THE ROYAL ENGINEERS JOURNAL—SEPTEMBER 1959

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THE ROYAL ENGINEERS JOURNAL

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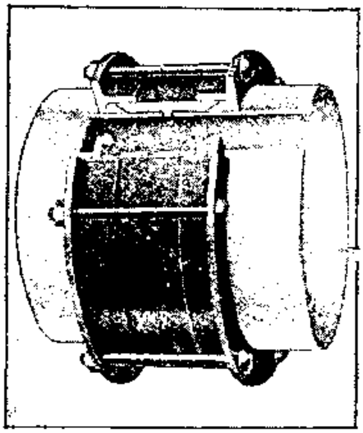

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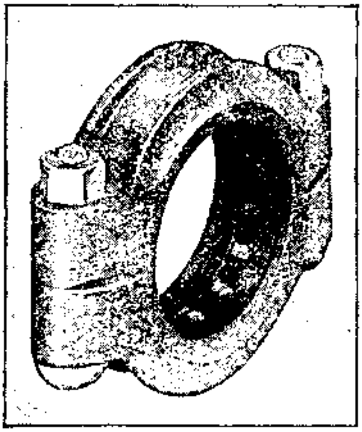

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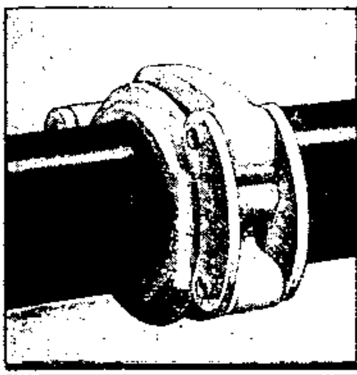

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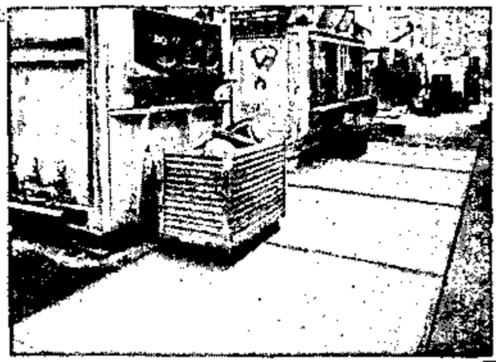

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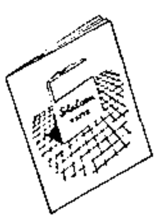

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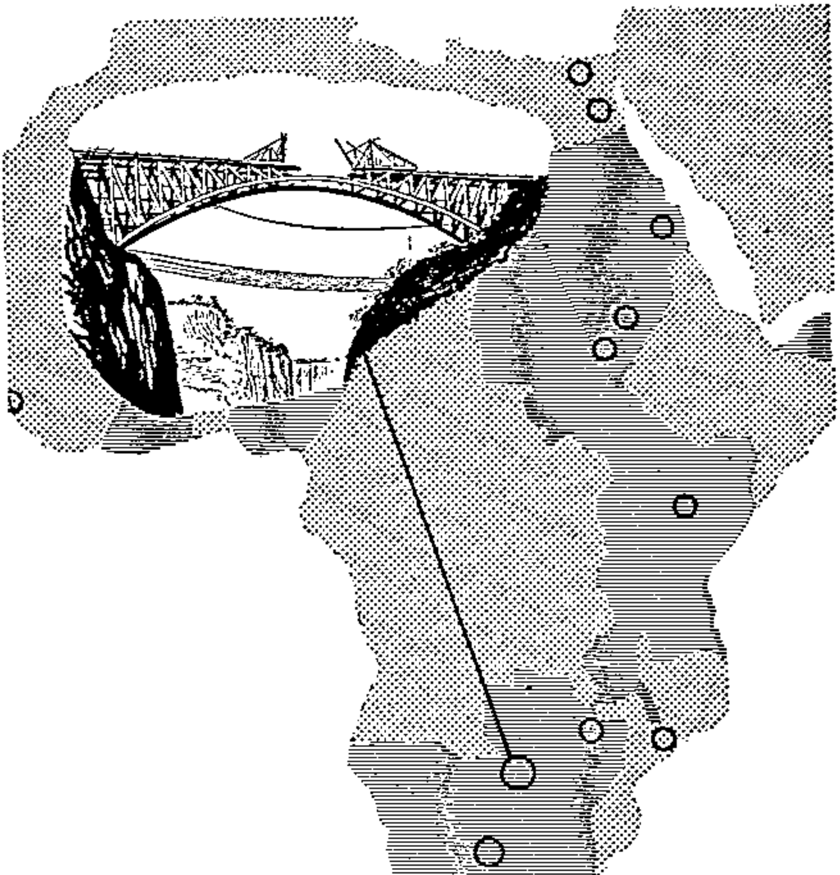

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SEPTEMBER, 1959


Borough of Stratford-upon-Avon

To THE CHIEF ROYAL ENGINEER, THE OFFICERS, WARRANT OFFICERS, NON COMMISSIONED OFFICERS AND MEN OF THE

Corps of Royal Engineers

GREETINGS

At a Meeting of the Council of the Borough of Stratford-upon-Avon held on Saturday the 25th day of April 1959

It was Unanimously Resolved:- That in recognition of the close association existing between the Borough of Stratford-upon-Avon and 1 Engineers Stores Depot and in order to recognise and foster an even closer relationship in the years to come and being sensible of the great record and glorious tradition created by your distinguished Corps we the Mayor Aldermen and Burgesses of the Borough of Stratford-upon-Avon do hereby by these presents confer upon The Corps of Royal Engineers

The Freedom of Entry into the Borough

and thereby the right, privilege, honour and distinction upon all ceremonial occasions of marching through the Borough of Stratford-upon-Avon with bands playing, drums beating and bayonets fixed.

In Witness whereof the Common Seal of the Mayor Aldermen and Burgesses of the Borough of Stratford-upon-Avon was hereto affixed in the presence of:—

Mayor

Town Clerk

The Scroll

Presentation To The Corps Of Royal Engineers Of The Freedom Of Entry To The Borough Of Strafford-Upon-Avon

Freedom of Entry to the Borough of Stratford-upon-Avon

By Colonel (now Brigadier) H. R. Greenwood, MA

At 1130 am on Saturday 25 April 1959, at a Special Meeting of the Borough Council of Stratford-upon-Avon, the Common Seal of the Mayor, Aldermen and Burgesses was affixed to the resolution: "That, in recognition of the close association existing between the Borough of Stratford-upon-Avon and 1 Engineer Stores Depot and in order to recognize and foster an even closer relationship in the years to come, and being sensible of the great record and glorious tradition created by your distinguished Corps, we, the Mayor, Aldermen and Burgesses of the Borough of Stratford-upon-Avon, do hereby by these presents confer upon The Corps of Royal Engineers the Freedom of Entry into the Borough and, thereby, the right, privilege, honour and distinction upon all ceremonial occasions of marching through the Borough of Stratford-upon-Avon with bands playing, drums beating and bayonets fixed." The Chief Royal Engineer, the Engineer-in-Chief, the Representative Colonel Commandant, the President of the Institute of Royal Engineers, the Commander 1 ESD, and their ladies were in attendance at this Meeting.

After this ceremony, the Mayor and Council moved to the Shakespeare Memorial Theatre, where the Chief Royal Engineer, General Sir Kenneth N. Crawford, KCB, MC, and some fifty officers of the Corps entertained 150 guests first at a reception in the Picture Gallery of the Shakespeare Museum, and afterwards at a luncheon in the Conference Hall. After the toast of "The Queen", General Sir Kenneth Crawford, on behalf of the Corps, presented the Mayor, Councillor H. W. Guyver, with an antique silver centrepiece.

After luncheon the guests moved to Bridge Street for the ceremonial handing over of the Deed of Privilege. The arrival of the Mayor, Aldermen and Councillors in procession was heralded by a fanfare from the Trumpeters of the Corps Band. The Mayor was met by the Chief Royal Engineer, and they took the General Salute presented by the two divisions of escort and scroll party drawn up under the command of Lieut-Colonel C. E. Jarrett-Kerr, MBE, RE.

The Deed of Privilege was read out by the Town Clerk and handed by the Mayor to the Chief Royal Engineer. Making the presentation the Mayor said:

"The history of our old market town is sign-posted with events and occasions of great importance and interest. Some are concerned with domestic affairs, local developments and achievements; others reflect national happenings and illustrate Stratford's contacts with the outside world.

Today, we are assembled for the purpose of witnessing a ceremony which will add another such signpost to the pages of Stratford's history.

My first and most pleasant duty is to offer a sincere and hearty welcome to the Chief Royal Engineer, General Sir Kenneth Crawford, and to all the officers and other ranks of the Corps of Royal Engineers.

This is your day. Speaking for my colleagues of the Borough Council as well as the Burgesses of Stratford, I want you to know how proud and delighted we are to have you as our special guests today.

Military occasions are not, of course, without precedent in a historic town

The Mayor presenting the Scroll to the Chief Royal Engineer.

like Stratford. At the time of the Spanish Armada in 1588 the Mayor reviewed the trained men contributed by the town to the fighting force of the country. The muster probably took place in this very street. They were infantry equipped with pikes, bows and arrows, matchlocks, swords and daggers. I have an idea that Shakespeare witnessed this scene and later recalled it in his portrayal of Captain Falstaff, Corporal Bardolf and the four raw Levies.

Again, in the days of the Civil War, Stratford was the scene of military activity of rather an unwelcome kind. Three barrels of gunpowder exploded and damaged the Town Hall and one arch of Clopton Bridge was demolished in the course of military operations. Not having a Royal Engineer Depot at Long Marston in those days we had to wait several years before the bridge was repaired.

The Borough records throw interesting light on other such episodes, but there is no need to mention them. They merely serve to show that over the centuries the traders and craftsmen and townsfolk of Stratford-upon-Avon have much to do with soldiers and their affairs. We accordingly want you to feel as much at home with us today as we do with you.

In recent years the close association of Stratford-upon-Avon with the fighting services has been evidenced by the fact that the Borough has conferred the Freedom of Entry upon the Royal Warwickshire Regiment, the Warwickshire Yeomanry and No 605 Squadron of the Royal Air Force.

Today the Mayor, Aldermen and Burgesses of the Borough are proud to confer a similar honour on the Corps of Royal Engineers.

In the dark days following Dunkirk I well remember the beginnings of the Engineers' Stores Depot at Long Marston. At a time when the ports of this country were in dire danger of heavy air attack, and indeed when the whole country was hourly expecting invasion, stores and equipment began to appear in piles in the fields at Long Marston. Huts began to rise and railway tracks and roads were laid down. We in the Home Guard in those days had some idea of what was happening, and the foundations of many friendships between Stratford people and the officers and men of the Depot were laid at that time.

What astonishes me, looking back, is the amazing speed and efficiency with which the Engineers established this Depot. Within quite a short time it was operating at full pressure and I question very much whether the average person appreciates the full extent of the contribution made by Long Marston to the victory of our fighting forces in all theatres of the war.

But although our association was born under conditions of adversity, it has continued and become closer in the post-war years of peace. We in Stratford-upon-Avon have watched the gradual transformation of a war-time dump into what I am certain must be the finest Engineer Stores Depot in the Commonwealth.

Officers and men have come and gone during the years but Stratford has remained little changed and many, who saw the beginnings of the Depot, are still here. During this period we as a town have received many kindnesses and assistance in various ways from the Depot and for some years past a contingent of Royal Engineers has done a very useful service for us on Shakespeare's birthday.

How fitting it is, then, that in the same week as we have celebrated Shakespeare's birthday and at the beginning of the One Hundredth Shakespeare Season at the Theatre, the Borough Council should feel moved to recognize and foster an even closer relationship between Stratford-upon-Avon and the Corps of Royal Engineers.

It is customary on these occasions to recite battle honours, but today I would refer instead to the many-sided achievements and experiences of your distinguished Corps.

In the fast-moving, scientific age, the prosecution of war and the preservation of peace can only be ensured by the experience, the research and the developments associated with the Royal Engineers.

General Sir Kenneth Crawford, I say to you as Chief Royal Engineer, that Stratford-upon-Avon is extremely proud of your Corps and our very friendly association with the Long Marston Depot.

As a token of our esteem we are happy to confer in this Scroll the highest honour a town can offer, the Freedom of Entry into the Borough, carrying with it the right, privilege, honour and distinction of marching through our streets with bands playing, drums beating and bayonets fixed.

May it prove possible for this right to be exercised on many future occasions."

Replying the Chief Royal Engineer said:

"On behalf of all ranks of the Corps of Royal Engineers, serving and retired, I thank you for the honour which you are conferring on us today, which is indeed the highest honour that soldiers can receive at the hands of their fellow citizens. I greatly appreciate, Mr Mayor, the kind terms in which you have referred to the Corps of Royal Engineers as a whole and, in particular, to 1 Engineer Stores Depot who represent the Corps in your district.

You have told us how the association, begun in war, has been strengthened and extended in peace. It gives me great pleasure to know that our troops at Long Marston have so commended themselves to you and that they have been able to be of assistance to you from time to time. I am sure you can rely on their fullest co-operation should you, at any time in the future, require their help. I know that all ranks have greatly appreciated the way in which your citizens have made them feel at home and the many kindnesses which have been shown them.

We believe that the Long Marston Depot is, in many ways, a model of its kind. In addition to its Regular complement, it is the training centre for many of our Army Emergency Reservists and they too have enjoyed your hospitality. The equipment held indicates many of the activities of the Corps of Royal Engineers, its technical and scientific character, and its world-wide responsibilities.

We regard it as a very special privilege to be associated with this historic Borough, the home of Shakespeare. There is a difference of opinion among the experts whether or not Shakespeare actually served in the Army. There is, however, no doubt about his intimate knowledge of soldiers and their ways. Fortescue, the historian of the British Army, says:

'Shakespeare is as truly the painter of the English Army in his own day as was Marryat of the Navy in later years.'

Shakespeare also showed quite a considerable knowledge of military engineering and understood some of the technicalities of siege work. Hotspur's wife complained that he talked in his sleep of 'mines, trenches, parapets, palisadoes and basilisks' but I rather deplore that Shakespeare should have made Hamlet regard it as good sport 'to have the engineer hoist with his own petard.'

Last night I had the pleasure of seeing the play *All's well that ends well.* I am afraid that the General in this play did not come out of it very well. However, this could be a reminder to senior officers of the virtue of modesty and could commend to them the words of Cassius (in *Julius Caesar*): 'I said an older soldier, not a better'.

I believe our young soldiers of today are very good, and it is to the younger soldiers, both officers and men, that we must look to maintain this country's freedom and its essential virtues. In the years to come, when we older soldiers have left the scene, those who are now the younger soldiers will continue to find, in the great honour which you have done us today, a source of pride, inspiration and encouragement.

Mr Mayor, on behalf of the Corps of Royal Engineers, I thank you for this beautiful illuminated scroll, which records the conferring on the Corps of the Freedom of Entry to the Borough of Stratford-upon-Avon. This scroll will be treasured by us and kept, for all to see, as a constant reminder of this great occasion."

The Scroll was then trooped before the divisions of escort. After the Royal Salute had been given, the parade, led by the Corps Band from Chatham, marched past the Mayor who took the salute, and through the streets of the Borough, exercising their newly-gained privilege.

The Mayor and Corporation were finally hosts to all who had attended the luncheon and a large number of civic guests at a tea in the Town Hall. The Corps silver was on display and occasioned great interest.

The occasion was successful in every respect save the weather. Unfortunately it chose to rain throughout the ceremony but not sufficiently to mar seriously the occasion or keep away large crowds from the parade and from the route of march. The Corps of Royal Engineers has received previously the "Freedom" of Gillingham, Rochester, and Ripon. All arrangements on those occasions were made by the SME and with the full Corps facilities. Other "Freedoms" have been given to individual regiments, such as the Royal Monmouthshire Royal Engineers and 127 Construction Regiment, RE at Smethwick. These were local affairs and did not involve the Corps as a whole. This is believed to be the first occasion that an individual unit of the Corps has earned a Freedom for the Corps as a whole and had to represent the Corps on the occasion of its presentation with its own resources. A word might, therefore, be of interest about the arrangements.

As the Officers' Mess at Long Marston still consists of war-time huts, a base in Stratford at which the Corps could entertain the Borough was necessary. The Directors of the Shakespeare Memorial Theatre very kindly lent both the Shakespeare Memorial Theatre Museum and their Conference Hall. The Reception was held in the lovely Picture Gallery of the Museum. The strict "non-smoking" rule was relaxed for this occasion. A covered way gave access to the Conference Hall of the theatre proper, which in fact is a second theatre, complete with stage and gallery, where rehearsals are held. These premises were only available from 4 pm the previous afternoon and had to be given back spotless by the evening of the day in question.

The seating capacity for a guest night type of luncheon was calculated at 198, and numbers were limited accordingly. To keep the costs to a minimum, all food was cooked in the OR cookhouse 7 miles away at Long Marston, taken to Stratford in transport loaned by Flowers Brewery and there reheated in a manner learnt from the Dorchester Hotel. It was served by fifty Pioneers from the labour force at Long Marston who had never done anything of this sort previously. The high standard of their waiting was noted by all and reflected great credit on the Chief Steward of the HQ Mess, Chatham, who polished up in four days the preliminary training already given them. Private cars brought from the HQ Mess eighteen pieces of Corps silver, table linen and many other accessories. The menu was rehearsed beforehand at a Ladies Dinner Night. Official guests were kept to a minimum, all others paying their way in order that the cost to Corps Funds should be kept to a minimum. The orchestra of the Corps Band played in the Gallery throughout lunch.

The Corps Band greatly endeared itself to the citizens of Stratford by playing throughout the Shakespeare Centenary Celebrations, at the Freedom and at the Sunday Shakespeare Church Parade following. Their smartness, bearing and excellent performance brought great credit to the Corps. This standard was also maintained by the Royal Engineers of 1 ESD representing the Regular Corps, and a Detachment of 127 Construction Regiment representing the Corps from the Territorial Army. Senior officers of Resources Units based on Long Marston and their Honorary Colonel, Major-General Sir Eustace F. Tickell, KBE, CB, MC, represented the Army Emergency Reserve.

Seating for 240 families of officers and other ranks was arranged on mobile stands which were built on trailers. These were placed in position in Bridge Street during the luncheon and were towed away immediately after the procession moved off. The dais and seating for 200 VIP was arranged by the Borough Engineer.

The DAA and QMG who is the only Staff Officer at 1 ESD was responsible for all the arrangements in addition to his normal duties. He sat in with the Town Committee meetings to ensure co-ordination of all arrangements and co-ordinated the many 1 ESD Committees which included entertainments that night for all in Long Marston including the Polish Camp.

The 1 Engineer Stores Depot are proud to have earned during their eighteen years this Freedom for the Corps and they are proud to have been given the honour and privilege of representing the Corps on the occasion of its presentation.

Closing of Cairnryan Military Port

By LIEUT-COLONEL O. C. RADFORD, RE

CAIRNRYAN PORT closed on 30 April 1959 after some sixteen years of life as a military port.

The story of the construction of No 2 Military Port, as it was originally named, was told in the March 1958 edition of the *RE Journal.*

With the end of the war, the need for a military port rapidly dwindled and from 1948–51 the port was leased to a civilian firm for shipbreaking.

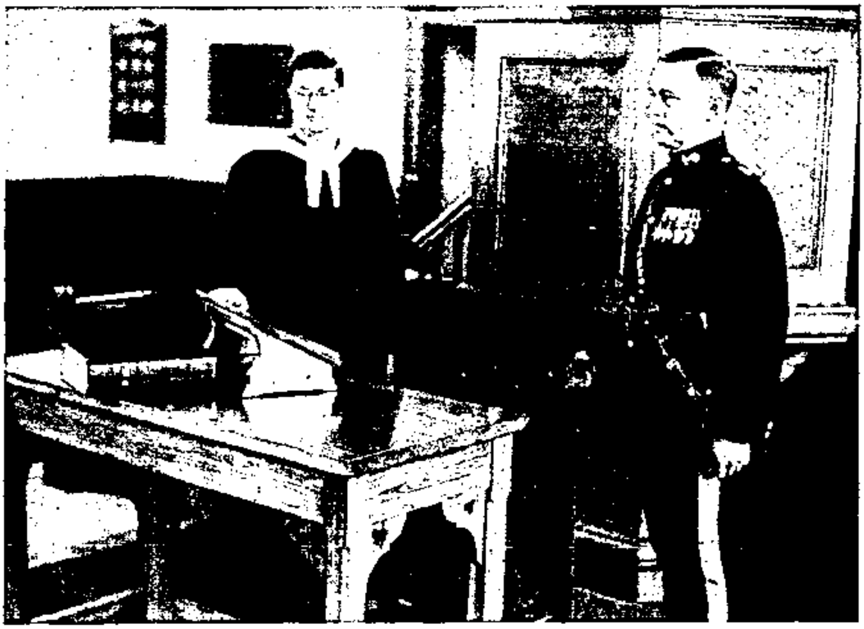
In 1951 Cairnryan was reopened as a military port, this time mainly for dumping of surplus ammunition and explosives at sea. A new Tn unit, largely civilianized, was formed to operate the port. Craft for ammunition dumping were provided by the RASC, who also manned the fire brigade. Technical advice on the handling of ammunition was given by an RAOC unit formed for the purpose. Labour for actual dumping came from the RPC. RE (MC), RAMC and REME detachments completed an all arms garrison all under the command of the Port Commander.

Because of its excellent facilities for handling military cargoes and its particular suitability for ammunition and explosives, considerable use was made of Cairnryan during this period by deep sea shipping, mainly carrying ammunition. The Royal Navy, who found Cairnryan ideal for their fleet auxiliaries, were the largest customers followed by the US Navy. Ships were also loaded for the Ministry of Supply, the Air Ministry and the War Department who were, strangely enough, amongst the smallest users of the port.

During the years 1951–9, nearly a quarter of a million tons of ammunition was loaded at Cairnryan for dumping and approximately 325,000 tons of other traffic passed through the port.

A highlight of this period was the visit of HM The Queen and The Duke of Edinburgh to Wigtownshire on 10 August 1955. The Royal Yacht *Britannia* berthed at Cairnryan, where the royal party came ashore to be welcomed by the Lord Lieutenant of Wigtownshire, the Earl of Stair, and began their tour of the County.

On Sunday, 26 April 1959, to mark the closing of the port and the final departure of the military garrison from Cairnryan, a parade service was held in the parish church at Cairnryan. In a brief ceremony during the service, the Port Commander, Lieut-Colonel O. C. Radford, RE, on behalf of all ranks of Cairnryan Garrison, presented to the church a Communion chair, a lectern and a table, which were then dedicated by the Minister.



Presentation of Communion Chair, Lectern and Table.

The chair and lectern were made of pitch pine to match the other furniture in the church. The Bible contained the following inscription on the fly leaf:—

To the Glory of God

This Bible, together with the Lectern and Minister's Chair, was presented to Cairnryan Parish Church on the 26th day of April, 1959, by the Officers, Warrant Officers, Non-Commissioned Officers and men of the units stationed at Cairnryan, to mark the closing of Cairnryan Military Port on the 30th day of April, 1959. The port, originally named No 2 Military Port, was built in 1941–3, and there was a military garrison at Cairnryan from 1941 to 1948 and from 1951 to 1959. During that time many units of different regiments and corps were stationed at Cairnryan for duty in war and in peace. When the port closed the garrison consisted of:—

Headquarters, Cairnryan Military Port, Royal Engineers
Movement Control Detachment, Royal Engineers
99 Company, Royal Army Service Corps (Water Transport)
8 Army Fire Brigade, Royal Army Service Corps
Detachment, 13 Company, Royal Army Medical Corps
Explosive Disposal Wing, Royal Army Ordnance Corps
99 Company RASC (WT) Workshops, Royal Electrical and Mechanical Engineers
Detachment, 26 Command Workshops, Royal Electrical and Mechanical Engineers
13 Company, Royal Pioneer Corps

These gifts were presented as an expression of the appreciation felt by all who served in these units and their predecessors, for the kindness and hospitality shown towards them by the people of Cairnryan, whose lovely village was so spoilt by the building of the port.

RE Demonstration 1959

By CGS

THIS year's Demonstration was held at Chatham in early May. It was spread over three days. On 11 May some 330 officers of all arms attended; on 12 May the Commandant, Directing Staff and students of the Staff College, Camberley, visited the Demonstration and on 13 May it was the turn of the Commandant, Instructors and cadets of the Royal Military Academy, Sandhurst. Other notable visitors were two Members of Parliament, twenty Military Attachés, including Major-General Ivaniev of the Russian Army and Lieut-General R. Legrand, Inspector General of the French Engineer Corps. A preview of the Demonstration was staged for Army Emergency Reserve and Territorial Army Sapper Officers during the week-end 9/10 May, and a dress rehearsal on 7 May played to a full house of RE Boys from the Junior Leaders' Regiment RE from Dover, and CCF and ACF Cadets.

As in previous years mine warfare, field defences and dry bridging were shown at Gordon Barracks and river crossing, wet bridging, plant, roads and airfields at Upnor, where visitors also saw a static exhibition of many other Corps activities. The demonstration was favoured by perfect weather throughout; from the beginning of rehearsals until after the end of the last performance the sun blazed in blue skies, and although some of the Staff College students did get a little wet this was not due to rain.

The most spectacular innovation in this year's demonstration was undoubtedly the performance by the Westland "Westminster" helicopter on the Monday. This helicopter, claimed to be the largest in the western world and named by its makers the "Flying Crane", placed a bridge in position over a dry gap at Gordon Barracks and subsequently lifted and put an outrigged light assault floating bridge pontoon into the pond at Upnor. Whirlwind helicopters from the Joint Experimental Helicopter Unit also took part in laying a hasty minefield, carrying a demolition party to blow up a bridge, and bringing up assault boats for infantry to build a raft.

The Engineer-in-Chief held a Study Period for senior Sapper Officers of the Army Emergency Reserve and Territorial Army on Friday 8 May. Besides discussing problems of the Reserve Army of mutual concern, the officers studied the operations of Port Task Forces, and engineer tasks in support of the civil power in the event of a thermo-nuclear attack on the United Kingdom. There was a guest night in the HQ Mess that evening.

Lieutenant-General R. Legrand, Inspector General of the French Engineer Corps, besides visiting the RE Demonstration on the previous day, paid an official visit to the SME on Thursday 14 May. He was received by a Guard of Honour, mounted by the Officer Cadet Squadron of 12 SME Regiment, and subsequently presented by the Commandant, Brigadier Duke, with a plaque of the Corps badge. After visiting the Institution of Royal Engineers and all the Schools and other Branches of the SME, General Legrand was entertained to luncheon in the Headquarter Mess.

RE Demonstration 1959

Regiment in Top Gear

By Lieut-Colonel R. L. Clutterbuck, OBE, RE

Christmas Island is sometimes regarded as an enemy or rival to the cold war in that it drains tradesmen and equipment away from other theatres. I certainly held this view myself while I was serving in Malaya, but I now know better. Although Christmas Island has for some years made heavy demands on other units for tradesmen, I am convinced that these tradesmen—and more particularly the officers and NCOs who commanded them—have gained experience that they could not otherwise have gained, and that this experience is the finest training for the cold war that they could get anywhere. This sounds paradoxical, but the reason of course lies not in the nuclear tests themselves, but in the demand they created for intensive engineer work against time in a remote theatre. Many thousands of sappers have now served on Christmas Island, and I know that this view is very widely held in the Corps. Like many others, I would like to see field units not actually engaged in cold war theatres spending more of their time on projects such as Christmas Island, and think that we should go to great lengths to get ourselves more such projects—not at the expense of military training for the cold war, but at the expense of some of our training for the rather remoter possibility of a major war in Europe. By describing something of what our regiment did on Christmas Island in 1958, I hope to contribute a little ammunition for those who are trying to bring this about.

A Sense of Urgency

Projects such as Christmas Island give the best possible training, both professionally and in the command of men, because young officers and NCOs have exceptionally big responsibilities thrust upon them, in which they stand or fall by their own efforts. The background to the project, and the essence of its value, was the sense of urgency behind it. The whole Task Force, and the Ministries responsible for it, were imbued with the determination to achieve the object of the tests, up to time, *at all costs.* This was the only sensible attitude, because any "extravagances" or "savings" were negligible in terms of the huge cost—both financial and political—in delaying or prolonging the programme. Because we were more or less free from the financial stranglehold which frustrates us almost everywhere else in the world, our output from the effort and money expended was in the event vastly increased.

Christmas Island was, in fact, a great education for us in real values. Generally, we are unwilling prisoners of a system which encourages us to waste £100 in manpower (which is not accountable) to "save" £5 in equipment (which is); and which often compels us to keep a train of machines whose output is worth £1,000 a day idle for a week to save £5 in air freight for a spare part. But the practical men who backed our venture from London were aware that it cost about £3,000 to put a man on Christmas Island and keep him there for a year—in other words, his day's work cost £10. To keep a man idle was a crime. If a machine reached the stage of eating up excessive manpower in repair and maintenance, it was cheaper to scrap it. Rather than maintain a huge stock of spares in a highly corrosive climate, it was cheaper to accept the cost of flying in spares when they were needed. Perhaps the greatest lesson we learned was that it really does *pay* to have an ample scale of plant—or not to put more men on to a job than there is adequate plant to support.

With the cold war becoming more and more of an economic war, it would no doubt be bad for an officer to work for too long with such priority behind him. But we get plenty of practice at working on a shoestring, and it is good for junior officers to have a taste of the power that a field troop can wield when it has all the plant that it needs. They will in the future be better able to judge when an "economy" is real and when it is false. They will be better able to recognize and exploit the opportunities when time is more important than money. And above all, as engineers they will have learned to "think big".

The Task

This sense of urgency has prevailed throughout the two and a half years since Task Force Grapple first landed on the Island; 28 Field Engineer Regiment led the way in June 1956, and in under twelve months they had done the essential engineer work to enable a number of high yield nuclear devices to be dropped from Valiant aircraft based on Christmas Island in the spring of 1957. These rounds were exploded near Malden Island, some 400 miles away. The work in this phase was described by Colonel J. C. Woollett in the *Journal* for December 1957. He also gave an excellent description of the Island, which I shall not, therefore, cover again.

After the experience of these first few rounds, it was decided that it was safe to fire subsequent tests some way off the coast of Christmas Island itself instead of at Malden. This meant building a fresh system of shelters and recording installations on Christmas Island, and part of 25 Field Engineer Regiment was flown out at short notice from the UK to do the essentials for the next test, which was fired in November 1957.

In January 1958, they were relieved by 38 Corps Engineer Regiment, and we saw the firing of several more rounds, ending with a grandstand finish of four rounds in August and September. Two months after that we came home.

Broadly speaking, our tasks were:—

(*a*) Development of the area in which the recording instruments were situated, and its reconstruction between rounds.

(*b*) Construction of new laboratories, darkrooms, etc in the camp and an airfield area for the scientists of the Atomic Weapons Research Establishment (AWRE).

(*c*) Construction of 55 miles of asphalt roads—17 miles two-way and 38 miles one-way.

(*d*) Conversion of the tented camp into a semi-permanent hutted camp. This job is still in hand.

(*e*) Completion of the earthwork for a new runway, to be asphalted by our successors.

Organization

The organization of the Regiment and its deployment during the months leading up to the final series of tests in August and September was broadly as follows:—

61 Fd Sqn	Instrument area
48 Fd Sqn	AWRE Base and airfield installations
12 Indep Fd Sqn (Plus Fijian Tp)	Buildings in Main Camp and Port
59 Fd Sqn	Roads and airfields (asphalting)
63 Fd Pk Sqn	Operating plant, quarry, workshops and E & M Troops

Our total strength was about 1,200 men.

In addition to the regiment, there were a further 600 soldiers in the permanent Island units, which do not change as units but turn over their men all through the year—73 Squadron who run the power stations, water, maintainance etc, the Port detachment, Postal, Signals, RASC, RAOC, REME, all under the HQ Army Task Group, whose Commander is the Chief Engineer.

The Regiment's allotment of Plant amounted to 270 machines, including

30 dozers
14 scrapers
15 graders
43 cranes and excavators
6 stone crushers
2 large Starmix Asphalt mixers

and a mass of rollers, dumpers, highlifts, forklifts, wheeled tractors, concrete mixers and bitumen boilers.

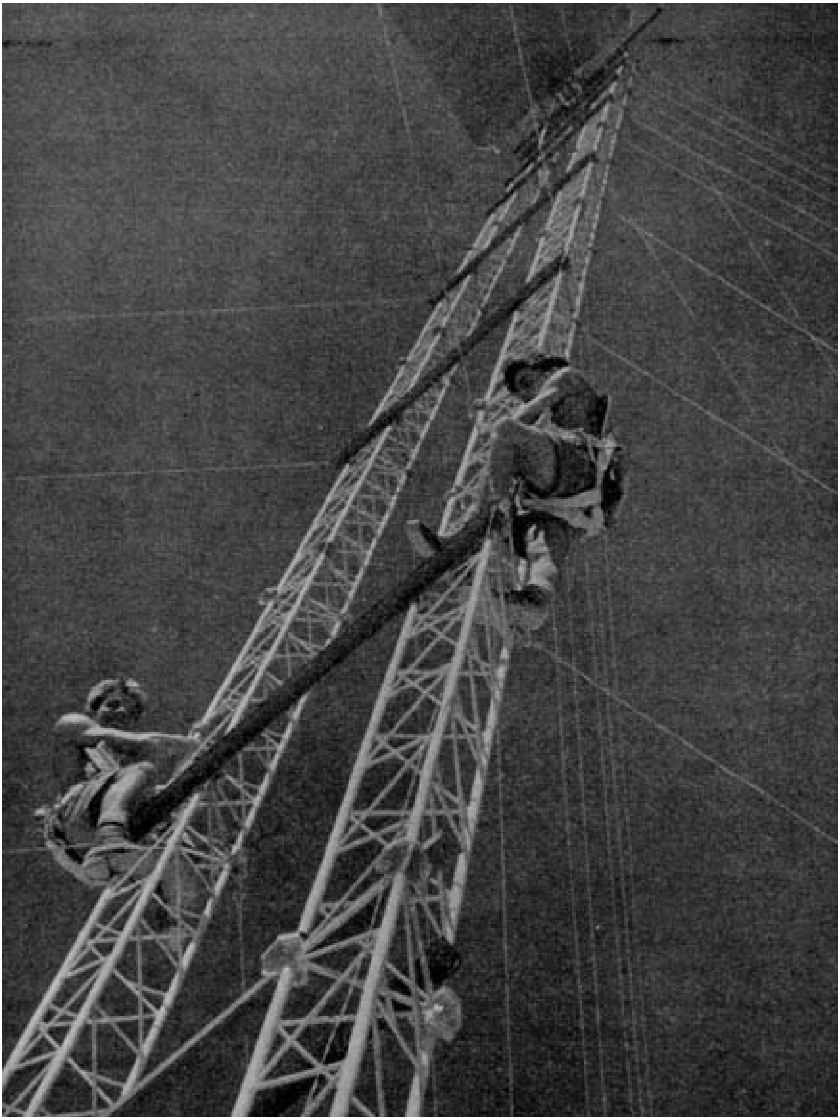
We worked flat out. This was a boon, because too much leisure on Christmas Island does more harm than good. For our first eight months on the Island, everyone worked six full days a week—Saturday afternoons included. Like 28 Regiment, we found that six days was enough. When men had to work on Sundays to meet target dates we gave them a day off later on.

I shall not attempt to describe everything we did, but will confine myself to trying to give an idea of the kind of tasks that arise in a project such as this, and to give evidence as to the value of such projects to field engineer units in terms of experience for war as it is being waged today.

Work for the Scientists

Until October, we had roughly two squadrons working directly for AWRE—one in the instrument area and one in the base/airfield area. In the former the work included the construction of buried steel cube shelters containing instruments for recording the various effects of the weapons. In some cases, the readings were recorded on film for collection after the test. In others, they were transmitted back to the Control Site, for which purpose we erected BICC masts, from 100 to 150 ft high, and fixed aerials and reflectors on the top. (Some of these weighed several hundredweight, and presented the instrument area sappers with some challenging problems.)

Every shelter was served by its own generators to operate the instruments inside; also its own air-conditioning plant, to keep the instruments at proper temperature and humidity and to make the shelters tolerable for the scientists to work in while preparing for the test.



Regiment In Top Gear 1

Regiment In Top Gear 2

Regiment In Top Gear 3

This led to the sappers performing their traditional function of being "first in—last out". In the early hours of the morning before each bang, the scientists making their final adjustments were accompanied by parties of sappers, who set the generators and cooling units to run reliably on their own for the next few hours, and finally secured and sandbagged the shelter doors when the scientists were ready to leave. Scientists and sappers then climbed into their Landrovers, and checked into the stations allotted to them in the "Personnel Safety Plan". Immediately after the bang, the sappers went forward with the Health Physics Team (who checked for radioactivity) to mark safe routes, put out fires and reopen the shelters.

There were about a hundred generators and cooling units in the instrument area. They were manned in shifts 24 hours a day for three months on end, covering the last four tests. The men manning them were widely dispersed and lightly supervised. A few were engine fitters and engine hands, but the majority were plain field engineers. They learned a great deal about engines in those months, because every man knew that a failure by his particular generator while the round was being fired would mean that no readings would be recorded by the instruments in that shelter. It was a challenge which they accepted, and there were no failures.

The last four rounds fired were crammed into one month exactly (23 August to 23 September 1958) sometimes with only eight or nine days gap. During these eight or nine days, the damage in the instrument area had to be repaired, and new work done for the next round. Some of the work was forecastable—new installations, and replacement of various BICC masts and other structures which were certain to be destroyed. Other damage was guesswork—fires and their effects, for example, cannot be forecast. But the complex organization behind each test necessitated the sappers giving an expected time of completion before the burst, and then being able to stick to it. We were all aware of the cost of delaying a test unnecessarily by an over-conservative forecast, so we assumed that everything would go with a swing. Many snags were possible, for example, in the erection of the masts and their top hamper, but we felt confident that the sappers who had erected them in slow time before the tests would show a sure touch in re-erecting them against the clock, and indeed they did. These sappers, incidentally were chosen from amongst many volunteers, and very few of them had ever worked at heights before.

Some of the rounds were fired from balloons suspended from anchorages on the ground, and others were dropped by Valiant bombers. In either case, great accuracy was required of the RAF in positioning or dropping the weapon, and by our surveyors in helping the scientists to get every instrument and camera accurately trained on the prescribed spot.

The work for the scientists in the back area consisted generally of building construction, with some particularly testing problems for tradesmen. Some of the laboratories looked like horrors taken from space fiction, particularly those with complicated ducting for extraction of contaminated dust and air. Other buildings, such as darkrooms, stores, offices, workshops etc were quite normal. One story will suffice to show the approach to these tasks. Just over a month before the last series, Grapple HQ (who were still in UK) sent a signal asking for a new AWRE building, with brief specifications. The signal was originated at 1605 hrs. It went through the aether the same way as the sun, but much faster, so it reached us before lunch. We switched men from another job, reconnoitred the site with the local AWRE representatives, and started setting out that afternoon, reporting that we had done so—before the time of origin of the London signal, much to the bewilderment of the Londoners.

Boffins have wild staring eyes, just as Colonels are blimps and Sergeants are bullies. You know that's wrong, I know that's wrong, but in Fleet Street and Filmland they know that's right. All the same, it's not. We found the scientists to be highly practical men, more interesting to talk to than most, with individuals as easy or as difficult as in any other body of men. Their organization, however, was very different from any service organization, in that there was very little "chain of command". They worked in some twenty "Groups" each basically responsible for some particular type of measurement (e.g. heat or blast). They were loosely co-ordinated by a scientific superintendent with a very small staff, who dealt with all twenty direct. Their engineering requirements were co-ordinated by the "Technical Services" Group whose relationship to us was in theory that of architect to contractor. But we found it best to keep our own co-ordination equally loose, and the troops generally tried to put into effect every bright idea produced by the men in the shelters on the spot, and only referred it back if they needed extra help. At times, the changes were maddening—for example, a request to lengthen or shorten a mast just after the aerial had with great difficulty been fixed on top. Such things are, however, inevitable in experimental work of any kind, and it doesn't help to moan about them.

The things we learned to refuse, however, were requests for particular tradesmen, because the men were nearly always wrongly employed. We insisted on being shown the job and then choosing our own men—the sound and ancient principle in dealing with all other arms and services. But generally, we reminded ourselves that the reason for our being on the Island at all was to enable the scientists to take readings from a bomb delivered at the required spot by the RAF—so whatever they wanted we tried to do.

Roads

We built an asphalt road at a rate of nearly a mile a day (or half a mile where it was two way). The total length of road was about fifty-five miles. The formation throughout is 36 ft wide (except where restricted by plantations etc). On 17 miles of it we laid a 24 ft asphalt surface. On the remaining 38 miles, a 12 ft width has been asphalted, leaving room for doubling up later if required.

This task was carried out by a field squadron specially organized for asphalting, supported by the Plant and Quarry Troops of the Field Park Squadron, and a fleet of tippers, initially operated by the regiment but later taken over by 94 Coy RASC.

The organization was as follows:—

	Approx. Requirement of Plant & MT (excl. reserve)	*Men*
Road formation		
Single shift 8 hrs per day	4 Euclid Scrapers 4 Dozers 4 Graders 2 Rollers	16

Quarry		
Three shifts	4 Crushers (20 tph)	92
24 hrs per day	6 Face Shovels	
	4 Dozers	
	2 Towed Scrapers	
	12 Dumpers	
Bitumen Boilers		
Three shifts	7 Distributors	50
24 hrs. per day	(1,000 gallons) plus a number of battered 250-gallon kettles	
	Also Cranes, Forklifts, Tractors etc.	
Asphalt Mixing		
Two shifts—14 hrs	1 Starmix 40	24
12 hrs output	2 Grabs	
	1 Dozer	
	2 Dumpers	
Asphalt Laying		
Two shifts—14 hrs	1 Barber Greene Layer	28
	1 Distributor (Spraying)	
	2 Rollers	
Transport		
Two shifts—14 hrs	30 3-Ton Tippers	90
	12 10-Ton Tippers	
	Total	300

The road formation required some cut and fill. Coarse or fine gravel, sand or lagoon mud could all be found locally, and were added as necessary to form a stable and well-grained base. One subaltern with a plant detachment made 40 miles of it—which was a worthwhile job to be given at the age of 22.

The Quarry produced an average of 1,100 cu yds of crushed stone per day, graded in three sizes (this provided for concreting and other construction work as well as for asphalting). The raw material was beach coral.

Manning the bitumen boilers was the nastiest job on the Island. Most of them were of ancient vintage, with very poor burners, which gave constant trouble and took their toll of casualties by firing back at the sappers who served them.

The Parker Starmix 40 Asphalt Mixer was excellent. In nine months working, it only once broke down for as much as a day, and never more. Its output was about 50 tons per hour—more in dry weather, less after rain (because of time to heat the stone). The best day's output was 690 tons; 600 tons a day was bogey, and this was enough for one mile of one way road.

The transport haul as the end of the road was reached was a 70-mile turnround. Using two drivers per truck, the RASC 10-ton tippers did five round trips per day—a tremendous achievement.

This roadmaking cycle was as delicately balanced as Nature. Increased efficiency on the Starmix 40 at once produced a stone crisis. More men were put in to man extra shifts on the crushers, and fitters in the quarry were stepped up to reduce stoppages. Face-shovels then became the bottleneck, so cranes were extracted from other tasks and re-rigged. Then the main frames of the Fowler dozers started to crack under the heavy work on beach coral so we reinforced with D7s and D8s. Quarry output reached a record of 1,430 tons in one day. This coincided with the road stretching farther and farther from the Starmix, and led to a transport crisis. The RASC rallied nobly, temporarily abandoning many cherished principles, and other tasks were pruned of tippers. The appetite of the Starmix for stone was satisfied—and then it overtook the combined output of all the filthy fire-spitting bitumen boilers on the Island. And so it went on till the road was finished. A mile a day proved to be our "sound barrier" and we seldom broke through it.

Airfields

We received orders to make a new runway in a signal from London, which gave the general area and the bearing, and the following month was taken up with reconnaissance, soils tests and discussion of specification with the RAF. The runway was to be 6,000 ft by 100 ft, with 50 ft shoulders either side. Natural drainage was possible by siting on top of a shallow ridge with 1 in 100 crossfall. The surface was to be 3 in of asphalt laid on a 6-in base of compacted lagoon mud.

The timing of the job was as follows:—

	Time	*Plant & Tpt*	*Men*
Reconnaissance			
Siting, survey, soil tests	1 month	Mechanical Augur	6
Clearing and Levelling			
Sandy soil with scrub	1 month	4 Euclid Scrapers	30
Cut 10,000 cu yds		4 Dozers	
Fill 9,000 cu yds		2 Graders	
		6 Rollers	
Mudding			
40,000 cu yds	$2\frac{1}{2}$ months	1 38 RB Dragline	50
excavated from borrow		2 19 RB Draglines	
pits about 500 yds		4 Euclid Scrapers	
from site, laid,		2 Towed Scrapers	
levelled and compacted.		6 Dozers	
To get below the water		5 Graders	
table, 27,000 cu yds		8 Rollers	
of overburden had to		9 10-Ton Tippers	
be removed.			
Asphalting			
3 in. in two courses	2 months	See "Roads" above	
		(being done by our successors.)	

Lagoon mud is a useful material with interesting properties. It consists of fine coral silt with a lime content. Provided that it is excavated from below the water table (average 3 ft in the borrow pits we used), and levelled and compacted before its moisture content has fallen below 15 per cent, it sets like cement, and CBR values of 70 to 140 were obtained. If, however, the set is disturbed after it has dried out below that critical mosture content, it will never set properly again and the CBR may be as low as 6. Levelling and compacting therefore demands highly skilled plant operating and control.

Regiment In Top Gear 4

We did not have enough Plant Operators to work shifts on this task. Allowing for maintenance, and a 20 min break from the equatorial sun every 2 hrs, the actual operating hours on the clock were 6 to 6½ hours a day. I doubt if more would have been practicable for a continuous period in this climate.

To get down to the water table, 27,000 cu yds of overburden had first to be removed. This was done by four Euclid 14 yard scrapers—superb machines—with push dozers. The mud itself was then dug out by one 38 RB and two 19 RB draglines. Nine 10-ton tippers kept pace with the task of carting it an average of 500 yards to the site. The day's output, measured theoretically in terms of dragline buckets or tipper loads, was 1,000 tons a day. In practice, because the mud was like thick soup, bucketloads and tipper loads were much reduced and, after compaction, the mud actually laid averaged only about 500 tons per day—which was just about all the levelling and compacting parties could cope with.

Surveyors were the decisive bottleneck. Only five teams (surveyor, chainman, pegdrivers etc) could be spared as there was much other work on the Island; 6 in of mud were laid in two 3-in layers. The laying, levelling and compacting of the top layer followed roughly the following sequence on each patch of runway in turn.

	Plant	*Svy Party*
Day 1—500 cu yds wet mud tipped and roughly spread (400 ft by 120 ft) to pegs laid by surveyor	Grader No 1 Tractors Rollers (WW)	No 1
Day 2—Mud Plastic (25 per cent to 15 per cent MC) Rolled and graded to about 1 in above final level	Grader No 2 Tractors Rollers (WW) Rollers (8 Ton)	No 2
Day 3—Accurate grading and rolling	Grader No 3 Rollers (8 Ton)	No 3
Day 4—Final adjustments to level	Grader No 4	No 4
Day 5—Final levels recorded		No 5
Day 8—CBR Tests	Mob CBR Machine (Improvised)	

From Day 3 onwards, the grading had to be extremely accurate, and it was essential to dispose of all mud which was cut, because the critical point for its set was past. Any cut below final level was irreparable—except by tearing up the whole 3-in layer and starting again, or filling it later with asphalt.

Once the mud had dried, the surface was so hard that the grader would scarcely touch it. It took in one case five passes to remove ⅛ in with the blade shuddering and screaming almost as loudly as the Plant Troop Commander, who was an agonised witness.

The asphalt was to be laid in the form of a 2 in binder course, and a 1 in surfacing course. It was undesirable to use stone smaller than maximum 1⅜ in for the binder course, and consequently any high spots left on the mud surface more than 1 in above datum level would present the asphalt layers with the task of laying a layer thinner than the size of the largest stone. In some areas, it was necessary to raise the whole asphalt surface level for the sake of a few high spots. In others, such highspots were assaulted by the graders, which returned to their dressing rooms with almost as much loss of rubber from their driving wheels as of mud from the surface. (Dozers, scarifiers, etc would, of course, have damaged the set and necessitated stripping and starting again.)

The solution to keeping within a tolerance of 1 in would have been to have more grader/surveyor teams, or enough water-bowsers to keep the mud plastic for a day or two longer. But even on Christmas Island we didn't have everything we wanted. We used all the bowsers and surveyors we could raise as it was. By the time we reached the final third of the strip the surveyors and grader teams had advanced in skill and co-operation, and there were no high spots above the tolerance at all. So, as with every other job on the Island, we were learning all the time.

Those who read Colonel Woollett's article may, incidentally, be interested to hear how the original runway has fared—the one surfaced by 28 Field Engineer Regiment in 1956 for the first series of tests. This consisted of a 1½-in layer of asphalt laid at great speed on top of the disused American lagoon mud strip. It was designed to last six months. It has taken all the operational and transport traffic for two years, and is still serviceable. It has subsided slightly along the junctions of the successive strips laid by the Barber-Greene, and long puddles collect there in wet weather. The asphalt is also beginning to crack in these places, and some cracks have penetrated the full 1½ in. Herein lies the danger, for a period of continuous heavy rain would cause softening of the lagoon mud under the cracks and could lead to a general collapse. But the prolonged survival of this runway is a tremendous credit to the quality of the work of the sappers who built it.

Accommodation, Administrative Buildings and Services

When our regiment came to the Island, virtually the only administrative buildings were the cookhouses and a Romney hut providing the nucleus for the NAAFI. Everything else—messes, dining-rooms, offices, sleeping accommodation, hospital wards—was in tents. Power stations consisted of generators in the open, and the Power Lines were becoming heavily overloaded. Roads were of loose gravel or mud. Sanitation was by Elsan. This was in January 1958, and the disadvantages of life under these conditions were well and truly brought home to the Regiment when it rained almost solidly for the next two months.

For most of our tour, the equivalent of only one field squadron could be spared to work on improving conditions in the camp. But after the September trials came to an end, we were able to build up to three field squadrons on it for our last 2½ months. The total effort expended on the camp was sixteen field squadron/months with Field Park Squadron support.

Their output included the following buildings and services:—

Messes for 400 officers and 600 Senior NCOs (all AWRE and other civilians had officer status).

Dining rooms for 3,000 ORs.

Junior Ranks Club, with Restaurant, for 3,000 ORs (23,000 sq ft).

Hospital with operating theatre.

Approx. 50,000 sq ft of hangars, store sheds etc for RAF and AWRE.

Offices, garages, education and newspaper buildings etc.

Additional cold storage (100 tons) and POL storage (250,000 gallons).

Two Power Stations, totalling 2,200 kVA, with new overhead distribution system.
Barrack rooms for about 1,000 men.
A Waterborne Sewage System with 108 WCs, 90 showers, 12 baths and 216 wash basins.

The most interesting and satisfying of these tasks were the Junior Ranks Club and the Sewage and Ablution system. The ablutions we completed before we left were in three blocks, and sewage was pumped through a series of four pumping stations to the sea two miles away. The wet sumps in the pumping stations provided particular problems because concrete made with coral is very porous, and because the water table was level with the bottom of the sump. (36 Regt tell us that the system they found at Port Said in 1956 was very like this. There are many other places to which the Strategic Reserve might be sent where similar conditions prevail, so our experience could prove useful.)

For those who like yardsticks, ninety sappers built hutted sleeping accommodation for ninety men per week. The huts were arranged in rooms for two to seven men apiece, lined with hard and softboard with timber floors on concrete foundations, concrete verandahs, louvred windows and bedside lamps. Put another way, a party of fifteen erected a hut for forty-five (seven rooms) in three weeks. These were imported prefabricated huts, but many other buildings were made of sections prefabricated in our own Workshops. If the imported hutting had not been available, seven men in the woodworker's shop could have prefabricated all that the ninety men could erect (6,000 sq ft of hutting a week). So the figure of each builder housing one customer per week would still roughly apply using normal raw materials.

Inter-Service Relations

The Task Force was commanded by an Air Vice Marshal, and the three services and the scientists were evenly balanced. It was a great experience to work with them, and with the RAF in particular, we were very closely integrated—for they administered the whole Task Force. I think we were all surprised at how very well this worked. This was due in great part to the personalities involved and I doubt if sappers have ever been better fed, in spite of being on a desert Island 9,000 miles from base. The RAF administrative system is designed for static conditions, and Christmas Island is fixed and immovable. In such conditions, I would in future always welcome centralized administration of all three services by one of them. It saved us an immense amount of trouble and worry. Seconds-in-Command could really concentrate on organizing plant, stores etc for their squadrons. All we had to run was our small Q staff—clothing and G 1098—with a total of eighteen men. Office staff for RHQ and five squadrons totalled thirty, and RAPC staff ten—i.e. a total of about sixty on administration out of 1,200. Everyone else worked as an engineer (or driver) all day and every day with no outside duties whatever—5 per cent administrators for 95 per cent producers.

It is difficult to talk about "Inter-Service Relations" without being pompous, but I will try to describe the prevailing atmosphere with a number of examples.

The ships of the Royal Navy scattered about the Pacific during the operation (mainly on weather duties), carried a number of sappers acting as sailors. The white caps of the sailors they relieved were to be seen bobbing about on our dozers and graders.

When we finished mudding our new runway, the RAF knew that the men who did the work would not be there to see the asphalting completed. They therefore flew in a Hastings, and did circuits from the mud strip until every man who had worked on it (seventy-seven) had taken off and landed on it. The pilot was OC Flying Wing and the co-pilot was the Station Commander.

Shortly before the last operation, one of the senior scientists toured the regiment, explaining the scientific side of the tests to six groups of about 200 in turn, and answering their questions. (Some of the questions were remarkably shrewd, though there were the usual few silly ones. The silliest came from a gate-crashing sailor. "Are you working for the good of mankind," asked the sailor in a voice of doom, "or his destruction?" "I," said the scientist, "am working for the Government to earn my living. What about you?")

The crew of the Valiant which dropped the last bomb had a few days to "unwind" before they flew their Valiant home. They spent one of these at the controls of the scrapers and draglines building the new runway, and responded by showing the plant operators round their Valiant. They ended the day with a talk to the RE Association followed by questions and discussion over the beer lasting far into the night.

Regimental Matters

There is a school of thought that anything other than military training and field engineering drags a field unit down. I agree that "Minor works"—i.e. modifications and maintenance of existing buildings—does do harm, and is a most unsuitable and uneconomical employment for young fighting soldiers. But a big engineering project such as Christmas Island—particularly when it is done under difficult conditions and against time—is a most stimulating task. As well as giving invaluable technical experience (which encourages men to stay in the Corps), it produces a team spirit which will pay dividends everywhere.

One of our joys was that there was so much to do that no one had time to do the job of the next man down. The prevailing trouble on peacetime establishments is "too many Chiefs and too few Indians." Supervision becomes too heavy at every level, and no officer can give of his best if the back of his neck is constantly chilled by the icy breath of the author of his next Confidential Report.

With five squadrons in the regiment on Christmas Island, there was little risk of this. A troop leader often had anything up to seven jobs in hand at once. He quickly learned to organize his work and to look ahead over stores, plant and transport. He got into a ghastly mess if he didn't, and he knew it was obvious to his sappers when he was to blame. His squadron commander had far too much to do to help him out all the time so he either made good or lost command of his troop. The same applied to NCOs. They were judged on their results, and there were no alibis.

Similarly, all the squadron commanders had virtual autonomy in their own spheres, and of course they thrived on it. We ran with a very small RHQ, and I am sure that we all gained in efficiency by commanding more rather than fewer sub-units. If economies are needed, might we not gain by cutting down the number of HQs of groups and regiments and giving each one more squadrons to command?

In spite of sensational publicity in certain newspapers (which was in no case inspired by soldiers) we found that morale was no problem. The lack of girls and home atmosphere was offset by the fact that there was plenty of work to do, a good reason for doing it, and something to show for it when it was done. To build something that is wanted and will be used is far more satisfying than to build it for the sake of building it in training. Complaints that work was too hard were almost unknown. On the contrary, I was repeatedly asked by sappers in conversation why the Army didn't always work like this. The bangs helped to provide a climax, of course, but there was no noticeable falling off in effort afterwards, when we switched on to building accommodation and amenities. This seemed to be a worthwhile job, and the fact that the men would not themselves reap the benefit made no difference at all.

Discipline also came naturally under such conditions, and crime was low. NCOs had to assert themselves on the job, and carried the habit with them into the tent lines. Drill parades were only held on special occasions—on the Queen's Birthday and a Farewell Parade when we left—in each case with only one rehearsal. On both occasions, the sappers entered into the spirit of it, and more than made up for lack of practice by a conscious desire to be smart and soldierly.

Their tour on Christmas Island, in fact, did not make them go down hill regimentally. On the contrary, it made them prouder to be soldiers, and gave them a deeper sense of discipline. So much so that one of the inhabitants of San Francisco wrote to the Minister of Defence commenting on their smartness and bearing in the streets of that city when we staged there on our flight home.

Training for Modern War

During 1958 the regiment fired no weapons, handled no explosives, ferried no tanks, did no screaming down the wireless, and laid no barrier minefields. Yet I am convinced that 1958 gave us the best training for modern war that Field Force sappers could have. For modern war—the war of the 1950's—is surely not nuclear war. It is the cold war. The past ten years have seen it, rumbling and flaring up in varying degrees in Trieste, Berlin, Palestine, Malaya, Persia, Korea, Kenya, Cyprus, the Trucial States, Egypt and Jordan. Since both sides would seem likely to lose more either by abandoning the struggle or by turning savage with nuclear weapons, the pattern seems likely to continue in the 1960's.

Cold war is waged primarily by infantrymen in parties of five to twenty, in the jungles or the hills or the disreputable quarters of insanitary towns. The task of the sappers supporting them has included a great deal more engineering and a great deal less assault pioneering than we used to do in the more spectacular battles of the Second World War.

In addition to the normal engineering tasks of enabling the other arms and services to establish themselves on the ground, to get their supplies and equipment by sea and by air, and to live and to move and to fight, our work in the past ten years has been taking increasing account of the effect it can have on the local population, for whose hearts and minds we are fighting. By making the insanitary towns less insanitary, we safeguard the health not only of the troops but also of Asian or African mothers and babies. Better port facilities, airfields and roads bring trade and prosperity, and prosperity brings reaction against violence and revolution.

There are people who will think that this sounds tame and old-fashioned compared with buzzing about the Soltau training area in a dingo, co-ordinating the Corps obstacle plan in conditions of nuclear sufficiency. We have been doing that kind of thing with half our army every training season for years, and one day perhaps some of them might do something like it in earnest. That is a matter of conjecture.

What is quite certain, however, is that most of the regulars amongst them will some time find themselves taking part in real operations in the Middle or Far East, where the rifles have been firing all the time and where the sappers continue to go doggedly about their business in support. We could well devote less energy to training for the next war and more to winning the current war.

The cold war problems of the sappers in establishing a force of all three services to do warlike things in an administrative desert are precisely those which faced us on Christmas Island. Many hundreds of the regular officers and NCOs of the Corps have now done a tour there, and are thereby the better trained for the war in which many of them are already once more involved. The Corps would do well to seek more such projects as Christmas Island, and to accept calculated risks in peaceful theatres to find the units to do them.

The Use of Modern Flexible Containers in Water Supply

By MAJOR H. D. VERNON-BETTS, RE

INTRODUCTION

THE development of large flexible containers for the storage of petroleum products has now reached an advanced stage. The time has come when serious consideration should be given to the use of these containers by the Services for the storage of bulk liquids other than petroleum.

This paper describes the present position and discusses the use of flexible containers for the carriage and bulk storage of drinking water in the field.

GENERAL

Both the Americans and ourselves are working to develop a satisfactory flexible tank for the storage of bulk petroleum products. The common term for these containers is "Pillow Tanks". Considerable success has been achieved in both countries, but the main difficulty of storing high aromatic petrol at high temperatures has not yet been overcome. However, the other problems of construction, optimum shape, weathering, abrasion, permeability and so on have been virtually solved. Pillow tanks will hold water almost indefinitely.

In the United Kingdom, both the Ministry of Supply and Industry are working on pillow tanks. The main effort is towards petroleum storage, but at least two firms are engaged in private ventures involving tanks for the carriage and storage of other liquids.

One of the firms, Marston Excelsior Ltd, is a subsidiary of Imperial Chemical Industries. For many years they have had experience in making flexible aircraft fuel tanks. Their "Portolite" tank has recently been announced. It is made in sizes ranging from 500 gallons up to 3,000 gallons, or to the customer's order. It is constructed of a number of layers of rubber-coated nylon fabric. The outer layer is abrasion and weather resistant neoprene synthetic rubber, while the inside is lined with a natural or synthetic rubber or other material resistant to the liquid to be carried.

Photo 1 shows the Portolite tank loaded on a 3-ton lorry. Note the webbing harness to restrain the tank while the truck is on the move.

Another firm, Fireproof Tanks Ltd, also make flexible aircraft fuel tanks and are the only other firm engaged on small pillow tank work. Their development is not so far advanced as Marston Excelsior, but they have some promising ideas in hand.

At a small demonstration at their works in Portsmouth on 30 September 1958 they showed their first 1,000-gallon pillow tank. The tank is made of five thicknesses of terylene cloth impregnated with soluble nylon. The panels are joined by a high frequency welding process, eliminating the troubles sometimes experienced with adhesives. It is 12 ft long, 6 ft wide and about 2 ft high when filled. When empty it weighs 65 lb and can be put in a small suitcase.

The tank was loaded into a long wheel base Bedford 3-tonner, filled with 700 gallons (approx. 3 tons) of water and driven about the streets of Portsmouth. Spectators sat on a bench with their backs to the driver's cab. The tank surged considerably in all directions depending on the movements of the vehicle. However, it was seen that the bottom of the tank did not move in relation to the floor of the truck and that the movement was confined to the top and sides of the tank. On sharp corners the side of the tank sometimes touched the truck side but without any undue force.

After about three miles of road travel, the truck was run on to some waste ground and driven about. The tank surged more violently of course but with no adverse effect. The driver reported no undue difficulty but said that he could "feel" the load shift when he changed gear or cornered sharply.

The truck was then run on to a sideways slope. The truck side was removed and the vehicle moved off. As the side slope increased, the tank "flowed" off the truck, fell 3 ft 6 in on to the ground, rolled rapidly down the hill and stopped in a ditch. The tank was completely unharmed. This operation has been performed three times and on no occasion has the tank been damaged.

The demonstration showed three things:—

(*a*) A tank made of this material will stand up to any stresses induced by movement in a vehicle. The material has a strength of 500 lb/in width as measured on the British Standard one minute tensile test. As the load/time curve is asymptotic to the load axis, the material can take very high loads for short periods of the order of a few seconds.

(*b*) Although it behaved satisfactorily unrestrained, the general concensus of opinion was that some means of limiting surge was desirable for long term use. This would either take the form of an external harness similar to the Portolite tank, or internal bracing and baffles, or a combination of the two.

(*c*) This type of fluid load does not impose undue strain on the driver, nor apparently on the vehicle.

The Water Truck

The unit water truck has three main functions:—

(*a*) Fetching water from the water point and distributing it in unit lines.

(*b*) Supplying a unit on the march with water.

(*c*) Spraying water on roads for dust laying or in airfield construction.

Very occasionally the truck may be called on to use its built-in equipment for pumping and filtering crude water. This requirement usually arises only with small detachments in isolated areas.

In common with all specialized vehicles, the water truck suffers from certain limitations. If it breaks down, there is no alternative means of fetching and carrying water. It always has to travel one way unloaded. If the unit has access to a piped water supply, the vehicle cannot be used for any other purpose and simply remains in the lines as an unwanted maintenance commitment. Repair or replacement of damaged tanks is difficult.

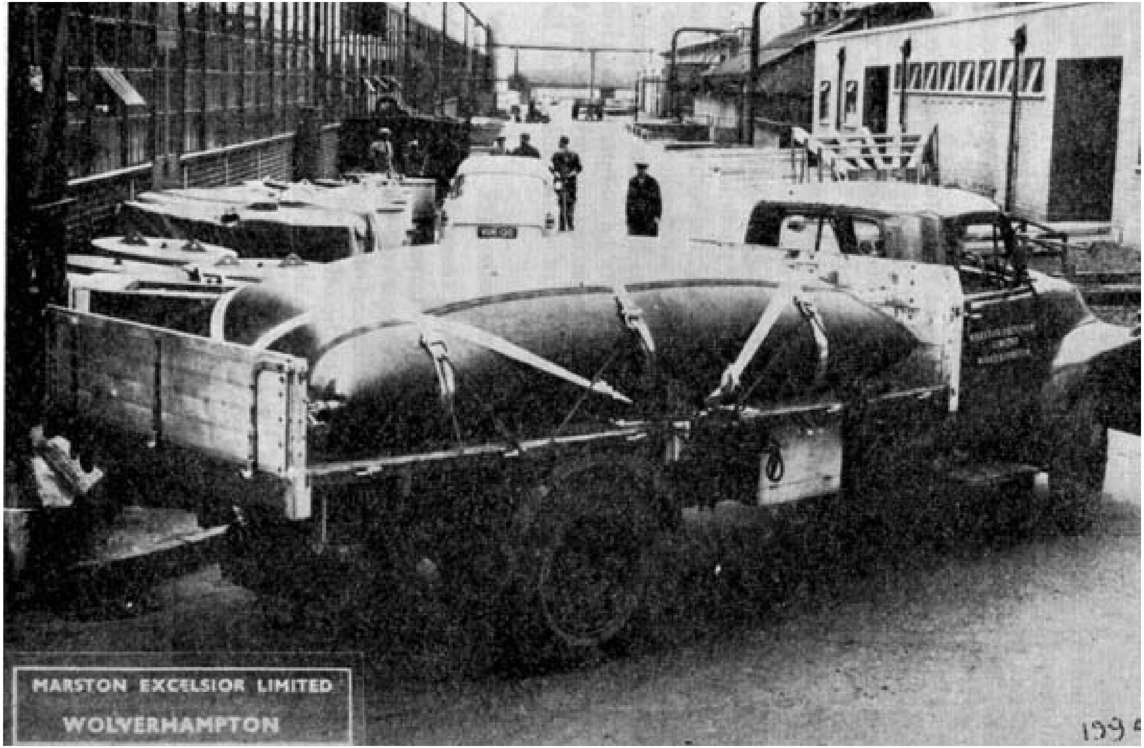
The Alternative

The alternative to the water truck is the small pillow tank. Instead of having a one-purpose specialized vehicle to carry water, units could be issued with one or two small pillow tanks which could be carried in any vehicle. If it breaks down, another vehicle can be used. The vehicle can carry a useful load one-way. When there is no water supply requirement, the tanks can be rolled up and stored. Repair of tanks is usually simple and replacement economical in weight and shipping space.

A number of water trucks would have to be kept of course for use in isolated areas. However, even this small number can be eliminated when the new 1,000 g.p.h. water purification trailer is in production. This trailer, together with one or two small pillow tanks, will give the same service as a water truck.

The detailed technique of handling small pillow tanks is a matter for trials and experiments. Certain facts are, however, known or can be deduced. There are for instance two ways of unloading a filled tank; one is to tip it off the vehicle as happened in the demonstration; the other is to empty the tank by hose into another tank on the ground. As far as tipping off is concerned, obviously some preparation and practice would be needed. An earth bund would be required to stop the tank rolling and the tank would have to be tipped off at the correct distance from the bund to ensure that it landed the right way up.

Attractive though this method is, it would probably lead to damage eventually, and the alternative of emptying by hose would be safer. One great advantage of the pillow tank is that only one hose connexion is required for filling and emptying and this connexion can be in the top of the tank. So far, the best method found has been to connect a length of suction hose to the tank with a valve on the end of the hose. For filling, this valve is connected to the supply. When the tank is full enough, the valve is closed, the hose remaining full of water. Even if the tank is on the ground, when the valve is opened, water will flow out of the tank until it is completely empty. The additional head which produces this effect is small and in order to fill cooking pots and bottles it would probably be necessary to put the tank on a low bank or to dig a hole for the containers.



The use of modern flexible containers in water supply 1

Another advantage of the pillow tank is that it can be made to the exact shape to suit the customer's requirements. For example a tank with recesses to fit the wheel boxes in a 3-ton truck is possible; a special tank to fit in a jeep trailer can be made; large tanks for 10-ton trucks are another alternative.

The Water Point

The standard storage tank for the water point is the 1,200 gallon circular canvas tank with a floating rim, known as the S-tank. These tanks are very susceptible to damage, have no proper hose connexions and, due to their small capacity, have to be used in considerable numbers. A canvas cover is sometimes provided, but since this doubles as a transport bag, it is usually too dirty to use as a cover. These tanks are easily damaged by ice formation in cold weather.

The alternative is the large pillow tank of up to 10,000 gallon capacity. This size is 42 ft long, 14 ft wide and 3 ft 9 in high when filled. It weighs 930 lb empty and three can be carried in their boxes in a 3-ton truck. Used with a Patterson trailer, they provide the perfect means of portable, clean bulk storage at the water point. They can be frozen solid without damage. The question of keeping the tank clean inside would have to be checked. However, since the water is not exposed to sunlight, algae could not form, and since the draw-off is from the top, sediment would not be a problem. If periodic cleaning out is found to be necessary, the solution lies in the method of manufacture of these large tanks. They are made in the shape of open ended tubes, the ends of which are clamped by means of a special flexible metallic end closure. The tanks can therefore be re-opened for cleaning.

The saving in ground space, transport space, pipework, and the time and labour necessary to operate a multitude of small tanks, will be readily appreciated.

Bulk Storage Reservoirs

One other aspect of petroleum storage research which has water supply applications is the "Polpond". The use of tarpaulin lined dish-type reservoirs is not new. The idea of supplying the reservoir with a floating roof is new. In its simplest terms this means that instead of laying one sheet in the excavation two sheets are used one on top of the other. They are secured round the edges and water is pumped between the sheets. The top sheet then floats up on the water preventing the entry of dust and debris and eliminating evaporation. By the use of plastic sheets, very large reservoirs of the order of ½ million gallons capacity can be made. The plastic lined pond is now being increasingly used in agriculture for water storage although, so far, without the floating roof.

Prices

The price of a 1,000 gallon Portolite tank is quoted at £220. The Fireproof Tanks Ltd tank is quoted at about £200 to £250. The Ministry of Supply 10,000 gallon pillow tank, at present in limited production, costs £1,800. However, all these tanks are designed for petroleum products and, generally speaking, use more expensive materials than would be necessary for water. The price would also come down with quantity production. It is estimated that a 700-gallon (i.e. 3 ton capacity) pillow tank could be made for not more than £150. The 10,000-gallon tank could probably be brought down to about £1,200.

Conclusions

The financial benefits to be obtained from this scheme are alone sufficient to make it worthwhile. The virtual elimination of a vehicle from unit holdings offers many attractions particularly as it is an expensive vehicle to produce and maintain.

The financial saving in the large size pillow tank is negligible, but the increase in efficiency and the saving in manpower, equipment and transport is of great value. The same arguments apply to the construction of large reservoirs although in this case the financial saving would be considerable, while the saving in time and man hours would be very large indeed.

It is, therefore, suggested that development of existing petroleum storage equipment should be undertaken with a view to its use in all fields of carriage and storage of water for the Services. Particular emphasis should be placed on the small pillow tank to supersede the water truck and on the 10,000-gallon pillow tank for the water point.

Estimating Plant Required for Major Military Engineering Projects

By Colonel C. E. Warth, AMICE

Introduction

The aim of this paper is to encourage thought, suggestions and correspondence on the problem of the broad estimating of plant requirements for a major military engineering project or for a theatre of operations.

In the Royal Engineers one of our current cries is "we must be more plant-minded." There is some doubt as to what this cry really means. On a low level of engineer planning it is now normal for the RE Officer to think about employing plant to execute as much of a task as possible and only to use men to supplement the plant work or to do such work as cannot be effectively done by plant. By now a large number of officers have knowledge and often experience of estimating plant requirements for the smaller tasks or projects and of how to plan its efficient use. The recent introduction of the Military Plant Foreman should do much to eliminate past short-comings in the actual application of plant and its efficient employment on a site. Where there is still scope for improvements is in finding a logical, simple and sound method of estimating plant needed for a major project or for a theatre of operations as a whole.

As for any equipment, the provisioning of plant requires justification and there is none so good as logical calculation. Without good justification a project or a theatre may be starved of its essential minimum plant needs.

The problem of estimating plant requirements for a major military engineering project cannot be compared with that for a large civil engineering project for which months or even years of preliminary planning, design and abstracting of quantities should provide a wealth of information. Nor can it be compared with a single military task or small project for which at an early stage a rough programme of work can be quickly produced. Our particular problem is to estimate plant requirements when the scope of work is expressed in such broad terms as the number of airfields to be built, the miles of road to be constructed or the tonnage of stores to be held. There is unlikely to be any knowledge of quantities and little of site conditions.

It is often easy to obtain rough estimates of labour requirements *but the principle of allotting plant on a basis of proportion of machines to the number of men employed is entirely out of keeping with modern organization and planning in which the labour should merely be an adjunct to the plant.*

Engineer Planning Data

All engineer planning, whether at a low level dealing with details or at a high level dealing in broad terms, has the same aim, namely to ensure that the men, machines and materials required to execute the engineer work are provided at the right place, at the right time. To satisfy this aim both provisioning and movement have to be planned.

Many sources of data for broad planning are available, the most comprehensive being Engineer Stores Bricks. All sources provide valuable data capable of ready interpretation and application for assessing labour and materials, but no really satisfactory system exists for estimating plant requirements.

In the case of labour, units of squadron-weeks or man-days for individual tasks can be added together to give a total for the project. Likewise stores tonnages or items of stores required for the individual tasks can be added together.

The total of squadron-weeks required for a project when divided by the number of weeks available gives the number of squadrons required. (Note for simplicity of explanation no account is being taken of contingency, weather or other factors.) As an example consider a project of four tasks, selected from four Engineer Stores Bricks, requiring labour as shown below:—

Task	*Sqn-weeks*	*Civilian man-weeks*
A	72	23,108
B	34¼	9,435
C	35	16,950
D	10½	2,252
Total	151¾	51,745

If this project has to be completed in approximately one year, then obviously the labour force required is about three squadrons and 1,000 civilian men.

It is as well to observe here that no effort has so far been made to assess the number of each type of tradesman required, since it is assumed that the squadron has roughly the appropriate proportion of each type and that any adjustments can be made when recruiting civilian labour.

In the case of estimates for materials, calculations are even easier than for labour and involve merely the addition of tonnages or of individual items for each task.

When considering plant, the information provided by Stores Bricks appears at first sight to be ideal. For each type of machine, the number of machine-hours of work to be done is given. In fact this information is only useful for compiling a detailed programme of work and there appears to be no way in which it can be used in a simple manner for broad planning. The reasons for this will now be considered.

The Plant Problem

When considering labour, the available working time should be known. This is not so for plant since on practically no task can an item of plant work for the whole period of construction. The reason for this although obvious is illustrated by the two following examples in, let us suppose, the construction of a depot:—

(*a*) An 8 cu yd scraper cannot be expected to start preparing the site and still to be working on it as the finishing touches are put to the last structure.

(*b*) A concrete mixer cannot start to be used until site preparation and excavation have at least made some progress, nor is it likely that it can be usefully employed up to the very end of the construction time.

It is obvious that the fraction of the whole construction period for which a machine works depends on the type of task, the type of machine and the site conditions.

Although the number of variables appears excessive for estimating, certain assumptions have to be made when making rough estimates for labour and it should be possible to make assumptions regarding working time for plant. For real simplicity it would be preferable to eliminate the detail of types of machine as one eliminates the detail of types of tradesmen in the case of labour estimates. In effect the aim should be to calculate the total number of machines and, at a later stage, use some scale to work out the distribution by types. The possibility of doing this will be examined later, but it must be admitted from the outset that plant falls into at least two very different categories—earth moving plant and project equipment. Whereas the former is employed on nearly every task the latter is employed in very varying degrees and often not at all. As with labour which is split into the categories of military and civilian, some degree of separation is likely to be necessary in the case of plant.

Analysis of Plant Work

Data exists for plant work required on constructing one mile of 18 ft wide heavy duty road (from an Engineer Stores Brick) and for a transport airfield in undulating country (from a fully worked project). A comparison between these is interesting, for it shows that in both cases the plant work in machine hours is divided in the same ratio, 73 per cent for earth moving plant and 27 per cent for project equipment.

The project for the transport airfield having been fully analysed provides further interesting information such as:—

(*a*) The average time worked by earth moving machines is 25 per cent of the whole construction time. The average for project equipment machines is about the same.

(*b*) In the case of individual machines the variation is considerable (from 24 per cent to 38 per cent for earth moving plant and 4 per cent to 66 per cent for project equipment).

If, however, one team of machines and men were to construct four such airfields in planned sequence, by good programming the average time worked by machines can be raised from 25 per cent to 44 per cent. Thus even on

TABLE I

MACHINE-WEEKS OF WORK BY PLANT ON A PROJECT

TASK	EARTH-MOVING PLANT					PROJECT EQUIPMENT							
	TYPES OF MACHINE					TYPES OF MACHINE							
	P	Q	R	S	Total	T	U	V	W	X	Y	Total	Z
A	52·9	70·0	61·2	44·7	228·8	60·5	7·0	7·0	29·0	7·0		110·5	6·1
B	18·7	85·0	49·2	25·4	178·3	7·1	4·5	4·5	13·9	4·5		34·5	13·6
C	36·4	134·3	73·9	32·5	277·1	41·8	12·3	12·3	34·8		12·3	113·5	27·3
D	6·2	12·9	6·5	4·9	30·5	4·2	0·8	0·8	1·8	0·8		8·4	
Total	114·2	302·2	190·8	107·5	714·7	113·6	24·6	24·6	79·5	12·3	12·3	266·9	47·0

KEY TO MACHINE TYPES USED IN TABLES I, II, III, IV & V :-

P = Tractor, Angledozer, Size II
Q = 8cu.yd Scraper with Tractor.
R = Grader.
S = Trencher
T = Concrete Mixer (10 NT)
U = Paver, self-propelled.
V = Mixer, asphalt
W = Roller, smooth-wheeled (8 to 10 Ton)
X = Roller, rubber-tyred
Y = Roller, wobbly-wheeled
Z = Dumper

TABLE II MACHINES & LABOUR PER SQUADRON

	LABOUR		EARTH-MOVING PLANT					PROJECT EQUIPMENT					
	Sans	Civ	P	Q	R	S	Total	T	U	V	W	X & Y	Total
A	1	320	0·73	0·97	0·85	0·62	3·17	0·84	0·10	0·10	0·40	0·10	1·54
B	1	376	0·54	2·48	1·44	0·74	5·23	0·21	0·13	0·13	0·41	0·13	1·00
C	1	484	1·04	3·84	2·11	0·93	7·92	1·19	0·35	0·35	0·99	0·35	3·24
D	1	214	0·59	1·23	0·62	0·47	2·91	0·40	0·08	0·08	0·17	0·08	0·81
Average			0·69	1·99	1·26	0·71	4·70	0·75	0·16	0·16	0·52	0·16	1·76
Max Deviation			51 %	93%	67%	35%	68%	72%	119%	119%	90%	119%	84%

TABLE III MACHINES PER 1000 WORKING MEN

	P	Q	R	S	Total	T	U	V	W	X & Y	Total
A	1·67	2·21	1·93	1·41	7·22	1·91	0·22	0·22	0·91	0·22	3·48
B	1·39	6·30	3·65	1·88	13·22	0·53	0·33	0·33	1·03	0·33	2·55
C	1·73	6·34	3·49	1·53	13·09	1·97	0·58	0·58	1·64	0·58	5·35
D	1·77	3·68	1·85	1·40	8·70	1·20	0·23	0·23	0·51	0·23	2·40
Average	1·64	4·32	2·73	1·54	10·02	1·62	0·35	0·35	1·15	0·35	3·81
Max Deviation	15%	49%	32%	22%	31%	67%	66%	66%	55%	66%	40%

TABLE IV MACHINES PER ANGLEDOZER

	P	Q	R	S	Total	T	U	V	W	X & Y	Total
A	1·0	1·32	1·16	0·85	4·33	1·14	0·13	0·13	0·55	0·13	2·09
B	1·0	4·55	2·63	1·36	9·53	0·38	0·24	0·24	0·74	0·24	1·85
C	1·0	3·69	2·03	0·89	7·60	1·15	0·34	0·34	0·96	0·34	3·12
D	1·0	2·08	1·05	0·79	4·92	0·68	0·13	0·13	0·29	0·13	1·32
Average		2·65	1·67	0·94	6·26	0·99	0·22	0·22	0·70	0·22	2·34
Max Deviation		72%	57%	45%	52%	62%	55%	55%	59%	55%	43%

TABLE V MACHINES PER TRACTOR

	P	Q	R	S	Total	T	U	V	W	X & Y	Total
A	0·43	0·57	0·50	0·36	1·86	0·49	0·06	0·06	0·24	0·06	0·90
B	0·18	0·82	0·48	0·25	1·72	0·07	0·04	0·04	0·13	0·04	0·33
C	0·21	0·79	0·43	0·19	1·62	0·25	0·07	0·07	0·20	0·07	0·67
D	0·33	0·68	0·34	0·26	1·60	0·22	0·04	0·04	0·19	0·04	0·44
Average	0·28	0·73	0·46	0·26	1·72	0·27	0·06	0·06	0·19	0·06	0·64
Max Deviation	57%	22%	26%	40%	13%	76%	29%	29%	51%	29%	48%

one type of work a rule-of-thumb factor for working time would be difficult to assess.

Table I shows the plant work required for a project comprising the four tasks A, B, C and D, previously used to illustrate labour calculations. It is believed to be purely accidental that the proportions of work for earth-moving plant and project equipment happen once again to be respectively 73 per cent and 27 per cent but this fact might be worthy of further investigation with regard to actual tasks recently carried out.

In Tables II, III, IV and V attempts have been made to find a common denominator which can be used to relate the required number of each type of machine either to labour or to one particular standard machine. The only conclusion which can be drawn is that the variation from task to task is too great to give a reliable relationship, although

(*a*) For labour, Table III (all labour) gives better results than Table II (squadrons only).

(*b*) For a standard machine Table V (all tractors) gives better results than Table IV (angle dozers only).

It therefore appears necessary to make a separate calculation for each type of machine. If this is so then the logical method is to divide the total machine-weeks for any type of machine by the probable working time for that type. The probable working time might be assessed by taking some fraction, to be known as the utilization factor, of the total construction time for the project. This utilization factor could only be determined for each type of machine by statistical analysis which has probably never been applied to military plant. Such an analysis has, however, been carried out by the Building Research Station in the case of plant employed by civilian contractors.

Table VI gives an extract from Table 2 of *BRS Digest* No. 113 of August 1958, to which have been added the deduced utilization factors. Thus it will be seen that on an average a tractor only works for 165 days per year which gives a utilization factor of 0.45. A further deduction from this table is that for every ten tractors at work, twenty-two must be held of which

TABLE VI

TYPE OF MACHINE	Days per Year spent		Utilisation Factor
	On Site	Working	
Concrete Mixers	190	75	0·205
Dumpers	200	165	0·45
Excavators	225	175	0·48
Tractors & Shovels	215	165	0·45
Compressors	200	140	0·38
Compressor Tools	90	25	0·07
Road Rollers	200	140	0·38

thirteen may be expected to be on working sites. Clearly such data should be of real value for engineer planning although there is little doubt that the utilization factors for civilian plant would be considerably higher than those for military plant. The reason for this is that a civilian contractor can work to far narrower margins for contingencies due to a more accurate knowledge of his commitments, his ability to hire additional plant at short notice and his ability to purchase both spares and additional plant rapidly in an emergency.

Summary

Limitations of planning time and lack of information on quantities at present leave us with no satisfactory system for making an estimate of plant requirements for a major military engineering project, yet on such an estimate depends the adequate initial provisioning of plant.

There appears to be no fixed relationship between the numbers of each type of machine required nor between the numbers of machines required and the labour employed.

The most likely line of approach to solve this problem appears to be by estimating, for each type of machine, the numbers of machine-weeks of work to be executed and to divide this by the probable working time. In effect a formula of the following type might be used:—

$$\text{Number of graders required} = \frac{\text{Number of grader-weeks of work}}{\text{Period of project in weeks} \times \text{ultilization factor}}$$

Such a procedure necessitates the derivation of utilization factors from statistical analysis.

The more thought, suggestions and data based on practical experience that can be contributed to this problem the more likely is a sound solution to be evolved. Above all else in importance is the fact that, in an age when planning of work should be based on what machines can do, it is unsound to provide plant by arbitrary scaling to labour requirements. The greater the shortage of manpower the greater must be the amount of plant provided.

Acknowledgement

The author wishes to express his thanks to the Director of the Building Research Station for permission to use the very valuable information provided in *BRS Digest* No. 113.

The Computer as an Aid to the Planning of Engineer Work

By Lieut-Colonel P. M. Ronaldson (Retd)

Introduction

The advent of automatic electronic digital computers gave rise to a new era of mathematical work in university research, nuclear physics, and aircraft design. The introduction of automatic coding systems has now made computers easy to use, and they are being employed more and more by engineers for the better preparation of designs. The results are more efficient, more accurate, obtained more quickly, and unaffected by human fatigue.

Problems which were formerly intractable are being solved by methods which could not reasonably have been attempted before.

The Survey Branch has taken the lead in the automation of numerical processes, and the purpose of this article is to suggest that the use of computers can lead to really significant improvements in other fields of military engineering activity, not only in speeding up planning procedures, but also in so improving the plans that time and effort are saved in the execution of the work.

To dispel any doubts about the practicability of the Corps making widespread use of computers it should be explained that a simplified coding system can be understood by a Sapper Officer in a day or two, and he can develop fair programmes within a week. A particular new computer is transportable, weighing about 11 cwt and occupying little more space than a large desk, and it has stood up well to considerable rough-handling followed by long periods of continuous operation.

For an example of the potentialities of computers, reference is made to the article in the *RE Journal* of June 1959, by Lieut-Colonel Warth, on the subject of Earth-Moving Computations for Military Airfield Construction. He has done much to rationalize the procedure, but I believe that far from proving that computers are dispensable, he has shown the way to applying a computer to obtain an earlier, more accurate, and more efficient earth-moving plan, which will lead to quicker airfield construction with less effort.

The Airfield Problem

It is required to devise an earth-moving plan which satisfies the following conditions:—

(i) The rate of change of longitudinal gradient is restricted.

(ii) The maximum gradient is restricted.

(iii) The proximity of intersection points on vertical curves is restricted.

(iv) The maximum and minimum cross falls are restricted and must remain constant along the whole length of the runway.

(v) The cross-fall on the shoulders is restricted.

(vi) The longitudinal haul of earth-movement is to be minimized.

(vii) *Topsoil* is to be discarded.

(viii) Material from "cut" which is unsuitable for "fill" is to be discarded.

(ix) The formation cross-section is to be adjusted to allow for the depth of pavement.

(x) The compaction factor for cut re-used in fill is to be applied.

The statement of any problem in terms such as those given above, provides a suitable basis from which to determine the procedure by which a computer may be brought into use.

Characteristics of the Digital Computer

A computer is much faster and more accurate than other means of calculation, and being automatic it is unaffected by human fatigue.

It has only to be told the method of calculation and be given the data to work upon, and the engineer is free to concentrate on other matters of prime importance.

It may be instructed to adopt alternative courses of action without human intervention, depending on the significance of intermediate results in the calculation (or perhaps on the magnitude of the data supplied to it).

Any particular procedure in the computation need only be defined once, regardless of how many times it is to be applied, at what stages, or whether its application is dependent on the intermediate results.

Thus a computer extends the scope of the calculations, by making possible the adoption of methods which were hitherto impracticable. For instance, if one adjustment to a plan will inter-act with many other conditions which must be fulfilled, and there is no clear method of formulating the solution, a procedure of progressive approximation may be adopted in which the computer continually improves the result. It would continue to do this until it wore itself out unless some limit were imposed. A logical limit to impose may be the standard of accuracy of the original data (or perhaps the accuracy to which the earth-moving plant will work); then when successive improvements in the result become of smaller degree than this accuracy, the computer will automatically stop calculating and produce the solution (or go on to the next stage in the calculation).

A full description of how a computer works and how one instructs it to execute such procedures cannot be given briefly, but some indication is given in Appendices "A" and "B".

A Suggested Method for Solving the Airfield Problem

The first consideration to apply is whether the computer is to be regarded as an automaton to produce the complete design, or whether it is to act as an extremely fast and accurate analytical aid to the engineer, who will use his skill at various stages in the procedure. In military engineering the latter course will often be more realistic for a variety of reasons, such as that a rigid adherence to the text-book specification does not always produce the best result.

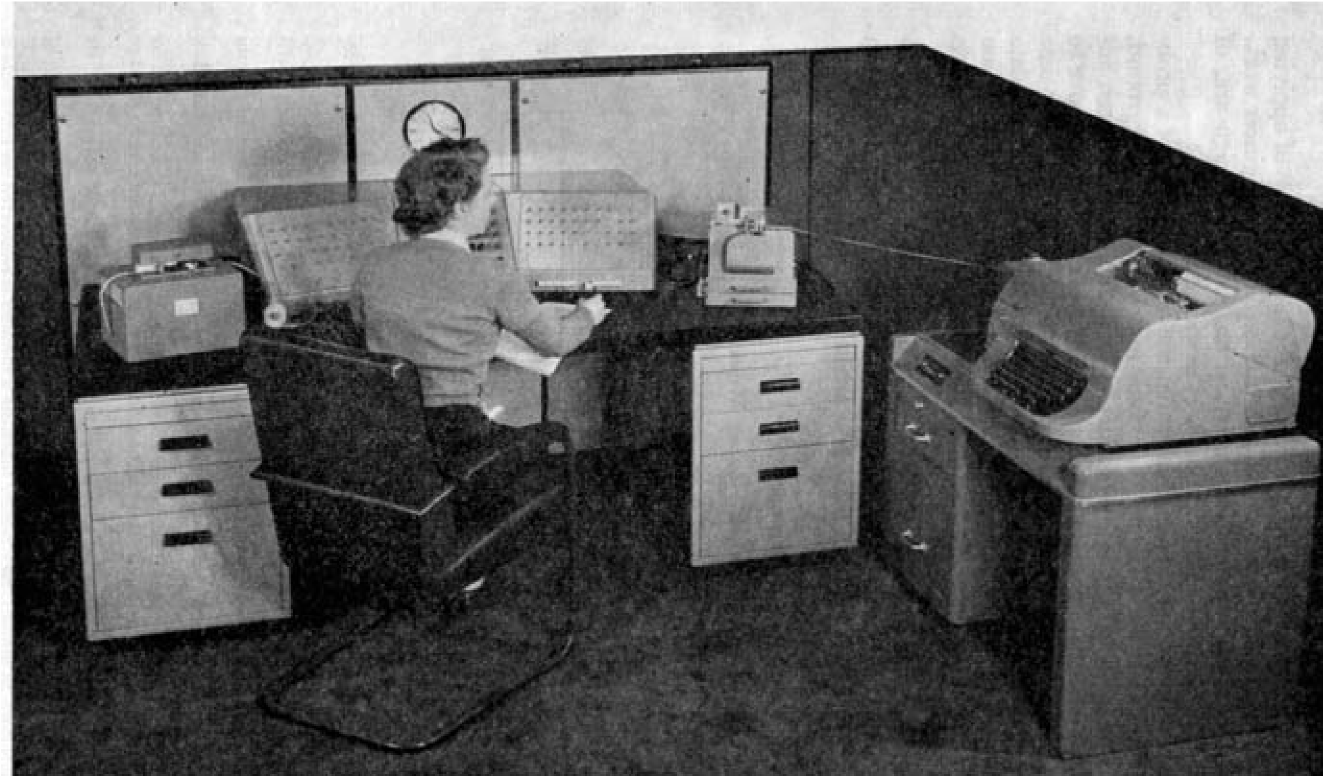
The role of the computer will then be, first to analyse the data and prepare it for the engineer to use. During this stage the survey grid will be read in, the topsoil volume calculated, the survey grid adjusted for the removal of topsoil, the areas in which cut is unsuitable for fill will be labelled, and adjustments will be made for the depth of the proposed pavement; then the computer will determine the best inclination of the crossfall within the permissible limits by the criterion of minimum earthwork, and produce a corrected centre-line profile such as would require no longitudinal haul.

Now the engineer will examine the results and superimpose a trial grade line. The computer will check that he has complied with the restrictions on gradient and vertical curvature and report on any discrepancies. It will proceed to evaluate the cut and fill on every cross-section and present the results as required. The engineer will re-draft an improved grade line, have it evaluated by the computer, and this procedure will continue until he is satisfied that no significant further improvement can be made. This is analogous to a proved procedure which is already in use for industrial design.

The results will be presented in a suitable form, e.g. a disciplined grid in numerical form, showing the original level and finished level at each point, a balance sheet of cut and fill, and graphical representations of the work on each cross-section and on the grade line.

This method is likely to result in significantly better solutions than were possible by former methods, as the engineer will be relieved of the drudgery of lengthy arithmetic, so that his efforts are concentrated on the vital grade

Characters Of The Digital Computer 1



Characters Of The Digital Computer 2

line, and he has had the opportunity to make a large number of successive improvements. The planning time will nevertheless be shortened, and the resultant plan will be economical in plant requirements and construction time.

Conclusions

The above example has been given to describe a simple way of applying a computer for economy in time and effort in the execution of engineer work. The potentialities of computers for numerical analysis and design are, of course, vast, and the field of application is ever widening.

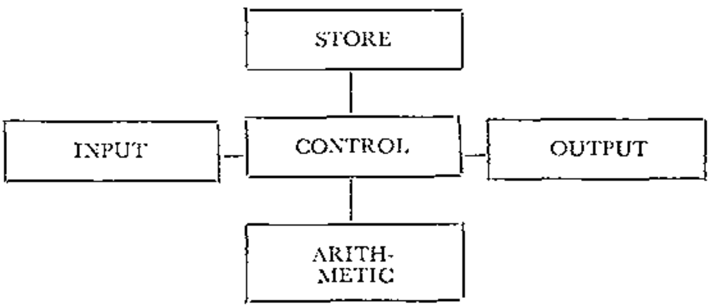
Experience with computers has shown that the detailed study of a problem is best undertaken by an engineer who fully understands the background, and that this often leads on to by-products which disclose unforeseen advantages. For instance, one might proceed from the example given above to determine what degree of detail is justified in survey grids, so that the time spent on surveying is minimized, to extend the procedure to work on data obtained from sources other than ground survey, or to deal with the selection of runway alignments, and perhaps even to develop fully-automatic methods of design.

Such benefits in this and other fields of application are likely to materialize only when military engineers become familiar with computers and develop an understanding of how to exploit their potentialities.

APPENDIX "A"

How a Computer Works

An electronic digital computer may be regarded as having five units:—



Input may employ punched paper tape, which is prepared by the use of a special teleprinter.

Pressing a switch on the computer has the effect of telling Control to read in the programme of instructions from Input and put them into the Store. The computer then starts to obey the instructions.

Often the first instruction is to read data from Input and put it into the Store in certain places.

Further instructions may be to bring data out of the Store successively, and add, subtract, multiply, etc. and to put intermediate results back into the Store elsewhere.

Other instructions may be to test the value of an intermediate result. Depending on its value, the computer may be required either to carry on, or to skip some instructions, or to go back and do something again.

Similarly an item of data may be tested, and the subsequent course of action may be dependent on its value.

Anything in the Store may be extracted, amended in the Arithmetic unit in the light of intermediate results, and put back again in the same place.

Arithmetic is done as follows. In a binary machine a number is converted on input into a string of electrical pulses, timed against a crystal "clock" at high frequency. Each pulse has a certain value, depending on the time at which it comes along any wire. If there is not a pulse at a certain time there is no value of that significance. Thus a number is represented by pulses or no-pulses at controlled intervals of time. In the store the pulses chase round a closed circuit until Control tells them to come out (but certain types of store operate in a different manner).

If an addition is to be done, the two strings of pulses are channelled to a junction-point, in synchronization. The value of the first pulse is 1, the second 2, the third 4, the fourth 8, and so on. So the number 10 would be represented by 01010 and 15 by 01111 (travelling towards the right, where 1 represents a pulse, and 0 no-pulse at the time when it would have been significant). When the right-hand pulses or no pulses arrive at the junction point, a single pulse (as in this case) will get through and proceed along the wire. When the next pulses arrive simultaneously, the result is like the collision of two inebriates at a revolving door; neither gets through and they experience a delay of one digit-time during which one of them passes-out. (The electronic devices are somewhat more reliable than this simile.) At the next digit-time another inebriate joins the survivor and the performance is repeated; neither gets through, a delay of one digit-time occurs, and one of them passes-out. At the next digit time there are two new arrivals, making three competitors. In this case two of them argue, and the other slips through during the confusion; a delay of one digit-time and the passing-out of one baffled inebriate recurs. Finally the survivor experiences no opposition and gets through. The resultant string of pulses looks like this:—11001. Giving the appropriate value to each pulse according to its timing, the answer is 16+8+0+0+1=25. Apologies are tendered for the levity of this explanation. No computer functions so simply, but the effect is the same.

Output occurs when Control reaches an instruction to do this, and the string of pulses or no-pulses is channelled to output, converted and punched as holes through paper tape, which a teleprinter then prints.

Then the computer may be made to read in another programme and do quite a different calculation. The programme tapes are preserved and can be used any number of times on any similar machine, and can be copied automatically if desired, for simultaneous use on different installations.

APPENDIX "B"

NOTES ON THE PEGASUS AUTOCODE

(A simplified scheme for the coding of instructions for the computer to obey)

Introduction. These notes have been prepared as an introduction to the Autocode which is used with the Pegasus computer. They are not intended as a guide to writing such a programme, for which reference should be made to the Handbook.

By a "programme" is meant a sequence of instructions for the computer to obey. An example of a part of a programme (which is explained at the end of this appendix) is written as follows:—

```
   v100=TAPE*
   v1=0
   n1=0
1) v1=v1+v(100+n1)
   n1=n1+1
   →1, 10 > n1
   PRINT v1, 3126
   STOP
```

Variables. The computer may be visualized as having a store or memory which will hold a very large number of numbers. Most of the numbers in the computer are called "variables". These are the data, the intermediate results on which arithmetic is being done, and the final results which have to be printed. We have to be able to distinguish between one variable and another in the store, so they are called v_0, v_1, v_2 up to v_{1379}.

Indices. It is also possible to hold in the store a second kind of number, called an index, which is mainly used for counting and controlling repetitive processes. These indices are denoted by n_0, n_1, n_2 up to n_{27}.

Input. Numbers may be put into the store by first punching them in normal decimal form on to paper tape, the process being similar to typing. The computer is made to "read" and store a number, by an instruction also punched on to paper tape, such as v_{10}=TAPE; this means that the value of the variable v_{10}, after the instruction has been obeyed, will be equal to the number which was punched on the tape. n_1=TAPE 3 means "read in the next 3 numbers on the tape, and store them as n_1, n_2, and n_3 respectively". Another important input instruction is, for example, v_{100}=TAPE,* which makes the computer read in a group of numbers punched on the tape (until it reaches a letter "L" also on the tape), putting them in the store as v_{100}, v_{101}, v_{102}, etc.

Arithmetic Instructions. Instructions like $v_1=v_2+v_3$ are used for doing the arithmetic. This one means that the value of the variable v_1 after the instruction has been obeyed is equal to the previous value of the variable v_2 added to the previous value of the variable v_3. The instruction $v_4=0$ means that the variable v_4, after the instruction has been obeyed, will be zero. When an instruction such as $n_1=n_1+1$ has been obeyed, the value of the index n_1 will have been increased by unity; this is the method of "moving on" a counter.

The symbols − (subtract), × (multiply), and / (divide) give the remaining simple arithmetical operations. Certain words are used, with the following meanings:

MOD means consider the number as positive whether it was positive or negative;
INT means take only the integral part of a mixed number;
FRAC means take only the fractional part of a mixed number;
SQRT means square root;
SIN means find the sine of an angle;
LOG means find the logarithm;
EXP means find the exponential (antilog); etc.

Jump Instructions. As instruction like $\rightarrow 1$ is a jump instruction. Instead of working sequentially down the list of instructions, the computer will be made to jump to another instruction which has been preceded by a label, 1) in this example. Often these jumps go back to a previous instruction, thus forming a loop of instructions and giving repetitive operation—one of the most characteristic processes in computing.

These repetitive loops have to be controlled. This is done by including within the loop an instruction which will move on a counter by unity each time the loop is repeated; and the jump instruction tests this counter to determine whether the process has gone far enough. Thus the meaning of an instruction like $\rightarrow 1,\ 10 > n_1$ is "jump to the instruction labelled 1) if 10 is greater than the current value of the index n_1; if not, go on to the next instruction".

Jump instructions are sometimes used to jump forwards, skipping a group of instructions which are included for tackling only an exceptional case, for example.

Modification. Many instructions contain something like $v\,(100+n_1)$. This would make the computer refer to the index n_1, take its current value, add it to 100, and then select the variable thus identified; for example, if the value of n_1 at the time the instruction was obeyed were 9, then the variable v_{109} would be selected. This technique, called modification, is a very important process in computing, and it makes it easy to work through series of numbers held in the store.

Output. When arithmetic has been done the results are brought out of the computer by being punched on paper tape and then printed automatically on a typewriter. An instruction like PRINT v_{20}, 3126 will do this; the number on the right specifies whether the result is to be typed on the same or a new line, the number of places before and after the decimal point, and spaces required to give nicely laid-out columns. Words for titles and notes can also be printed.

An example. If it is required to read in 10 numbers (storing them, say, as $v_{100}, v_{101}, v_{102} \ldots v_{109}$), to add them up, and print their accumulated sum, we write:—

v_{100}=TAPE*	Read in and store all 10 numbers.
$v1 = 0$	Use variable v_1 as the accumulated total; set to zero initially.
$n1 = 0$	Use index n_1 to control the process; set to zero initially.
$\rightarrow 1)\, v1 = v1 + v(100+n1)$	The main arithmetical instruction.
$n1 = n1 + 1$	Move on the index n_1 by unity.
$\rightarrow 1,\ 10 > n1$	The jump instruction.
PRINT $v1$, 3126	Print the accumulated sum.
STOP	

The first time round the loop of this programme, v_{100} will be taken, and the index n_1 will be moved on to 1; the second time round, v_{101} will be added in, n_1 moved on to 2; and so on until v_{109} has been added in, n_1 will be brought to 10, and n_1 being no longer smaller than 10, the loop will be broken and the result printed.

Military Survey in Iraq 1956–58

By Major J. A. H. West, RE

19 Topographic Squadron RE moved to Iraq in 1953 under command of Major D. M. Gunn RE who was mainly responsible for evolving the methods of operation described in this article. The author was posted to the Squadron in May 1956 and was in command from early in August that year until June 1958.

A Topographic Squadron, as established at present, is a small unit, consisting of a Headquarters and the three Troops, each commanded by a Subaltern. Overall strength is below 100 and the Squadron organization is very flexible, allowing surveyors and transport to be distributed to suit the survey tasks in hand. A working party might consist of a Sapper Surveyor and Driver in a Landrover away from base for two to ten days, or the greater part of two Troops working in an area up to 450 miles from HQ. Such an *ad hoc* Troop could remain in the field indefinitely.

Background

Iraq, once known to the Serviceman as Mesopotamia, is a country rich in oil. It is divided by the twin rivers Euphrates and Tigris, which have their confluence near the Persian Gulf. North and East along the Turkish and Persian frontiers there is a ridge of high ground of valleys and mountains rising to over 12,000 ft; these are but foothills to the higher Zagros and Armenian ranges beyond the Iraq frontiers. Apart from cultivation along the rivers, and marshes in the south, the rest of the country is desert. The Squadron's work was mostly North of the latitude of Baghdad and so the remarks that follow relate only to the northern part of Iraq.

Climate

The climate is extremely hot in summer. During July and August day shade temperatures exceed 118°F with probably a few days touching 122°F or more locally. Towards the end of August the daily maximum temperature falls, accompanied by a swing in the prevailing wind. These southerly winds bring a sharp rise in humidity and discomfort but are welcomed by the locals as they ripen the date crop, and by us because they portend the end of the hot season. Rain falls any time between November and April, varying between an average of under 10 in. in the desert to over 30 in a year in the hills. However, averages are extremely misleading, and the monthly distribution of rainfall varies sharply from year to year. Rainstorms can also be very local in effect. An area, particularly in the desert, might go without rain for years and then be brought up to scale in one tremendous storm.

The winters are very pleasant, particularly the months of November, March and April. In the desert there is ground frost on some nights. The winter snowfall in the mountains has encouraged the start of ski-ing parties in recent years. There are three passes into Persia; only one remains open during the winter snows and that too may be impassable for days at a time.

People

The tribesmen of the desert remain largely poor and unspoilt. The impact of civilization shows mainly in increased use of motor transport. A group of families may own a lorry or hire one for their sheep for a major move or sale. A rich sheik's son might own a large American car. These family groups and sub-tribes are contracting in size and an increasing number of young people leave for a more settled life in the towns. The tribespeople, however, still practise all their old traditions.

The mountain country is inhabited by Kurds. They are a race of many tribes, some settled, others transient. They are also to be found in Syria, Turkey, Russia and Persia. The Kurds are typical hillmen, well-built, proud and quarrelsome. Their contempt for the Arab of the south is equalled only by the Arab's low regard for, and indeed fear of, the Kurd. These people live under perpetual martial law and have risen in revolt against the Baghdad Government many times, and against us in our day.

Survey Tasks

The Squadron during the period 1956–8 was occupied with topographic mapping in the western desert at a scale of 1/100,000 and in Kurdistan at a scale of 1/20,000. In late 1956 some primary triangulation was done and there was a limited amount of route revision at 1/100,000 and 1/500,000 scales in each year. There is of course hardly a limit to the amount of survey work that can be done in any country. Throughout this period a close liaison was maintained with the Iraq Civil Survey Department. The Squadron Commander made at least one visit a month to the Department and sometimes weekly, when necessary. Latterly this liaison resulted in our Survey Service preparing the specifications for the Department's major mapping contracts with civilian air survey firms; a satisfactory state from everyone's viewpoint.

Habbaniya

From the time of the Topographic Squadron's arrival in Iraq its Headquarters were established in Habbaniya. With the 1956 Treaty Habbaniya became an Iraqi Military and Air Force Base. The RAF maintained a Staging Post and Maintenance Unit within the cantonment so that our Squadron was able to draw common-user stores and have a share of the too-few quarters, to mention only two advantages.

The Base is located on the western bank of the Euphrates, 50 miles west of Baghdad. It has two airfields and is near a large lake which was once an overnight stop for the flying boats of Imperial Airways.

The camp perimeter is 7 miles in length. Buildings are permanent and the whole area is well wooded with many lawns and gardens although surrounded by desert. Military, social and recreational facilities were excellent and the more valuable because of the never failing goodwill and kindness of the Royal Air Force.

Operating

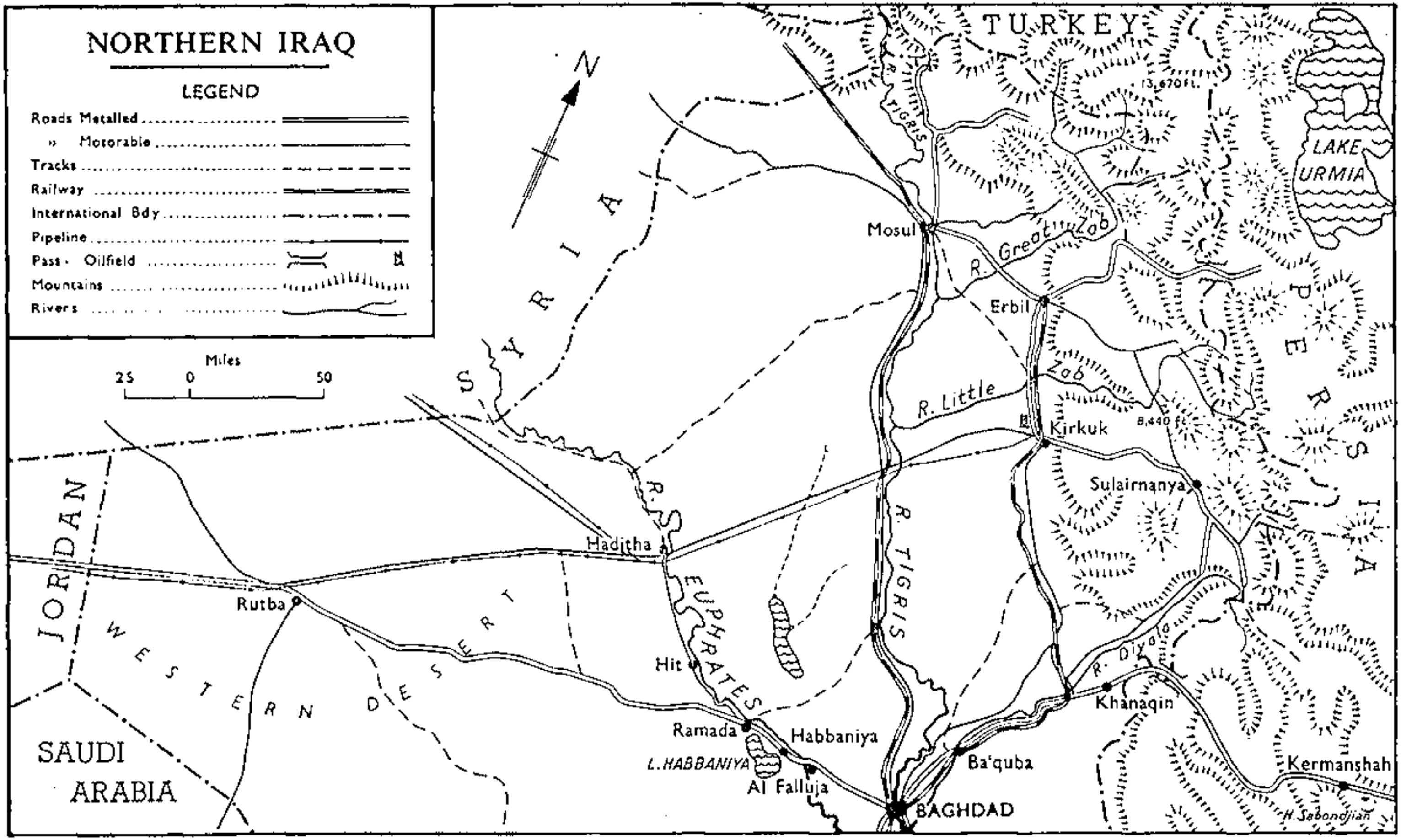
The Squadron was required by the Iraqi Government to work outside Habbaniya in mufti and not to carry arms; to use vehicles painted in a civilian fashion, with civil registration plates, and not to move in convoy. There was otherwise no secret about us. Our wireless net operated on a fixed frequency and used the procedure common to Oil Companies and Contracting Firms.

These restrictions gave a certain piquancy to our survey parties. During the Squadron's early days in the country the civilian dress provided by Ordnance was the pinstripe, three-piece de-mob suit, loose collar shirt with tie and pork-pie trilby. A previous Squadron Commander had the satisfaction of parading a Troop in this dress at a mountain survey camp before the then General Officer Commanding-in-Chief, Middle East Land Forces.

The training effort expended in perfecting trilby raising for the dismiss was justified by the subsequently improved issues of working clothing.

The Squadron's custom was to work in the field from February to mid December. Time in Habbaniya was devoted to one month's military training and four to six weeks technical training with a break at Christmas. Squadron Headquarters, including a small technical control office and an overworked MT Repair Section remained in Habbaniya throughout the field season.

Troops in the desert would be between 150 and 300 driving miles from Headquarters, some eight to twenty hours drive for a 3-ton truck. In the



NORTHERN IRAQ
LEGEND
Roads Metalled
" Motorable
Tracks
Railway
International Bdy
Pipeline
Pass · Oilfield
Mountains
Rivers
Miles
25
0
50
N
TURKEY
LAKE URMIA
PERSIA
SYRIA
JORDAN
SAUDI ARABIA
WESTERN DESERT
13,670 ft.
8,440 ft.
R. TIGRIS
R. Great Zab
R. Little Zab
R. EUPHRATES
R. Diyala
L. HABBANIYA
Mosul
Erbil
Kirkuk
Sulaimanya
Khanaqin
Kermanshah
H. Sebondjian
Ba'quba
BAGHDAD
Haditha
Hit
Ramada
Habbaniya
Al Falluja
Rutba

mountains a base camp might be 300 to 450 road or track miles away, and a 3-ton supply truck would take five to eight days for the round trip. Much cross-country driving was involved, indeed desert survey is all cross-country work. As a result the Squadron MT Section up to 1957 undertook repairs normally done in a Base Workshop, if not in quantity. Replacement vehicles, at about one quarter establishment, were immediately available in reserve in Habbaniya after mid 1957.

Troop Organization

A Troop was normally composed of a Subaltern, Sergeant, ten R and F surveyors, six drivers, a fitter, cook and a general duties man. The majority of surveyors were ex-Army apprentice tradesmen (Surveyor Trigonometric or Topographic), the remainder were National Servicemen with civilian technical qualifications.

Transport would be two Landrovers, three 1-ton GS 4 by 4 trucks and a 4 by 4 water truck. All 3-ton trucks were brigaded at HQ for supply runs, two or three would be attached to a troop when it moved base camp, which was about once in six to eight weeks both in the desert and mountains.

Each troop operated a 19 HP wireless set; control had a similar set, but with an elaborate aerial set up. These would work voice up to 250 miles in the desert at a pinch, and CW beyond. Range in the mountains obviously varied according to set location, indeed suitability for wireless transmission was the first factor a Troop Officer had to consider in siting a base camp in the mountains. Although wireless played a vital part in control of troops, their administration and frequently in casualty evacuation, we were never satisfied with our resources or results; wireless equipment, training and set maintenance being below par for reasons outside Squadron control. When we were thrown back (in the mountains) upon the vagaries of the civil telegraph service, a notable decline in technical work would follow after a period as administration faltered. In the desert, where there are no Post Offices, there is no substitute for wireless.

1/100,000 Work in the Desert

The desert mapping was based on RAF air photography. A 1953 appreciation resulted in a decision to contour and interpret by ground work rather than by Multiplex mapping equipment. The Regiment supplied Principal Point plots from slotted template laydowns in Cyprus. In some instances the Topographic Squadron supplied extra tertiary trigonometric control for the laydown.

The area of a sheet would be some thirty by thirty-four miles. The Troop Commander would set up his tented camp near the centre. This camp would be heighted by three independent means from neighbouring triangulation or oil pipe line bench marks. Two sets of photographs would be available to the Troop, one to be contoured (VI 25 metres), and one to have the ground interpretation added (we distinguished between eight types of surface or going).

The sheet would be divided up into between three and six areas, depending on surveyor strength and individual experience, and bordered by the more easily recognizable features such as scarps, wadis, tracks, etc. A surveyor, or pair of men, would spend two or three days familiarizing themselves with their areas and planning barometer traverses. Thereafter, with a barometer base manned in the Troop Technical tent, the surveyors would make daily ring traverses in Landrovers or 1-ton trucks. Traverses would run between ten and eighteen miles and last five to eight hours, and include ten to twenty points heighted, depending on the going and weather. The closure standard set gave a likely accuracy of at least one-third the vertical interval. These heighted points gave a basis for running in contour lines at the 25 metre VI.

By the time the surveyors responsible for an area had completed contouring they would be able to record the ground interpretation of the area on the second photograph set in a very few days of mostly "office" work. Compilation of the finished map was done in Cyprus or England.

The Troop Officer and Sergeant would be fully occupied throughout in planning and supervising the work, physically checking by repetition a proportion of the field work, and with camp administration, including no doubt explanations to the Squadron Second in Command of such unaccountable things as the previous month's jump in petrol consumption or the non-return of an egg-box on the last supply truck.

Desert Life

There are many tricks and habits to learn before becoming desert-wise. They are, however, more quickly learned than forgotten. Some more important points follow:—

(*a*) Navigation. Every vehicle operating alone should have a sun compass fitted. The Squadron used the simple "Gunn" type which is mounted in the driver's sight and in use does not require the truck to stop. Single vehicles must carry at least one desert-wise man. Training and experience is required.

(*b*) Safety rules. A simple, clear set of orders must cover action in the event of breakdown or getting lost. It might be fatal to "walk back" for instance. Every vehicle must carry a reserve of food, water and fuel.

(*c*) Drivers and surveyors must be trained in recovery of vehicles from soft ground by letting tyres down, winding on handle, jacking etc. Practice in righting overturned vehicles is desirable.

(*d*) Men must know how to use their individual snakebite kits (scalpel type) and NCOs how to use the serum and hypodermic outfits. All should have some first aid knowledge.

(*e*) Heat stroke and exhaustion prevention and the use of salt. It is quite possible to work hatless and stripped to the waist under the sun in 120°F shade temperatures without ill effects; many never will, however, and new arrivals would be unwise to attempt it before acclimatization.

(*f*) Cleanliness. Desert life is healthy providing men keep their flesh clean. Some skill is required to wash well with limited water. Salt, drinking water and "pop" should never be limited.

(*g*) Morale requires particular attention from officers in these circumstances. Our troops in the desert tended to work in what might have been their spare time. Attention to rank distinctions helps here as an interesting incidental to good military discipline.

(*h*) Hot weather MT modifications. Our Landrovers had their petrol feed pipe between the pump and carburettor bound with issue asbestos tape. Coils and petrol pumps were mounted inside the dash-board. This allows a passenger to wet a rag round the petrol pump without stopping the vehicle. (Asbestos tape only, sufficed for 1-ton trucks.)

Photo 1. No 3 Troop camp, Ruwanduz Pass, Kurdistan. November 1957.

Photo 2. Kurdish Tribesmen. April 1957.

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Photo 3. No 3 Troop Surveyor checking detail. March 1958.

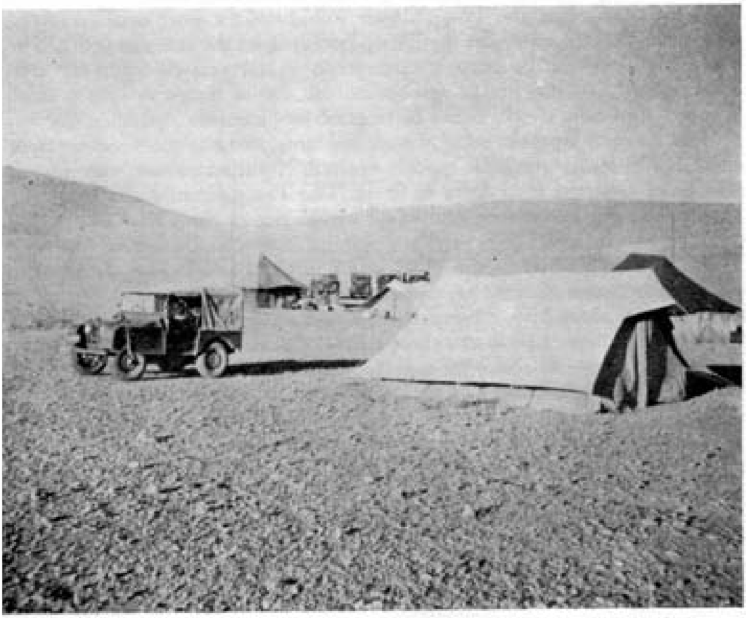

Photo 4. No 2 Troup Camp near Rutbah in Western Desert. August 1956.

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1/25,000 Work in Kurdistan

In 1955 the Iraq Government placed an order with Huntings Aerosurveys Limited for a block of some 400 sheets of the Kurdistan mountain region, the scale of mapping being 1/20,000. The specification for these maps resulted in a skeletal product in that the mapping was on a civil grid, lacked names and omitted many topographic features and distinctions required in military mapping.

The Squadron checked the planimetry of some sheets, which incidentally was faultless, in 1955–6 and at the start of 1957 the unit was ordered to revise the topography and detail of the remainder with the intention of producing a military edition on a reduced scale of 1/25,000.

The method of approach was to give each troop concerned successive blocks of twenty to forty sheets. There were certain priorities in latitude and in distance from frontiers. Within these priorities it was arranged that the blocks on lower ground were done early in the season when the mountains were still under snow, and that the higher areas were reserved for mid-summer, falling back again to lower areas towards the end of the field season. The access routes, and the rivers and ranges which might be impassable, governed the shape of these blocks.

The Troop Commander might be given such a block, a task lasting between four and eight weeks. The general area where his base camp should be would be indicated to him by the Squadron Commander and he would go off on his reconnaissance with an interpreter and a week's food. As well as choosing his camp site he would call on the civil governor of the Province, perhaps two or more such calls if the mapping area exceeded one Province, the military commanders, the minor district officials and the tribal chiefs. To omit a single visit would probably result in difficulty later.

When established, the Troop Officer would make a more detailed reconnaissance of the block whilst the Troop Sergeant set the camp in order. The prevailing Technical Instruction's paragraph on route classification required every village to be visited; this entailed the use of mules as only a small proportion of most blocks could be reached by "jeepable" tracks.

The Troop camp, consisting of some ten tents, two marquees and seven or eight 180-lb tents, would be quickly erected. Night watchmen were invariably hired from the local Agha or Sheik. The Troop Commander would be able to send his first survey parties off within two or three days of arriving in an area.

Each skeleton sheet in the block was quartered and mounted on pieces of cardboard, some nine inches square. A surveyor, perhaps with a learner or even a non-tradesman as a companion, would be given an area of ground to cover varying between one and three sheets; that is between four and twelve mounted boards—between 30 and 100 square miles. Depending on the ground and the availability of mules, such a task would take in the region of three to fourteen days. A good Sapper or junior NCO with more than one field season's experience could undertake a trip without an assistant. The 9 by 9 inch boards were convenient to use in transport or on mules.

When the Troop officer gave a surveyor his area and route, he would give him money to hire mules (10s each animal per day) and to buy food. During this time the survey party would be out of contact with the Base Camp, sleeping in a different village every night, the Kurdish muleteers having a proper respect for the danger of attack by ghosts at night.

On return to Base Camp the party would be "debriefed" and have two to four days' "rest" spent drawing up the addition and deletion traces in their appropriate colours and also the route classification traces.

The Troop Commander and Sergeant were required to make at least one mule run per month by way of checking field work. This, together with the local purchase of all fresh rations and routine troop administration, ensured them a busy time.

The collection and decision on the transliteration of place names was carried out in agreement with the Iraq Survey Department. This task presented many problems but at least we avoided the more obvious pitfalls of naming places with transliterations of phrases such as "I don't know" or "This is a good place to make tea".

The compilation and printing of the final maps was undertaken in England, in this particular series, under War Office arrangements.

Command and Control

The Squadron was throughout under the command of 42 Survey Regiment in Cyprus and attached for discipline only to the RAF in Habbaniya. The Commanding Officer would visit the Squadron with the officers of his Regimental Headquarters during the winter military training period and carry out an administrative inspection. Other visits would be made during the field season, particularly at the more interesting junctures in technical work. The Squadron Commander visited the Regiment once a year.

Command within the Squadron in the field season was exercised largely by use of the wireless net, traffic being confined to non-technical subjects, and by frequent visits by Squadron Headquarter personnel to Troops. The Squadron Commander and the Second in Command would visit troops in turn at about ten-day intervals. SSM and SQMS would make less frequent visits. As a matter of policy all Squadron Headquarters staff, including clerks, made one or two visits to the troops during a field season. It was necessary to call in Troop Officers and Sergeants for three or four days every month or two for what might be described as "reorientation".

Conclusion

All survey work is interesting and such work in undeveloped countries requires a high standard of initiative and energy at Troop Commander level, in addition to purely technical skills. The author was particularly impressed by the way in which a succession of National Service Officers, as Troop Commanders, succeeded in achieving splendid results. They set a high standard which junior Regular Sapper Officers entering Survey in the future must maintain.

Field survey work is both constructive and satisfying. It places great responsibility on all ranks engaged on it and there can be few branches in the Service today which can offer so fine a command as that of a Field Survey Troop.

The British Schools Exploring Society

By CAPTAIN A. G. BOMFORD, MA, ARICS, RE

THE British Schools' Exploring Society was founded in 1932 by the late Surgeon Commander G. Murray Levick, a member of Scott's last expedition. He was the leader of the Northern Party, which had to spend an eight-month winter in a snow cave. With him was Sir Raymond Priestly, who succeeded him as President of the Society in 1957. Murray Levick had perceived that in good company, hardship and adversity are not wholly unpleasant, and have their compensations on return to civilization. During the summer holidays of 1932, he took a party of eight boys to Finland. The outing was a success, and each year until the war he led increasingly ambitious expeditions to Lapland or to Newfoundland.

The war called a halt, but in the summer of 1947, an expedition of nine leaders and seventy boys went again to Newfoundland. This was the last expedition Murray Levick led himself; and it was the first on which the survey party was led by a Sapper, Captain P. C. Sherwood.

Murray Levick's aim was to take boys into wild and trackless country and teach them to fend for themselves. There has always been a very pleasant absence of both school and scout mastery. Following Scott, the leaders have mostly been service officers, with a few scientists and doctors from civil life. Modern scientific exploration, properly conducted, still demands every ounce of endeavour, as well as every particle of intelligence and every second of time, that a party has at its disposal. On BSES expeditions, here is a refreshing absence of make-believe, of going-through-the-motions; the development of character, which is the underlying motive of each expedition, is unobtrusively achieved by an energetic but workmanlike programme of survey and research.

The expeditions are split into parties traditionally called "fires", each of which concentrates on one aspect of exploration under a competent leader. Captain Sherwood found himself in the middle of Newfoundland, with two fires, about twenty boys, an assortment of survey gear, and six weeks to map as large an area as accurately as he could. The boys are about seventeen years old. There are usually four applicants for every vacancy, and the standard of those accepted is very high. They are intelligent, enthusiastic, and as fit as a summer term at school can make them. Map making calls for a surprising variety of skills, and gives the boys an intimate knowledge of the terrain. It is an admirable discipline for them, and first-rate experience for the survey officer in charge. He has not merely to measure his bases, triangulate out from them, observe the stars for position and azimuth, compute and plane table; he has to train his boys to do these things, plan their work, check it and compile it, all in six weeks. Captain Sherwood was run off his feet, emerged with an excellent map of the Terranceville area of Newfoundland, and recommended that two Sapper officers should go every year. His recommendation has generally been accepted. In 1948, Captain R. J. Francis and I went to Northern Quebec, and since the war some sixteen Sapper officers have accompanied expeditions.[1]

I was 21 at the time, and as someone kindly remarked, barely distinguish-

[1]See Appendix at end.

able from the boys. Luckily I went on the advance party, and by the time the boys arrived I had a few clues, and my moustache had three weeks start on theirs. We mapped an area which had been cleared by fire in 1923, marched many miles through the forests, and saw beaver, moose and bear. These expeditions are a far more profound experience than any amount of camping and climbing in Wales or Scotland. As many people found in Burma and Korea, getting off the roads and living completely in the bush for a period of weeks is a novel experience. Apart from yourselves, there is no one for perhaps twenty miles to the south, and more probably a hundred miles to the north. On a still night, it is absolutely silent. The jungle certainly is neutral, but there is a certain amount to learn before one feels really at home in it.

The only way to get anything anywhere is to carry it. The expeditions are most people's introduction to light-weight camping and to light-weight rations: biscuit, pemmican, cheese, oatmeal, sugar and tea, with a few luxuries like chocolate and sultanas. It is an adequate ration, about 4,000 calories, weighing 2 lb, but when walking long distances under load, most people have their first experience of real persistent hunger; not to the extent of feeling weak, but certainly to the extent of talking about food almost incessantly. In 1948 the food on the ship in which we had crossed the Atlantic seemed fabulous, and we discussed what we were going to eat on the return journey in great detail. Nevertheless, while I do not actually enjoy being hungry, nor choose to eat much pemmican when living at home, there is no doubt that one derives far more pleasure from a mug of pemmican when one is really hungry, than from oysters or breast of milk-fed duckling when one is really full.

What each expedition achieves depends very obviously on each man's individual effort. It is a real pleasure to command a party of ten or twenty fit, intelligent people all of whom are ready to work flat out without pause for six weeks on a common task.

The Society cannot go where the jungle is too aggressively neutral, or fever ridden, or too distant; the expeditions have to fit into the eight-week summer holiday and whatever happens, all the boys have to be brought back alive. Apart from Lapland, Newfoundland and Quebec, expeditions have gone to Iceland, Norway, Labrador and the Rockies and in 1960 the plan is to go to Spitzbergen.

In 1957, the expedition went to Finnish Lapland, about 120 miles inside the Arctic Circle. I was invited to go as Chief Leader, and very readily accepted. Of all expeditions, those run by the Society must be in many ways the pleasantest to lead. There is none of the usual worry about raising funds, and all the administration in the UK is done by the Society's professional secretary, who has been doing it for many years and knows exactly what he is about. The boys are selected by an experienced and expert committee, but the Chief Leader has a free hand in the selection of his assistants. In 1957, there were many volunteers, and we had a powerful party: Major A. P. H. B. Fowle, MC, RA, second in command; Captain G. S. Seaton, RE, in charge of the survey; Captain W. M. M. Deacock, Special Air Service, who had been in Alaska and went in 1958 to the Himalayas; one of the mountaineers from the South Georgia Survey expedition; the leader of an expedition from Oxford to Kurdistan; a professional botanist from the British Museum, a meteorologist from Bristol University, a second surveyor and two doctors. We corresponded with each other and our contacts in Finland throughout the summer, and by the time we set out, knew exactly what we hoped to do.

The advance party established our base camp at the limit of vehicle access, about fifteen miles south of the tree line. Beyond base camp, everything had to be back packed, 70 lb being a full load. When one knows that everything one takes has to be carried on one's back, it becomes possible to leave a remarkable amount behind. Everyone soon realized the importance of the great dictum: "If you can't eat it, don't take it," and we were later able to set out on a fourteen-day, 220-mile march carrying loads of only 50 lb.

Travelling long distances under load, I always march fifty-minute stages, ten minutes between stages, an hour for a brew at noon, eight stages to a full day. In Lapland there is much bog and many rivers, so that one is perpetually wet to the knee; but we were mostly above the tree line, there was no thick forest, and this routine would take us a hundred miles in five days without strain.

The Finns had published uncontoured maps of the area we were in, at 1:100,000, with the river systems fairly well portrayed, but the relief very weak. The frontier with Norway had been surveyed in 1950, but the computations afterwards disclosed an error of 500 metres which could not be accounted for. Nobody ever goes there except a few nomadic Lapps who come and go across the border at will, so that it was not a very vital matter. But we co-ordinated eighteen of the boundary cairns with a probable error of about a metre, and resurveyed a complete Finnish map sheet at 1:50,000 with 10-metre contours. On the botanical side, 520 gatherings of plants were brought back which have been incorporated in the National Collection in the British Museum. Very well equipped meteorological stations were set up in base camp and on the summits of two mountains, where high camps were maintained and hourly readings taken day and night for twenty-eight days. There was gold in the mountains 40 miles to the east, and we learned to pan in the traditional style; a group of ice mounds was discovered and excavated; and the traditional cine film made of all our activities.

Relations between the Corps and the Society have invariably been happy, and of great benefit to both. The Society likes to have Sappers to lead the survey party because of their technical competence, previous field experience, and all those qualities that distinguish officers from schoolmasters. The War Office lends survey equipment, and the map has frequently been printed at the School of Military Survey. The Society's call for volunteers is published in Command Orders, usually in February each year.

The benefit to the Corps has been equally great. It is not merely that the expeditions provide a series of first-rate training exercises for survey officers, they completely alter one's outlook on living and travelling in the field. They take people off the road into the bush, and deploy them over large areas, thousands of square miles, for six weeks, with no logistic support of any kind. Parties learn to move through virgin country at an easy 100 miles per week; and while it is true that they do not have to carry arms or fight, they carry their technical equipment, and turn out very competent work. They learn how to live comfortably, and how to travel light. The survey party in 1957 discarded even its wireless sets. In Captain Seaton's words, they found that more could be achieved by "economy in weight, foresight and hard marching". In 1959, economy in weight and hard marching are among the less fashionable military virtues, because we have grown accustomed to having ample petrol. But we may not always have ample petrol in the next war, and anything which teaches us how to get on without it is greatly to be valued.

APPENDIX

The following Sapper officers have accompanied BSES expeditions since the war:

1947	Newfoundland	Captain P. C. Sherwood
1948	Northern Quebec	Captain R. J. Francis
		Lieutenant A. G. Bomford
1949	Northern Norway	Captain G. A. Hardy
		Captain G. S. Seaton
1950	Northern Norway	Major F. G. Hannell (TA Second-in-Command)
		Captain E. E. Jones
1951	Iceland	Major F. G. Hannell (TA Chief Leader)
		Captain E. E. Jones (Second-in-Command)
		Captain A. G. Bomford
		Captain H. York
1952	Iceland	Captain R. A. Morris
		Captain M. Woods (TA)
1953	British Columbia	Major F. G. Hannell (Chief Leader)
		Captain R. J. Francis
		Captain W. D. Rushworth
		Lieutenant P. P. Rich
1954	Northern Quebec	Major M. R. R. Goulden
1956	Iceland	Major F. G. Hannell (Chief Leader)
		Major M. Woods (TA Second-in Command)
		Lieutenant R. P. Mills
		Lieutenant D. H. Elliott
1957	Lapland	Captain A. G. Bomford (Chief Leader)
		Captain G. S. Seaton
		Mr. M. D. Kamm (National Service 1954–6)
1958	Labrador	Captain D. K. Bell

Fusion Produces Greater Mass and Terrific Energy

By MAJOR S. N. WHITE, MA, RE (Retd)

(The views expressed are the author's own and do not in any way reflect official opinion)

(This article was the runner-up for the Bertrand Stewart Prize Essay 1958. The winning article was written by Major J. H. P. Curtis, MC 2nd Green Jackets, The King's Royal Rifle Corps and was published in the Army Quarterly, January 1959.)

Subject

THERE is no doubt that the advent of nuclear weapons on the tactical battlefield requires a re-appraisal of our defence concepts.

During the past few years the old conceptions of the armoured division and the infantry division have been modified to try and meet these new conditions.

As a first step to this end it was decided to remove the armoured division and to provide an armoured regiment as an integral part of the infantry brigade in the infantry division.

In the opinion of many this has resulted in the infantry division becoming too big and unwieldy and the armoured division has become little more than a brigade group.

As a result opinion is now tending to favour brigade groups as the tactical entity and leaving a standard divisional H.Q. free to command whatever number of brigade groups the situation requires, armoured or infantry.

Discuss the tactical problems involved and give your views on the best organization of infantry and armour to meet defensive problems likely to be encountered in a European theatre of war in any future contest.

The Organization of Armour and Infantry for Defence

The nuclear era, opening with the delivery at Hiroshima and Nagasaki, of the first atom bombs, and bringing forth as one of their offspring the tactical nuclear weapon, is an age in which a new tactical doctrine remains as yet unborn. In the past, the invention of new weapons, or the development by an enemy of new tactical methods, has tended to lead to modifications of, or adaptions to, our own military machine. While never a very satisfactory procedure, it has, up to now, sufficed, since few innovations have in themselves been more than logical developments of former methods and knowledge. However, when so completely revolutionary a weapon as the nuclear bomb, missile or shell is added to the arsenals of the world, such a procedure is no longer adequate, and it is necessary to carry out a complete re-appraisal of our tactical methods. Should this not be done, some of the worse aspects of former organizations and systems may be perpetuated, while modifications made to correct newly apparent inadequacies may take the form of unwieldy additions or complex procedures, either of which could lead to the development of an unnecessarily cumbersome tactical machine.

New conditions call for new methods; arrived at, not by adding a bit here and subtracting a bit there, but by a process of logical deduction starting at the very beginning, and based on, in this case, the characteristics of the tactical nuclear weapon. Too much of our thinking in preparing for nuclear war on land has been devoted to considering how the capabilities of battalions of infantry, squadrons of armour and batteries of artillery, and the methods of employing them must be altered to meet the new characteristics of war. It is suggested that this is a totally wrong approach to the problem, and that all former concepts of establishments should be strictly banished from the mind; so that the best organizations can be deduced from those functions which are necessary to produce an effective defence. If, for instance, it is accepted that some infantrymen, some tanks and some guns will be necessary, in as yet undetermined numbers of formations, then the correct mental point of origin will have been established and the study can proceed, unfettered by preconceived ideas.

It is therefore the aim of this essay to discuss the tactical implications of the use of nuclear weapons on the battlefield; and, disregarding all former organizations and tactical methods, attempt by a process of logical reasoning to arrive at those which are likely to be most effective in a defensive battle in Europe. Hence the essay is divided into three parts:—

Part I	A general discussion on the implications of the tactical use of nuclear weapons.
Part II	The winning of the defensive battle when nuclear weapons are available to both sides.
Part III	The development of the best organization for defence.

PART I

Implications of the Tactical Use of Nuclear Weapons

The employment of nuclear weapons gives to the user certain major advantages which his tactical machine should be geared to exploit. On the other hand the use of such weapons against him creates major problems which he must be prepared to solve. It is the purpose of this part of the essay to analyse what those advantages and problems are, and how they are likely to affect the operations conducted by an attacking commander, or a commander on the defensive.

Characteristics

Probably the most significant characteristic of the nuclear weapon is its blast effect, and the tremendous destruction which it can cause. The table below gives an indication of the type of damage that could be caused by three arbitrarily selected weapons with different energy yields. It also shows the size of the areas which could be turned into complete obstacles in either built-up areas or forested terrain.

	Radius in miles of total Destruction		Radius in miles up to which obstacles can be created by destruction of: Built-up areas of Masonry bldgs.		Forests		Radius in miles within which parked vehicles may be rendered useless	
	S.B.	A.B.	S.B.	A.B.	S.B.	A.B.	S.B.	A.B.
1 KT	0.19	0.28	0.25	0.38	0.22	0.4	0.32	0.42
5 KT	0.33	0.48	0.41	0.64	0.43	0.78	0.52	0.7
20 KT	0.53	0.75	0.68	1.0	0.78	1.3	0.9	1.1

NOTE: S.B.—Surface Burst
A.B.—Air Burst

The figures in the above table indicate the effects on objects in the open. With men, weapons and vehicles dug-in, additional protection would be achieved and the distances shown above considerably reduced.

The second major characteristic of the nuclear weapon is thermal radiation, sometimes called heat flash. This has the capability of causing severe burns to personnel and igniting flammable materials at a considerable distance from ground zero. Fortunately it is comparatively easy to achieve protection from this effect, since almost any material interposed between the flash and a person or object will have the desired effect although such material may itself be ignited. Thermal radiation is also affected by the atmospheric visibility. The table below demonstrates this characteristic of a nuclear explosion, by indicating the slant ranges at which certain effects take place under optimum atmospheric conditions.

	Radius in miles at which burns can be caused to humans			Radius in miles up to which various thermal energies are delivered			
	3rd degree	2nd degree	1st degree	12 cal/sq. cm.	8 cal/sq. cm.	5 cal/sq. cm.	3 cal/sq. cm.
1 KT	0.4	0.5	0.7	0.28	0.32	0.43	0.52
5 KT	0.75	0.9	1.3	0.59	0.68	0.9	1.2
20 KT	1.4	1.8	2.5	1.2	1.2	1.8	2.3

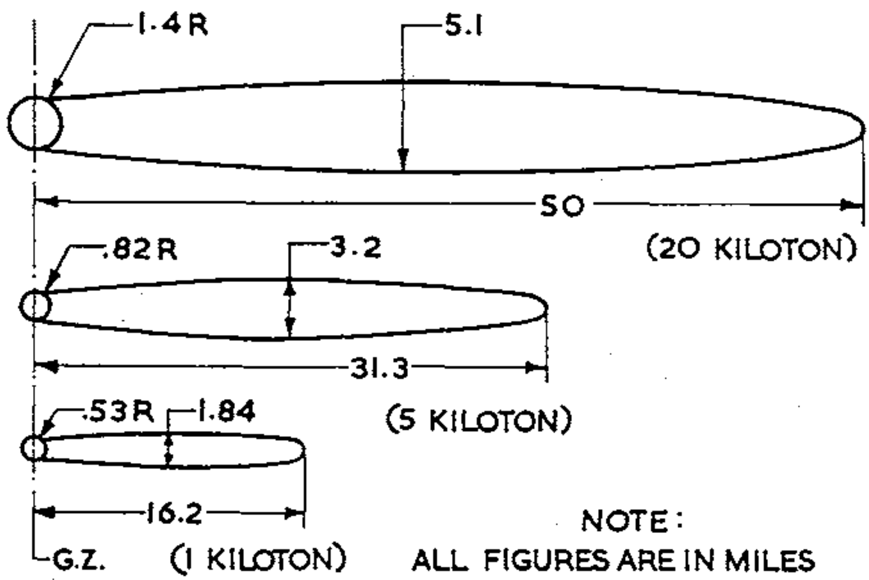
N.B. It should be noted that forest fires could be started under favourable conditions at an ignition energy of about 8 calories per square centimetre, and that various textiles such as cotton, cotton-denim and wool flannel will ignite at approximately the same value.

At the time of the explosion a large amount of radiation is released in the form of gamma radiation, which is harmful to human beings to such an extent that a soldier can only accept a limited amount without becoming operationally ineffective. Protection against this hazard is achieved by placing a mass of material between the individual and the explosion. In the field the most readily available material of sufficient density is earth, so that troops dug-in in slit trenches are likely to have the best possible protection. The table below shows the slant ranges from a nuclear explosion, at which a lethal dose of initial gamma radiation would be received. It should be noted that delayed casualties could be caused at much greater ranges than those shown.

Slant Ranges for a Lethal dose of 500 Roentgens	
Size of weapon	Slant range in miles
1	0.4
5	0.6
20	0.75

In addition it is possible, at the will of the user, to have these tactical weapons create an area of residual radioactivity, simply by arranging for them to be detonated on, or close to, the ground. In such a case there would be a fall-out of radioactive dust over the ground, down-wind of ground zero. If the weapon is detonated high enough in the air to ensure that the fireball does not touch the ground, then no significant fall-out will result. The diagram below shows the relative size of the areas of significant residual radiation which could be created by the three weapons under consideration.

If it is accepted that rockets and missiles with a range of up to 500 miles are tactical weapons then a commander in the field has at his disposal weapons which can take over a considerable part of the role of a tactical air force, and which are not subject to the same weather limitations. This will enable him to influence, with reasonable certainty and to a very great depth, the conduct of operations centred on the actual area of engagement.



The corollary of this is that the considerable range of tactical missiles will enable a commander to disperse his projectors or launching sites over a wide area and still be in a position to concentrate their fire at any single area.

It is considered that no other characteristics of the tactical nuclear weapons are relevant. As a piece of artillery it has the same characteristics as normal heavy artillery. As a missile, it is conceivable that the equipment necessary to launch, direct and control it may present some special problems in concealment. In addition the need for extremely accurate survey of launching sites is likely to place some restrictions on the frequency with which launching sites can be moved. Finally the weapon may be delivered as a bomb or air-to-ground missile by tactical air forces, with the advantage of accurate delivery against moving targets; and the normal limitations imposed by weather on flying.

To summarize so far it has been demonstrated that the use of tactical nuclear weapons gives the user the ability to:—

destroy, swiftly and without any hope of evasive action, concentrations of forces and administrative areas, although within the general damage areas, troops and weapons which are well dug-in may still survive;

destroy towns and villages initially by blast, and as a secondary effect, with fires started by thermal radiation;

create other obstacles by large scale demolition and/or residual radioactivity; and

attack targets in much greater depth than has hitherto been possible with ground-to-ground weapons.

On the other hand the proximity to one's own troops that such weapons may be used is strictly limited by the large size of the associated damage areas.

Tactical Considerations

The capability of swift and total destruction of groups of military units, whether they be combatant or administrative, is perhaps the greatest single factor affecting the employment of forces armed with nuclear weapons. On the attacker, this confers a tremendous potentiality for surprise. It has been demonstrated that tactical nuclear missiles do not have to be concentrated in a restricted area adjacent to the intended point of attack. As an example, a missile with a range of 100 miles can, in order to hit a given target, be located anywhere within an area of some 15,000 square miles. In addition, the terrific power of the weapon gives one the ability to break into an opponent's position without the need for concentrating superior forces and fire power opposite the desired points of break-in. Gaps can be created in a defensive system into which can be moved comparatively weak forces, but yet sufficiently strong to take advantage of the annihilation in the vicinity of ground zero, and the temporary stunning and neutralization of those farther out. This is an additional means of achieving surprise; and, provided that the relatively weak forces referred to above can be supported quickly by reserve forces converging on a prearranged objective, probably well within the defensive zone, is likely to be one of the major advantages favouring the attacker.

To the defender, the destructive power of the nuclear weapon gives the capability of destroying concentrations of troops and supplies either before or during an attack, always provided that he has the ability to detect and recognize such concentrations. With such weapons it would have been possible to break up, before they started, the German attacks into Belgium in 1940 and in the Ardennes in 1944. Similarly, neither operation Overlord nor the crossing of the Rhine would have been possible in the form they took. The build-up of huge dumps to support an attack, once possible under air supremacy, now becomes folly; and the picture of vast numbers of men, tanks and guns concentrated in a beach-head or bridge-head prior to a break-out is a thing of the past.

Where an attacking enemy has the initiative, the defender will be hampered in his ability to use nuclear weapons, being unable to use them against those enemy forces actually in contact with his own. He will, of course, be able to use them against opportunity targets in the enemy support zone and against any enemy within sufficiently large gaps in the defences.

Turning to damage potential, the effect of even a 5 kiloton nuclear weapon for instance, delivered with reasonable accuracy against a small town will be to create an area of rubble up to a mile and one-quarter in diameter through which all movement will be impossible. Hence the use of the routes passing through communication centres can be denied for periods of several hours depending upon the engineer effort available to clear a way through, and the standards to which the routes must be restored. Such delays in a fast moving battle could be disastrous to either side, especially if movement from dispersed locations to the battle area is necessary. The logical deductions from this are that communication centres must cease to be vital to military operations, and the cross country performance of all arms and services, including supply echelons, will have to be substantially improved.

Allied in part with this ability to destroy communication centres, is the similar power to create obstacles and extend and improve natural ones. Where a nuclear missile is detonated so as to create fall-out it does, in effect, produce a temporary obstacle, through which it is impossible to pass troops without subtracting something from their radioactive life and hence their long-term operational efficiency. Only a commander on the spot can decide on the advisability of taking the risks involved, but such obstacles will sooner or later take their toll of military efficiency.

Much more powerful than this, however, is the blast effect of the nuclear weapon, which, as we have seen, can turn towns and villages into heaps of debris; forests into tangled masses of splintered trees and defiles into impassable barriers. This capability of confronting an opponent with serious obstacles to movement, swiftly and suddenly, injects more than the usual amount of uncertainty into a battle. Further, it materially assists the attacker in his aim to isolate the battlefield, and the defender in his efforts to delay the arrival of the enemy supporting troops at the scene of action.

Summary

It is convenient at this point to summarize the tactical capabilities which the characteristics of nuclear weapons give to a commander.

To an attacking commander they give:—

an effective means of achieving surprise;

an effective and economic means of breaking into a defensive position;

some protection, against the use of such weapons, to his forward troops in close contact with the enemy;

an effective means of restricting the enemy to cross-country movement;

very material assistance in isolating the battlefield;

the ability to influence the battle at much greater ranges than was heretofore possible in all weathers; and the ability to destroy any land-bound logistic system.

These mean that the defender should endeavour to:—

disperse and conceal his forces so as to offer no attractive target to the enemy;

arrange his dispositions so that an enemy break-in can be countered quickly;

devise tactics whereby he can use nuclear weapons against attacking troops;

improve materially the cross-country performance of all his forces;

maintain great mobility and the ability to cross obstacles quickly and on a wide front; and

devise an extremely flexible logistic system.

The user of nuclear weapons gives the defender the following:—

the capability of destroying enemy concentrations of troops and supplies once they have been detected;

the ability to restrict enemy movement to cross-country;

the ability to create limited obstacles to movement within enemy territory; augment suddenly the effectiveness of natural obstacles, and hence delay the arrival of supporting troops on the battlefield; and

the ability to destroy large sections of the enemy's land-bound logistic system.

To minimize the affects of these the attacker should:—

remain dispersed and concealed up to the last possible moment before an attack;

have a high cross-country performance enabling him to avoid movement through communication centres, thus by-passing the effects of his own, as well as the enemy's weapons;
be organized to cross obstacles on a wide front and have an efficient and swift system of doing so; and
have an extremely flexible logistic support organization.

PART II

The Defensive Battle

How an enemy, planning any future European conflict on land, would decide to conduct operations is open to a considerable amount of speculation. With the ability to direct strategic nuclear weapons at the home bases of the Western Allies, he must feel that the destruction of their forces in the field is no longer the prime method of bending their will to his. Nevertheless it is most likely that he would still wish to destroy these forces in order to remove any retaliatory threat that they might possess, and to remove a potential source of disciplined resistance.

The enemy's land operations are, therefore, more likely to be designed to exploit his numerical superiority and to be aimed at surrounding and annihilating our forces, than at making territorial gains, although the latter would be an inevitable by-product of successful operations. The swiftest and most effective way of achieving his aim would be to carry out a series of deep, encircling penetrations, concurrently with the destruction by air or missile attack, of all land bases and depots on the European mainland and in the U.K. It is this very broad concept of the enemy's probable strategy on land which will be taken as the background against which the various tactical principles deduced in Part I must now be thrown into relief. It will be well to examine these principles and consider how their application by an enemy might affect his tactics before studying the resultant implications on the tactics employed by a commander on the defensive.

The Attack

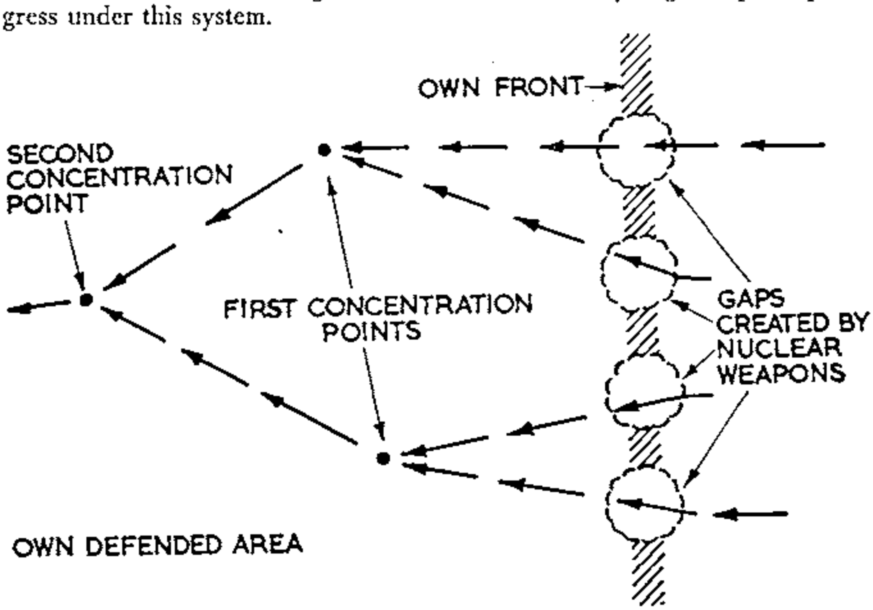
It will be accepted that the initiative for the first attack is likely to rest with the enemy, since he undoubtedly has the ability to co-ordinate this with the more important strategic nuclear attack. It is inconceivable that the attack on land would precede the strategic attack, nor is it likely to follow it by any considerable time, since any delay might enable the Allies to wrest from him some local initiative.

If he wishes to increase this already considerable potential for surprise, the enemy will refrain from carrying out any pre-attack concentrations of troops, or any logistic build-up which might be taken as an indication of an impending offensive. Formerly this would have been such a serious drawback as to have been impossible of achievement; however, as has been shown in Part I, the use of nuclear weapons enables him to break into a defensive position with relatively weak forces. The problem then becomes how to concentrate these forces, and reinforce and support them for further operations.

The enemy's ability to carry out this reinforcement and support will be subject to the effects of all manner of defensive fire from conventional and nuclear weapons, and from air attack. To minimize the effects of such measures it is likely that the enemy will attempt:—

to conceal the whereabouts of potential reinforcing troops until the last possible moment, and then to reduce their time of exposure by ensuring that they are extremely mobile;
to ensure that the cross-country performance of such troops is sufficiently high to enable them to by-pass any newly created "nuclear obstacles";
to create a logistic supporting organization that is equally flexible, and with as high a performance as his combatant troops; and
to train and equip his forces to cross major obstacles on a wide front and without offering attractive targets to the nuclear weapons of the defence.

The enemy problem can be likened to the World War II problem of concentrating a bomber force, drawn from a great many bases, over a given target within a specified minimum time. In the matter under study it is likely that the enemy point of concentration will be within our defensive zone for two reasons. First, he would hope that proximity to our forces would preclude the defence commander from using nuclear weapons against him, lest in so doing he destroy some of his own troops. Second, in order to present the least attractive targets to nuclear attack, and to minimize the effects of such attacks if launched, he would wish to defer concentration until the last possible moment. He would therefore make a calculation, based on his own estimated rate of progress and intended axis of advance, of the various points at which the defence might be expected to concentrate effective resistance. These would then become desired points of concentration for his forces. The diagram shows how the enemy might hope to progress under this system.



Similarly, the defence will be taking steps to avoid undesirable concentrations, and while it is intended to examine these later, suffice it to say here that the enemy will also appreciate this fact and will expect to meet a defence just as mobile as the attack he is planning. It is likely therefore that he will plan to use for his operations, tanks, mechanized infantry, supported by tactical air forces and self-propelled artillery and mobile mortars; with airborne troops used for particularly swift reinforcement where necessary, as for example, assisting in the crossing of obstacles, or for deeper attack aimed at disrupting movement in the rear of the defensive zone.

Enemy tactical nuclear weapons would probably be under higher control, with some available on call to, and directed by, the forward troops, assisted probably by aerial tactical reconnaissance. This would be desirable, because with a fluid battle expected, the enemy commander would wish to retain under his own control such a potent means of influencing it. Furthermore a subordinate commander with a more restricted vision of the battle could prejudice future operations by his use of such weapons.

The Defence

Having examined the tactics likely to be employed by the enemy, it is now possible to obtain a much clearer picture of the problems that the commander of the defence forces must solve to be successful in battle. These problems are discussed in the ensuing paragraphs.

It will be accepted that in the first instance the enemy will have the initiative, enabling him to strike when and where he wills, and without any prior intimation to the defence. It should, therefore, be the aim of the defence so to dispose its forward forces that they would be too strong to be attacked by an enemy using only conventional weapons, without that enemy having to carry out some pre-attack concentrations, thus inviting attack by the nuclear weapons of the defence. As a corollary of this the forward defence forces should also be sufficiently well dispersed to reduce to a minimum the casualties resulting from an enemy attempt to create gaps by the use of nuclear weapons. The only way that these two apparently paradoxical principles can both be satisfied is to ensure that the forward troops are equipped with weapons of sufficient range and fire power to permit them to be placed at a comparatively low density across the front.

As the enemy has the initiative it should be possible for him to plan a successful break-in into the forward area of the defence. Not until he has launched his attacks will the defence machine be able to get into motion, but when it does its first task will be to attempt to stay the forward motion of the enemy spearheads. This task would be best effected by moving mobile forces towards the advancing enemy and engaging him in a running and delaying fight. This type of action is considered to be more effective than the previous system in which the enemy was allowed to run on to troops dug-in and entrenched in carefully prepared positions for four reasons:—

first, while the use of prepared positions in depth may give the defenders some local advantage, it is considered that unless one can achieve the well nigh impossible state of perfect concealment, they will be known to the enemy in advance and hence liable to further gap-opening atomic blasts in front of the advancing enemy:

second, the enemy will be uncertain as to where he is liable to meet resistance, which gives some advantage in local surprise and initiative to the defence:

third, while a static position once cracked loses a very large part of its effectiveness, mobile forces can remain engaged, even if the enemy retains some of his forward momentum, and conduct a running battle which will certainly take a toll of the enemy's resources and may well divert him from his intended point of rendezvous with other enemy groups, or, at the least, delay his arrival there: and fourth, this is one method by which an inferiority in numbers can be offset to some degree, in that maximum effects are produced by minimum numbers.

At this stage it is possible to consider in general terms, the development and method of operating of our forces. If these are to be organized, as has been already suggested, into widely dispersed localities, then each locality should be manned by a self-contained battle group. That they should be able to engage in a running battle implies that these battle groups should be highly mobile. The same is equally true of all combatant forces deployed in depth; and the picture, therefore, is of a series of similar battle groups arranged checker-board fashion over the whole of our defensive zone, which must be in great depth to allow adequate space for manoeuvre. This is a still picture up to the moment of enemy attack, but thereafter it becomes a moving one, with all battle groups, capable of engaging the enemy advantageously, set in motion, with the object of halting his forward movement and inflicting a heavy rate of attrition on him. Even troops in the forward line, once engaged, should not necessarily be compelled to remain static; their sole function being to destroy the enemy in the most effective manner possible.

The several actions resulting from this type of operation will in essence be extremely local; and battle groups will, for the most part, be able to fight over open sights without the necessity of calling for and controlling indirect fire. As will be seen later, this has some effect on the composition of the group.

Concurrently, with the action described in the preceding paragraphs, the defence must endeavour to seek out and destroy all enemy reinforcing troops on the move towards the battle area. This will call for intensive reconnaissance in which all scientific methods of detection as well as conventional air reconnaissance will have to be called into use. Such reconnaissance must be backed up by an adequate striking power and an efficient system of control and direction of fire including nuclear-armed tactical air support so that no opportunity to separate the enemy reserves from their spearheads is missed. It is not inconceivable that, if unfavourable weather conditions precluded the accurate direction of nuclear and/or air attack, mobile forces of the defence could be moved forward to intercept such enemy reserves and prevent them from reaching their previously assigned points of battle.

Successful operations in the manner described above could well result in the winning of the defensive battle, since the enemy would have been prevented from achieving any concentration of superior force; and his various battle groups would have been defeated in detail or crushed by air and nuclear attack. Should however the defence's operations fail to achieve this result and the enemy succeed in concentrating superior forces within the defensive zone, then different tactics will have to be employed in order to destroy him.

At this point in the operations the only means available to the defence of destroying superior forces is the use of nuclear weapons. The defence commander is, therefore, faced with the task of creating a situation favourable to the use of these weapons. There are two pre-requisities to this, which are:—

the extrication of his own troops from close contact with the enemy; and

containing the enemy, by now more densely concentrated than before, in that condition in a pocket (or pockets).

Some further tactical requirements can now be deduced. First our troops must be trained and equipped to establish around any enemy penetration a screen of fire power strong enough to prevent any outward movement, except perhaps at the spearhead of the attack, which may still have sufficient momentum to carry it forward. Second, our own battle groups engaged in this fluid type of battle must be capable of disengaging swiftly, and moving behind our containing fire screen and outside the salient now formed.

A great deal of the commander's skill will be called forth in estimating the moment by which he will have slowed down the enemy spearheads to such a degree that further enemy reinforcements would be moved forward—their arrival being the critical moment for the use of his nuclear weapons—and to co-ordinate with this the withdrawal of his own troops from within the salient. By this swift creation of a pocket in which the enemy are more highly concentrated, the stage is thus set for the use of the defence's nuclear weapons. If the commander has been correct in his reading of the battle, and the control system necessary to effect the various moves is efficient, and we must presume these to be so, the use of nuclear weapons will shatter the enemy attack, leaving the defence commander with the tasks of organizing mopping-up operations within the pocket and the re-establishment of his forward line.

To sum up therefore, the argument presented in this part of the essay is as follows. An attacking enemy has the initiative and may therefore be presumed to have the advantage of surprise. The use of nuclear weapons materially assists this advantage. In order to make the enemy reveal his hand the forward posts should be established strong enough to make him attack in strength, but sufficiently dispersed to reduce to an absolute minimum, the effects of nuclear attack. This calls for high fire-power and low man-power. Enemy penetrations should be resisted by the more economic use of mobile battle groups engaging in running battles, rather than by a succession of static lines or zones, in which positions, once by-passed, become useless. This should be accompanied by all possible air and missile attack on the enemy supporting zone. Should these measures fail to halt the enemy, the defence commander must artificially create a situation favourable to the use of his own nuclear weapons. To do this he must offer such resistance as to force the enemy into the maximum possible concentration of effort, and arrange to contain him in that condition by using a fire-power screen to seal off a salient. Discharge of his nuclear weapons into this salient should then leave only mopping-up operations to restore the *status quo*.

We have thus arrived by a process of logical deduction at a method of conducting a successful defence in operations in which nuclear weapons are used by both sides. There is, of course, one major proviso to this, which is that we must be capable of organizing and controlling battle groups to carry out the functions specified above. It will be the aim of Part III to discuss the ways of achieving this.

PART III

Organization for Defence

Since the earliest days of warfare, armies have been based on two separate arms—the infantry and the cavalry. For hundreds of years the functions of these have been entirely separate and virtually unchanged—the one being the more ponderous and slow moving means of fixing the point of manoeuvre, while the other, even under its newer title of armour, has been the manoeuvring arm of swift decision. Other arms, as they were developed, were placed in support of these two major arms. Even in World War II, when the need for closer integration became apparent, battles were still regarded as predominantly "armoured battles" or "infantry battles". In other words, although the need for close mutual co-operation was recognized, it still seemed to be necessary to designate the predominant arm in order to ensure the right type of battle being fought. As a result, and despite the considerable strides made in infantry armour co-operation, each arm fought according to its own methods and principles: and although the operations of each had undoubtedly the same common aim, yet there was then, and still is, no such thing as completely integrated tactics.

This concept that battles must be either "armoured" or "infantry" is still with us, and is one factor responsible for leading us into several pitfalls in our tactical thinking. For instance the comparative immobility of the infantry as related to the armour in typical European terrain, and the difficulty of maintaining it logistically, or extricating it once by-passed, has led us into the belief that ground can be vital to the defence and must be held at all costs; whereas the only thing vital to the defence is that all enemy entering the defended area should be destroyed immediately. The tacit acceptance of static defences is a result of this type of thinking. Again, we have been led into the creation of an unbalanced armoured division in which the main role of the infantry brigade is regarded as holding ground captured by the armour.

In our attempts to arrive at a suitable organization for the defensive battle, it is therefore important that our thoughts should not be coloured by such thinking as that referred to above. A suggested conduct of the defensive battle has been outlined in Part II and it is now the aim of this part of the essay to devise an organization that will be capable of carrying out the functions so far discussed. In doing this the necessary tasks will be examined and the desirable weapons and organization thus derived from fundamental basic principles.

The first requirement is to examine the forward defences. It has been shown that these should be high in fire-power and low in man-power, so that the enemy would be forced to attack in some strength and yet be incapable of inflicting more than minimum casualties by the use of his nuclear weapons. To achieve this we must reduce not only the numbers of localities, but also the total number of men in any given distance along the front, while maintaining the same, or greater, fire-power. This can be achieved by taking advantage of new weapons with increased performance, and concentrating on grouping the necessary killing weapons into battle groups capable of covering by fire wide extents of front.

Stripping the battle group down to its bare teeth has a great many economies, but leaves those teeth without any form of local protection. Such protection is necessary, if the crews of the major weapons are to be able to fight without looking over their shoulders in apprehension; and to protect them from enemy fighting patrols. There is therefore a need for some infantry within the battle group.

Next comes the question of artillery, or mortars to provide the necessary high explosive, fragmentation type of fire support. The argument is briefly this. Artillery with its longer ranges can provide support over a great area but has to be concentrated in gun areas to accomplish this. These are vulnerable in fluid operations of the type that we are considering, and would therefore require some additional protection to be supplied. This in turn would lead to the establishment of what would in effect become static localities that would have to be defended at all costs. It was shown in Part II that even the forward localities should not be required to remain in static positions after the attack had commenced; and that in their operations they would in effect be only concerned with those targets that they could engage over open sights. It is, therefore, considered that battle groups should have their fire support, be it guns or mortars, with them and that this should be capable of the same cross country movement as the rest of the group. This being the case the weapon, if a gun, should be mounted on a tank; or on a carrier, if a mortar, as either would provide the most suitable and versatile means of moving and controlling the weapon itself.

The use of tactical air forces against the enemy support zone has already been referred to as an essential part of the defence operations; and there might therefore be none available for close support of the forward positions. However, any that could be made available would, of course, be invaluable; although in this case the aircraft would probably have to use conventional weapons.

Anti-tank weapons, too, must be capable of rapid movement, and here again the tank seems to provide the best answer. It has long been accepted that static anti-tank weapons were altogether too vulnerable, even in the old type of static defence, and with the added requirement of high mobility they should be discarded entirely.

This naturally leads in to the role of armour itself in the defence. Here it seems that, in addition to the support described in the two preceding paragraphs, there will be a role for a cavalry type of action. This is when an attacking enemy has established itself in too favourable a position in relation to the battle group, at which time, an armoured counter-attack could have the effect of dislodging it and restoring the situation. Again there is a need for the battle group to be able to disengage from an action swiftly, and it would be most desirable to have a strong screen to cover its initial critical movements.

To sum up so far, therefore, we have established that for defensive purposes in the front line, a battle group requires armour to provide anti-tank, cavalry and perhaps anti-infantry support, automatic weapons with a high rate of fire and mortars, and some infantry for local protection.

Let us now turn to the role of the battle group in the running type of battle. In this type of operation the group will be required to co-ordinate its action with other groups and will be continually engaged in fire and movement as it seeks to carry the fight to the enemy, and harry him in his forward movement. This is a role in which armour excels, and demands that the battle group be well equipped with that arm. There is also a requirement for infantry in this type of battle, since the temporary occupation of tactical features would materially assist the armour in its role, and would enable some extra weight of automatic weapons to be brought to bear on the enemy. Such infantry would of course have to be as mobile as the armour it was accompanying, and should therefore be carried in armoured personnel carriers. Fire support will primarily be against opportunity targets; and therefore once again, the advisability of having the weapons as an integral part of the group is emphasized. Once again, the use of close tactical air support in this type of battle would be invaluable, but would require close co-ordination and very careful target indication procedures.

As a result of the examination of these two differing roles of the battle group, it has been demonstrated that there is a need for three basic components—armour, infantry, and automatic or close support weapons, with, of course, a headquarters for control purposes. It now remains to decide what size these various component parts should be.

The size of the battle group is dependent on two factors. First, the area of ground it should be capable of covering, which in turn depends on the ranges of the weapons with which it is equipped. Second the numbers of sub-units that it is possible to control from one headquarters in a mobile battle.

With regard to the first factor, present automatic weapons are capable of firing at ranges of, in many cases, over 2,000 yds. This means that, if the terrain were favourable, localities could be placed as far apart as 2,000 yds and still be mutually supporting. This is unlikely to be possible in most cases, and therefore this extreme distance will have to be reduced. However, it must not be reduced beyond the point at which too many localities could be caught in the blast of one nuclear weapon. Turning to the table on page 287 it can be seen that the maximum radius of total destruction of a 20 kt weapon is 0.75 miles; for a 5 kt 0.48 miles; and for 1 kt 0.28 miles. Hence if localities were located 1,000 yds apart and a 20 kt weapon directed at one of them it would also destroy the two adjacent localities on either side; but with either a 5 or a 1 kt weapon only the target locality would be completely destroyed. It seems, therefore, that localities should be placed not less than 800 yds apart and not more than 1,200–1,400 yds apart.

Considering the second factor it is generally accepted that the optimum number of subordinate headquarters which one senior headquarters can control is three or four, depending upon the level of command, and the area over which control must be exercised. It has already been shown that there are only three basic components to the proposed battle group, but it may be necessary to split these up into smaller composite sub-groups to facilitate tactical handling. At this level it is considered that four would not be excessive and this being the case the three major components should be capable of being so divided.

The shape of the battle group is now at last beginning to appear. It has three major components—armour, infantry, heavy weapons—each of which is divided into four sub-units. The size of these sub-units will be dependent upon the "killing" task that they are expected to perform. As before, this depends on the weapon characteristics with which the sub-units will be equipped.

At this point a difficulty arises in that the use of classified material must be avoided, whereas the logical following of the line of argument necessitates the use of the characteristics of new weapons under development, and reference to operational research studies. How these would be used can therefore be indicated only and hence no conclusive figures will be deduced.

Based on our knowledge of the enemy and his tactical methods we should be in a position to decide the numbers of troops and tanks with which he is likely to launch an attack. We therefore know the amount of killing that has to be done. From this we have to turn to operational research from which we can determine the number of rounds of each type of weapon that would be necessary, taking into account the accuracy of the weapon, the human error and possible rates of fire. From such a calculation the numbers of weapons themselves can be arrived at. This will then indicate the size of each of the major components in the battle group.

The table below represents the fire support that could be concentrated in the area in front of a battalion position after the end of World War II.

Type of fire	Arm or weapon	No. of guns	Rds. per min. per gun	Total Rds. per min.	Total Rds./ min. all types
High explosive (fragmentation)	Artillery battery	8	5	40	178
	Heavy mortar troop	4	12	48	
	Infantry mortar platoon	6	15	90	
Small-arms	Two sections medium machine-guns	4*	240	960	4,460
	Light machine-guns	30*	60	2,000	
	Rifles	approx. 100*	15	1,500	
Anti-tank	Infantry anti-tank platoon	4*	10	40	80
	Tanks	4	10	40	

NOTE: *Remainder presumed to be in depth and not capable of firing on battalion front.

Allowing for improvements in types and designs of weapons it is not unreasonable to suppose that following the process outlined above we would arrive at a requirement for an establishment of some eight to twelve quick firing guns or mortars, sixteen automatic weapons in the medium or heavy machine-gun range, and eight to ten anti-tank weapons in order to cover the same width of front. As this approximates the width of front chosen for the battle group, an establishment for the latter emerges and can be written as under:

Armour	8–10	tanks in anti-tank role	say two troops
	8–12	tanks as close support gun tanks	two or three troops
Mortars	8–12	carrier mounted, if close support tanks not included	two or three troops
Infantry		for local protection etc	say four platoons

It was however, decided that the battle group should be capable of being sub-divided into four groups, and this decision enables us to arrive at a more suitable establishment, which would be:—

Armour one squadron of four troops each of four tanks

Heavy weapons one squadron of four machine-gun troops each of

	four guns; and one mortar troop of four detachments each of two mortars
Infantry	one company of four platoons

So far little has been said about the battle group headquarters. If the group is not to become too unwieldy, this must be kept to a minimum, and administrative functions reduced to bare essentials. The functions which are deemed essential for the headquarters to perform are:—

control, for which an intercommunication network will be essential with normal forward links to all elements of the group, and rear link to superior headquarters;
reconnaissance, which will assume great importance in mobile operations and must include radiation monitoring;
support control, which will be necessary to call for and direct long range support such as tactical air support and even in some instances nuclear missiles; and
administration, which should be limited to demanding, receiving and distributing deliveries of supplies, fuel and ammunition for the battle group. This may involve the setting up and marking, of dropping zones for air drops or helicopter landing areas.

It appears therefore that the headquarters of the battle group should consist of:—

a command and control element,
a reconnaissance troop, and
an administrative troop.

The need for this battle group to live together, train together and become a thoroughly and completely integrated group must be abundantly obvious from any consideration of the role which it is expected to play. It is, therefore, suggested that the battle group should in effect replace the present infantry battalion or armoured regiment. The nomenclature of either could be chosen so that a former infantry battalion could be organized with one tank company, one heavy weapon's company and one rifle or infantry company; whereas the use of "regiments", "squadrons" and "troops" could be applied to units with cavalry backgrounds and traditions. In essence, however, all units would be the same and completely interchangeable in all respects.

With regard to the higher formations, there seems little reason to deviate from the present system, this having been derived from the numbers of subordinate units readily controlled by one senior H.Q. Whereas four were accepted as the optimum number at the lower level considered above, it is probably better to restrict this to three at the higher command levels where greater distances are likely to be involved and hence the maintenance of control more difficult. Brigades, as before, would therefore be constituted of three regiments (or battalions); and divisions of three brigades.

The problems of logistic support for operations of this type have been discussed in other recently published essays, and are certainly not within the scope of this essay. However, it would be undesirable to leave a discussion of this nature without some reference to the problem and some indication as to the direction in which the solution might be sought. The concentration on killing weapons will of course increase the load on the ammunition supply system, while the emphasis on great mobility will add to the problems of fuel supply. Both the above problems will be considerably aggravated by the abandonment of any form of static defence and the inability therefore to establish fixed lines of communication and supply. Even if this were not the case it is doubtful if in the face of enemy nuclear weapons such luxuries as supply dumps, railheads and corps maintenance areas will be a possibility, and other arrangements will have to be made. It is difficult to see how these problems can be solved without recourse to some completely abnormal system.

In such a system there can be no doubt that units in the field will have to be capable of carrying a great deal more with them; but this can never approach a complete solution. Even supply direct from home base to the formation in the field is dependent upon the home base being non-vulnerable, a state which is patently extremely difficult to achieve. It appears, therefore, that during any land operations in Europe our troops will have to be dependent completely upon a system which is as flexible and mobile as the system of defence it must support. Just as we have established the need for a checker-board layout of mobile battle groups, so there is a requirement for a network of mobile supply groups, each affiliated to a regiment or brigade, and able to connect with it, either direct, or, if conditions made this impractical, by means of an air link, at certain mutually arranged rendezvous. The problem is similar to refuelling aircraft in flight or naval vessels at sea.

The supply groups may have to rely on air-borne re-supply from seaborne bases or depot ships, or even preferably huge cargo carrying submarines.

The development of such a system of logistic support for the type of operations discussed here would be a most interesting study; and it is therefore with regret that the subject must be relegated to minor position in this essay, although this is not done without a full realization of the immense importance that it has in completing the overall tactical capability of the defence.

Conclusion

In conclusion it must be said that the whole secret of warfare in the nuclear age is constant movement. Static defences can be pin-pointed and destroyed; and counter measures and counter-counter measures can only end by cancelling each other out leaving the advantage with he who has the initiative and strikes first. The only possible hope of wresting the initiative from such an aggressor is to have one's forces initially widely dispersed, but in such a condition that they can be put into a state of fluid motion in an instant—motion with a purpose and designed to hamper and restrict the enemy's movement and reduce it to the point where he in turn becomes a worthy target for nuclear attack. To achieve this aim our forces must be reorganized to have great mobility and terrific fire-power concentrated in comparatively small units. In this, the most effective reorganization will be to abolish the infantry and armour as separate corps; forming in their place, only one cambatant corps in which tanks, infantry and heavy weapons are fully integrated in the basic units. The defence we have foreseen will then become, not a question of slogging it out in static positions over which the tide of battle can pass, but rather a series of offensive actions in true British character, in which personal initiative and resourcefulness can inflict great destruction on the enemy—actions which in their nature will resemble classical naval engagements in which the battle flows over a wide area and in which the formations engaged are left free to choose the most advantageous manoeuvres to achieve their aim. Such a battle is much more in line with our national characteristics; it is one which is most likely to maintain morale and furthermore is considered to be the only method, apart from scientific stalemate, likely to ensure success in defence.

ACKNOWLEDGEMENT

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Specification and Selection of Silicone Water Repellents

By BRIGADIER A. M. ANSTRUTHER, CB, OBE (Retd)

THE use of Silicone Water Repellents is extending rapidly and these interesting new materials are now being employed for a wide range of purposes. An air-drying silicone solution can now be used to proof, or reproof in the field, almost any type of fibrous material such as timber, plywood, wall board, cardboard or even paper, as well as canvas, hessian, cotton or linen fabrics, by brushing, spraying or dipping in just the same way as low-grade building materials and even earth walls can be made water repellent. This means that the RE officer has a powerful new ally to assist him in the improvised work which he so often has to carry out.

Although responsibility for "Works Services" is passing from the Corps this does not mean that Sappers need no longer concern themselves with construction problems though they are more likely to be called upon to provide temporary, or semi-permanent structures rather than permanent buildings.

Silicone water repellents are, moreover, finding an increasing use in civil engineering works and it is in this context that Sapper officers may well find them of particular value.

Since the technique of using these new materials is still in a relatively early stage of development and not widely known or understood even amongst members of the Architectural and Civil Engineering professions or the building industry, Sapper officers may find some difficulty in framing a suitable specification for applying them and they may also not find it easy to make a wise choice amongst the various products offered for sale. It is hoped that this paper will help to resolve these difficulties and will encourage officers to make greater use of this new, convenient and economical medium.

It may be as well first to recapitulate the main properties of Silicone Water Repellents and the results which can be achieved by their use. All silicone resins possess in varying degrees the properties of chemical inertness, non-toxicity, colourlessness, tastelessness, odourlessness, water-repellency, ability to spread themselves extremely thinly and to act as release agents. When we treat a surface with them we hope to confer upon it water-repellency in such a way that this property proves durable without altering in any way the appearance of the treated material, and to do this with the maximum economy.

So far as durability is concerned, properly applied silicone treatments have already shown themselves to have remained fully effective for more than ten years and their "life" may well prove to be very much longer than this. Where it is desired to take full advantage of the long life obtainable, one must aim to give the surface to be treated the optimum dosage of silicone to a sufficient depth to ensure that protection is not lost by complete erosion or abrasion of the treated portion. On most materials of average porosity and hardness such as brickwork or concrete this will call for a penetration by the solution of from $\frac{3}{16}$ to $\frac{1}{4}$ of an inch. With harder materials a lesser penetration will be acceptable, with softer materials, however, such as cement-sand blocks or stabilized earth from $\frac{1}{2}$ to $\frac{5}{8}$ of an inch may be necessary.

Even with correct penetration the desired long life will not be achieved unless the silicone solution used has the required content of silicone solids.

In this connexion it should be noted that there is at the present time (January 1959) only one Standard Specification for an air-drying silicone solution in existence. This is the US Federal Specification SS-W-00110 (GSA-FSS) of 10 December 1954.

A sub-committee of the British Standards Institute is engaged upon drafting a British Standard, but it seems unlikely that the results of their work will become available for some time to come.

This American Standard Specification relates to silicone resins in petroleum solvents and calls for a silicone solids content of 5 per cent by weight and an application rate of 75 fs to 100 fs per US gallon, one US gallon being approximately five-sixths of an Imperial gallon, for most surfaces.

The figure of 5 per cent silicone solids by weight was determined as a result of trials with percentages varying from 1 per cent up to 8 per cent. It was found that a steady increase in repellency was obtained by increasing the percentage of silicone solids up to just over 4 per cent, but that beyond that figure the curve flattened out abruptly and no appreciable gain was indicated above 5 per cent. These results were also confirmed by trials in Canada and it seems virtually certain that the figure of 5 per cent will also be adopted in the new British Standard specification when this is published.

The American Standard figure for rate of application 75 fs to 100 fs per US gallon, allows a considerable margin of safety when applied to most types of material in general use in the United Kingdom. It was probably adopted by the US Authorities because of the very wide use which is made in the southern part of the United States of very porous cement-sand blocks for house-building. This type of block, which is also widely used in certain British Commonwealth territories, is so porous that much of the solution is absorbed so far into the block that it contributes nothing towards the water repellency of the surface and a low rate of coverage is, therefore, essential if the surface of these blocks is to be made fully water repellent.

It remains to be seen what coverage figure will be adopted in the British Standard Specification, but experience to date indicates that 150 fs to 160 fs per gallon will give very satisfactory results on average brickwork or concrete in the UK. Except on materials of very low porosity combined with great hardness, application at a lower rate than 160 fs per gallon is likely to lead to reduced "life" of the treatment.

If for any reason only a short "life" is required, better results will be achieved by using a solution containing a lower percentage of silicone solids, than to try to apply a normal 5 per cent solution at a greater coverage, since this is bound to lead to uneven distribution. A specialist firm with experience in the application of silicone solutions should be consulted, setting out clearly the result to be aimed at, and they will be able to advise on what concentration should be used and also to supply the appropriate solution. In certain circumstances they would probably advise the use of a different solvent, but this again is a technical matter on which previous experience is essential.

In specifying the application of silicone water repellent solutions it must be borne in mind that quite different solutions are needed for the treatment of fibrous materials as distinct from porous materials. When treating porous materials a distinction must also be made between surfaces which are reasonably dry and those which are permanently damp; the former can be treated with a petroleum soluble silicone resin, provided that they are not deficient in silica such as limestone masonry or gypsum plaster, whereas the latter and the silica deficient surfaces must be treated with a water soluble siliconate.

It should also be remembered that it is possible to obtain any of the foregoing solutions with fungicides or insecticides added to them, which are of particular value in treating lichen or moss infested walls or roofs or old timbers, and are also much used in tropical or sub-tropical climates where algae and fungal growth is so prolific that unprotected surfaces often become disfigured by them very shortly after erection or redecoration.

Another point which the specifier should remember is that silicone solutions can be obtained with a fugitive dye incorporated in them which fades away a few days after application but which is of great value in assisting the supervision of work carried out by contract or by directly employed labour. These dyes are usually supplied at no extra charge.

The method of applying the selected solution should also be specified. This should where possible be by means of a low-pressure constant pressure sprayer so manipulated as to give a good run down (6 to 12 inches) and working at not more than 15 lb/sq inch, as this will ensure even distribution and will avoid wastage due to atomization. If a suitable sprayer is not available, or if the area to be treated is small, the solution may be applied by brush. It is, however, important to ensure that the solution is flooded on so that the requisite amount may be absorbed into the surface by capillary attraction and that it is not "brushed out," as when painting. This can best be done by insistance on the correct coverage being adhered to and by refusing to accept suggestions that the application specified is too lavish.

Remember also that if the solution is applied as described above only one application is necessary and that there is no advantage whatever in a second application unless the first one has been skimped.

Having drafted his specification the would-be user of silicone water repellent solutions has then to select a suitable product for the job, often amongst samples submitted by a contractor or from a range of products offered by various firms of suppliers. This is made more difficult for him by the fact that there is no simple field test which will show whether or not a given solution is likely to prove suitable for his purpose. Solutions containing insufficient silicone solids to ensure a long life will give apparently good results initially and a lengthy and involved series of laboratory tests is required to determine the silicone content by weight of a given sample.

It is, therefore, essential to accept only the product of a reputable firm whose interest clearly lies in producing an optimum result over a long period and even then preferably to purchase from a firm who specializes in the application of silicone solutions and which markets a number of different solutions to meet various needs.

Here it is worth noting that many of the larger and very reputable paint firms market a silicone solution but that few of them have so far found it worth their while to specialize in the subject. They have relied upon the general knowledge of their sales staff to cover the use of these new materials which are in fact totally different from paint. On the other hand one or two smaller firms have devoted far more attention to the study of silicone water repellents and are thus in a much better position to advise on their use and to supply a fully satisfactory product.

Again, the question of cost is not necessarily a guide to the excellence of the product. It is sometimes the case that the smaller specialist firms have lower overheads than the bigger paint firms who are obliged to spend considerable sums on advertising and high-powered selling techniques in order to sell their principal wares in a highly competitive market.

To sum up, therefore, in order to get the best results from silicone water repellent treatments it is necessary to specify the right type of silicone or siliconate for the job and the correct percentage by weight of silicone solid content for the solution. Having done this a suitable coverage must be specified, having regard to the results aimed at, and only the products of specialist firms of high integrity should be accepted. When all these requirements have been satisfied the price at which the product is offered should govern the final selection.

International Balloon Race

By Colonel R. F. A. Butterworth, CMG, DSO*, late RE

The gallant attempt last autumn of the "New World" balloon to cross the Atlantic Ocean took me back more than half a century, when flying was in its embryo stage, and the only practical method of air-travel was in a "free" balloon. Captive balloons had been used for some time for military purposes, and free balloons brought refugees out of Paris during the siege of 1870. But in the "nineties" ballooning had become more popular, and international races were being held periodically to stimulate interest and to gain experience in this form of air travel and research. The Hurlingham Race of 1909, sponsored by the Royal Aero Club, was more of a sporting event, and took place on 22 May of that year. I came into this by the invitation of Griffiths Brewer—a well-known aeronaut—who asked me to take part in the race as his navigator. I was stationed at Leeds at that time, and went by an early train to King's Cross, where Griffiths Brewer met me in his car and drove me down to Hurlingham. When we arrived there, the competing balloons were all drawn up on one side of the polo ground, in process of being filled with gas from stand-pipes specially installed for the occasion by the Metropolitan Gas Company. The balloons of those days consisted of a spherical envelope made of oiled cambric or silk, covered with a hempen net, to the ends of which was hung the car or "gondola", which carried the crew, instruments and spare gear. The cubic capacity of these balloons varied from 30,000 to 10,000 cu ft, or even less in the two-man balloons. It was a weird sight. Fifteen immense globes being rendered lighter than air, tugging and swaying at their moorings in the breeze. The majority of the balloons were manned by Englishmen, but there were also one Belgian and three German competitors. There was a military balloon from the R.E. Establishment at Farnborough, and another private R.E. balloon flown by Sir Alexander Bannerman, a Sapper Major. Griffiths Brewer was a great expert, as he owned his balloon, and had made many trips for pleasure or experiment. He was by profession a patent agent in the City, and acted as such for the Wright Brothers, who designed and flew the first practical "Flying Machine". He flew with the Wrights and was responsible for much useful research in the early days of aviation, as well as for the development of aerial photography.

Other well-known competitors were Moore-Brabazon (later Lord Brabazon of Tara) and Charlie Rolls, co-founder of Rolls-Royce, who was unfortunately killed a few years later in a flying demonstration at Brighton.

Brewer's balloon, the *Vivienne*, was one of the largest in the race, and we had a crew of five. These were: that well-known Edwardian sportsman, Sir Claud Champion de Crespigny, Harry Delacombe (reporter for *The Times*), Massac Buist (*Morning Post*), Griffiths Brewer, and myself. The race was a point-to-point event. At the start we were handed an envelope containing a map, which was not to be opened until we were air-borne. On this map was an X, and the competitor who landed nearest the X was the winner. There was no time limit. It was as simple as that, or appeared so.

While waiting for the start, a series of small pilot-balloons were set free, and we all had a chance of seeing the direction they took at various altitudes. This was very important, as the currents of air vary considerably at different heights, though the general direction today was NW, and you had to get your balloon into the right current to take you over the X, out in the country beyond London. This current was actually between 7,500 and 7,800 ft, as we found later. There was a tremendous concourse of spectators to watch the start which was at 2 p.m. The balloons got off independently as soon as they were filled up, and all started in a SE direction over London. It was essential to get your balloon just balanced, so that all you had to do at the start was to jettison a little of the ballast, and off you went. The ballast consisted of a sack of sand which, added to the weight of the crew, instruments, and gear, made the balloon just lighter than air. Two or three men held on to keep the balloon steady, till you were given the signal to start. It was necessary to make height quickly, or you might hit a tree or building on your way up. Our pilot knew all about this, so we ascended sharply, and then Brewer opened the envelope, took out the map, and ruled a thick pencil line from Hurlingham to the X. He then handed the map to me, saying "Here you are, please tell me when I am north or south of that line." That was not very difficult, if one knew the rudiments of map-reading.

We were soon up to 2,000 ft, and moving fast SE. It was at once evident that we were going to find it difficult—as did the other balloons—to keep to the north of the line. In fact some of the balloons were already drifting to the south, and would have trouble in getting back to the north again. Two of these came down among the houses in the dock area, and two more in the mud of the Thames estuary near Gravesend. So Brewer at once aimed for more height, and lightening the balloon, we found a current between 7,500 and 7,800 ft, which gave us the right direction towards Colchester, and the village of Billericay, where the X was. We passed over Buckingham Palace, Charing Cross, St Paul's, and then out of London by Barking, and above the green fields of north Essex.

In a flight like this the balloon is perfectly steady and only moving imperceptibly a little up or down. You had to watch this, as the balloon, if not checked, might develop a downward movement, which had to be countered by throwing out a little sand, or the heat of the sun might expand the gas and cause a too rapid ascent, which meant releasing some gas. The pilot watched all this very carefully. For instruments we had a barometer giving our height in feet, and a statometer, which was a very delicate instrument showing whether the balloon was going up or down. We also had a compass and a sextant, but used these very little on this flight.

When nearing Billericay we were still a bit too much to the south, and Brewer tried to correct this, dropping a little, by releasing gas from the valve at the top of the envelope. This didn't help, so we went up again to about 7,800, when we did better. It was soon after this that we spotted the white X, consisting of two strips of canvas pegged down in the middle of a field. Brewer decided to land, and he put the balloon down to about 200 ft and stabilized her there. We then let fall the mooring rope, which is carried on the outside of the car. This reached the ground, and trailed over the fields and hedges taking the impetus off the balloon. Next we attached the grapnel, and let this slide down the rope. This soon caught into a hedge, and held us fast. Brewer then let out the gas very fast, and warned us to bend our knees when the car bumped on the ground. This it did once or twice, and then Delacombe pulled the "ripping cord", which tears open the envelope from top to bottom, and the whole of the fabric collapsed and came down in a heap. Then we all climbed out.

Within a few minutes people started to arrive over the hedges etc, and Brewer, who knew the game, soon found a farmer, who agreed to fetch his wagon and take the car, with the balloon fabric, instruments etc, all neatly packed inside, to the nearest railway station. This packing only took a short time, and Brewer had the labels all ready to tie on the outside, addressed to the Short Brothers in Battersea, who would sew in a new ripping panel, and have the balloon ready for its next flight.

Sir Claud was well known in Billericay, as it is not far from Champion Lodge where he lived, so someone went off to the telephone, and got a message through for his car. This was soon on the spot, and we all got in, and were driven to Champion Lodge. Here we were greeted by Lady de Crespigny, who had seen us off at Hurlingham (where she gave Sir Claud a farewell kiss before he embarked) and had made very good time by road to Colchester. Sir Claud wouldn't hear of our going back to London that night, and entertained us like princes, including the loan of pyjamas etc for the night. It was a happy and remarkable experience.

The official placings were:—

1 Mr. John Dunville, *Banshee*; 2 Major Sir A. Bannerman, RE, *Satellite*; 3 Hon. C. S. Rolls, *Mercury*; 4 Mr Griffiths Brewer, *Vivienne*.

The Ziegler balloon (Dr Linke of Frankfort) finished in the first four, but was disqualified for irregularities as regards ballast.

The prizes were presented at a luncheon party given to all competitors at Hurlingham Club next day.

Vital Statistics

By "DAN"

We build 'em nice barracks—they swear they are bad,
That our Colonels are Methodist, married or mad,
Insulting Her Majesty's Engineers,
Her Majesty's Royal Engineers,
With the rank and pay of a Sapper! —*Rudyard Kipling*

HER MAJESTY was Queen Victoria. Now that we have another Queen, has Kipling's verse aged? "Are we still M, m or m?" I wondered, or to be more correct, "Are they?", them being Colonels. Now the ready reckoner for simple bets is *The Guinness Book of Records.* On Sapper matters one would expect the RE List to fill the same role. "November 1958", mine said, "Corrected to 26 August". Of religion there is no mention, but there are plenty of little m's, meaning married. Madness one has to deduce unless one happens to know the chap.

I kept to the permanent commissioned officers, for it must have been them to whom Kipling referred. All the Generals, fifteen of them, are married. So are all the twenty-seven Brigadiers and fifty-three full Colonels, or nearly all. There are two exceptions: a Director of Ordnance Survey UK and, bless my soul, a Deputy Director of Ordnance Survey UK. I know statistics lie, but coincidence it certainly is. You will not be surprised to hear, therefore, that the senior unmarried Lieut-Colonel is on the Military Staff of the Ordnance Survey UK. However, here the sequence ends. There are seven other bachelor Lieut-Colonels and if they have the remotest connexion with the Ordnance Survey UK the List keeps it a secret. We end up with 227 Lieut-Colonels and above, of whom 217 are married. Yes, our Colonels are married!

Looking at lists has a nasty habit forming effect on me. It is virtually impossible to count m's without becoming fascinated by the seventy odd other hieroglyphics which officers may be credited with. I kept counting until the joints of my hands grew numb. I doubt if anyone else today has more useless, and I hope harmless, facts literally at his fingertips than I. If you doubt my capability of assessing these results I would have you know that I once worked out the odds at Crown and Anchor. This was after lesson 2 of 30 in a statistics course, before I realized that there was to be no exam.

Of the 1,556 officers, 1,065 are married. As Generals do get married, so Second Lieutenants do not. The jam, as usual, provides the interest in the sandwich. Lieutenants take the matter seriously and nearly half are not only married before they become Captains around the age of 27, but have remembered to send the announcement to *The Times* or *Telegraph* as well. About one in every five of these marry before they are 25, but seldom before 24. The financial dissuasion appears to achieve its object. By the age of 33, 90 per cent of officers are married. Slowly the trend continues and it looks as if about 97 of every 100 eventually fall.

In the List you either have an m, or you do not. Not so with decorations for gallantry, where an asterisk denotes a bar. One of my relatives would have qualified for m**, all at one and the same time. Such entries might not be conventional, but they would not be dull.

I would have liked to follow marriage by the numbering of Sapper children, but, though it might, the List does not tell us anything of them. Which officer has the most? I would bet that Kipling's Colonels could have beaten him. And how many of these children will become Sappers? And so, try to keep off it as I might, I arrived at that popular old problem, recruiting.

There are 1,404 serving officers who were commissioned between 1935 and 1957. This gives an average of sixty-one a year. Allow for war and wastage and my guess is that seventy a year has been the average intake. If you were to plot the numbers commissioned each year, and I do not suggest you do, you will find that it is anything but average. It wiggles up from twenty-five survivors of 1936 to 125 in 1948, then down again to twenty-five in 1957. A 500 per cent change in values in ten years would be interesting even to stockbrokers. Needless to say I bought very near the top, 1946 to be exact. Now supposing, just supposing, I were ordinary, I reckon that my chances of becoming one of the ninety or so substantive Lieut-Colonels promoted during the course of every three years are about one in three. This always presumes that we are still required to "build 'em nice barracks". Something, of course, is being done about it. Something also will doubtless be done about me.

So far as I know, all officers of age in the Corps have the vote. This must exclude the two Peers of the Realm, who are debarred. In the eyes of the Law, therefore, we are not mad in the imbecile sense. Mad, brainy, is rather more what I think Kipling must have been driving at, or perhaps just plain mad, odd. But, before proceeding with madness and oddness, let me return to the Lords for a moment. Both are rather senior, and we do not possess a single serving Baronet. If the tone is to be maintained at least an Hon. or two are urgently required.

Whatever the Corps used to be, it was brainy. Even pre-war the relative braininess was extremely high; 97 per cent of the serving officers commissioned between 1926 and 1937 have degrees. Doubtless the 3 per cent who have not could produce excellent reasons for the omission. Of those commissioned between 1938 and 1953, 29 per cent of graduates is the total score. The war is not all to blame either, as, for the post-war years alone, the average is no better. However, in the Corps as a whole, there are 532 officers with degrees, forty-two of them gaining 1st Class Honours. This represents a considerable accumulation of learning and, I estimate, around ½ million officer beer-drinking days. Yes, degrees are good things. If we are unable to find enough officers capable of obtaining scientific degrees, what about recruiting a few graduates of the Arts and teaching them to be military engineers? Few Romans had degrees, but they were excellent engineers. They also, presumably, read classics. Remembering the boat race there might now be no harm in having a few Sappers who went to Oxford.

Back to those decorations, bars and all. The Corps appears to be remarkably well found in them. More than one officer in six who was old enough to fight in the 1939–45 war holds a medal for gallantry, sometimes two or more. The most is four, three DSOs and an MC. In all there are twelve bars to the 106 MCs and one bar and one second bar to the twenty-five DSOs. There are three DFCs, three GMs and one Albert Medal—rare in any company. The grand total stands at 352 decorations, spread around fourteen different grades of Honours and Awards. For sheer quantity MBEs, at 110, just beat MCs.

My ready guide to the chances of being decorated for merit is as follows: Unless you are a Lieut-General, you are unlikely to be knighted. The youngest is 53. Outstanding actors and sportsmen can usually beat this. CBs appear to be a fiftieth birthday present for well-established Major-Generals. CBEs, although still worn around the neck, are more for Brigadiers, though a substantive lieut-colonel aged 43 already holds one. For Majors to become OBEs is unusual; 40 seems to be the limiting age. MBEs become popular at 32, though there are several younger. The List does not show foreign decorations, mainly I suppose due to lack of space. I wonder whether something could not be done about the Club column though, which includes plenty of blank space? Could it not be renamed "Remarks", or if that would lay open too many opportunities, "Various", as in the game book?

Not that I have anything against clubs. Between us 277 club subscriptions are apparently paid. This figure is probably even more inaccurate than my adding-up, as many officers have doubtless never told the Secretary of the Institution of what they are members. Nor does the Lord Chamberlain's outstation at Chatham print all the clubs we may offer up. I suggested a reputable cricket club of which I am a non-playing member, with a view to swelling my qualifications, but No! Just you try having your night clubs entered.

The most popular club is the United Service with seventy-seven members noted in the List. Of the Army and Navy there are thirty-one, the United Hunts twenty-eight and the Naval and Military twenty-three. On the sporting side the RORC wins easily with fifty-seven, followed by seven Climbers and six each of Leander and the Ski Club of Great Britain. Perhaps the most interesting of the clubmen are the eight gentlemen who choose clubs frequented by no other Sapper. Amongst those thus patronized are the Athenaeum, Bath, Junior Carlton, Travellers and Saville.

Staff Colleges are an interesting sapper diversion, to the extent of 380 serving pscs. Of these sixty-one have proceeded to jssc and fifteen to idc. On the technical side there is one officer who attended the pre-war advanced class and forty-four others who have become ptsc at Shrivenham since. Of these, five are psc as well. If we add four officers who have qualified at the Royal Air Force Staff College and one with the Royal Navy we end up with a total of 506 staff courses. Here indeed is a formidable paper writing potential. In comparison the number of sapper courses, Survey, Transportation, E and M and Civil, which officers have attended, 283 between them, seems small. Supply and demand are great things and, as in this instance, can be used to explain away almost anything which one does not understand. At any one time over 200 officers, or around 15 per cent of the Corps, are on long courses.

When it comes to higher things in the realm of education we have exactly 100 members of learned Institutions with engineering connexions, that is, of course, excluding the Institute of RE. As positively my last list, these are split down into one FRAeS, two LRIBAs, four AMIStructEs, six MInstTs, and eight AMIEEs. The remainder either belong to the Civil Engineers, thirty-seven, the Mechanical Engineers, sixteen, or the Chartered Surveyors, twenty-six. The one Barrister-at-Law adds just what is needed as the 101st, but I understand he is no longer the only one in the Corps.

The RE List surely could divulge many more secrets. I have no doubt that in my ramblings errors of omission abound, and just on your pet subject too. "Why on earth didn't he mention the twenty-five interpreters, to say nothing of those other intrepid three who have done light aircraft courses?" Well, now I have, and I must also apologise to the six worthies who hold qualifications which I am quite unable to trace. I hope the errors of commission (can you spot the intentional mistake?) help to keep a few healthy arguments going. To add a little fuel let me now pick the outstanding group of officers and the outstanding individual amongst those whom I have considered. The prize for the group goes to the serving officers commissioned in 1931. There are eighteen of them. All have degrees and all are married. Fifteen are staff trained and between them they hold twenty-two decorations. I rate as the outstanding individual the officer who, at the age of 41, has just retired. He has managed to remain unmarried and unqualified. I hope that he is pleased to have achieved fame now. What worries me is that he may never know. Even the letter "I" as a member of the Institution has passed him by.

"Why hasn't he compared the Corps figures with the Gunners, the Signals, the Infantry, the Navy, or any other bunch of the population?" Because I have found the Corps alone bewildering enough. Because, both in your eyes and those of my family, I have already qualified for the letter m for mad. Because I like to think we would show up pretty well against most opposition and I do not want to be disillusioned. I leave the comparisons to you. Please could you write an up-to-date poem too, or is Kipling still good enough?

ARTICLES FOR THE "RE JOURNAL"

Articles for the "RE Journal" will be typewritten and submitted in duplicate, one copy being the original.

Line drawings must be in black ink. Ink tracings on linen are very suitable. All lettering must be clear and bold to allow for reduction in size when reproduced. Scales will be drawn and not worded.

If tracings are submitted one print should be sent for the duplicate copy.

Photographs should be on glossy prints, and no writing should be on the photograph itself. Any reasonable size print may be submitted.

Not more than four photographs can normally be reproduced with any article. More photographs may be submitted and the Editor will make a selection.

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It is suggested that prospective authors should read carefully Queen's Regulations, 1955, paragraphs 679 and 680.

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Memoirs

LIEUT-GENERAL SIR DUDLEY S. COLLINS, KBE, CB, DSO*

(Colonel Commandant, RE Retd.)

DUDLEY STUART COLLINS was born in Australia on 14 January 1881, the son of Henry M. Collins of Gracehill, Frankston, Australia. As a boy he returned to England and was educated at Hawtreys and Haileybury and at the RMA, Woolwich. He was commissioned into the Corps on 22 November 1899 and remained under instruction at the SME until March 1901 when he attended a Submarine Mining Course at Portsmouth.

In September 1901 he was posted to South Africa and joined a detachment of the London Electrical Engineers who manned mobile searchlights drawn by steam transport. In April 1903 he joined 26 Field Company, stationed in Pretoria, where he remained as Machinery Officer until being posted home in 1906.

On returning home he attended a Mechanical Engineering Course which included an attachment to Messrs. Williams & Robinson of Rugby. At the end of 1906 he was posted to 30 Fortress Company at Plymouth and whilst with the unit he was sent on an Advanced Course at the SME.

He was promoted Captain in 1908, and for the next four years was an Instructor in Electricity at the Royal Military Academy, Woolwich—for the first two years as a Company Officer and for the last two as a Company Commander. He was known to the Gentlemen Cadets as a strict, but very just disciplinarian with the result that he soon won their lasting affection.

During 1913 he attended an Electrical Engineering Course and he was attached to the Manchester Corporation Electricity Works. After completing this course in February 1914 he was posted once again to 30 Fortress Company at Plymouth and remained with that unit until the end of the year when he was given command of 71 Field Company which formed part of the Mediterranean Expeditionary Force that sailed for Gallipoli in 1915. For gallant service in Gallipoli he was awarded the DSO, but early in 1916, due to ill health, he was invalided home and was for a short time with the Training Depot at Aldershot before being posted as Brigade Major 121 Infantry Brigade, then serving in France. In April 1917 he became CRE 8 Division as a Temporary Lieut.-Colonel and soon afterwards became CRE 14 Division with which formation he remained until the summer of 1919. For his services in France he was three times mentioned in dispatches, awarded a Bar to his DSO and in January 1919 promoted Brevet Lieut.-Colonel. As CRE 14 Division he took part in the battle of Langemarck in August 1917, the final battle of Ypres and in the advance which led to victory in November 1918.

Returning from the Army of the Rhine in July 1919 he was Assistant for E and M Duties to the Chief Engineer, Southern Command, until May 1922 when he became Chief Instructor, School of Electric Lighting, Gosport.

From the end of 1925 to August 1928 he served in Egypt as CRE Cairo District.

He was promoted Colonel in 1928 with ante-dated seniority due to his Brevet, and returned to England as Assistant Director of Works, War Office.

Lieut General Sir Dudley S Collins KBE CB DSO

From 1931 to 1935 he was Chief Engineer (Brigadier) Southern Command.

In June 1935 he was promoted Major-General and appointed Director of Fortifications and Works. His term of office was no sinecure. Acceleration of the Coast Defence and Anti-aircraft defence programmes at home and overseas, the doubling of the Territorial Army and the introduction of compulsory service resulted in a great increase in the work of his Directorate. It was largely due to Major-General Collins' tact and efficiency in dealing with Senior Officials of other Ministries and Departments that prompt decisions were obtained and this, combined with the happy control of his own staff, enabled the intensive programme of work to be completed so rapidly.

In 1939 he was appointed Deputy Quartermaster General (B) with rank of Lieut.-General to relieve the QMG of the direction of policy on Works Services.

On 30 March 1940 he was made a Colonel Commandant, Royal Engineers which appointment he held until 1949. He retired on 14 January 1941, after nearly forty-two years service. He was awarded the CB in 1937 and the KBE in the 1941 New Year's Honours List.

After his retirement he was appointed Commander of V Sector Home Guard with its Headquarters at Kingston-on-Thames. The sector consisted of eight battalions, spread over a large area of SW London and Surrey, which were started from scratch and it was principally due to Sir Dudley's drive and popularity with Battalion Commanders that the sector attained a high standard of training and readiness.

During the last years of his life Sir Dudley had been crippled with arthritis which he bore with the greatest fortitude. He died on 12 June 1959.

In 1909 he married Edith, second daughter of F. A. Collins Esq of Trelawney, Torquay, who survives him and to whom our sympathies go in her sad loss.

E.J.B.B.

MAJOR-GENERAL ARTHUR VICTOR TROCKE WAKELY, CB, DSO, MC.

VICTOR WAKELY was born in 1886 at Avoca, Co Wicklow, the son of the Rev J. M. Robinson. He was educated at Campbell College, Belfast, and the Royal Military Academy, Woolwich.

He was commissioned into the Royal Engineers on 20 December 1906. He served for four years in Ireland with 59 Field Company at the Curragh and then joined 32 Fortress Company at Gibraltar where he stayed until the outbreak of war in 1914. During the war he commanded 32 Advanced Park Company which had been formed out of 32 Fortress Company. Later he served at the BEF Bridging School in France until in 1919 he became Assistant Director Engineer Stores, France and Flanders.

He won the MC in 1916 and was promoted Brevet Major in 1918.

His next appointment was OC the Experimental Bridging Company at Christchurch where he stayed until he went to the Staff College at the end of 1922.

In 1926 he went to India where he was destined to do the rest of his service except for a short period at home when he was an instructor at the Senior Officers School at Sheerness.

Major-General AVT Wakely CB DSO MC

He will be remembered in the North-West Frontier for the extensive road development schemes which he carried out as A/CRE and later as CRE Peshawar District. He was instrumental in introducing earth-moving machinery and mechanical equipment on a comparatively large scale into the Frontier where the mule was still the main means of transport and manual labour, the pick and shovel the only means of road building.

For distinguished service in the Mohmand Campaign of 1933 he was awarded the DSO.

During the last war he commanded 7 Indian Division for two years in India. Then he was appointed GOC, L of C, Burma and later Commander 101 L of C Area, India. He was Director of Movement and Director General Transportation and Storage, Civil Supplies Bengal, from 1943 until he retired in 1945.

Victor Wakely was always connected with hunting. He was an enthusiast. During his time in India he founded the Master of Foxhounds Association in India and he was its Hon Secretary for many years. He did much to improve the quality of foxhounds in India by getting drafts from England. He was MFH the Delhi Hunt from 1929–34 and of the Peshawar Vale Hunt 1934–5. During his time at the Senior Officers School he was Master of the Beagle pack kept by the School. After his retirement he was MFH of the Teme Valley Foxhounds 1945–7 before settling in Co Tipperary in 1948. He became Secretary of the Golden Vale Hunt in 1948 and organized most successfully the annual Point to Point races at Templemore. He was President of the Thurles and Templemore Branch of the British Legion and many of its members have reason to be grateful to him for his painstaking efforts on their behalf.

In 1913 he married Ruby Clone Jellett, daughter of Judge John Wakely and in 1919 he changed his name by Deed Poll to Wakely.

His wife, who died last year, was deeply mourned by many friends in Ireland, England and India.

He died on 29 April 1959, aged 73, at Templemore. His funeral cortège was exceptionally large and was representative of the farming, sporting and professional life of the district and far beyond. It denoted the popularity and esteem in which the kindly and courteous General had been held by so many.

His two sons survive him. N.A.C-R.

BRIGADIER A. H. MORSE

AMYAS HENRY MORSE died on 5 March 1959 at St Leonards-on-Sea. Born on 16 February 1890 he was commissioned into the Royal Engineers on 26 January 1910. After completing his studies at the School of Military Engineering he attended a searchlight course and served with 30 Fortress Company at Plymouth from October 1912 until January 1913.

In March of that year he started his first tour of duty in India where he was to spend a great part of his service. His first appointment was Garrison Engineer Lucknow. During the 1914–18 war he served in India and in Mesopotamia. In 1921 he was with 65 Field Company 2nd Queen Victoria's Own Madras Sappers and Miners in Persia and in 1922 with 69 Field Company QVO Sappers and Miners in Iraq.

He returned to India towards the end of 1922 and served continuously there until January 1933, during which time he commanded 11 Army Troops Company 2nd QVO Madras Sappers and Miners from 1922 to 1924, commanded 9 Field Company QVO Madras Sappers and Miners from 1925 to 1927 including a short spell at Bangalore and then on the North-West Frontier including Piazha, Munzai and Wasiristan, completed a tour of duty in Works at Calcutta from July 1927 until October 1928 and finally returned to Bangalore to become Superintendent of Instruction of the QVO Madras Sappers and Miners which appointment he held until January 1933.

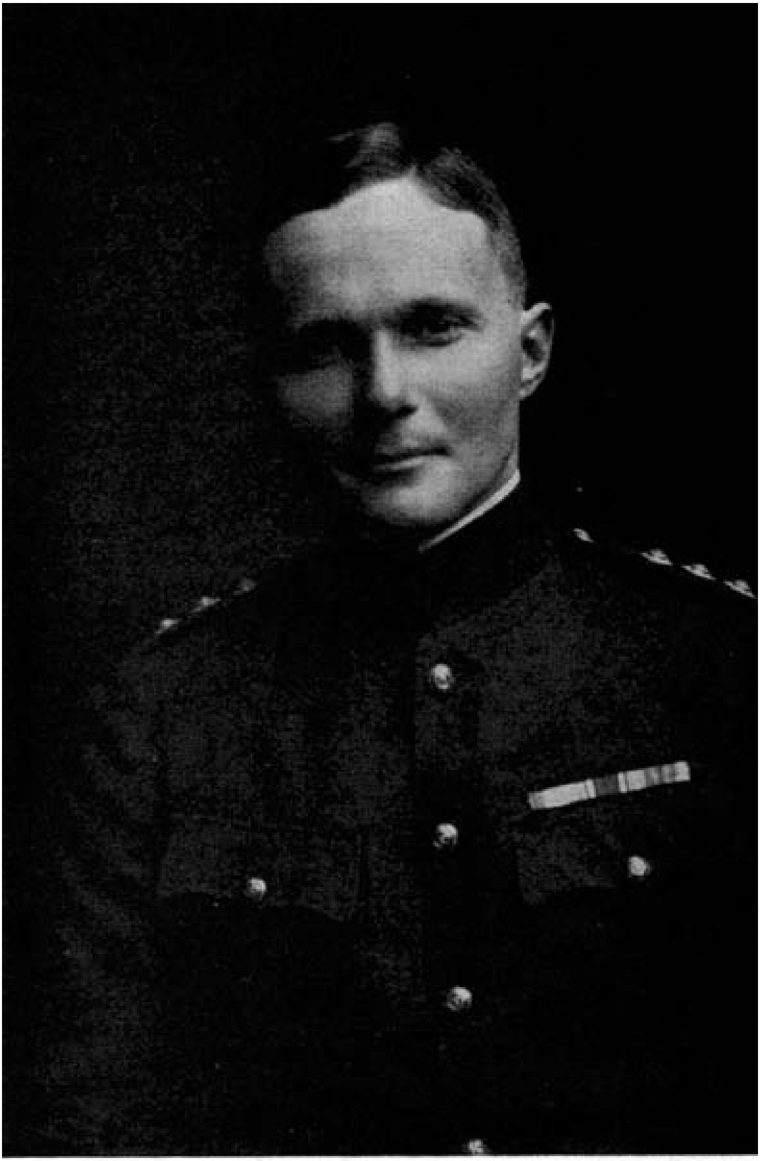
In April 1933 he was DCRE West Hampshire and from 1934 until 1937 CRE Northern Ireland District.

In November 1937 he was promoted Colonel and, after a short period on half pay, re-employed as Chief Technical Adviser, Works Services, the War Office. In October 1940 he was promoted Brigadier and appointed DDFW, the War Office. In 1942 he was Chief Engineer, North Wales Area, which post he held until his retirement in January 1945 at the age of 55. He then became Director of opencast coal production Ministry of Fuel and Power until 1947.

On 28 July 1924 he married Audrey, youngest daughter of the late Captain R. W. E. Middleton, Royal Navy, who survives him. There is one son, now a Captain in the Royal Scots, and two grand-children aged 9 and 3.

A friend writes that "Bill" Morse was a cheerful companion with a quiet sense of humour, a loyal friend who was generous to a fault, conscientious and meticulous to a degree both in work and play and well respected by all.

J.L.



Brigadier AH Morse

BRIGADIER G. T. DENISON, OBE, MA

George Taylor Denison was born on 27 October 1906, and after passing through the Shop where he excelled scholastically and in boxing and athletics he was commissioned into the Corps with 16 Y.O. Batch on 30 August 1926.

After completing his YO Training at the SME and at Magdalene College, Cambridge, he was posted to the School of Electric Lighting, Gosport, in 1929. He then served for a year with 38 Field Company at Aldershot and for a year with 30 Fortress Company at Plymouth. From 1932 to 1935 he was with 1 Training Battalion RE, at Chatham.

In June 1935 he was posted overseas as Assistant Civil Engineer, the Air Ministry Works and Buildings Directorate, in Iraq where he stayed until June 1937. It was here that he had his first taste of airfield construction which was to become his métier during the war.

On 30 August 1937 he became one of the first "Belisher" Captains and in September of that year he was back once again at Chatham as a Company Commander in the Training Battalion and, from June 1938 until the outbreak of war, as Assistant Field Works Major at Chattenden.

His war service, except for a period at the Staff College in 1941, was spent almost entirely in airfield construction work. He went to France with the British Expeditionary Force as SO2 RE Air Component. In 1942 he was SO2 RE Army Co-operation Command RAF and he commanded, as a Lieut.-Colonel, 15 Airfield Construction Group RE in Sicily and in the early days of the Italian Campaign. In 1944, as a full Colonel, he was Deputy Air Force Engineer, Engineer Division, SHAEF. In May 1955 he was appointed Brigadier as Chief Engineer, Tiger Force, a British Force designed to build landing grounds on the islands in the Pacific Ocean. This Force, however, was never employed in that role and George Denison was made Chief Engineer, Headquarters Air Command SEAC. He held that appointment until being posted back to Italy in late 1946 as SO1 RE CMF.

Early in 1948 he was seconded to the Overseas Food Corporation and employed, together with other Sapper officers, on the East African Ground Nuts Scheme. He did not stay long with the Corporation and in 1949 he was posted to the Directorate of Engineer Stores, the War Office, as an ADES responsible for stores planning. In 1951 he became CRE Hampshire and early in 1953 he was posted to Egypt as a full Colonel to command the Engineer Stores Group at Fanara. He later became DDES, GHQ MELF, which appointment he held until the end of his overseas tour in 1956.

His last post was once again in the Engineer Stores Directorate, the War Office, as ADES responsible for stores provision. Ill health caused his retirement on 12 July 1957. He died in the Royal Hospital early in the morning of 28 April 1959 after a long illness patiently borne.

To those that knew him George Denison was a true friend. He was patient, kind, gentle and generous. In his work he was always meticulous and thorough. During the last period of his life, when he suffered no less than twenty-six heart attacks, he displayed an amazing fortitude and cheerfulness.

Our sympathies go to his widow and two children in their sad loss.

J.H.S.L.

COLONEL E. N. BICKFORD, AMIEE

Edward Napier (Peter) Bickford, who died at Sevenoaks, Kent, on 19 May 1959, was born on 18 January 1903, the son of Brigadier-General and Mrs. E. Bickford. Educated at Oundle and the RMA, he was commissioned on 31 January 1923, and, on completion of his YO training at the SME, was posted to the 5 Field Company at Aldershot in April 1925.

Two years later he was seconded to the Nigerian Survey Department, for special topographical work. Returning home in July 1929, he was posted to the Training Battalion RE at Chatham, where he served as a "Recruit Party Officer". He went back to West Africa again in October 1930, for work on the Ibadan Water Supply project in Nigeria. Reverting to the Home Establishment in August 1931, he spent eighteen months as Garrison Engineer at Catterick Camp, Yorkshire, and in April 1933 was appointed Military Instructor at the RAF School of Photography at Farnborough.

He was promoted to Captain on 31 January 1934. In April 1935 he was posted to the AA Searchlight Battalion RE at Blackdown, and later became an Instructor at the School of AA Defence, Biggin Hill, where he was serving when War broke out.

As searchlight work was then transferred to the Royal Artillery Captain Bickford was given command of the newly formed 112 Workshop and Park Company RE, which he took out to the Middle East. Shortly afterwards he was appointed CRE Cyprus and was "mentioned in dispatches" for his good work on the important task of airfield construction. He was promoted to Major on 31 January 1940.

Leaving Cyprus for North Africa he became CRE 10 Corps Troops, which he commanded at Alamein. After a year in the Western Desert he became CRE 50 (Northumbrian) Division, which took part in the assault on Sicily. Colonel Bickford was again "mentioned in dispatches" for his good work during this hard-fought campaign. 50 Division then returned home to train for the Normandy assault, but shortly before D-day Bickford had to go into hospital and was temporarily posted to "home duties" as GSO1 at the SME Ripon.

He became an Associate Member of the Institution of Electrical Engineers in September 1946.

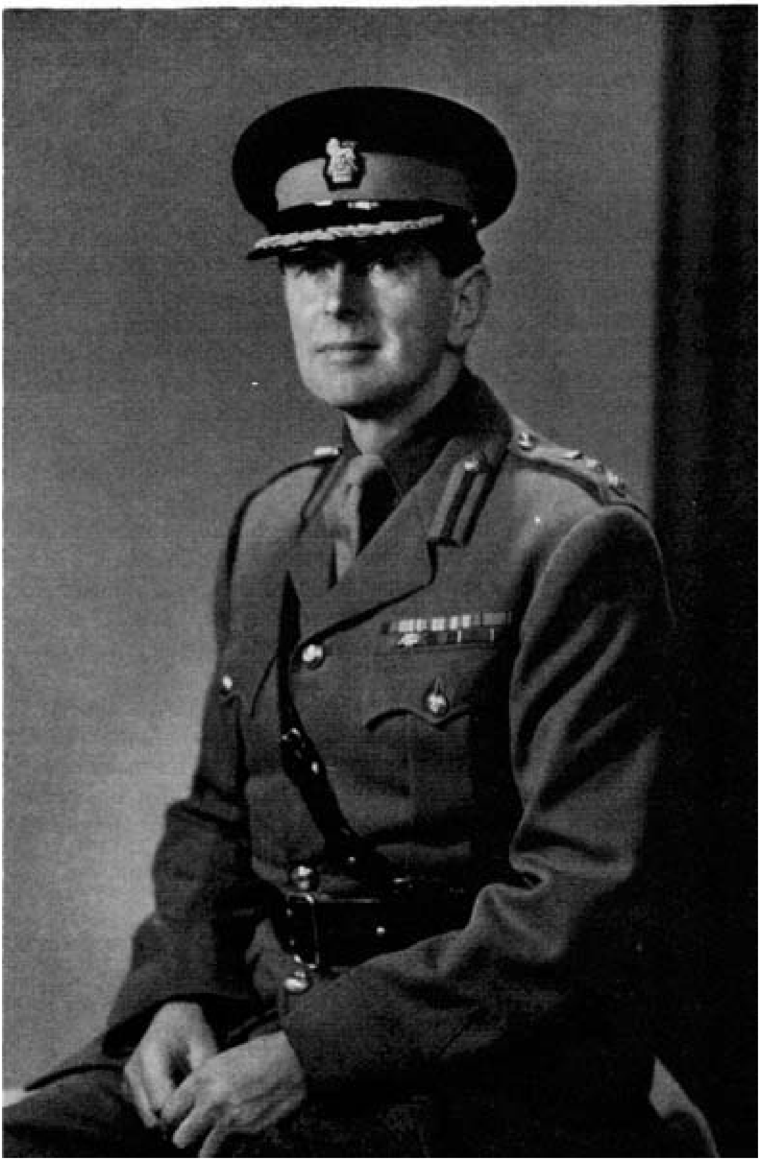
After the War he was CRE Guards Division till its disbandment, and then held CRE (Works) appointments in Singapore, to November 1948, and Aldershot to November 1949.

He was promoted Lieut-Colonel on 6 April 1948. In May 1951 he was appointed Deputy Chief-Engineer, Hong-Kong, having been promoted to full Colonel on 27 March 1951.

His work in Hong-Kong was, unfortunately, terminated by a serious illness in November 1952; but he made a typically courageous recovery from an illness which might well have induced others to give up Service life at once.

After a short rest at home he became Assistant Director of Fortifications and Works at the War Office (E8), and in May 1954 he took up his last task for his Corps as Deputy Commandant SME. He retired on 29 December 1956.

"Peter" Bickford is missed by a large number of friends he made during his unusually varied career. Perhaps his most marked, and endearing quality was a deep sense of fairness, clearly shown by the great trouble he



Colonel EN Bickford

took to "sort out" difficult cases, which might have led to injustice if not faithfully analysed.

Though the last years of his life were seriously handicapped by physical disability, he never showed it and he was a shining example of the triumph of will over material things. He married, in December 1938, Mary Estill, daughter of Mr and Mrs Patterson, who, with a son Anthony Napier, survives him. C.E.A.B.

LIEUT.-COLONEL F. L. SPARY, MBE

With the death of "Buck" Spary on 28 August last there passed away a splendid and colourful Sapper who in his day had served the Corps nobly and continuously for almost forty-five years.

He came from a Sapper family and was born on 30 June 1895 "within the lines" in Ireland where his father was Foreman of Works, Birr Barracks, King's County. Before enlisting as a boy at Chatham in July 1910 he spent a large part of his early days in Egypt. He joined the ranks as a Sapper in the Training Battalion, Brompton Barracks, Chatham, in June 1913 and stayed in the Battalion until he joined 7 Field Company, as a Lance Corporal, in July 1915. The unit was then serving in France and he stayed with it throughout the war.

The Training Battalion claimed him again and he served there as a Sergeant from 1921 to 1926 when he became a Fieldworks Instructor at the RMA, Woolwich. After a year at the Shop he became CSM of 38 Field Company at Aldershot, and during his Sergeant Majorship the "Three Eight" performed wonders. His fortissimo exhortations from the touch-line on many a famous occasion literally inspired a flagging Company side to victory. His vocal support for RE Aldershot teams was no less generously and efficaciously given. On parade, at Wyke Regis Bridging Camp and on Manoeuvres, Spary's hall mark was on everything the 38 Field Company did.

Chatham, however, once again claimed him as Senior Drill Instructor in 1931 and for three years he reigned supreme on Brompton Square. In January 1934 he was promoted Regimental Sergeant Major of the Training Battalion. In July 1938 he was commissioned Lieutenant and Quartermaster and presented with his sword by the officers at Chatham.

His first commissioned appointment was as Stores Officer at Headquarters London District, but on the outbreak of war he was soon back at Chatham again as Quartermaster of the Depot Battalion, Kitchener Barracks. Many a draft of Regular Officers, Warrant Officers, NCOs and Sappers returning home from overseas in those early days of the war, often arriving at the Depot unexpectedly and at the most outlandish times of the night or day, were eternally grateful to Quartermaster Spary for the way he buckled to, and made others do the same, to see to their reception arrangements.

Spary moved with the exodus from Chatham to Ripon and filled the appointments of Adjutant and later of DAA and QMG the SME. He was eventually promoted to command a Depot Regiment, which appointment was the culmination of his career. He had served in every rank in the Royal Engineers from Boy to Lieut.-Colonel including, during his early service, the now extinct rank of Second Corporal. He retired in May 1955. His contribution to the Corps was incalculable. He had a wonderful way with men and he was a splendid educator of the Young Officer. J.L.

Book Reviews

THE ROYAL CORPS OF SIGNALS

A History of its Antecedents and Developments

By Major-General R. F. H. Nalder, CB, OBE, with a Foreword by The Rt Hon The Earl Alexander of Tunis, KG, GCB, GCMG, CSI, DSO, MC, DCL, LLD.

(Published by The Royal Signals Institution. Price 30s)

In the world of communications it is not uncommon to hear an operator receive a signal with the crushing retort "Unreadable: Unreadable," and it would not have been surprising if this History had qualified for the same epithet; because a Corps History is essentially intended for a special circle. The author has however done better than that. Some parts are of general interest to military readers of all sorts; some are of peculiar interest to Sappers; and there cannot be much that will not interest past and present members of the Royal Corps of Signals.

The author begins with references to methods of signal communications in the days of antiquity, quoting Genghis Khan and the Pharaohs. He might, in passing, have quoted St Paul who tells us that "evil communications corrupt good manners," though he had it in another context.

Having dealt with the Ancients, the author begins in earnest in the nineteenth century, explaining the primitive systems used between ship and shore in the Peninsular War and traces the growth of Signals through its days as a branch—and a popular branch—of the Royal Engineers up to the present time including the Korean War. There is an Appendix on "Signals in India."

From about 1915 onwards one sees developing a problem to which so far no very good answer appears to have been found. The problem is this: Signalling is an intensely technical business and can no longer be left to gallopers. (Incidentally, it is said by some authorities that the Charge of the Light Brigade was only brought about by the shouted words of a mounted Liaison Officer being misunderstood; and the British Infantry attack at the Battle of Minden was almost certainly launched as a result of a misunderstanding.) However, to return to the problem; if you must have technicians, how will you recruit officers who can combine technicalities with first-class general military ability? The youth who conceives himself to hold a Field-Marshal's baton in his knapsack will not go into Signals because he has but to look at the Army List to see that the odds are heavily loaded against him. Equally, though you may get sound technicians, their mental outlook makes them anti-pathetic to the empirical methods by which military leadership is inevitably exercised.

The author of this History, in dealing with the severance of Signals from the Sappers, expounds every shade of opinion in this never-ending argument of how to attract sufficient good officers for communications duties.

Your reviewer hesitates to suggest what our forefathers found necessary, namely to give them Corps pay and let *auri sacra fames* do the rest. Certainly some answer is needed because, as Earl Alexander points out in his Foreword, "effective communication has always been vital to Commanders in the field"—and is always likely to be. It must be entrusted to good officers only.

There are many other interesting fields of speculation raised in the History and although it could not be classed as easy to read from cover to cover, there are plenty of places where one can dip with enjoyment in the stream and remain for some time without getting into too difficult waters.

The book is well produced and both author and publisher are to be congratulated on making the most of a difficult subject. M.C.A.H.

BRITAIN AND THE ARABS

By Lieut.-General Sir John Bagot Glubb, KCB, CMG, DSO, OBE

(Published by Hodder & Stoughton, London. Price 30s)

We live in an unstable age in which political systems and international relationships are continually changing. It has become commonplace today to see new orders arise, sweeping the old away, with scarcely a murmur from the rest of the world at the toll of human suffering and misery which so often results. It is fair to say that the Arab peoples have had more than their share of this sort of turbulence during the last fifty years, a period which has seen the break up of the Ottoman Empire, and the repercussions of two world wars leading to the eclipse of British and other European influences through the pressure of "nationalism." These events have been set against a background of constant struggle and intrigue between the various Arab leaders, and if this were not enough there has been the added complication of the establishment of a Jewish State in their midst.

General Glubb has set himself a tremendous task in attempting to present this story within the covers of a single volume, and it is a measure of his success that he has not only managed to give a historical review of the main events during the period, but he has found space to draw conclusions, and make suggestions for the future. The General has restricted his survey to the countries of the Arabian Peninsula and the Fertile Crescent, but inevitably he has had to include Egypt, for although the Egyptians are African delta dwellers, rather than Arabs, they are Arabic speaking and are becoming more and more closely associated with the affairs of the Arab countries. Even with this limitation the account of some events has had to be ruthlessly compressed, and over such a wide field the narrative is at times rather disjointed.

There is one central theme, which is that Britain's interest in the Middle East has always been merely to ensure its stability as a corridor for her trade to and from the Far East, in other words commercial rather than imperial. The story starts with the rise and fall of the Ottoman Empire, and General Glubb sets out clearly the difficulties which we brought on ourselves by conflicting promises made to the Arabs and the Jews under the stress of the First World War as the new Arab states were emerging from Turkish domination. He goes on to describe how the establishment of the State of Israel in Palestine has embittered Britain's relations with the Arab countries, and incidentally played into the hands of the Russians.

The book contains many interesting observations, based on the author's life-long experience of the countries and peoples of which he is writing. For example he holds strong views on the futility of forcing Western style democratic government on communities which for centuries have known nothing but despotic rule, views with which many officers who have served in those parts will cordially agree. He quotes Lord Kitchener as saying "Party politics in the East are more dangerous than strong drink," and he reinforces this argument by showing how each country in turn, as it achieves independence, has organized some form of revolution which has substituted dictatorship for democracy.

It is written in a most readable style, and although mainly historical in character there is sufficient personal background to give it a human interest. The General's conclusions set out at the end of the book are clearly the result of much thought and study, and stem from strong convictions. They are especially interesting in that he gives full weight to spiritual considerations in international relationships, an approach which is too often lacking in this modern materialistic world. For those who want a concise summary of events in the Middle East during the last fifty years, written by a man who really knows his subject, this is undoubtedly a good book. G.W.D.

ARMED DIPLOMAT

A Military Attaché in Russia

By BRIGADIER J. V. DAVIDSON-HOUSTON, MBE

(Published by Robert Hale Ltd, 63 Albemarle St, W1. Price 21s)

In his foreword to this interesting book, the author comments on the difficulty met by most people seeking enlightenment on the Russian scene. This is a country of extremes, of sharp contrasts, of great size and immense potentialities. There is a vast amount of information, official and unofficial, available about it. Most of this, however, consists either of superficial impressions of the casual tourist, or is so coloured by political prejudice as to be untrustworthy if not deliberately misleading.

To mitigate this difficulty to some extent the author deals mainly with people; their characteristics, way of life, feelings towards foreigners and so on. He has made a praiseworthy attempt to portray fairly and sympathetically those encountered on his extensive journeys, and to explain at least some of the anomalies that exist. Widely travelled himself, an experienced observer of foreign customs and a notable linguist, his qualifications for this task are beyond dispute and his impressions cannot but be of value.

It may be said that such impressions tend to be superficial. Up to a point this is true. The obstructive methods so well described here and sickeningly familiar to anyone who has served behind the iron curtain, added to the instinctive distrust of many Russians for the foreigner, make normal relations with the local people extremely difficult. Some contacts, however, cannot be entirely prevented, nor, if travel is permitted at all, can changes in living conditions, for good or bad, be concealed from a practised observer. This book gives a very fair and certainly very readable description of some of the people of the many races which comprise the Soviet Union.

Material progress in the USSR during the last thirty years has been considerable and, if considered in isolation, impressive. When, however, it is compared with advances made in the same period by other nations, including our own, a picture emerges which is more realistic and less awe-inspiring. Where possible the author has tried to do this. He has also given a number of necessarily brief but clear and vivid glimpses of the actual conditions under which ordinary people of different classes live and work, a necessary background to any assessment of the country and its people.

A question that must strike the reader of this and other books about present-day Russia is what, if anything, can be done to bring the soviet system of government more into line with, in the author's words, "The normal feelings and aspirations of humanity?" How can a ruthless and competent upper-class, in full control of the apparatus of power, be made to loosen its grip? A clue to the answer lies perhaps in the final summing up which includes this sentence "The Iron Curtain was erected not by the Russian people but against them."

Making every allowance for inherited suspicion and international distrust, this obstacle is maintained primarily to prevent the majority of Russians discovering how indifferently their amenities and way of living compare with those of most Western nations. If it could be removed, or penetrated on a wide scale, there is little doubt that the system of government would have to be sensibly modified to meet popular demand and in due course might well lapse altogether from its present form. It is therefore quite understandable why the soviet ruling classes, realizing and fearing this, are at great pains to keep the iron curtain inviolate from any but innocuous tourists, while it is clearly in the Western interests to make, expand, and exploit any chink in it.

The author's powers of lively description and easy style make this book one to be recommended both to the casual reader and the alleged expert. Unlike many of its kind there is more in it than meets the eye at first glance, and a second reading will give good value for the extra time spent.

G.A.D.Y.

HISTORY OF COAST ARTILLERY IN THE BRITISH ARMY

By Colonel K. W. Maurice Jones, D.S.O.

(Published by Royal Artillery Institution. Price 25s.)

An interesting and well written history of the activities of a large portion of the Royal Regiment of Artillery over the period of the last 400 years.

It brings into strong relief the very large numbers of men and masses of material that were locked up in passive defence at various crises of our history during that period, with what effect on the history of the war in progress at the time can never be known as they were very rarely tested by enemy action.

Undoubtedly, however, the mere fact that they existed must often have influenced the enemy action, often to his detriment, and our admiration must be extended to the officers and men of the Royal Regiment who kept the batteries at a high state of efficiency in spite of long hours of boredom and monotony often under adverse conditions of climate, accommodation, and maintenance.

The author mentions the work of the Fortress Companies of the Royal Engineers and pays a tribute to the men who manned the searchlights that served the guns, but it seems a pity that no mention is made of the Submarine Mining Companies who for some time formed an integral part of the harbour defences.

An informative and detailed account of a period of warfare which has now been finally superseded by the development of modern weapons. M.L.

THE BATTLE OF GETTYSBURG

By Frank A. Haskell, edited by Bruce Cotton

(Published by Messrs. Eyre & Spottiswoode. Price 25s.)

The notice on the dust cover of this book claims it to be a "Classic" eye-witness account of the famous battle of Gettysburg and sure enough it has something of that very quality, which is strange, for eye-witnesses have seldom written of battles with such splendour as to produce an enduring memorial. The odds against an onlooker having the requisite touch of genius are too great. Frank Haskell himself speaks, in almost Churchillian idiom, of "the literary infirmity of reporters of battles" and seems conscious that he, on the contrary, well knows how to use a pen. Indeed he writes with fine passion and prejudice in a hyperbolical style which suits the occasion. If his criticism of human failure under load is ruthless, it comes from a man, who was soon to die gallantly at the head of his brigade in the murderous fighting of the Wilderness of Virginia. So he lived up to his ideals of military behaviour and the worth of his story is enhanced thereby.

The battle made such an impression on Haskell that he sat down within a fortnight to put it on paper. The vivid description of being under short-range artillery fire recalls the famous experience of Goethe, who in his diary of 1792 wrote majestically of "Cannon fever" during the attack on Verdun. Both, in their different ways, admirably reproduce for posterity the tense emotions caused by the twin brothers death and fear on battlefields.

Gettysburg was in many respects the turning point of the Civil War. Whether because the desperation of the combatants has reached a crescendo or because later detailed study makes them clear-cut to all, critical battles often seem to have a striking simplicity of outline. Waterloo had that characteristic as did Stalingrad and El Alamein in the last war. The operations at Gettysburg were also rough hewn. The Federal Army, concentrating the quicker, ensconced itself in a magnificent defensive position "shaped like a fishhook" some three miles in extent with the shank running south. The Confederates had either to attack it or to abandon the strategic object for which they had crossed the Potomac. The setting was as simple as that and lent itself to a furious frontal combat.

For those whose forgetfulness of past campaigns is an enduring pest, General Fuller provides a masterly perspective of the events leading up to the battle. Editor Bruce Cotton sketches in the brief but brilliant military career of the one-time lawyer Haskell and is a little puzzling on the extent to which the original narrative has been altered to meet subsequent indignant complaints of its bias and injustice. Soldiers, as a matter of course, have ever had inveterate likes and dislikes for units and formations, to which they do not belong. Some they deem to be blood brothers, some are adequate, whilst others again can never put a foot right, however well they really acquit themselves. Haskell was no doubt hasty in his judgement of rival formations and commanders, yet most military readers will note the failing with an understanding chuckle.

The book is a delight and can be read from cover to cover in a few hours. As for its style, what could be better but than "the infantry must do the sharp work"?

B.T.W.

THE GREAT CIVIL WAR

By Lieut-Colonel Alfred H. Burne and Lieut-Colonel P. Young

(Published by Eyre and Spottiswoode. Price 36s)

The Great Civil War was waged between the King and Parliament from 1642 to 1646; and battles were fought in every part of England from Marston Moor in the north to Cheriton in the south and Lostwithiel in the west. When one considers the great preponderance of force possessed by Parliament—the fleet, the chief ports and arsenals, the "clothing" towns and the capital—the result in retrospect seems a foregone conclusion. It seems that it was bound to be only a matter of time before a Cromwell on the Parliamentary side set about organizing these resources and man-power to achieve victory. Yet the Royalist leaders and their followers enjoyed a high morale throughout the early years; and it was only towards the end that a religious zeal, almost amounting to fanaticism, on the Parliamentary side began to tell.

The book follows the course of the war and describes with admirable maps and great lucidity how each battle was fought. It is in fact a regular military history in the best Staff College manner; and, if one may be permitted to criticise anything that so much bears the stamp of psc, your reviewer would say it is rather lacking in the romantic touch that distinguishes a campaign from a game of chess. War is, above all things, a matter of people; their characters, their wills, their strengths and their weaknesses; yet this book leaves one with very little idea of what sort of people they were. That is not to say that the authors omit a character study of the leaders; they give an admirable one, but it is put together neatly in a chapter at the end and does not simply emerge in the course of the narrative. Every schoolboy knows how Horatius held the bridge and many of them could tell you what sort of a chap he was, and what the other men were like too; their characters being a by-product of the narrative. That, in your reviewer's opinion, is how military history should be written, though it is asking much of the author.

However, there has always been a place in our literature for an authoritative military account of the Great Civil War and your reviewer commends this one strongly to any reader who wants to learn the military aims and methods of both parties, how each campaign and battle was fought, what the material factors were that influenced the strategy and the results. It is all done in the most business-like way and there will be few readers who will not be the richer intellectually by reading it.

M.C.A.H.

WIND PRESSURES IN VARIOUS AREAS OF THE UNITED STATES

By GUTTORM N. BREKKE

(Published by US Dept of Commerce, National Bureau of Standards, Washington, DC. Price 15c)

This paper analyses the effects on buildings of wind pressures, making allowances for gusts and abnormal conditions which give rise to exceptional winds. From these considerations a Wind Pressure Map was compiled for use in setting up Design Standards for use throughout the USA. While this paper is of particular interest only to engineers responsible for deciding on Codes of Practice, it is very intriguing to see how statistics can be employed to get to grips with such an uncontrollable medium as freak weather. T.W.T.

Technical Notes

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, March, 1959.

CAVITATION DAMAGE OF METALS: Cavitation is a hydraulic phenomenon relating to the formation and collapse of vapour bubbles in a flowing liquid. Cavitation damage is caused by repeated mechanical stressing of a metal surface in the presence of chemical reaction. It is similar to corrosion fatigue and may cause plastic deformation and strain hardening. Its main destructive effect is experienced in hydraulic turbines and diesel cooling systems. This paper describes the apparatus used, employing high-speed photography, to compare the relative resistance of materials to accelerated cavitation damage, and it also summarizes the incidence of such damage in turbines and diesel engines. The illustrations are clear and convincing.

SOME ASPECTS OF ICE PROBLEMS CONNECTED WITH HYDRO-ELECTRIC DEVELOPMENTS: The St. Lawrence River and its tributaries, now the scene of intense hydro-electric development, present peculiar problems because of ice conditions in winter. Several papers in previous issues of the *Engineering Journal* have described methods adopted to exclude ice at the intakes of individual installations, but the author of this paper has studied the general aspects of ice formation on these rivers over a period of ten years. His exposition of the physical conditions governing the formation of various types of ice is clear and interesting. The main lessons are that, by providing a forebay with adequate cross-sectional area, good ice cover must be formed and held upstream to prevent, by insulation, further ice formation and, above all, that it is essential to prevent jams downstream that might flood the tailrace and drown the power units. Study of local conditions is, however, essential since the solution of the ice problem on one stream cannot be applied to any other stream indiscriminately.

POWER REQUIREMENTS FOR COMMERCIAL AIR CONDITIONING SYSTEMS: Air conditioning is now installed in many commercial structures, as well as in industrial buildings. This increases power requirements, and affects water supply and drainage disposal. This paper examines the factors contributing to the electrical requirements of commercial installations, of which about 50 per cent is due to the internal cooling load created by occupants, lighting, and office machines. Requirements in any particular building are also affected by location and orientation, ratios of net to gross floor area, and of window space to wall area. The total installed motor horse-power is likely to be of the order of 5½ per 1,000 sq. ft. of net area, compared with about ½ h.p. per 1,000 sq. ft. for ordinary heating and ventilation.

PHOTOGRAMMETRY IN HIGHWAYS AND RAILWAYS ENGINEERING: Route selection, final location, and survey by "classical" methods are lengthy and laborious operations.

Air reconnaissance and aerial survey have reduced work on the ground in the earlier stages, but the military engineer, often working in inadequately mapped country, still seems likely to be condemned to much detailed ground reconnaissance and survey.

The past few years have brought remarkable developments in precision aerial cameras, plotting instruments and advanced interpretation and compilation methods; photogrammetric instruments have also been combined with electronic computers to achieve greater speed and accuracy in the computation of earthwork quantities.

This paper cannot fail to impress those interested in road, rail, or airfield location, or those concerned with survey. The author describes the normal steps in location work, and illustrates each phase with practical examples, and he also touches on the techniques used in photoanalysis, photogrammetric survey, and the computation of quantities. Some of his statements will not go unchallenged in the absence of more detailed description, notably those concerning the establishment of geological and soils data, but there can be no doubt that photogrammetry is now a powerful weapon in the engineer's armoury.

Notes from *The Engineering Journal of Canada*, April, 1959.

QUEBEC-LABRADOR TROPOSPHERIC SCATTER RADIO SYSTEM: This report of an unusual engineering project, to provide multiple voice channels to widely separated locations in northern Quebec and Labrador, is divided into two parts dealing respectively with the planning of the communications system and with the design and construction of buildings, roads, etc. The second part is of particular interest because it exemplifies the adaptation of normal materials and skills to unusual requirements, and shows what can be done by good organization to overcome the difficulties imposed by severe climatic conditions giving a frost- and snow-free period of less than three months.

DEAS ISLAND TUNNEL: The Deas Island Tunnel, to provide an additional crossing of the Fraser River south of the city of Vancouver, carries four traffic lanes, each 12 ft. wide, with a vertical clearance of 14 ft. The design is unusual in that the under-water portion consists of six prefabricated reinforced concrete elements containing, in section, two 24-ft. roadway tubes and two air ducts, each some 6½ ft. wide. Each element is about 344 ft. long, 78 ft. wide, and 24 ft. high, weighing approximately 18,000 tons. These were cast in a dry dock near the site, and subsequently floated out and sunk in position in a dredged trench. The approaches, over extremely flat land, drop about 50 ft., and take the form of deep, open concrete troughs. This symposium of five short papers provides a great deal of interesting information under the headings of Introduction, General layout and structural design, Hydraulic design, Technical installations, and Construction procedures.

THE FREE PISTON ENGINE: The first free piston engine was developed exactly 100 years ago, but the free piston gas generator, or gasifier, using two pistons operating in opposition, was not originated until about 1920. Prior to that time the return stroke depended upon gravity, and applications were limited.

The gasifier turbine eliminates the load-carrying bearings which limit the development of the reciprocating diesel engine, and it is now firmly established in the fields of electric power generation and marine propulsion. Although a 1,000 h.p. locomotive with a single gasifier has been in main-line service for seven years, and has run well over 125,000 miles, the application of the free piston engine to rail and road traction is still under development, but its characteristics and many practical advantages must inevitably lead to widespread adoption. Advantages for military use include the following:—

(*a*) Reliability, and ease of maintenance by relatively unskilled labour.
(*b*) Quick starting.
(*c*) Ability to burn a very wide range of fuels.
(*d*) Elimination of vibration, which simplifies foundations and structural support.
(*e*) Light unit weight, and reduced bulk, leading to suitability for air transport.

Design of a Functional Structure in or on Rock: Having stated that the design and construction of underground excavations for civil defence or other purposes are in the province of the civil engineer, the authors of this paper affirm their intention of pointing out the inter-dependence of civil, geological, and mining engineers. In this object they succeed, largely by means of a very technical and theoretical approach, although their final conclusion is that the *designing engineer*, if he has a proper background in geology and structural engineering, should be able to determine, from diamond drill cores, the physical characteristics of the rock, and how it will behave under the complicated stresses imposed by excavation. Their paper does not seem to support this contention.

Notes from *The Engineering Journal of Canada*, May, 1959.

This issue constitutes a record of engineering and industrial achievement in Canada during 1958, a year of modest recovery from the 1957 recession. It is a most interesting summary which, apart from a wealth of statistical information, provides a comprehensive impression of continuing development and of major projects pushed through as if they were routine tasks. As an example of the scale of achievement, a net total of over 2½ million horse-power of new hydro-electric generating capacity was brought into operation in 1958. There are twelve short papers, with some excellent photographs.

Notes from *The Engineering Journal of Canada*, June 1959.

Ecole Polytechnique New Engineering Building: Virtually the engineering faculty of the Université Laval de Montréal, l'Ecole Polytechnique is now housed in new quarters on the University campus. The most interesting structural features are a torsion-supported concrete canopy over the front entrance (illustrated), a prestressed concrete base for the building structures laboratory, and prestressed concrete tanks in the hydraulic laboratory. Unfortunately, structural aspects are not described in this paper, which is devoted primarily to the services, equipment, and facilities provided. The heating, ventilation, and electrical services are in some respects unusual, and the scale of provision of technical facilities is enviable.

Capacitor Developments in Great Britain: The electrical engineer will find in this paper a concise and interesting summary of the types and properties of electrical condensers, in use or under development for a variety of special purposes. Sizes range from massive banks of the order of 15,000 kVAR to miniatures, smaller than a pea, used in transistor circuits.

Measuring Human Motions for Designing Machines: An interesting application of electronics is the development of a device for measuring and recording the body movements of an individual when performing a particular task. Known as UNOPAR (Universal Operator Performance Analyzer and Recorder), this apparatus may revolutionize methods of time and motion study. Its application to the design of military equipment, and of complex control systems, could increase the efficiency of the fighting services.

A 3,500-ton Building Moved 250 Ft: The movement of complete structures to other sites is quite common in the United States, especially when new roads are driven through built-up areas. The example here described was undertaken at the University of Toronto in 1958, to allow the extension of existing laboratories. The three-storey building, of brick and stone, measured 84 × 57 × 55 ft high, and its relocation was completed, on new foundations, in twelve weeks. The cost of the move, new foundation, and the construction of an extension showed a saving of nearly 50 per cent, compared with the estimated cost of new construction. This short and clearly written paper describes the supporting cribbing, jacking, and the move by 60-ft stages, and it encourages the thought that such techniques might be studied by planning authorities in this country.

CONSTRUCTION OF FOUNDATIONS FOR VERNON NARROWS BRIDGE: This is a straightforward account of the construction procedure adopted in the building of eight reinforced concrete piers on a difficult river bottom. Each pier base comprised two tripod pipe pile supports with RC caps and an RC strut, the piles being driven through an average of 55 ft to bedrock. Circular sheet pile cofferdams were used for dewatering, and special arrangements were made for test loading selected piles with 400 tons each. The equipment and materials used are fully described.

Notes from *The Engineering Journal of Canada*, July 1959.

GRAPHITE IN THE WORLD NUCLEAR POWER PROGRAMME: This paper, by the late Sir Claude Dixon Gibb, sets out very clearly the considerations governing the use of different kinds of moderator in nuclear power production, and explains why British reactors are graphite moderated. The processes used to produce graphite of the highest possible purity and maximum density, and with adequate structural properties, are briefly described. The exceptional precautions taken to avoid contamination are justified by the quality of the end product.

MOBILITY ON THE MUSKEG FRONTIERS: Muskeg is predominantly peat, often charged with water or ice, covered by various categories of vegetation. The type of vegetation indicates the probable structure of the peat underlying it, and the author has evolved a system of cover formulae which he claims can be applied by studying air photographs. He gives examples of the requirements of certain types in terms of vehicle operation factors, but unfortunately his paper pre-supposes acquaintance with some of his earlier publications, and its practical value is very limited. The reader is left with the impression that he may require a wide selection of different vehicles in order to traverse an area comprising different muskeg types. There is a short reference to a special vehicle called a "slipe", which progresses by hauling on an anchored cable, and which may prove to be the basis of a generally satisfactory solution. The method of laying out the cable, and of anchoring it at intervals of about a mile, is not mentioned.

THE USE OF ELECTRONIC COMPUTERS IN THE FIELD OF CIVIL AND STRUCTURAL ENGINEERING: The journalistic phrase "electronic brain" has fostered popular misconception of the function of the computer, which can only carry out instructions, and which is just as much a tool as the engineer's slide-rule. This exposition of its principles, and of its practical application to commonplace problems, is well worth reading. RE officers will find particularly interesting its application to earthworks computations, and its successful marriage with aerial photography to conceive the optimum grade line related to the physical conditions of a proposed route. This need not be merely a question of balancing cut and fill. Design can take into account the nature of hauls, type of material excavated, and comparative speed and capacity of different types of plant. The answer given by the computer will, however, only be mathematically correct. It is up to the engineer to ensure that data fed to it takes account of relevant factors, and is based on valid assumptions.

Applications to structural design, and to repetitive hydraulics calculations, are less likely to affect the military engineer, but they give convincing examples of techniques that may soon become matter of course for large-scale projects.

RIVER ENGINEERING AS A COLLEGE COURSE FOR CIVIL ENGINEERS: This intriguing paper, on a subject which the majority of engineers have probably never thought about, gives six hypothetical but entirely credible examples of the almost catastrophic results of ill-conceived interference with natural waterways. The author suggests that an understanding of river behaviour is as important as a knowledge of soil mechanics. His style is persuasive and amusing, and his argument is convincing.

Notes from *The Engineering Journal of Canada*, August 1959.

VERTICAL LIFT BRIDGES FOR THE ST. LAWRENCE SEAWAY AUTHORITY: Of the twelve crossings over the St Lawrence Seaway, five are vertical lift bridges. Major vertical lift spans are comparatively uncommon, and this paper describes in some detail both design and erection features of the five bridges concerned. Mechanical and electrical aspects are also discussed. The varying methods adopted for erection are of particular interest, since there were considerable differences in site conditions, length of span, height of lift required, and the nature and density of traffic to be contended with during conversion.

OIL TANK SITES PRELOADED BY WELL POINT SYSTEM: Methods of providing satisfactory foundations over a poor subsoil are of interest to all constructional engineers. At the site described in this paper, storage tanks had previously been erected on piles driven to a depth of from forty to fifty feet, but settlement had occurred, causing serious rippling of the tank floors. After careful soil investigation, it was decided to test the effect of pre-loading the subsoil by placing a fill surcharge and lowering the water table by means of rings of well points. The results obtained agreed well with the predicted settlement values, and the preloading method undoubtedly effects a very considerable reduction in the eventual movement of the final structure. The well point system has the great advantages of flexibility, and ease of installation, operation, and removal, while also improving the drainage of a marshy site.

R.P.A.D.L.

THE MILITARY ENGINEER

Journal of the Society of American Military Engineers

MAY–JUNE, 1959

"Demolition of Ripple Rock," by F. D. Bickel. The Inside Passage is a protected sea lane extending from Paget Sound, northward for 850 miles to the Gulf of Alaska. It is bounded on its west or ocean side by a chain of islands which make it virtually an inland waterway of great value both to war and peace-time shipping. This waterway was impeded by the existence of the Ripple Rock shoal situated in a narrow strait about 100 miles north of Vancouver. The shoal consisted of two pinnacles of basalt rock lying on a north–south axis rising to within 9 ft. and 20 ft. of mean low water. The narrows restricted the ebb and flow of tidal currents producing high velocities and much turbulence which limited passage to periods of slack or slow velocity flow. Attempts were made during the war to lower the height of the shoals by drilling and blasting from floating plant but on both occasions they were unsuccessful. This article is an account of the third, successful, operation. The idea of working from floating plant was given up after further consideration and the idea of tunnelling out from the mainland was adopted. The charges were placed in a series of drifts running parallel to the longer axis of the shoals and about 100 ft. below low water level. The rock coverage was about 45 ft. The operation was completely successful and the height of the shoal lowered to a general level of 70 ft. The article is very well illustrated with photographs and diagrams and is full of interest. A striking feature is the care taken throughout over preliminary investigation and planning at every stage. The Department of Public Works of the Canadian Government was in charge of the operation.

"New Military Techniques. Electronics: Equipment," by John E. Quaile. This article gives brief accounts, with illustrations, of new equipments available to the US Army or under development.

"Frescanar" is a three dimensional radar which detects airborne targets at extreme range and simultaneously computes distance bearing and altitude. This equipment is in service. It provides information needed to fire missiles such as Nike Hercules, Nike Ajax, or Hawk at airborne targets.

"Radio-Active Fallout Survey." A small team organization, Radiological Control Center (RADC), has been developed by the Army Chemical Corps School, to evaluate radiological monitoring and survey data in the combat zone. A RADC is to be established at Army, Corps, and Division Headquarters which will predict fallout from enemy weapons and will evaluate and distribute radiological data.

"Tracking Nuclear Clouds." Tests have shewn that the advanced weather radar system ordinarily used to detect storms can also be used to detect and give warning on the probable areas of radio-active fall-out.

"Amphibious Tank Transporter." This vehicle is like a large DUKH and can climb offshore barriers, cross beaches and most types of terrain carrying any Army or Marine Corps tank at present in the service. Its load capacity is 60 tons, its speed on land is 13 miles an hour and through water 7 miles an hour. There are two good photographs.

"Army Training for Nuclear Power Plant Personnel," by Captain Daniel C. King, US Air Force; Captain Joseph D. Lafleur, Jnr, Corps of Engineers; Lieutenant Walter J. Eager, Civil Engineer Corps US Navy. A short illustrated article on the methods of selection and training of the staff needed for the operation of military nuclear power plants most of which, to begin with, will be in remote locations, isolated from any network of generating plants. Extreme reliability will, therefore, be required of each installation since strategically critical loads must be supplied with uninterrupted power. Staffs are formed from personnel of all three services and the training is carried out under the Army Chief of Engineers at Fort Belvoir. A very high standard of character and education is demanded of candidates and the course of instruction is both thorough and practical.

"The Lake Survey and the Great Lakes," by Major Ira A. Hunt, Jnr. Corps of Engineers. This article contains a brief history of the US Lake Survey and a description of its present activities and responsibilities which include, in addition to the provision of up-to-date charts, service as an agency of the United States on many international bodies dealing with the navigation of the Lakes and St Lawrence Waterway, hydro-electric plants, locks, and industry. All these activities are liable to be affected by the levels, deviations and outflows.

"Giant pre-cast Concrete Beams," by Robinette E. McCabe. Girders weighing 84 tons and 134 ft. in length were used in the construction of a special purpose hangar built by the Corps of Engineers at Hill Air Force Base, Ogden, Utah. This article describes the construction of the girders and their movement into position and hoisting into place. The girders were tensioned in the casting yard to 65 per cent of the ultimate stress. The tensioning was completed after erection with full proof dead load to bring the stress up to its full design value.

Estimates showed that a structural steel truss building with a suspended ceiling would have been slightly cheaper but the pre-stressed rigid frame design offered lower maintenance costs, permanence, and increased fire resistance. The account is well illustrated by photographs.

Military Engineer Field Notes

"Construction Equipment Operator Training." A short interesting account of the system of instruction employed for the training of construction equipment operators at the Army School at the Engineer Training Centre, Fort Leonard Wood, Missouri.

"Professional Engineering Preparatory Course," by Colonel J. D. Strong, Corps of Engineers; Lieutenant-Colonel Robert B. George, Corps of Engineers Reserve. The Army Engineer School developed a sixty-hour resident course intended to help qualified personnel in the Corps of Engineers and other government agencies near Fort Belvoir to prepare themselves for the examination leading to registration as Professional Engineers. The course was so successful that non-resident courses have been initiated which cater for personnel preparing for the examination for registration as engineers in training and for those taking the examination for Professional Engineer licences. A brief description of the organization of the courses available is given. The scheme has had great success and the numbers applying to take part are increasing. It is worth considering whether something similar would not be popular in the Corps here. It would give an opportunity to officers to keep in touch with engineering problems when in posts which offered little engineering work.

"Mobile Photographic Train," by Lieutenant-Colonel S. Presser, Corps of Engineer Reserve. This is a description of the mobile equipment developed in the U.S. Army to provide units capable of carrying out all the processes involved in photo-mapping in an army area. The article goes into considerable detail and is well illustrated with photographs.

"Nuclear Radiation: Radioisotopes," by Lieut.-Commander J. C. LeDoux, Civil Engineer Corps, U.S. Navy. A very clearly written informative article on radioisotopes, their characteristics, production and use in industry, medicine, and scientific research with suggestions for other possible uses in the future. An interesting and valuable introduction to the subject.

"The Braddock Campaign," Part III, Aftermath. This is the last of three articles dealing with this campaign and consists largely of accounts of the subsequent careers of the Engineer officers engaged. The three articles give a comprehensive story of the disastrous operation but there is little of purely engineer interest.

"Engineers in the Drive to Davao, 1945," by Kenneth J. Deacon. This is a short well illustrated account of the engineer work involved in the rapid move of 24 Division across Mindenao Island in the Philippines which was still in Japanese occupation. The Division covered about 160 miles in sixteen days and the engineer tasks included crossing numerous rivers and streams where the bridges had been destroyed, clearing mines and booby traps and road construction and maintenance. Although there is little that is new, it is the sort of engineer action which took place in most theatres of war, the account is of great interest because it brings out the vital rôle played by the engineers and the excellent spirit of co-operation among all arms which existed and contributed so much to the success of the operation.

"Trends in Army Engineer Organization," by Lieut.-Colonel A. H. Bouldin (Retired), United States Army. Discusses briefly and rather obscurely, the organization of the Engineers in the US Army in the light of an atomic war. It has been decided that a single multi-purpose Construction Battalion should replace the various specialized Construction Battalions which exist at present. A new all-purpose construction group headquarters is also being formed with separate specialized design and control teams to be attached to groups as required. There will be little or no time to construct facilities required to meet specific war plans once hostilities have started therefore as much as possible must be provided now. This will lead to a tendency progressively to reduce the number of engineer construction units. On the other hand on the atomic battlefield the part of the combat engineer ensuring mobility, deception and field fortification is as insistent as ever. The same type of unit will be required for operations in support of the Army and Air Force in all areas within range of enemy missile systems.

"Naval Civil Engineering Laboratory," by Lieut.-Commander T. H. Cushman, Jnr, Civil Engineering Corps US Navy. The Navy Civil Engineering Laboratory is the primary research development arm of the Bureau of Roads and Docks. A few of the projects in hand of particular interest to army engineers are described and illustrated in this article. One is a pontoon causeway extension for use across unstable beaches and mud-flats. In its folded position this is cylindrically shaped and can be rolled across terrain of almost any type. The roll can be opened to form a four-trussed structure that in multiple sections can be used for a roadway. Another project is ship to shore bulk liquid fuel delivery. The laboratory is also engaged on investigations dealing with arctic weather conditions and has made much progress in the construction of airfields using snow on which aircraft can land without using skis.

JULY–AUGUST, 1959.

"Missile Construction for Security," by Major-General E. C. Itschner, Chief of Engineers, United States Army.

This article brings to notice the vast and varied engineer construction programme involved in the provision of missile testing installations and launching sites for the United States Navy, Army, and Air Force. The Corps of Engineers is the nation's principal construction agency. The article gives few technical details but is profusely illustrated with photographs covering the testing and launching of most of the service missiles and includes diagrams of site lay-outs of Atlas and Titan missile bases. The magnitude and variety of the engineer problems solved and still requiring solution are clearly demonstrated.

"Concrete Pavement without Forms," by Gordon K. Ray.

A short article well illustrated with photographs describing the development of a machine which will lay concrete pavements from 6 to 10 in thick and 24 ft. wide without the use of forms at a speed of 5 ft. a min. Details of design are given with a description of the method of operation and the preparatory work required in forming the subgrade, and finishing off.

"To Be or Not To Be." Civil Defense in the Nuclear Age. A Summary.

The subject of the Symposium of the Society of American Engineers held as part of the Annual Meeting in May 1959 was Civil Defense in the Nuclear Age. This article consists of digests of the papers presented. The problems and broad solutions are similar to those in this country. The impression given, however, is of considerable preparedness in the way of communications and command posts in actual being.

"Radiation Slide Rule for Passive Defense Problems," by Lieut.-Commander L. C. Le Doux, Civil Engineer Corps, United States Navy.

This is a description of a slide rule which has been devised to solve the various problems which need answering in connexion with radio-active contaminated areas, their clearance and re-occupation. For instance if the time of detonation of an atomic weapon and the intensity (roengtens/hours) at a certain locality are known it is possible to obtain by the use of the slide-rule the intensity at any other time, the total dose which would be received in the contaminated area for a stay of a given time, and the length of time a man can stay in the area without exceeding a specified dose and many other things which it is necessary to know when dealing with the effects of atomic weapons.

"The Parachute, We can't live with it, Nor can we live without it," by Colonel Frank Milner, Corps of Engineers, and Lieut.-Colonel John E. Burke, Corps of Engineers.

There is a limit to the weight of items of engineer equipment which can be landed satisfactorily by parachute. As a result engineer support for airborne operations cannot be as efficient as it should be. This article describes a method of free dropping a heavy load from an aircraft without the use of parachutes and without calling on the aircraft to land.

The method proposed is to extract a skid or sled mounted load directly from the aircraft while it is still in flight or with wheels just touching the ground. The operation is essentially similar to that used in landing an aircraft on the canted deck of a carrier with the difference that the tail hook is attached to the load to be extracted. The arresting mechanism in a carrier is too heavy for transportation by air and the authors of the article describe a very much lighter device containing an energy absorber which depends on drawing a strip of metal tape through a series of rollers and straining it past its yield point in both tension and compression.

There is no indication whether the method has been tried in practice or not though there is a photograph suggesting that the energy absorber, as described, has been made. The method certainly appears to have great potentialities.

Military Engineer Field Notes

"Combat Engineers in Exercise Banyan Tree," by Lieutenant Carleton Coulter, Corps of Engineers.

A short interesting account of an engineer unit's training in a special training area in the Panama Canal Zone. The conditions allowed for a large amount of fully practical combat and constructional work which is well described. The great value of such an area for engineer training is well brought out.

"High Pressure Equipment Washer," by Lieut.-Colonel William A. Allison, Corps of Engineers.

This a description of an improvised water jet device for cleaning unit vehicles and equipment in the field using an air compressor. The device seems practical and useful and sufficient detail is given to enable a unit to make one.

"Nike Construction Formosa," by Lieut.-Colonel Harold St. Clair, Corps of Engineers.

Description of a high-speed operation to install a Nike battery in Formosa. Much administrative detail is given and there are interesting photographs of the equipment.

"Cantilever Hangar Design," by Royal C. Flanders.

A description of a special purpose hangar for the accommodation of two B50 aircraft in connexion with modification and electronic tests. There are two hangars, one each side of and constructionally part of, a central office and workshop block. The hangar roofs are cantilevered out to a length of 86 ft. and are supported by cables tied back to the roof of the central block. The article is well illustrated.

"The Deas Island Tunnel," by Norman D. Lea.

This is a description of a four-lane vehicle tunnel being built by the trench method under the Fraser River in British Columbia as part of the expansion of the City of Vancouver. There is an interesting summary of the reasons for the choice of a tunnel rather than a bridge and much technical detail of the design and construction of the tunnel itself. This consists of six pre-cast elements constructed in a dry dock, specially excavated close to the site, which are then floated into position and sunk into a dredged channel. The article is well illustrated.

"Electronic Computers in Flood Control Studies," by C. E. Brabant.

A fairly detailed description of how electronic computers can be used in flood control studies. The article brings out what a large number of varied and inter-related problems there are calling for solution in the control and use of the water flow of a river basin.

"Surveys and Maps. Current Surveying and Mapping News."

Contains interesting short articles on the St. Lawrence Seaway and the development of plastic relief maps by the Army Map Service. J.S.W.S.

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Books Review*, May, 1959.

"A Method of Finding Prestressed Beam Sizes": The method described gives a simple first approximation to the size of member required. By selecting a typical cross-section, and working out the Section Modulus required, the principal dimensions of the beam required can be found by scaling. The examples quoted demonstrate the method clearly.

"Technical and Economic Considerations in the Use of Timber Shell Roofing": The author analyses the advantages of timber for the construction of Shell Roofs under the following headings:—Lightness of weight, Thermal Insulation, Durability, Ease of Cutting and Fixing, and Comparative Costs. He also discusses one of the main disadvantages—the fire hazard. The principal advantages arise from the fact that a concrete shell roof requires a considerable amount of timber in false work, which is subsequently removed—and the weight of the concrete makes handling difficult and places a heavy load on the foundations. In addition, extra thermal insulation is required when concrete is used. By using timber alone, a light-weight structure of ample thermal properties can be erected more speedily and easily.

Notes from Civil Engineering and Public Books Review, June 1959.

Optimum Design of Structural Frames

The article describes a graphical method for obtaining a safe design for a rigid jointed plane frame such that the total weight of the structure is a minimum. This is not a truly practical technique, but illustrates an important general principle in plastic design theory. It is interesting to see how, in the ultimate design selected, several different "mechanisms of failure" become critical due to entirely separate types of loading. This emphasizes that there is no "worst system of loading": the minimum weight design is the one which is the most successful in balancing the effects of a number of extreme loading states. T.W.T.

THE CONTRACT JOURNAL

The Contract Journal, 19 March 1959.

"How can the Advantages of Prestressed Concrete Best be Utilized?"

Professor H. Rüsch, in his lecture to a meeting of the P.S.C. Development group in London, introduced his subject with a brief history of the development of Prestressing. He emphasized the fact that the technique is excellent for solving certain problems although yet not applicable to every case. He described in detail the following advantages when prestressing was used correctly:

(*a*) a saving in steel.

(*b*) a saving in weight—thereby encouraging longer spans.

(*c*) control of shear forces, leading to slender web sections.

(*d*) reduction of tensile stresses and cracking, improving durability, proof against corrosion, and waterproofness.

(*e*) Control over stresses, which may be indeterminate, by the substitution of a determinate system—for example railway sleepers, for which the position of support may vary from year to year.

(*f*) Reduction in deformation.

(*g*) Control of Secondary Stresses, enabling concrete trusses to be constructed without having to arrange for "pin-joints".

(*h*) Overcoming the problem of transfer of stress from a curved shell to its ring beam.

(*j*) The use of precast units, successively jointed to make a composite structure, such a process even being possible under conditions of frost.

(*k*) Reduction, and even complete elimination, of scaffolding.

(*l*) Alteration of stresses during construction, or prior to live loading, so as to avoid embarrassing bending moments.

The Contract Journal, 28 May, 1959

"Corrugated Arch Shell Construction": The article describes the construction of two large warehouses at Paisley for which a 2½-in. thick concrete shell roof has been designed on the "Ctesiphon" principle to span 100 ft. Expanded metal was draped over ribs to form the corrugated shape and act as the distributed reinforcement. The main reinforcement of ½ in. and ⅜ in. mild steel was placed where needed, and a 2-in. thick layer of approximately 1 : 2 : 4 concrete, made up of ⅜ in. down gravel was placed on top of the expanded metal formwork. A ½-in. thick layer of rendering of one part cement to three parts of sharp sand was applied in two coats to the underside. Two more warehouses are to be built on this principle, but in this case a re-usable plywood form work has been designed to give a fair finish without rendering, and a built-in soffit insulation layer is to be incorporated which will bond in with the concrete shell.

The Contract Journal, dated 2 July, 1959.

"Recent Developments in Rock Tunnelling": This article reports a paper presented by Mr. L. H. Dickerson, MICE, at the annual conference of the Royal Institution of Chartered Surveyors. It gives a general review of the progress made in the mechanization of tunnelling, quoting largely from experience gained in modern hydro-electric schemes, and forms a useful background to the subject.

T.W.T.

Correspondence

Gordon Boys' School,
West End, Woking,
Surrey.
5 June, 1959.

The Editor,
RE Journal.

Dear Sir,

May I add one further note to your article in the June edition of the *RE Journal* on the Statues of Kitchener and Gordon. The Gordon Statue is being re-ected on the quadrangle of The Gordon Boys' School, and the design of the setting and surrounds has been entrusted to Mr. Louis de Soissons and Partners.

We are well aware of the adventures that this statue has already undergone, and are taking care that as far as possible there will be no further shock for it when it is erected on its new site!

Yours faithfully,
F. C. Nottingham, Brigadier (Retd.)

Oriel College,
Oxford.
10 June, 1959.

The Editor,
The Royal Engineers Journal.

Dear Sir,

THE TWILIGHT TO A MILITARY CAREER

As one who a few years ago successfully negotiated the change to civil employment without the aid of influence and without paying the slightest attention to the extremely depressing literature showered on those about to retire, I was interested in Lieut.-Colonel Power's article on this subject. His article is more constructive than most of the hand-outs which leave one with the impression that one will be lucky to get a job sweeping a crossing. I disagree with him, however, in his advice not to mention rank in correspondence in search of work; most employers look for some sign of success in an older man, and after a life in the army, which they may not understand, the attainment of field or higher rank is at least a measure of success. As to what one does after getting a job, that no doubt varies with the job; I am referred to and written to here as "Brigadier", "Mr" or "Treasurer", and care not which it is.

I think the main things for the officer contemplating retirement to remember are, firstly, that his career as an officer of the Royal Engineers fits him for success in almost any type of employment, and secondly, that his main difficulty will be to persuade a prospective employer that this is so, without ramming it down his throat. A combination of absolute self-confidence with a measure of modesty—but not too great a measure—is what is needed, together with good luck. If firms do not select one for an interview, or prefer someone else after an interview, you are lucky not to have become an employee of such poor selectors. I had several near misses, and in no less than three cases the job has now folded up.

Finally, I agree with Lieut.-Colonel Power that the change to civilian life is a challenge, and would add that the main weapon needed to meet this challenge is self-confidence.

Yours faithfully,
R. E. Bagnall-Wild, Brigadier (Retd.)

Transportation Inspectorate RE
Headquarters,
British Army of the Rhine,
British Forces Post Office 40.
14 July, 1959.

The Editor,
Royal Engineers Journal.

Dear Sir,

Captain Knowles' interesting article "Loading and Unloading" (*Journal*, June 1959) raises the question of the possibilities and the limitations of "non-specialist" (e.g. Field) units carrying out "specialist" (e.g. Transportation) tasks. This is an Important subject which deserves study and discussion; obviously the possibilities should be exploited to the full, but at the same time the limitations must be clearly understood; the consequences of not appreciating these limitations can be serious.

I offer, as a basis for discussion, the theory that any Sapper unit can successfully tackle Transportation work provided that the scope of the task is sufficiently limited, but that there is a threshold beyond which only trained Transportation units can go. This threshold is determined by two factors.

Firstly, Transportation work is full of traps for the unwary; up to a certain point "amateurs" may avoid these by the application of common sense and foresight, by intensive officer supervision, and by a reasonable amount of luck. But experience is the only sure safeguard, and with inexperienced men (and officers) one is always taking a gamble in which, if one loses, the penalty may be not only casualties but a severe disruption of the Transportation facilities.

The second factor is that a Transportation unit, unlike any other Sapper unit, is designed specifically to exercise management over a Transportation facility; that is, to operate and maintain it with professional skill for an unlimited period. A Field Squadron could certainly undertake a limited task in an emergency with a fair chance of success, but one would be wise to provide for a Transportation unit to cope with any foreseeable Transportation commitment. The distinction may be described as the difference between limited Stevedoring and full Port Operating. One can contemplate a Field Squadron discharging the odd ship in an unforeseen emergency, but not three Field Squadrons combining to operate a small port to capacity for any length of time.

The threshold can be seen more easily in Railway work. There is a definite affinity between "sticks and strings" and stevedoring, and between, say, bridging vehicle organization and quay clearance; there is also a slight affinity between Watermanship and IWT; but there is practically none between any Field activity and Railway work, and the possibilities and the limitations of Field units in this rôle are more clearly recognized.

In the Suez Operation, 1956, the railways in and south of Port Said were worked for a time by a Corps Engineer Regiment personnel, and as a result I formed quite definite conclusions on this point. I consider that any sapper unit could work a short length of line (say up to 25 miles) under "one engine in steam rules", provided (*a*) that the track and plant was found in, not perfect, but reasonably undamaged condition, (*b*) that the period of operation was not so long (say up to three months) that major mechanical and track maintenance problems arose, and (*c*) that traffic was sufficiently light to enable all operations to be done by numbers, with intensive officer supervision, and in slow time. But to attempt, for example, to run more than a skeleton service without trained blockmen and formal rules would be to invite a major catastrophe (luckily this was not tried). Sooner or later disaster overtakes (as it did) those who think that facing points are secure merely because they are connected to a signal box, or who (as I did) try to keep an oil-fired engine in steam overnight with Sappers whose experience was confined to British Railways coal-burning locomotives.

To summarize, the employment of Field units on Transportation work is certainly feasible in certain limited circumstances, but beyond these limits it involves considerable risks, not merely of Sapper casualties, but of complete failure to carry out the task which may well jeopardize the success of an Operation. It is therefore essential to distinguish between the ability of a resourceful Field unit to handle an unforeseen emergency and the proper requirements for meeting a serious Transportation commitment.

Yours faithfully,
N. B. PEATFIELD, Major, R.E.

CRE, Hong Kong,
BFPO 1.
27 July, 1959.

The Editor,
RE Journal.

Dear Sir,

"WHITHER THE CORPS"

I was interested in Lieut.-Colonel Clutterbuck's letter in the June number, and I agree with his list of priorities. Field Engineering training for cold war tasks must obviously come first, but for his second priority I think he is optimistic in hoping to carry out so much civil engineering work with field units.

The supply of "Christmas Islands" is not going to last for ever, and the carrying out of such tasks by troop labour is most uneconomical and will only be done in areas where there are almost no local resources of labour. As a side issue such an area is almost certain to be a non-family station and we do not wish to acquire the reputation of doing most of our useful work in such places.

As far as carrying out civil engineering tasks in the United Kingdom is concerned, I think he has much under-rated the difficulties. During the years since the war, when there has been a great shortage of labour and plant at home, we have done very little except help in flood emergencies and blow up long disused bridges. With unemployment increasing and contractors at home having surplus capacity, I think we will meet very strong opposition both from Trade Unions and Contractors if we try to undertake any major tasks. Taking into account the cost of materials and fuel, and the depreciation on the Army plant employed, the true savings from employment of troop labour may not be as great as Lieut.-Colonel Clutterbuck implies.

In addition, the military climate at home, with its emphasis on sports and games, administrative inspections, and annual range courses, PE tests and education, guards, fatigues, leave and administration of married quarters, is not conducive to getting a real job of work done.

Concerning his third priority, I foresee only field engineering tasks for the Corps in a hot war. Rehabilitation of civilian installations after an atomic attack will be a job for the civilian expert, presumably working under martial law. We cannot justify civil engineer training for the Corps for this task.

I agree that the maintainance of barracks in non-operational theatres is no training for a military engineer. However, the Works Services do not only function in such theatres. For the past few years Cyprus could be considered one of our most operational areas. During that time, work on two major cantonments continued with surprisingly little interruption or sabotage. I do not believe that this would have been the case if a civilian works organization had been in charge during the period.

During the emergency in Cyprus, a DCRE constructing temporary camps employed a labour force equivalent to the effective working strength of at least three Engineer Regiments at lower establishment, and although this labour force was drawn from a theoretically hostile and technically backward population, the standard of work that they produced was higher than that of a normal field unit.

It is easy to sneer at works training, but it has in the past produced the type of officer who could be sent off into an unfriendly country with a bag of gold, or an allotment slip, and who could there make the best use of the local resources and labour that were available. A civilian works organization is unlikely to provide an equivalent, nor I think will field units do so. Abroad the Works Officer and Military Clerk of Works have to get to know and to understand the local inhabitants in order to get the best out of them. To the soldier of a field unit, and alas to, too many of his officers, the local inhabitant is merely a useless and probably hostile part of the scenery.

Before we give three cheers for the end of the Military Works Services, we should be clear what the Corps is likely to lose. For the reasons given above, very little civil engineering work will be done by field units. Having lost Works Services, we shall find it increasingly difficult to justify the retention of the Construction and E & M Schools at Chatham, or to justify sending our officers to university or long engineering courses. We shall become, in course of time, purely field engineers. Attachments to the civilian works organization will be unpopular, and will not attract the best officers.

Since everyone is actuated in some degree by self-interest, we shall lose the main factors which have brought us a high standard of officer in the past. We shall be able to offer neither university degree nor training for a good career in civil life on retirement, and in addition we shall have lost what in the past has been a far better chance of promotion than that in any other Corps.

What shall we have to offer against the glamour, the tradition and the territorial connexions of a famous infantry regiment? Inevitably the standard of officer we obtain will fall below that of the infantry. This will be a sad thing from the point of view of the Corps.

From the point of view of the Army as a whole, the sad thing will be the loss of the type of officer who could be sent with a bag of gold to some unpleasant part of the world where he could get done work that would otherwise require many hundreds of bored soldiers and all the administrative tail that follows them. We can only hope to keep him by retaining some form of Military Works Organization entirely separate from the civilians.

Yours faithfully,
A. C. Dalgleish, Major, RE.

Merton Court,
Knoll Road, Sidcup, Kent.
7 August, 1959.

My Ref. WD/P
The Editor,
Royal Engineers Journal.

Dear Sir,

NARROW GAUGE RAILWAYS 1914/18 WAR

I am endeavouring to compile an account of the *60 cm.* (and 2 ft. 6 in.) gauge light railways operated by the Royal Engineers on several fronts during the 1914–18 War. I have now got as far as the rather scanty published records permit and will be grateful if you will allow me to use your columns to appeal for further information.

These lines made a vital contribution to the success of the war effort but little seems to have been written about them, and I think it would be a good thing to have a record of them, which might perhaps also act as a memorial to those who built and operated them; in which case, I feel it should be as complete and accurate as I can possibly manage.

I am sure that among your readers are some who have personal recollections and records of these lines and I would be very grateful for the loan of any unpublished information or photographs. Any material would be most carefully treated, and returned as soon as possible.

I hope that you and your readers may feel able to help me in what I am sure is a worthwhile task.

Yours faithfully,
W. J. K. Davies.