ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

Volume 91 SEPTEMBER 1977 No. 3

THE ROYAL ENGINEERS JOURNAL SEPTEMBER 1977 VOL 91 No. 3

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THE ROYAL ENGINEERS JOURNAL

Published Quarterly by The Institution of Royal Engineers, Chatham, Kent ME4 4UG. Telephone Medway (0634) 42669

Printed by W & J Mackay Ltd, Lordswood, Chatham, Kent ME5 8TD

Volume 91 SEPTEMBER 1977 No. 3

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Editorial

Dear Editor,

It was we 62 that opened the Mess
With champagne, mushrooms and all the rest.
It was not 63 who turned up in style
To celebrate the event with a smile.

But due to an error in the Editorial
63 YO crept into the Journal.
We, crimson with rage put the score right
By writing this ditty—a poet's delight.

We agree with what you say of the Corps
And all the officers we hold in awe;
So we say unto you
Follow the example of 62

Dear Sixty Two,

Oh sixty two,
Be thine the glory,
Be mine the shame,
Apologies be now my task.

I enquired here, I enquired there,
I enquired nearly everywhere.
I cannot count, but nor could they,
And now I have the price to pay.

Sixty two, well hast thou said,
That of my errors I can frame
A ladder, if I will but tread
Beneath my feet each deed of shame.

In the fell clutch of circumstance,
I have not winced nor cried aloud:
Under the bludgeonings of chance
My head is bloody, and well bowed.

Oh sixty three
The glory was short lived,
The published fame, alas, alas,
Was not earned by your class.

To lose good days that might be better spent,
To waste long nights in pensive discontent,
My apologies today, I'll err again tomorrow,
To feed on hope but suffer fear and sorrow.

with further apologies to
Dryden, Orczy, Longfellow, Henley and Spenser

1977 Corps Annual General Meeting

ADDRESS BY ENGINEER-IN-CHIEF

AT the Annual General Meeting of the Corps, held on 29 June 1977, the Engineer-in-Chief, Major-General J H Foster, spoke on the state of the Corps.

He said:

This has been a memorable year for the nation and particularly so for the Corps. The highlight for us was undoubtedly the visit by Her Majesty the Queen, our Colonel-in-Chief, and Prince Philip to Minley last October. Our aim was to show her the whole range of our activities and skills as well as letting her meet as many of all ranks of the Corps as possible. We wanted to show that we take pride in being her Sappers and I think there is no doubt that she enjoyed her day.

I believe it was appropriate that we had this opportunity of showing ourselves off to our Colonel-in-Chief at this time as it has been a remarkable period for the Corps in many ways and I apologize in advance if I cause any of you mental indigestion—my problem has been what to leave out. For the Services as a whole it has been a difficult time as the attrition of the Defence Review of 1975, and subsequent budgetary cuts, have made themselves felt. The Army is well into its restructuring, which was directed to producing the Army of the 80's, and is grappling with the problem of new organizations and deployment, as well as their implications in training and administration; all this is to be done with fewer men and less money. Every corner is being looked at to see if there is anything spare and there is little to be found. The Corps is taking its share of the load and there have been plenty of problems to tackle. Paradoxically, it has been a most encouraging time because the Corps has been more in demand, by all three Services, than ever. We are doing a wider variety of tasks for a greater variety of reasons and the "why" and "for whom" is becoming as interesting as the "what".

Let me start my survey by updating you on the reorganizations that are at last taking place. In Germany, the first amalgamation took place last September when 23 and 25 Engineer Regiments combined to form the new 2 Armoured Division Engineer Regiment. Further amalgamations to form the other three regiments will be taking place between this September and next April. Two field squadrons have still to move and the Sapper presence in Hohne will disappear. Last year I mentioned that we were thinking of forming a Corps Armoured Engineer Squadron. This will now happen with all the Armoured Engineer elements moving to concentrate at Munsterlager by next March. Another change which will have taken place by early next year is the reduction of 40 Army Support Regiment to become 21 Army Support Squadron. The main differences from last year in the 1(BR) Corps sapper picture concern the Armoured Engineers, the Amphibious Engineers which are down to two squadrons, and the Support Organization within the divisional regiments.

In the United Kingdom the restructuring of the four Engineer Regiments is going on now. Three Field Squadrons (Airfields) have become Field Squadrons (Construction), as has 50 Field Squadron. 60 Field Squadron and 15 and 61 Headquarter Squadrons have become Field Support Squadrons, and 9 Parachute Squadron has now lost its independence and become part of 36 Engineer Regiment. Although four squadrons are having to move only two squadron numbers are being dropped—63 and 66, the latter when the Plant Squadron disappears early next year.

There are changes elsewhere in the world. The Specialist Team in Malta finishes in November this year, having made a most valuable contribution to many projects on the Island, and we have gained valuable engineering experience in a variety of tasks. In Gibraltar 1st Fortress Squadron becomes 1st Fortress STRE by next February.

At home there have been reorganizations at the Royal Engineers Manning and Record Office, at the Engineer in Chief's Recruiting Liaison Staff and within our Training Establishments. Within RSME there has been considerable reorganization with the renaming of all the Schools as "Wings", changes in the command structure

and the establishment of the Regimental Colonel. Within 11 Engineer Brigade the roles of the two training regiments have been re-defined with 1 Training Regiment now responsible for the basic military training of recruits and driver training, and 3 Training Regiment for all combat engineer training. Petronius Arbiter said in 210 BC that reorganization can be a wonderful method for creating the illusion of progress. Our problem today is that we are tailored so tight in our resources that a small change in one place produces a chain reaction throughout the whole. Changes are necessary as we adapt to our new roles but there is virtually no slack left and we must fight hard for those elements which are vital to our efficiency, versatility and professionalism.

Our most important resource is of course the man: the sapper with his knowledge and skills as a soldier, as a combat engineer and as an artisan; the officer who plans, manages and leads. Soldier recruiting, especially for juniors and apprentices, continues to go well and by 1 January this year we had appreciably reduced the deficit in our trained soldier strength. By next March we hope to be virtually fully manned.

In 1975 I made officer recruiting the top priority for the Corps. I am pleased to say that the very considerable efforts by our recruiting organization (and many others) are paying good dividends. We exceeded our quota last calendar year and will do the same again this year. We still have some way to go to recover lost ground but more young men, and girls, are looking to the Army for a career and we are well placed to make the most of this. Although things are going better we must beware of complacency; we still need young men of high quality and I believe that all of us, serving and retired, have a part to play in ensuring that the Corps is in good hands in years to come.

After men, equipment is our other prime resource. At the moment the Corps is probably better equipped, in "quality", than it has been for a long time. The Barmine system, MGB, M2, CET, plant and LMD are all first class equipments that are ahead in their field of anything in the world, although we could do with more of them. You saw slides of most of these items last year. My regret is that I cannot show you slides of anything new of significance although of course there is still new equipment coming into service and on the drawing board. It is with the next generation of equipment that I am most concerned. Not only are we having to stretch the life of the present equipment to the limit, but the current financial climate is forcing the Army to take the most economical line for the future. This could well lead to compromise either in quality or in quantity and I believe this could be most dangerous. As a Corps we are relatively cheap to equip and, although we still equip the man rather than the man the equipment, there is no doubt that hardware is becoming increasingly important to the combat engineer in warfare of the future so that best use is made of limited manpower.

Our third resource is "time": time to train; time to practice our skills; time to care for our equipment; time to plan ahead; time to enjoy our life. We have to cram more into the time available, we battle to maintain our standards and juggle to meet the demands made upon us. A busy, interesting life is the ideal; over-do it—the current catch-phrase is "overstretch"—and everyone gets browned off. Of course this is not just a Sapper problem. It is an Army one, and the question for the Army as a whole is "do we devote enough time to training for our number one role: War."

Northern Ireland continues to consume much of the Army's time, but I am happy to say that efforts are being made to ease this burden so that combat readiness in BAOR can improve. To strike the correct balance in how we allocate our time calls for sound judgment at each level and never before has it been so important to get it right. I would ask you to bear in mind these three resources—manpower, equipment and time—while I now go at a brisk canter over some of our activities of the last year.

Firstly, operations. Although it is not so much of a popular topic for the mass media these days the problem of Northern Ireland goes on. Sapper involvement continues with most of the engineering work consisting of replacing the older

generation of protective structures with newer maintenance-free ones. An equipment just coming into service is the Christchurch block blast wall. It consists of interlocking bricks that can be quickly put together to make a blast and bullet proof wall. Not surprisingly the Sappers in Northern Ireland have already christened it "leggo". The production of these blocks is just one of the many manufacturing tasks undertaken by our Engineer Support Group in the last year. Another new item is rapid assembly protective wall (RAPW). It consists of concrete slabs supported on commercial steel racking, and its purpose is to give temporary protection to engineer working parties against high velocity rifle fire; it can be dismantled quickly after use. The Corps also continues to provide units for Northern Ireland in the infantry role and earlier this month the newly formed 2 Armoured Division Engineer Regiment deployed from Osnabruck to Belfast for a four month tour as infantry. I mentioned last year that the Corps had taken on the responsibility for search training for Northern Ireland. This responsibility continues to grow as the importance of search techniques and procedures become fully realized, and as more emphasis is placed on search as an offensive technique in securing evidence which will lead to the conviction of terrorists. Yet another Corps involvement in this troubled province was the reinforcement with formed RE units and individual specialists to help maintain essential services during the recent strike. Although in the end they were not required to deploy to installations, they did carry out some useful maintenance work in barracks and their mobilisation gave us a chance to test our planning. Finally on Northern Ireland, the series of six paintings by Mr Howard depicting the Corps' varied activities in the Province are almost finished.

Moving on now to operations elsewhere, I would like first of all to mention Oman where we have been providing a field squadron to carry out engineering and MACC tasks, including mine clearance, in support of the Sultan's forces. The counter insurgency campaign officially ended last September although we have continued to provide a squadron to give engineering assistance to the civil community. Next is Belize, where we have been providing a reinforced field troop on a continuing basis in support of the British Forces Garrison. In addition, 38 Engineer Regiment has recently returned from that country having spent seven months constructing a semi-permanent 160-man camp. Construction work included an ablution building, two water towers, access roads, monsoon drains, a Romney and several Nissen huts. This is a well-known Sapper task, but in this case there were a host of logistic problems to be overcome as well as the weather. The new camp is called Rideau Camp in honour of a Sapper officer, Lieut-Colonel John By, who designed the Rideau Canal in Canada.

That concludes the operational theatres but we have also undertaken a number of projects elsewhere. Typical of these was the construction of permanent facilities at Rheinsehlen Camp on Hohne ranges last summer by 34 Field Squadron from UK. Work included concrete roads, a tank wash-down point, a servicing facility and ablutions. The task was undertaken on behalf of the PSA and a substantial saving was made on the estimated German contract cost.

We undertook further work last year for the PSA in Gibraltar. One of the tasks involved the construction of a stop butt wall of reinforced concrete for the training range. The saving we achieved for the PSA on that job was some £124,000. A troop is currently in Gibraltar extending the Forces Post Office. Moving now to the Eastern Mediterranean, we built a roll-on roll-off jetty at Akrotiri which was completed last November with an estimated saving in Defence expenditure of £150,000. We have also been saving money for the Army at home. We have extended the close quarter urban battle range at Hythe and we have also assisted with the construction of the training circuit for the new Army Driving Centre at Driffield in Yorkshire. This latter task yielded a saving of £160,000.

In the present economic climate people are finding that it pays to employ the Sappers. But it is not only our work force that is in demand but also our engineering knowledge and experience. During the last year we have had numerous requests for

advice and assistance and we have been able to provide small teams of engineer specialists and in some cases individuals to meet such commitments in Malta, the Pitcairn Islands, in Peru, Brunei, Christmas Island and St Helena. One of the most encouraging requests for help came from Saudi Arabia earlier this year when the National Guard asked for a team of professional engineers to assist them with two 500-bed hospital projects. A Belgium consortium had won a design and construct contract for these two hospitals, and the National Guard required their own team of specialists to monitor the progress and quality of the construction. This was the sort of work we had been looking for to replace Malta and will be valuable experience for a Royal Engineers team. Two of our officers went to Saudi Arabia in April, followed a month later by four Warrant Officers. By the end of this year the team will have grown to seven officers and thirteen warrant officers and senior NCOs. Our quick response to this request seems to have made the right impression and we have been invited to take on another sizeable project. It is vital that we have this type of work to maintain a truly professional element within the Corps and to give them engineer management experience on the right scale.

I would like to emphasize that the projects I have mentioned so far are not training exercises but commitments undertaken by the Corps to produce an end product. However, they do of course give excellent training value. For our Corps the reverse can also be true; when we undertake a training exercise we often leave behind an end product of use to others. Exercise Water Leap, our annual exercise in Canada, is typical, and last September 53 Squadron built a 9km road for CFB Petawawa.

The more specialized parts of the Corps have also been very active. The demands of the three Services for survey data, maps and air charts have given our surveyors a busy year while international map exchange agreements and joint production programmes, particularly within NATO, have made efficient use of combined resources. In addition to conventional forms of mapping, development in other ways of presenting map displays continues, particularly for the RAF. A projected map display system is now in use in several types of aircraft which moves the map to keep the aircraft position in the centre of the screen. In Germany 14 Topographic Squadron, formed by the amalgamation of 14 Field Survey Squadron and 3 BAOR Map Depot in April, continue to provide a variety of survey data and mapping for 1 (BR) Corps and RAF Germany. Apart from the worldwide activities of the Satellite Tracking Team, overseas field survey projects have been undertaken in Kenya, Belize and Norway. The survey section in HQ Northern Ireland continues to provide mapping and survey services, and have recently introduced plastic coated maps which are proving to be very popular.

The Postal Branch of the Corps continues to support exercises abroad as well as maintaining the permanent post offices for Servicemen and their families throughout the world. In this Jubilee year the Philatelic side has been given even greater prominence and an estimated £20,000 will be earned for Defence Votes by the sale of commemorative covers. This is of course over and above the profits made for the sponsors of each cover. Another money making opportunity has presented itself to the Postal Branch in the form of a request by certain mail order companies to send large consignments of parcels to Servicemen and their dependants in Germany. The companies were finding normal postage costs too high and have asked for an agreement to be drawn up for the parcels to be delivered direct to the Home Postal Depot where they are carried by container to Germany. This new system is already bringing in an additional £380,000 per annum to Defence Votes and it is expected that this kind of contract will be netting half a million by the end of this year.

Units of the Corps, and particularly RSME, have continued to provide support for the Defence Sales Organization. The best seller is still MGB, but other items such as bar mine, trackway, CET and Giant Viper provoke interest from several countries. The RE Sales Team, normally based at Chatham, played its part on a recent successful sales tour of the Far East on the *RFA Lyness*.

There are of course a great many other activities which we have been engaged in:

bomb disposal, fire fighting in the drought last summer, disaster relief in the Solomon Islands and so on, but in order to keep within my time I have had to be selective in what I could describe.

You may be wondering when I am going to talk about TAVR, particularly as I am the one who will be taking over next January as DVT & C. The Defence Review stressed the need for closer integration of the TAVR with the Regulars, and the concept of the "One Army" has very much been the theme for the Corps this year. Again I think that the Corps is in the lead, and our planning is increasingly based on units comprising both Regular and Reserve Army elements. TAVR recruiting is going well, especially officers, and one of the most encouraging signs you can meet are the splendid young men and girls in the RE sections of University Officer Training Corps. Our independent and sponsored units, as well as individuals, have continued to make a valuable contribution to all Corps activities and TAVR soldiers have taken part in Regular exercises in Kenya and Norway, and have undertaken construction work in BAOR, Cyprus and Gibraltar. We continue to rely heavily on the Engineer and Railway Staff Corps and on the Engineer Specialist Pool for expertise in technical matters—this relationship flourishes and I am sure that it is vital to our future. In consolidating the relationship between the Regular and Reserve Army I am sure we must make more opportunity for officers and men to move more frequently from one to the other—and I mean this as a two-way business. Both parts will benefit enormously.

I began by saying that this year will be remembered as the one when the Queen reviewed the Corps at Minley. For the Royal Monmouthshire Royal Engineers (Militia) it will also be remembered as the year in which they celebrated their 400th anniversary. It was a proud occasion for the country's senior Reserve Army regiment and for the Corps, and it was an appropriate time to recall their splendid record of service. For our Gurkha Sappers it will be remembered as the year when they became the Queen's Gurkha Engineers on Her Majesty's birthday. It was the year when the Corps were granted the freedom of Hameln; there has been a Sapper presence in the city now for over thirty years. For our Headquarters Mess it was the year of recovery from the fire. To those of you who have not yet had the chance to see the Mess recently I would say that a really splendid job has been made of the restoration. Yet another milestone was the establishment of the Regimental Headquarters at Chatham under the new Regimental Colonel who has taken on the load of Corps regimental matters. Finally on Corps affairs I would like to mention that we have been looking into the subject of Corps publications. Two reports have now been published by Colonels Johnson and Read and you will be hearing more about their findings later this afternoon.

Despite the pace of life, we do still manage to find time for sport and adventurous training. Royal Engineers units continue to do well in the team events: the Home Postal Depot, for example, won the Army Minor Units Athletics Championship. Our individual representation in Army and Combined Services sides is as strong as ever, with members of the Corps captaining Army cricket, hockey and soccer. We still manage to get people away on adventurous exploits in faraway places. Captain Peter Cooper led an expedition to the South Peak of Annurpurna and they conquered the summit on 3 November 1976. However, I have to report that we do not succeed in everything. I regret to say that an expedition mounted from Junior Leaders Regiment earlier this year failed twice in their mission to rid a Kent fish pond of "Jaws", the notorious killer carp.

Before I close, I would like to say a few words on the quality of life in the Corps. The Pay Review has quite naturally dominated discussions on this subject for the last two months and I would be the first to agree that officers and soldiers are very hard up indeed. I am most anxious that this is put right as a matter of urgency and I trust it will be as soon as Government policy permits. As I said last year, and probably under-rated it, the effects of high inflation permeate every aspect of our traditional military life. Greater stress is placed on leadership at every level as well

as on the quite remarkable cheerfulness and tolerance of adversity for which the British soldier is renowned. We must continue to be very much alive to this problem so that we can maintain the essential spirit of our Army and our Corps. Pay is important, but job satisfaction must surely rank as high—if not higher. In the Corps we can offer a more satisfying and varied career than can any other Arm or Service. We see more of the world, we do a greater variety of tasks and we are more often rewarded with that sense of achievement which comes from completing a worthwhile job with a useful end product. Next week parties of schoolboys and undergraduates are coming to Chatham to attend a presentation and demonstration on the life and work of a Royal Engineer officer. I am confident that they will be most impressed by what we have to offer them.

I have deliberately ended on the "next generation" because, despite the many problems to be faced and the changes that will occur, I believe the Corps can take these in its stride as it has done before and it is to the future we must look. I hand over next month and I would like to thank all of you, of all ranks, serving and retired, for your loyal and cheerful support during my tour as E-in-C as well as wishing my successor as rewarding a time as I have had. Thank you all very much.

Engineer-in-Chief (Army)

MAJOR-GENERAL C P CAMPBELL CBE

MAJOR-GENERAL CHARLES PETER CAMPBELL was born on 25 August 1926. He was educated at Gillingham Grammar School. After thirteen months in the ranks he was granted an Emergency Commission on 28 October 1945 and a Regular Commission on 1 November 1947.

From 1946 to 1950 he served as a junior officer in East Africa and the Middle East where he was Mentioned in Despatches for service in Palestine. On returning to the United Kingdom he was posted as Adjutant of 131 Assault Engineer Regiment TA and in August 1953 he was appointed Staff Captain in the RE personnel branch (AG7) of the War Office. In late 1955 he joined 9 Independent Parachute Field Squadron and saw service in Cyprus before going to the Staff College in 1957.

From Camberley he was promoted to Major and appointed DAA and QMG at Headquarters Training Brigade RE at Aldershot. Three years later in December 1960, he took command of 11 Independent Field Squadron in 28 Commonwealth Brigade in Malaya. On completion of a two year tour in the Far East he attended the Joint Services Staff College at Latimer. This was followed by an appointment on the staff of the Director of Manning in the Ministry of Defence. In May 1965 he joined the Royal Military Academy Sandhurst and served for two years as a Company Commander.

Promoted to Lieut-Colonel in September 1967, he was appointed CRE 1 Division in BAOR. Following the reorganization of Divisional Engineers in Germany in 1969, he relinquished the appointment of CRE and took command of the newly reformed 21 Engineer Regiment. In July 1970 he returned to the Ministry of Defence for a short tour as a GSO I on the Central Policy Staff. Promoted to Colonel in April 1971 he was posted as CRE 3 Division at Bulford. In December the same year he was promoted to Brigadier and became Commander 12 Engineer Brigade; an appointment he held for two years. In 1974 he attended the Royal College of Defence Studies and in January 1975 he was posted as a Chief of Staff (Brigadier) in the United Kingdom. In early 1977 he was made a Commander of the Order of the British Empire.

He was promoted to the rank of Major-General in July 1977 and became Engineer-in-Chief (Army).

General Campbell is a keen follower of rugby football. He has been a Class I Army referee and from 1972–73 he was President of the Royal Engineers Rugby Football Club. He is married with two sons, the elder of whom is a regular Sapper Officer.

The Queen's Gurkha Engineers

ON 21 April 1977 it was announced that Her Majesty the Queen had granted to the Gurkha Engineers the title "The Queen's Gurkha Engineers". The notes which follow are intended to remind readers about the history of the Regiment and to show the facts and precedents which have led to the granting of the Royal Title by Her Majesty.

Between September 1948 and April 1950 three squadrons of Gurkha Royal Engineers were formed. These were the Gurkha Training Squadron RE, 67 and 68 Gurkha Field Squadrons RE. Then in 1951, these squadrons of Gurkha Royal Engineers were formed into a regiment consisting of RHQ and HQ Squadron plus 67, 68 and 69 Field Squadrons and 70 Field Park Squadron. There have been modifications to the establishment of the Regiment since 1951 but Gurkhas have served continuously in engineer units of the British Army since the first squadron was formed in 1948. Although the Regiment was associated with, and in many respects dependent upon, the Brigade of Gurkhas it did not belong to it until 1955. On 28 September 1955 The Gurkha Engineers were created as an integral component of the Brigade of Gurkhas. It followed that The Gurkha Engineers on their creation surrendered the "Royal" prefix and lost the Crown symbol from their cap badges and uniform buttons.

Until 1955 the Gurkha Royal Engineer units had British officers and some Warrant officers posted from the Royal Engineers. The Gurkha officers and Gurkha other ranks were, however, enlisted first into the Rifle Regiments (2, 6 and 10 GR) and then seconded to the Royal Engineers. In 1955, it was the British officers who were seconded and the Gurkha officers and Gurkha other ranks who were posted into the new Regiment and subsequent batches of recruits have been enlisted as Gurkha Engineers. Today all ranks enlisted as Sappers have spent their entire service in the Regiment.

The Regiment has no permanent cadre of British officers as in the case of Rifle Regiments in the Brigade of Gurkhas. The officers (and British warrant officers and senior NCOs on the establishment) remain Royal Engineers, seconded for tours of duty with The Queen's Gurkha Engineers, and there is maintained a roster of RE officers who have served with the Regiment and who are eligible to return to it for further tours. From among them are found a succession of Squadron Commanders and Commandants.

The Queen's Gurkha Engineers are formally affiliated to the Corps of Royal Engineers and constitute the only other regular body of Engineer Troops in the British Army. At the time of its incorporation under the Royal Warrant of 28 September 1955, the Regiment was invited by the Chief Royal Engineer to retain in use the rank badges, colours and motto of the Corps of Royal Engineers and to adopt certain other regimental details of dress and procedure peculiar to the Corps of Royal Engineers; but in all other respects the Regiment conforms in dress and custom to those of the Rifle Regiments of the Brigade of Gurkhas.

Since 1948, Gurkhas have served as Engineers in the British Army, for a large part of that time committed operationally and on active service alongside Gurkha Rifle Regiments. In Malaya units of the Gurkha Engineers were employed on the construction of roads and airfields in areas dominated by insurgents, on the building of forts for infantry companies deep in the jungle and on many other engineer tasks required to support 17 Gurkha Infantry Division. In Borneo similar tasks were carried out during the Brunei Revolt and the confrontation with Indonesia from 1962 to 1966. In 1962/63 one squadron was stationed in Tidworth and one troop was sent to Aden. Later, in 1967 units of the Gurkha Engineers were active during the serious disturbances in Hong Kong resulting from the Cultural Revolution in China, including the laying of mines on the border, construction of border defences, and the disposal of bombs placed by dissidents. Units of the Gurkha Engineers have since carried out tasks in aid of the civil administration in Brunei, British Solomon Islands,

Fiji and the New Hebrides. Gurkha Engineers have also worked in Korea and the Philippines. These tasks are in addition to their regular commitment to support both the garrison and the civil administration in Hong Kong. On 1 January 1976 they became the only British Military Engineers in the Far East when the last Royal Engineer field unit, 54 (Hong Kong) Support Squadron, was disbanded. Thus in 1977 The Queen's Gurkha Engineers have exceeded twenty years as an integral component of the Brigade of Gurkhas and have served for twenty nine years as sappers in the British Army.

In considering the background to the new title, it is worth looking at the titles of the three organizations to which the Regiment was related. These are the Corps of Royal Engineers, the British Gurkha Rifle Regiments and the Indian Sappers and Miners.

The Military Company of Artificers ("The Soldier Artificer Company") was raised in 1772 and by Royal Warrant in 1787 became the Corps of Royal Military Artificers. They became the Royal Military Artificers or Sappers and Miners in 1812 and were redesignated Royal Sappers and Miners in 1813. The Royal Sappers and Miners were officered by Royal Engineers in the same way in which The Queen's Gurkha Engineers are provided with British officers now. At the conclusion of the Crimean War in 1856, Queen Victoria approved, as a mark of recognition of their joint services, the inclusion of both officers and men in the same Corps. "The Queen has been graciously pleased to direct that the Corps of Royal Sappers and Miners shall henceforward be denominated the Corps of Royal Engineers and form one body with the existing Corps of Royal Engineers."

Until direct enlistment into The Gurkha Engineers began in 1955, the Sappers came from the British Gurkha Rifle Regiments which have been honoured with Royal Titles as follows:

The 2nd King Edward VII's Own Gurkha Rifles (Sirmoor Rifles) were raised in 1815, became Prince of Wales' Own Rifles in 1876, and received their present designation in 1906.

The 6th Queen Elizabeth's Own Gurkha Rifles were first wholly composed of Gurkhas in 1886 under the style of 42nd Gurkha Light Infantry, became 6th Gurkha Rifles in 1903, and received their present title in 1959.

The 7th Duke of Edinburgh's Own Gurkha Rifles were raised (as the 8th) in 1902, renamed 7th in 1903, and received their present title in 1959.

The 10th Princess Mary's Own Gurkha Rifles were raised in 1890 as 10th Madras Native Infantry, became 10th Gurkha Rifles in 1901, and received their present title in 1950.

The Regiment can be said to be the direct successors of the three Sappers and Miners Corps which stayed with the Indian Army when India was granted independence in 1957:

The Bengal Sappers and Miners dated, as a Corps, from 1818. On January 1st 1904 HRH The Prince of Wales was appointed Colonel in Chief and the designation of the Corps was altered to 1st Prince of Wales' Own Sappers and Miners, changed in 1910 to 1st King George's Own Sappers and Miners.

The Madras Sappers and Miners originated, as a Corps, in 1831 and, in 1876, the title 2nd "Queen's Own" (later Queen Victoria's Own) Sappers and Miners, was conferred on the Corps.

The Corps of Bombay Sappers and Miners were so named in 1840 and became, in 1903 3rd Sappers and Miners. As a reward for service in the Great War HM the King-Emperor bestowed on the Corps the title Royal Bombay Sappers and Miners.

Readers may wonder why the Royal Title conferred by Her Majesty was not, simply, The Royal Gurkha Engineers. This might have led to confusion with Dominion Corps, for example, the Royal Australian Engineers. In choosing the title "The Queen's Gurkha Engineers", Her Majesty continues the tradition, established over six hundred years ago by King Edward III, that military engineers shall be appointed,

as individuals, to the service of the Crown. Under the new designation therefore, each officer and man in the Regiment can, with pride, call himself a "Queen's Engineer". This distinction is unique among the regiments of the Brigade of Gurkhas.

Wet Bridging in the 1940s
New Pontoon Bridge—March 1936 to August 1939

THE EDITOR

THIS short historical note was prompted by the discovery of a "Chronology of Events" by Lieut-Col J B Wilks RE while studying a 1939 Staff College exercise on weapon and equipment development. It draws upon archive information at the Military Vehicles and Engineer Establishment at Christchurch (MVEE(C)), (who kindly provided the photographs), supplemented by memories of past and present members of the staff in order to fill-in some of the background details of the activities at the time and to arrive at some conclusions. I am indebted also to Colonel J H Joiner, Major (Retd) J N Barnikel and Major D G Saunders who assembled the background information and to all four for their help in the preparation of this note.

CHRONOLOGY OF EVENTS

(a) *NEW PONTOON BRIDGE*

Mar 36 Instructions given to Royal Engineer and Signal Board (RESB) to design a new Pontoon Bridge to meet GS requirements of a bridge to take loads of 14 and 20 tons. (The 14 tons was to be for normal construction but the bridge was to be capable of being strengthened to take 20 tons).

Jul 36 RESB produced alternative types for this new bridge. This was then considered at War Office, and the lines on which this new bridge was to be designed were decided.

Nov 36 It was decided that production was to be accelerated so that sufficient equipment would be made available for full scale troop trials during the summer of 1937. Orders placed for trial equipment, in anticipation of decision below.

Dec 36 GS decided that the load capacity of this bridge was to be increased to 18 and 24 tons. This increase had been made possible as the result of the RESB investigation; 18 tons were to be carried by two floating piers (four pontoons) per bay, and 24 tons by introducing a third pier, ie six pontoons per bay. The third pier can be added or removed at any time under traffic.

Jan 37 First six pontoons received at EBE Christchurch (Experimental Bridging Establishment, predecessor of MEXE and MVEE(C)), but without superstructure.

Jul 37 Equipment produced complete at Wyke Regis Bridging Camp for trials by several Divisional Engineers, sufficient for twelve bays of 20ft, of which eight could be floating. All units reported on the new equipment.

Oct 37 Reports received and considered at War Office.

Dec 37 Meeting at WO to decide the best method of obtaining the maximum amount of equipment in the shortest time.

Dec 37 to Jan 39 Final design of various parts produced.

Feb 38 to Feb 39 Contracts placed for the various items as designs were completed. About fifty separate contracts are required. In the earlier contracts the quantities ordered were provisional.

May 38 Scales of pontoon equipment for Bridge Company RASC and Training Camps finally settled. Quantities previously ordered were sufficient for these requirements.

May 38 Delivery of small items commenced, and all equipment for Field Force, War Reserves and Training should be complete by August 1939.

(b) *TRANSPORT*

Consideration of the transport for this new equipment started during 1936, and various types of trailer to carry two pontoons were tried. It was finally decided that no trailers would be used, and all equipment should be carried on lorries, as being more suitable for difficult bridge sites.

The special superstructure for these was designed during summer 1938.

Lorries with superstructures of three types (one for pontoons, one for trestle bay and one for sliding bay) were tried out at night bridging operations in August 1938; as the result of which minor alterations were made to bridge parts, and several alterations to the lorry superstructures.

Dec 38 Design of transport clear and contracts placed.

May 39 Transport for Pontoon equipment held by one Bridge Company RASC should be ready.

(c) *SUMMARY*

It therefore will have taken about three and a half years altogether to produce this equipment, and this in spite of the initial stages being carried out more rapidly than usual. This period is from initiation of the idea for a higher capacity bridge, to actual issue to troops complete with transport.

* * * * *

The files of the EBE have long since departed but the old photograph albums, which have been retained, record historical events over the period of about fifteen years leading up to the entry of the bridge into service in 1939/1940. The captions used in this note are based on those in the photograph albums.

The Bridge (photos 1(a) and 1(b))

The equipment refered to in the Chronology is *Pontoon Bridging* (*Pontoon Mk V and Trestles Mk VII*) – *1940*. It was constructed from the following main components:–

(a) Closed plywood pontoons, joined in pairs to form floating piers.
(b) A superstructure of rolled steel joists (with simple fittings), timber chesses and ribands.
(c) Steel trestles with tubular legs, feet, transoms (adjustable by screw jacks) and bracing struts.
(d) Connectors for joining bays of bridge.
(e) At a later stage, Small Box Girder bridges which were used as long landing bays.

Load Capacity of the Bridge

The Chronology states that the load capacity requirements for the bridge were increased from 14/20 tons to 18/24 tons, and it is of interest that the captions to the photographs are at variance with these figures in that three phases of design are recorded—14/20 tons, 17/23 tons and, finally, 20/26 tons. (The twin figures depend on whether bridge bays had two or three pontoon piers.)

The 1943 edition of the User Handbook tells another story in that it refers to load classes of 18 and 24 for the bridge and a "batswing" raft with a class of 30. The answer lies in the fact that, during the intervening period, a load class system was devised which took into account both vehicle weight and its distribution—maximum axle and wheel loads were specified as were track ground contact dimensions. The

Photo 1(a). 26 Ton Bridge—Sliding Bay—Side View.

Photo 1(b). 26 Ton Bridge—Sliding Bay—Showing Connector in more detail.

NATO load class system that is used today evolved from this in that it is based on similar principles.

History Prior to the Bridge Development Programme

The photographic records show that experimental work, which was directly relevant to the Pontoon Bridging, had been in progress since the early 1920's so that,

Wet Bridging In The 1940's (1a,1b)

when development was authorized, all work stemmed from well tried principles and basic designs:

Pontoons. Experimental "Consuta" plywood pontoons are to be seen as early as 1925.

Trestles. Tests covering all aspects of design, emplacement and use of trestles ran concurrently with pontoon development.

Superstructure. The basic configuration of the superstructure did not change over the period but timber roadbearers were replaced by steel as loads increased and improvements in bridge bay connector design were introduced.

Changes in the Load Capacity Requirement

It is interesting to see what the photographs disclose about the design changes that arose from the more demanding requirements and to speculate on how these affected the development timetable.

Undoubtedly, it was necessary to recalculate the live load stresses in critical members and to strengthen certain components but, apart from this, only two significant modifications can be identified from the photographs. The number of roadbearers in, for example, the sliding bay from the trestle to the floating section of the bridge was increased from twelve to sixteen (Photo 2). Secondly, the simple hinged connection between bridge bays (Photo 3) was replaced by a braced connector which permitted limited articulation before locking and then caused the superstructure to spread the load over several pontoon piers (Photo 1(b)). This technique was also used in the Folding Boat Equipment Mk III and Sir Donald Bailey has affirmed that it was an innovation which EBE introduced into military pontoon bridging.

These changes cannot be called far reaching but it should be noted that the EBE was then very small and so there are bound to have been significant repercussions on the project timetable. Retired members of staff recall that all project work was undertaken at that time by four designers; the Superintendent, Major S A Stewart (later Brigadier S A Stewart, CBE, MICE, MI Struct E), Lieut H A T Jarrett-Kerr (later Brigadier H A T Jarrett-Kerr, CBE, FICE), Mr D C Bailey (later Sir Donald Bailey Kt, OBE, MICE, MI Struct E) and Mr D M Delany; two draughtsmen; a general workshop with a complement of about twelve artisans and a test gang with a similar

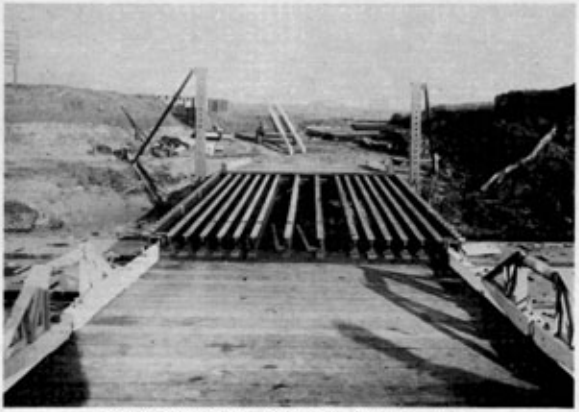


Photo 2. 26 Ton Bridge—Sliding Bay—Chesses removed.

Photo 3. 17–23 Ton Pontoon Equipment—Medium "B" at worst tipped position.

number of men. From all the evidence available, it is unlikely that the changes in requirements delayed the project by more than six to nine months.

Transport

The Chronology refers to the decision to transport the equipment on trucks rather than on trailers and this is a timely reminder that, when a new bridging equipment has been under consideration, there has usually been a debate as to whether it should be carried on standard cargo vehicles or whether the additional handling facilities which could be provided justified the adoption of a "special". In this instance, the latter course was chosen and Photo 4 shows a pontoon carrying vehicle in use.

Photo 4. 26 Ton Bridge—Pontoons—Upper pontoon raised and lower pontoon being manhandled off platform rollers.

Wet Bridging In The 1940's (3 & 4)

Photo 5. Launching a trestle—55 Fd Coy at Wyke Regis 1938.

Footnotes

Reference is made in the Chronology to trials at Wyke Regis and Photo 5 showing troops of 55 Field Company RE practising the emplacement of trestles in 1938, may bring back nostalgic memories to older readers.

Trials did not always go according to plan and Photo 6 shows the result of a

Photo 6. Accident under 17 ton load. Trestle foot slipped down the bank.

Wet Bridging In The 1940's (5 & 6)

trestle foot slippage. Have we been suspicious of ground bearing piers ever since?

The following financial comparisons are enlightening. The 1938 Army Estimates provide £1,126,000 for the running of "Establishments for Research etc", of which £180,000 was allocated to the Royal Engineer and Signals Board (RESB). The 1977/78 Defence Estimate for Ordnance and other Army R & D totals £62,000,000!

CONCLUSIONS

The Pontoon Bridging was developed just prior to a period of rapid evolution during World War II and, like the Inglis and Box Girder Bridges, it became obsolescent when Bailey Bridging appeared. Nevertheless, although production ceased, the Mk V Pontoons were used with Bailey in its floating roles.

The time required in 1937 to develop an equipment should be contrasted with that required soon afterwards when the Bailey Bridge pilot set was produced in four and a half months and production started two and a half months later, seven months from the commencement of the project. As a comparison the Medium Girder Bridge took nearly seven years from start to ordering of first production sets and the first set was available one year later. This time scale however includes the evolution of a new weldable aluminium alloy.

Simple comparisons of development time are obviously unfair; money and effort available; the use of known or experimental technology; the time required during the paper cycle of drafting and approving General Staff Targets/General Staff Requirements etc; fixed or changing requirements during development; the priority of the project and therefore the urgency generated; the time required for troop trials (a Wyke Regis one equipment was used by many units over a short period of time, this is not always possible); the money available for the troop trials sets (do we have one set and two years of trial or four sets and six months of trials) etc. All these factors play their part.

Present day designers look back with envy at the rugged simplicity of the bridges of those less complex days, realizing that similar changes in requirement can no longer be met with such apparent ease and knowing that, in similar circumstances, with high performance equipments, they would be faced with a lengthy and arduous programme of work.

The moral must be that, as technology advances, it becomes ever more important to get the requirement right at the outset.

A Huff and a Puff And I'll Blow your Bridge up

MAJOR G D K BERRY, RE, B Sc

INTRODUCTION

In the military environment there is often a need to provide a quickly constructed, re-usable surfacing on ground of low bearing pressure, across water obstacles or on combinations of the two such as beaches or river banks. Depending on the nature of the problem, these needs may be filled by anything from a temporary jetty to a landing craft, from a causeway of wooden planks to a roll of prefabricated trackway, or from an assault boat to a floating pontoon bridge.

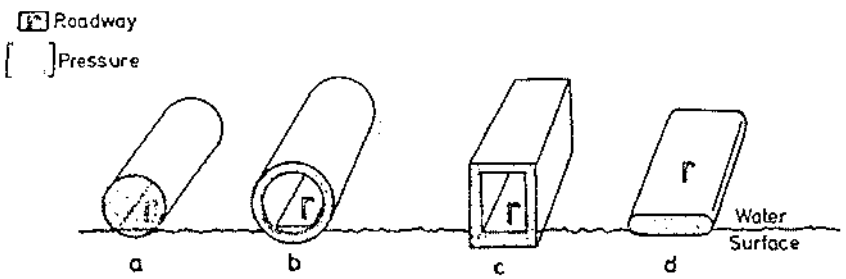
Current practice is to have a different set of equipment to meet each problem type. Thus, current portable floating bridges do not lend themselves easily to construction as jetties and certainly are not suitable for use across soft land. Similarly, the trackway at present available is unusable across a bog; indeed really soft ground poses a greater obstacle than a fast flowing river. Equipment today also tends to be of composite construction, embodying the most sophisticated materials in a multitude of separable components and consequently requires considerable logistic support to store, to move, to build and to repair. Several attempts have been made to reduce

this logistic problem, typical of which is a pontoon bridge using lightweight stackable pontoon skins which are filled on site with a plastic foam delivered in liquid form. Once manufactured, however, even this suffers all the disadvantages of a normal pontoon bridge to which are added the joint hazards of a river-bank chemical factory and a questionable control of quality.

The answer, of course, is to simplicate and add lightness; one way to do this may be to use an inflatable structure.[1] Inflatables can be rolled up when not in use to a packaged density close to that of the material used and yet when pressurized produce remarkably strong structures, (a fireman's hose, among other examples, goes almost rigid when pressurized). The concept of an inflatable bridge is not new; MVEE Christchurch (still pronounced MEXE?) produced an inflatable fascine some years ago and has since worked on an inflatable bridge to span a nine metre gap.[2] Goodyear produced a model (but not a prototype) over seven years ago of an inflatable bridge intended to carry a weight of twenty tons across a free span of sixty feet.[3] What has not been given detailed study (although probably re-invented as often as the wheel) is the use of the inflatable as a continuously supported "ribbon" bridge or causeway. So, on the grounds that this concept has been allowed to lilo for too long, this article is an attempt to fill the gap.[4]

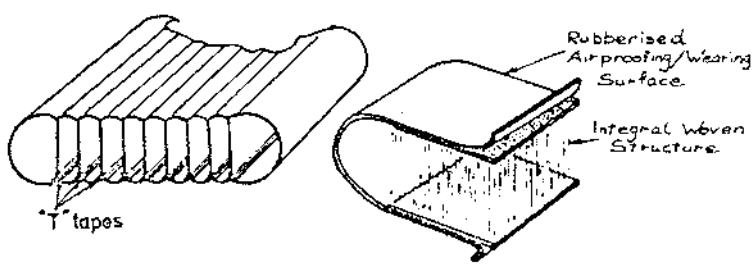
TYPES OF INFLATABLE BRIDGE

The various forms that an inflatable causeway could take are shown in Fig 1. The



The four basic shapes employable in the design of Inflatable Bridges

FIGURE 1



Mattress Beam Design

FIGURE 2

Figure 1. The four basic shapes employable in the design of Inflatable Bridges
Figure 2. Mattress Beam Design

Photo 1. An APC on the MVEE 9-metre inflatable bridge when used (upside down) as a raft. (MVEE Photograph).

simplest is a hollow, pressurized tunnel (Fig 1a) but, since it would involve airlocks, it would probably be unacceptable for general use. The second (Fig 1b) avoids having airlocks by containing the pressurized air within dual walls but it is no longer at all simple to construct, and retains two disadvantages common to the simpler form: firstly, it is inefficient in its use of the upthrust gained by displacing the water (since displacement is small relative to initial vertical movement), and secondly, it is rotationally unstable when there is a vehicle in it, (unless submerged, say on a river bottom).

The third form (Fig 1c) overcomes both these objections and for any given internal clearance offers more efficient use of materials. This is the shape of the Goodyear model bridge referred to above, and can be taken as the ideal shape. There could be other hybrid shapes, using inflated ribs with membranes stretched between them, for example, but whatever the shape chosen, there is likely to be one feature common to all—a flat running surface, probably in the form of a long mattress-shaped beam. Such a beam could be folded to form the walls and roof of the "ideal" bridge, but it can also be treated as a somewhat weaker and much simpler bridge in its own right (Fig 1d). For brevity, this will be the only type considered in this article.

THE MATTRESS BEAM

The mattress beam, then, constitutes the second most simple form of inflatable bridge. The MVEE bridge was of this sort, but had varying depth of cross-section to cope with bending moment variation across the span (a refinement which is unnecessary in a continuously supported bridge). Its faces were constrained into a relatively flat plane by the use of closely-spaced longitudinal diaphragms (Fig 2a) whose precise behaviour was, alas, imperfectly understood—the bridges all showed a tendency to become nine-metre footballs (at 20 k£ a pop) when loaded in free span. At least one, however, was tested successfully as a raft capable of carrying a tracked APC. (See Photo 1).

A more efficient method of achieving a flat surface is that developed by Goodyear

A Huff And A Puff And i'll Blow Your Bridge Up (1)

in their product "Airmat". Invented to meet a NASA requirement for an inflatable re-entry vehicle,[5] it is made in a similar way to velvet and consists of two woven covers connected together by a multitude of closely-spaced "drop-cords" which are an integral part of the run- and tear-proof weave (Fig 2b). The length of each drop-cord determines the shape of any cross-section and internal air pressure keeps them taut, but fabric end and side walls are needed to keep the air in and the whole surface must be air-proofed. Wearing surfaces, reinforcement, tie-downs, etc, can be adhered as required and the finished product can then be rolled onto a 15in diameter spool for delivery to site.

ANALYSIS OF A MATTRESS BEAM

Fig 3 shows an idealized mattress beam, simply supported in air, to which must be added the complications of sidewalls and diaphragms, if any. Neither drop-cords nor end-walls have a direct effect on the bending or shear strength of the beam, so both can be ignored. Readers familiar with sandwich-beam theory[6] will recognize the simplest form of sandwich, where the jam—the enclosed air—acts as an homogeneous "core".

It can be shown[7] (but will not be) that the air fulfills all the vital functions of a real core (an "antiplane" to be precise). The figure can therefore be analyzed as a sandwich beam, the sidewalls being treated separately as a sandwich tube. The contribution from diaphragms depends so much on imponderables such as the direction of their weave that they will be ignored in this article, but they can be treated in the same way as I-beam webs once their material has been selected (an open weave with one lay vertical and two inclined at 45° would appear to be best).[4]

The following section is a brief look at the theory as it applies to a mattress beam. Some of the equations involved are gathered at Annex A in case any reader wishes to design himself a floating trampoline for his swimming pool.

BENDING AND SHEAR CHARACTERISTICS

The flexural rigidity of a drop-cord beam can be taken to be almost entirely due to the separation of the faces (the core contributes nothing, the sidewalls less than 15%). The faces are kept correctly separated by the combined action of the drop-cords and the air pressure, but the latter creates both longitudinal and transverse stresses in them. The transverse stress remains constant for a given pressure but a bending moment applied to the beam will cause an increase in the longitudinal pre-stress of one face and a decrease in the other. Since a membrane cannot support a compressive force, the beam will develop a wrinkle at any point in the face where the compressive bending stress exceeds the tension pre-stress due to pressure and the structure will start to collapse in a manner analogous to a plastic hinge, up to twice the wrinkle load being required to cause total collapse.[8] Bursting failure can also occur in the opposite face if the cumulative tensile stresses reach their maximum before wrinkled failure occurs elsewhere, but balanced design is not recommended—wrinkle should always occur first, especially as recovery requires only that the overload be removed.

The shear deformation of a sandwich beam is always relatively large, being resisted only by the shear modulus of its weak core. By various means it can be shown that the gauge pressure of the air is directly analogous to the shear modulus of a drop-cord beam,[8] so that doubling that pressure will double the shear rigidity of its core. The sidewalls may contribute as much as half of the shear rigidity of the complete beam, the exact proportion being dependent on the relative values of the air pressure and the shear modulus of the sidewall material. Thus the shear rigidity of a beam can be varied to meet a given situation by changing its air pressure.

Prediction of the precise behaviour of a real beam is hampered by the effect of two-dimensional stresses on the behaviour of the woven fabric faces, but the use of "assumptions", fiddle factors and some two-dimensional material test data allows good enough estimates to be made in what is bound to be a fairly imprecise field.

BEHAVIOUR WHEN LOADED

Plodding through conventional theory, but taking shear deformation into account,

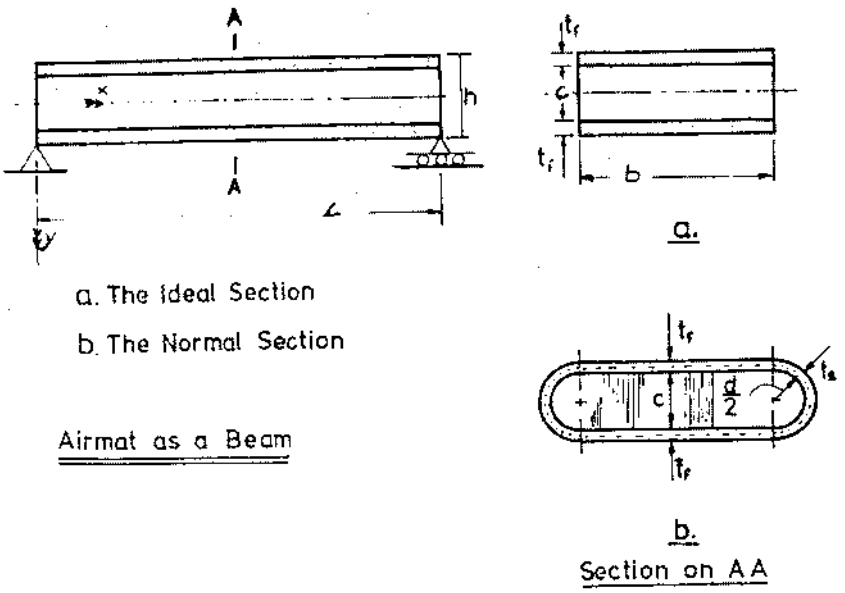
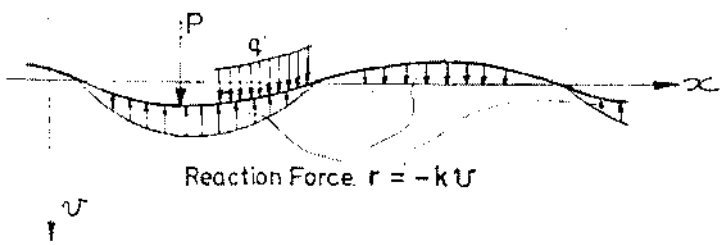


FIGURE 3



Infinite Floating Beam Under Arbitrary Loading Conditions

FIGURE 4

Figure 3. Airmat as a Beam.
Figure 4. Infinite Floating Beam Under Arbitrary Loading Conditions.

eventually produces a fourth order differential equation defining the deflection of a mattress beam in terms of its flexural and shear rigidities (discussed above) and the applied load. If the loaded beam is now placed on water or very soft ground, an upthrust will be produced proportional to the deflection (Fig 4), the effect being that of strengthening the beam. The water or the ground can generally be assumed to act as a perfectly elastic ("Winkler") foundation[9], with a "spring constant" equal to the product of foundation density and mean submerged width, so the above-mentioned deflection equation can be rewritten in terms only of the spring constant and the beam rigidities. The problem then is to solve it!

THE DAMPING FACTOR AND PRESSURE RATIO

The deflection of the beam under a point load will have the form of a damped wave,

the shortness of distance in which the "wave" dies out being dependent on the flexural and shear rigidities of the beam and on the foundation spring-constant. The first and last of these factors are constants for any given beam and foundation so it is convenient to incorporate them into a Damping Factor—it is rather satisfactory that the greater this Damping Factor, the less chance there is of getting wet.

The dampening effect of the shear rigidity is a function of the pressure. At high pressures the beam will tend to rise out of the water each side of load (to "overshoot") before alternately sinking back and rising again further away rather like two Loch Ness monsters in head-on collision; at low pressures, the beam exhibits no overshoot but merely curves directly from the load to the surface level. At some intermediate pressure there is a critical state where the beam has the steepest rise possible without overshoot. This critical pressure is a constant for any given beam and foundation (and indeed can be simply expressed in terms of the Damping Factor) and is directly analogous to the Critical Damping Factor of vibration problems. Following this analogy, with a grateful sigh, allows one to emerge from a mass of tedious formulae with a much clearer picture of the behaviour of our accident-prone monsters, defined simply in terms of the Damping Factor (whence the critical pressure) and a Pressure Ratio (of the critical to the actual pressure).

Thus when the Ratio is greater than one (low pressure), the beam will rise gently to the surface without overshoot and the deflection, shear force and bending moment at any point can be calculated in terms of the Factor and Ratio from the two real roots of the deflection equation. When the ratio is less than one, the beam will overshoot its unloaded position and we must look to the two imaginary roots for further information. The unlikely case of the beam being at critical pressure produces easy answers because everything cancels, but is really only of passing interest. Distributed loads take the form of a Particular Integral added to the deflection equation and complicate its solution, but if they can be treated as multiple point loads application of the principle of super-positions allows an easier approach.

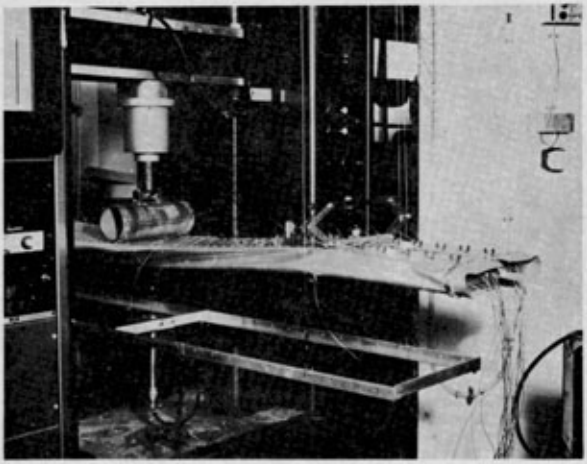


Photo 2. The metal-skinned inflatable beam. Note the classic shear deformation.

A Huff And A Puff And i'll Blow Your Bridge Up (2)

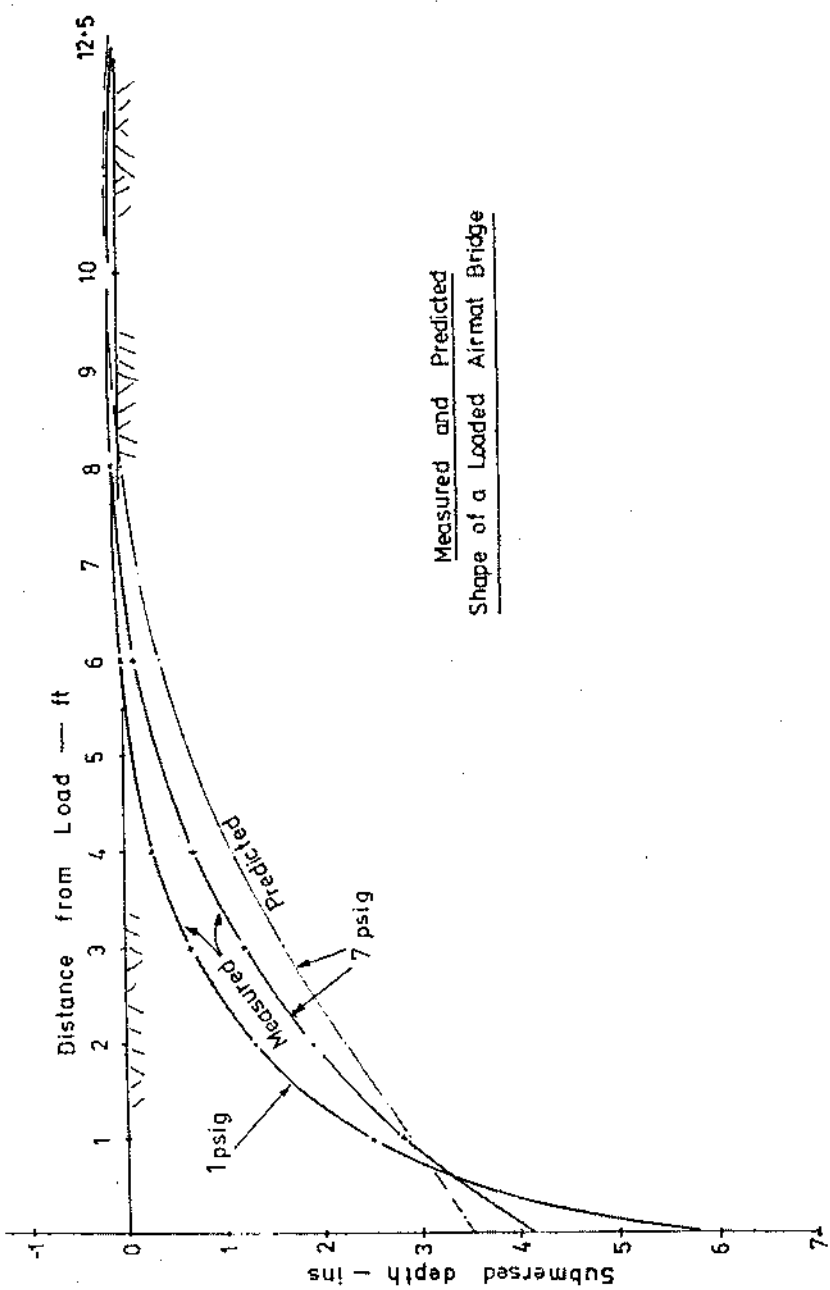


FIGURE 5

Figure 5. Measured and Predicted Shape of a Loaded Airmat Bridge.

A REAL BRIDGE

This theory is all very well, but how does it marry up with real life? In an effort to find out, tests were carried out on a model with metal skin. (See Photo 2). They were inconclusive because of leakage but were encouraging enough to justify a full-scale experiment. Accordingly, a strip of Airmat four feet wide, sixty feet long and nine inches deep was scrounged from RFD-GQ Ltd of Godalming (they make aircraft escape chutes) and transported to site in the back of a Maxi (just!). A 75cfm compressor was used for inflation to pressures of up to 7psig (a process taking about four minutes), and the bridge was launched by allowing it to unroll itself across the water as it inflated.

Experimental problems were numerous, mainly associated with the anisotropism of woven materials, but once these were solved or by-passed the test results all matched the predicted values to within 15%. A quarter-ton point load was found to cause a deflection of less than 4in at 7psig, rising to 6in when the pressure was reduced to induce wrinkling at just under 1psig (Fig 5). Doubling the load to a half-ton increased the deflection at 7psig to 6in but the steepest slope was still less than 10°. The predicted critical pressure for the bridge was less than 2psig and at higher pressures the expected overshoot was apparent, but even with the half-ton load the hump only rose to a nominal ¼in above the unloaded level and the effect had substantially disappeared within 12ft of the load. (See Photo 3).

Dynamic loading was achieved by running a group of amused soldiers across the bridge (Photo 4). Their smiles faded a bit at pressures below 2psig, but they could actually run in step (single file) when the pressure was raised to 6psig. A limited amount of lateral "snaking" was apparent at all pressures, which indicates that this is a factor to be considered in longer bridges, but the restraining cable that would be required where there was any current could probably be designed to provide sufficient lateral restraint.

OTHER POINTS

The effect of a concentrated point load (or of the transverse line load implied in the theory above) is to generate radial tensile and circumferential compressive stresses in the fabric.[10] These will be superposed on those already in existence and may cause the skin to tear or to form radial wrinkles. The dynamic effects of wheels or tracks have not been examined but it is likely that some separate load distributing surface would always be required. Class 30 trackway, or a lower classed equivalent, is probably the ideal and was successfully used on the MVEE bridge when tried as a raft. (Photo 1).

The skin under the load will deflect into the beam to a depth which is inversely proportional both to the fabric tension and to the foot print area of the load itself (the total area of the depression is equal to load/pressure). The deflection will release the tension on the drop-cords or diaphragms underneath, which in turn will allow the opposite surface to blow outwards in sympathy. If, however, the unloaded surface is resting on flat ground, say, the drop-cords/diaphragms will remain loose and the skin will be pressed against the ground with the full internal pressure. Provided there are no humps on the ground to act as local point loads, with associated fabric reaction forces, this pressure is the maximum load which the beam can apply to the ground. Inflatable beams can therefore be used as causeways on pressure sensitive solid ground (minefields for example), and accommodate the transition from water to beach to hard ground without trouble.

Fabric is available with a non-run weave (indeed Airmat incorporates this already), so that punctures need not cause a catastrophic blow-out, and it can readily be shown that the experimental package above, for example, could have supported a workable pressure in spite of six three-inch holes. Minor repairs are simply carried out in the field with the lowest level of skill, and even major modifications are not difficult. Two sections can be joined together by cutting off the adjacent side or end-walls and glueing the surfaces together, but where a temporary joint is required for say, a ramp section, the wearing surfaces should be butted

Photo 3. The inflatable causeway under a half-ton load. The deflection is only 6 inches.

together in some way that leaves the walls slack but intact.

CONCLUSIONS

The mattress-beam is an effective way of providing a simple inflatable causeway or

Photo 4. The 60 foot inflatable causeway, at 5 psi. The bag in the foreground shows the packaged size.

A Huff And A Puff And i'll Blow Your Bridge Up (3 & 4)

Photo 5. Launching a trestle—55 Fd Coy at Wyke Regis 1938.

Footnotes

Reference is made in the Chronology to trials at Wyke Regis and Photo 5 showing troops of 55 Field Company RE practising the emplacement of trestles in 1938, may bring back nostalgic memories to older readers.

Trials did not always go according to plan and Photo 6 shows the result of a

Photo 6. Accident under 17 ton load. Trestle foot slipped down the bank.

Wet Bridging In The 1940's (5 & 6)

floating bridge, having the dual advantages of being relatively cheap and extremely portable. Drop-cord structures are available now which are suitable for use as infantry assault-bridges and to provide safe passages across bogs, quicksand and possibly across certain types of minefield. These off-the-shelf structures can theoretically be combined to carry a Class 3 load and can be designed for much more, while a diaphragmal structure has already carried loads of up to Class 16 when used in conjunction with Class 30 trackway.

The beams can be analyzed by being treated as a sandwich structure on an elastic foundation but further study is required on the behaviour of diaphragms and on the effects of vehicle and water movement. Accurate prediction from this theory of the behaviour of a prototype beam is dependent on the availability of sufficient two-dimensional data for the materials concerned.

Last, but not least, the siting of an HQ near the bridge site should allow some use to be made of all the hot air usually available therefrom, but failing that perhaps vehicle exhausts could be used for inflation purposes. Regardless, with all the Inflation there is around these days, isn't it time it was put to use?

ANNEX A

KEY EQUATIONS RELATING TO FLOATING INFLATABLE MATTRESS-BEAMS

FLEXURAL RIGIDITIES

Fabric Faces $D_{ef} = \frac{(E.t)_f . bh^2}{2}$

Sidewall Fabric $D_{es} = \frac{(E.t)_s . \pi h^3}{8}$

Diaphragm Fabric $D_{ed} = \frac{n.(E.t)_d . h^3}{12}$

Air Core $D_{ea} = 0$

Where: Suffix *e* relates the rigidities to bending resistance.
Suffixes *f*, *s*, *d* and *a* refer to faces, sidewalls, diaphragms and air-core, respectively,

and: b, c and h = beam dimensions shown at figure 3.
(E.t) = the modulus of elasticity of the fabric, per unit width (typically about 900 lb/in).
n = the number of diaphragms, if any.

Thus, the flexural rigidity of the complete beam is given by:

$$D_e = D_{ef} + D_{es} + D_{ed}$$

SHEAR RIGIDITIES

Fabric Faces $D_{qf} = 0$

Sidewall Fabric $D_{qs} = \frac{-(G.t)_s . \pi h}{2}$

Diaphragm Fabric $D_{qd} = \frac{-n.(G.t)_d . 5h}{6}$

Air Core $D_{qa} = -p.A$

Where: Suffix *q* relates the rigidities to shear resistance.

and: (G.t) = the shear modulus, per unit width, in the plane of the fabric (typically about 100 lb/in).
p = the gauge pressure of the air core (analogous to its shear modulus and typically less than 7 lb/in²).
A = the cross sectional area of the air core $\simeq (bh + \frac{1}{4}\pi h^2)$.

Thus the shear rigidity of the complete beam is given by:

$$D_q = D_{qs} + D_{qd} + D_{qa}$$

LIMITING BENDING MOMENTS

Assuming the beam to be constructed throughout from the same fabric yields the following maximum bending moments:

Wrinkling of Compressive Face: $M_w = \frac{p.A^2}{(2b + \pi h)}$

Rupture of Tensile Face: $M_r = A.T_r - M_w$

Where: Suffixes *w* and *r* denote wrinkling and wrupturing wrespectively

and: M = Bending Moment.

T = Fabric tensile stress, per unit width.

Note: "Balanced design" is undesirable since one of the advantages of inflatables is that wrinkling provides visual indication of overload without collapse, the wrinkling being analogous to plastic hinge formation; up to twice "wrinkle" moment is required to cause even a simply supported structure to collapse by folding, yet complete recovery requires only that the load be removed.

DEFLECTION EQUATION

The general equation describing the behaviour of a mattress beam on water (or for that matter, any weak beam on an elastic foundation) is as follows:

$$v'''' - \frac{kv''}{D_a} + \frac{kv}{D_e} = 0$$

Where: Primes '' and '''' denote the second and fourth differential of deflection "v" with respect to position "x" (both v and x being shown on figure 4).

and: k = spring constant of the "foundation"

= average submerged width times water density "ρ".

SOLUTIONS TO DEFLECTION EQUATION (Point Load "P")

The bending moment at any point "x" is given by:

$$M_x = D_e(v'' - 4\nabla R v)$$

Where: ∇ = Damping Factor $= 4\sqrt{\frac{k}{4D_e}}$

R = Ratio of Critical Pressure "ψ" to internal gauge pressure "p".

ψ = Critical Pressure $= \rho/4h\nabla^2$

ρ = Water density

When R > 1: Deflection at "x", $v_x = \frac{P(\alpha^3 e^{-\alpha x} - \beta^3 e^{-\beta x})}{2k(\alpha^2 - \beta^2)}$

Maximum deflection $v_0 = \frac{P\nabla^2(2R + 1)}{k(\alpha + \beta)}$

Maximum bending moment $M_0 = \frac{-P}{2(\alpha + \beta)}$

Where: $\alpha = +\sqrt{2\nabla^2(R + \sqrt{R^2 - 1})}$

$\beta = +\sqrt{2\nabla^2(R - \sqrt{R^2 - 1})}$

P = load

When R < 1: Deflection at "x", $v_x = Pe^{-\xi x}(C_1 \cos \eta x + C_2 \sin \eta x)$

Maximum deflection $v_0 = C_1 P$

Maximum bending moment $M_0 = -P/2\xi$

Where: $\alpha = \nabla\sqrt{1 + R}$

$\eta = \nabla\sqrt{1 - R}$

$C_1 = \frac{\nabla^2(1 + 2R)}{4k\xi}$

$C_2 = \frac{\nabla^2(1 - 2R)}{4k\eta}$

When $R = 1$: $\alpha \to \beta \to \xi \to \nabla\sqrt{2}$
$\eta \to 0$

Hence: Maximum deflection $v_0 = \dfrac{3P\nabla}{2k\sqrt{2}}$

Maximum bending moment $M_0 = \dfrac{-P}{4\nabla\sqrt{2}}$

FINITE LENGTHS AND MULTIPLE LOADS

The deflection and its derivatives are all proportional to the load P, so both the principle of superposition and the reciprocal theorem can be applied to find solutions for multiple loads and for finite lengths of the bridge. Distributed loads take the form of a Particular Integral and complicate the relatively simple solutions shown above.

Reference Notes

[1] Dent, R N—*Principles of Pneumatic Architecture*, The Architectural Press, London 1971.
[2] Tutt, F J H & Perkins, D—*9 Metre Inflatable Bridge*, MVEE Report RES 48 2/8, Mar 72.
[3] Anon—*Goodyear Inflatable Tank Bridge*, Product Engineering Vol 41, Jul 70.
[4] Berry, G D K—*The Analysis of Inflatable Causeways*, 25 Degree Course Report, RMCS Shrivenham, June 73.
[5] McComb, H G et al—*Structural Considerations of Inflatable Re-Entry Vehicles*, NASA Tech Note D-457, 1960.
[6] Allen, H G—*Analysis and Design of Structural Sandwich Panels*, Pergammon Press, Oxford, 1969.
[7] McComb, H G—*A Linear Theory for Inflatable Plates*, NASA Tech Note D-930, 1961.
[8] Topping, A D—*Shear Deflection and Buckling Characteristics of Inflated Members*, Journal of Aircraft, Vol No 5, Oct 64.
[9] Winkler, E—*Die Lehre von der Elastizat und Festigkeit*, Prag Dominicus, 1867 (page 182).
[10] Tutt, F J H—*Concentrated Loads on Inflatable Structures*, Paper presented at International Symposium on Pneumatic Structures, Delft, 1972.

Roots-Who Was The Father of the Corps?

MAJOR J T HANCOCK RE

TRACING ancestors is a popular pastime at the moment but a Corps as distinguished as that of the Royal Engineers, with its well established lineage, hardly needs to trace its ancestry—or does it? Are we descendants of Bishop Gundulf, or does he belong to a different branch of the family? Arguments for and against are many and varied, but if we take the Corps as it is today and look for an event that effectively started the Corps towards its present role and organization, the year 1812 stands out as a landmark. It was the year in which the Royal Engineer Establishment, or the Royal School of Military Engineering as it is now called, was founded and the soldier branch of the Corps changed from being little more than tradesmen in uniform, to trained combat engineer tradesmen.

Who begat the Royal Engineer Establishment? Was it the Duke of Wellington, as is popularly claimed? Or have we taken the name of a famous man in preference to that of the lesser known Charles Pasley who, as its first Director or Commandant, so carefully looked after the infant RSME for the first thirty years of its existence?

Major General Whitworth Porter, the Corps historian for this period, writing in 1889 states:—

"The School of Military Engineering at Chatham unquestionably owes its origin to the persistent advocacy of the late Sir Charles Pasley, RE, . . ."[1]

His only reference to the Duke of Wellington is to mention his letter of the 11 February 1811 as urging the addition of Sappers and Miners to the Corps, and the prompt and decisive results.

The not so well known, but equally important Corps historian, T W J Connolly, merely states that Pasley is believed to be the first officer to represent the advantage of training in military fieldworks, and that Wellington represented the forming of a Corps of Sappers and Miners in the most forcible manner.[2]

Neither historian does justice to either the Duke or to Pasley and it is, perhaps, a desire on the part of the Corps to be connected with the name of Wellington, that has led to the growing preference to his name, rather than that of Pasley. The facts show quite clearly that Pasley was the true father of the Corps, as we know it today, and that Wellington's part was a very minor one indeed. Fortunately both Wellington and Pasley were prolific writers, so that it is fairly easy to establish the chronological sequence and the background to the events which led to the all important changes in 1812. The life and achievements of the Duke of Wellington are well known, but those of Sir Charles Pasley are not so well known and are worth summarizing.

Pasley was commissioned into the Royal Artillery at the age of seventeen, from the Royal Military Academy at Woolwich, and transferred to the Royal Engineers the following year. He served in Minorca, Malta, Naples, Sicily, Copenhagen and Spain before serving in the Walcheren Expedition where he was wounded at the Siege of Flushing in 1809. (On the plaque under his portrait in the RE Headquarters Mess, the item that commemorates this period in his life is "ADC on Sir John Moore's staff, Peninsular 1807-08". This is an unfortunate and inaccurate choice since he was only appointed extra ADC, employed as a translator and interpreter, for seven weeks from 25 November 1808. His active service career was not particularly distinguished, but this event hardly does justice to him and "Wounded at the Siege of Flushing 1809", would seem to be a better choice.) His wounds were severe enough to end his future in the Army on active operations, so that it was his undoubted academic abilities which led to his high rank in the Army. Born at Eskdale-Muir, Dumfries on the 8 September 1780, he was educated locally up to the age of fourteen. He was an apt pupil; by the age of eight he could read the Greek Testament and by the age of thirteen he had written a local "history", in Latin, in the style of Livy. He also learned French during this period and later became fluent in Spanish, German, Welsh and Irish. Throughout his life he studied not only military but also political and scientific subjects, and these led to his being elected a Fellow of the Royal Society in 1816 and his connections with the Astronomical, Geological, Geographical, Statistical and other Societies. During his life he wrote a number of learned papers, including one in which he recommended decimal currency and metric weights and measures.

Pasley took the first important steps in his academic career, while recovering from his wounds, by completing a 530 page "*Essay on the Military Policy and Institutions of the British Empire*". It was an appeal for increased resources, and greater singleness of purpose, to be used in the war with Napoleon. Published in 1810, it was hailed as the most important political work of the time and by 1813 it was in its fourth edition.[3] Amongst other subjects, the essay criticized the lack of training and preparation for war of the Army as a whole, and of the Corps of Royal Engineers in particular. It had no significant effect on the Corps, but the name Pasley was now known, not only in the Army, but also to influential civilians. The ideas of a thirty year old, fairly junior Captain, had received public approval and this must not only have encouraged him, but also meant that his future ideas had to be given consideration.

At the beginning of the nineteenth century the Corps had two separate branches, the officers of the Royal Engineers and the soldiers of the Royal Military Artificers. The soldiers were little more than civilian tradesmen in uniform, who were formed into companies based on the main fortifications in the United Kingdom and the Colonies. Training and recruitment were by companies and their standards, both as tradesmen and as soldiers, were very poor. An improvement was made in 1807, when Captain J T Jones was appointed adjutant, and recruits were at least centrally trained in drill and duties at Woolwich.[4] The senior officers of the Royal Engineers did not

accept, or they chose to ignore, the changing role of engineers in continental warfare. These changes meant that engineer soldiers trained in field, or combat, engineering were becoming more important than artificers or tradesmen trained to build fortifications. The junior officers, who were serving in such campaigns, could see the necessity at first hand and a group of them discussed, lobbied and corresponded on the subject. Pasley and J T Jones were two of the officers in this group. Both of them were severely wounded and, when "chair bound", used their academic abilities to improve the Corps in their own ways.

The Peninsula War demonstrated the inefficient state of the Corps to the Army in general. At the sieges of Ciudad Rodrigo and Badajoz, in Spain in 1811, the Duke of Wellington's Army and the Royal Engineers in particular, suffered from the lack of engineer soldiers trained in any of the arts of siege warfare. The Royal Military Artificers had not even been trained to make fascines and gabions which were so essential to siege work, and had little knowledge of the art of making a sap when under fire. To make matters worse, there were only twenty-seven of them available for duty at the siege of Badajoz in May 1811. Reinforcements were sent to the Peninsula later in 1811, but they too were untrained and to make up for the lack of numbers the Duke of Wellington gave orders for 200 infantry soldiers to be trained, as sappers, for future sieges.[5] After the successful siege of Ciudad Rodrigo in January 1812, Wellington wrote his letter of 11 February 1812 to the Secretary of State for War. In it he recommended the addition of a corps of sappers and miners to the Engineer's establishment, and stated that he had been obliged to rely upon infantry who lacked both knowledge and training.[6] He wrote a further, much longer and more detailed letter to the Secretary of State for War on 7 April 1812. In this letter he pointed out that their heavy losses at the siege of Badajoz were due to the lack of a regular, trained corps of sappers and miners; he adversely compared the British with the French establishments; and he pointed out the ways in which lives could have been saved if the siege had been conducted with adequate means.[7] It is upon these two letters that the claim is made that the Duke of Wellington was the instigator of the formation of the Royal Engineer Establishment. While the power of his position would have had a great deal of influence upon such a decision, the effects of his letters must be examined in conjunction with the work of Pasley, in order to assess their relative merits.[8]

Having recovered from his wounds, Pasley was posted to Plymouth in December 1810. He was not the man to criticize the Engineer Department, in his *Essay*, without also taking some constructive action and in early 1811 he wrote to Lord Mulgrave, the Master General of the Ordnance. He pointed out the defects in the Engineer Department and asked Lord Mulgrave to take action to remove them, before a disaster occurred at a siege. He received a polite and favourable reply and this encouraged him to experiment with the men in the Royal Military Artificer company at Plymouth. Starting in May 1811, he taught them the practical tasks and drills necessary for effective siege work, and in addition he taught them practical geometry and plan drawing. On 27 July 1811 he wrote to Wellington, sending him a copy of his *Essay* and at the same time pointing out how important it was for the engineers to have men trained in siege work. Wellington did not reply to the letter[9] and, as has been shown, his first letter supporting trained sappers and miners, was not sent until the following year. Pasley also wrote to the Duke of York, the Commander in Chief of the Army, who replied to say that he was interested in Pasley's ideas. On 11 December 1811, Pasley again wrote to Lord Mulgrave to report on his successful attempts at training the Plymouth Company. He received a reply, dated 26 December, in which Lord Mulgrave said that he was pleased with the progress that had been made and stated that:—

> ". . . the digested system which you propose to arrange for the use of young officers of Engineers, and of non-commissioned officers and soldiers of the Department is an object of great interest; I shall be happy to give my attention to it, when you lay it before me."[8]

On an unknown date in February, Pasley went to London to present his system. He had been informed that the Inspector General of Fortifications was:—

> "very desirous that the instruction of the R M Artificers in the construction of field-works should be put in train and he seems to think that Woolwich will be the most eligible station to make a beginning. He wishes to see you as soon as convenient, after you have given General Nepean all the information he requires. Colonel Rowley further requests an outline of the proposition and some idea, if possible, of the expense which would attend it on any given scale, . . ."[8]

Wellington's letter of 11 February could have been the all important recommendation that caused the summons, but on time alone and the apparent lack of haste in the summons, it is unlikely. Even allowing for Pasley's visit to London being on the last day of February, Wellington's letter would have to travel from Spain to London, be read and acted upon by Lord Liverpool, and the summons sent to Pasley, in only eighteen days. By 14 March Pasley's scheme, for instructing both the Royal Military artificers and the officers of the Royal Engineers, had been considered by a Committee and a report sent to Lord Mulgrave recommending that the scheme should be adopted. There would have been time for Wellington's first letter to influence the Committee, but it should be noted that the decision was made twenty-four days before his second, and more detailed, letter had been written. In addition it must be remembered that Pasley had written to Wellington, the previous year, to gain his support.

Pasley's fame, as father of the Corps, cannot rest on letters and lobbying alone. Although he was the most persistent, others were doing the same. Richard Fletcher, the Commanding Engineer in Spain, and J T Jones, now his Brigade Major, both wrote to the Inspector General of Fortifications on the subject, although Jones' letter can hardly have helped the cause since it reminded the Inspector General that "Nero fiddled while Rome burned". The pressures to train sappers and miners in siege work came from so many sources, that even the inefficient Ordnance Board would have taken action eventually, but without Pasley it could only have been to train men in the simplest practical work. Far more than that was needed. At the siege of Ciudad Rodrigo in 1812, up to 1200 infantry were used in working parties and these were supplied by the divisions in rotation.[10] Highly trained NCOs and men were needed who were capable of supervising this type of work. In the field they would also be required to lay out field defences and to read and adapt plans to the available ground, with the minimum of officer direction. To achieve anything approaching this standard a new and revolutionary type of training was essential, since the vast majority of the civil population and therefore of soldiers, were completely illiterate. The men of the Royal Military Artificers were probably better educated than most, but as Pasley described them:—

> "Few of them understand more than the first common rules of arithmetic; and a considerable proportion of them are totally uneducated."[11]

Schoolmasters were in short supply even in private schools, and the expense of their wages would have been an insuperable obstacle in any army school. In addition, the establishment held strong views on education of the masses and of soldiers in particular. At a much later date the Duke of Wellington is reputed to have said:–

> "By Jove! If ever there is a mutiny in the army—and in all probability we shall have one—you'll see that the new fangled schoolmasters will be at the bottom of it."[12]

In 1857 the relatively liberal minded Prince Consort wrote that:—

> "To educate the Army was very laudable, but the Army was not there to be educated, but to defend the country."[13]

Prejudice against soldier education was not just a matter of opinion, but also official policy. In 1800, Colonel J G Le Marchant received strong opposition when he proposed that a "legion" of 200 soldiers should train with Officer Cadets in the Junior Department of the Royal Military College. His idea was that the soldiers would give the Cadets practice in handling men, while the soldiers would be given

an elementary education and become a source of potential NCOs. The proposal was considered by a Committee of General Officers, with the Duke of York as President. The Committee agreed to the establishment of the Junior Department for Cadets, but rejected the idea of the "legion" since it was:—

> ". . . inconsistent with the habits of the country to raise private soldiers to so close an equality with their officers."[14]

Just twelve years later, a Committee considering Pasley's proposals agreed to officers and men receiving instruction together at Chatham, and the education of soldiers in a course of practical geometry (they did in fact add that they did not think it advisable that this should be carried further). This was a considerable achievement and it is worth looking further at the system which Pasley evolved to overcome these difficulties.[11]

There were very few free schools, in England, in the early nineteenth century and this was partly due to the shortage and expense of suitable school-masters. A method of overcoming this problem had been developed for use in the few charitable institutions that did exist. It was known as the monitorial system and is attributed to both Joseph Lancaster and Andrew Bell, who published separate accounts of their methods. The more advanced and intelligent pupils were appointed as monitors, who acted as assistant teachers. Pupils were also paired off, so that a brighter child could act as a tutor to the not so bright. In this way, one teacher could supervise the instruction of a very large number of pupils, who were in effect teaching themselves. The system was used at the Royal Military Asylum in Chelsea, which opened in 1803 as a home for the orphan children of soldiers. The system was only used to teach reading, writing and the basic rules of arithmetic, but Pasley considered that it could be adapted, not only to teach adults more advanced subjects, but also to produce suitable teachers. The basis of his ideas is best given in his own words:–

> "But it may be laid down as a maxim, that in any body of men, however indiscriminately collected together, there is always a latent fund of superior talent, which, if proper steps are taken, may be called into action for the benefit of the state: and although military men have less stimulus to individual improvement than civilians; their habits of obedience, and the pride, and emulation which may so easily be excited amongst them, render them much more docile and improvable as a body, than any other class of men, provided their instruction is carried on under the eye of superiors zealous in the cause."[11]

In his first experiment, Pasley selected potential instructors and taught them the relevant subject. He found that although they understood and learned the subject thoroughly, they were still not capable of instructing in the subject. The main reason for this failure was that normal text books left too much to the discretion of the teacher, so that an instructor needed a good all round education, combined with experience in teaching, to make full use of them. His solution was to write his own courses of instruction and to adapt the "monitorial system" to produce potential instructors. He laid out each course, lesson by lesson. Each lesson consisted of a part to be read out to the class by the instructor, and a part containing notes on the method to be used to illustrate the lesson. By keeping to the lesson, as laid down, instructors did not need additional knowledge. Classes were kept to a maximum of thirty pupils, since Pasley did not consider that an instructor could effectively teach more than that number, unless an assistant teacher was appointed to assist in inspecting class work. Pupils were divided into parties of six men and each party sat in a row. After three or four days instruction, the most intelligent men were appointed as monitors to each party.

Each lesson started with the instructor reading out the laid down detail for that lesson, using a blackboard for illustrations where necessary. The pupils had slates on which they then had to draw a diagram or write an answer, to illustrate the item that had been taught. On the command of—"Show Slates"—the pupils held up their slates for inspection and the instructor inspected the slate of the monitor for each party. If the monitors work was correct, the monitor then examined the work of the

other men in his party. If the monitor was wrong, the instructor inspected the next man's work and the first man with the correct solution would take over as monitor and inspect the work of the rest of his men. If a man had the wrong answer, the monitor was expected to show him how and why he was wrong. The system had the obvious advantage that the instructor only had to examine the work of five monitors for each problem and did not have to attempt to give individual instruction to the slower and less intelligent pupils. At the same time there was a spirit of competition in the class while the monitors, as potential future instructors, were also gaining teaching experience.

Variations of the command—"Show slates"—were—"Prove figures" and "Explain methods". These were used when it was appropriate for the monitors to explain how they arrived at their answer or constructed their diagram. Before going on to the next lesson, each lesson was repeated until the instructor was satisfied that it had been thoroughly understood. Frequent revision was also used to ensure that the class was progressing satisfactorily.

The standard set was very high. In the course of instruction in practical geometry, the following are sample lessons:–

Problem 20—In a given circle, to inscribe a regular hexagon.

Problem 46—To make a triangle equal to a given pentagon.

Problem 51—By means of three centres to draw a compound arch of a given span and rise, resembling an ellipse.

Problem 57—To make a scale of sines.

The course of plan drawing included the drawing of sections, oblique elevations, perspectives and projections.

Pasley did not rest when his method and ideas had been accepted for an engineer school. On 8 April he visited Joseph Lancaster's school; on the 14th he was at the printers with the first sheets of his manual on Practical Geometry; and on the 23rd, the day that the Royal Warrant was signed to establish the school, he visited Andrew Bell's school. As the Royal Engineer Establishment's first Director, he applied all his energies to developing the scientific aspects of the Corps for the next thirty years. It is strange that during his lifetime, it was J T Jones and not Pasley who was affectionately known by his brother officers as "The Father of the Corps".[15] Jones, who has been mentioned previously in this article, continued to suggest improvements to the Corps, but does not appear to have brought about any particular changes. It may be that Jones was the more popular and likeable man. There are very few clues to Pasley's character. His letters indicate that he was rather impatient, jealous of those promoted above him, and he was not afraid to praise his own abilities. A Frenchman who visited the school, gives an impression of Pasley as rather bigoted, pompous and self opinionated. One of the few comments on his private life is given in a letter written by J T Jones in July 1814:–

> "By the bye, wonders will never cease—Pasley married!—the last thing I should have supposed; I hope it is an advantageous connection for him—I hear she is pretty."[16]

Perhaps this letter is a clue to the difference between the two men. Nevertheless, whatever faults there may have been in his personality, without his system of instruction the Corps could not have had such an advanced school until very much later in the nineteenth century.

Reference Notes

[1] Porter, Maj Gen W—*History of the Corps of Royal Engineers*, Vol II, p 169.

[2] Connolly, T W J—*History of the Corps of Royal Sappers and Miners*, (London 1855) Vol I, p 181.

[3] Tyler, H W—"Memoir of Gen Sir Charles Pasley, KCB", *Professional Papers of the Corps of Royal Engineers*, New Series, Vol XII, 1863, pp ix to xi.

[4] Pasley, C W—*A Course of Elementary Fortification*, (2nd Edition, London 1822), Notes to the Preface p iii.

[5] Jones, J T—*Journal of the Sieges carried on by the Duke of Wellington in Spain*, (3rd Edition, London 1846) Vol I, pp 1 to 139.

[6] Gurwood, Lieut-Col—*The Dispatches of Field Marshal The Duke of Wellington*, (London 1837), Vol 8, p 601.

[7] *RE Journal*—Vol XIXX, June 1889, p 132—"A Missing Letter from the Duke of Wellington".

[8] The majority of the details and dates of Pasley's work, towards the establishment of the Royal Engineer Establishment, are given in Chapter XI of an MS held in the RE Library —*General Sir Charles W Pasley KCB, His Family and his Career* by Col J C Tyler (1929).

[9] Wrottesley, Lieut-Col The Hon George—*Life and Correspondence of Field Marshal Sir John Burgoyne*, (London 1873) Vol I, p 165.

[10] Jones—Vol I, pp 100 to 122. (see [5])

[11] Pasley's own description of his attempts to teach the Plymouth Company of the Royal Military Artificers is given in the Preface to his *Course of Instruction*, Volume I, (London 1814). His description of the theory behind his system of instruction, and the system itself, is hidden away between the Course on Practical Geometry and that of Plan Drawing in same book.

[12] Watteville, Col H de—*The British Soldier—His Daily Life from Tudor to Modern Times*, (London 1954), p 147.

[13] Verner, Col W—*The Military Life of HRH George, Duke of Cambridge*, (London 1905). Vol I, p 201.

[14] Thoumine, R H—*Scientific Soldier—A Life of General le Marchant*, (London 1968). p 78.

[15] Jones, J T—*Autobiography of Major General Sir John T Jones*, (Limited Printing, copy in MS in the RE Library), editors note p 212.

[16] Shore, Commander The Hon H N—"Letters from the Peninsula During 1812 to 1814", *RUSI Journal*, Vol LXI, 1916, p 126.

Experiments with Wind-Machines

BRIGADIER SIR MARK HENNIKER Bt, CBE, DSO, MC, DL

"On his seventieth birthday he launched his first panemone" might well be my epitaph; but the reader—whether of the epitaph or of this paper—might be pardoned for asking: "What is a panemone?" It is a good question; for you will only find the word in rather obscure books of reference.

A panemone is a machine, powered by the wind, which always revolves in the same direction, regardless of the direction of the wind; and does not need to be pointed head to wind for the purpose. A panemone is usually mounted on a vertical axis, and is exemplified by the often-seen cup anemometer or wind-speed indicator. This consists of three or four hemispherical cups, each on the end of a spoke, revolving on a vertical axis. The greater the windspeed, the faster the spokes revolve. The drawback to this sort of wind-machine as a source of power is that only half the apparatus is productive; the other half is moving against the wind and is counter-productive. There are other types of panemone (See Figure 1) which I shall mention later; and my experience has led me to suppose that there is much to recommend the panemone.

The word panemone seems to be French, for it occurs in *Petit Larusse* but not, so far as I know, in any standard English dictionary. In *Petit Larusse* it is defined as a hoisting machine, but I question whether this is an essential characteristic. It is said to be derived from two Greek words: *pan* (meaning all) and *anemos* (meaning the wind) which is appropriate, because a panemone will accept "all winds". Research in the library of the Athenaeum revealed that a Frenchman patented a panemone (under that name) in the early part of the last century; but that wind-machines of the panemone type (but under other names) had been in use by the Chinese, the Egyptians and the Greeks long before the Christian era. They are also mentioned in the most complete book that I have come across dealing with wind-power: *The Generation of Electricity by Wind Power*, by E W Golding; published in 1955 by E and F N Spoon Ltd of London. On the whole they seem to be regarded as curiosities or freaks and of no practical use. I agree that this is so if you want to generate electricity, but they seem to have possibilities for other uses.

Nevertheless, when I first turned my attention to harnessing the wind for energy, it seemed natural to begin with a propeller design and try to make it as efficient as possible. The old-fashioned windmill had survived for centuries and I had seen many working in East Anglia in my boyhood; so I began there.

There were several English versions of the windmill and they all had one factor in common; the miller lived on the site. He more or less had to live there; because, like the skipper of a sailing ship, he was required to supervise the setting of the sails to suit the strength and direction of the wind. All depended on his judgment and sagacity; and the tales and fables of many European nations tell of the misfortunes of the miller and of his donkey when he slept late or went revelling. Millers in fiction are often depicted as figures of fun, who suffered infinite catastrophe through lack of attention to duty.

Apart from storms that might wreck a windmill, there was always the danger of fire. It was, apparently, usually caused by the brake getting hot and throwing out sparks that ignited some wooden piece of machinery—perhaps the very wheel on which the brake rubbed—and the sparks were fanned by the wind. When they were in working order, however, windmills did present a huge swept area to the wind; and this is evidently an important factor in developing power. That led me to consider the mathematics of a propeller; and I soon became indebted to Mr Ross of the Royal Military College of Science. He not only introduced me to the basic theory, but overcame the difficulties of making it comprehensible to me. While I take full responsibility for the mathematics set out in the Appendices, I at once record my debt to Mr Ross; but I absolve him absolutely of all responsibility for any errors recorded therein.

The essential mathematics of a propeller are set out in Appendix A for those who care to read it; but for practical comprehension of the principles of the design of a propeller, a few general considerations are enough. Consider a cylinder of air of "unit" length, with a diameter equal to that of the propeller of a windmill, and so arranged that it will pass a fixed point at a stated velocity in one unit of time. This cylinder of air has inherent in it a calculable amount of kinetic energy, which the propeller is designed to extract; and the more efficient the design, the greater will be the proportion of the inherent kinetic energy that it will be able to extract. But here we come upon a mysterious thing, namely: however gifted you may be as a craftsman or a designer, it is absolutely impossible to extract from the cylinder of air more than 16/27 of the kinetic energy available. What is so strange is that this fraction is derived by applying to the wind, "that bloweth where it listeth", the inexorable logic of the differential calculus. Yet of all the possible numbers that might come out of the mincing machine, the one that *does* come out can be expressed in terms of the first three; for 16 is 2^4 and 27 is 3^3. It seems to reveal one of those quite simple things in the Universe that pass Man's understanding.

However, when it came to the manufacture of a propeller I found that I was more governed by what I could afford than by what seemed the most efficient design. I looked at an early wooden aircraft propeller, hanging on the wall of a saloon bar, and saw that the pitch varied from the tip to the hub. It seemed that while the cylinder of air passed through the propeller disc at a constant speed, a point on the tip of the propeller moved much further—and faster—round the periphery than did a point nearer to the hub. You therefore needed a finer pitch at the tip than at the hub. If you say—as I do in Appendix A—that the air comes out of the propeller disc at $\frac{1}{3}$ of the speed that it enters it, you get quite a simple method of determining the pitch at any point of the blade for a given windspeed, and the number of revolutions per minute of the propeller. This method is set out in Appendix B, and is offered with considerable reserve. It should perhaps be concluded with the initials E & OE like the bill from a country grocer of the last century.

Following this method of designing a propeller I was at first tempted to make one out of laminations of wood; but being impatient, and having some sheets of aluminium from a scrap metal merchant in the Docks, I cast science to the winds

and decided arbitrarily to make a propeller with six blades, having a diameter of 6ft 6in. Then, applying the theory of setting the pitch as propounded in Appendix B, I gave the blades a pitch commensurate with 200rpm in a 20mph wind. Each blade was to have the general profile of the wing of a Dakota transport aircraft of World War II, being bent round a main spar, consisting of a 1¼in water pipe, screwed into the hub and locked with a locking nut. Whatever may have been the shortcomings —and they must have been legion—of the design theory, the product looked reasonable on the drawing board; (the idea that what is beautiful in mechanical design is also efficient is ill-founded. The converse, however, may be true; for Beauty is relative whereas Truth is absolute.) My friend and contemporary, Felix Cunuder, said he would put it all together for me.

Felix also offered to make up the "headstock"; that is the swivel-mounted chassis to carry the propeller shaft, the gearing, the alternator and the tail fin, each of which I will mention in turn, and illustrate in Photograph 1. The swivel-mounting was made from the front stub-axle of an old motor car in a scrap yard. This, with its brake drum and wheel nuts, was a good, solid basis on which to found the rest. The chassis itself was made from two angle-irons, separated by distance pieces, to match the wheel bolts on the brake drum. This too was strong and rigid. On top of the chassis Felix mounted an alternator fitted with diodes so as to produce 24 volts DC at 2,000rpm. We decided we must have an alternator; because we foresaw that at high windspeeds we should get very high revolutions and sparking would inevitably occur across the segments of a commutator if we used a DC generator. But to get a

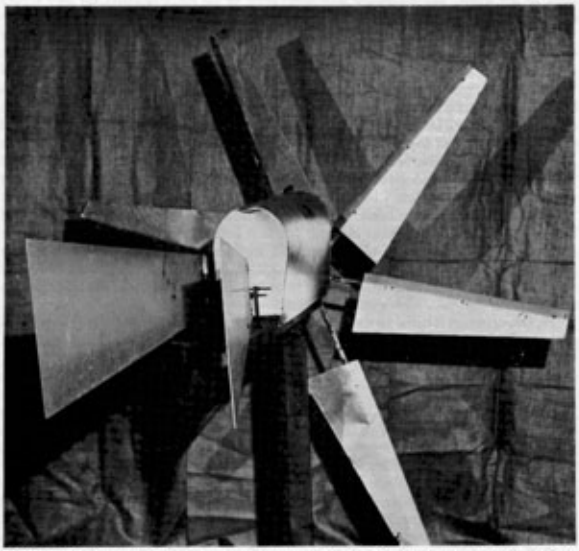


Photo 1. Windmill awaiting repairs to propeller blades. Note: There was no significant difference in performance whether the blades were set with the wide or narrow ends towards the hub.

Experiments With Wind Machines (1)

reasonable speed at low revolutions we had to have a 10 to 1 gearing, set up with studded belts, in two stages. Unfortunately, the only alternator that I could "pick up" cheaply had field coils that needed exciting. This would produce difficulties when there was no wind, unless we did something about it; for the field coils would drain current off the batteries we proposed to charge, and that might damage them in a long, calm spell. Consequently, we resorted to a device thought of by Felix, whereby, when there was no wind, a metal flap hung vertically beneath the chassis. In this position no current flowed from the battery to the field coils of the alternator. But when the wind sprang up, the flap was blown into a tilted position, so that contact was made in a mercury switch and the field coils were excited. This seemed to me cunning worthy of an engineer.

Another piece of cunning was embodied in the tail fin. This consisted of two identical pieces of sheet aluminium, set in the form of a "V". One half of the V was rigidly set; while the other was hinged to it at an angle of 30 degrees, but held off by an adjustable spring. The theory was that in an acceptable wind the V-shaped tail would keep the propeller shaft on a line bisecting the V; but in an excessive wind the two parts of the V would be pressed together on the alignment of the fixed one. The propeller would then be off-set from the wind by 15 degrees, and so reduce the chances of excessive speeding. This turned out to be "too cunning by half", as the only way to adjust the spring was by trial and error; and the error unhappily occurred first. The whole headstock, as will be seen in the photograph, was covered by a suitable cowling.

While Felix was busy with all this, I had bought a job lot of rusty tubular scaffolding and had constructed a tower, 4 foot square and 21 foot high, which I attached to a corner of the warehouse of my business premises in Cardiff Docks. Against this tower, which was easy to climb because of the nature of its construction, I fixed a wooden mast with a top-mast, such as one might expect to find in a top-sail cutter. The headstock of the windmill was to perch on the top of the top-mast, which was within reach of the top deck of the tower; and by hauling on the halliard one could hoist the windmill aloft to a height of 30 feet. This was rigged in a manner that might be described as "shipshape and Bristol fashion", which was very suitable within sight of the Bristol Channel.

So far we had met with very little difficulty and no expense that I could not foresee covering with the ultimate sale of the finished product; but I was advised to take out an Industrial Insurance Policy in case someone fell from the tower or got decapitated by the propeller. Neither of these misfortunes befell, though many others did, as I shall recount. It was these that made me turn to a panemone.

The first difficulty occurred when I tried to lift the headstock. I staggered with it to the weighing machine in the warehouse and found it weighed over 100lb. This was just acceptable on the solid ground, but it was too heavy to manage on top of the tower. Luckily our neighbours owned a mobile crane, but it was not licensed to travel on the road. However, during the crane operator's tea break, one of the Directors next door manned the crane and by going to full stretch he just managed to hoist the headstock, from over the fence, into place. He then raised the propeller and I managed, in a blistering North East wind, to bolt it into place. Felix manned the top-mast halliard and the windmill soared on high. It was a great moment!

A reporter from the local Press happened to be passing and next day we had a Press photographer and a reporter in the Boardroom. I sought to speak learnedly on kilowatts and wind energy; but unhappily at that moment the wind evaporated and all I was really able to demonstrate was the self-evident proposition that when there is no wind a windmill is no good. Moreover, the occasion turned out to be the beginning of a long period of perfect calm: never a breath of wind till there was a storm.

I could see the storm coming as I locked up the warehouse on a Friday evening. I should have lowered the top-mast and followed Nelson's order: "Anchor, Hardy, anchor". But my wife and I were going out to dinner and I was in a hurry. Like many

better men, I succumbed to an error of judgment. While we were at the party there was the "father and mother" of a storm—lightning, thunder, high wind, rain and even hail, until well into the night. Nothing could be done until next morning.

As I hurried to the warehouse after breakfast, I could see the windmill from afar. It was in a bad way, spinning fast but erratically with only five blades. Where, I wondered, was the sixth? Had it sailed, like a scimitar, across the Docks, beheading Docksmen on the way? The thought of the Industrial Insurance Policy was no comfort, while I searched for the missing blade. Fortunately there was no disaster. The windmill had behaved like the mutinous soldier who threw down his hat and jumped on it, shouting: "I'll soldier no more!" The missing blade lay crumpled on the ground at the foot of the windmill tower. "Thank God for that!" was a natural reaction.

The crane next door was non-operational that day, but by extreme good luck a mobile crane was careering down the road at the moment and I hailed the driver. "Yes", he said, he could get the windmill down easily if I could unbolt it; but the minimum charge for a job was £15. After the exercise of some diplomacy we settled for a quid, and he lowered the propeller.

The hub of the propeller was much too slender, and I strengthened it. But added strength meant added weight, and therefore added difficulty in getting it back into place. However, my neighbour rose to the occasion in due time—though I felt most diffident in asking—and raised the propeller for me to fix in place. Then for another fortnight there was so little wind that few kilowatts were generated; but the fortnight ended in another splendid storm; this time on a Sunday evening during Evensong. I heard the wind howling and wondered whether to cut and run; but I judged that all the damage that could be done would be done before I got to the Docks, and I listened to the sermon with scant attention. When at length I reached the warehouse there was still a stiff breeze, gusting from all directions. There were plenty of kilowatts notching up, but in a very "dodgey" manner. As the propeller revolved it was yawing this way and that, with the two tail fins clashing together like cymbals in a band. The yawing was setting up gyroscopic stresses in the fast rotating blades of the propeller, and causing them to shudder with sickening vibrations. Something seemed certain to shatter if nothing were done; and I clambered up the tower with a boathook and pinioned the rebel. It was really quite a Sunday treat!

A simple measure was to incorporate in the hub either an air brake, actuated by centrifugal force (which is not difficult); or else some sort of feathering device, so arranged that when the speed of rotation exceeded a pre-determined maximum, the blades would automatically feather. On the whole this seemed the better plan; but it held two drawbacks. First, it was likely to weaken the hub, which I had only recently found too weak and had had to strengthen. Secondly, it would add more to the weight of the headstock; and that was not a good idea. Whatever I did, it seemed, I should have on my hands a piece of machinery as heavy as a mowing machine (and about as complex) that would always need a crane (which I did not possess) to get it into place, or to get it back into the warehouse for any overhaul.

When I considered all this, I began to realize that a propeller device might be an efficient kind of wind-machine, but it is not the kind for the "owner driver". It is logical for a large organization, such as the Central Electricity Generating Board, to build a metalled road out to a windswept headland in the North-West of Scotland, and there install a maintenance crew to watch over the most sophisticated windmill that the wit of man can devise. But not so the private user. He must have something that is as nearly trouble-free as possible; he cannot afford to hire cranes and expensive plant to service his wind-machine. Efficiency for him is measured by reliability, not by any standard of mechanical engineering in the scientific sense. This is where I had gone wrong. My project had inflated itself into a nonsense. However, I had learnt my lesson without too much expense; the know-how would come in handy, even if some of the hardware had to be disposed of. That is the sort of argument that turned my mind to the idea of a panemone.

As I said earlier, there are several possible designs for a panemone; but being in the oil business I was naturally inclined to look first at those types that lent themselves to manufacture from cast-off oil barrels. First I considered the primitive S-type rotor (Figure 1a). Then I made some small models of the other types illustrated in Figure 1.

Small scale models are notoriously misleading; because the minutest variation in the friction of the main bearing throws all your results out of proportion. But it was all I could afford, both in the time and energy devoted to *extra mural* activities, and the application of business resources to unbusinesslike activities. (After all, if you seek to run a business, you must make it pay!) I believe it might have been possible to evaluate some of the panemone designs I tested by the application of pure thought; but that was beyond my mathematics. These only went as far as I have indicated in Appendix C. I therefore had to rely on the models, and for what they are worth, I

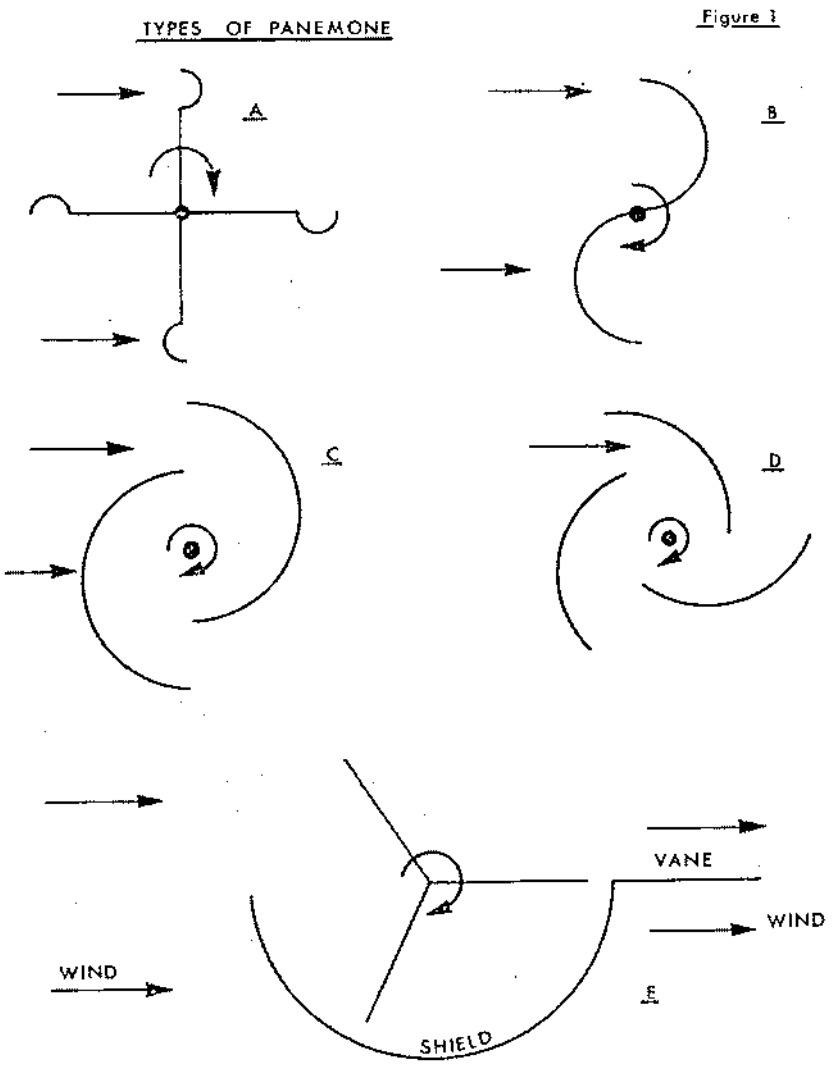


Figure 1. Types of Panemone.

record some of the principal findings. Rightly or wrongly I came to the conclusion that an odd number of blades was better than an even number. Secondly, it seemed that those designs in which the windstream was deflected from one blade to another tended to perform best. Those in which one blade was intended to take all the available energy from the particular section of air that hit it came second. Thus, the design in Figure 1c was better than 1b; and 1d was better than 1a, 1b or 1c. The idea illustrated in Figure 1e seemed attractive; but then I found myself getting back to a heavy piece of equipment to hoist up the tower. So I settled for the pattern illustrated in Figure 1d and in Photograph 2. This I called Mark 1.

Mark 1 had VIP treatment. Through the kindness of the Commandant of the Royal Military College of Science, and with the help of Mr Ross, Mark 1 was tested in a wind tunnel during a lull in the tests of some other equipment. Mark 1 was mounted on the differential of a scrap Hillman car. The rotor was attached to the flange properly intended for a road wheel, while the take-off from the differential came from the flange intended for the driving shaft of the engine. This gave a ratio of about 4½ turns of the driving pulley to every turn of the rotor. By using a 9in pulley from a washing machine, and a conventional fan belt to the generator from a "Mini", a measurable output seemed possible. We clamped the panemone and its generator to the floor of the wind tunnel and shut the hatch. We turned on the draught slowly, and at first nothing happened. There was no sound and I began to think that nothing was going to happen; when, much to my surprise, the rotor began to turn. Mr Ross with a pocket computer beat me to it with a slide-rule and pronounced the windspeed (calibrated in metric units) to be 7mph. Soon the instruments began to register electrical output.

The output of a wind-machine depends, amongst other things, upon the cube of the windspeed, so it was not long before we began to get significant readings. We did several series of tests, each with a different resistance in the circuit. I was reminded of those carefree days at Cambridge; but whereas then it was an imposition, now it really seemed to matter. There can seldom have been a more vigilant pupil—or one with less technical qualification—in the "labs" of the College. I plotted the figures with the greatest care; and although it may seem odd, I somehow felt an extraordinary exhilaration over the whole affair. I even risked a technical bet with Mr Ross over the accuracy of his calculations and lost a bottle of "bubbly". The main lesson of the whole exercise was that nothing went wrong. And why should it? The panemone is essentially robust and trouble-free; if a rather inefficient machine.

I drove home in the evening with the panemone standing in the back of my Land Rover, spinning contemplatively in the eddies. It mystified the Traffic Cops who wondered what it was. (It is apparently not illegal to carry a panemone on a motorway).

When I got home I continued testing various practical applications of the panemone. It was all very easy to do because, unlike the propeller-type machine, the panemone offers no difficulty in "bringing the motion down to ground level". The rotor could be left spinning aloft with or without a load. Its rotational velocity could not exceed what was clearly quite safe; and the only piece of equipment at the top of the tower that could possibly need attention was the Hillman differential—a piece of equipment so designed and perfected by practical trial that it is well known to require no attention at all. All winds were grist to the mill, and the real need was to find the best application for the energy extracted.

The generation of electricity does not appear to be a very good use for a panemone —nor indeed for any wind-machine. Although a panemone has sufficient inertia to minimize fluctuations in speed, it still suffers sufficient fluctuations to be annoying. What one wants, is to find uses that lend themselves to intermittent application of energy. In other words you must find your best way of storing the energy. The miller of old stored his energy in the bags of flour that lined the walls of the mill. There lay the energy intact till he wanted to sell it. The same applies to the process of pumping water. Every drop of water pumped to an elevated tank remains there, with the

Photo 2. Panemone Mark 1, showing the spar used to hoist it into place and the motor car differential on which it could be safely mounted without a central spindle.

energy within it, till it is wanted to run by gravity to its appointed place. No supervision of a water pump is needed. My own panemone has worked a diaphragm pump, whenever there was wind, for weeks on end unsupervised; and it seems possible that the same might be true of a heat pump.

Every schoolboy knows how a heat pump works, and most adults have forgotten; but it is easily explained in outline. The essential elements of a heat pump include a low temperature heat exchanger which is immersed in a natural source of heat, such as the sea, where the temperature may not be high, but the supply of calories is infinite. Even at its low temperature, the sea is capable of making a liquid, such as ammonia, "boil" and turn into gas. The gas is compressed by a small compressor, operated by a panemone, and gets very hot in the process. The hot gas enters a high

Experiments With Wind Machines (2)

temperature heat exchanger and surrenders its heat to a controlled amount of air or liquid which also becomes hot. This hot air or liquid is the end product and may be used in several useful ways. Meanwhile, a release valve lowers the pressure and the gas reverts to a liquid and the cycle is repeated.

The process may be expressed thus:—

$$H = S + E$$

where H = the heat given to the end product;
S = the heat taken from the natural source (the sea);
and E = the wind energy supplied by the panemone.

It is evident from this equation that if you only have E to supply the heat, by whatever means, it will not produce so a large value for H unless it is supplemented by S. Hence the apparent paradox whereby you get heat on the cheap. A common use of a heat pump is to be found in a dairy, where heat is taken by a heat pump from the vast quantities of fresh, warm milk and put into lesser quantities of water, to make the water hot enough to wash the milk bottles. Moreover, if the natural source of heat were kept continually warm by the use of solar panels, an even more economically successful process appears to be possible.

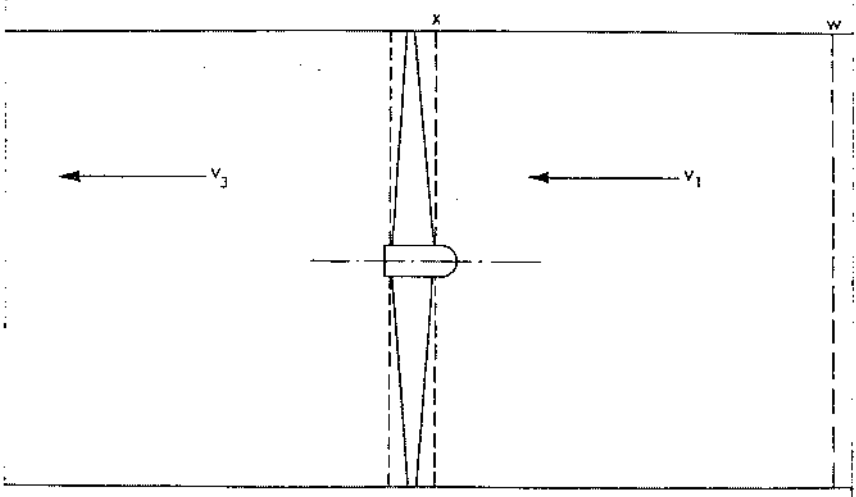
In general, then, the lessons I seem to have learnt from my experiments are four. First, the greater efficiency of a propeller wind machine, compared with a panemone, is off-set by the greater difficulty in managing it. Secondly, the limiting factor in the use of a docile machine like a panemone is the size of rotor you feel like building. Thirdly, you will do better in devising ingenious ways of using the energy so easily captured with a panemone than in devising more efficient machines to capture it. Finally, if a simpler type of machine could be devised it is likely that men like Archimedes or Heron of Alexandria would have put it on the market some time ago.

APPENDIX A

THE POWER AVAILABLE FROM A PROPELLER

THE POWER AVAILABLE FROM A PROPELLER

Figure 2



Consider a cylinder of air passing through a propeller disc where:—

WX represents a cylinder of air of such a length that it will pass a point in unit time when travelling at Velocity = V_1

A represents the area of the propeller disc

V_1 represents the Velocity of the air approaching the propeller disc

V_2 represents the Average Velocity of the air as it goes through the propeller disc

V_3 represents the Velocity of the air after leaving the propeller disc
ρ = The Specific Gravity of air

Then:—

Kinetic Energy inherent in WX = $\frac{1}{2}\rho AV_1^3$ . . . . . (1)

Average Velocity through propeller disc = $\frac{V_1 + V_3}{2} = V_2$ . . . . . (2)

Amount of air passing through the propeller disc = ρAV_2 . . . . . (3)

If the air enters the propeller disc with Velocity V_1 and leaves with Velocity V_3, then:—

The KE surrendered in the propeller disc = $\frac{1}{2}\rho AV_2(V_1^2 - V_3^2)$ . . . . (4)

Therefore Propeller Efficiency, η = $\frac{\text{KE Surrendered}}{\text{KE Inherent}} = \frac{\text{Equation 4}}{\text{Equation 1}}$

$$= \frac{\frac{1}{2}\rho A V_2 (V_1^2 - V_3^2)}{\frac{1}{2}\rho A V_1^3}$$

$$= \frac{V_2(V_1^2 - V_3^2)}{V_1^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

In Equation 5 substitute the value for V_2 given in Equation 2

Then $\eta = \frac{(V_1 + V_3)}{2} \times \frac{(V_1^2 - V_3^2)}{V_1^3}$

$$= \frac{1}{2V_1^3} \quad (V_1^3 - V_1V_3^2 + V_3V_1^2 - V_3^3) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

At Maximum Efficiency $\frac{d\eta}{dV_3} = 0$

Therefore, significantly $-2V_1V_3 + V_1^2 - 3V_3^2 = 0$

or $V_1^2 - 2V_1V_3 - 3V_3^2 = 0$

and $(V_1 - 3V_3)(V_1 + V_3) = 0$

Therefore when η is maximum $V_1 = 3V_3$ . . . . . (7)

In Equation 6 substitute $3V_3$ for V_1 from Equation 7

Then Maximum Efficiency = $\frac{1}{2(3V_3)^3}((3V_3)^3 - (3V_3)V_3^2 + V_3(3V_3)^2 - V_3^3)$

$$\therefore \frac{27V_3^3 - 3V_3^3 + 9V_3^3 - V_3^3}{2(27V_3^3)}$$

$$= \frac{32V_3^3}{54V_3^3} = \frac{16}{27} \simeq 60\%$$

From Equation 1 the Max Theoretical Power available = $\frac{16}{27}(\frac{1}{2}\rho V^3A)$ . . . (8)

Translating Equation 8 into concrete terms, we get:—

Max Theoretical kW available = $3AV^3 \times 10^{-6}$

When A is in ft² and V in ft/sec

The best, however, that will ever be achieved will be much less; because the above takes no account of mechanical or other losses.

APPENDIX B

DESIGN FOR A PROPELLER FOR A WINDMILL

(The following is put forward as a suggestion, not pontifically)

Consider AB (Fig 3a) which is the tip of a windmill propeller of radius 6ft.

If the blade is wrongly set as at A_1B_1 (Fig 3b) it may absorb all the KE in the wind that hits it, but it will not revolve. Equally, if it is wrongly set as at A_2B_2 it will absorb no KE from the wind, and still not revolve. But if it is set as at A_3B_3 it will be displaced by the wind (ie, it will revolve) to take up a position A_4B_4 while the wind gets from the plane A_3–A_4 to the plane B_3–B_4.

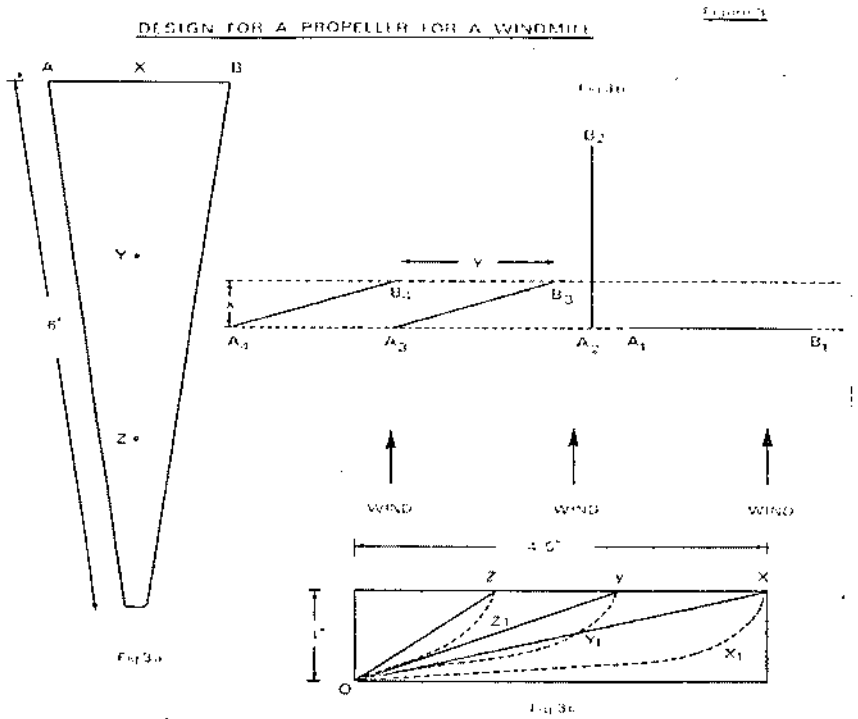


Figure 3. Deciding upon the pitch of a propeller blade.
3a. Profile of a propeller blade.
3b. The set of the blade and the movement of the wind through the propeller disc.
3c. Possible cross-sections of the blade at X, Y and Z

Therefore if x = the distance moved by a particle of air in time t secs, then y = the distance the tip of the blade will move in the same time of t secs.

We know that maximum efficiency will be achieved when the windstream emerges from the propeller disc with a velocity of $\frac{1}{3}$ × (the free wind velocity).

Therefore for max eff $\frac{x}{y} = \frac{\frac{2}{3}(29.5)\,t}{2\pi6\,(3.33)\,t} = \frac{1}{4.5}$

where Time = t secs
Windspeed = 20mph = 29.5 ft/sec
Propeller revs = 200rpm = 3.33 revs/sec

If, however a point X on the tip of the propeller moves 4.5 inches while the wind moves 1 inch, a point Y which is $\frac{2}{3}$ of the way from centre to tip of the propeller will only move $\frac{2}{3}$ × 4.5 = 3in and a point Z will only move 1.5in.

We can now design a propeller.

Take a piece of wood 6ft long with cross section 1in × 4.5in (Fig 3c)
The tip of the blade should have cross-section OXX_1
At Y the cross-section should be OYY_1
At Z the cross-section should be OZZ_1

APPENDIX C
THE BASIC MATHEMATICS OF A PANEMONE

Consider an S-type Panemone, made from an oil barrel cut in two.

If the blades X and Y (Fig 4) were both flat there would be no rotation, as the

THE PANEMONE

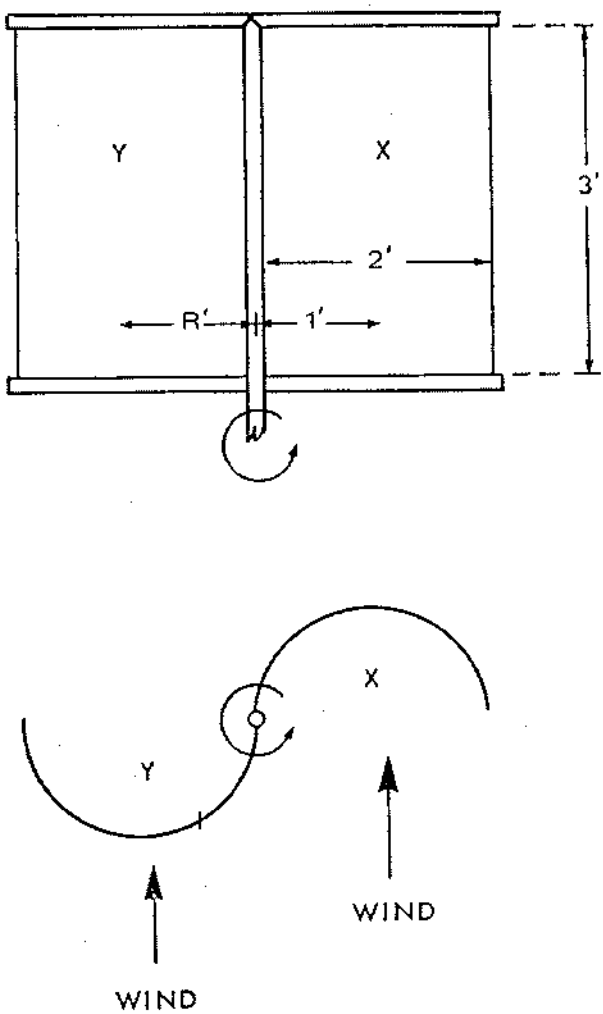


Figure 4. Plan and elevation of an S-type panemone.

Dynamic Pressure on both blades would be equal and opposite. But X presents the concave side of a half-barrel to the wind, so the Dynamic Pressure on it is 1.2* times that on a flat plate of the same size, whereas Y presents a convex face to the wind and only exerts in opposition a Dynamic Pressure equal to 0.4* times that of a flat plate of the same size. Consequently there is an effective positive Coefficient of Drag (as it is called) of $1.2 - 0.4 = 0.8$ which may be applied to the concave blade, and that blade may be considered in isolation.

It is known that a 30mph windspeed (44ft/sec) exerts a Dynamic Pressure on a flat plate = 2.3 lbf/ft².

Therefore a windspeed of 44ft/sec will exert a Resultant Dynamic Pressure on blade $X = 0.8 \times 2.3 = 1.84$lbf/ft².

Frontal Area of Blade X = 2ft × 3ft = 6ft².

Moment Arm = 1ft, but for this calculation call it "R" ft.
Therefore Initial Torque in 30mph wind = $6 \times 1.84 \times R = 11.04R$ lbf/ft

We know from Appendix B that when the aft-moving blade of the panemone attains a velocity equal to $\frac{1}{3}$ the windspeed (14.7ft/sec) the maximum output will have been achieved.

Then, Max Power = Torque × Rotational speed

$$= 11.04R \times \left(\frac{44 - 14.7}{44}\right)^2 \times \frac{14.7}{2\pi R} \text{ ft lbf/sec}$$

$$= 11.04 \times \left(\frac{29.3}{44}\right)^2 \times \frac{14.7}{2\pi} \quad \text{(The "R's" cancel out)}$$

$$= 4.89 \times 2.3$$

$$= 11.25 \text{ ft lbsf/sec}$$

$$= 0.02 \text{ HP (1HP} = 550 \text{ ft lbf/sec)} \quad \ldots\ldots\ldots (1)$$

Also, at Max Power the aft-moving blade travels at $\frac{1}{3}$ windspeed

$$= \frac{44 \times 60}{3} \text{ ft/min}$$

$$= 880 \text{ ft/min}$$

In one revolution it travels $2\pi R$ ft and as R = 1ft

$$= 2\pi \text{ ft}$$

$$\therefore \text{ RPM at Max Power} = \frac{880}{2\pi} = 140\text{rpm} \quad \ldots\ldots\ldots\ldots (2)$$

and max possible RPM = $3 \times 140 = 420$rpm $\ldots\ldots\ldots\ldots (3)$

* These coefficents must be determined empirically.

Early Days

MLC

1877 was the year of one of the Russo-Turkish conflicts, this one lasting from April 1877 until January 1878. For many this may (or may not!) be a well known page in history (as one of the Great Powers taking part in the final peace negotiations, the UK guaranteed the Turkish Asiatic frontier, "if necessary by force of arms," and gained administrative control of Cyprus in return). For those not immediately aware of these events, the January number of the 1877 *RE Journal* could have seemed daunting indeed. It mostly consisted of a long description of Montenegro. The reader is treated to every geographical and demographical detail—its lakes, mountains, geology and so on. Since there is no mention of its strategic importance or hint of how its geography might influence the military events of the times, the Editor in 1877 seems to be up to his old game of being determined to fill his publication—come what may! His apparent difficulties in this respect have been noted more than once in previous editions of these notes.

This impression is reinforced by the February issue, in which the main article is about the duties of the driver and fireman of a locomotive, "as practised on the Trunk Lines of the English Railways". Without any indication as to why it is being printed, the Journal launches into all the minutiae of what was to be expected from these indeed important people. Even to the fact that the Fireman attends principally to the boiler and the Driver ensures that his engine is properly cared for and cleaned in the shed!

The Corps has been concerned with railways—particularly with the provision of Inspectors of Railways—since their earliest days, and the subject was not exactly a new one. It would seem to be rather like publishing in today's Journal a detailed account of the duties of, say a plant operator. There were—as now—other publications dealing with such things!

The Corps was still much concerned about the form of its publications. It is, perhaps, unfair to judge the *RE Journal* of a hundred years ago by the ideas of today. In 1877 the new policy was to publish "Occasional Papers" on matters of general interest to the public, and to the civil engineer, the architect and military engineer in particular. The papers, generally on technical military/civil engineering subjects were to be published—perhaps three or four at a time—quarterly, in order to preserve topicality. However, an officer could elect to have all that year's papers bound together in one volume and sent to him annually. The *RE Journal*, on the other hand, was to remain a monthly publication of social and general "but ephemeral" interest. As far as the "Occasional Papers" were concerned, it was hoped that officers would "contribute for the benefit of the Corps at large any useful information which they may have acquired in the course of their various duties". The "Occasional Papers" were still issued under the general heading of *Professional Papers of the Corps of Royal Engineers*. In fact they still are—but only very occasionally!

Twenty four "Occasional Papers" were published in 1877. Some of them now seem very laborious but in their range of subject—from the use of pigeons in war, experiments with Portland cement, to the Strength of Besieging Armies—and in their overall professionalism, the Corps, one would judge, must have been well pleased. One of the most interesting described the very elaborate mine warfare at the siege of Sebastopol waged underground between the French and the Russians, in which many thousands of pounds of gunpowder were used and many hundreds of yards of tunnels were constructed.

This latter account was very much reflected in a major field engineering exercise carried out in June 1877 by the SME, the Royal Artillery and other troops of Chatham Garrison. This was the so called "Siege Operations at Chatham". Here the New Ravelin, built as an addition to the main Chatham Fortifications a few years before (also probably as a training project) was attacked by the construction of formal siege works, including the necessary parallels, trenches, saps and batteries. Of course the interval between successive parallels had to be much scaled down—otherwise the works were as realistic as possible. Tunnels were constructed and mines and counter mines blown. Indeed some 7,000lbs of powder were used—one charge alone being as much as 1,200lbs. After mines had been sprung to destroy the counterscarp, the main assault went in, including columns which were directed on the flanking bastions and on the St Mary's casemates, which were stormed by escalade. "Sufficient having been done for instructional purposes, and the soil having been rendered foul by camouflet, the operations were brought to a close". This must have been a memorable and hair raising exercise indeed—not the least hazard being the presence of HRH the Field Marshal Commanding in Chief (The Duke of Cambridge) at the final assault, when many of the mines were fired!

The account of Sebastopol and the Chatham siege operations brings home to the reader the enormous effort which went into the construction of fortresses (see also Brig Hamilton-Baillie's article on fixed fortifications in the March 1974 *RE Journal*) and the fact that they invariably fell to a determined besieger. One of the lessons of the Russo-Turkish War mentioned above, was that the Turks (who otherwise seem to have been incredibly inefficient in the conduct of the campaign) in the defence of Plevna "derived immense advantage from the most simple form of hasty entrenchment. Instead of being massed into the redoubts, where the men would have been slaughtered wholesale by the Russian shells, the infantry were withdrawn and placed in shelter trenches outside . . . These trenches were 3ft deep with a parapet never more than 2ft high." It was also judged that such trenches afforded far better cover than the English standard fire trench, which was 7½ft wide but only 1¼ft deep with a parapet 1¼ft high in front. "We shall probably shortly find Turkish shelter trenches superceding those at present described in our text books!"

An interesting article by the Adjutant of the Royal Monmouthshire Engineer Militia appeared in the September 1877 number. He points out that "Engineers are not made in a day and should not be lost sight of. The second line has been

provided to a certain extent by the formation of the Corps of Volunteer Engineers, and more recently by the conversion of two Regiments of Infantry Militia into Engineer Militia". These two latter Regiments were the Royal Monmouthshire Light Infantry and the Royal Anglesea. Incidentally, a poem published in the June issue to celebrate this conversion has a refrain on the theme "For I must have done something or other horribly wrong I fear, To find myself at my time of life, turned into an Engineer."!

Captain Mackworth, the Adjutant, is at pains to point out that the "Volunteers are far too keen on social status, the private Volunteer (often a master tradesman) and his officer both coming from the same station in life—a class which would spring in horror from the barrack life of a regular soldier. The militia privates, on the other hand, were of the class and type most needed as potential volunteers for the Corps". The Volunteers, he goes on, do not set out to be a second line as well as a peace time nursery for the Corps—it was only the Militia who volunteered freely for the ranks of the regular army in peace.

A correspondent in a latter issue was quick to disagree. Even to the extent that many men in the Militia could not understand English (only Welsh) and beyond making their mark could not read or write, while the Volunteers (with very few exceptions!) could manage both. The Militia were thus not the sort required as regular Sappers.

The Editor published what must have been three eagerly read notes for those being posted to various stations (in this case Gibraltar, Bermuda and St Helena). Those going to Gibraltar are warned that a local groom would need some supervision "not having a very acute perception of meum and teum", while at St Helena "the gay young subaltern will probably find his heart gone before he has been a week on the Island".

The December issue has an interesting tip on how to get on in the Army—or at least in the Corps! A small paragraph records that a very fine engraving had been produced at the SME of Major General the Hon John Armstrong Esq, who was the Chief Engineer of England and Surveyor General of HM Ordnance in the reign of George II. Armstrong lived in the days when the highest Staff appointments were open to Engineers. He was also QMG, "all of which is clearly inscribed below the portrait".

"This portrait appropriately framed", the notice goes on, "will not only be an ornament to any officer's quarters, but will serve to make the above more generally known, and to remind the world in general that what has been, may be." And all this for 1/-!

Armstrong, Rommel, Montgomery—who knows where the display of the right photographs may not lead—even if they do now cost more than 1/-!

Into the Sappers from School

SECOND LIEUTENANT J B OLLEY RE

I LEFT school in December 1974 with no specialist knowledge, little military knowledge and no practical experience. This article endeavours to trace the first two years of my efforts to rectify this.

Shortly after leaving school, I spent three weeks at RMA Sandhurst and one week at RSME Chatham and arrived at 39 Engineer Regiment (Airfields), Waterbeach, for the start of a six months attachment on a Short Service Limited Commission with 52 Field Squadron (Airfields) before going to University later that year. Prior to Sandhurst my only military experience, apart from a slightly military colonial background, consisted of eighteen months in the school cadet RAF section, the majority of which time was spent gliding.

The week at RSME had successfully increased my knowledge of BAOR, but 39

Engineer Regiment is a specialist airfields unit and I was completely without any specialist training. My first lesson in administrative procedure was connected with the issuing of stores. I learned how unwise it was not to check carefully before signing for them. Also, within a few weeks of arrival at Waterbeach, I ran out of petrol in a rather ancient and unfamiliar car I was using at the time. It seemed logical to obtain a gallon of fuel from the nearest source. I was surprisingly lucky, I thought, in choosing exactly the right place to stop, next to a petrol pump I had seen being used earlier that morning. I was most surprised by the reaction of those manning the pump, a mixture of bewilderment and mild amusement to what I thought was a perfectly serious request for fuel. It had occurred to me that the issuing system at a POL point would not cater for wayward subalterns out of petrol, and I was very disappointed when I discovered that I would have to find an alternative source of fuel. Within a few days the incident seemed to have waned a little in popularity as a source of amusement in the Mess, and I was given my first chance of command.

The task was providing a raft to float down a river for a local school to use as a base for their display in a historical pageant. Four assault boats and Bailey chesses were chosen for the project, and a practice date was decided. The boats arrived on a flat bed Bedford lorry, stacked one on top of each other. Fortunately the unloading procedure had been covered in one of the many training films I had seen at RSME Chatham, although it had only dealt with a single boat. Having been told of the assault boat's reputation for being sturdy, I felt confident enough to handle the situation, without referring to any of the experienced SNCOs in the area. I arranged for the boats to be attached to the nearest rigid object, had them released from the flatbed and ordered the driver to drive slowly forward. Unfortunately the combination of the whole operation being conducted on a slightly sloping area on concrete, and there being four boats instead of the one shown in the film, meant that the boats landed rather more heavily than expected. Luckily, despite some damage they could still float and the operation proved to be a success—if somewhat expensive in terms of repairs, later.

The next few months were occupied by a trip to Scotland to erect a temporary hangar for Phantoms at RAF Kinloss, and a fortnight's military training camp on the Isle of Man on attachment to the unit's REME Workshop, during which time I had a chance to let some others profit from the knowledge I had amassed during my three weeks at Sandhurst. The first opportunity was on the subject of radio procedure. For the first time I felt useful in being able to instruct personnel and arrange exercises. In these we could all benefit from coming into contact, on the same net, with the more experienced operators.

On returning from the Isle of Man there was just enough time to complete a troop hand-over before training began for operation "Safe Haven" in Gibraltar, 52 Field Squadron (Airfields) was acting in support of the Property Services Agency (DOE), resurfacing sports fields and setting up and converting buildings to service accommodation. The conversions consisted of a miniature range which was basically four walls and a roof, and an old school which was slightly more substantial.

On arrival in Gibraltar, we first cleared the sites and prepared the buildings. For the miniature range this meant removing the roof and purlins, all of which were beyond repair, and knocking holes in the walls for doors and windows. As a result after a fortnight's work a passerby could have been forgiven for thinking that we were demolishing, not converting. It was only then that it was possible really to see what needed to be done and the enormity of the job could be fully appreciated. That nothing had been constructed up till that point meant that the conversions appeared to present an even greater challenge than they had at first. In addition to this the initial enthusiasm had dampened, and the troop no longer had the novelty of a new routine.

The nature of the work necessitated daily conferences for planning and tasking especially later in the project when any hold-ups in the supply of stores would have

been disastrous in terms of lost man-hours. It was realized at an early stage that time would be at a premium, with very little for recreation. It was not possible to fit in any leave. Some of the equipment hired from civilian contractors was only available at weekends. This did not help in keeping to a slightly optimistic cascade plan. The conversions progressed uneventfully—the main problem being excessive heat, and delays in the supply of stores. The miniature range was located in a sun trap beneath a limestone cliff face and work for any length of time in the open, especially on the roofing, was difficult. The supply of stores by the Property Services Agency was a critical factor but, once established, the demand and issuing system ran smoothly. However extra care was needed because access to the site was difficult, and there was virtually no storage area available on site to maintain a reserve of stores. Setbacks and unforeseen difficulties arose. The task therefore had to be re-programmed with zero float after the first month leaving just over two months of the project remaining. Of this I could only spend a month in Gibraltar before returning to the United Kingdom to start my university course. Handing over the sites before completion was a disappointment in many ways although I was thankful for the experience I had already gained.

My Civil Engineering course started shortly after returning from Gibraltar. It was a pleasant surprise to find a thriving Officer Training Corps (TAVR) unit within walking distance of the university grounds in Nottingham. There I could continue my military training, in enthusiastic and lively surroundings. This also meant that I would have a greater chance of being able to take the Territorial Army Certificate of Military Training, with subsequent advantages on my return to Sandhurst after the three year university course. I decided to concentrate on this in the first year, so that I would have the remaining two years to benefit more from the other aspects of university life.

By the end of June 1976 University annual exams were finished and the prospect of a comparatively unacademic period of three months stretched ahead. Once again I arrived at Waterbeach, this time to join 53 Field Squadron (Airfields) on Exercise "Waterleap 76" in Canada. Within a few hours the previous nine months had dwindled into insignificance. With less than a week until the main body was scheduled to move there was little for me to do but reap the benefits of someone else's good administration, and familiarize myself with the members of the Squadron and the task ahead.

On landing in Ottawa the spaciousness and apparently inefficient use of ground, even in the city, was in stark contrast to arriving in Gibraltar the year before. An all-pervading feeling of anticipation was prominent, as was a desire finally to start after all the preparation. This must have been felt even more by others, as I had missed the vast majority of the pre-exercise planning and training. Despite this, a chance to look around and inspect the areas where the Squadron was going to be working for the next few months was welcomed as an opportunity to put the task at hand into perspective.

The majority of the unit was to be employed on the construction of a 5½ mile stretch of a road in a Canadian forces training area. The reconnaissance photographs could not possibly have done justice to the terrain through which the road was passing. Solid bedrock outcrops intermingled with swamps and the occasional stream for the length of the alignment. The remainder of the Squadron was tasked with the construction of a recreation area, including a beachside building by the Ottowa river. Although this task was less daunting it was probably of more importance to the Canadians in the area, who would benefit directly from its construction. Deployment was as far as possible on a troop basis, as in Gibraltar, with three troops on three different sections of the road and one on the beach hut area. Various other groups such as the surveyors were in less well defined areas. It was here, in the surveying and setting out of the road formation, that I had a chance to put into practice some of the theory I had been learning over the last nine months at university. In addition it put me in a position where I could view the progress of the construction troops

objectively, without being too involved.

The work was quite obviously very different from that encountered in Gibraltar. The project was linear, and transport and communications were of prime importance. The seemingly inexhaustible supply of jeeps and ¼ ton vehicles, the majority of which were over twenty years old, very rapidly proved to be barely sufficient, especially as the rough terrain began to take its toll. The radio net was very useful for both communications and for training in voice procedure. It made a refreshing change to be actually using a net instead of passing text book messages.

Within a few days of arrival a noticeable impression could be seen to have been made on the road, and this had a significant effect on morale. Good preparation before arrival meant that work on pushing the formation through could be started almost immediately. Driving back each night along the road that had just been built generally ended the day on a high note.

The Squadron seemed to retain its identity very well especially considering the relative isolation of the individual sites, the shift work, and the small number of chances to collect the unit together. The weekly conferences and occasional military training days helped this sense of unity. So also did the frequent games with the local Canadian teams, varying from "broomball" played on ice without skates using a stiff broom, to cricket, rugby and baseball.

As the exercise progressed the pressure on the surveyors eased and I found myself in the project office for a short spell, looking behind the scenes, being involved in the sort of jobs that I had rather taken for granted before.

Several chances to visit the Montreal games had already arisen, which together with the possibility of leave, contributed to maintaining the high morale. The Canadians were particularly generous with indulgence flights, and the chance to see the United States was very welcome.

On returning I was lucky enough to be with the Squadron at a time when there was a troop commander shortage, so once again I was out on the road. I very rapidly became aware of the large gap in my knowledge of plant. Neither the work in Gibraltar nor the various small projects I had been involved in during my stay with 39 Engineer Regiment (Airfields) prior to going to Gibraltar, had necessitated the use of much heavy machinery. Overall equipment deployment was dealt with at project office level, but the diversity of the jobs on each site meant that there was some flexibility in tasking within each troop allocation. The extreme conditions prevalent meant that it was easy to over-estimate the capabilities of the machines, especially the smaller pieces of plant. Equally, towards the end of the exercise, when tasks such as landscaping and ditching began to feature more, it was difficult to exploit the potential of the larger machines to the full.

It soon became obvious that because the work was largely plant orientated, it was costly in terms of work output to find a place for the more inexperienced operators on pieces of equipment. A conscious effort had to be made to try to employ them as much as possible on non-critical tasks, while still allowing them the experience they should have been getting in the situation. This was in direct contrast to Gibraltar where work was very much more orientated to craftsmen, so even the most inexperienced were, by necessity, finding that they had to use their skills to the full. As before, a good troop sergeant proved invaluable in knowing the capabilities of the men, and also of the plant. I found this particularly helpful.

The exercise rapidly drew to a close with only relatively minor tasks being carried out, such as completing the surfacing of the road and landscaping. We also attempted to finish, once and for all, the continual war being waged with the local beaver population against their efforts to maintain the water level in their dams by halting the smooth flow of water through our culverts. Regrettably, despite digging out and eventually blasting, the beaver dams still stood, although thankfully, not in vital positions. So perhaps we shared the victory! Spare time available after the construction of the beach building was put to good use by building an extra squash court in the camp gymnasium. Returning to England I was just in time to start the second

year of the university course.

During the past two years since leaving school I have had many opportunities to learn, both from academic theory and practical experience. I have been faced with an exciting variety of challenges and have been placed in many different situations. In today's technical army there is much to learn. When one task has been mastered the situation is changed and a totally fresh set of circumstances open up new challenges and perspectives. Particularly in the Royal Engineers the ground rules can be changed not only in terms of continents, but also in local situations. There is no substitute for experience.

It was once said that "a day is a long time in politics". Two years employed partly in the Royal Engineers and partly at University is not very long at all.

Joint Professional Meeting

Recent Developments in Construction Plant

MR DEREK WELSH, Plant and Service Manager UK of John Laing Ltd, and Lieut-Colonel R B Downs RE, MICE, FI Plant E, Chief Instructor PRA Wing RSME, presented a joint paper on Recent Developments in Construction Plant to a Joint Meeting of the Institution of Royal Engineers and the Kent Branch of the Institution of Civil Engineers at Chattenden Study Centre on 8 March 1977. Some 150 attended including some wives.

Mr Welsh, in introducing the subject, emphasized that developments were the result of a number of factors; higher productivity, higher efficiency, accuracy in operation, safety regulations, better materials and technology, operator availability and flexibility, transportability, to make the role of the operator less arduous and environmental restrictions.

He concentrated his remarks on two areas, the part played by hydraulics development in improving civil engineering plant and improvements in concrete paving equipment. After comparing the performance of steam, cable and hydraulic excavation equipment through the years he opined that developments in hydraulic telescopic cranes of the tower variety would find favour with contractors in the future. He developed this theme using the Canadian GCL 5400, a 30 ton telescopic crane on top of a self elevating lattice tower, as his vehicle. It is a very impressive piece of hardware. On modern paving equipment he emphasized that superb equipment was already available but could not be used efficiently in UK largely because of restrictions of specification.

Colonel Downs explained that wherever possible the Corps used "civilian" construction plant for exactly the same reasons as any contractor. Because the military engineer had a combat role there were areas where the Corps required plant specifically designed for its own purpose. He concentrated his remarks on unconventional plant and drew attention to three particular equipments, the Light Mobile Digger, (an example of a virtually standard piece of civilian equipment mounted on a virtually standard MOD vehicle in an unorthodox way to satisfy a particular requirement), the M2 Amphibious Bridge (a true military special designed for speed of erection with minimum manpower), and the Combat Engineer tractor which in effect was a maid of all work in the combat zone. It performed the task of civilian tractors plus a range of military tasks and at the same time protected its crew and had tremendous mobility over quite appalling terrain.

Following the excellent presentations the formal discussion was a little disappointing. This could not be said of the informal discussion which continued in the Chattenden Mess.

Three Weeks to La Panne
A Diary of 1940-Part 3 and Last

LIEUT-COLONEL R L CLARKE, MA, C Eng, FI Mech E, FIEE, FI Prod E, MIWM, MInst MC

PART 1 and 2 of this diary took the reader from 9 May to 27 May 1940. In this final part the withdrawal into the Nieuport-Dunkirk area is about to begin:

Monday 27 May (continued)

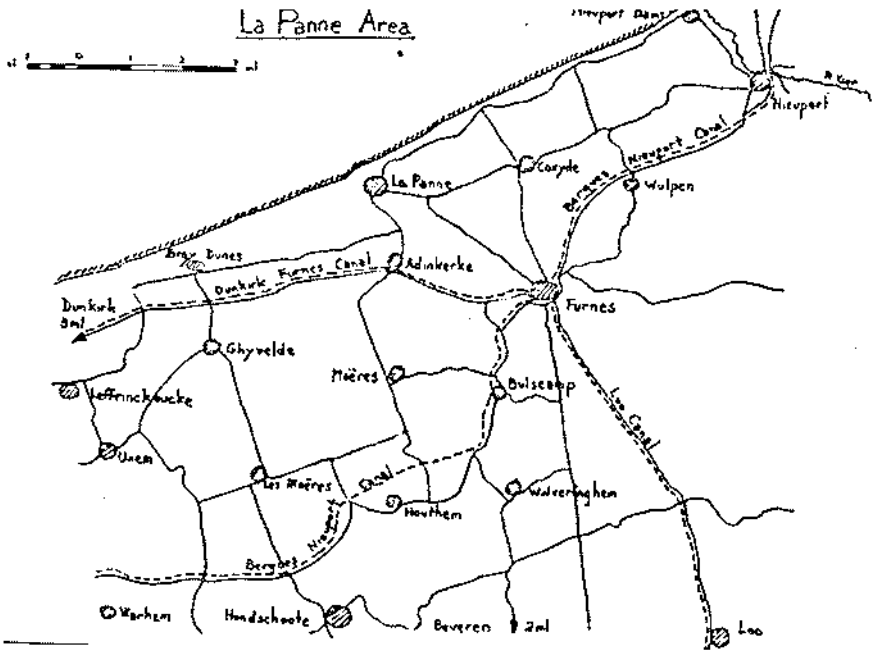
The BEF is withdrawing into the area Nieuport-Dunkirk and the bridges across the Nieuport-Bergues canal have to be prepared for demolition. We have no one inch maps of the area so borrow one each from the limited Corps stock. We decide to divide the bridges between us; I am to take inclusive from Furnes to the railway bridge halfway to Hondschoote. I study the map with the doctor and choose for our destination a wooded area near Adinkerke about the middle of our sector. He sets off in the Snipe with Graham on his motorcycle having fixed a road junction as rendezvous. I bring on the section as soon as it has packed up, taking the main road to Furnes which is not overcrowded.

I am pleased at the sight of a line of Belgian troops in overcoats digging in. "Are you digging an anti-tank ditch?" asks Sauervein. "No, m'sieur", replies the sentry, "We are building a railway". Hoogstade is deserted. As we turn left down the street I see a provisions shop with the door swinging upon, and rubbish on the pavement. Inside it has been ransacked. Piles of tins have been pulled off the shelves and out of the drawers, many without labels. We may need these. I bundle the lot into the back of my truck.

The road to Furnes is long and straight, running through open fields. On our left a Bofors AA Gun suddenly opens up and I see a flight of Messerschmidt 109 fighters flying low towards us. As soon as they have passed overhead the leading aircraft peels away and comes screaming down. Regulations require that under air attack a convoy should proceed as if nothing were happening. In practice every vehicle has stopped and every man is lying flat in the field before the first guns start ripping. The Messerschmidts sweep over one after the other, jerking and swerving as though they are thoroughly enjoying it. The Bofors keeps firing; I keep praying. Then they are gone. Sheepishly we walk back to our trucks; they are still there. There are no casualties either. They must have been firing blanks. We drive on.

At Furnes there is a Belgian guard on the bridge but it does not look to have been prepared for demolition. I turn left along the tarmac road which leads along the south side of the canal to Dunkirk. Graham is waiting at the road junction. He leads us up a side road to the left where we stop to wait for the doctor. There is no air cover and plenty of aircraft about so I tell the section to leave the vehicles and get inside an old first-world war German pillbox in the field alongside. When we are inside, the RSM asks me to tell the section what is happening. "Mr Galloway", he says, "has told his section that the whole Royal Navy is lying off the beaches ready to take us off". I tell them what I know which is not much. "Watch it Sir", says a voice, "There's some civilians in here with us". At this moment the doctor arrives. He leads us down the road, turns right across a wooden bridge, then by grass track across a field to a wood. Inside the wood there is a large white house and a couple of empty huts. It seems perfect and nobody is there.

We are within a few yards of the Furnes-Dunkirk road having come round into the estate the back way. I tell the section to dig slit trenches and get the cooks offloaded into one of the huts. Coming back I find that the trenches have not been started and there is some grumbling. The RSM says the men are tired. There is a noise of machine guns close outside the wood, and a high-winged monoplane with British markings, a Lysander, flies down the road gunning the transport. From now



on all aircraft are treated as hostile. When I look round the trenches have been dug.

I explore the house. It is empty and ransacked. Rummage is piled in every room and the lavatories are clogged; no water. There is a grand piano, rather out of tune. The batmen clear out a small room and erect our camp beds. The doctor feels the need for fresh bread so we set off on a shopping expedition leaving the section resting. There is nothing in Adinkerke. The frontier post beyond is deserted. Ahead a column of smoke fills the sky and stretches back over our heads. As we reach the Bray crossroads we hear a dull booming overhead and decide to observe events from the ditch. We can see bombers weaving in and out of the smoke clouds ahead, the sparkle of heavy AA bursts and the red five-bead strings of light AA curling slowly upwards. Over all the thunder comes the continuous whistle of falling bombs.

We decide against the fresh bread and enjoy a pleasant late dinner of Camembert and tinned lobster.

Tuesday 28th May

Paul Hodgson arrives in the shooting brake with news. The Div RE have counter-attacked with the bayonet at Warneton and Macdonald is missing believed killed. Gus Galloway has to take over from him so I am to look after the 59 Fd Coy HQ Section. We have fallen back and are occupying the left of the perimeter and Div HQ is at Coxyde. I am to stay where I am and carry on preparing the bridges I have allotted myself, while 7 Fd Coy take over those on the other side of Furnes. I am to do the work tomorrow morning; there is an ammunition point near Les Moëres. Any spare effort I must put into collecting barbed wire from the hedgerows and any picks and shovels I can find. 18 Fd Park Coy will send a lorry. He does not want any tinned caviare.

Soon after he has gone, 59 Fd Coy HQ Section move in bringing with them a wounded man who groans in a corner of the hut under the doctors supervision. I divide the sections up into search parties and set off on my reconnaissance. I soon run into trouble. At Furnes when I examine the bridge a jumpy Belgian officer asks me what I am doing. When I tell him he pats his revolver and says that this is a Belgian Bridge and is not to be blown up by the British. I leave immediately and go to find

the Town Major. He says that liaison is tricky but he will try to sort it out. It is very quiet, and a shot rings out from across the canal. I lower the windscreen of the 8cwt truck and rest the Bren gun on the bonnet. Round the corner is a group of soldiers, John Osborne with a party from 225 Fd Coy. I warn him about the Belgian.

Set off driving along the towpath. First comes a lattice girder foot bridge; 20lbs of guncotton should settle that. Then comes a steep old single arch masonry bridge which will need ammonal. There are about twelve bridges including the steel girder railway bridge at the end. I am looking at the last when the Chief Engineer, Brigadier Phipps, drives up with Major Boggs, both calm and cheerful. They are pleased to see that things are happening. Boggs gives me specific advice about the ammunition point. While we are talking a formation of bombers flies over towards Dunkirk so we lie down on a grassy bank. I find the ammunition point in the form of boxes dumped for a mile or so along the verges of a road with nobody in charge. Just help myself to guncotton, ammonal and accessories in liberal quantities.

Back at the section a lot of material has been brought in and the CSM of 59 Fd Coy has been a tower of strength. A lorry load has already been collected. We are no longer alone. An infantry battalion wearing red hackles has occupied the field, and in our house there is a brigade HQ. The mess staff have made a very good job of clearing the dining room, and have laid the table for dinner. After I have called on the brigade major I work out my plans for tomorrow. There is nobody in either section who knows anything about demolitions so I allocate a party under an NCO for each bridge and will just have to tell them what to do. I give a short lecture on demolition equipment in the hut, and send them off to bed to be ready for an early start.

Wednesday 29th May

We set off at 0500 hrs in three vehicles. At Furnes I arrange for Bourner to cover me with the Bren gun in case the Belgian is still there. But the bridge has already been prepared for demolition and a party from 225 Fd Coy is standing by.

We stop at each bridge and I drop off the demolition party and the explosives, briefing the NCO on what to do. This takes time but nothing can go wrong. It is mid-morning before we reach the last bridge. Being a railway bridge the only wheeled access to it is by the road which here runs on the wrong side of the canal and upon which German troops might appear at any time. How am I going to get the demolition party away? Fortunately on my way back I find an abandoned Renault car in working order which I leave with them. I work up the bridges again from Furnes to see how preparations are progressing. While giving a hand to excavate an abutment a party of Belgian troops marches up the road towards the enemy carrying a white flag to the jeers of the British. There is a small wooden bridge for which I have no NCO so I set alight to it and am duly rebuked by Brigadier Phipps who arrives at that moment for attracting the attention of the enemy. No burning is to be permitted.

Once the preparations are complete I leave an NCO and one man on each bridge as firing party with orders to fire and withdraw if the bridge is in danger of capture by the enemy. Assure them I will send out rations, but before I have to do so the bridges are taken over by 225 Fd Coy and I pick my parties up. The sector is now humming with activity. There is not enough room for a whole army's transport. In a field an RASC unit is having a splendid time lining up its lorries along a drainage canal and knocking them in one by one. A column of thick-armoured French tanks with tiny guns stands deserted along the verge. The Cameronians have moved into our wood. We have collected a large pile of wire and shovels which no lorry has been recently to collect. Have we been forgotten? We entertain a stray Pay Corps officer to dinner, and afterwards I set off on my motor cycle to report to the CRE. It is now dark and I stop to ask the way of a military policeman. His hand clamps like a vice onto my shoulder, and then relaxes. "Christ, Sir; thought you were a Jerry!" After a long search around Coxyde I find Colonel Coxwell-Rogers up a dark flight of stairs and he welcomes me with courtesy. I am to keep my section in the wood and the stores will be collected. The Division will be withdrawing from the perimeter for

embarkation in the next day or two and the HQ Section of 59 Fd Coy will revert to its own command. It will be wise to stay away from the beaches as long as possible. Back to the wood in the small hours.

Thursday 30th May

All quiet in the morning. Our infantry neighbours have left in the night. The doctor goes off with the wounded man. HQ 59 Fd Coy pull out.

By midday no lorry has arrived to pick up the material so I send Leeming off to find the CRE. He comes back two hours later to say that he can find nothing and nobody in Coxyde. Outside the wood everybody has gone. The countryside is silent and empty except for all sorts of abandoned vehicles. I decide to get ready to move. Destroy three of our trucks including the office truck, burn papers discreetly, put on my best service dress and boots, pocket my razor and toothbrush and throw the rest of my things with the stores down a pit in the wood. Load the food, ammunition and weapons into the remaining two trucks and the Humber Snipe, and marshal them so we can pull out at a moments notice. The doctor arrives, a welcome sight, to say that 4 Div HQ has moved to La Panne but we are definitely not going to embark tonight. Sauervein is to report immediately to the French Liaison Mission.

We relax and offload for supper. I tell the section we shall not be moving that night, but set off on a motor cycle afterwards for La Panne to prospect. I find the CRE in a house on the front. While I am there a message comes through from G Branch about embarking the following night. The sea is calm and the tide is falling revealing a long sandy beach. In the mist offshore the dark shapes of ships can be seen, blue lights winking from mastheads. Outside I run into Brigadier Phipps. He tells me that the II Corps engineers are to act under his orders to embark the Corps. I am to move my section down to the beach bringing all floating equipment possible. Back to the wood by midnight.

Friday 31st May

Move off before dawn, leaving the wood which has served us so well and cross the canal bridge at Adinkerke, prepared for demolition by 48 Div RE. There is a lorry on fire in the road but we can squeeze past. An embarkation office has been set up at the entrance to La Panne where tickets are being handed out for the beach. As sappers we are waved past; nobody pays any attention to the tickets. I turn along a sandy road running parallel to the beach. On my right is waste ground, on my left a line of houses standing on higher ground which slopes down to the beach beyond. I find an empty one without difficulty for the section, off load the food and cooks gear and park the transport opposite.

It is a fine windy morning with sand blowing along the beach. The sea is rough. No ships are visible. A party is trying to launch a boat through the breakers but it overturns. There are several boats lying at the waters edge without oars. A pier made out of lorries parked alongside one another stretches down towards the sea. Beyond there is a light AA Bofors, about half a mile up the beach. The beach is almost empty but groups of people stand around by the houses chatting. Having reported I find a warm place by a sand dune and go to sleep.

I am aroused by the arrival of Brigadier Phipps and Lieut-Colonel Le Sueur, now CRE 5 Div and formerly OC 7 Fd Coy. A second pier is to be built but no more boats are to be launched until dark. Some folding boat equipment will shortly be arriving. Meanwhile I am to search for "runner" lorries which are difficult to find because of the rule about not bringing transport back. I set off in the Snipe with Smith driving. Aircraft are beginning to appear in ones and twos but are met with such a terrific Bofors and small arms fire that they veer off. Even Smith has his rifle out as soon as we stop, taking pot shots but a long way behind. I show him how to follow through. Two aircraft are brought down, to great cheers from the sand dunes, one in flames, the other into the sea. It is quite a social gathering now that everybody seems to have arrived, CREs Harrison and Coxwell-Rogers, with Gillespie, Hodgson, Galloway, Tubby White and Derek Curtis. It is amusing to see the French Liaison Officers crouched in a row in a slit trench they have dug and wearing their tin hats.

Their trench is near an access road onto the beach. Across the road there is a small house where a military police post has been established. I am standing on the pavement near a glass grating, about to ask Sauervein what he thinks he is chasing down that hole when there is a mumbling which rises to a roaring whistle. I throw myself flat into a depression in the sand. . . . Dizzy with concussion I look at the grating where the glass is all shattered and conclude that the bomb has gone down there. Across the road smoke is rising from the shattered police post and people are being helped out.

Is the section all right? I find them comfortably settled in the billet. The cooks are handing out cups of tea. We shall not need the transport again now so I get Corporal Wilkinson to drain out the oil and run the engines hard. One by one they seize up, but I keep the Snipe intact for emergencies locking it up with the imprest box in the back.

The second pier of vehicles has now been built and the Corps Fd Park Coy arrives with its folding boat equipment and decking lorries. As soon as the mens dinners are finished I get them out onto the beach offloading decking and lashing it onto the tops of the lorries to make a continuous footway. It has to be tied very firmly to resist the breakers when the tide comes up.

Rumour comes that the CRE has been killed. "Oh My God!" says Graham, but his face lightens for a moment on hearing that it is some other CRE. It is in fact Le Sueur. He, Hodgson and Galloway were talking together on the beach when another bomb from the same stick as mine killed all three. Tubby White was wounded. Now it is not fun anymore.

Bill Hedley brings out a section of 225 Fd Coy to help with the lashing down, but we are beginning to run short of decking so I walk off along the waterline to see if there is anything useful among the flotsam. There is a young soldier floating face downwards in the surf. I pull him out and try artificial respiration but he is cold as ice and I am wasting my time. Take one identity disc and his paybook to send in.

It is mid-afternoon when I get back to the piers. At the end of the beach towards Nieuport an observation balloon can clearly be seen. It must be German because shelling starts at about 1600 hrs, falling several hundred yards away near the Bofors gun. Bill Hedley goes off to search for boats and oars while I carry on with the lashing down. By 1700 I look round and I find am working alone with Bourner, so I go back to the billet where I find the section sitting. The RSM says they have come in for tea, but the billy-can is still cold. I get them out again grumbling; they can have tea when the job is finished which should not be long.

By 1800 hrs we have used up all the decking and all the lashings, and the shelling has come too close to be comfortable. There is not a soul in sight, still no ships, no boats, but at least the wind has dropped. There is a lot of junk near the sandhills which I prefer not to look at too closely. Embarkation from La Panne seems like a wild dream. The section settle down to sleep after their tea. It is getting dark and the billet is illuminated by the flickering light from a burning lorry in the street outside. Small arms ammunition keeps popping off. Open the last tin of lobster and chat with Bourner. Gloom. Go to check up on the Snipe as a possible getaway vehicle, but find that somebody has broken a window and stolen the imprest box. More gloom. Have a short nap.

When I awake I feel much better. The shelling has stopped and the sea is glassy calm. The dark shapes of several ships look to be within swimming distance. The tide has risen and nicely submerged the bottoms of the piers where folding boats have magically appeared. I hardly reach the embarkation point before a line of troops starts moving silently down from the sandhills, stopping and starting again as the boats get away to the ships. There is a stove-in dinghy at high water mark in which I stand making encouraging remarks to people I know as they load up to the gunwales and splash off into the darkness. There goes 12 Brigade HQ. Now comes the HQRE section led by the doctor; they have not had a single casualty under my charge so now I can relax. Feeling the need of a good clean-up I walk up the beach to the

houses where I meet John Hanson of 59 Fd Coy bound on a similar errand. We walk into a pitch black house and find ourselves in a big echoing room. From the corner comes the sound of groaning. A Belgian lad is lying on a bed and we ask if we can do anything to help him. He wants a glass of water. He has been hit in the back by a splinter and this is a hospital but the staff got frightened and ran away leaving him alone. I bring him water and wish him luck.

Back at the piers embarkation is still proceeding, but more slowly. Several officers are running about efficiently giving orders and gathering in stray boats. There is nothing I can add so I curl up in my dinghy and have a nap. When I feel better I stand up and find that embarkation has stopped. There are a few small groups at the waters edge but the orderly queue has withdrawn. There are apparently no more boats. Some folding boats have been stove in on the superstructure of the lorry piers; others have been abandoned by their crews at the ship and washed along the coast without oars. Shortly after midnight shelling begins again, this time on the houses which are soon merrily ablaze. The tide is falling fast; offshore the ships are still standing by, their blue masthead lights winking.

A powered whaler appears with a naval coxswain. We hold it clear of the lorries. He asks what is happening and why people have stopped coming. When he hears there are no more boats he is surprised and says he will pass the news on. He takes on a full load and roars away into the darkness. Ten minutes later he is back for another lot of people, but drives the whaler onto the beach and sticks fast. We all push to no avail. "Christ," he says "What's the petty officer going to say now?" The tide is now clear of the bottom of the pier and the whaler is high and dry. I walk round the end and come across Jake Calvert with a remnant of 59 Fd Coy. We discuss what to do. I think of the Snipe, look up at the blazing town and reckon that the outlook is not *that* bad. In an hour or two La Panne will be outside the perimeter so there is no future in staying here. We gather up the group and move along the beach towards Bray Dunes keeping as close to the water as we can away from the light of the fires.

The ships are still lying off the beach, but will have to pull back before first light.

Saturday 1st June

Another group joins us led by an officer with a flashlight. Some way along there is a ship lying close in and somebody suggests signalling for help. It works. There is an answering signal from the deck and within a few minutes a boat appears in the surf. This time we hold it well out and make people wade waist deep. A rough queue is formed and the whole party is embarked in three trips. Nobody breaks queue and one officer goes with each boatload. Kind hands help us up the companion way of a minesweeper and give us hot cocoa. They take away my uniform to dry it and I collapse exhausted on the floor of the wardroom. I hear vaguely through my dreams the diving of a Stuka and the shout "They've got Grasshopper!"

When I wake it is light and I look outside; we are still horribly close inshore, engaged in pulling a destroyer off the sand. Rumour comes that we have been ordered to proceed to Dunkirk. I am woken up next by people pouring into the wardroom. We are alongside a mole packed with troops wearing French helmets. At last we put to sea to the accompaniment of five bomb crashes and the deafening noise of the ships anti-aircraft cannons firing above our heads.

At Sheerness I am given back my uniform nearly dry, minus my silver cigarette case and wallet—without money I cannot make my way home and have to deliver myself to the troop train. We are given a very welcome lunch at the naval barracks but I feel somewhat ill-dressed covered in tar. The RTO gives us cards to write our telegraph messages on, but in the event they are sent by post which causes my family some anxiety.

In the train the DADMS says that to win back what we have lost will take many years of bitter fighting. We feel ashamed of our "also-ran" performance, but are much moved by the sight of every road, as we come into London, packed with cheering people waving Union Jacks as if we had won a splendid victory.

It could be that these people are worth fighting for.

Documents of Historical Interest

THE Royal Engineers Bureau of Archives, housed with the Royal Engineer Library at Chatham, holds records of important events in the life of the Corps as well as official reports of projects undertaken or planned. It is intended that the Archives should be comprehensive, but there are gaps in the records, both from the period before the Archives were opened in July 1969 and afterward, where copies of the relevant documents have not been sent to the Archives.

Private individuals often hold documents, maps, drawings or photographs of historical interest without realizing that information is lacking in the Archives on the event in question. Anyone holding such material, who feels that it might be of interest—even if only dealing with one aspect of an event—is invited to offer it to the Archives. If found suitable, it could either be accepted as original material, or be photo-copied and returned.

Some examples of material which has been offered and accepted into the Archives are:

Correspondence relating to the North Russia Relief Force (1919)

File of correspondence relating to "Hedgehog" obstacle for defence against seaborne landings (1946–49)

Exchange of letters concerning Operation "Crown" (1966–69)

Booklet describing the organization and functions of 24 Fd Sqn RE (1972)

An example of a document which is not held in the Archives, and of which copies are sought by the Librarian, is the series of CRE 1 Commonwealth Division Liaison Letters during the period 1951 to 1954 in Korea. There were at least ten of these Liaison Letters, but only one—No 6— is held in the Archives.

Offers or enquiries, listing the documents held, should be sent to: The Librarian, RE Library, Brompton Barracks, Chatham, Kent ME4 4UG.

Correspondence

Major R M Stancombe RE
Engineer-in-Chief's Recruiting Liaison Officer
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EXERCISE MIRZA 2

Sir,—I received a letter the other day from Amadi in Southern Sudan. It was from a colleague of mine whom I had met during Exercise Mirza 2, the reconstruction of Mundri Bridge by 11 Field Squadron during the Spring of 1975. My article in the RE Journal June 1976 described the project.

The letter was an excellent report on conditions in Southern Sudan nearly two years after the Squadron had departed. I will quote from it verbatim. "I came out last month and have been at Amadi for the last five weeks, evaluating progress and advising on the present and the future. As you can imagine it is a rather slow and tedious process, interrupted by public holidays—Unity Day (3 days!) held in Juba this year, Port Sudan last year, next year? We have not yet had a report on how things went as there was a week's travel bar. I hope to fly out to Juba tomorrow and avoid the long, hot dusty run to Juba on the road you remember, but which has had no attention since you left. However, the stretch from Amadi landing strip to Mundri is a mute tribute to your efforts as, though it also has had no work done on it since you left, the grading and drainage have lasted surprisingly well. The bridge is fine and most people have forgotten what it was like before the RE took over. That is with the exception of Canon Ezra and similar types who obviously wish you were still here. So do I, very much, as you chaps could have had a wide variety of projects on which to try your skills at getting this place ship shape. They have done quite a good job with the buildings but did

not do as suggested and consult anyone else, changing some of my ideas without any valid reason. This has led to some buildings being badly sited so that they will be much hotter than they need have been. The buildings, by a German volunteer, are quite good though he has had no tropical experience and a fantastic amount of cement was used and little attention paid to the slow curing of concrete, plaster and pointing. In fact most of the buildings have cracks due to subsidence as foundations were used almost immediately after digging, when they could have been exposed for some months in the rains to settle, as we used to do in Zambia. Building in this heat and dryness is difficult, as you very well know, so in the time they have done a reasonable, though rather expensive job in that estimates have been exceeded by 50%! But Peter did a good job on the orchard where there are now some good citrus trees from old Bartolomeos near Mundri Bridge, pineapples from Yambio, custard apples, guavas, pawpaws and bananas, all doing well and some producing for the first time. Once the rains get going there should be plenty of fruit. They pump water from the river but at last have carried out my suggestion of a borehole and now have more than 500 gallons per hour, from a depth of 66 metres; very potable too.

PS The Vice President and entourage used your airstrip when they came to open the place last month. It is in very good order—kept up by ACORD and ACROSS (relief organizations)."

It is pleasing to know that all our efforts are appreciated. A great tribute to the men of 11 Field Squadron who worked so hard.—Yours faithfully, R M Stancombe.

Brig R E Fryer OBE C Eng MICE FRICS
Winchfield
Comrie
Perthshire

MEETINGS WITH MONTY

Sir,—You may be getting too many stories about meetings with Monty. If you are, then tear this letter up.

But here are two more stories by another Sapper, also with the same initials—R. E.—as Major Ward in his story in the March 1977 Journal.

Many older officers will remember a week long exercise code named "Bumper" held in late September 1941. It was between a force commanded by General Alexander, representing the Home Forces, and General Carr the invading enemy force, all under the direction of the GOC General Alan Brooke. Monty was Chief Umpire with his HQ in Oxford. I was Director of Survey at Home Forces at the time.

At about 1800 hrs on the evening of Saturday September 27th, I was told by the Staff that Monty wanted a large scale wall map of the latest situation for his conference to be held at 0900 hrs on the Sunday morning. After vigorous protests from me about the magnitude of the task in the time available, the Staff merely shrugged their shoulders and said "You have heard of Monty haven't you?

As luck would have it my Aunt lived in Oxford, and I begged the use of her kitchen floor for the night. I and my Survey Staff—I think from 19 Field Survey Company RE, who celebrated their 150th anniversary on March 25th this year—worked all night on the job.

We finished about 0800 hrs on Sunday morning and I had ordered my Staff car to be ready at that time outside my Aunt's house in Oxford, but to my horror it wasn't. My Cousin, who normally worked on an 'I' job at Blenheim Palace was sick that morning, so she shouted down the stairs "take my car, it is outside in the car park". But alas, it wouldn't start, and time was running out fast. With the aid of many willing Sappers pushing, I at last got it going and I arrived at Monty's HQ, a large house quite a way out of Oxford, with only minutes to spare.

The General was already in his chair, and we worked desperately behind him to get this large map mounted on the wall. With about five minutes to go, and with Officers already assembling, Monty turned to me and said "Very good timing my boy. Very good timing". (I was a full Colonel at the time!) I then retired as fast as possible to get some breakfast and to deal with my absent driver.

The first time I ever met Monty was just a year before in September 1940, when I was Assistant Director of Survey I Corps, and we were on the march up from the base at Laval to the Belgian frontier. I was a bit late for tea one afternoon in "A" mess in the village of Hénu, near Amiens, and was the only officer in the mess. Someone with a red hat poked his

head round the door and said could he come in and have a cup of tea.

The General, whom I had never seen before, was with me alone for at least half an hour chatting over tea. I realized at once that I was talking to someone with a very strong personality and "far above the ordinary" on any confidential report. When he had gone, I asked the mess sergeant if he knew who that was. He said he wasn't sure, but he thought his name was Montgomery. It was, and he was on his way up to command the 3rd Division.

Although later in the war I saw and heard Monty lecture many times in Cairo and in the Desert, Sicily and Italy, I never again actually spoke to him after Oxford, but my first meeting with him in the mess at Hénu still remains very vividly in my mind. I was also present in Cairo, again on a Sunday, when Monty came back from the desert fighting to give out his orders for operation "Husky", the attack on Sicily. Anyone who was lucky enough to hear him that morning, could have had no doubt about what he had to do, and by when. A great man indeed.—Yours Faithfully, R E Fryer.

Major H E Vialou Clark RE, B Sc, MICE
DCRE British Gurkhas Nepal
Dharan, Nepal
BFPO 4

JUNE 1977 EDITORIAL

Sir,—In your Editorial in the June 1977 *RE Journal* you ask "are we taking ourselves too seriously?" Of course we are! You touch on some of the reasons yourself, such as the pace of life today, increased awareness of responsibility, being shielded from responsibility for too long and an inability to switch off at the end of the day. What fools we are! What mad streak in our natures compels us to behave thus? Why do we generate so much unnecessary dreariness for ourselves? What mental aberration allows us to accept, for example, the grotesque life of a London commuter? Surely no young officer joins the Corps with all this in mind.

And yet, who made the rules? Are they not the legacy of the "old and bold"?

The dull little midpiece officer is left with the task of struggling against increasing costs at home and decreasing establishments in the office; against more demanding superiors and less demanding problems; against a greater possibility of serving in a faceless headquarters and a lesser likelihood of soldiering; against being a dropout from a declining industry and worrying about his suitability for re-employment in the world outside. These are all real problems which the "old and bold" has no need to contemplate and the young officer has not yet appreciated. Do not mock us! One day we might make a strike for freedom—but then, perhaps not. What would the Colonel say?

May the young officer for ever exhibit his fun, flare and style; may he continue to enlighten the lives of the "crusties" and help to give the midpiece officer a sense of proportion; may he and I serve together and may I watch with awe as he eats his breakfast!—Yours faithfully, H E Vialou Clark.

Memoirs

MAJOR GENERAL SIR HENRY H C SUGDEN KBE, CB, DSO, FICE

Born 15 April 1904, died 11 March 1977, aged 72

HENRY HASKINS CLAPHAM SUGDEN, or "Suggy", as he was affectionately called was a great Sapper. Although he passed through the Staff College before WWII, when the gate was very narrow, he held few staff appointments and devoted himself to the Sappers enjoying a wide range of experience, including the Training Battalion, Searchlights, Works Services, Fortress and Field.

He rose to be Chief Engineer of three Army Corps (XIII, V and VIII), also Hamburg District, Northern Command and BAOR and Northern Army Group and finally he became Engineer-in-Chief for which, unusually, he was knighted whilst holding the appointment.

He was on active service continuously in World War II from 1940–45, serving in

East Africa, North Africa, Sicily and Italy. He landed on the Normandy beaches on D+2 and served throughout the campaign in NW Europe. He was wounded in North Africa, twice mentioned in dispatches, and awarded the DSO while CRE 51st Highland Division in 1943.

It was as CRE 51st Highland Division that he really made his name. It was at Alamein that this tough little Colonel, somewhat withdrawn and prematurely aged, first confounded his superiors. Wisdom and humour they may have expected from him and duly received. What surprised them was his toughness and tirelessness. He was to be seen everywhere, and particularly where it was most dangerous. His bravery, not born of stupidity but of disciplining a lively imagination in the pursuit of professional excellence, amazed his superiors and bound his subordinates to him with the strongest ties of admiration and affection. Junior officers recognized in him one who understood their difficulties, because he went out of his way to experience them; they were content to be judged by a commander who was a master of his profession and absolutely straight. At that time he was the epitome of the able, unconventional and successful Sapper commander.

As a YO he developed a love of sports cars and drove a Morgan three-wheeler with skill and verve. However he had a bad motor bicycle accident which left him with a scar for life. He was prevented from graduating from the SME with his batch, but completed the course while posted to the old Training Battalion. It was in this tough environment that he learned the minutiae of soldiering, to understand soldiers and to stand up for their rights. He learnt the art of dealing with the rank and file, and never lost his touch.

He had another experience, too, that left its mark. In the early 1930s he joined the 42nd Field Company in Egypt. Officers, who only half understood this Company would say—rather disparagingly—"Oh, Forty-two! It has good NCOs but lazy officers". It certainly produced good NCOs, because it had a curious railway commitment, which made it necessary on many occasions to despatch small groups of Sappers, each under an NCO, to tackle tasks far away from Camp. This frequent independent responsibility brought out the best in the very high grade of NCO that seemed to gravitate to Egypt; but it could only succeed if their officers learned to delegate wisely, to give good orders and to pick the right men to send. Mere activity was not enough. The officers had to learn to judge men. This was a thing Suggy learnt very thoroughly. He became an excellent judge of men, which is not a natural gift but the fruit of thought and practice. Here, too, he never lost his touch.

He was happy in 42nd Field Company. It was a happy Company and gave him a chance to participate in plenty of sport, including shooting, polo and sailing. The Company was ordered up to Palestine and Suggy was left in charge of the rear party for a spell. The Company had just started to teach some Sappers to sail dinghies. Being a keen sailor, Suggy was in his element. The Canal Brigade organized a dinghy competition. A Company team was entered and, competing against Battalion teams from the Brigade, they won the Cup. Sailing was always his love and later he did a lot for BAOR sailing.

When Chief Engineer BAOR in 1953, on his own initiative, he organized prompt Allied engineer relief work following the disastrous floods in Holland. For this, he was appointed to the Order of Orange Nassau. At this time he also started the Northag Annual Engineer Exercise "Makefast", which celebrated its 25th anniversary this year.

He was a great countryman, with a deep knowledge and understanding of nature; and an enthusiastic and energetic gardener. When Chief Engineer Northern Command at York in the early 1950s there was no quarter available so he took over a Nissen Hut on a disused wartime airfield. He moved his family and various livestock there and made a garden. He was also an excellent shot, and carried a 12-bore throughout WWII.

As Engineer-in-Chief he took a particular interest in Corps sport. He always believed that people in the Army should be encouraged to play games and cultivate

their particular interests, saying to one staff officer who asked for time off "The less I see of you in the office the better!"

Contributors have written; "He was a fearless, tireless, able and tough Sapper"; "He was always the same able, practical, common sense, humorous, caustic Suggy"; "He never played to the gallery and gave far more than was apparent on the surface"; "He devoted his life to the Corps".

He retired from the Active List in 1960, became a Colonel Commandant in 1961 and Representative Colonel Commandant in 1963.

He and his wife, Joan, were always immensely kind and hospitable. Many correspondents have written to say what helpful and encouraging friends they were. They took this trait with them into retirement and there must have been few Sappers or their wives that visited the Isle of Man without being entertained at the River House, Ramsey.

He took a very active part in Manx affairs and was an elected Member of the House of Keys for fourteen years, until just before his death. Joan used to attend to hear when he intervened in debates. She relates how she could always see the storm signals from afar when he was getting angry, and trembled for the explosion that she knew would come. But there can have been no malice or rancour in it, because the legislators "always seemed to love it!"

The Lieutenant Governor struck a true chord when, in paying tribute to him in the Manx Parliament, he said "He was truly an honourable and gallant gentleman".

Few people, one suspects, knew Suggy well; only the lucky few. But no one could work with him, or even meet him in a social gathering, without feeling instinctively that there was a man with a generous heart. In Suggy the Army had a resourceful Sapper, and the Sappers a Man among Men. Let us pay tribute to his memory and offer sympathy to his family.

CPJ, CLR, JGC, AJHD, IHFB, MCAH

BRIGADIER R H PERRY, CBE, MC

Born 9 May 1896, died 6 February 1977, aged 80

REGINALD HUGH (REX) PERRY, commissioned from "The Shop" in October 1915, was soon posted to Mesopotamia where, in mid-1916, he joined 72 Field Company RE. He was with this unit when the Turks surrendered at Mosul in October 1918 and also during the subsequent "Adventures of 72 Field Company". Corps History Vol VII describes how a section under Lieutenant R H Perry was sent across the Caspian to Krasnovodsk to support the White Russians against the Bolsheviks. "Rarely", concludes the Corps historian, "has any RE unit wandered further afield".

In 1922 he applied, and was accepted, for service in the Bengal Sappers and Miners, of whom he had seen so much during the campaign in Mesopotamia. He was to serve for twenty-one years on the Indian Establishment. A keen and competent horseman, he was for seven years OC 35 Field Troop, a Cavalry Divisional Engineer unit. In those days the Indian Cavalry followed their own fancies in the matter of dress and, while sojourning in their midst, Perry had followed suit. The Assistant Adjutant at Roorkee recalls that he was filled with admiration for the smart cavalier who appeared at Orderly Room to report his return to the Depot. Unfortunately the Commandant, who could be a bit "touchy" before breakfast and who emerged from his office at that moment, did not share this view, and lost no time in issuing instructions that Field Troop Officers should conform, in future, to the standard habits of the Bengal Sappers. The A/Adjutant felt that that was a pity, for Perry's get-up certainly lent tone to the rather unspectacular uniformity; he was indeed a gay, dashing "Royal Horse Engineer". He probably enjoyed his time in command of the Field Troop more than any other period in his service. He was

intensely proud of the Troop, and his pride in the unit was passed on to his men. Watching them come on to a Corps parade one could sense that feeling of pride in themselves, which is something that can only be born in a unit under a good commander. His leadership did not stem from any flamboyant brilliance, it came rather from his dependability, his kindness and good manners, and his contempt for anything dishonest or shoddy.

Later, after a three year tour as Garrison Engineer, he commanded 1 Field Company; and with this unit took part in the 1933 NWFP operations and in the emergency "Quetta Earthquake Relief Force" in 1935–36. He was then a substantive Major with a string of medals from World War I, including a MC, and had graduated from Saugor, that Mecca of all keen horsemen. The subalterns stood in awe of such seniority and achievement. But Perry-ji was never awe inspiring, just the opposite, kindly, humorous, yet discerning, efficient and quietly standing no nonsense.

He was a good horseman, and perhaps a better horse-master, and was never known to be rough with a horse. On the polo field he rode hard, as one learned, painfully, when his bony knee made contact in any tussle for the ball. The love of polo must have stayed with him to the end, for it wasn't so long ago that he related how much pleasure he got from driving fast in the London rush-hour traffic when his wife was not in the passenger seat!

1936 was the year when the Viceroy held a review of the Eastern Army near Delhi. Perry-ji took his company down to the site, which was virgin scrub countryside, and proceeded to carve out a vast arena in preparation for the review—camps, roads, water supply etc, all were dealt with. He pitched his own camp in a strategic place and outside the Officers Mess erected a beautiful pub sign "The Three Feathers" (the Prince of Wales's Feathers was the Corps badge of the then Bengal S & M). Other units mistook this for the real thing, a pub miraculously provided in the wilderness, and quickly took to dropping in for a drink at opening time, which was, of course, the object of the exercise. Fifteen or so years later this vast arena was to become Delhi's international airport.

In 1937 he married Margaret Alice (*née* Roy), who had come out from England to be married to him, at Colaba Garrison Church, Bombay. She returned to England in 1942 when Perry went overseas with his Regiment. Their one son, Richard, was born in England in 1945.

On the outbreak of World War II he was promoted and posted to GHQ India as CE Air Force Works. However, after a few months he became CRE 31 Indian Armoured Engineer Regiment (the first of its kind) which he raised in 1940, trained and took overseas for service with PAIFORCE in 1942–43.

He reverted to the Home Establishment on promotion to Colonel and was soon appointed Chief Engineer L of C 21 Army Group, with the rank of Brigadier. Corps History Vol IX quotes his article in the *RE Journal* of March 1946 on the rehabilitation of Caen.

He returned from BAOR in early 1946 to become CE Salisbury Plain District. But "Home Service" was not for him; for in July he was appointed Chief Engineer (Brigadier) Palestine and Trans-Jordan. His arrival in Jerusalem on 22 July coincided with the disastrous blowing-up by Zionist terrorists of the King David Hotel. He was at once plunged into top priority work connected with the establishment in Palestine of the new "Middle East Base", due for completion at the end of 1947. In September 1947, however, orders were received to stand fast on all current works: a few weeks later, to collect all valuable stores: and finally the announcement of the decision to end the British Mandate for Palestine which involved the total evacuation of troops and stores from the country. In April 1948, after what Mrs Perry describes as "an anxious journey by road from Jerusalem", all three of them (Richard, their son, was with them) embarked at Haifa—"the last military family to leave Palestine". His last year of service was spent in Shrewsbury as CE Mid-West District.

He retired to Norfolk, and, with a great deal of help from his wife, grew apples and created a beautiful garden. Suddenly he found his new vocation—a return to

India again as Regional Director of the Eastern Region of the Imperial (later to become Commonwealth) War Graves Commission. For the next nine years, ending 1962, he travelled throughout India, Pakistan and South-East Asia. One can be sure that the care which he devoted to his own garden in England would have been equally lavished on those other gardens for which he was now responsible. Recently, in the eightieth year of his life, his knowledge and photographic records have been of inestimable help to a newly-formed society for the preservation, conversion and registration of former European cemeteries in South Asia.

"Perry-ji's humour was dry like a vintage wine; he had a fund of anecdotes, about his beloved sappers, horses, senior officers, or life in general, one or two a trifle salty, all of them true, but never with a cutting edge."

"Having reached his four score years he looked just the same, not noticeably greyer, perhaps a slight cavalry-man's stoop, but that was all to mark the passage of the years. One is sad at the passing of an old friend but thankful indeed for the glad memories with which he has furnished us."

"Perry-ji to his contemporaries, he will be remembered as a man who combined the highest principles with a keen sense of humour. He had a deep understanding of "Indian" troops (including those nowadays renamed "Pakistani") and among his papers he has left a volume of correspondence with Subedar-Major Abdul Qadir, who served with him for many years. It is typical that since his final retirement in 1962 he has never once failed to attend the annual reunions of the Officers Association of the old Sapper and Miner Corps in which he spent so many happy years."

SHMB, GCC, TB

He was obviously a good Sapper Field Troop Commander, devoted to his men and unit, and his manner with other people created good relations. It was a pleasure to take over duties from him because one would know that, by his example and relations with other arms, the Sapper standing would be high and the incoming unit be made welcome. As we British Officers of these small units lived in other Regimental Messes, it meant everything to have a well liked and much respected predecessor.

EFEA

On his work with the War Graves Commission, JFDS writes:

"Honk Kong, Siam, Malaya, Burma, India and Pakistan—new Cemeteries and Memorials to be created and old ones to be restored. That he and his tiny staff succeeded in the task is evidence enough of his ability. I never saw him in a flap and he had a quiet but keen sense of humour. His conversation was quick-witted and often spiced with a quotation from Kipling."

BRIGADIER H E PIKE CBE DSO

Born 13 June 1900, died 14 March 1977, aged 76

BECAUSE of his shortness of stature H E Pike was universally known as "Nipper." I cannot claim to have known him well, but I attended a "CRE's Course" at Ripon when he was Chief Instructor and clashed with him on all sides. But in 1944, after he had been wounded in Normandy, I took his place as CRE 43 Infantry Division and soon perceived his worth; for he had trained the 43rd Divisional Engineers as he had sought to train the CRE's Course; and had produced an effective organization. Had I taken more heed of his teaching I see now, in the after-light, that I should have been a much better CRE.

In one set of operations in 1945 he was Chief Engineer of the Corps under which 43 Division was working, and he came to see me. I tried to make amends for having been so much at loggerheads with him at Ripon; but he smiled and said generously: "Perhaps I wasn't 100% right either." I am glad our acquaintance ended on that note; and I grieve for those who have lost a friend they knew better than I did.

MCAH

BRIGADIER R H REYNOLDS OBE BA

Born 24 November 1909, died 8 February 1977, aged 67

RONALD HUGH (RONNIE) REYNOLDS after Sherborne and RMA, Woolwich, was commissioned into the Corps in 1930 and took his degree at Trinity College, Cambridge. He applied his excellent brain purposefully and effectively to all that he undertook, never sparing himself. All who worked or played with him soon gained a sense of his utter dependability. Not being a man of extremes, he did not specialize, but followed a career which admirably blended service with troops (both Indian and British) and in works, leaving behind him a series of really well done jobs. He was an outstandingly keen and successful sporting shot with both rifle and gun. In 1937 he embarked on an enduringly happy marriage with Eileen Bovell.

NHLC

Ronnie Reynolds arrived in India some time in the fall of 1933. He was immediately posted to a Bengal S & M Field Company in Peshawar. Ronnie was not a polo player but his prowess with a gun or a rifle soon spread to Roorkee. In the spring of the following year he took two months leave and disappeared over the passes, hardly clear of snow, into the Himalayas. There he accounted for, amongst other game, two astoundingly large *ovis ammon*, so large in fact that the Adjutant in Roorkee, when the news came, refused to believe it until it was confirmed by the Game Department in Sirnagar. For many a year these two trophies looked down in gaunt splendour on officers dining in Mess. *The Indian Sappers and Miners*, Sandes, P 659, referring to the wonderful collection of sporting trophies in the Roorkee Mess, lists: "*Ovis Ammon*, 45½in, (Lieut R H Reynolds RE, 1934)". Then came the Quetta earthquake in 1935 and Ronnie found himself, with other Field Companies, clearing up the mess, building huts and generally getting Quetta back into business.

His quiet efficiency and organizing ability soon marked him for a headquarter appointment and he found himself sitting in the orderly room as assistant adjutant. It was about this time that the then Commandant reminded all junior officers that it was not done to marry, in the Bengal Sappers, as a Subaltern. This stricture fell on a number of deaf ears and promptly, Ronnie and several other young officers announced engagements. On a quick leave home Ronnie and Eileen were married. It was to the lasting benefit of Roorkee that such a pair should have spent some happy months in that bastion of bachelors. Alas for Roorkee, Ronnie decided, at the end of his five year tour to revert to the home establishment.

War was almost in sight and it was some years before I had news of Ronnie again. Then it was that a tellermine had lifted him out of his jeep (he was OC 1 Field Squadron at the time), and deposited him in hospital. After some anxious months he recovered and I next met him as SORE 1 to Drummond Inglis, working with his usual calm efficiency. Later, we were lucky enough to be in Mideast together where I enjoyed Ronnie and Eileen's hospitality in Cyprus where he was DCE. When GHQ moved to that Island we saw a great deal of them and their delightful family.

Whenever one met Ronnie and Eileen in later years they were always the same genuine utterly likeable pair and it was a profound shock when the news of Ronnie's death came through.

SHMB

Roorkee with its unique opportunities for shikar, was probably his favourite military station. He quickly became very knowledgeable and proficient in all matters of shikar and was seldom happier than when he was in tiger jungle or on the duck jheels. His concern for and understanding of people, his many interests and enthusiasm and his sense of humour gave him many friends and he was a delightful companion.

After the war he became an enthusiastic gardener, fisherman and golfer. He applied his immense energy to these and to his very successful second career, in civilian life. His early death so soon after his second retirement was tragic.

JKS

I knew Ronnie for nearly forty years, starting in 1939 when he was Adjutant 48 South Midland Div RE (TA) and I was a TA officer of two years service. His rather crisp voice was the feature which came across most markedly but how wrong an impression of the man this gave, for underneath he was very kind and considerate. Next I was his 2IC in 226 Field Company RE and here too he was greatly respected for he set everyone an excellent example and was strict and yet considerate. Later in the war I served under him again when he was SORE 1 (Ops) 21st Army Group and once again found him to be an outstanding leader. I always had the impression that being wounded in the Western Desert in 1942 had rather slowed up his career and that he would have preferred a more active post but he never allowed this to show or affect his efforts in any way.

DHLK

As Chief Engineer 21 Army Group I was fortunate enough to have Ronnie as my SORE 1 (Ops). I could not have wished for a better Staff officer; he combined efficiency, charm and absolute dependability.

DI

For much of, but not all of, the time Ronnie was Deputy to CE Cyprus District (1954–56) I was CRE Dhekelia. He had, inter alia, the unenviable task of reconciling three C's RE to the overall staff shortages. Ronnie had a marvellous ability for pouring oil on troubled waters. Where indignation, bluster or even procedural nonsense clouded a situation or heated it up, his calm common sense and practical ability brought peace. Even when a decision of his was unpalatable, one knew that it was entirely fair and absolutely sound. Surely there could have been no one to whom he was not a friend.

CEW

Brigadier Reynolds joined the Council of The Royal Engineers Officers' Widows Society in 1960, and up until the time of his death continued to serve the Society in the capacity of a Council member. Always mindful of the needs of the less fortunate, his quiet but acute observations on the Society's affairs were of great value to the Council. A gentle man in every sense, his presence will be sorely missed by us all.

EWS

Ronnie rounded off a notable military career as Deputy Director of Fortifications and Works. He retired early because of the imminent cessation of RE responsibility for Works Services. He started a second, and equally successful, career at the age of forty-nine when in 1958 he joined British Oxygen as part of the team to build a major plant complex for a Government contract in Cumberland. After a short time he became Chief Executive of their Gases Division, by far the biggest one in the company, and he controlled more than fifty gas producing plants and distribution centres. He brought to BOC his exceptional skills as an organizer and administrator for its many operations, and proved to be a forthright, successful and popular manager—not always an easy combination in industry—but above all he set an excellent example as a leader of men by always being hard working, cheerful and taking a genuine interest in people. No time was ever wasted, and the impact of his personality extended from factory floor to the board of directors; he was respected and admired not least because he was scrupulously fair and always backed his subordinates. He undoubtedly proved to many in industry the true worth of a first class sapper officer.

He and Eileen were charming and generous hosts at their home in Hemel Hempstead—to her and their two sons, his many friends in BOC join those in the Corps in offering most sincere sympathy.

HWK, RLT

LIEUT-COLONEL G P DAVIES OBE, BA

Born 12 November 1914, died 18 April 1977, aged 62

PETER DAVIES was a remarkable man and an outstanding Sapper Officer. Perhaps his chief characteristic was his ability to make friends in many countries around the world and it was fitting that his Memorial Service should have drawn together such a large number of them.

His principal work was as the Sales Director of the Elastic Rail Spike Company Limited, a subsidiary of that great pioneering company, Charter Consolidated. ERS manufactures and sells a remarkable product the "Pandrol" clip, which is now used as a fastener by fifty major railway systems around the world. A measure of his success can be gauged from the thirty-fold rise in sales between 1972 and 1976 and the six-fold rise in exports between 1973 and 1975. This great success led to the recent grant of the Queen's Award for export achievement. Never was this award more justly deserved—a fitting summit of his career and reward for the time spent travelling across the continents as a superb ambassador extraordinary.

As a man he was kindly, always helping others and encouraging them with subtlety to greater efforts, especially in spheres close to his heart such as politics, "The Senior" and rugby football. Frequently he would stop to help a friend less fortunate than himself. As a personality he was strong, direct, upright, warm, humorous and jovial. These were the qualities from which his successes sprang.

He was a proud patriot, critical of anything or anyone whom he thought failed to contribute to Britain. He disliked anything bogus or weak and, of course, as an exporter of some significance, it can be said that his personal contribution to the national economy was greater than that achieved by the great majority of men.

He was a great lover of rugger—a love begun at his preparatory school, St Hugh's Bickley, and continued through Oundle; the Shop; the Corps; Magdalene College Cambridge; and the LX Club. In recent years he organized annual visits to the Varsity Match, occasions for much talk and great conviviality. He was a proud member of the Hawk's Club. At St Hugh's he played the big drum in the school band and it might be said in a kindly way that he continued to do this all his life. He was an enthusiast for everything which he loved especially music and he encouraged almost every Magdalene activity both officially and unofficially. It could be said that his studies did not always receive priority but Cambridge was the source of other facets of wisdom and strength.

After leaving Chatham (32 YO) he went to Longmoor for the Railway Course, and then joined 29 Railway Survey Company. Early in the war he was employed on transportation duties in France and then in Norway during the German invasion. This was his first visit to far flung railways and he was concerned with the transport of iron ore from Narvik and the operations in the Lofoten Islands. After a spell in Northern Ireland, he was sent to Egypt in March 1943 where he served with the Combined Operations Training Pool. In April 1944 he moved to India and finally reached Malaya in an assault craft. He was awarded the OBE for his activities in Malaya, principally road construction. Much to his joy he then attended a US Transportation Corps course at Fort Eustace, Virginia where he made many friends; many US Officers will remember him before others. In May 1949 he became Assistant Military Attaché in Turkey. He then returned to the School of Amphibious Warfare and was subsequently posted to Australia as ADTn, Australian Army Staff in 1954. Here he met Jill, his wife, who was to become a strong and constant support. He retired in 1958.

Peter was a staunch member of "The Senior" where those of us who were fortunate enough to be his friends frequently met him in a constant spirit of conviviality. He was indeed a very "clubable" man. Behind the scenes he was an ardent worker for the continuation of the club but, much to his sadness, this was not to be. He was also a sort of member of El Vinos, where he spent light hearted sessions with his friends. For he was essentially light hearted and friendly, but behind it all was a

more serious purpose, the search for excellence of performance and government and this was the core of his being.

Sappers should remember him as an outstanding human being who served his country well and who contributed with panache and strength to the teams to which he belonged throughout his life.

BAEM

Book Reviews

FAR TO GO

CELIA DAVIES

(Published by Terence Dalton Ltd, Lavenham, Suffolk. Price £3·80)

HAVING, quite logically, read the Foreword of this book first I said to myself—"follow that if you can."

The book is delightfully written and is well illustrated, both by the Author's husband (an ex Sapper and well known artist) and by carefully chosen photographs, and will appeal to everyone as it is about life, *real life*. The book covers the period from her marriage to an RE Captain until her husband's retirement from the Army.

I do so enjoy "the woman's point of view," particularly when it describes a "perfect team" relationship. I do not mean that all goes well all the time, there are sad incidents and then suddenly a flash of humour and the reader is laughing again with Mrs Davies. The book is not a chronicle of her husband's career, though this does form the framework for the book. The pre-World War II life of a Sapper wife, particularly in India, makes one regret the never-to-be-repeated opportunities missed. The War years—very often without her husband—in the North Americas make one realize how very kind our "cousins" were. To be a stranger in a strange place one minute and to be accepted by the community of the delightfully named Falls Church, (indeed taken into their very hearts), the next is quite moving. The frightening sea journey home in convoy, harrassed by U-boats, without her husband but with her children, makes dramatic reading.

This is the second book by Mrs Davies, (the first, *Clean Clothes on Sunday*, tells of her childhood). Is it too much to hope for a third?

BP

MANUAL OF APPLIED GEOLOGY FOR ENGINEERS

Published by The Institution of Civil Engineers and obtainable from Thomas Telford Ltd, 26–34 Old Street, London EC1V 9A. Price UK £9·00; Overseas, by air, £11·50)

MILITARY ENGINEERING VOLUME XV APPLIED GEOLOGY FOR ENGINEERS

(Published by HMSO Price £9·00 net)

THIS book was sponsored jointly by the Ministry of Defence and the Institution of Civil Engineers and is published separately as shown above.

It was written by some of the most eminent men in their respective fields under the direction of, and in consultation with, a small steering committee composed of geologists and engineers. Despite the standard jokes (a camel is a horse designed by a committee!) on the end results of committee activities, this particular method has worked very well indeed.

The book is intended as a guide to geology for the practising engineer. Its aims are to enable him to appreciate the relevance of geology to the engineering decisions he may be called upon to make; to make the right choice of sites for engineering works; to solve the more simple problems of geological investigation and above all to recognize those more complex cases where specialist geological advice is required. The book certainly achieves the aims. Indeed I believe it takes the subject even further without overcomplication and will be equally useful for students of geology and associated courses.

The book is well illustrated (147 figures, 4 pull-out maps and 28 tables) but above all it presents the subject logically starting with a 21 page glossary, an absolute must in any text book. Chapters cover general theory, formation of rocks, their properties and identification, landforms and soils, geophysical methods and other information sources. The particular

problems of terrain evaluation, site selection and investigation, ground water control, stability, foundations and underground work are examined and there are chapters on materials and hydrogeology.

There can be no doubt that a working knowledge of geology is essential for an engineer if he is to design his structures economically, build them safetly and ensure that they remain safe during use. This book provides such a knowledge.

EEP

GUERRILLAS AND TERRORISTS

RICHARD CLUTTERBUCK

(Published by Faber and Faber Ltd. 125 pages. Price £4·25)

THIS book is a concise study of the lessons to be learned from the activities of Guerrillas and Terrorists in the past thirty years, based on the six Lees Knowles lectures given by the author at Cambridge University in 1975/76.

Early chapters dispel the common illusion that these are new forms of warfare; in fact there is ample emphasis that they are as old as warfare itself. The campaigns in Malaysia and Vietnam are portrayed with the conviction and authority which stems from the author's personal involvement in the Malayan emergency and his visits to Vietnam. The value to Western National policies of the peaceful use of military force is fully argued and illustrated though it is unfortunate that some readers could be left with the impression that it is the exclusive prerogative of the West. To take one example, railway construction by Chinese Army Engineers in Africa presumably serves their National policy as effectively as Western interests are served by roads built by British Troops in Thailand.

The complex and involved political history of Ireland since 1600 is outlined in a model of balanced and unbiased description which spares none of the contributors to Ulster's unhappy situation today—British Government policy in particular.

Completely different views of the subject are presented by the Palestinian Terrorist struggle backed materially and financially by the Arabs.

Final chapters turn to the international nature of modern terrorism and to the price which must be paid for protection from it.

This is a stimulating and interesting book, written in a brisk and effective style, and which ought to command wide interest in military circles, perhaps especially to those aspiring to Staff Colleges.

DJNG

TOMMY ATKINS

THE STORY OF AN ENGLISH SOLDIER

JOHN LAFFIN

(Published by White Lion Publishers Ltd. Price £4·25)

THE story of the English (or more accurately, British) soldier is an epic of incredible loyalty and devotion to duty. Life was often intolerable yet he cheerfully fought and won against appalling odds. He died without complaint to save governments from their follies. His superiors often treated him with sickening brutality. Poorly fed, poorly housed, woefully equipped, mercilessly worked, over-loaded and underpaid this unique soldier deserves considerable praise.

The author covers the period since the mid 17th century, some 300 years. At the beginning of the period Tommy Atkins was "not paid to think, merely to obey." At the end of the period he was "a man of many parts with skill in the use of several weapons, able to read a map, with some knowledge of signalling and co-operation with other arms (and armies) . . . trained to use his own initiative and taught to survive under arduous conditions." The author relates the change against educational background, social conditions, moral standards and the actual campaigns and tactics of the time.

In the prologue the author quotes some fifty appraisals of Tommy Atkins. Not everybody has found the soldier, or indeed the Army, subjects for praise and even some of the most favourable comments have been spiked with forthright criticism. The stated object of the book is to show that there is some truth in all of them. This is too great a task for a 235 page book and to this extent the book does not achieve the object.

The book has been well researched and is well worth reading. It does, in the opinion of the reviewer, dwell overlong on the brutalities and punishments of the earlier days though does not over-exaggerate them. There is no doubt that Tommy Atkins has earned his keep.

EEP

Corps History

THE published *History of the Corps of Royal Engineers* ends with Volumes VIII and IX, which cover the period 1938 to 1948. Work has been going on for some time on Volume X, which will cover the period 1948 to 1958. Recently it came to light that one Command had not been incorporated into the synopsis, and that little material was readily available; this was West Africa Command. A start has been made in rectifying this situation, but it is thought that there may yet be significant activities of the Corps which have not been covered.

The synopsis as it stands at present is set out below; if any reader feels that a significant activity of the Corps during the period 1948–1958 may not be covered, or that he may be able to contribute towards the parts as yet unwritten, he should contact the Project Officer, Corps History, c/o Director Engineer Services, Old War Office Building, London SW1A 2EU.

Corps History, Vol X, 1948–1958. Synopsis

Introduction
Political background—NATO and other treaties and pacts—Role and size of the Army

Chapter I—UK (Unwritten)
Role and organization of the Corps—Training—Operations—Survey—Works

Chapter II—Germany—a general survey. (Written, but to be revised and checked)

Chapter III—Germany—Field Units. (As Chapter II)
Field Engineers—Royal Canadian Engineers—Berlin Troops

Chapter IV—Germany—Logistic Units (As Chapter II)
Works Services—Resources—Survey—Movement Control—Transportation

Chapter V—Austria and Trieste. (As Chapter II)

Chapter VI—Middle East (Unwritten)
General—Egypt—Suez—Cyprus—Jordan, Lebanon, Iraq—Aden—The Gulf (Bahrein, Trucial States, Muscat & Oman)—Libya, Malta, Gibraltar—Greece, Sudan, Eritrea, Abadan

Chapter VII—Withdrawal from Palestine (As Chapter II)

Chapter VIII—East and West Africa (As Chapter II, but West Africa unfinished)
East Africa—Mackinnon Road Depot—Mau-Mau—Groundnuts Scheme—89 Field Survey Squadron RE
West Africa—Gold Coast Riots, 1948

Chapter IX—Far East (As Chapter II)
Singapore—Malaya—the Emergency—Malaysian and Gurkha Engineers—Hong Kong—Nepal—Gurkha Recruiting Depot, Dharan

Chapter X—Korea (Being written)

Chapter XI—The Nuclear Test Programme (As Chapter II)
Monte Bello—Christmas Island

Chapter XII—Specialist Services (Partly written—Postal and Courier being written)
Bomb Disposal—Postal and Courier

Chapter XIII—The Reserve Army (As Chapter II)

THE HISTORY OF THE CORPS OF ROYAL ENGINEERS

FOUR volumes of the History of the Corps of Royal Engineers have been reprinted and complete sets are now available.

The nine volumes have been printed, reprinted and bound at various times in the last fifty years. On each occasion the actual cost to the Institution was dependent on the "going rate" at the time. This led, over the years, to many apparent inconsistencies in the prices of the individual volumes.

Although the policy of the Institution has been, and still is, to recover costs only from Members, the latest reprints have provided the opportunity to adjust the prices to remove these inconsistencies.

All Members will be aware that postal charges are now very high. Regrettably "postage and packing" will now be charged on all orders despatched through the GPO.

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