his own cook and bottle-washer this must be accepted.

The way in which the permanent staff is deployed and used will necessarily depend on circumstances, including geography. The aim must be to divide duties as evenly as possible, and to ensure that they are not under employed and consequently bored. The bigger danger is to make certain that when, as is often the case, they are employed intensively during week-ends without respite they receive adequate breaks in lieu. They will probably have numerous extra mural tasks in addition ranging from CCF training in grammar schools and public schools, through AER training week-ends, to their own education.

The foregoing applies equally to the small civilian staff of clerks, storekeepers, and handymen who keep the unit running on a day to day basis. Their efforts are often unapplauded and unappreciated outside the unit. Without their unstinted help little can be achieved even by the most competent regular military staff.

## Training

Everyone has their own views on this subject, and few think alike. To the regular officer used to the product of the Training Brigade and, until very recently National Service, the major difficulty is to produce officers and sappers, probably from scratch, in the very limited periods available for training. The minimum training commitment, as we have already seen, has been unaltered since the TA began. When this is measured against the increase in complexity of equipment and procedures, and the complete lack of service of new intake the difficulties are obvious. It must also be realized that consecutive training periods, are often impossible despite arguments to the contrary. A Combat Engineer Course run on drill nights, and alternate week-ends over a period of three months will be attended haphazardly by many because of shift work, night schools, the weather and a variety of other factors. Extended to recruit training and other elementals this makes progress slow. The provisions of recent regulations regarding trade qualifications are at present unworkable from this aspect. Not wishing to be torn asunder I suggest no doctrinal answer. This is largely dictated by circumstance. It is, however, obviously desirable to restrict recruit and other training to the bare essentials in order

**Photo 1.** A Typical Drill Hall Frontage.

that an intelligent man can feel he is making some progress, and that such progress does achieve an end result within his comprehension and capability. At present too many people without experience of the TA visualize individual training as scaled down regular training; whereas a completely different approach is increasingly necessary as the intake of 17½-year-olds without any previous service mounts up.

In passing it should be noted that the enthusiasm of many of these young men is immense, and the initial length of their hair should not be taken as a criterion of their possible merit!

Collective training is easier since this can take place at week-ends, and even if only half a squadron actually attends something useful can be done. Units vary greatly in their approach to collective training. The primary need however seems to me to have units that are able at short notice to get out of the Drill Hall, and to move out on exercise with the capability of cooking, sleeping, and looking after themselves without this being considered unusual. Once this is achieved engineer tasks can be added and the facilities of WETC used fully. Sub units can also train more easily with other arms if their field administration is competent and workable.

Within Divisional Engineers every opportunity must be taken to train with other Arms. This is often possible and good liaison can be cemented by training of infantry pioneers, help with demonstrations and competitions e.g. brigade mine warfare competitions, and the like. This all helps to broaden the TA soldiers' outlook, and brings him in contact with others outside his own unit. This is particularly desirable in the TA where the limited viewpoint is a permanent danger.

Photo 2 shows a class on the Heavy Girder Bridge model in the Drill Hall. Photo 3 shows an exercise with the RMFVR Liverpool to illustrate the variety of approach that is possible. Other aspects of training will probably be completely new to the regular CO e.g. band training. Most TA units have a Regimental Band, which may be very good. It requires the same encouragement as other aspects, and must not be forgotten. Photo 4 shows the Regimental Band of 42 (Lancs) Div RE (TA) at Stratford-on-Avon when playing at the Shakespeare Birthday Celebrations.

Active, interesting and adventurous training is given as one of the keystones of a successful unit. This is undoubtedly so, but much of this must stem from the regular staffs initiative, originality, and enthusiasm. TA sub units must learn to paddle their own canoes, but they have not the time to obtain them, much less manufacture them. Little extra or new equipment is available now, or likely to be in the near future, at unit level. The best answer (whenever possible) is to get the unit to locations where it exists, e.g. bridging camps. In this way minor administration will be practised and other military activity encouraged especially at squadron level. Too many units, in my view, tend to make "attendance at the Drill Hall" the be-all and and end all of training plans.

Despite the difficulties imposed by man days and petrol a hard core of each sub unit works very hard devoting almost all their spare time to achieving progress. On occasion this yields unlooked for triumph such as winning the China Cup at Bisley which this unit was fortunate enough to do last year—with the aid of one bombadier to keep our feet on the ground!

### Administration

A complete book could be written on this well worn subject. Basically there is need to review and revise all TA administration to bring it on to a factual basis. It is at present based on the regular pattern with certain concessions to the TA. To the volunteers however, especially to officers who may have responsible business posts, some of it appears ludicrous. A stock example is MT maintenance. The TA has the discarded champ in many units. There is nevertheless a need to write up the fact that the rear oil scale is leaking again at least every month if one is not to get a poor CIV Inspection Report. Is this really necessary in view of the time available and the relative cost in time and effort to accomplish it? The cumbersome system of accounting on AF P 1965 for ration cash allowance for week-end training is inflexible and defeats its own object. The issue of a straight cash allowance would be no more costly, and cut out a lot of paper work. Pay is still paid from two separate public accounts each of which has to be run by one of the two regular officers in a major unit. Many more examples can be quoted but a radical overhaul would seem indicated. Owing to lack of continuity of attendance it is difficult to get more than a proportion of TA volunteers to undertake book-keeping and documentation. If the squadron storeman has to go on nights (or lose his job) he obviously cannot check the stores before they are returned to CESD. This is of course an oversimplification but the principle is there. In any event in practice no volunteer can be made to pay for deficiencies or damage so the system, although in most cases hopefully (and often punctiliously) observed does not measure up to the requirement. The permanent staff are already cumbered with a great deal of administration, including pay, drill books, storekeeping and its associated aspects, vehicle maintenance and so on. A reduction in these would enable much more time to be spent on practical training. This particularly applies in spread-out units dealing with two or three Territorial Associations and with stores and equipment in up to four Drill Halls.

### Recruiting

One of the possibly alarming aspects of service with TA which is sometimes overlooked is that the CO is his own recruiter. No one outside the unit or formation is directly responsible in the TA, although the TA Associations help in every way possible. More alarming is the fact that recruiting is often, quite rightly, regarded as a yardstick of a unit's progress and success.

To quote an East Lancs TA Association Circular "Every aspect of TA life has a bearing on recruiting". This is trite but true. Recruiting for the TA is as intangible as it is for the regular army, and all the problems confront one in miniature. Again no one has an infallible answer. The best recruiter is the satisfied TA volunteer, provided he is prodded hard and often enough. The recruiting pattern varies widely between units and is beset with many problems including the present need to balance youth and experience as the age of the volunteer decreases. In passing it is worth noting that Horse Shows, Civic Parades and similar events have little or no effect on recruiting, although they serve to keep the unit in the local public eye, which as a separate aim is desirable in itself.

Civic events will probably make big inroads into the year's work but must be accepted. The TA is a citizen army and must play its public part as such however irrelevant and time-consuming this may seem. Photo 5 shows a typical Armistice Day Parade.

Individual contacts based on sound unit administration and training are probably the best source. The social side of TA life must never be forgotten in the desire to improve the standard of training, since men join for the "club" aspect of TA life as well as for the training. A compromise of both is the best that can be achieved. In view of the limited training time available this requirement is not always as readily grasped as it should be.

### The Regular Commanding Officer

The following probably consists of blinding glimpses of the obvious, but a few sentences may not be totally amiss. The majority of units will only have a regular CO from time to time. Some may argue that the task is now becoming too great for the average TA officer of the right age and seniority, who will probably have a responsible civil job with consequent calls on his time and energy. I do not think this will be so since the appointment is sought after by the majority of TA Officers, and is a strong incentive to the right ones. If the DTAs figures of the cost of the TA is correct at 5 per cent of the cost of the regular army then some run down in unit efficiency may profitably be accepted over relatively short periods of time in exchange for the value to the country of maintaining COs appointments for TA Officers.

The regular CO, however, may at best be accepted initially as an inevitable necessity. In a regular unit the CO is very close to being a god. In a TA unit he will be accepted only on his merits, and will have to build these up. Past background counts for little or nothing, and effort must be devoted to creating confidence as early as possible. Until this is achieved obviously little can be done. He is bound to be regarded as a new broom, and a good

**Photo 2.** Heavy Girder Bridge Class.

**Photo 3.** Assault Exercise with RMFVR Liverpool.

**Our Man In Old Trafford 2 & 3**

**Photo 4.** Band of the 42nd Divisional Royal Engineers (TA) at Stratford-on-Avon.

**Photo 5.** Armistice Sunday. Civic Group.

**Our Man In Old Trafford 4 & 5**

deal of sweeping will certainly be necessary, but this is best done after confidence has been engaged.

The CO's life in the TA consists of being a troop commander on a glorified scale, and much personal time is spent in not only thinking up plans, but in doing them oneself. The popular theory is that there is a lot of spare time. In practice this is not so. Squadrons may go out one week-end a month. The CO will go out every week-end. Regular COs are in constant demand for everyone else's exercises in addition to devising, writing, organizing, and running their own. If there are say four drill halls then time must be spent at each. There may be two or three Territorial Associations. They must all be kept in touch with over a great variety of matters. It is probable that they will tackle problems, e.g. recruiting expenditure in different ways, and works service procedure in respect of the unit will differ. All these duties will probably involve a good deal of non-productive travelling driving your own car. It is essential to have a reliable one as Colonel Hamilton underlines from his own experience. Delegation of duties to squadrons must be achieved, but the process will be slow; and after the most detailed briefing something will go awry because the officer concerned has been delayed on business in Ireland, or because of the weather in Brussels—or something. These are not painted as insurmountable because they are not, but it is important to realize that the amount of checking up, flexibility and personal resumé of detail are in themselves much greater than in a regular unit. Regimental Accounts are in themselves a matter of full-time prodding if they are not to slide towards the abyss.

Certain events e.g. public parades often involve participation with the minimum of rehearsal and are fraught with such difficulties as moving the band and a contingent of troops 40 miles on a Sunday morning to be in position by 1000 hrs. The snag is to get them to the Drill Hall by say 0830 before all the Sunday buses and trains have started running. To their credit they meet such demands with a wealth of information and initiative, but encouragement is the keynote. There is no Commanding Officers fund in a TA unit and the lack of this may preclude the purchase of many items e.g. office equipment cleaning aids, vehicle transfers, and other items which would be of great assistance in raising morale and increasing efficiency. In view of the basic nature of some of these problems a sum of money available annually, as is the case in a regular unit, would be of immense value. Again, however, inspiration and self help provide certain tests in overcoming this deficiency.

## E and OE

Undoubtedly these are legion. Nothing has been said of either Annual Camp or the "Ever Readies". These have, however, been purposely left out. The former because no two camps are alike, and the second because it is too early to see what their effect and effectiveness will be. Suffice to say that Annual Camp is not all alka-seltzer, and Boards of Inquiry, and the "Ever Readies" have got some way to go yet before being ready.

## Conclusions

It is as well to have no preconceived views. Units vary considerably and local politics apart, a great variety of factors may influence the best methods of obtaining a given end result.

The aim, which may have been largely attained in some units, is to produce a self-reliant force, with the capacity to become an administratively independent entity at short notice, backed by the essentials of a command and control organization and flavoured as strongly as possible with RE knowledge related to its particular task in war. The difficulty is to strike the compromise between commands and sub-units doing things for themselves and avoiding any major administration short falls as a result. The right balance will produce the right result, but this may take time and considerable patience if a short lived "gladiator" organization is not to spring from the inevitable desire to do it oneself, and get on with it more efficiently and quickly.

Enthusiasm and a spirit of service are the mainstay of the TA. A great many do of course join with an eye to the financial recompense, especially in areas of under employment. In this day and age, however, this must be expected. In areas of over employment TA training often means a financial loss in terms of overtime and this fact is often overlooked in making comparisons.

Training will be limited by these factors, but must aim at the traditional Sapper concept of being able to turn one's hand competently to any engineer task. The more this spirit can be fostered by training with other arms the better. The results will speak for themselves.

Administration must aim at a balanced delegation of duties and an awareness of the importance of fundamental administrative tasks and machinery if a unit is to last longer than a few days as a fighting machine. This aspect is easily forgotten and has sometimes never been learnt or appreciated especially by the younger officers and NCOs without active experience.

A padre, doctor, and paymaster are all invaluable in introducing outside air into the unit. Get them if humanly possible as enthusiasts in these appointments are without doubt pearls of great price.

Remember that the permanent staff military and civilian are the backbone of the unit. Willing workers can very easily be driven too hard and too long. Make certain they keep their views and your own in perspective, and that they have proper leave and time off "in lieu".

Man management does not appear to be the art in industry that it can be in the army. It will require constant fostering and prodding—but will pay an enormous dividend.

The low level of TA command in terms of ambition projects, scintillating parades and spot on administrative inspections can be disturbing and frustrating. This, however, is in itself a challenge which, if met and overcome will give back a sense of achievement and corporate spirit of a high order.

# "Chief Engineer at Gettysburg"

## A Centennial Vignette of the American Civil War

### Prologue

THIS was indeed the Hinge of Fate.

Two years of bloody fighting had left the South terribly weakened both in man-power and resources. Lee rightly judged that the only hope of bringing the war to a successful conclusion was to strike a stunning blow at the main Union Army before the situation deteriorated still further. This he planned to do by making a wide left hook to the north-west of Washington, deep into the former slave state of Maryland, where he reckoned on receiving substantial aid from the local country folk. Thus assisted, he intended to cut the Union communications with Washington and then to destroy the Army of the Potomac, which comprised the bulk of the Union forces in the east, in a situation of his own choosing. This would almost certainly have led to the fall of Washington and a rapid end to the war.

### Prelude

On 3 June 1863 Lee began the disengagement of his army from the static defences in front of Fredericksburg. Crossing the Blue Ridge his troops passed down the Shenandoah Valley to cross the Potomac River at Williamsport. They then advanced northward through the foothills of the Appalachian range towards Harrisburg, whilst cavalry patrols held the passes through the Blue Ridge to protect their right flank (Map 1).

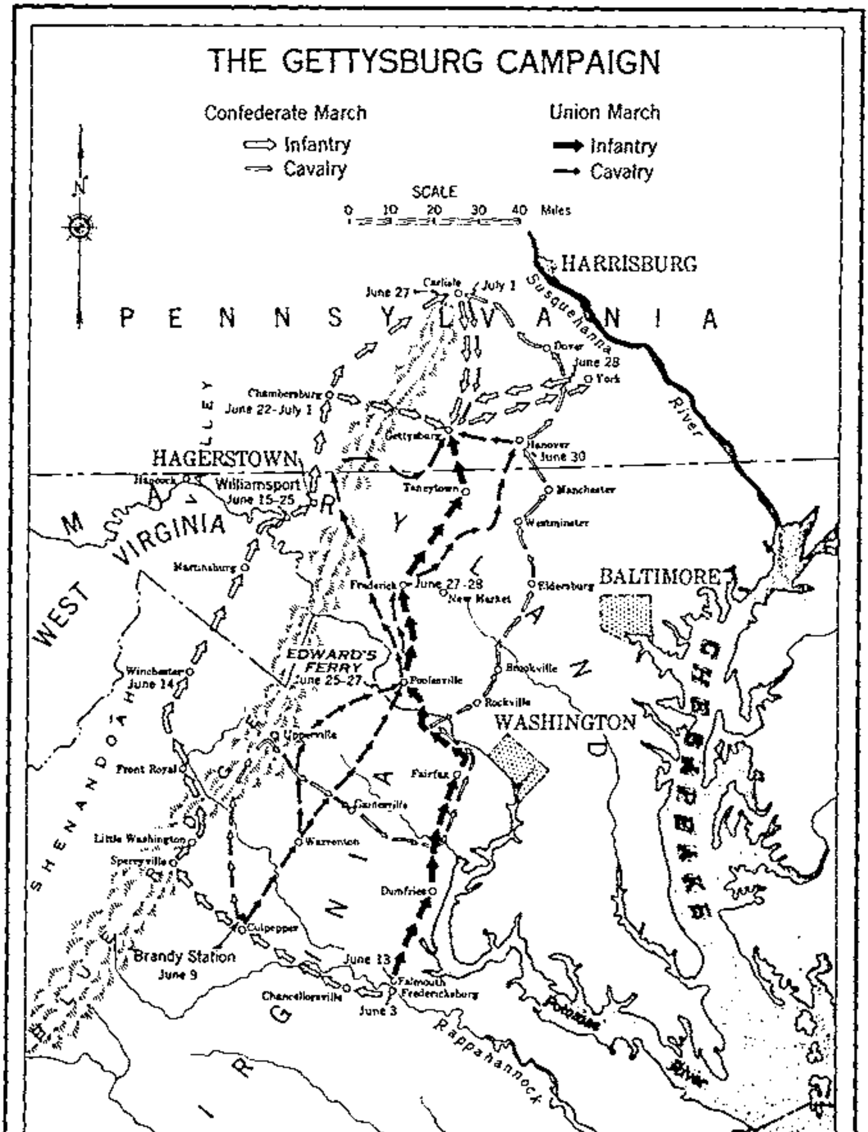
In the meantime, Hooker, commanding the Union Army of the Potomac, was also marching north to keep between the Confederate Army and Washington. On 28 June, when he refused to obey Halleck's order to abandon Harper's Ferry, he was replaced by Meade, who directed the army northward by forced marches towards the Pennsylvania border.

On 29 June, hearing of the rapid Union reaction, Lee decided to abandon his advance on Harrisburg and to concentrate for battle in the area south of the Susquehanna River. On 30 June, reconnaissance troops of the Confederate Army observed mounted Union Cavalry in the area of Gettysburg and on the morning of the following day (1 July 1863), Hill's Corps advanced along the Chambersburg road in a probing attack to test the strength of the Union forces. Shortly after 8 a.m., the Union and Confederate troops clashed a short distance north of Seminary Ridge, on the outskirts of Gettysburg and the most decisive battle of the American Civil War had begun.

### The Battle

Initially Hill's Corps achieved considerable success against the numerically inferior Federal troops. After severe fighting, the latter fell back through the town of Gettysburg toward Cemetery ridge, a defensive position of considerable strength, which was being occupied by the main elements of the Federal Army (Map 2).

By the afternoon, Lee's left wing was pushing up against Culp's Hill, the key to the northern sector of the position, but was checked by the Corps Commander when his troops were about to launch an assault. At this moment,


THE GETTYSBURG CAMPAIGN
Confederate March
Infantry
Cavalry
Union March
Infantry
Cavalry
SCALE
0 10 20 30 40 Miles
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HARRISBURG
PENNSYLVANIA
Susquehanna River
Carlisle
June 27
July 1
Dover
June 28
York
Chambersburg
June 22-July 1
Gettysburg
Hanover
June 30
HAGERSTOWN
Williamsport
June 15-25
Taneytown
Manchester
Westminster
MARYLAND
WEST VIRGINIA
Martinsburg
Frederick
June 27-28
New Market
Eldersburg
BALTIMORE
EDWARD'S FERRY
June 25-27
Winchester
June 14
Poolesville
Brookville
Rockville
WASHINGTON
SHENANDOAH VALLEY
Upperville
Front Royal
Fairfax
Gainesville
Little Washington
Warrenton
Sperryville
Dumfries
Culpepper
Brandy Station
June 9
June 13
Falmouth
Fredericksburg
Chancellorsville
June 3
VIRGINIA
Potomac River
Rappahannock River
CHESAPEAKE BAY
RICHMOND

MAP 1.

Lee's lack of good cavalry reconnaissance was most severely felt. Had he known the true state of the Union forces at this time, there is little doubt that he would have ordered his forces to push straight through the positions at Culp's Hill before the defences could be properly organized.

The following day, after a late start, Lee developed his main attack from the other end of his line against the left wing of the Union position, where Sickles' Third Corps had occupied a vulnerable salient beyond the main ridge. Beyond Sickles' position lie two well defined hill features, Little and Big Round Top, which gave excellent observation along the whole of Cemetery Ridge. Little Round Top, situated at the end of the ridge itself, was clearly vital to the defence of the whole Union position, but inexplicably it was completely undefended and was at this time occupied only by a small signal detachment. So it was found by Brigadier General Warren, the Chief Engineer of Meade's Army, riding on reconnaissance with two engineer lieutenants of his staff in the early afternoon of 2 July, just as Confederate Troops under General Hood swept through the broken ground in front in an effort to outflank Sickle's position.

Brigadier General Gouverneur K. Warren was a regular engineer officer, who in peacetime had worked on the Mississippi delta survey and had taught mathematics at West Point. It is to his everlasting credit, that, like a true Sapper, he instantly appreciated the vital importance of the position and the necessity for taking immediate action to hold it.

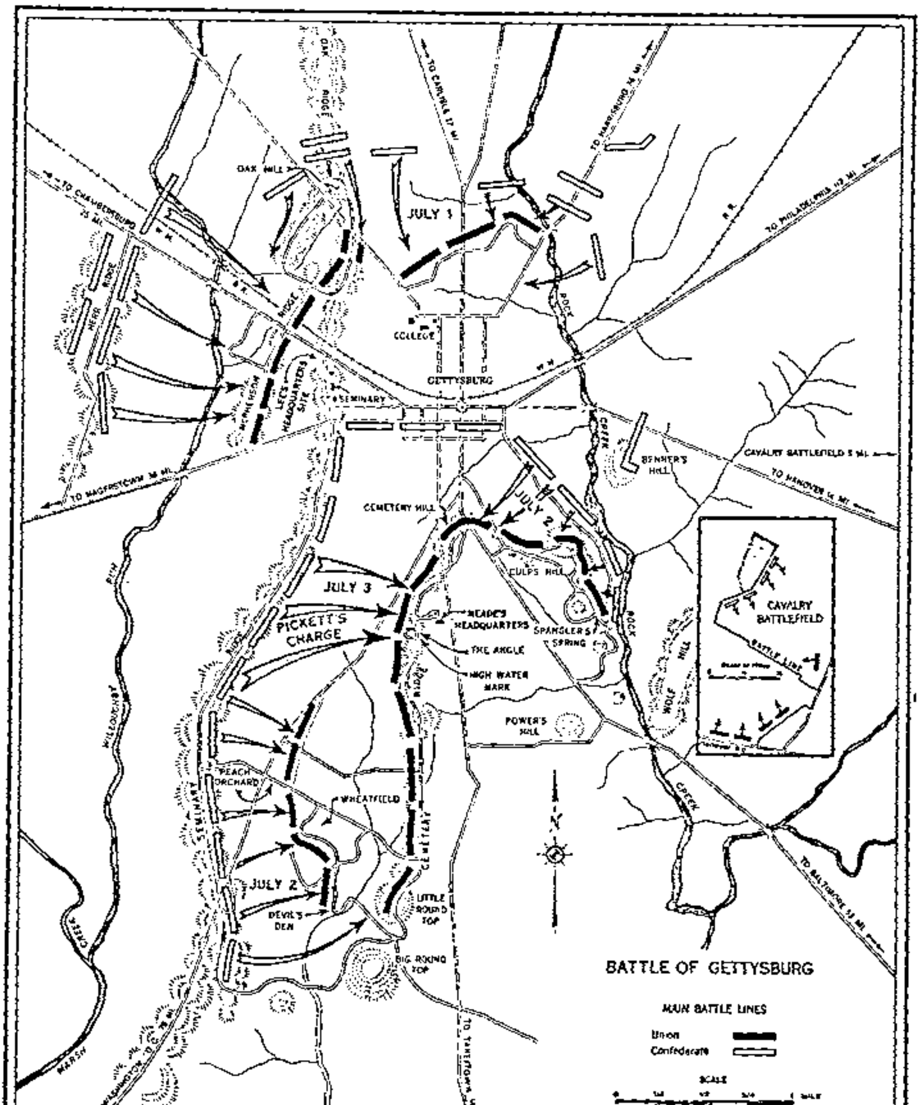
Ordering the signal detachment, which was about to withdraw, to hang on at all costs, he personally galloped back to intercept the 140 New York Infantry, then moving up under Brigadier General Weed towards the main Cemetery Hill position. He directed them on to little Round Top with the words: "I'll take the responsibility—but get there on the double", and then moved on to contact General Weed himself, whom he managed to persuade to march his whole brigade, including a battery of rifled cannon under Hazlett, into a position extending from Little Round Top to link up with Sickles' left flank.

He was only just in time. As Hazlett's guns opened up the advanced elements of Hood's division were already half way up the slope. For two hours a furious struggle took place on and around Little Round Top, but the natural strength of the position and the fire of the Union artillery finally proved decisive, and in the evening Lee gave the order to withdraw.

Thus was the Union left flank preserved intact and, although the next day saw the culmination of the battle with the failure of Pickett's gallant charge upon the centre of the Union line, in retrospect it is clear that it was at Little Round Top on the second day of the battle that the hinge of fate turned and the door slammed in the face of Lee's Army and the aspirations of the Southern States.

## Epilogue

One hundred years later, Warren's statue looks out from the summit of Little Round Top on a scene little changed from what it was on the day of the battle. It serves to remind us that it was largely through the initiative, resourcefulness and courage of this great engineer officer that Lee's strategic gamble failed, that the Union was preserved intact, and that, for the American nation, "government of the people, by the people, for the people" did not perish from the earth.


OAK HILL
OAK RIDGE
HERR RIDGE
TO CHAMBERSBURG 25 MI
TO CARLISLE 17 MI
JULY 1
COLLEGE
GETTYSBURG
SEMINARY
McPHERSON
LEE'S HEADQUARTERS SITE
ROCK CREEK
BENNER'S HILL
CAVALRY BATTLEFIELD 5 MI
TO HANOVER 14 MI
CEMETERY HILL
JULY 2
CULP'S HILL
JULY 3
PICKETT'S CHARGE
MEADE'S HEADQUARTERS
SPANGLER'S SPRING
THE ANGLE
HIGH WATER MARK
POWER'S HILL
WOLF HILL
CAVALRY BATTLEFIELD
BATTLE LINE
PEACH ORCHARD
WHEATFIELD
SEMINARY
CEMETERY
JULY 2
DEVIL'S DEN
LITTLE ROUND TOP
BIG ROUND TOP
WILLOUGHBY RUN
MARSH CREEK
TO BALTIMORE 52 MI
BATTLE OF GETTYSBURG
MAIN BATTLE LINES
Union
Confederate
SCALE

MAP 2

Plaque on the base of General Warren's Statue.

ACKNOWLEDGEMENT

The two maps are taken from the booklet *Gettysburg* by Frederick Tilburg, published by the US Department of the Interior, and are reproduced by kind permission of the Superintendent of Documents.

WORDING ON THE PLAQUE ON THE STATUE
OF GENERAL WARREN
ON LITTLE ROUND TOP, GETTYSBURG

By his military sagacity on July 2nd, 1863,

GENERAL GOUVERNEUR KEMBLE WARREN

The Chief Engineer of the Army of the Potomac, detected General Hood's flanking movement and promptly, by assuming the responsibility of ordering troops to this place, saved the key of the Union position.
Promoted for gallant services from the command of a Regiment in 1861 through successive grades to the Command of the 2nd Army Corps in 1863, and permanently assigned to that of the 5th Army Corps in 1864, Major General Warren needs no eulogy—his name is enshrined in the hearts of his countrymen.
This statue is erected under the auspices of the veterans organization of his old Regiment—the 5th New York Vols. Duryee Zouaves—in memory of their beloved Commander.

*Dedicated Aug. 8th, 1888*

**plaque on the base of General Warren's Statue**

# Memoirs

## BRIGADIER A. G. BONN, CBE, MC, MICE

Albert (Bertie) Guido Bonn, who died in Wimbledon Hospital on 7 November 1962, was born on 20 September 1889, the son of Carl R. L. Bonn, Esq, MICE, of Glasgow. He was educated at Dumbarton Academy, Glasgow High School and Glasgow Technical College.

He began his professional career with Sir Robert McAlpine & Sons at the age of 17 where he was employed mostly on railway and docks projects until 1911 when he went to Canada. From 1911 to 1913 he was Resident Engineer on the construction of the Sudbury–Port Arthur section of the Canadian Northern Railway and from 1913–1914 he was a Resident Engineer on the Toronto Harbour Improvement project.

During the First World War he served with the Royal Canadian Engineers in France, eventually commanding a Canadian Railway Construction Company. He was awarded the Military Cross in 1918.

After the war he returned to Robert McAlpines' and remained with them until 1924 during which time he was engaged on the construction of the Middlesbrough Dock and the Anniesland–Duntoder Boulevard, Glasgow. From 1924 to 1927 he was employed under the Ministry of Transport on road construction in Skye and from 1927 to 1931 he was employed under the Liverpool Corporation on the City Section of the East Lancashire Road and the Otterpool Reclamation Scheme. In 1931 he joined Richard Costains' as a Director of Civil Engineering and between 1931 and 1939 he was responsible for such projects as the construction of a section of the Trans-Iranian Railway, development and sewerage schemes for the Anglo-Iranian Oil Company, the construction of the Dolphin Square blocks of flats, the construction of Army Barracks at Dover and the construction for the Air Ministry of the Airfield at Silloth in Cumberland.

Shortly after the outbreak of the Second World War he raised 692 General Construction Company, RE, and took the unit to France where it was employed on airfield construction for the Air Component of the British Expeditionary Force. After Dunkirk he became CRE (Airfields) Scotland and the Islands. In June 1941 he was appointed Deputy Chief Engineer Works (Airfields) on the staff of the Engineer-in-Chief, Middle East, and later he became Chief Engineer Airfields, Middle East with responsibility for airfield construction and maintenance in Egypt, Palestine, Syria, Cyrenaica, Tripolitania, Algeria and French Morocco. He was made CBE in 1943 in recognition of gallant and distinguished services, and three times mentioned in despatches.

He rejoined Richard Costains' after the war as a Director of Civil Engineering, but he continued to maintain a close connection with the Corps. He was Honorary Colonel of 114 Army (now Corps) Engineer Regiment (TA) from 1953 to 1958.

He served on the Management Committee of the Royal Engineers Benevolent Fund continuously from 1945 to 1960, and on the Publications and Library Committee of the Institution of Royal Engineers from 1946 to 1961. He served as an elected Member of the Institution Council from 1948 to

**Brigadier A G Bonn CBE MC MICE**

1950 and from 1954 to 1957, in which year he became a Vice-President, a post he held until 1961. During that time he did a great deal to improve the professional status of the Institution, being the first Chairman of a Sub-Committee set up by the Council to study the matter. His wise and informed views on all subjects coming before the Council were quite invaluable.

He was one of the earliest and certainly one of the most enthusiastic members of the Blythe Sappers and was for many years on the Committee where he made his characteristic warm contribution.

Many regular officers went to him for advice and help when the time came for them to retire and seek employment in civil life; he never failed to do his utmost for them and became almost an employment agency!

In a wider sphere he devoted himself to strengthening in every possible way the warm links which bind together the regular and non regular officers who served in the Corps in both World Wars. Only an officer with such a genius for making friends in both categories could have had the success he did, and his lasting influence in this respect will be not the least of his memorials.

He became a Corporate Member of the Institution of Civil Engineers in December 1945. He was a Governor of King's College School, Wimbledon and a Member of the Caledonian Club and the Liver Club.

In 1916 he married Mary Florence, daughter of Captain James L. Black of Blundellsands, Liverpool. Their two sons were killed in the Second World War.

A Memorial Service was held for him at St Columba's Church of Scotland, Pont Street, Chelsea, on 28 November 1962, Sir William Christie, Chairman of the Caledonian Club, read the Lesson, and the Rev. Dr J. Fraser McLuskey officiated. Sir Richard Costain gave the following Address of Remembrance:—

"We meet this morning to pay tribute to, and honour the memory of, Brigadier Bonn, and the many who cannot be with us I know share our feelings of respect and affection for a man who personified the sterling qualities of high citizenship. It is not of his attainments in his business life that I want to speak because in that sphere his qualities were unbounded and well known to you. His professional standing within our industry affords abundant proof. Rather it is about his character that I wish to direct your thoughts.

Bertie Bonn was a man of the highest integrity and unswerving loyalty. Even so, his most outstanding virtues were his fortitude and his friendliness and this was exemplified in his daily life, not by precept but by example. He volunteered in the two World Wars and served his country selflessly. He was until recently a Vice-President of the Institution of Royal Engineers and Honorary Colonel of the 114 Army Engineer Regiment (TA): he was the original officer commanding 692 Company of the Royal Engineers at the beginning of the last war: he joined the Management Committee of the Royal Engineers Benevolent Fund in 1945 and in two years had personally raised more than £10,000 for that Fund.

His personal service was in itself a meritorious record but that was not all. He lost both his sons in the Second World War. This tragic blow would have been too much for men of less fibre than Bertie. Instead his fortitude was reflected in a determined deeper sense of service to his country by the giving of his all in the common effort. Such courage was an inspiration in itself and could only have been sustained because, with his dear wife, he shared the great quality of fortitude based on a profound Faith in his God.

Bertie Bonn was a great lover of his fellow men. His kindliness, his zeal and his abiding sense of humour, nay of fun, were such as to arouse instantly in those who met him, the continuing desire to be in his company. I have known very few men, who, with such natural grace, could find the best in another man's character.

For many years he was a Governor of King's College School, Wimbledon. Youth, in fact, was always one of his great loves. I am sure there are many people here today who, in their own trials and tribulations, have had considerable help from him in their young days. To see him with young boys and girls lightened the heart of anybody who had that experience. No one who came within his sphere of influence could help but capture something of his happiness nor escape a sense of feeling better for having been near him or with him.

The capacity to give of oneself is a heaven sent blessing, not an acquired virtue and he had this in abundance. It was this facet of his character which, with a knowledge of his fortitude and accomplishments, made him such a complete man. Whilst we mourn his passing and revere his memory, we are equally moved to rejoice that Bertie Bonn lived his life—a life that was rich in the art of giving all that was so good in himself. To try to emulate his virtues would be the finest tribute to his memory.

Our deep sympathy goes to his dear wife but I am sure that she will be given considerable comfort from the knowledge of everybody's appreciation of her husband. I am also quite sure that the fortitude in the life these two people led together, will help to strengthen and comfort her for the rest of her days.

I think I can conclude by saying that surely he will have been welcomed into the Hereinafter with the saying: 'Well done thou good and faithful servant.' "

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## BRIGADIER J. H. BOYD, OBE

J. H. Boyd was born on 20 April 1899, and was commissioned into the Corps on 6 June 1918. He had been christened John Hardy, but within the Corps, and outside it, he was always known as George. The name stuck because it suited him. In an aircraft the automatic pilot gear is called "George" because it will never let you down; and this went equally for George Boyd.

Commissioned just too late to see active service in the First World War, he did a short course at the SME followed by a course at the School of Electric Lighting at Gosport. Gosport was the training school in the use of searchlights for harbour defence against enemy surface attack, and it was here that he learned the rudiments of the subject on which the greater part of his service was spent—anti-aircraft searchlights.

His first posting abroad was to India, to the 3 Sappers and Miners at Kirkee. From Kirkee he was sent to Aden to command the Sappers and Miners Defence Light Section. In 1924 he came home to do a Supplementary Course at Chatham and Cambridge, but in 1926 he went back to searchlights as Adjutant of 1 AA Battalion at Blackdown. After three years there he had an interval at Edinburgh as Staff Officer RE at Headquarters, Scottish Command, and then returned to AA duties as an Instructor at the School of AA Defence, Biggin Hill. He made an admirable instructor. His patience, lucidity and wide knowledge of his subject enabled him to bring a lesson within the grasp of even the stupidest audience. He had, too, the gift described in Kipling's line: "and 'e learns to make men like 'im so they'll learn to like their work."

He went to Biggin Hill in October 1931, and from then until after the outbreak of the Second World War and on until 1942 he was intimately concerned with the development of the AA defences of Great Britain. Those were the critical years during which the performance of our AA equipment—guns, predictors, searchlights and sound locators—was being outclassed by the increasing speed and performance of aircraft, and this inferiority was only redeemed, just in time, by the introduction of radar. The earliest, and very secret, experiments in the use of radar stations along the south coast were made when Boyd was on the staff of 1 AA Division at Uxbridge, and he was the only member of that staff who took part in the experiments.

Though he was a man who never fussed about trifles he would stand firm on a matter of principle, and his long connection with AA Defence came to an end when he refused to accept a tactical doctrine which he believed to be wrong. He next found himself in a completely different world—the world of Normandy on and after D Day. He was a CRE GHQ Troops RE, in a Beach Sub-Area during the landings and was responsible for the removal of obstacles and mines from the beaches and for the construction of roads and tracks leading inland. He continued to hold this command in the break-out to the east of Caen, and again had to clear minefields and improve routes forward, including a bridge over the River Orne. In the Rhine crossings of March 1945, he and his troops constructed the Class 9 FBE bridge "Waterloo" near Honnopel. In April 1945, he was appointed a Group Commander in 21 Army Group and was promoted Acting Colonel. Few RE officers can have seen more varied and eventful service during the closing stages of the war.

In May 1946 he was sent to Malaya as Chief Engineer. His last appointment was Commander of the Army Apprentices School at Taunton, and he retired in October 1949.

He soon found for himself civilian employment as Bursar of St Bees School in Cumberland. Here he found a task for which his methodical efficiency was well suited. Taking a keen interest in all the business aspects of running a school he served St Bees well for eleven years. At the end of each term, when the teaching staff left for their holidays, work for the Bursar's office reached its peak. It was then that his uncomplaining nature was most fully tested and the truth behind his joking claim to "do everything at the School except teach" became apparent. He and his family lived in a house looking out over the sea and extended their invariable warm welcome to friends who made their way there. In 1955 came the first sign of failing health. He had a slight stroke, and although he quickly recovered and went back to work he was warned by the doctor to "be careful". Much as he disliked "being careful" he obediently did as he was told, though he continued as Bursar until his tenure ran out in 1959. He then moved to a charming house at Weyhill, but by that time he was no longer the robust and

**Brigadier J H Boyd OBE**

active George of his earlier years. In November 1962, he suffered a severe stroke and died at Salisbury Hospital a fortnight later without regaining consciousness.

George Boyd was a man with no enemies. Cheerful and sociable, he made friends easily and he and his wife were the natural centre of a circle. Cricket was his game but he also enjoyed hockey, golf, tennis and squash. In conference he was not given to making long speeches and when he did speak it was quietly and deliberately, but his listeners were conscious of a wise head and a safe pair of hands. Staunch and stout-hearted, he had abilities which might have taken him higher in the service but he disliked publicity and was incapable of pushing himself forward. He was the type of officer which is the strength of the Corps.

He married at Edinburgh in 1931 Christobel, only daughter of Arthur H. Dickson, Writer to the Signet. There were three children of the marriage —two sons and a daughter.

A.C.D.

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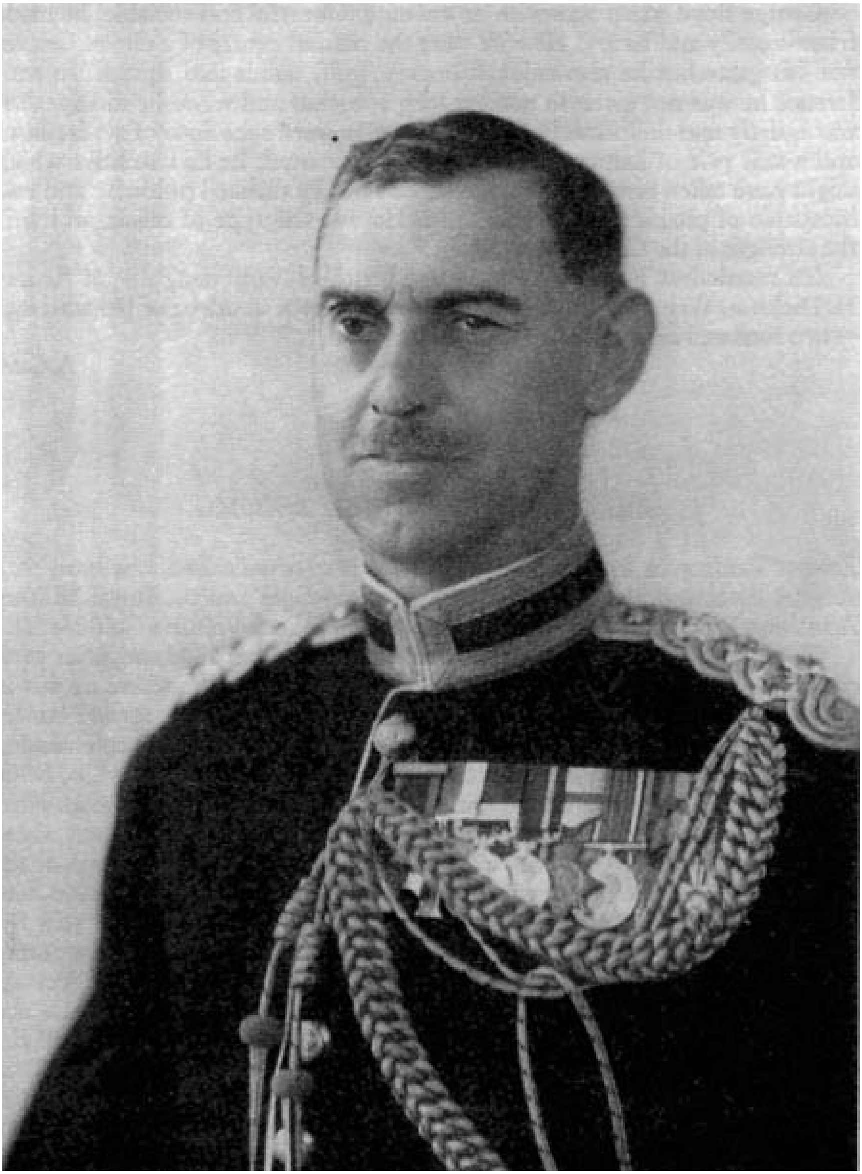
## BRIGADIER E. F. J. HILL, DSO, MC

Ernest Frederick John, or "EFJ" as he was so often called, was born on 8 August 1879, and was educated at St Paul's School and the Royal Military Academy, Woolwich where he was awarded the Queen Victoria Gold Medal.

He was commissioned into the Corps on 23 December 1898 and, after completing the usual Chatham Courses, he was posted to India where he was to spend most of his service. Shortly after joining the Bengal Sappers and Miners he was posted as a Company Officer to 3 Company, at that time commanded by Captain S. H. Sheppard (later Major-General S. H. Sheppard, CB, DSO) with whom he formed a strong partnership for the next five years. In November 1901 he and Sheppard were sent on special duty to Waziristan where they commanded detatchments from 3 Company in counter-raids against the Kabul-Khel. The Company was withdrawn to Roorkee in January 1903, and in November of that year it was sent to the railhead at Siliguri to join the "Military Escort", some 3,000 strong commanded by Major (Temporary Brigadier) J. R. L. Macdonald, RE, which accompanied Colonel Younghusband on his Mission to Lhasa. The distance from Siliguri to Lhasa was nearly 400 miles, the route led over the Himalaya Mountains through Sikkim and across the Brahmaputra River and the wild mountainous highlands of Tibet; throughout its length it was set about by natural climatic difficulties seldom surpassed. So great were the engineer problems that over two-thirds of the total strength of the Military Escort were Sappers, and but for their outstanding work in road making and bridge building under appalling conditions the advance to Lhasa would have been impossible. Furthermore, the progress of the force was stoutly opposed and, in their traditional manner, the Sappers blew breaches in the walls of defended towns and spearheaded the assault on them. After the successful conclusion of the Mission 3 Company was withdrawn in November 1904 to Roorkee. In 1906 Sheppard went to the Staff College and EFJ was given command of the Company, and he was still in command on the outbreak of the First World War in August 1914.



**Brigadier E F J Hill  DSO MC**

3 Company Bengal Sappers and Miners at that time formed part of the Meerut Division, the first formation of the Indian Army to be sent to the Western Front, where it took part in the battle of Neuve Chapelle and other engagements before being withdrawn in December 1915 for service in Mesopotamia. For his services on the Western Front EFJ was made a Brevet Major, awarded the MC and mentioned in despatches. In March 1917, whilst serving in Mesopotamia, he was made a Brevet Lieut-Colonel, awarded the DSO and appointed CRE of the 7 (Meerut) Division. The Division left Mesopotamia for Egypt and Palestine in January 1918 and took part in General Allenby's final offensive which led to the surrender of the Turkish Armies in Syria. EFJ advised Allenby on the water supply resources of the country, so vital for the cavalry formations, and with his Division he was throughout in the forefront of the battle opening the way for the victorious advance.

The Division was sent back to India in the early part of 1920 and on its return EFJ was posted to Roorkee as Superintendent of Park in charge of the workshops at the Headquarters of the Bengal Sappers and Miners. In June 1922 he became Commandant at Roorkee which appointment he held for four years. It was a splendid term of office. He was a keen polo player and an excellent shot and he did much to encourage the young officers to take advantage of the excellent sporting facilities available near Roorkee. It is said there were no married subalterns whilst he was Commandant!

In 1926 he was made a Brevet Colonel and appointed Colonel on the Staff RE (redesignated Brigadier RE in 1928) at Army Headquarters, India, and in that capacity EFJ was the senior Sapper officer on the General Staff in India. He retired in 1933.

From 1937 and throughout the Second World War until 1949, when he was seventy years of age, he served in the Home Office and Ministry of Home Security—a remarkable achievement.

On 26 September 1929 he married at Killiskey Church, Ashford, Co Wicklow, Edeline Botelier Marjorie Bellingham Somerville who survives him.

EFJ maintained his interest in, and connection with, the Bengal Sappers to the last, and was a regular attendant at its annual reunions.

He died in hospital on 19 November 1962, aged eighty-three years, after suffering from ill health for some time.

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## LIEUT-COLONEL E. D. CARDEN, OBE, AMIEE

Edward David Carden was born on 1 May 1882 and commissioned in the Royal Engineers in July 1901. During his time at the Shop he was an outstanding athlete. He won the Silver Bugle in 1901, the Governor's Cup and Silver Medals in the Athletics Matches against Sandhurst.

After completing his courses at the SME, Chatham, he was posted to the Divisional Telegraph Battalion RE at Aldershot at a time when experimental work on wireless was being started. Lieutenant Carden was given command of one of the two new Wireless Companies RE forming the Wireless Experimental Establishment at Aldershot which did much original work in this field and in 1910 he became an Associate Member of the Institution of Electrical Engineers.

**Lieut Colonel E D Carden OBE AIMEE**

He served with Fortress Companies RE Malta in 1912, but returned to Aldershot next year for duty at the Army Signal School and in 1914 was posted to "A" Signal Company, Aldershot. In 1915 he moved to Woolwich Dockyard to work under the Inspector of RE Stores until July 1916 when he formed part of the new Signals Experimental Establishment on Woolwich Common. He was awarded the OBE in 1919, in which year too he became an Inspector, RE Stores.

In 1920 he was posted to the Signals Training Centre at Maresfield then, after doing a refresher course at the School of Electric Lighting, Gosport he became in 1922 an Instructor at the School of Anti-Aircraft Defence, Perham Down. A year later he joined the Works Services first at York, then in 1926 at Singapore and for the next two years at Rawalpindi in India, where he was CRE for a short time before becoming CRE Presidency and Assam District at Calcutta until September 1930. He retired in March 1931.

He died in hospital on 29 March 1962, aged 79 years, after a serious illness.

He married on 13 December 1934 Millicent Reynolds who survives him.

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## THE LATE MAJOR-GENERAL A. BROUGH, CB, CMG, CBE, DSO, COLONEL COMMANDANT RE

Many senior serving and retired officers of the Corps will preserve affectionate memories of Major-General Brough, who died in retirement in 1956, after forty-one years' service (Memoir: December 1956 *Journal*).

It will come as no great surprise to those who knew him well to learn that he set the seal on the deep interest in the welfare of the Corps, which he had sustained throughout his life, with a very generous bequest.

The RE Corps Committee wish to make it known that, upon the death of his sister, the residue of General Brough's estate has passed to the Corps; and they take this opportunity of expressing their deep gratitude on behalf of All Ranks.

Under the terms of the will, the Corps Committee has been granted absolute powers to use these funds for the benefit of Corps charitable, educational and sporting institutions in such a manner as they think fit, and they have accordingly opened a new fund to be named "The Royal Engineers Brough Bequest Fund", the net value of which is estimated at about £19,000.

## COLONEL J. W. D. MALLINS, MC

John Wilfred Douglas Mallins, the only son of Lieut-Colonel Mallins of Alverstoke, Hampshire, was born on 22 September 1892.

He won the Armstrong Memorial Medal at the RMA Woolwich, and was commissioned in the Royal Engineers on 23 December 1911. After passing through the Schools at the SME, Chatham, he went to Darlington to take a Long Mechanical Engineering Course with the North-Eastern Railway.

On the outbreak of war in 1914 he immediately joined the BEF and went to France. He was wounded in October 1915 and sent home on sick leave. In this period he was married in November to May Gwendoline, only daughter of William Moon of Durham. For his services in France he was mentioned in despatches and awarded the MC.

Early in 1916 he was posted to the Training Depot, RE, at Aldershot for a year. He then, when fit, returned to the Western Front as Adjutant to CRE First Army, and was again mentioned in despatches. In January 1919 he went to the SME, Chatham, and in June that year became Assistant Instructor in Workshops. Late in 1923 he left to go on an E & M Course sponsored by the War Office. In January 1925 he went to Catterick as an Assistant DO (E & M).

Early in 1928 he went out to India, was promoted Major in April and became ACRE (E & M) at Peshawar. He moved to Quetta in June 1929 as SORE 2 (E & M) to the Chief Engineer, Western Command, India. Then in February 1933 he went home to become DCRE Woolwich. Two years later he returned to India and was appointed SORE 2 Southern Command Headquarters, at Poona. In July 1935 he was promoted Lieut-Colonel and in March next year went to Naini Tal as SORE 1 (W), Eastern Command.

In September 1937 he was sent to Burma as CRE Burma at Maymyo. After two years he was "specially employed" in that country until July 1942. From October 1942 until March 1945 he was again employed as a SORE 1, and he later became Deputy Chief Engineer.

He retired in April 1948 and died on 13 November 1962.

## LIEUT-COLONEL C. H. R. CHESNEY, DSO

CLEMENT HOPE RAWDON CHESNEY was the eldest son of Colonel H. F. Chesney, RE, and a member of a famous Sapper family. He was born in July 1883, educated at Blundell's School and the RMA, Woolwich, and commissioned in the Royal Engineers. in December 1901.

After leaving the SME, Chatham, he served in Hong Kong with 25 Fortress Company until early in 1907 when he went to join 20 Fortress Company at Plymouth. In March 1910 he began his long connection with India, and served in the Works Services at Landsdowne and Lahore. During 1911 he was attached to 5 Company of the Bengal Sappers and Miners and took part in the Mishmi Mission. Afterwards he joined the Public Works Department to serve as Executive Engineer successively at Ambala, Moolton, Deva Chari Khan, Lahore and again at Ambala.

In 1915 he joined the British Expeditionary Forces in France where he served with 62 Field Company. In June 1916 he was placed in command of a factory at Amiens for the supply of camouflage material to the Third and Fourth Armies and for the valuable services he rendered he was awarded the DSO and mentioned in despatches.

After the war he went back to India and served in the Afghan War 1919, when he was a Director of Works. From 1920 to 1928 he was Executive Engineer, PWD in India at Rawalpindi, Simla, Lahore, Dharmsala and Kangra, in turn. From 1922 to 1924 he was an Under Secretary to the Punjab Government. In 1928 he returned home to become Assistant to the CRE Salisbury and later CRE at Larkhill. He retired in June 1932.

In 1941 he published a book entitled *The Art of Camouflage*.

In September 1914 he married at the Cathedral, Bombay, Millicent Margaret (Diddy), youngest daughter of Captain A. G. Douglass, RN. He died in South Africa on 17 October 1962.

# Book Reviews

## REACTOR SAFEGUARDS

*By* Charles R. Russell, PhD, PE

(Published by Pergamon Press Ltd, London. Price 80*s*)

Doctor Russell has written a detailed and comprehensive study of all aspects of nuclear reactor safety. In the introductory chapter he discusses general problems that have arisen since the first crude, working model went critical in the squash court in Stagg Field, Chicago University, twenty years ago, and some that are likely to arise with nuclear powered engines for ships in the future. At the end of each chapter is a detailed bibliography for those who require more knowledge of the subjects covered.

The author writes from the American point of view, though he gives credit to accomplishments in Great Britain and elsewhere. Some of the terms (e.g. "dollar" as a unit of reactivity) will be unfamiliar to British readers, though their use does not detract from the value of the text.

The book is well illustrated, and not only goes into detail of design and safety features for various types of reactor, but also thoroughly covers radio-active materials, reactor kinetics, and hazards to both employees and outside populations. The final chapter on Operating Experience is a summary of all reactor and criticality accidents that have been documented. In spite of a dry, terse style, the author depicts powerfully the hair-raising situations that have led to the mercifully few unfortunate incidents. "The operator was under the impression that", and "it was thought that", occur with unnerving frequency.

This study will be invaluable to officers who may be concerned with reactor operation, siting, erection or rehabilitation, now or in the future. D.N.F.

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## THE WINGS OF PEGASUS

*By* Brigadier George Chatterton, DSO

(Published by Macdonald & Co. (Publishers) Ltd., 16 Maddox Street, W.1. Price 30*s*)

This is the story of the birth and development of the Glider Pilot Regiment. The author commanded the Regiment during World War II after the untimely death of the pioneer of airborne operations, Lieut-Colonel J. F. Rock, RE, as a result of a flying accident when experimenting on a Night flying glider operation in 1940.

The story is well told by a mixture of autobiographical references and the personal stories of many of his officers and men in relation to specific operations.

The author begins from the days when he was a Cadet at the Nautical College, Pangbourne, and continues with his subsequent short career as a Pilot-Officer in the RAF, his short spell in civil life, and his service in the early days of World War II as an officer of the Queen's Royal Regiment. With this background he was well suited to select and train recruits to the "Total Soldier" role demanded by the Glider Pilot Regiment.

The pages are strewn with the names of famous wartime service personalities, British and American, who either helped or opposed the development of the Regiment to its final composition and standard at the end of the War. The stories associated with these names exemplify the motto of the Regiment "Nothing is impossible". These references coupled with the personal experiences of many of his officers and glider pilots throw yet another light on the background and performance of airborne operations, successful or otherwise, in North Africa, Sicily, Normandy, Arnhem, the Rhine Crossing and Korea. The subsequent disbandment of the Regiment and the development of the new Army Air Corps is also covered.

Included as an Appendix is a reprint of the German War Diary of the SS Panzer Grenadier Depot and Reserve Battalion 16 of the Battle of Arnhem, this is an unusual addition to the public records of this epic operation. F.T.S.

## FLIGHT MECHANICS
Volume I
THEORY OF FLIGHT PATHS

*By* ANGELO MIELE

Director of Astrodynamics and Flight Mechanics, Boeing Scientific Research Laboratories

(Published by Addison-Wesley Publishing Co, Inc, Pergamon Press, London. Price 70*s* net)

This is the first of three volumes by the Author that will be published under the title "Flight Mechanics". The second and third volumes are now in preparation.

Volume I is a textbook for graduate engineering courses and a reference book for engineers. The Author, however, makes extensive use of advanced mathematical techniques and readers would need to be well practised mathematically in order to follow the text. After expounding the elements of kinematics, dynamics, aerodynamics and propulsion necessary to the analytical development of the theory of flight paths over either a flat or spherical Earth; the Author deals with quasi-steady flight over a flat Earth with applications to an aircraft powered by turbojet, turbofan and ramjet engines flying at subsonic, transonic or supersonic speeds; and the non-steady flight over a flat Earth with applications to rocket vehicles operating in the hyper-velocity domain. Analytical exercises are included at the end of each chapter to demonstrate the use of the techniques given in the text.

This volume would be an acquisition to the libraries of Universities, Colleges of Technology and the design offices of the aircraft industry. F.T.S.

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## ENVIRONMENTAL TESTING TECHNIQUES FOR ELECTRONICS AND MATERIALS

*By* C. W. A. DUMMER and N. B. GRIFFIN

(Published by Pergamon Press. Headington Hill Hall, Oxford. Price £5)

The book is Volume 15 of the Pergamon International Series of Monographs on Electronics and Instrumentation. It has an extensive annotated bibliography, is well indexed and contains a fair number of photographs, diagrams and reference tables.

The two World Wars gave considerable impetus to the development of engineering sciences and their practical application. Today the military engineer is reaching forward into the realms of atomic power and space travel in his quest for new weapons. This has resulted in the rapid design and development of all kinds of electronic devices from which infallible and efficient operation is expected under conditions of service and environment not fully visualized at the end of World War II.

The Earth's maximum climatic variations on land, under the sea, or in the adjacent atmosphere are no longer the ultimate environment factors which have to be considered in engineering design; to them must be added the problems involved with very high speeds, extreme altitudes and space environment. In addition, the engineer has to couple with these the search for new materials, efficient maintenance, and realibility of operation in order to ensure that Commanders are not faced with too big a risk of critical failure.

The assessment of risk is not a new problem of command; it is the core of all big decisions in battle; and this book expounds the means of reducing the odds of operational risk by studying the effects of variable environment on electronic equipment and components incorporated in modern weapons and missiles.

Whilst this book has been written to advocate the study of environment engineering, it does contain a wealth of technical information which is worthy of the attention of all military engineers. It outlines the need for environmental testing and successfully pleads the case for the introduction of specialist environment engineers into the present day works organization for contracts, design, progressing and manufacture. Thereafter it deals with instrumentation, high humidity, extremes of temperatures, mechanical hazards and their effects, transport hazards and packaging techniques, long-term storage, high altitude, space travel, nuclear radiation, acoustic noise, materials and protection techniques. All with a service bias.

Some of the design principles expounded and the resultant inferences which may be deduced from them are applicable over a wide range of the engineering field. The information contained in the chapters on Transport Hazards, Packaging Techniques and Long-Term Storage are of particular worth to military engineers, who are always faced with these problems.

This book is highly recommended to military engineers of all classes and not just those immediately concerned with electronic equipment and components. It contains a wealth of detail which the military engineer would be wise to absorb in order to appreciate the conditions which lay behind the design, manufacture, storage and performance of modern missiles and their operating equipment, the variety of which increase yearly. F.T.S.

## INTRODUCTION TO STRUCTURAL PROBLEMS IN NUCLEAR REACTOR ENGINEERING

*Edited by* J. R. Rydzewski

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 84*s.* net)

This book is Volume 2 of the Reactor Engineering Division of the International Series of Monographs on Nuclear Energy published by Pergamon Press. It comprises thirteen chapters, each dealing with a specific structural problem in Nuclear Reactor Engineering. J. R. Rydzewski, the Editor, is a Lecturer of the Civil Engineering Department, Southampton University. The chapter authors are a team of experts from industry, the UK A.E.A. Harwell, Universities and Institutes of Technology in England, Australia and the USA.

The first three chapters, covering an introduction to nuclear reactors, the material used, and the construction of pressure vessels in mild steel, deal with fundamentals and are written in a style suitable for students. The next six chapters giving the analytical and computation techniques used to solve various problems, are naturally more advanced in nature and only suitable to designers and specialists. The remaining chapters detail the methods favoured by industry at present for the design of components. Some text on experimental stress analysis and the use of prestressed concrete pressure vessels is included. The references for further reading given at the end of each chapter are international in range.

The book has some 400 pages which are excellently printed and contain many diagrams, reference tables and photographs. It would be a useful, compact reference book for the libraries of technical colleges and universities, and those engaged on the design and construction of nuclear reactors. F.T.S.

## PROBLEMS IN THE AUTOMATION OF THE METALLURGICAL INDUSTRY

*By* A. B. Chelyustkin

Translation edited by H. T. Prothero, BSc, PhD

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 25*s*)

This book will be of interest to engineers and other readers who wish to study the present degree of automation which the USSR have achieved in this branch of their industry, and what they propose to do in the same field during the current seven-year Economic Plan. The introduction summarizes their requirements in order to obtain automatic operation throughout the complete range of their metallurgical industry from blast-furnaces to steel end products. Subsequent chapters discuss the separate requirements in turn under the headings—The Automation of Blast-Furnace Production, Steel Smelting Production, Reversing Blooming Mills, Multi-Stand Section Mills, Sheet-Rolling Mills, and Cold-Rolled Sheet Production.

The text deals simply and broadly with the subjects, their operation, and their problems, but some specific automation methods and their associated equipments are described in detail. The automations proposed have either been already developed and adopted by the leading steel production installations in Western Europe and the USA, or are being studied. F.T.S.

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## GEODESY (SECOND EDITION)

*By* BRIGADIER G. BOMFORD, OBE, MA, D.Sc

(Published by Oxford University Press, Amen House, London, EC4. Price 90*s*)

Global War has for many years been an accepted phrase. Its connotation presumes the solution of many problems, and amongst these may be included those of relating points which may be hundreds or thousands of kilometres apart, and of measuring and recording positions, distances, directions and heights over the surface of the earth, the sea level shape of which only approximates to a known mathematical form. Such problems are essentially Geodetic.

A decade ago Brigadier Bomford published the first edition of *Geodesy*. This book was soon accepted as the major English language reference in the science. This first edition was almost wholly based upon geodetic theory and practice proved and exercised over many decades prior to its publication. The need for a second edition so soon is attributable to the growing awareness in developed and developing countries of problems of "communication and transport" the solution of which involves applied geodetic techniques. The fact that so many of these problems have arisen in a military context has reduced the time scale of development by many orders.

The major objectives of geodesy are the detailed description of the size and shape of the earth, and of its gravity and magnetic fields, and the accurate expression of position in three-dimensional terms. In achieving these ends the science relies upon complex theory and precise practice. The latter has always involved the measurement of distances and angles, of positions astronomically, of the force and direction of gravity (usually relatively very occasionally obsolutely) and of the magnetic field. In all these practical aspects, in some of them to a considerable degree in others to a revolutionary extent, there have been changes during the interval between the two editions of Brigadier Bomford's book and most of these changes have been included in the second edition.

The first rule of land surveying has always been "to proceed from the whole to the part". It has never been possible for geodesy to obey this precept. It is, therefore, a measure of the significance of the progress in the science that with the use of artificial satellites it is at last possible for geodesy to fall in line with the remainder of the Land Survey profession. Brigadier Bomford explains the dynamic and geometic uses of satellites for geodetic purposes. He shows firstly that the major force acting on a satellite in orbit is the earth's gravitational field, and that by analysing variations of orbits, a description of the earth's gravity field can be obtained. Secondly he describes how geodetic co-ordinate systems may be connected by analysing simultaneous observations made at sufficient points in each system of an illuminated satellite against the star background. It is interesting also to appreciate that satellites provide a means of measuring the longest lines over the surface of the earth.

Apart from satellites, it is in the measurement of distance that the greatest advances have been made in the last ten years. Electronic distance measuring instruments of the Geodimeter and Tellurometer type are described in Brigadier Bomford's book, though the examples he quotes even in his most recent footnotes, are already obsolescent. Other instrumental developments with which Brigadier Bomford deals include the use of sea and airborne gravimeters. He does not, however, refer to the development of a portable absolute gravity meter or of a gyro-theodolite, though such omissions are probably justifiable since such instruments are in their infancy and certainly not yet geodetically useful.

It is not only in the instrumental field of practical geodetic observations that developments have occurred since the first edition of Bomford's *Geodesy*. There have been important changes in the theory underlining and hence recommendations concerning the handling of geodetic observations. Classically geodetic observations were reduced to a spheroidal surface, and in this way difficulties of vertical refraction could be obviated. Papers attributable to Marussi and Hotine amongst others now describe precisely the actual fields in which geodetic phenomena occur. The new "spatial" school claims that observations should be computed in the field in which they exist, namely three-dimensional space, hence the name "spatial". Brigadier Bomford has included an account of the new methods in this second edition and has given the mathematics in a cartesian form rather than using tensors. This may make the theory easier to assimilate.

The computation and adjustment of geodetic observations has always presented a severe problem not only from the point of view of the complexity of the calculations involved, but also because of the length of time they take by manual methods. The new edition describes in detail the old methods, but also gives recognition to the advent of electronic computers and their advantageous use for certain computational processes.

As a work of reference *Geodesy* deals with many of the aspects of the subject at length giving much mathematical and physical detail. Where the author judges that further information may be relevant the reader is referred to a bibliography containing 438 references. The second edition, as the first, has eight most valuable appendices covering explanations of a number of associated topics. The appendix dealing with the theory of errors has been increased to include a somewhat unconvincing defence of the continued use of the term "probable error" rather than "standard deviation."

Generally Brigadier Bomford has given all of the old and much of the new. This he justifies on grounds that many survey departments are still only equipped with older instruments and must, therefore, retain older methods for the time being. However, today one can scarcely conceive of any major survey department undertaking a geodetic traverse with "invar in catenary", or of adjusting a large triangulation or trilateration scheme by least squares using manual methods. The book is a compendium of geodetic knowledge and, like its first edition, will become a classic English language reference book of geodesy. It is unlikely that the long accounts of classical methods could justifiably be included in a third edition and hence this second edition may assume historical as well as current importance as the last detailed account of these methods. P.H.K.

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## ELECTRONIC COMPUTERS

*By* A. I. Kitov and N. A. Krinitskii

Translated by R. P. Froom, BSc(Eng), AMIEE

*Edited* English Translation, A. D. Booth, DSc. PhD

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 30*s* net)

This book is Volume 13 of the Pergamon International Series of Monographs on Electronics and Instrumentation.

The 112 pages of this small closely printed book are divided into four chapters which cover the subject matter in considerable detail.

Chapter 1 traces the growth of cybernectics—the study from one point of view, of questions of the control of signals in various scientific systems such as mathematics, logic, biology, psychology, linguistics, theory of signals, theory of automatic control, and the theory of electronic digital programme-controlled machines—from the early beliefs in the dissociation and association of sciences into separate or extended fields of activity. The theory of the supply of information, its various signals and the use of memory is explained by analogy with the reaction of the human brain and body to the senses. The theory of information, a section of cybernetics, and its measurement, application, processing, transmission and regulation by machine computers, in conjunction with the use of algorithms (formulated laws), is explained in detail.

Chapter 2 summarizes the means by which man has sought the simplification of physical and mental labour and the growth of automation; and the essential differences between electronic computers for continuous operation and programme-controlled electronic digital computers, and the principles of the construction of both types. The majority of EDC's use the binary system of calculation (the base of which is the number 2 and the only figures used are 1 and 0), and this method of representing and using numbers is fully explained. The principles of operation to enable EDC's to solve arithmetical and logical problems are covered by reference to schematic drawings and descriptions of the various components of the Russian EDC's "BESM", "STRELA", and "URAL".

Chapter 3 outlines the methods of preparing the sequence of solution of problems on a computer, and the means of checking the accuracy of calculations. The principles of programming work are expounded by a series of examples with the "STRELA" machine. References are also made to variable and cyclic programmes, the constitution of computer commands and programme branching.

Chapter 4 summarizes the range of the Russian programme-controlled digital computers in respect of the solution of mathematical and logical problems, automatic programming, machine translation from one language to another, the playing of machine versus man games, and the control of industrial processes.

Students will find the text of this book a reasonable introduction to the subject matter; unfortunately the type used is not easy to read and words tend to get blurred. The photographs reproduced are below the standard normally expected in a textbook of this kind. F.T.S.

## MAN AND RADAR DISPLAYS

*By* C. H. Baker

(Pergamon Press, Headington Hill Hall, Oxford. Price 70*s*. net)

This book has been published for and on behalf of the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization. It is one of a series of books thus published and in consequence is sub-titled AGARDograph 60. The author is employed by the Defence Research Medical Laboratories of the Department of National Defence, Toronto, Canada.

In this AGARDograph the author discusses in detail the factors that effect the working efficiency of human radar operators and the influence such effects have on their interpretation of radar signals. As truly efficient automatic radar sets are unlikely to be available for some time the fallibility of human operators will continue seriously to effect the value of radar, particularly in connexion with the Long Range Early Warning Systems, a major concern of our times. The extent of human error in the interpretation of radar signals can be gauged by the author's statement that—"in 1956, 52 radar-equipped ships were in collision. The number grows".

After a general introduction to the subject the author deals with the following factors in separate chapters:—Radar Scope Brightness, Pip Decay Time and the Visibility Threshold, Visibility as a function of Pip Dimensions, Ambient Illumination, Some Visual and Perceptual Factors, Searching for Pips, Visual Estimation of Range and Bearing, Plotting and Transmission of Radar Display Data, the Operator as a Monitor.

The chapters firstly describe the factor concerned and the possible effects they may have on operator efficiency. These are then investigated in detail by reference to the more important experiments which have been carried out by recognized radar and medical authorities. The experiments are described in detail and the inferences obtained are well illustrated by the text and various graphs and comparative tables.

Lastly, the author advances his own findings on the experimental results and makes certain recommendations relative to the design of radar sets and the environmental conditions of operators.

This book does not cater for the student but it is of considerable value to radar designers, writers of radar specifications, radar instructors, and those responsible for the selection and control of radar operators.

The book also contains a good deal of information useful to civil and other engineers who are concerned with the provision of accommodation for radar equipment and operators. Environment and the associated factors of ambient illumination, ventilation and room decoration etc, all effect the degree of efficiency likely to be achieved by human operators interpreting radar displays. Many recommendations are made which will help civil engineers to design the accommodation best suited for good results. F.T.S.

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## VICTORY IN THE WEST

### Vol I—The Battle of Normandy

*By* Major L. F. Ellis, cvo, cbe, dso, mc.

(Published by Her Majesty's Stationery Office, 1962. 63*s*)

The rhythm of time attracts the attention of all men and particularly of soldiers. For Britain the dramatic reappearance of her forces in Normandy in 1944 was a counterpoint to their headlong withdrawal from Dunkirk in 1940 and in harmony with the prospect of the final defeat of Germany.

That Major Ellis should follow up his distinguished official account of the earlier struggle in France and Flanders with this two-volume history of the *Victory in the West* constitutes a lesser but also pleasing rhythm. This first volume of the two describes the shattering of the German armies in Normandy, followed by the triumphant launching across the Seine of the Twenty-First British and the Twelfth US Army Groups. Thus far, apart from a few top level discordances, the story is a smooth-flowing detailed and accurate narrative of the actions and reactions, which the landing and deployment of a huge host on a hostile shore brought about. So vast was the enterprise that on the very first day the Allied Navies and Air Forces contrived to set down on *terra firma* no less than 130,000 men, which *ipso facto* made the landing by far the biggest in the history of war. Whereafter the astonished world saw the British and American navies proceed to construct two artificial harbours which in a few days were complete with their "Mulberries", "Gooseberries", "Bombardons, and articulated Tidal piers." By the same token no history has yet produced close-up photographs and sketch diagrams to give readers a clearer idea of the details of these ingenious contraptions and in an official history they would have been valuable.

The Cossack plan, quite excellent within its terms of reference, was a great credit to Lieut-General Freddy Morgan and his staff and it remained the basis of the Overlord operation even although it was rather brusquely enlarged by Eisenhower and Montgomery. Interesting to recall are two important factors which led to the choice for the landing on the 50-mile stretch of coast between the River Orne and the base of the Contentin peninsula. The first was the unsuitability of the Pas de Calais hinterland for armoured attack and the second was the 100 mile radius of action of shore-based fighter aircraft, which just covered the Normandy beaches.

Operation "Fortitude", planned to make the enemy believe that the main thrust would be at the Pas de Calais, not only achieved its purpose but also got 100 per cent security for the actual assault.

The admirable descriptions of the fighting on the beaches and in the bridgeheads beyond the Orne and the Vire, bring home to the reader the passionate courage and determination that animated the sailors, soldiers and airmen of the Allies. All of them seemed keyed-up to make the supreme effort required for victory. The prevalence of such high morale was much due to the consummate expertise in mounting the Overlord operation which the soundness of the Allied Command structure made possible. Its German counterpart was an almost farcical semblance of what it ought to have been. Indeed it is a great tribute to the basic high quality of the German troops that, in spite of such faulty direction, they fought on to the inevitable end with such enduring skill and devotion.

Whether a command system is good or bad, however, results still depend on the statesmen and commanders who have to make it smoothly. Already in this first volume, Montgomery with his customary small handful of staff officers is seen, occasionally, to be at odds in operational matters with Eisenhower and his mass of advisers at SHAEF. Rather characteristically, some of the British members of the allied Supreme Headquarters were among the most adverse critics of Montgomery's conduct of the Normandy battle. Equally characteristic was the steady refusal of Eisenhower to interfere seriously with Montgomery's operations, even although, as Major Ellis points out, he did not really understand or perhaps believe Montgomery's constantly avowed intentions. Anyhow Eisenhower's attitude seems far more to be commended than the efforts of a few of his British staff to be more American than the Americans. One of them who was not even a soldier, began quite soon after the landing to have misgivings, which the result of the battle proved later to be nothing but a load of old rubbish.

A point, which has always interested your reviewer, evidently also occurred to General Bradley the commander of US Twelfth Army Group, who on one occasion was much disappointed that the massive bomber support to one of his attacks was delivered frontally and not in enfilade. It may be that bombing in enfilade hazards too many aircraft?

Sappers will note with pride that the maps of Normandy were produced and issued to all concerned with complete secrecy, that the first of 1,500 Bailey bridges destined to be erected before the end of the war went up over the River Orne within a few days after the landing and that special squads of engineers duly demolished the deadly but fruitless explosive charges that cluttered up the shallows and infested the beaches. In other words the Royal Engineers were on their multifarious jobs as usual.

A more detailed account of the German casualties and loss of equipment west of the Seine would have emphasized the grandeur of the Allied victory.

The excellent maps are a distinct trial being unnumbered and awkwardly placed.

This is a very good book, worthy of one of the decisive battles of history in which Britain true to form once more played a leading part. B.T.W.

# Technical Notes

## CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review* for May 1962

AN ELECTRO-MAGNETIC GAUGE FOR THE MEASUREMENT OF SOIL PRESSURE. This paper describes a gauge designed to measure the pressures acting at a soil-structure boundary such as the base of a foundation or retaining wall. It may be used either on laboratory models or on full scale structures in the field.

The gauge operates on the principle that a change in reluctance of a magnetic circuit occurs when a combined soil thrust and magneto-motive force overcomes the resistance of a precompressed helical spring. It is possible to obtain an initial reading of soil pressure prior to any relative movement of the pressure sensitive gauge face. Subsequent readings enable the effect of movement on recorded pressure to be studied.

SUPER-SULPHATED CEMENT IN CIVIL ENGINEERING WORKS. This is the second part of an article commenced in the April issue of *Civil Engineering and Public Works Review*. This article describes the main properties of super-sulphated cement. It shows that the heat of hydration is lower than other Portland cements and thus super-sulphated cement is eminently suitable for mass concrete work—even under hot tropical conditions. Compressive strength and setting time are similar to those for Portland cement concrete, shrinkage is only slightly less, and although super-sulphate cement concrete is more prone to surface dusting, this can be minimized by careful curing. Its particular advantages are that it is less prone to sulphate attack, is less susceptible to acid aggression, and is almost immune from attack by sea water. It should be noticed, when calculating proportions by weight, that its bulk density is 70 lb/cu ft as against 85–90 lb/cu ft for Portland cement.

COMPACTION OF MORTAR AND CONCRETE BY VIBRATOR. This is the second of two articles describing experiments on the vibration of various concrete mixes. The conclusions drawn from this series of experiments are that:—

(*a*) The optimum frequency of mixes with single-sized aggregates tends to increase with particle size.

(*b*) In graded aggregates the optimum frequency of rich mixes increases as the predominate particle size increases.

(*c*) The cube strength at optimum frequency can be up to 30 per cent greater than that at other frequencies, and strengths drop off rapidly at slightly higher and lower frequencies.

(*d*) The water content of the mix does not have a great influence on the optimum frequency.

(*e*) Strength appears to be dependent on acceleration, velocity and amplitude at a given frequency.

J.R.J.

Notes from *Civil Engineering and Public Works Review* for June 1962

THE SHELL CENTRE. The Shell centre, now a recognized London landmark, is the largest office building scheme in the UK. The site is on the South Bank of the Thames, adjacent to County Hall. The buildings comprise a U-shaped block and a tower block upstream of Hungerford railway bridge, and an L-shaped block downstream of the bridge. The U and L blocks both have 10 storeys above ground level, and are of reinforced concrete construction, whilst the tower block has 26 storeys and is framed in steel. The majority of the floor space in all blocks is devoted to office accommodation but there are also a four-floor basement garage, a theatre, an underground swimming pool, and a number of rooms for plant and amenities.

The article describes the foundations, including the special measures which had to be taken where the Bakerloo Railway tunnel passed only $2\frac{1}{2}$ ft below them. The steel framework for the tower block has its principle columns and beams built up from plates, shop-welded together. The steelwork for the lower floors was designed and built as a series of rigid frames, using site welding, whilst the steel for the upper floors had a combination of bracings and moment connections between beams and columns. High strength bolts were used extensively.

To speed up construction, the general contractor was selected unusually early and joined the design team; in this way his requirements were considered whilst drawing up construction plans. Work proceeded around the clock and over 250 kw of electricity was used in floodlighting at night.

THE QUEEN ELIZABETH II RESERVOIR. This reservoir has recently been built at Walton for the Metropolitan Water Board. The design incorporates a continuous ballast embankment, some 40 ft high, around the site. Construction started prewar with a puddled clay cut-off trench and core wall, but the contract was closed down early in 1940; a fresh contract was let after the war, the puddled clay being replaced by compacted clay for the remainder of the core and cut-off. The ballast for the embankment was all excavated from the interior of the site and further ballast was excavated as surplus for use elsewhere, thus increasing the reservoir capacity and conserving a valuable material.

The excavation for and construction of the clay walls is described as is also the laying of the concrete slabs to protect the embankment from wave erosion. There is much information on the inlets and outlets, the main flows of which are carried in tunnels deep under the London clay, to avoid settlement in the upper layers below the embankment. Much thought has gone into the positioning and design of the inlet orifices to prevent stratification of the water in the reservoir.

EPOXY RESIN CONCRETE. This is the first of a series of articles describing some tests which have been carried out on concretes made using epoxy resins in place of the usual Portland cement–water binder. Very high strengths can be obtained, and the physical properties can be varied to suit particular applications by changing the types of resin, curing agent, or flexibilizing agent. On the other hand, such disadvantages as the high cost of the resins, their short "pot life", and the precautions to prevent toxic effects when handling them, are likely to limit their use on a large scale for some time. Details are given of nine different mixes, including their compressive and tensile strengths, elastic modulus, and Poissons ratio; there are also some figures for shrinkage during curing, temperature effects and bond strength.

SUPER SULPHATED CEMENT IN CIVIL ENGINEERING WORKS. The concluding part of the series stresses that if sulphated concrete is to be of value it must be well mixed, densely compacted, and have an adequate cement content; mixes should not be leaner than 1 : 2 : 4 by weight, and may have to be as rich as 1 : $1\frac{1}{2}$ : 3. Several applications for the use of this concrete are given, being mainly those where chemical attack is likely.

PRECAST FEATURES OF THE NEW UNIVERSITY OF SUSSEX. Some of the features of the new university buildings were described in the *RE Journal* March 1962. This article refers to the various precast concrete members of the structures, in particular the vaulted roofs, their moulds, precasting, and the methods of assembly into the building frames.

J.C.P.

Notes from *Civil Engineering and Public Works Review*, July 1962

A supplement to the July 1962 issue of the *Civil Engineering and Public Works Review* contains details of the Engineering Models and Apparatus exhibited during the annual conversazione held at the Institution of Civil Engineers on 20 June 1962. Some details of the more interesting exhibits are summarized below.

R.E.J.–D

THE TRITON OFFSHORE MARINE PLATFORM: Shown by International Marine Developments Ltd. The Triton platform consists of a superstructure designed for the particular requirements of the user (e.g. oil drilling, radio or television relay, refuelling station, etc) supported by a deeply submerged buoyancy chamber held down to the sea bed by sinkers and normal anchorage. The whole forms a stable "island" that can be permanently moored in one location at sea or moved from one place to another as required. The positive buoyancy of the platform exerts pre-tensioning forces in the mooring tendons so that the whole assembly becomes a non-redundant space frame, which under any system of external loading, up to the limit determined by the magnitude of the pre-tensioning forces, will behave elastically in the same way as a steel tower of similar dimensions. Beyond these limits the structure becomes a "mechanism" but on reduction of the external load once again the structure reverts to its previous condition without injury.

The article goes on to describe the dimensions of a typical offshore petroleum drilling platform and the many exhaustive tests that have been carried out on models at the Imperial College, London University, by Professor C. M. White, DSC(ENG), PHD.

AN AUTOMATIC READING CATHETOMETER: Shown by N. P. Roberts, BSC(ENG), AMICE. The cathetometer is used for sighting on to targets attached to a structure in order to measure deflections when load is applied. Results are displayed as + or − from datum in inches to four places of decimals. However, a digitizing unit can be incorporated to translate the readings into binary and punch them on tape in Pegasus or Sirius code. The combination of cathetometer and fast recording unit demonstrates how the study of model structures and derivation of shear forces and bending moments on an electronic computer can be simplified by instrumentation.

HEAVY GIRDER BRIDGE AND PANEL PIERS: Shown by R. A. Foulkes, MA, MICE, and E. Longbottom, BSC, AMICE. This is a short article describing the use of the heavy girder bridge in the communications zone. It gives a few details of permissible spans for different types of construction and illustrates the use of panels to form piers up to 100 ft high.

A TERMINAL FOR A 100 TON HOVERCRAFT: Shown by E. W. H. Gifford, BSC(ENG) MICE. In this article the operation of a hovercraft is briefly described and the construction of a suitable berth and terminal is then illustrated. The berth envisaged is a heavy concrete pontoon with a positive connection to the shore terminal by means of a full hold-width ramp. The hovercraft "sits down" firmly on keel pads in the pontoon and is held laterally by fender units. No warps are needed for mooring.

A DESIGN FOR A CROSS-CHANNEL BRIDGE: Shown by J. C. Maxwell-Cook, FSE, AMICE, MISTRUCTE, MCONSE. This is a very brief article describing the models and sketches of a proposed channel bridge. The design incorporates crossover parabolic arches, providing resistance to wind, connected to pairs of parallel arches supporting the articulated-continuous traffic lanes by tension cables. Each arch, spanning 2,250 ft, is a rigid independent structure supported on reinforced concrete foundations embedded on the bed of the channel.

THE SEVERN ROAD BRIDGE: Shown by Messrs Mott, Hay and Anderson and Messrs Freeman, Fox and Partners. The new Severn Bridge near the Aust ferry site is now under construction. The main span is 3,240 ft and each side span is 1,000 ft. Navigational clearance above HW is 110 ft, and the height of the main towers is about 485 ft OD. The article goes on to describe some of the unique features of design decided upon after exhaustive model testing at the National Physical Laboratory.

THE PRESSURES DEVELOPED BY CONCRETE ON FORMWORK: By A. G. B. Ritchie, BSC, ARCST, AMICE, AMISTRUCTE. The author begins by summarizing the previous work on the lateral pressures developed by placed and setting concrete. Particular reference is made to the findings and formulae devised by Rodin and the American Concrete Institute. He then goes on to describe a series of tests carried out by him on a 6 in × 6 in × 8 ft high column using 1 : 3 and 1 : 6 concrete mixes. The results of the tests seemed to substantiate the pressure distribution predicted by Rodin but the theoretical critical depth and maximum pressure calculated from the formulae of the latter were far in excess of the actual values recorded in this series of tests.

SOME RECENT DEVELOPMENTS IN STRUCTURAL PRECAST CONCRETE: By M. Rees, BSC (ENG), AMICE, AMISTRUCTE. This article describes and illustrates some recent developments that may be used in structural precast concrete work. Composite connections, such as the angle-T and the *in situ* collar for the design of beam to column joints, bolted connections by the use of torque bolts, the production of large precast wall panels, and end fixity by the use of rectangular or triangular strainer frames are all discussed and illustrated.

EPOXY RESIN CONCRETE: By G. B. Welch, A. J. Carmichael, and D. E. Hattersley. This is the second of two articles, the first of which appeared in the June issue of this *Journal*. In this article, the authors discuss the results of the experiments previously described. The conclusions drawn were that:—

(*a*) The workability of the epoxy concretes examined were unlike that of Portland cement concrete, having a greater tendency to flow as a viscous liquid. Because of this finer sand and aggregates were found to be more preferable than the courser gradings used in normal concretes.

(*b*) The ultimate compressive strengths of the epoxy concretes were of the order of 10,000 lb/sq in, and tensile strengths were as much as 1,500 lb/sq in. The high tensile strengths and good adhesion properties resulted in bond stresses of up to 1,200 lb/sq in.

(*c*) Other properties, such as the elastic modulus and shrinkage, appeared to be similar to those of normal concrete.

(*d*) The inclusion of a flexibilizer resulted in a reduction in ultimate compressive and tensile strengths and in the elastic modulus, but increased the compressive strain at failure and the value of Poissons ratio for the concretes.

The overall results indicated that epoxy resin concretes have properties which may make them suitable for a variety of uses, including the repair of damaged concrete work.

Notes from *Civil Engineering and Public Works Review*, August 1962

STRUCTURAL LIGHTWEIGHT CONCRETE: At a recent symposium on Structural Lightweight Concrete held by the Reinforced Concrete Association, several papers on different types of lightweight concretes and their uses, were discussed.

The symposium first discussed "Siporex" and "Thermalite Ytong" as examples of aerated concrete, the principle advantages of which are low weight compared with dense hollow-cast units, insulation properties, and the fact that the materials (like wood) can be sawn, nailed, screwed, and chased with hand tools. Reinforced slabs may be used as wall cladding or as floor slabs. Because of possible penetration of water vapour, the reinforcing in such slabs must be coated. "Ytong" uses a special bituminous material for this, whereas "Siporex" use a cement/rubber laytex mixture. Autoclaving renders the coating hard and produces good chemical and mechanical bond.

It was suggested that a Code of Practice was needed to cover aerated concretes. In several papers on lightweight aggregate concrete, synthetic lightweight aggregates such as "Lytag" and "Aglite", formed slag aggregate, and lightweight expended clay aggregate (LECA) were discussed. Consultants and Contractors viewpoints of the use of such aggregates for structural concrete were also expressed.

AN ELECTRONIC COMPUTER ANALYSIS OF RIGHT BRIDGE DECK SUBJECTED TO MINISTRY OF TRANSPORT ABNORMAL LOADING: This article, the first part of which appeared in the July issue of this journal, discusses the preparation and subsequent assessment of a computer analysis of the design of right bridge decks. The example chosen was a typical single span bridge previously analysed by Morice and Little.

It was concluded that the abnormal load vehicle should be placed astride the transverse centre-line and the extreme outer edge of a roadway to produce the maximum longitudinal bending moment in an outside main beam, and should be placed directly over the centre of the bridge to produce a maximum transverse bending moment in the central diaphragms. It is, however, stated that this may not be true of a different bridge geometry.

THE PRESSURE DEVELOPED BY CONCRETE ON FORMWORK: Again this is the second of two articles commenced in the July issue of the *Journal*. The investigation was planned to study the effect of rate of pour, mode of compaction, workability and formwork details, on the shape of the pressure diagram and maximum pressure exerted on the formwork. The conclusions reached were that fresh concrete develops a pressure distribution close to that predicted by Rodin and that variables have a significant effect and should not be ignored to produce a simplified formula. An approach to design of specialized formwork is suggested in the light of the results obtained in the experiments although no attempt has been made to develop a new pressure concept at this stage. J.R.J.

Notes from *Civil Engineering and Public Works Review*, September 1962

THE WAYOH RESERVOIR of Bolton Corporation Water Works has recently been enlarged by increasing the height of the impounding earth dam. The work on the dam, and on certain modifications to the installations which were carried out at the same time, is described in an article by R. A. Jones, the resident engineer on the project.

The dam has a puddle-clay core, and the core for the new top section had to be carefully keyed to the original one. The new earth banks were laid to steeper slopes than the existing ones, this cutting down the amount of fill required, but calling for secure keying to prevent relative movement; a pattern of steps and a toe trench was employed to achieve this. To reduce the risk of seepage due to the increased hydraulic pressure, a puddle-filled cut-off trench was built at one end of the dam; the other end of the dam was satisfactorily sealed into a rock out-crop. A new overflow shaft has been built to replace the weir at the original lower level. Other work included road diversions and modifications to the discharge and treatment works.

ROSTOCK HARBOUR: An article on the recent developments at Rostock, the only large port in Eastern Germany, gives a large number of statistics on the capacities, sizes, etc, of the various quays. Due for completion in 1965, the new port will have about 4½ miles of quay, capable of handling 7 million tons of cargo each year. The original harbour, further up the Warnow river than the new one, had a capacity only one-seventh the size. Few details are given of the construction, which appears to be mainly in reinforced concrete on piled foundations. The quays are well served with cranes, cargo handling equipment, and warehouse accommodation. Railway marshalling yards have been built to serve the port, which is also to be connected to the Autobahn in the near future.

UNDERGROUND SEWAGE PLANT: A new sewage purification plant for Stockholm has been built below ground under a local beauty spot, in chambers blasted out of the rock. The few buildings necessary above ground level have been specially designed to be as unobtrusive as possible. An article on the plant is primarily concerned with the sewage treatment aspect.

HEAT-RESISTANT CONCRETE: Professor Billig discusses the problem of the effects induced in nuclear reactor structures where temperatures of 500°C are maintained in concrete over long durations. There is a considerable thermal gradient between the inside and outside of such structures, and there are also additional stresses set up by the heat cycles of shutting down and starting up the reactors. Ordinary Portland cement concretes deteriorate, with a fall-off in strength and an increase in plastic deformations, on heating to much over 100°C. The deterioration is mainly caused by shrinkage of the cement paste due to dessication, by relative thermal movement due to contraction of the cement paste and expansion of the aggregates, and by certain chemical changes produced or accelerated by heat. Total disintegration takes place between 500° and 600°C. Heat-resistant Portland cement concretes have finely ground admixtures of silica and alumina to reduce the shrinkage of the cement paste; fine resistant minerals having low expansion coefficients are used as aggregates. This concrete gains strength between 200° and 250°C, whilst above 250°C there is a slow deterioration due to thermal deformation; above 500°C a further marked decrease in strength is apparent, due to dehydration of hydrates. Further cycles of heating and cooling do not produce any further loss of strength. Details of the effects of high temperatures on various types of heat-resistant concretes are discussed.

RUBBER IN CIVIL ENGINEERING: The special feature of this number of *Civil Engineering* is a selection of articles on the use of rubber in civil engineering. The main topics are bridge bearings, waterstops, road materials, dock fenders and damp-proofing.

Rubber bridge bearings are becoming increasingly popular in absorbing the high acceleration and braking forces of modern heavy vehicles, as well as the thermal expansion and contraction of bridge decks, without putting undue horizontal loads on the abutments. These bearings have a good life and require no maintenance; they are relatively inexpensive in comparison with steel roller bearings. The plan area of the bearings is chosen to conform with the bearing strength of the concrete or steel supports, and the thickness is designed to limit the horizontal stiffness; the vertical stiffness required is then obtained by inserting metal spacer plates between horizontal layers of rubber to the required thickness, and bonding them firmly together; in this way the rubber is restrained from bulging outwards as easily as it would if not restrained by the metal plates. Improved resistance to atmospheric decay is given to rubber for engineering purposes by the addition of anti-oxidants, anti-ozonants, and carbon black filler. Improved rubber/metal expansion joints have also been produced which give a smooth road surface under extreme conditions of expansion and contraction.

Rubber waterstops are more versatile than metal ones in providing waterproof joints between concrete sections. They are resistant to mechanical damage, and, being flexible, can easily be bent to conform to irregular contours. They can be obtained in long lengths, so that few joints are necessary; however, jointing by vulcanizing is relatively easy. Being pressure-sensitive diaphragms, the rubber stops do not rely on adhesion to the concrete to perform their function.

The addition of rubber to bituminous binders for road materials greatly improves the properties of the laid surfaces. The rubber can be added in the form of powder or latex; powder has to be suitably blended, but this tends to be easier than mixing in the latex which is a much cheaper material containing water and tending to cause frothing. The duration of any high temperature mixing periods of materials containing rubber should be restricted to prevent breakdown of the rubber; recommended periods of heating for various temperatures are given in a graph. The use of rubber mixes is increasing; they have already shown their worth on steep hills and roundabouts on busy roads where the conditions are particularly severe.

Rubber is being used increasingly as a cushioning medium for modern dock and harbour fendering installations. Several types of fenders have been produced, many of which are described and illustrated.

A method of damp-proofing has recently been developed which consists of injecting a latex/siliconate fluid into mortar joints in masonry. Progressive blocking of the pores take place, thus sealing them against water flow. The major use of the method is in stopping damp in old houses.

Other uses of rubber which are described in a more general article include rail pads, springs for vehicles, anti-vibration mountings for machinery, giant tyres, ductube and textured panels for concrete formwork, and inflatable huts. J.C.P.

Notes from *Civil Engineering and Public Works Review*, October 1962

High Marnham Power Station: The construction of this power station, near Newark, has recently been completed. With an installed capacity of 1,000 MW, made up of five 200MW sets, this is the largest thermal power station under one roof in Europe. The cost of the civil engineering and building works alone was over £12 million, whilst that of the whole project exceeded £49 million. Much of the civil engineering work is described in an article by J. T. Edwards.

The turbo-alternator blocks have to limit relative vertical movement between the shaft bearings to the absolute minimum; they were therefore built on large raft foundations and the various component members of the blocks were heavily prestressed together.

The railway sidings were designed for a daily inward traffic of 10,000 tons of coal. To limit maintenance and improve the speed of operation, 109 lb FB rail was used; all the turnouts and signals are electrically operated by remote control from the coal handling plant.

The station is designed to burn coal having up to 20 per cent ash content; the removal of the coarse ash is by lorry, whilst the majority of the fines are mixed with water and pumped for over five miles to worked-out gravel pits on the other side of the River Trent.

The cooling water for the condensers, etc, is circulated by pumps rated at 93,000 gallons per minute. There is one condenser, cooling tower and circulating pump to each of the five generating sets, all of which are interconnected by common mains, so that the number in use can be varied to suit the demand.

Large diameter bored piles are being used to support the foundations of many new tall buildings. A report is given of loading and settlement tests carried out on a 4-ft diameter pile, under-reamed to 10 ft 6 in diameter, which is founded deep in the London clay and was constructed for the improvements to the West London Air Terminal.

Water flow calculations: Design calculations for flow of water in channels and culverts entail many variables, such as the area, the wetted perimeter, the bed slope, and the discharge. Various formulae are available. The author discusses different ways of tackling the problems, depending on which variables are unknown. He then goes on to give several worked examples of the use of Manning's formula, and refers to charts, published by DSIR, which simplify the use of the Colebrook-White transition formula for laminar flow conditions.

Storm water estimation: This article describes different methods which can be used to estimate the probable maximum flood conditions, when insufficient records are available. The first method, based on the Regime Theory entails taking measurements of the watercourse itself, and calculating the flow from functions of these measurements. Other methods deduce the required information, using the theory of probability, from recordings taken over a relatively short number of years.

Heat resistant concrete: The effects of a temperature on both steel and concrete are considered. Reinforced concrete has a coefficient of expansion between that of the steel and that of the concrete, so that on heating, the concrete is subjected to tension and the steel to compression; these stresses are partially reduced as soon as cracks appear in the concrete. The loss of "bond" consequent upon the relative movement of steel and concrete can be considerably reduced by the use of deformed bars. One of the major problems in structures subjected to thermal cycles is the occurrence of tensile stresses in parts of the concrete on cooling; these parts must be reinforced to prevent cracking. Some methods of compensating for excessive thermal stresees are given.

TIMBER IN CIVIL ENGINEERING: The special feature in this month's edition is "Timber". A report is given of a series of tests carried out on a timber grid roof frame, made up of joists in two directions at right angles. The recorded deflections, recovery, and apparent stress were well within the requirements of CP 112.

Another article is on Finnish Birth plywood of WBP (weather and boil-proof) quality for exterior use. This plywood has more plies for a given thickness than other exterior plywoods, and each ply is permanently bonded with phenolic resin to the next ones. The strength of birch is good in comparison with other hardwoods, so that the plywood is exceptionally strong and stiff, and it is often possible to use smaller thicknesses than would otherwise be necessary. Suitable applications for its use, of which some examples are given, are box beams, portal frames, stressed skin panels, and curtain walls. Special plywoods are available as shuttering boards, either plain or with plastic faces, and their availability in sizes of up to 10 ft by 5 ft is a distinct advantage. Some hints for obtaining the maximum life from plywood shutters are included.

SEA-WALL CONSTRUCTION: A new sea wall is being built to protect headlands at Birchington, near Margate; the wall has a curved face, and is built up from large precast concrete blocks. The contractors decided to construct as much as possible of the wall during the summer months, and spent the first part of the contract period, during winter, in preparing a casting yard and casting a stockpile of blocks. During the summer it was necessary to work double tide shifts with an unusually large amount of plant, so that the work could be completed before the return of winter conditions. J.C.P.

Notes from *Civil Engineering and Public Works Review*, November 1962

FLY ASH IN GROUT: Fly ash, which is the name for the residue from burning pulverized fuel in furnaces, is used to a large extent in concrete and grout as an additive. Some fly ashes have a very high specific surface area, and are finer than most cements; this fineness improves the pumping characteristics of grout to which the fly ash has been added, by keeping the particles in suspension and by reducing sedimentation; it also enables penetration into fine interstices. Fly ash has a lower specific gravity than cement or sand, and it can therefore be used to give a light weight concrete. Particular aspects which are discussed in this article are the lubricating action of fly ash in grout, and also in lean concrete where it increases the workability and eases pumping; mention is also made of the age-hardening effect of neat fly ash.

DRY DOCK AT HEBBURN: A new dry dock, the largest on the NE coast, has recently been built for Vickers Ltd. at their Palmers ship-repair yard at Hebburn-on-Tyne. The dock is 850 ft long, 145 ft wide, and can accommodate tankers of up to 85,000 dead-weight tons.

Site investigations showed strata of made ground, alluvium, glacial deposits including boulder clay, and earlier deposits, on top of bed rock which was at some 73 ft to 84 ft below Ordnance Datum. Water present below the clay was at a considerable artesian head, and the dock was designed to be sufficiently heavy to resist any tendency to float; this called for such a floor thickness, 24 ft, that the underside of the floor slab was situated within water bearing strata. This presented serious dewatering problems in the construction, and it was necessary to sink and pump from a number of deep wells around the site. The walls of the dock are of concrete, having an average thickness of 5 ft, and were cast against a backing of steel sheet piling, used originally as revetment to the excavation. The head of the dock is built as an arch of relatively light section; it is likely that this may later be demolished to allow the length of the dock to be extended to 1,000 ft.

Several of the features of the equipment are described, including the box-type dock gate with its operating machinery, the pumps and their motors, the rotating rubber fenders, and the remotely controlled bilge-blocks which allow adjustment to suit the contours of a ship's hull.

Spencer Steelworks: An article on the Spencer steelworks at Llanwern, recently opened by HM The Queen, contains an enormous fund of facts and figures about the project. The whole steel plant is highly automated and is an immense undertaking. A large number of points are described, including the piling, steel fabrication and services, but the scope covered is so wide that the information given has become a mass of statistics with insufficient detail to be of more than interest value.

Hyde Park Corner improvements and Underground Garage: The first part of this article deals mainly with the Underpass, describing the construction, the revetments for the excavations, and the methods adopted to prevent movement and subsidence around adjacent structures. Excavation was carried out within inches of both St George's Hospital and the escalator tube for the LTE Underground station; careful measurements were taken to record deflections, and struts were preloaded to limit movement on transfer of load. The lighting and ventilation arrangements for the tunnels are described.

The underground garage was constructed by cut and fill methods (as was also the underpass). The project was carried out as a "package deal" by Sir Robert McAlpine & Sons Ltd, who had to detail the structure and services to suit a specification. The garage was designed to interfere as little as possible with the amenities of the Park, and there is now little evidence of its presence below ground. Most of the construction is in reinforced concrete, placed *in situ*, although some members were precast.

Carquinez Straits Bridge: The deep water piers for this new bridge in California have been constructed by a novel method. The concrete pier footings, which have a cellular formation, were built on land and floated out into position where they were duly anchored. Temporary steel tubes, to act as caissons, were lowered down from the footings into the soft material overlying bedrock. Excavation was then carried out within the tubes, followed by boring into the rock beneath; the spoil was removed by airlift pumps. When the rock had been suitably prepared, smaller steel tubes were passed down inside the caisson tubes, and these were filled with concrete and forming a key with the rock. The corner tubes were completed first, after which the weight of the footing was transferred on to them, and the remaining cells flooded. Further tubes were later sunk down to the rock, and the tops of each were concreted into the footing cells.

Considerable savings in the weight of the superstructure of this bridge were achieved by the use of a high strength alloy steel in place of the normal structural steels.

Notes from *Civil Engineering and Public Works Review*, December 1962

Construction of the Grantham By-Pass: The contract for this by-pass included major road improvement works on 4 miles of the A1 South of Grantham. The existing winding single carriageway had to be replaced by a re-aligned dual carrigeway construction with greatly reduced curves and gradients. The flow of traffic on the A1 had to be maintained unimpeded during the execution of the works, which were further complicated by having to re-align a main GPO telephone duct and cables, again without a break.

The by-pass itself was mainly in concrete construction, with some flexible surfaces adjacent to bridges. There was an unexpectedly large amount of excavation in rock which delayed work; further delays were caused by slips in the cuttings through clay, where further excavation was then called for to decrease the angle of slope.

The construction of the concrete carriageways is described, including the prepratory work, the concreting train, and the arrangements for batching.

Strand Prestressing Tendons: Strand is used where it is required to have a greater prestressing load in a tendon than can be obtained with a single wire. The article describes the construction of the strand, in which helical wires are laid around a straight core. When the strand is loaded, it extends due to the normal elastic strain and also due to a certain amount of unwinding of the wires; this latter extension is usually non-reversible. The effects on the strand of stabilizing and stress-relieving are described, and compared with the as-drawn condition. The January 1963 number contains information on the problem of relaxation of strand.

Repairs to Chicken Rock Lighthouse: This lighthouse was badly damaged by a fire late in 1960; it is situated on an isolated rock, three-quarters of a mile south of the Calf of Man, an island off the Isle of Man. The base of the rock is completely covered at high water, and the currents in the surrounding water make landings difficult; the major problem was one of access. A helicopter was chartered for the project, and was found to be most effective in making use of fleeting spells of calm weather for making landings or dropping stores, in conditions when it would not have been possible to land a boat. The repairs were carried out by guniting; all the necessary plant had to be kept inside the lighthouse.

The Analysis of Multiple Rigid Frames: The various steps to be taken in determining the redundant moments and reactions in multiple-bay portal frames are carefully described, with examples, using Clapeysons theorem. The effects of dead, live, and wind loading are considered, and settlement at supports is also taken into account.

Fly Ash in Grout: This is the final part of the article on fly ash; various examples are given of the use of this material for such purposes as righting tanks with differential settlement; control of fires in shale tips; grouting of preplaced aggregates; and the formation of *in-situ* piles by intrusion grouting using a mixing head.

Three-Dimensional Frameworks: Braced barrel vaults, and various forms of space-grid are described, together with folded-plate roofs systems and roof structures suspended from cables. All these forms give rigidity combined with lightness over large spans.

Notes from *Civil Engineering and Public Works Review*, January 1963

Reconstruction of Chepstow Railway Bridge: Brunel's railway bridge across the River Wye near Chepstow was opened in 1852. It had a wrought-iron superstructure with separate construction for each of the two tracks; each main river span of 300 ft consisted of a truss with a large tubular member, 50 ft above rail level, as a compression chord, and plate girders in tension and bending supporting the cross-girders below. The girder webs were insufficiently stiffened, and some minor failures had occurred. The approach spans were replaced in 1948, and the river spans in 1962; the latter task is the subject of a most interesting article.

The new spans have two underslung mild steel Warren trusses side by side with the addition of vertical members. The trusses are made up of large shop-welded units joined together on side by double covered butt joints with high strength friction grip bolts. Each span was replaced separately whilst the other was kept open to allow single line working. The new spans were moved out below the existing ones, which were then dismantled to allow the new steelwork to be jacked up into position.

The article is in two parts; the first, in this number, is mainly concerned with the design and fabrication of the truss members.

Drilling through Reinforced Concrete: It has recently been necessary to drill holes through reinforced concrete reactor shields, sometimes to take sample cores, and sometimes for alterations. Diamond faced bits have been used satisfactorily, driven by a light pneumatic drill. Great care has to be taken when cutting through steel, and a special procedure adopted, but it can be done. Whilst 5 in diameter cores can be cut at about 1 ft per hour through good concrete, it takes about three-quarters of an hour to cut through a $\frac{7}{8}$ in dia steel bar.

Timber Feature: This issue contains several articles on timber roof structures of various types. Laminated timber beams are relatively light, and can be shaped to suit the anticipated loading, thus giving an attractive appearance. Two timber shell roofs are described.

STEEL TUNNEL AT BRISTOL: An 11-ft diameter steel tunnel has recently been built under a busy thoroughfare in Bristol using the pipe-jacking principle. A tunnel shield and sections of lining were forced forward under the pressure of four hydraulic jacks, acting against a temporary thrust pad in the access pit; from time to time the jacks were retracted and a further length of tunnel lining fixed in position in front of them. Excavation was carried out within the shield, and the tunnel roof was continually supported by the lining. The resistance of the lining to forward movement was reduced by grouting with Bentonite through holes in the circumference. J.C.P.

## THE MILITARY ENGINEER

NOVEMBER–DECEMBER 1962

"ICBM SITE CONSTRUCTION", by Brigadier-General T. J. Hayes, III United States Army. The Army Corps of Engineers is the construction agency which builds the facilities for research and development and for operational launching of the United States Intercontinental Ballistic Missiles (ICBM). This article describes the design and construction of operational launching sites for each of the ICBM's in the order of their production, Atlas F, Titan I, Titan II and Minuteman. The article is well illustrated with photographs and diagrams. The amount of work involved was tremendous and each new missile called for virtually a fresh design of launching site.

"ENGINEERING ASPECTS OF THE RANGER PROJECT", by J. D. Burke. The Ranger Project is the first attempt to make close-up measurements and to land equipment on the moon. Nine flights are scheduled of which four have been made, the latest of which Ranger IV landed on the moon. This short well illustrated article summarizes some of the principal engineering problems connected with the project and describes some of the reasons for failure of earlier efforts.

"ENGINEER COMBAT EFFECTIVENESS". The series of articles which follow this heading describes the new equipments of all kinds which are already in the service with the Engineer Corps or are in active development.

"ENGINEER RESEARCH AND DEVELOPMENT", by Colonel J. H. Kerring, Corps of Engineers. A short, well illustrated, article describing new equipments which include, infra-red visual devices, mechanical minelayers, a light-weight transistor mine detector, capable only of detecting metallic mines though work is continuing to perfect a portable detector that can find both metallic and non metallic mines, a power trench digger that can dig a trench 4 ft deep 2 ft wide, and 20 ft long in one minute and many others.

"MOBILE ASSAULT BRIDGE (MAB)", by F. J. Tamanini. This is a description of the design of a mobile assault bridge-ferry which has been designed in the Engineer Research and Development Laboratories at Fort Belvoir. A very detailed specification is given illustrated by photographs of models. The general idea of a mobile amphibious bridge as developed by Colonel Jean F. Gillois has been followed but much improved upon. The equipment consists of a standard mobile amphibian boat unit which can be used as a ferry or fitted with a roadway unit or a landing bay unit for bridge construction. Positioning the superstructure is done by hydraulically operated mechanisms. From the article it appears that the design has been approved but is not clear when it will come into service.

"GERMAN M2 BRIDGE-FERRY", by Lieutenant-Colonel Joseph J. Rochefort, Corps of Engineers. This is a description of the German design for an assault ferry-bridge. The principle followed is the same as in the American design, with which it is compared.

"MILITARY POTENTIAL OF LASERS", by Aaron S. Soltes. Lasers are devices that "produce a new kind of light—coherent light—which has predictable properties that can be controlled in a manner comparable to signals at radio and microwave frequencies." The high frequency of the laser offers enormous channel capacity for communications and great range, particularly applicable to space projects. It has great value for the design and construction of radar devices, for instance light-weight range finders. As a weapon its capacity to focus high energy and power densities into narrow beams makes it possible to inflict damage at a distance with the speed of light. Lasers are able to produce temperatures in target materials many times hotter than the surface of the sun.

The article goes into the scientific theory behind the design of a laser and gives technical information on the construction. There are clear diagrams and photographs.

"CONSTRUCTION SCHEDULING WITH CPM", by Captain Richard S. Kem, Corps of Engineers. CPM stands for Critical Path Method. It is a system for co-ordinating project planning, scheduling, and control of labour, equipment and materials. It is a logical way of approaching the problem and the system is clearly set out and described.

"THE MEKOMETER FOR MEASURING SHORT DISTANCES", by F. C. Livingstone. The mekometer is a new instrument using a centimetre wavelength pattern imposed on a light beam which can measure a distance of several hundred feet to an accuracy of about 0.05 mm. It was designed by the National Physical Laboratory, British Department of Scientific and Industrial Research. The article gives a detailed description of the instrument.

"SONIC PILE DRIVER. TESTS AND PERFORMANCE". This is a description of tests carried out of the Bodine pile driver which is a process of placing piles utilizing the tremendous power in sound waves. A previous article in the *Military Engineer*, January–February 1962 dealt with this subject. The tests were highly successful and demonstrated that this method is not only speedier but produces very little vibration in the surrounding soil.

"UNIQUE RESERVOIR CONSTRUCTION", by Colonel William C. Langley, Corps of Engineers. A well illustrated account of the design and construction of an extension to an existing reservoir at the Arnold Center where the Department of Defense carries out most of the testing of the high priority aeronautical weapon systems.

"ATLAS MISSILE PROPELLANT SYSTEM", by Major Edward R. Hindman, Corps of Engineers. A description of the layout of the fueling system with an account of the particular points to be watched during the assembly and erection of it. Exactingly high standards of cleanliness are essential. Illustrated with a diagram and photographs.

"ARMY TRANSPORTABLE NUCLEAR POWER PLANT." In the News and Comment section, page 457 there is a short description and photograph of a transportable nuclear power unit which will probably be available in about a year's time. It is the smallest reactor power plant to produce electricity. J.S.W.S.

## ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, September 1962.

75 YEARS OF STRUCTURAL STEEL: A significant proportion of steel was first used in bridge construction about 100 years ago, and the first all-steel bridge of any size was probably the Forth Bridge, completed in 1889. Steel-framed "skyscrapers" were first built in Chicago at about the same time. The development of early specifications into the present family of structural steels is outlined in this short review, which points the desirability of simplified standards.

MECHANICAL AND ELECTRICAL SERVICES FOR THE PLACE VILLE MARIE DEVELOPMENT: This paper describes a 7-acre commercial development on railway property in the heart of Montreal. Though primarily concerned with E and M installations, the author outlines the general layout in sufficient detail to stimulate thought by those interested in town-planning. E and M specialists will find some useful examples of modern techniques, but may deplore a lack of tabulated data.

ENGINEERS AND THE CANADIAN ECONOMY: Much has recently been written about the education and future status of engineers. This paper crystallizes the problem from an outside viewpoint. The author is ideally placed to analyse the changing trends in the employment of engineers, and he has the gift of clear and interesting exposition. The figures quoted define the Canadian background, but the technological and economic factors here examined cannot be disregarded by any forward-looking industrial nation.

ANIMATED FILM FOR TEACHING KINEMATICS: The instructional value of visual aids is well known. This paper describes the making of a film showing the displacements, velocities, and accelerations in a four-bar linked mechanism. As this involved a laborious process of drawing and photographing each individual frame, and the use of a digital computer to evaluate accelerations, the method is likely to be impracticable for the individual teacher unless standard films are made and distributed by a central agency.

FOUNDATION FAILURE OF A SILO ON VARVED CLAY: When a 50-ft high cylindrical silo suddenly collapsed on the day after it was first filled to capacity, soil tests and analysis were carried out to assess the applicability of bearing capacity theory to stratified clay. To the non-specialist this paper will serve primarily as an unusual, and extreme, example of "circular slip" in clay (see *RESPB No. 5A*, paragraph 77).

Notes from *The Engineering Journal of Canada*, October 1962

TAILRACE IMPROVEMENTS AT THE BEAUMONT HYDRO-ELECTRIC DEVELOPMENT: To increase the rated head at the site of the Beaumont power-house a major tailrace excavation was carried out, mainly by a 14-cu. yd walking dragline with a 165-ft boom. The base width of the cut varied between 120 ft. and 175 ft. in different sections, and the total material handled amounted to nearly 2¾ million cu. yds. This paper describes the hydraulic design studies and the execution of the field work, and it is well illustrated.

ECONOMICS OF HEAVY WATER POWER REACTORS: Nuclear plant is characterized by high capital outlay and low fuelling cost. Although the most expensive, heavy water has always been recognized as a most efficient moderator, and Canada has concentrated on its use. There are grounds for believing that, as new techniques are developed, the heavy water moderated power reactor will successfully challenge coal-fired plants.

BACKGROUND OF COLUMBIA RIVER PROJECTS: After a brief description of the topography and hydraulic potential of the Columbia River, the author gives a historical résumé of the work of the International Joint Commission who were instructed by the Governments of Canada and the United States to investigate the question of co-operative further development of the river's resources. The report of the International Engineering Board is summarized, and the Treaty terms are reviewed. These terms assure basic benefits to both countries, but incorporate a considerable measure of flexibility in detailed planning. The most unusual feature is the recognition that the downstream country, USA, should share with the upstream country, Canada, the benefits it will get from upstream storage installations.

PROGRESS IN POWER DISTRIBUTION: This is a concise but comprehensive review of the developments in power distribution from 1882 until the present day, including the evolution of many components. The author's predictions for the future are, like his history, based on conditions in North America, but they are of general interest.

DESIGN CONCEPTS OF THE BRAZEAU DEVELOPMENT: Increasing demands for power and water-supply in the Province of Alberta have brought into being a large-scale storage and power project on the Brazeau River, which has a high summer run-off due to snow and glacier melt, but low run-off in winter. Some 300,000 acre feet of storage will be provided to reduce flood peaks, to maintain the available flow by storage releases, and to provide peak capacity. Provision is also made for ultimate expansion to a storage capacity of 930,000 acre feet. The project is a joint undertaking by the Provincial Government and the power company. The agreement between the Province and the company is outlined, and hydrological investigations and methods used to estimate run-offs are discussed.

Notes from *The Engineering Journal of Canada*, November 1962.

GROUND CONTROL AROUND UNDERGROUND OPENINGS: Rock mechanics is a "new" subject dealing with conditions somewhere between those applicable to established structural materials and those obtaining in soil mechanics. During the past 15 years research has led to improved methods of preventing or controlling rock failure or deformation. The determination of stress distribution and the prediction of instability in underground openings concern the civil as well as the mining engineer.

SOME UNSUSPECTED CAPABILITIES OF THE STANDARD SLIDE RULE: The slide rule is a very simple form of analogue computer which, despite its inherent limitations, is capable of much more than the elementary tasks normally entrusted to it. The author's suggestions for the improvement of accuracy by planned procedure, and his discussion of out-of-the-ordinary applications, should interest any engineer, and a conscientious study of his paper may well convert a mere convenience into a powerful calculating machine.

GRAND RAPIDS GENERATING STATION: For the Grand Rapids generating station now being built on the Saskatchewan River, near its outlet into Lake Winnipeg, the reservoir will have a filled length of 64 miles, and it will be formed by a concrete spillway dam and a series of earth dams and dykes. This paper describes the investigations and computations carried out to determine the freeboard needed for the various dykes and the necessary spillway capacity. The controlling factors in the case of dykes were found to be the set-up of water, i.e. the rise in water-level on the lee shore, due to wind storms, and wave action simultaneously generated. The seasonal distribution of floods and wind set-up was an important factor in spillway calculations.

RESEARCH AND DEVELOPMENT OBJECTIVES: This is an interesting discussion of the functions of fundamental and applied research in industry. To justify the huge expenditure involved, industrial research, manufacturing, and marketing must be coordinated to establish and execute management development policy.

BEECHWOOD GENERATING STATION: *The Engineering Journal* of February, 1959, contained two technical papers dealing with the installation of the first two Kaplan turbines and generators at Beechwood (see *RE Journal*, June 1959). The third unit, now installed, is larger than its predecessors, and some difficulty was experienced in mating it with the existing layout. This account is mainly of specialist interest.

ISOLATION OF BUILDINGS FROM RAILROAD-INDUCED VIBRATIONS: This paper is an interesting sequel to that dealing with the Place Ville Marie development (see September issue above). It is to be hoped that this subject will be as thoroughly considered when railway property in this country is developed.

R.P.A.D.L.