THE ROYAL ENGINEERS JOURNAL—DECEMBER 1962 VOL LXXVI No 4

THE ROYAL ENGINEERS JOURNAL

Vol LXXVI DECEMBER 1962 No 4

CONTENTS

PUBLIS ... ERS

AGE

HISTORY OF THE CORPS OF ROYAL ENGINEERS

Volumes of this History, covering the period 1066 to 1948, are on sale from the Institution of Royal Engineers, Chatham, at the following rates:—

Volumes I to VII ordered together—price £2 10s. to members, or £10 to non-members.

Volumes IV to VII ordered together—price £1 10s. to members, or £6 to non-members.

Volumes I to VII—10s. each to members of the Institution or 35s. to non-members.

Volumes VIII and IX—15s. each to members of the Institution, or £2 7s. 6d. each to non-members.

You get big tyres of large cross-section on every Vickers Onions Scraper. This reduces rolling resistance and increases stability on difficult terrain, and gives better flotation. It also gives longer tyre life and reduces down-time caused by bruising, concussion fractures or other tyre troubles.

Other peak-output Vickers Onions plus points include

- Maximum cutting edge width
- Positive action, central thrust tailgate for easily controlled ejection
- Balanced towbar, giving minimum weight transfer to hauling tractor
- Low bowl, wide track for greater stability

And remember—the Vickers Onions Scraper range is the world's largest and includes a match for almost every crawler tractor.

a VICKERS Onions Scraper

VICKERS-ARMSTRONGS (ONIONS) LIMITED
Onions Works Bilston Staffs Telephone Bilston 41751/5

Distributors in Great Britain:
Jack Olding & Co Ltd Hatfield Herts
Jack Olding & Co (Scotland) Ltd Coupar Angus Perthshire

4,250 1.12.62

THE ROYAL ENGINEERS JOURNAL

Authors alone are responsible for the statements made and the opinions expressed in their papers

VOL. LXXVI

CONTENTS

DECEMBER, 1962

Sir Donald C. Bailey, Kt, OBE, D Eng, AMICE, MIStructE

Sir Donald Bailey relinquished his appointment as Director MEXE on 1 October, 1962 and has now taken up his duties as Dean of the Royal Military College of Science.

He was dined out of the RE Mess, MEXE on 25 September, 1962 and to mark the occasion, a model of a Bailey bridge was placed in the Mess.

A photograph of the model which was made by the Workshops staff at MEXE is reproduced as a frontispiece.

The Bridge is 1/48 scale, constructed from silver plated brass and mounted on a polished glass fibre gap section.

Operation Late Water

By Lieut-Colonel A. E. Younger, RE, DSO, OBE

Background

For two years prior to September 1961 the rains failed in Kenya. This means that the periods when the sparse vegetation of the deserts blossoms did not occur, and, as a result, a high percentage of the cattle of the nomadic tribes died. By the beginning of 1961 large numbers of Masai in the south and Turkana in the north were on famine relief. Some of the fierce Turkana had lost all their cattle and were concentrated in two large camps near the shores of Lake Rudolf. The Masai, proudly independent to the last, continued to roam over their deserts searching for grazing for the depleted herds on which their lives depended.

This situation was abruptly changed in the autumn of 1961 when the rains returned in unprecedented strength. Landslides occurred in the mountains, new lakes and rivers were formed and the roads and bridges were washed away in a thousand places. Victoria Nyanza rose 3 ft 6 in; this may not sound much, but the lake has a surface area of 21,000 sq miles, so the rise represented many thousand million tons of water. Again, Kenya's main river, the Tana, flooded an area of about the size of Wales between the town of Bura and the sea.

One of the effects of the destruction caused by all this water, was to stop the flow of food to the starving tribes. Also, tribes that had a more advanced and specialized economy were abruptly cut off from contact with the outside world. Examples of this were the agricultural tribes near Victoria Nyanza who depended for their protein supplies on the lake fishermen, and vice versa. These tribes could not reach each other.

The Government's immediate reaction was to request RAF Beverleys and institute a massive air supply programme. However, this could not last for ever and was very expensive, so there was a great need for engineer work to repair the damage and open up roads for normal traffic.

The Ministry of Works in Nairobi did their best through their normal chain of representatives throughout the country to cope with the disaster, but the most they could do was to concentrate on the main routes.

Initial Deployment

A dangerous situation threatened at once as HQ East Africa Command had no engineer branch. Consequently they were faced with an engineer problem of enormous magnitude and no engineer adviser. By a most fortunate chance the two senior members, the Chief of Staff and the Brigadier A/Q, were ex-Sappers. This stroke of luck covered up a gross example of the false economy of removing engineering advice from a Headquarters with a large territorial responsibility.

By yet another stroke of luck, there was a military CRE (Works) supervising the construction of extensive permanent cantonments at Kahawa a few miles from Nairobi. Dropping his normal work, he laid a firm foundation by co-ordinating the activities of two troops of 34 Independent Field Squadron that were made available at once, and of the three troops of 24 Field Squadron when they arrived from the UK by air. When the tactical headquarters of 36 Corps Engineer Regiment was established at Command he reverted to his normal task, but his experience of the country remained an important factor in keeping the engineer plan on the right lines.

The communications of the country had been so disrupted that little detailed information was available on which to base engineer plans. It was not possible to discern priorities from the mass of reports of where roads were cut. It was important to start work quickly, so the initial deployment was based as much as anything on which District Commissioner was most persuasive in his cries for help.

The process of building up engineer information then developed. The pattern was that a request for assistance would come in from a Provincial Commissioner. The Regimental tactical HQ would then reconnoitre the area, preferably by road but sometimes by air. The Provincial and District Commissioners would be visited, so that the correct priorities could be decided, and then an assessment in terms of Troop-days or weeks would be made.

From this reconnaissance the task would be fitted into a priority list by the Central Famine Committee in Nairobi. This committee met daily in East Africa Command Headquarters under the Chairmanship of a senior government official, with representatives of the police, railways, food and finance departments and the Ministry of Works. The Army and RAF were also members under the leadership of the Brigadier A/Q.

Once the priority had been agreed, the task could be allocated to a squadron, bearing in mind estimated dates of completion of other tasks. Details of stores and administration, such as possible camp sites, were then made by a Troop Commander in preparation for the time when he could move his men to the area.

Work Done

The engineering problems of each district were quite different. This was only to be expected, as the country varied between desert, jungle and swamps, between dense and negligible population and, in accessibility, between easy and most difficult. A list of the areas visited reads like the administrative organization of the colony.

The largest task carried out was the installation of a light assault ferry to replace the bridge swept away by the swollen Tana river at Garissa. This remote outpost in the desert towards the Somalia frontier was only approachable over 200 miles of atrocious roads from Nairobi. The major part of the task was to transport the stores in good condition to the site; once there, construction and operation were not complex.

British troops have always shown that they react well when the value of their work is obvious. They produce unexpected reserves of ingenuity and endurance, which in turn develop them so that they become capable of even greater efforts.

The men flown out from England were inexperienced in the practical problems posed by operation Late Water initially. No new lessons emerged from the mass of straightforward engineer work that was completed. The truth of the old "cries" was re-established, particularly the value to a unit and to the men in it of doing work requiring initiative and originality. The development and increase in confidence of individuals was marked.

Political

The political situation in Kenya pervades most aspects of life in that country and no report would be complete without mention of it.

The reactions of Africans to our work varied greatly. In the more accessible areas where they were better educated and more "advanced", they were at best apathetic and sometimes hostile. In the Machakos areas they actually dismantled much that we did. The motive behind this appeared to be nothing more than personal gain, as it took the form of stealing sandbags and timber. However, since work was often carried out in well-fed areas in order to open up a route to a far-away area in dire straits, this thieving betrayed a cynical disregard of the fate of others. These people also, by virtue of their education, were capable of helping us in our work, but they did not do so.

Against this, Africans in remote areas, who had been hard hit, showed at times a gratitude that was most touching. They did their best to help, but were so primitive as to be of little value.

However, the common sense and energy with which the Government officials tried to solve the many complex problems was most impressive. With their positions often being undermined in the most obvious way by local political parties, officials displayed a devotion to duty that was remarkable. It was the example constantly set by these men at all levels, that persuaded the working troops that it was all worth while, and that therefore kept them cheerful.

Conclusion

Much of the work done was of a "first aid" nature, designed to open up some route quickly. It will be swept away by the next heavy rains. But I firmly believe that the wholly constructive work of the Sapper squadrons, cheerful to the end in spite of dreadful conditions, will not quickly be forgotten, particularly in the more remote areas where white faces are still rare.

Conversely it is difficult to overstate the value in training and character development to men involved in an operation such as this. Troops were stationed more than twenty-four hours away from their parent squadrons and usually in areas where no man-made item was available. Nothing could be better calculated to train junior Officers and NCOs.

Presentation to 542 Field Squadron RE(TA)

By Colonel B. P. Tyrwhitt-Drake, MBE, BA

In 1958, Kingston-upon-Hull Corporation found themselves in a slight dilemma because the only access to a new housing estate was a narrow and weak bridge which was showing signs of deterioration. Authority for the re-building of this bridge was obtained, but because of site restrictions, the old bridge would have to be pulled down and a new bridge built on the same site. This would have meant isolation of the new housing estate for some eighteen months and was obviously unacceptable.

The City Engineer (an ex-Sapper), then had the idea of approaching 542 Construction Squadron RE (TA), as it then was, and asking if they were interested in providing a Bailey Bridge as a temporary diversion whilst the old bridge was being rebuilt. After the necessary permission had been obtained from Higher Authority, 542 Construction Squadron agreed to take on the work which involved the building of a 80-ft double single Bailey bridge. The site was very difficult and the only way to launch was to launch at an angle to the existing bridge and then slew the bridge parallel to the existing bridge. This task was successfully carried out, and for some eighteen months the Bailey bridge carried all traffic to the housing site. When the new bridge was completed, 542 Squadron removed and recovered the Bailey bridge.

As far as 542 Squadron was concerned this was the end of an interesting and practical bridging operation. However, the Corporation of Kingston-upon-Hull were so impressed with the help and co-operation that they had received from their local TA Field Squadron, that they approved the presentation of a piece of silver to the Squadron as a token of appreciation of their work and co-operation.

The piece of silver is a model of a Bailey panel supported by a Sapper, the whole being mounted on a plinth.

On Sunday, 22 July, 1962, the Lord Mayor and Corporation of Kingston-upon-Hull honoured 542 (East Riding) Field Squadron RE (TA), by visiting the Squadron's Drill Hall at Mona House, to present the piece of silver.

The Lord Mayor, supported by a goodly proportion of the Corporation, arrived and inspected a Guard of Honour commanded by Captain G. A. Mackley. After inspecting the Guard of Honour, the official party moved to the dais where Alderman Body, the Chairman of the Town Planning Committee, spoke of the great help that this bridge, built by 542 Squadron, had been to the Corporation and how grateful they were to the unit. The Lord Mayor then handed over the Trophy to Major T. H. Wilkinson, MBE, RE (TA), who thanked the Lord Mayor for the Trophy. After the presentation ceremony, 129 Corps Engineer Regiment (TA), led by their Band, then marched past the Lord Mayor to take the Salute. 542 Field Squadron is part of 129 Corps Engineer Regiment.

After the March Past, tea was served and the official party and the many spectators saw a short bridging display by 542 Field Squadron and the remainder of the Regiment. They also visited a display of Sapper equipment.

This very successful day was a very fitting tribute as it was the last official parade of Major Wilkinson, who has commanded this Squadron for four years, and in fact has served in this Squadron during peace and war for thirty-two years.

The fine piece of silver presented by the Corporation is to become the Bridging Trophy to be competed for annually by all the Squadrons in 129 Corps Engineer Regiment.

Photo by The Yorkshire Post

Guard of Honour (542 Field Squadron RE (TA)) being inspected by the Lord Mayor.

Photo by The Yorkshire Post

The Lord Mayor, Alderman Body presenting the Trophy to Major T. H. Wilkinson, MBE, RE (TA).

Presentation to 542 Field Squadron

Commanding a Territorial Engineer Regiment

By COLONEL H. G. W. HAMILTON, MBE, RE

THE list of commands available to Sapper Lieut-Colonels shows that provision is made for six regular officers at any one time to command TA Regiments, compared with the sixteen Regular Regiments or equivalent unit appointments. It may therefore be of interest if the life and experience of a regular TA regimental commander is described for the benefit of officers who are approaching that period of life to which all officers look forward—the command zone.

It is one of the regrettable facts of life that few regular officers who have not experienced the joys of being a post war TA adjutant, have any idea of what the TA does, how it is organized or what is required of TA volunteers.

A few lines on the TA generally may not be out of place at this stage. To start with, one can now almost forget the National Serviceman doing his 3½ years reserve service in the TA. He is a paper figure only, never met in person as he now has no compulsory commitment, he nevertheless causes the small clerical staff at Regimental HQ considerable work, as he has to be administered with Part II Orders and the like, taken on strength, documented, struck off strength, sent railway warrants for mobilization etc.

The majority of Territorial Commands are either Divisional Engineers or Corps Engineer Regiments and they are grouped for training and certain administrative functions into Engineer Groups, all of which are commanded by regular Colonels each with a Brigade Major.

Few TA Regiments have more than two Field Squadrons though some have a Divisional or Corps Field Park Squadron under them as well. The majority of TA Engineer Regiments are spread over a wide area and Field Squadrons may be split over two or even three drill halls which may be some considerable distance apart. A large amount of travelling particularly in the evening is therefore necessary and since a car is only provided on the peace establishment of a Divisional Regiment, the Corps Regimental Commander will usually use his own car or else go by champ. Anything up to and over 6,000 miles per year on duty running, additional to the normal home to office journeys, may be expected.

The TA volunteer signs on for a minimum of two years, but may sign on for more. He undertakes a minimum training obligation of thirty "Drills" (forty in the first year) and a fortnight's camp per year together with one day on the range. This commitment is very small when one realizes that a two-hour evening period counts as two drills and a day's attendance counts as four drills, but the majority of volunteers do far more, and the keen and good men can usually be counted on to attend one evening per week and one weekend per month. It is, however, very difficult to get to know the men in one's Regiment, other than the good attenders, particularly when the Regiment is spread over drill halls each containing only one Troop and one may only be able to visit each drill hall at the best, once a fortnight.

The permanent staff of a TA Regiment consists of an Adjutant, QM, RSM and one PSI per Squadron plus one extra PSI for seven or more drill halls, together with a number of civilian clerks, drivers and storemen. The majority of the civilian staff, other than female staff, are usually TA volunteers as well, as their pay is so low and they get no overtime. If you can organize them so that they are a civilian by day doing the same TA appointment in the evening eg, Storeman/SQMS or Driver/MT Sergeant, you have the best of both worlds. There are now no regular Rank and File in TA units so that you have no soldiers to be cared for, disciplined or administered, and although you may sometimes feel the lack of working numbers in uniform by day, this system is better, as otherwise a young regular soldier has to be fed, clothed etc, and found lodgings on his own which is usually unsatisfactory.

The Regular TA Commander lives and works in a much more intimate and close relationship with his adjutant and RSM, than his counterpart in a regular unit. The adjutant has a lot to do, particularly over pay and accounts. Even though you may be lucky enough to have a TA paymaster, the Regular CO will usually find himself running the pay etc, when the adjutant is away. He will usually take on all training matters, particularly the forward planning of training and exercises and will find himself preparing the charts, notices, maps etc, and doing the detailed recces, as there is no one else to do it.

The RSM leads a difficult sort of life as he has few of the accepted RSM duties to carry out, he has no men to whom he can pass on orders other than the PSIs and civilian staff, no "Orderly Room" to organize except in camp and even that is a rare occurrence, and the sergeants mess is, outside camp, a pretty small affair in most cases since the majority of squadrons are too far away from RHQ to make the Regimental Sergeants Mess a worthwhile organization.

The Regimental HQ is probably in a drill hall in a town, so that there are no guards to check or barracks to organize. The RSM therefore is usually used as assistant adjutant and MTO with particular responsibility perhaps for training films, travel claims, the library and so on. Like the CO he soon becomes a "do it yourself" expert.

The relationship of a PSI with the CO needs careful thought, he is part of the squadron and therefore is under the command of the squadron commander, he is not the SSM of the squadron although a WOII. Since by day, with the TA squadron commander away, it is only too easy for the CO to give instructions to the PSIs regarding training policy etc, this must be done carefully as otherwise the squadron commander may feel that the PSI is being used as an RHQ agent, thus by-passing himself.

The appointment of PSI is one which calls for the highest NCO qualities since he must be a first class administrator, a good instructor and organizer with initiative, yet he must never appear to overshadow the squadron commander or squadron officers or assume the rightful jobs of the senior TA NCOs in the squadron. He must therefore consider himself more as an adviser and someone who can fill the gap in instruction at short notice whenever a TA NCO instructor is not available.

The first few months of commanding a TA Regiment will inevitably be extremely frustrating to the keen regular officer who knows what he wants and the standards he wishes to maintain. To start with he has got to be prepared to drive miles in the evening visiting drill halls only to find a handful of men under training, some not even in uniform because they are going on or coming off shift work and probably not even doing the training laid down, because the nominated TA NCO instructor has not turned up. Then on other occasions he will go to considerable trouble to organize a really good weekend training exercise only to find that for some inexplicable reason insufficient men turn up to make it worthwhile or even possible to achieve the task. He may have a bright idea for improving *something*, and give orders for it to be put into effect, only to find it takes ages because the men he was expecting to do it have not been attending, probably because they are on permanent night shift or have some other perfectly valid reason.

At all times before ordering something to be done, he has to consider in detail who is going to do it, or what job may have to be postponed or even cancelled in order to get it done. It is a continual personal struggle not to let one's standards fall to the level of what is normally attained rather than what should be attainable. It is only too easy to accept the mediocre.

The problem of pace of achievement, not only over administrative matters but also over training must be viewed against the time available. For instance what may take a regular unit two days to accomplish (ie, say 12 hrs) will take you probably four weeks (ie, six evening drills). Patience and perseverence are thus essential qualities of the Regular TA Commander.

One's frustrations go and one's morale soars however when you get to camp and for the first time you realize that you really have a worthwhile command—you see all your men together in the flesh and not just as names on paper and they are all, at least the greater majority, very keen and ready to work really hard. You seldom have any discipline troubles and in my own case had only one man on a Regimental charge during my two years with the Regiment.

One of the great advantages of commanding a TA Regiment, particularly a Corps Engineer Regiment, is that you are very much your own master. Within a broad directive received from Group you can organize your training exactly as and when you wish, your time is your own and generally speaking you are not too worried by visits, conferences or orders imposed by higher authority.

You bear allegience to a variety of people, to your Engineer Group Commander for technical training, to your Divisional/District Commander for other training and certain administrative responsibilities, to your TA Association and if your unit is spread over several counties, to more than one association for other aspects of administration and also to your Honorary Colonel for regimental matters particularly regarding officers.

You have considerable liaison with local authorities, far more than in a Regular Regiment and you soon get to know the mayors, town clerks, civil defence officers and so on; in addition a good relationship with the local press pays dividends in getting your Regiment publicized and this has a definite affect on recruiting. It also pays to be on good terms with such organizations as the local Rotary, Round Table or Chamber of Commerce as it is a good way of liaising with local employers, putting the TA across to them at their dinners and generally getting them interested in the TA.

In addition to his normal duties, the TA Regimental Commander usually has a responsibility for liaison with the ACF and CCF. Most TA centres also accommodate an ACF Troop belonging to the local ACF Regiment, and these troops are usually affiliated to the TA unit in occupation, and wear their cap badge. Responsibility only extends to giving assistance over training and for carrying out an annual inspection. CCF contingents may have an

RE Troop formed from their "Passed" Cert "A" cadets and those troops are affiliated to the nearest TA Engineer Unit from whom they receive assistance over training. This additional commitment can be most interesting, and it should be possible to use it as a recruiting aid in the case of the ACF, with the long term possibility of getting officers from the CCF Contingents, if they come from local grammar schools.

The TA Commander, unlike his regular counterpart is responsible for recruiting his own men. If he is in an area of high employment where there is much overtime being worked, he will have greater difficulty than in an area where there is a large reserve of unskilled or semi skilled labour.

The problem of recruiting is therefore ever present with the majority of regiments and it is a task to which the Regimental Commander must give his personal attention. There are no set answers, and methods found workable in one area may not be the best in other areas. Visits to local firms have little effect other than to secure the co-operation of the management in letting their employees off for camp and other training. Press publicity has a long term background effect, particularly if you can get your Regiment's activities reported with good photographs, but straight advertisements in the papers for men are generally a waste of time, as are other forms of poster or "hand out" advertising. Special recruiting "drives" with displays of equipment, loud speaker vans bearing Regimental recruiting posters and men in uniform stopping passers by, usually pay a very small dividend for the effort required. The only effective recruiting agent is the "satisfied customer". A good troop with a good spirit, well organized training and above all a keen enthusiastic officer will draw recruits through its own members. At the same time one must keep up the background work of keeping the Regimental name in the local public eye as much as possible through the press and every other method one can think of.

Most TA Engineer Regiments have a band and this is something which the commander of a regular regiment seldom meets. A good band depends on its bandmaster, and if you are lucky enough to have a good band it helps recruiting and is a considerable asset in fostering the Regimental spirit. In addition a good band is usually very keen and the members attend far more regularly than do other TA volunteers.

Unless you are very unlucky you will get nothing but complete support and loyalty from your officers, and you will need their advice on local form, back history and their knowledge of TA customs and procedures, if you are to understand the necessity for arrangements which may otherwise appear odd to the regular soldier.

The majority of officers are extremely keen and devote a very large amount of their free time to the TA, many attend two evenings per week, often two weekends per month as well. For most of them the TA is their main hobby and recreation and it makes considerable inroads into their family life. With National Service finishing few new officers have any previous military training, and thus initial officer training is a problem which has to be contended with to a far greater extent than that found in a Regular Unit.

The use to which your Officers Mess is put and the type and frequency of mess functions depends of course on the geographical spread of squadrons and the distances officers travel from their homes. Where no suitable premises exist, as was the case in my Regiment, recourse has to be made to hotels for guest nights, ladies dinners and so on.

The TA Association provides the Regimental Commander with a quarter or a hiring and generally they are most co-operative in doing whatever is required within their financial limits. The standard of TA Association furniture is much the same as in the Regular Army, though there are minor differences. As there are no regular soldiers on the peace establishment, no serving batmen or driver is available, but the regulations allow the engagement of a civilian batwoman for up to 44 hrs per week.

If you join a Regiment which has had a Regular Commander previously, you will get good introductions to a number of local people, but if you are the first Regular in the unit you and your wife may find that it takes a long time to get to know people, as unlike coming to a regular garrison you have no ready made circle of friends, neither are you part of the local business or county community.

Although to start with the Regular Commander may find his task rather frustrating and look with covetous eyes at his contemporary commanding a Regular Unit, the experience he will gain will be well worthwhile. Not only will he greatly improve his knowledge of basic training through having to get down to detail himself, but he will have had the opportunity of widening his knowledge of the civilian world and of meeting and dealing with a different section of the community from that which he is used to. He will also have had the satisfaction of training an essential part of the Reserve forces of the country.

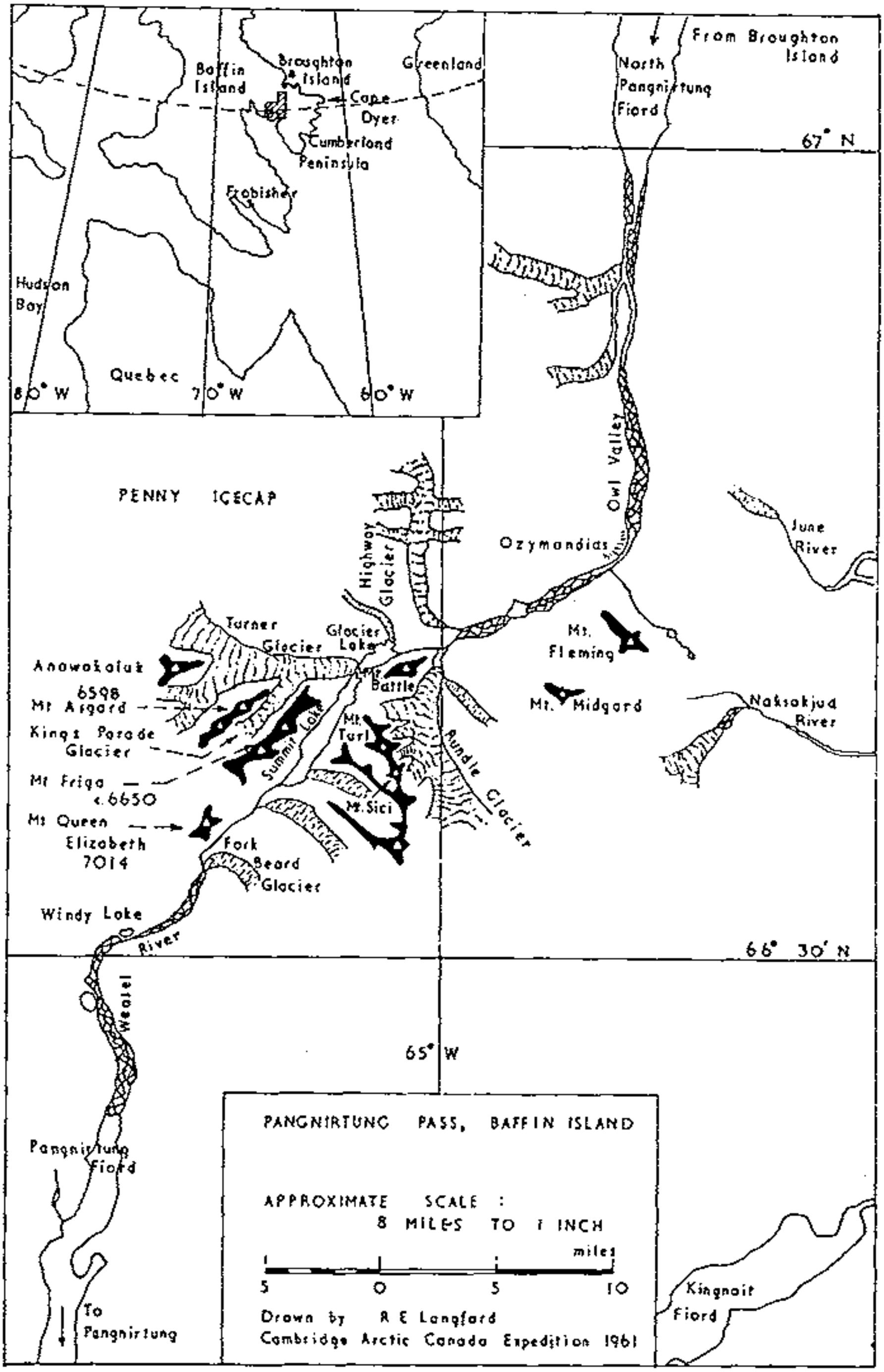
The Cambridge Expedition to Baffin Island 1961

By Lieutenant R. E. Langford, RE, BA, FRGS

Introduction

Ever since Alexander's time, people have been involved in expeditions. The undertaking may not be of military significance, and it is customary now to set out with a scientific purpose. The attraction of the unknown remains the same. At Cambridge University the atmosphere seems to be particularly conducive to expeditions. Though many of these are short-lived, no less than 200 are said to go through the embryo stage every year. When "cane" is replaced by "gown" and the academic long vacation is earmarked "Adventure Training", all the conditions are favourable and the "chain reaction" of planning is set in motion very easily. I was already contemplating an expedition, and had worked out initial plans more than a year before we left this country.

There hadn't been a British expedition to Baffin Island since Sir James Wordie's Arctic voyages of the 1930's. Explorers from Canada and the Arctic Institute of North America had visited the Penny Icecap, and crossed the Pangnirtung Pass. Very little was known of the Cumberland Peninsula to the east of the Pass. Photographs taken from the air show the sensational mountains around the Pass. Some of the glaciers reach sea level. The peaks rise to about 7,000 ft above sea level, and frequently have sheer precipices



From Broughton Island
North Pangnirtung Fiord
67° N
Baffin Island
Broughton Island
Greenland
Cape Dyer
Cumberland Peninsula
Frobisher
Hudson Bay
Quebec
80° W
70° W
60° W
PENNY ICECAP
Owl Valley
Ozymandias
June River
Highway Glacier
Turner Glacier
Glacier Lake
Mt. Fleming
Anowakalak 6598
Mt Asgard
Battle
Mt. Midgard
Naksakjud River
Kings Parade Glacier
Summit Lake
Mt. Turl
Rundle Glacier
Mt Friga c. 6650
Mt. Sici
Mt Queen Elizabeth 7014
Fork Beard Glacier
Windy Lake
River
66° 30′ N
Weasel
65° W
PANGNIRTUNG PASS, BAFFIN ISLAND
APPROXIMATE SCALE : 8 MILES TO 1 INCH
miles
5 0 5 10
Drawn by R E Langford
Cambridge Arctic Canada Expedition 1961
Pangnirtung Fiord
To Pangnirtung
Kingnait Fiord

of up to 3,000 ft. Their flat tops, usually well covered with a snow dome, give them a rather mythical appearance.

Such peaks as these would provide splendid climbing. There was the attraction that so little was known of the Peninsula, and much of the interior was unexplored. Luckily the University vacation would be just long enough to overcome the difficulty of getting to such a remote part of the world.

Constitution of the Expedition

The six members of the team and their responsibilities were: R. E. Langford (Leader, Survey), T. A. J. Goodfellow (Deputy Leader, Equipment), A. R. Crofts (Physiology, Food), G. F. Bonham-Carter (Geology), C. W. Barlow, and J. W. Dale (Medical). We were all from Cambridge, though Dale was in his final year at St. Bartholomew's Hospital. Our average age was 22, but between us we had eighteen Alpine seasons climbing experience.

The aims of the expedition were:—

(*a*) To reconnoitre and climb the major peaks in the area.

(*b*) To complete a programme of glaciological survey on certain glaciers. Other projects of a secondary nature, which would only be carried out when the main aims were unlikely to be prejudiced, were:—

(*c*) To amplify existing maps and obtain more accurate information on the heights of the mountains in the area.

(*d*) To study certain physiological phenomena.

(*e*) To make a small geological collection.

We were honoured in having Brigadier Sir John Hunt as one of our Patrons as well as Commander C. J. W. Simpson, who had led the British North Greenland Expedition in 1952–4. The expedition received the generous support of the Mount Everest Foundation and many other Institutions.

The Journey to Baffin Island

On 26 June 1961 we made use of the special charter flight for the trans-Atlantic crossing to New York. (Investigations proved that it was not feasible to travel to Baffin Island via Greenland.) The freight was shipped direct to Montreal. We spent a week there making final preparations for the flight north to Cape Dyer. At last, over the endless tundra and the ice-strewn shores of Ungava Bay, we flew to Frobisher on 6 July. The spring thaw had just begun but the fiords were still full of ice.

We landed on the dirt airstrip of the DEW Line base at Cape Dyer. The plane providing the "lateral" service for the DEW Line would go to Broughton Island the day we arrived, but this flight was normally made every two or three days, so we felt obliged to wait a couple of days to fulfil our promises to study the local geology.

The brilliance of the Arctic sun was quite dazzling. Vehicles trundled along the dusty tracks; melting patches of snow were exposing the wilderness of boulder fields which surrounded the airstrip. We set up our camp a mile from the runway. Nets were put around the tent entrances to keep out the mosquitoes which plagued us for twenty-four hours a day.

Geology and Acclimatization Period at Cape Dyer

Bonham-Carter and an assistant worked hard for the next three days to complete the geological investigation of the Cape. The tertiary age outcrop which had been predicted was located, and the horizontally-bedded lava flows examined. A number of paleomagnetic specimens were collected, giving as wide a scatter as possible, and were orientated by using a rock compass. This work is related to a larger programme. The magnetic field of the rock incorporated when it was laid down, is compared with the present-day earth's magnetic field. Providing the results are consistent, the information may help to throw light on several problems including theories on "polar wandering" and "continental drift".

We were delayed at Cape Dyer for longer than expected, as a failure of one of its engines kept the aircraft at Broughton Island until a replacement could be brought. Those of us not busy with the geologist took the opportunity to get fit by climbing some of the near-by peaks. "Near-by" is a comparative term, and distances in the Arctic are very deceiving. The slope on which we were camped led to an easy mountain about eight miles away. The best peak was 24 miles the other side of the fiord: Mount Raleigh, approaching 7,000 ft above fiord level, awaits a first ascent, though it was named in the sixteenth century.* This period of enforced acclimatization dragged on, but eventually the aircraft arrived, and we flew from Cape Dyer on 15 July.

Broughton Island Interlude

The next stage of the journey was to go up the North Pangnirtung Fiord from Broughton Island, enlisting the assistance of the Eskimos there. When we arrived, the ice was too broken for sledging up by dog team but not yet clear enough to allow safe passage for whaleboats. There was plenty to do during the few days we waited at Broughton Island. Over the sea there was still a good thickness of ice, so we took the opportunity of joining a seal hunt on the ice by dog team. At a party the next night, the schoolteacher organized a Bingo drive for the Eskimos and this was followed by some dances similar to highland reels, with one of the Eskimo women playing an accordion. Much as we would have liked to, we couldn't stay at Broughton Island for ever, for in the next seven weeks we had to cross the Pangnirtung Pass.

Approach and Load Carrying

On 19 July, the Eskimos took us up the fiord in two whaleboats. The ice was now mostly broken up. It was about 72 miles to the head of the fiord, where we set up camp.

During the days of our approach to the mountains, we shouldered heavier loads on each journey, as we acclimatized to the back-breaking job of carrying everything 30 miles. The most interesting peaks were around the centre of the Pangnirtung Pass. There were several rivers to be crossed; one of these torrents coming from a large glacier demanded a fixed rope, as the depth rose to waist-level in the early afternoon. Without the packframes supplied by the Army it is doubtful whether we would have been able to carry heavy loads.

The sides of the Owl Valley had been scoured by an immense glacier which had now retreated. Glacier Lake, at the centre of the Pass, formed the confluence of three large glaciers. Mount Fleming dominated the valley. We took a break from the load-carrying to attempt the ascent of this shapely peak.

* News has since been received of the ascent of Mount Raleigh by H. W. Tilman, DSO, MC, during late August 1962.

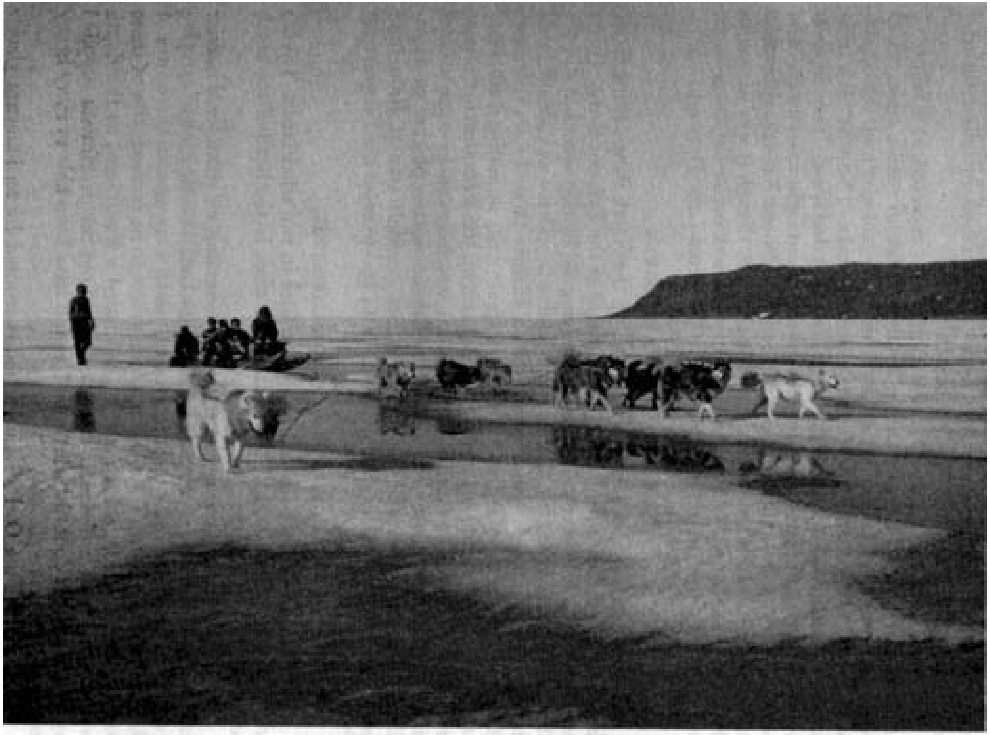


Photo by R. E. Langford

Photo 1. Seal hunt near Broughton Island.

Photo by R. E. Langford

Photo 2. Camp on King's Parade Glacier.

Photo by R. E. Langford

Photo 3. Load carrying during the approaches up the Owl Valley; the pack frames proved indispensable.

The Cambridge Expedition To Baffin Island 1961 2 & 3

Early Ascents: Mts Fleming and Midgard

It was two days' march to the foot of Mt Fleming so we broke our journey at a camp we called Ozymandias; towering above it were two immense bell-shaped pillars of rock, perfectly smoothed in their glacial conception.

"... Two vast and trunkless legs of stone, stand in the desert ...
... and on the pedestal these words appear:
'My name is Ozymandias, king of kings' ..." (*Shelley*)

Next morning, we left the valley floor up an open gorge towards the mountains. Higher up, the terrain became increasingly bare and elemental. The muskeg gave way to water and rock. We camped with enough food to climb Fleming and one other mountain. The choice for a second was not difficult to make. Across the other side of the valley, amongst a complex of glaciers, was a snow hump surmounted by an obelisk. We called the mountain "Midgard" and resolved to climb it.

Midgard was rectangular, like some lonely mountain cenotaph. Fleming on the other hand had classical proportions, with four ridges coinciding with the points of the compass. One of the ridges was attained from a glacier, where we encountered minor difficulties with soft snow and a small bergschrund. Once gained, the ridge was easy, save for a steep section towards the top; this we broke into three pitches. We spent at least an hour on the summit, congratulating ourselves on our first big unclimbed peak.

Next day we set off for "Midgard" across the frozen glacier, reaching the top of the snow mound by a rock ridge. In front of us was the obelisk. To the west it fell away to the glacier, 1,000 ft below; to the east it presented some 3,000 ft of impregnable rock. We traversed below the obelisk on this side, and found a route diagonally upwards to the summit.

Survey

In the following few days we completed the load-carrying, and started the survey work on a glacier near the summit of the Pass. The Rundle Glacier was thought to be advancing, since it had exposed no terminal moraine and the snout was covered with boulders.

The aim of this work was primarily to establish the positions of certain glaciers as a check for future movement. The Rundle Glacier was chosen for the majority of the work, as it was close to our camps on the Pass. The projects were adopted on the advice of the British Glaciological Society and other authorities. It is only possible at this stage to describe the work done:—

Glacier snout. Photographs on fixed bearings were taken of the snout of the Rundle Glacier from six rock cairns which we built around the glacier. The cairns themselves were also photographed to make it easier for a future visitor to locate them. This will provide a check for future advance or retreat.

Ice surface. The height of the ice surface was measured at several absolute positions, these positions being fixed relative to the rock cairns we had built around the glacier. The approximate altitude of the snow or equilibrium line was determined at the end of the ablation season.

Glacier section. Two transverse profiles of the glacier were established. The bearings for the section of levels were recorded, and the line of the profile was tied in with the cairns we had constructed on the mountainside. Thus later observers may be able to repeat the measurements in exactly the

Photo by T. A. J. Goodfellow

Photo 4. Snow peaks surrounding the lonely mountain cenotaph of Mt Midgard; from the summit of Mt Fleming, Barlow in foreground.

Photo by R. E. Langford

Photo 5. Halting for a rest before the ascent of Mt Midgard.

The Cambridge Expedition To Baffin Island 1961 4 & 5

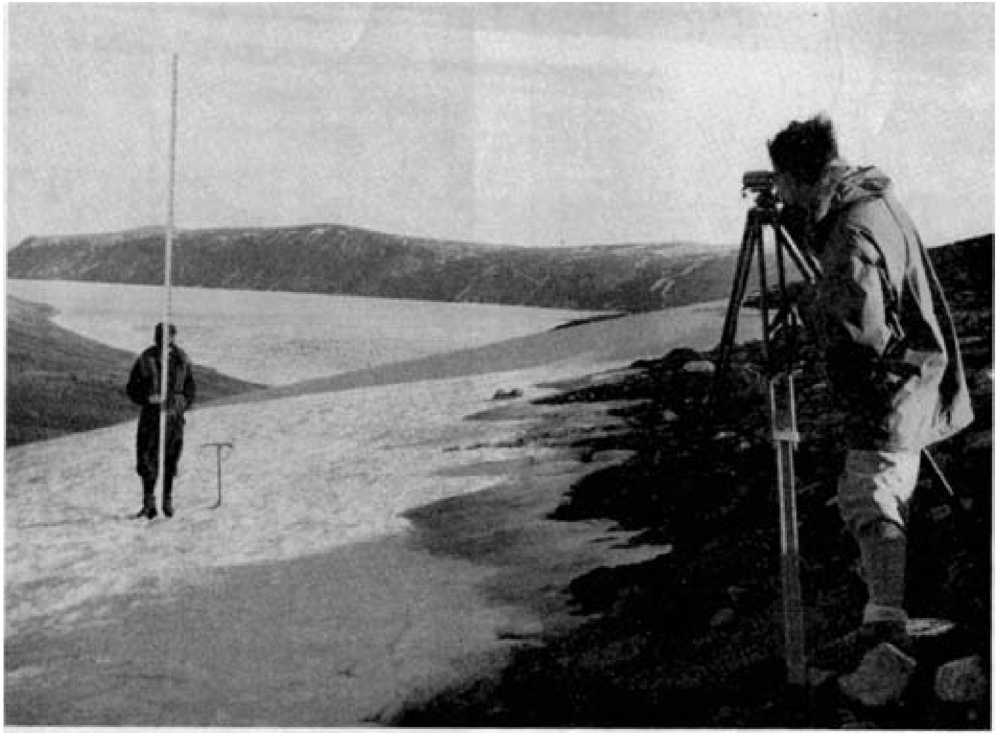


Photo by J. W. Dale

Photo 6. Practising the survey techniques during an acclimitization period at Cape Dyer. Barlow holding staff, Langford taking level sight. Ice-covered fiord in background is 4 miles wide.

same absolute positions, and determine the thinning or thickening of the ice flow.

Short period changes. Movement of the glacier close to a bedrock boundary was studied, as it was believed that this had never been measured on a glacier of this type; there was indication that the body of the ice was below its melting point. Local strain rates in each direction were measured near the centre of the glacier surface. An interval of three weeks elapsed before these readings were repeated.

Other glaciers. There was insufficient time to make survey observations of other glaciers, or to build cairns around them. However, photographs were taken of several of the glaciers in the area, and these will be made available to Dr J. D. Ives to add to the collection being made by the Geographical Branch of the Canadian Government.

Physiology

This programme consisted of investigations in two fields, and was carried out in full under the direction of Crofts. The results obtained covered a wide range of expedition activities.

One part involved the collection of urine samples during the course of a typical expedition day. Subsequent analysis was expected to show how Circadian rhythms are affected by working conditions in an Arctic environment, particularly during the time when there is no significant darkness. Samples and volume measurements were collected at intervals over a 28-hr period. Records were kept of activity, and consumption of food and drink during that period. These are being analysed at the MRC Laboratories.

It was also planned to correlate the "real" environment of individuals with that suggested by meteorological data. Studies of exposure (environmental) climate were undertaken by means of a hand anemometer, and a whirling psychrometer. The micro (sub-clothing) climate was shown by recording changes of resistance (and hence of temperature) in a wire vest worn by the subject. Meteorological data are being obtained from the Canadian Government. Records of activity, and readings from the various instruments were taken at 10-min intervals throughout a number of 24-hr periods. In view of the conditions under which the investigations were conducted, a very complete series or results were obtained.

The Lake Crossing

Whilst the scientific work was going on, two more virgin peaks were climbed, Mt Turl and Mt Sici. We had now reached the summits of four unclimbed peaks to the east of the valley and our thoughts turned to the fantastic mountains the far side of the Pass. Our arrangements to rendezvous with the RCMP Peterhead boat meant that in any case we had to cross to the other side of the valley before going down the Weasel Valley. The only place to cross would be between Summit and Glacier Lakes. We were therefore surprised to see from the top of Mt Battle that the lakes had joined; the ice-cored moraine between them had collapsed, leaving a gap about 150 ft across.

We tried wading, but the frigid water was up to armpit level before the unlucky victim was one-third of the way across. He was secured by a rope from the shore and hauled back quickly. The answer was therefore to build a raft. Contriving any sort of raft from simple expedition equipment was not easy. We hit upon the idea of a twin-hulled raft which would have more stability than an improvised boat. On 16 August, at our camp near the head of Summit Lake, work was started on each of the hulls, which we made from packing cases strapped together and covered with bright yellow tarpaulin; around the cases we inserted foam rubber mattresses, hoping to prevent rocks from puncturing the tarpaulin, and finally the 6-ft long hulls were strapped with cord. A couple of planks had survived from the 1953 base camp, and these we lashed between the floats. When she was launched, "Canary Cat", as we called her, had to undergo her "sea" trials. First of these was to be punted across the gap in the best of Cambridge tradition, carrying an intrepid boatman and the vital lifeline to the shore. Our loads at this stage were a modest 80–90 lb, but even so the raft was able to take only one man and two loads, or two men and one load. Once the fixed line was anchored, little more had to be done and the crossing went without mishap.

Mountaineering on Mt Friga and Mt Asgard

It was snowing as we trudged up the Turner Glacier towards Mt Asgard, "throne of the Norse gods". We broke through the frozen surface of a melt-water stream with an ice-axe, and pitched our tents near-by. It snowed throughout the night.

The weather was crisp and clear next morning. Dwarfed by the fantastic spires and icefalls around us, we made our way up the glacier towards Mt Friga, "queen of the gods". It had two snow summits, supported by seven sheer rock buttresses. We had used air photographs to plan the ascent. Skirting what was probably a frozen lake, we approached a steeper slope where the ice was overhung with snow. The glacier then narrowed, and we made directly for the rocks at its flank. Relaxing over a second breakfast, we surveyed the difficulties above, and fitted on crampons.

The couloir above looked much steeper than we expected, as we made towards the bergschrund. This was concealed with snow and demanded caution. Above it, the slope was not as sheer as we had thought, but presented the time-consuming problem of steep ice plastered with nearly a foot of new snow. About fifteen ice-pegs were banged in at stances in the couloir. At the top of this, a second couloir led up towards the ridge but the angle was now only 50 deg. We reached the ridge and trudged up the last few hundred feet of snow to the top. One of the twin summits now lay beneath our feet and we continued a little way along the ridge but there wasn't time to traverse to the second. The triple cornice of wind-carved snow was easier than it looked, but the knife edge which followed was quite uncompromising. There was a cornice on one side and a steep slope likely to avalanche on the other. Protected again by ice-pitons we descended the couloir and managed not to fall into too many of the crevasses on the way down to our camp. It was satisfying to know that all the team had joined in the conquest of the unclimbed Mt Friga.

Two days later we were ready to attempt Mt Asgard. A lot of new snow had fallen, but we would never have been satisfied without approaching this amazing peak. Four of us left the tents before 4 am to start the climb. From the upper glacier our route turned sharply, weaving a way through the icefall towards the towers of Asgard and its twin unclimbed peak. Once across the vast bergschrund we started up the slabs; these were plastered with snow and ice. We aimed towards the ridge on our right but the strata urged us to the left and the overlaps between the slabs were quite difficult.

Photo by R. E. Langford

Photo 7. Improvized rafting at the join of the lakes on Pangnirtung Pass. Turner Glacier in background.

We hoped to reach the col between Asgard and its mighty twin. A snow-filled gully led us easily from the top of the slabs to the foot of a chimney directly beneath the col. Entry to the chimney was barred by an overhang covered with ice, but this was overcome by using "artificial" technique and banging pegs in the rock; it was difficult to step up in slings while wearing crampons. The snow started to fall. The next pitch took the full length of the rope. The chimney was now vertical but sheathed in ice and unrelenting in difficulty. We stopped every now and again to beat some sort of feeling into our fingers.

From the col we looked up at the rest of the climb. The face was a maze of steep rock covered with ice. There was no case of going on, as time was now short. We abseiled down the steep ice pitches, floundering across the snow and over the slabs as fast as we could safely move. The bergschrund was approached with rather more caution, and wending a way through the crevasses we reached the tent in complete darkness.

The Last Ten Days

One more peak was attempted, but minor frostbite caused the party to retreat early in the day. Winter weather had now set in and our time was short. We completed the survey work and prepared for the descent to Pangnirtung. By general agreement we had resolved to complete the move down the Weasel Valley in one journey, with the result that our loads were initially 120–130 lb each. About 7 miles a day for five days was the target. The going wasn't easy; we gained a healthy respect for moraines and quick-sands on the way. A day's march was usually completed in half a day, giving us some time to rest. On the fourth day Bonham-Carter developed some type of illness, so we shared out his load. Unladen, he could walk at the same pace. On 2 September we met the Peterhead boat in which we had arranged for the RCMP at Pangnirtung to collect us.

From Pangnirtung to Cambridge

Several days were spent in the Eskimo settlement of Pangnirtung before the *C. D. Howe* arrived. We journeyed to Frobisher Bay aboard this ice-breaker, and then flew to Montreal. There was about a week left before we joined the return flight of the Canada Club at Idlewild. Within ten days we were back at our studies in Cambridge.

Conclusions

1. The expedition climbed seven virgin peaks of which the highest was about 6,950 ft asl. Winter conditions just thwarted our attempt on Mt Asgard; minor frostbite led to an immediate withdrawal from Mt Anawakaluk, our other failure.

2. The difficult harmony of mountaineering and scientific interests was to a large extent achieved by setting out with modest aims. We did not complete as much as we planned. but it was possible to put the limited time to best advantage by careful planning. This would have been impossible had we started with more ambitious aims.

3. More detailed study of time and distance should have been made. Aircraft are not 100 per cent reliable and ice conditions are unpredictable. We could have achieved more by getting the stores sledged up the valley in the winter, but this would have required planning two years in advance.

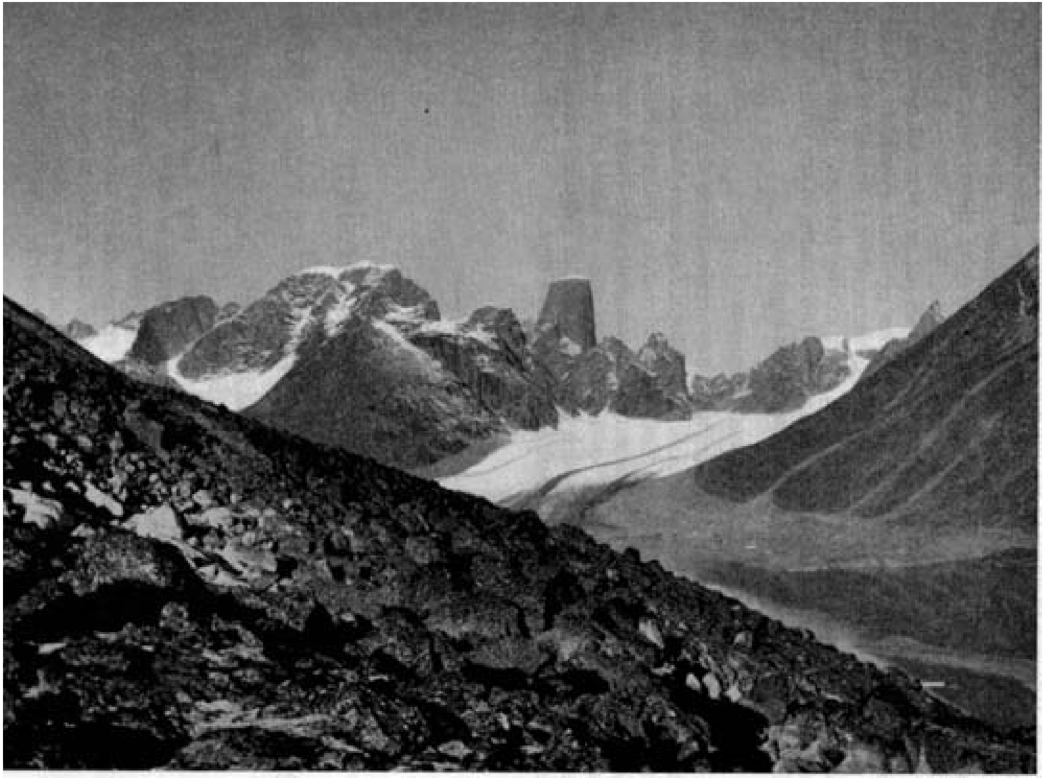


Photo by R. E. Langford

Photo 8. "Friga", Mount Asgard and the Turner Glacier, from above Glacier Lake.

4. Ice conditions may change rapidly and with no regular pattern in comparison with previous years. The maps could not be relied upon absolutely, as we found when we noticed Summit and Glacier Lakes had joined.

5. Our reconnaissance covered quite a large area and we have photographic coverage of much of the unexplored region. The area is thoroughly recommendable for a party of mountaineers of modest experience who will take pleasure in an abundance of interesting climbing. Our explorations *may* have made a small impression on the history of the region, but our climbs have only scratched its surface.

6. A concentrated diet of about 2 lb per man per day was sufficient, and the health of members of the expedition was generally excellent. There were no accidents and we were conscious of the need for a high safety factor. We got on remarkably well with each other during the many weeks spent together. It is worth mentioning that within two months of our return, four of us were contemplating another expedition together.

ACKNOWLEDGEMENTS

We are grateful for the financial assistance received from the War Office, the Army Mountaineering Association, the Royal Engineers Mountaineering and Exploration Club, Eastern Command Adventure Training Fund, and Commandant RSME Fund. The survey instruments were kindly loaned by the School of Military Survey. Special mention must be made of the service packframes which we used, which were invaluable. Medical stores were generously supplied by the Royal Army Medical Corps.

Airfield Pavement Design

By LIEUT-COLONEL J. H. FYSON,* MBE, MC, BA (CANTAB), AMICE, AMNZIE

Reproduced by kind permission of the Editor, New Zealand Engineering and their publishers Technical Publications Ltd., Wellington. This short paper is intended to serve two purposes. One is to acquaint engineers with typical aerodrome pavement designs of today; the other is to dispel some misconceptions about the current systems of classifying aerodromes as far as pavement strengths are concerned. It must be emphasized that the designs given, though useful as a guide, should not be used as a substitute for detailed design consideration in particular cases. Secondly, the conclusions drawn do not necessarily reflect any official doctrine, they are merely an opinion.

1. CLASSIFICATION OF AERODROMES

LOOKING through a list of some 250 international airports we find that their bearing strengths are officially defined in various ways:—

* Ministry of Works, Wellington

(1) By all-up weight, often under three headings "single wheel", "twin wheel" and "twin tandem". There are 76 such cases.

(2) By quoting a particular aircraft—sometimes with its weight as well—39 airports.

(3) By "single isolated wheel load"—sometimes including tyre pressures as well—88 airports.

(4) By "load classification number"—34 airports.

Of the rest, there are three which are confidently stated to be of "unlimited" capacity—Nassau, Okinawa and Panama; the rest are unclassified.

The bearing value of an aircraft pavement varies according to the shape and size of the load, and it would therefore appear impossible to give it a simple number. The first method recognizes this—if the distinction between the three undercarriage arrangements is taken into account—but it assumes a fixed pattern of wheel spacing for all aircraft; or rather, it assumes that the variations in wheel spacing are not significant. This method is used in the USA. It is simple and easily applied. The aircraft operator knows his weight and wheel configuration; he can therefore decide whether the airport will take him.

The second method is restrictive and does not give any lead for an operator to decide whether he is likely to be accepted if his aircraft is above the weight of the one stipulated—he must enquire.

The third method postulates an agreed system of describing aircraft by their "SIWL" where there is more than one wheel in the undercarriage; it is therefore not as simple as method (1).

The fourth method, introduced by the UK Air Ministry and accepted by the International Civil Aviation Organisation (hereafter ICAO) as one method of classification, looks simpler than it is. It will be described in more detail.

2. The Load Classification Number System

Air Ministry engineers, when testing wartime airfields for peacetime use, hit upon a chance relationship which within certain limits seems to hold good for both rigid and flexible pavements.

Defining the failure load for a concrete pavement, as that which when applied through a testing plate causes the concrete to crack, and for a flexible pavement, as that which causes a deflection of 0.1 in, a curve was obtained as a mean between curves obtained for the two types of pavement. (See Fig 1).

A purely arbitrary curve was then selected relating equivalent single wheel loads and contact areas, as shown in Fig 2. Along this curve suitable points were taken and called load classification numbers (hereafter LCN), being at those points equal to ESWL divided by 1,000.

These two curves—the one being the LCN and the other that given by the relationship $W_1/W_2=(a_1/a_2)^{0.44}$ are then combined into one chart showing tyre pressure, ESWLs and LCNs (see Fig 3).

We thus have a load classification number which is a purely arbitrarily chosen index, but with the characteristic that for both rigid and flexible pavements and for all aircraft with tyre contact areas (related to ESWLs) above 200 in^2, each LCN represents a family of aircraft which will cause pavement failure under the same conditions. This is why the system has a claim to be suitable for classifying aircraft and pavements.

Two sets of curves given in Fig 4 and 5 will show why this classification is not quite so simple as it sounds.

Looking at Fig 4 for flexible pavements, it can be seen at once that undercarriages with two or four wheels result in varying aircraft LCNs depending on the pavement depth. Thus an aerodrome with a flexible pavement must be quoted to the operator by its depth as well as its LCN. Here is a complication which immediately makes the system less simple in operation than the American one.

Again, from Fig 5 for rigid pavements, it can be seen that there is some variation in LCN with pavement characteristics. The variable usually quoted is "l", the radius of relative stiffness of Westergaard's theory. However, over the range of likely subgrade strength covered by "k" (modulus of subgrade reaction) from 150 to 500, there is not a great variation in the LCN. Tables published by ICAO quote LCNs for aircraft under three headings of "l", 30, 35 and 40 in. Fig 5 shows that for the larger aircraft "l" of 35 to 60 in would be more appropriate.

Thus the LCN method requires an airport authority to quote LCN and either pavement depth (flexible), or radius of relative stiffness (rigid). The aircraft operator then has to know his aircraft's LCN for various pavement depths and "radii of relative stiffness"—certainly a more complicated procedure than method (1).

3. LCN System for Design

Although not primarily intended for pavement design the LCN system when so used can prove a useful tool. It does not represent a new theory of pavement strength, but simply a convenient way of expressing existing practices.

3.1. Flexible Pavements

For flexible pavements the predicted California bearing ratio is the basis for design. The curves in Fig 4, although taken from UK Air Ministry figures and rearranged by the writer to give "form at a glance", are based on the US Corps of Engineers' figures. They represent design standards for pavements subject to 10,000 repetitions of load and not to the heavily trafficked areas where 40,000 repetitions are usually catered for.

These curves should be applied with caution, but they do give a good idea of both design thicknesses and aircraft characteristics simultaneously. When dealing with a known aircraft the LCN is seen to be irrelevant—which is as it should be as it is an arbitrary figure. Shown in Fig 6 for comparison is a plot of all-up weights against pavement depth for subgrade CBR of 4. This shows the merit of a system such as the LCN compared with one which only quotes all-up weights. Along the CBR 4 line of Fig 4 each aircraft of successive LCN requires a successively increasing pavement depth, in smooth progression. Not so in Fig 6 where in two cases increasing all-up weights result in decreasing pavement thicknesses.

An added note of caution is needed in considering the details of flexible pavement design. The depths of pavement in Fig 4 assume that the subgrade strength is critical. It may be, however, that other layers cause failure—particularly the surface, in the case of high tyre pressures. Careful study is required of the requirements for wearing courses under high pressure tyres.

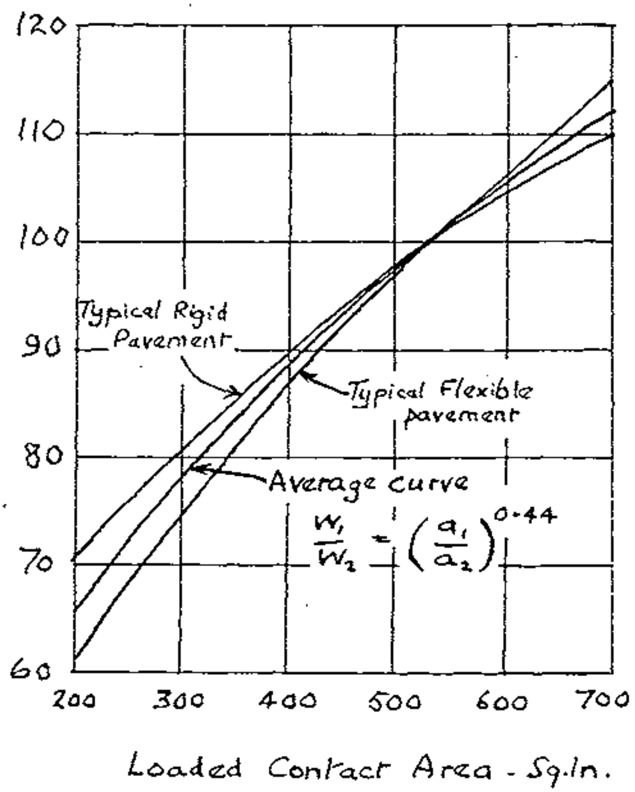


Fig 1.

3.2 Concrete Pavements

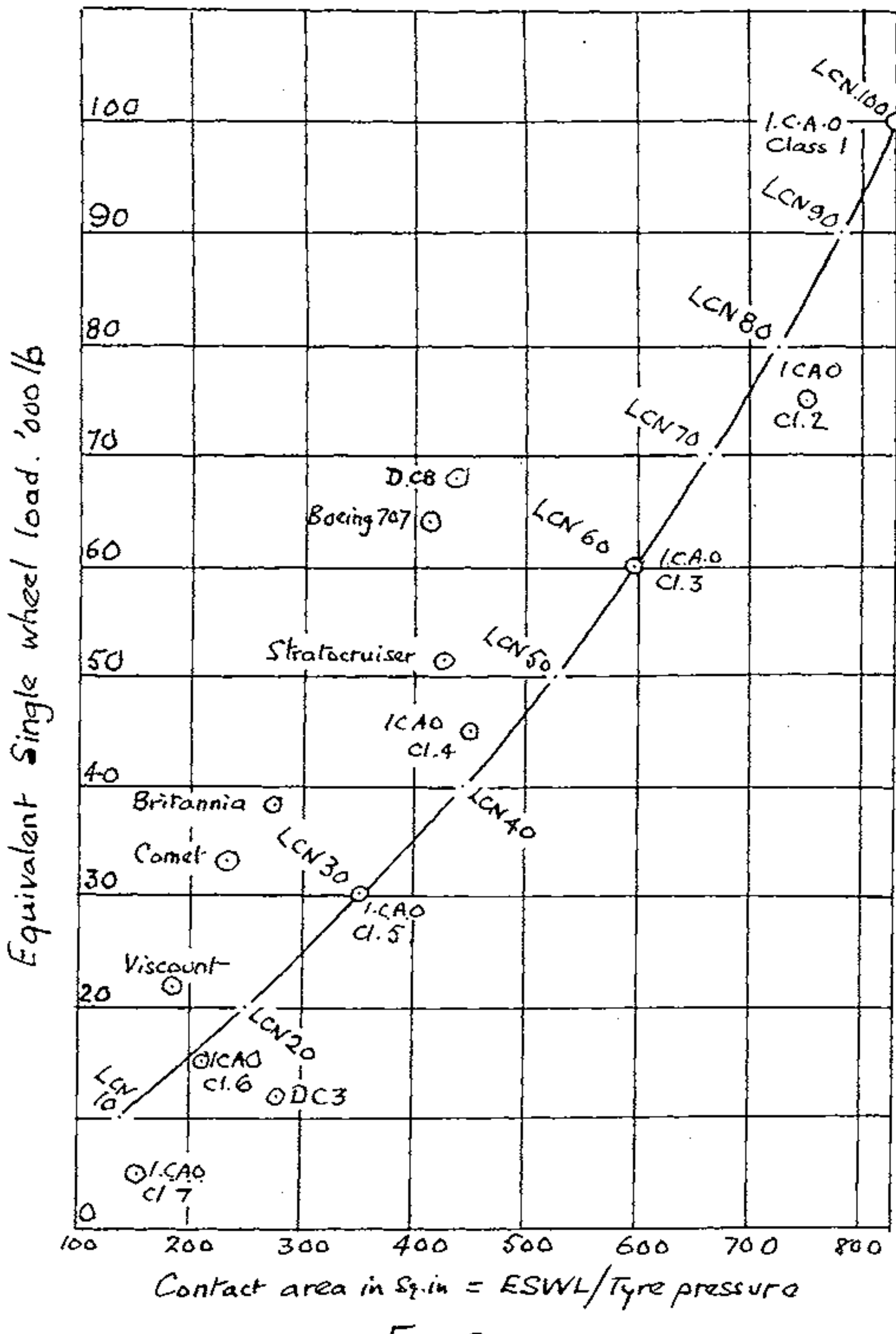
Pavements of plain concrete, with or without load transfer at the joints, are usually designed according to Westergaard's analysis. The curves given in Fig 5 are so drawn up—in this case assuming load transfer at joints. The concrete flexural strength for these designs is 350 lb/in². At this figure, using 0.50 water-cement ratio and the average cements and aggregates employed in New Zealand, failure is expected to occur after 40,000 repetitions of the designed load, and this should cater for the most heavily trafficked portions of any airport.

Concrete pavements have three peculiarities distinguishing them from ordinary concrete structures:—

(a) The age of the concrete is counted on for assessing the designed strength—the usual 28-day figure is not enough and the condition after at least 6 months ageing is taken into account.

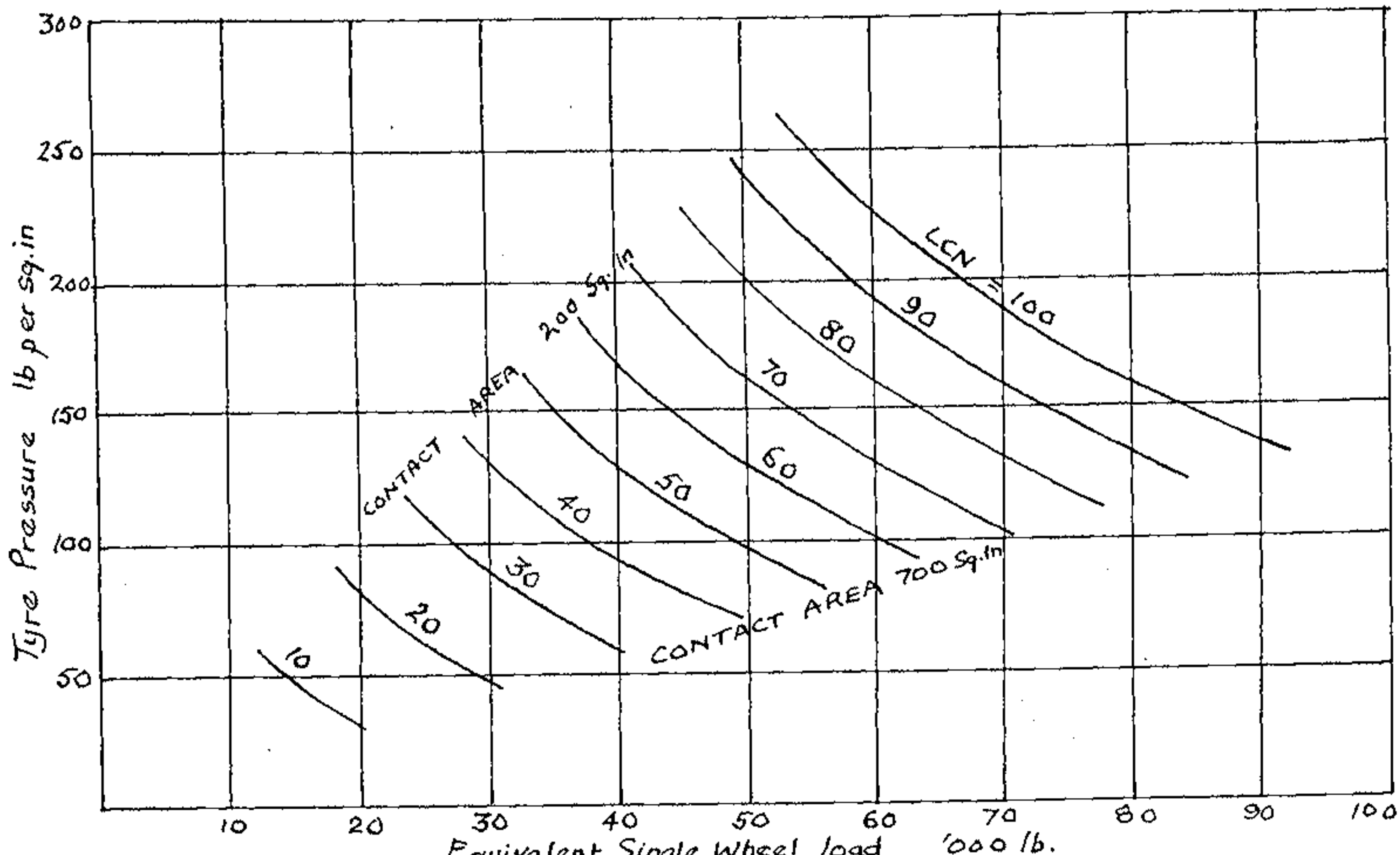
(b) The design of plain pavements is based purely on the strength of the concrete in tension, which is usually ignored in other work.

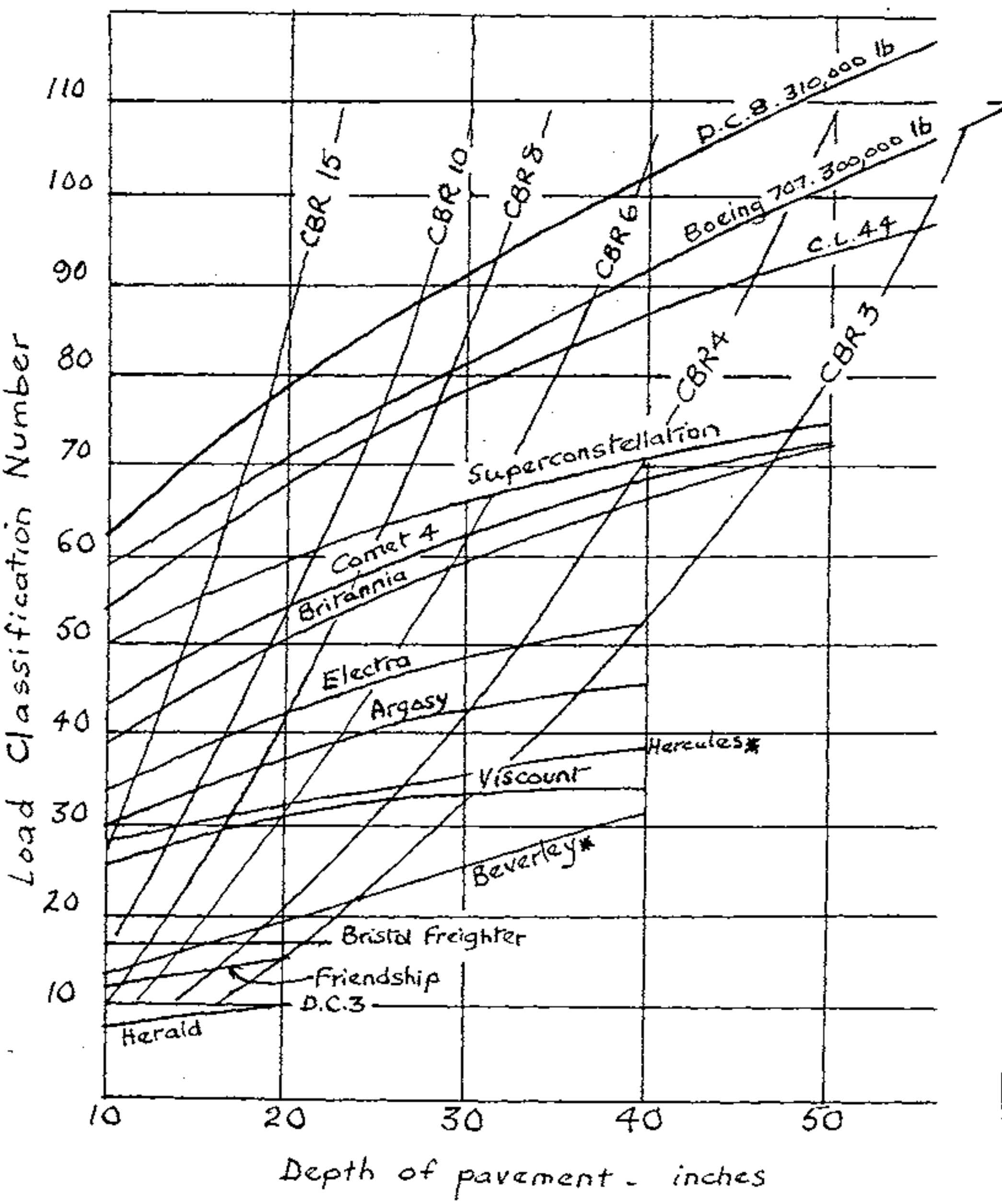
(c) A limited life of the pavement is expected and designed for, based on repetitions of the designed load. (Refer to *Concrete Pavement Design*, American Portland Cement Association.)



Equivalent Single wheel load. '000 lb
Contact area in Sq.in = ESWL/Tyre pressure
100
90
80
70
60
50
40
30
20
0
100
200
300
400
500
600
700
800
LCN 100
I.C.A.O Class I
LCN 90
LCN 80
ICAO Cl.2
LCN 70
D.C8
Boeing 707
LCN 60
I.C.A.O Cl.3
Stratocruiser
LCN 50
ICAO Cl.4
Britannia
LCN 40
Comet
LCN 30
I.CAO Cl.5
Viscount
LCN 20
ICAO Cl.6
DC3
LCN 10
I.CAO Cl 7

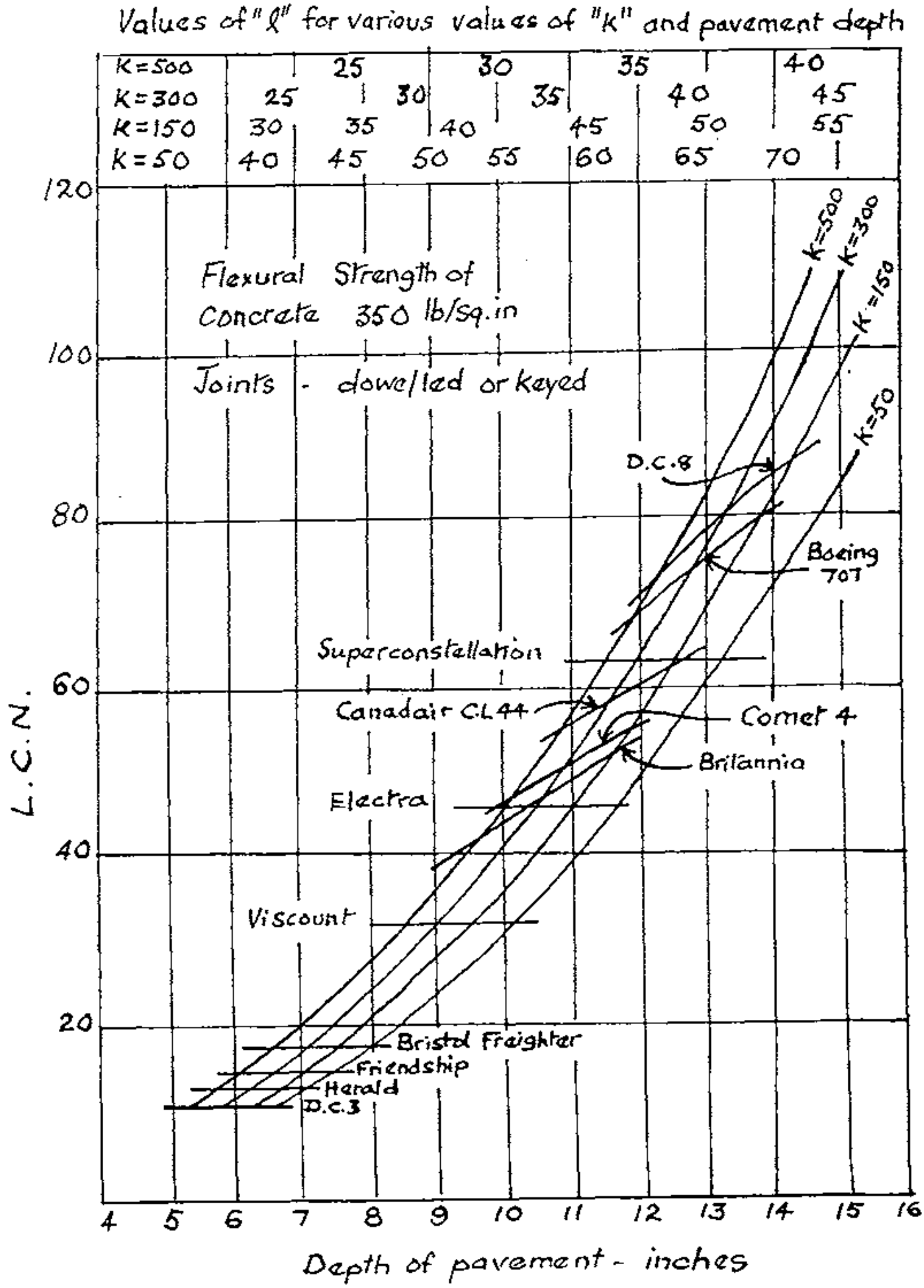
Fig 2


300
250
200
150
100
50
Tyre Pressure lb per sq.in
10
20
30
40
50
60
70
80
90
100
Equivalent Single Wheel load '000 lb.
LCN = 100
90
80
70
60
50
40
30
20
10
CONTACT AREA 200 sq.in
CONTACT AREA 700 sq.in



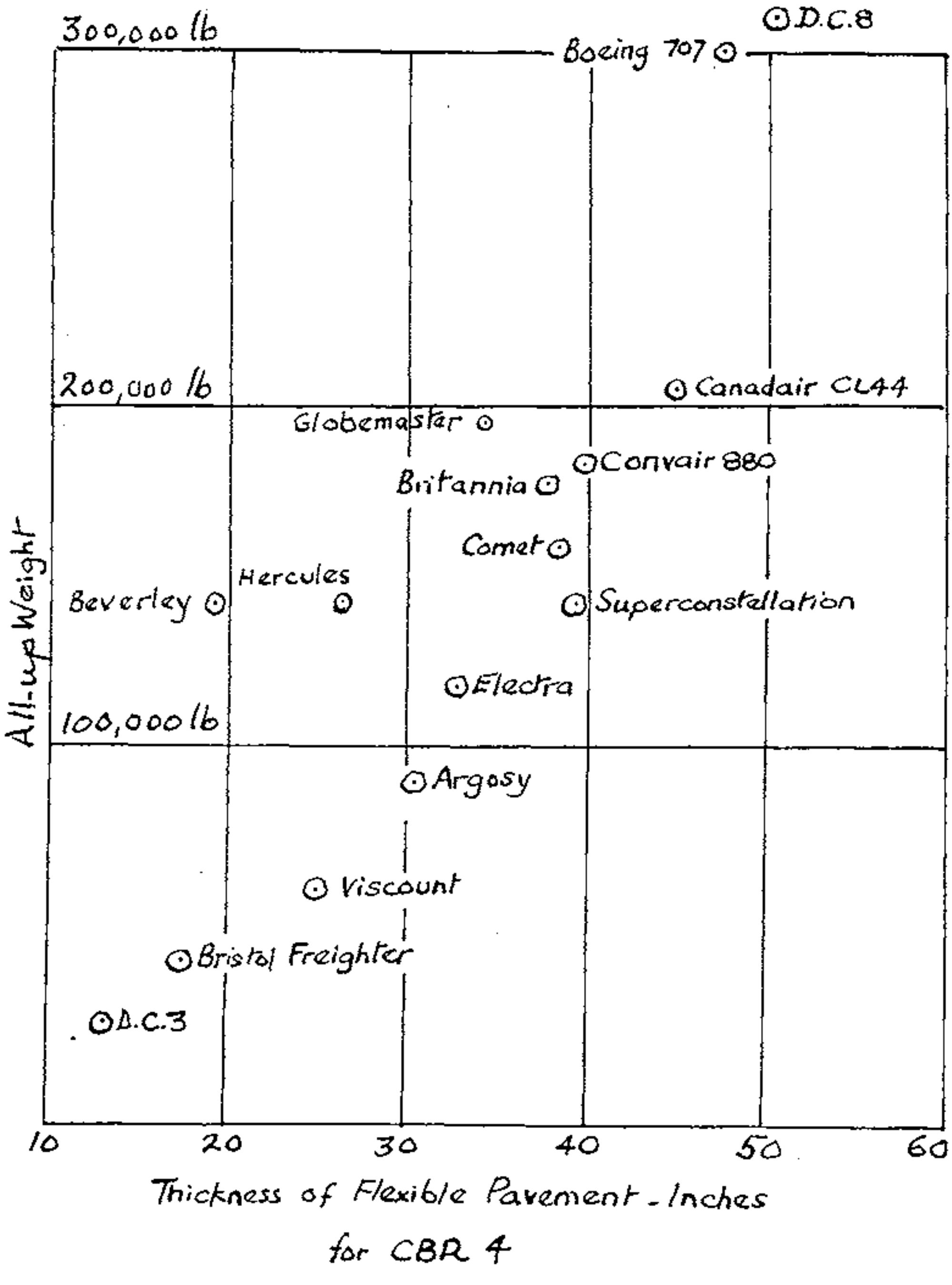
* Tentative only

Fig 4.



Values of "l" for various values of "k" and pavement depth
K=500 25 30 35 40
K=300 25 30 35 40 45
K=150 30 35 40 45 50 55
K=50 40 45 50 55 60 65 70
Flexural Strength of Concrete 350 lb/sq.in
Joints - dowelled or keyed
K=500
K=300
K=150
K=50
D.C.8
Boeing 707
Superconstellation
Canadair CL44
Comet 4
Britannia
Electra
Viscount
Bristol Freighter
Friendship
Herald
D.C.3
L.C.N.
120
100
80
60
40
20
4 5 6 7 8 9 10 11 12 13 14 15 16
Depth of pavement - inches

Fig. 5



300,000 lb
200,000 lb
100,000 lb
All-up Weight
D.C.8
Boeing 707
Canadair CL44
Globemaster
Convair 880
Britannia
Comet
Hercules
Beverley
Superconstellation
Electra
Argosy
Viscount
Bristol Freighter
D.C.3
10
20
30
40
50
60
Thickness of Flexible Pavement - Inches
for CBR 4

Fig. 6

Besides the concrete, the thickness of the sub-base must be considered. With good subgrades no sub-base may be necessary, but it is worthwhile having a layer of granular material over most subsoils. Authorities vary greatly in their recommendations as to this thickness, and it is better to treat each case separately than to attempt to standardize. The curves show that the "k" value does not have such a profound effect on the concrete thickness; and the main requirements of the sub-base are that it should be uniform and of sufficient strength and stability to permit the concrete pavement to be properly constructed with the high accuracy needed for runways.

4. Other Pavements

Flexible pavements with bituminous or tarred wearing courses are used in rather more than half the international airports mentioned above, and concrete in the remainder. Only one or two of the concrete pavements are prestressed. This may seem, to the protagonists of prestressing, to be a sign of lack of enterprise. However, although the small experience gained with prestressed pavements in New Zealand to date has been disappointing from the economical aspect, abroad they are now finding some favour.

One airport—Schipol, Amsterdam—has an unusual combination of flexible and rigid layers, the dry-lean 12-in concrete slab being buried under about two feet of ordinary flexible construction. Careful design and testing have shown this pavement to be suitable in its particular environment.

Often included in a flexible pavement is a cement-stabilized base course. Such a base course should be designed as if wholly flexible. The weight of published evidence does not yet support any significant reduction in overall depth of a pavement including soil cement.

5. Conclusions

For modern heavy aircraft pavements on weak subgrades, concrete is preferred. Big increases in all-up weights can soon render flexible pavements obsolete under such conditions.

On the other hand, with strong subgrades, flexible pavements can hold their own provided that they can be given adequate surfaces to resist shearing forces from tyres with very high pressures.

Prestressed pavements appear to have the strength that is needed on all subgrades, and they are likely to gain favour if their first cost becomes cheaper—they cost very little in maintenance. A further development here may be cement incorporating an expanding agent. With this cement, and with restraints from abutments, pavements could provide their own prestress.

6. Acknowledgements

The writer thanks the Commissioner of Works for his approval to present these notes.

It's Not Just Meccano

By Lieut-Colonel J. H. Frankau, MC, RE

Introduction

It was refreshing to read in the article on Clifton Bridge, York, in the June edition of the *Journal* how a small portion of a Corps Engineer Regiment had once again tackled a big bridge: yet we used to launch comparable bridges without the benefit of Specialist Teams or MEXE. Some of our practices should perhaps be recorded before they are forgotten. An account of the building of a series of multi-span bridges with particular emphasis on one large one may, therefore, be of interest.

Background

We were 571 Field Company of 10 (British) Corps Troops in Italy. In November 1944 the Corps was out of the line and so the Company was ordered to report to Chief Engineer, Polish Corps at San Piero in Bagno on route 71 in the Appenines, between Arezzo and Cesena. On arrival the OC was told that he was required to do the heavy bridging for POLCORPS; that the first bridge required was at Santa Sofia—Mortano, some 10 miles ahead; and that it was required quickly because a flood was expected in the River Ronco, across which the Carpathian Divisional Engineers had only a low-level Bailey in the river bed.

Organization

British Field Companies in Italy by this stage in the war were heavily reinforced and powerful units. The additional troops under command varied according to the task, but by the end of our bridging gallop the order of battle was approximately as follows:—

	Officers	R & F	Vehicles
Field Company	6	250	50
Regular Italian Artieri Coy. (From a regiment, two of whose companies served with us and one with the enemy!)	1	110	—
Two British-raised Italian Pioneer Coys.	3 [*sic*]	230	—
Three Secs Italian General Transport Coy.	—	20	18
Det Mechanical Equipment Platoon, 570 Fd Pk Coy.	—	7	Size 2 Dozer (Caterpillar D7) Size 4 Dozer (Caterpillar D4) Blade Grader Two Transporters.
Sec Tippers RASC.	—	10	6
Det 570 Fd Pk Coy (Welders).	—	3	1
	640 Souls		80 Vehicles

Present-day field sappers might care to note that the above engineer task-force produces far more working numbers than a Corps Engineer Regiment, carried in half the transport.

The Field Company had originally arrived in the Middle East early in 1941, since when the men had always slept within sound of the guns, except for three short periods. The OC had commanded them only since September 1943. Although there was one of the original subalterns left, officer casualties had been very heavy, but other rank casualties very light. Our average age was 26 and there were no "family problems" and no venereal disease.

Our only formal Bailey bridge training had been a fortnight at Tripoli before the invasion of Italy. The plant operators had worked with most of the British and many of the Allied divisions in Italy. They had all had at least one, sometimes two, dozers blown up beneath them on mines; deafness was their only occupational disease.

Each Italian company habitually worked under one British platoon. They would go anywhere the sappers led, but had no initiative. When things were going smoothly and vino was available, they would carry panels and transoms into bridge at the double, singing.

WORKING ROUTINE

In quiet periods we worked daylight hours only; in face of the enemy preferably dark hours only or, when necessary, an all-out effort to exhaustion. However, for sustained continuous effort for any task or series of tasks exceeding three days we worked a 7-hr shift by platoons. Shifts overlapped by half an hour, which ensured a good hand-over and maintenance of momentum. Other advantages of this sytem are that, as the platoon or individual sees it:—

1. There is a 12½ hour break between shifts for sleep, meals and movement.
2. Shifts follow in the succession: graveyard, early night, afternoon, midday, morning—and back to graveyard on the fourth day.
3. It is a 60-hr working week, which can be kept up for long periods.

FLASH FLOOD

As far as I can remember the leading platoon started the first shift at Santa Sofia at dusk. The Poles had already levelled off the stumps of two masonry piers in the river and the bridge was a simple one: a continuous girder of 240 ft double-single on 15-ft piers. Some stores were already on site and the remainder were on the way.

While we worked the river rose, but by morning the piers were ready and as much of the girder as could be built in the short approach street.

While the third platoon slept, someone stole their roller trailer. Each platoon carried a complete set of launching rollers, so that work could begin before bridging lorries arrived. We did not worry about the loss; courts of inquiry were unknown and equipment easily replenished, legitimately or illegitimately.

By late morning we were jacking. For some reason we found ourselves lifting the near bank end-posts as high as the first floor windows in the street before we could remove the rollers on the first pier. We made a mental note to work out jacking sequences more carefully in future: and not to avoid jacking on a pier top, which was really the trouble.

In the meantime the river had risen 2 ft over the deck of the low-level Bailey. As the entire Company turned out to pile rock round our piers, each 10-ft deck section of the flooded bridge flipped upright like so many sails. With the force of the water behind these and carried, presumably, by the moving gravel of the river bed, the whole 80 ft of bridge sailed majestically down stream towards us. Fortunately it ran aground and slewed parallel to the bank after 100 yds. The river went down and would never rise as high again because it had cleared the debris of demolished bridges from its bed. It was the bursting of these dams which made the first flood so dangerous to equipment bridges. (Conversely, we were once forced to build a dam to keep a floating Bailey open across the River Tiber south-east of Perugia—but that is another story.)

In the Mountains

My memories of the next bridge, 6 miles farther north-west over an unnamed gorge, are hazy: 230 ft of double-single, I think (all our bridges were Class 30). There was a 30-ft and a 40-ft pier which were slow to build and we certainly included two nights in the task.

It must have been towards noon on the second or even third day after we had completed Santa Sophia bridge that we jacked down. One platoon was working, one resting, and one spiking down skin decking (a wearing surface over the chesses) on the previous bridge.

Hitherto we had been moving laterally along the spine of the mountains and not north in the direction in which the enemy was retiring. It was no surprise, therefore, when the Company 2 i/c arrived to announce that POLCORPS was to take over 13 (British) Corps axis, the road Florence–Forli (Route 67?). Our lateral road joined this 9 miles ahead near Rocca San Casciano where British troops were held up by heavy demolitions. The Company task was to open the main axis—divisional engineers were to make a temporary diversion.

The OC ordered the resting troop and Company Headquarters forward at once. The other two troops were to follow when their tasks were complete. The OC and Field Engineer (Headquarters Subaltern) set off in Jeeps: their gear included, as always, mine prodders, measured signal cable and a dumpy level.

Rocca San Casciano—Reconnaissance and First Day

About half a mile south of the town, they fortunately fell in with the IORE of a British division (1st; 6 Armd.?) who was digging cautiously in the verge. The town was held, he said, by a squadron of armoured cars who would stay until relieved by the Poles. Some of his unit had bridged right-handed out of the town during the night, but had then been stopped by a long stretch of corniche road blown down and heavily mined: they had had casualties. As for the gap in the main road, no one had measured it, but it looked stupendous. He wished us luck, but was glad to be pulling out.

Arrived on site all was quiet, and the reconnaissance party cautiously prodded its way across the gap. The OC read the measurement of the main span—(it was a Company tradition that OC Bridge always did this, after a nearly disastrous error in the first operational bridge we ever built)—180 ft: double-triple with a 10-ft margin of safety within this type of construction. There was a damaged arch and pier on the near bank which would have to go: say an 80-ft span and a 30-ft pier. The far bank pier would be low, 15 ft with a 50-ft approach span.

The OC left the Field Engineer to set out a centre line, establish datum levels for the piers and devise a launching plan. The OC's next task was to reconnoitre traffic circuits and a marshalling area which was found in a public park. He then withdrew to where he had met the IO, who proudly showed him the first "Topfmine" discovered, which he had just deloused. This was an anti-tank mine in the shape of a Gouda cheese encased in bitumized fibre with a glass pressure-plate.

However, the OC had not come in search of technical intelligence, but to wireless back, in Codex, his demand for equipment. We had once been heavily mortared when bridging (at Grazzanise on the River Volturno) under Command of 7 Armoured Division, who had insisted on having a wireless set on site to report progress. Except by direction-finding the enemy were unlikely to have known exactly where we were; besides, a German had been detected on the net trying to cross-question the operator. The latter had happened on another occasion and we wondered how often enemy interception had not been detected. We believed that the Germans habitually listened to sapper nets because their distinctive traffic was easily identified and their layout revealed formation deployments and main thrusts. Be that as it may, we never transmitted from bridge sites; we thought it saved us casualties. I am convinced it was a factor at Rocca San Casciano, as will appear later.

Back in the town the 2 i/c's advance party was busy; the CSM was cajoling and bullying Italians out of billets. Bricklayers were building field ovens: we were a West Country unit and loved our Tiddi-Oggies. This is an ideal battle snack as its pastry cover is a natural insulator. However, it needs a lot of potatoes which we bought on the black market for "Victory Vs"—that unsmokable ration cigarette of which we still carried a large stock.

The leading platoon had deployed automatically to clear the site of mines. Its Commander and the Field Engineer formed up to say that the launching plane at road level was inadequate. (See sketch.) They recommended bulldozing down 7 ft 6 in of the curved approach embankment. Eleven hundred cubic yards of earth would be lost over the side and this would have to be replaced by 700 cub yds of fill from elsewhere after the bridge had been built. The advantages of this were that it would avoid constantly halting construction to boom forward: and as the double-triple centre span was to be decked in the middle storey, it would almost obviate jacking, an important consideration with a heavy bridge.

It was not an easy decision to take and while it was being debated the corporal in charge of demolishing the shaky arch asked us to withdraw a few yards while he set off his 30-lb charge. We did. There was a tremendous explosion and it seemed as if 300 lb of explosive had gone off. It had. We had touched off an unexploded charge in the pier and involved ourselves in lengthy digging down to sound masonry.

In demolishing masonry piers the Germans, whether by accident or design, usually left an upstanding tooth on one side and stone shattered down to the foundations on the other. Often this involved 4 to 6 hours digging before the grillage for a Bailey pier could be levelled.

Just after the launching plan had been agreed, a smart RASC corporal appeared on a motor cycle. The bridging equipment was one hour behind him, he said: what was the marshalling and unloading plan? He appeared to be interviewing the OC rather than vice versa.

We wanted a few special lorries for the piers right up to the gap, to be part-unloaded by hand. Main girder lorries were to be shunt-unloaded back along the embankment. The Field Engineer would give him detailed lists. ("Shunt-unloading" is backing a steel-bodied lorry fast up to the point where the load is required: on applying the brakes hard the load carries on and lands, stacked neatly within a few inches of the ideal spot.)

The corporal toured the traffic circuit and, saluting smartly, expressed himself satisfied. A professional who knew his job, had had bitter experiences with other engineers in the past, but accepted the arrangements of fellow professionals with gratitude. (In retrospect, I am amazed that this man's rank was only corporal, considering that he was leading a convoy of about fifty vehicles: but it was so, and we first saw his officer the next day.)

As the two rear platoons de-bussed to their billets in the dusk a few shells burst between the bridge site and the outskirts of the town and we wondered whether we were going to be left to bridge in peace.

Rocca San Casciano—Second and Third Days

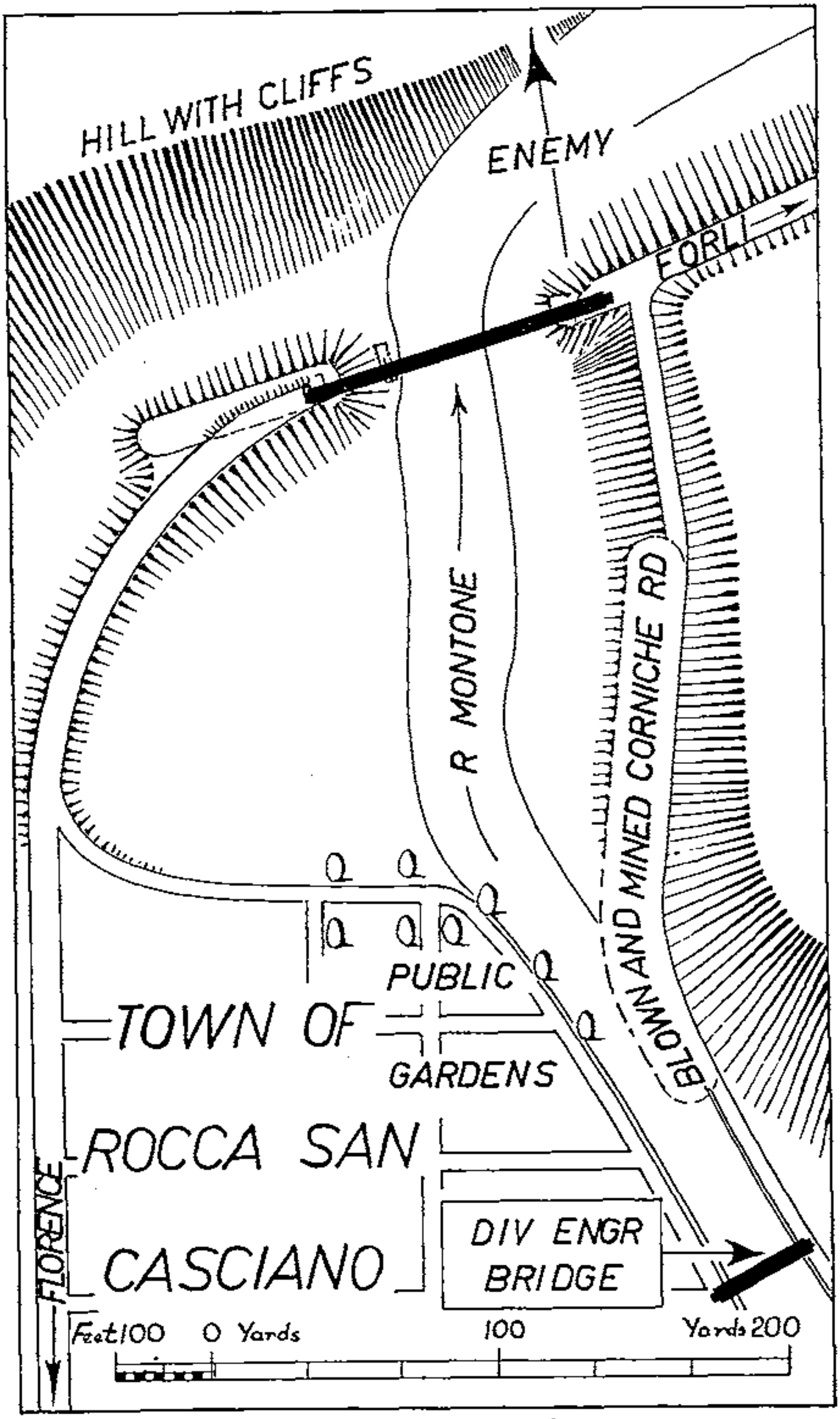
By dawn the launching plane was ready, the initial stores layout had been completed, and the girder had been started. Stores for the far bank pier had been humped across the gap. The near bank pier was one bay high. During the night the river had risen and a sandbag coffer dam was needed round the footings.

We could see that the Poles were moving very slowly along the other bank. The detonation of mines called down shellfire. They did not even achieve a cleared foot-path for twenty-four hours. There was no fire on our side on this day because the enemy had no reason to suspect we were there, and we were defiladed from view by a high cliff. (See sketch—and the shell-hole in the mud-bank in photograph No. 1 shows that we were not defiladed from fire.)

We called for the only crane possessed by Corps Troops and were lucky to get it. This was an American "Quickway", with the reach and nearly the lift of our present bridging cranes, but with limited traverse. With it, the Corps Field Park Company could turn round in twenty minutes a Bailey Bridge Platoon of 130 ft double-double carried in thirty vehicles, by practising parcel loading. The parcels were wired up by Italian labour, but were snipped free before delivery.

When the piers were complete and the girder nearly so, it looked as if the bridge might be open before the diversion, but the Poles finally got through on the third day after blasting the area with Cordtex nets.

At this period the enemy was mining to catch sappers and their dozers rather than infantry and tanks, because the progress of the Allied advance was dependent on the speed of engineer work. Not only was the debris of blown bridges mined as a matter of course, but any obvious diversion was more heavily mined. There would be anti-tank mines and anti-personnel mines near the surface and also a few deep mines dropped down auger holes which would blow up a dozer when it had been working on site for some time. Furthermore, many mines were practically non-magnetic while some of the soil gave a strong reaction to detectors, so reliance could be placed only in slow, careful and frequent prodding.


HILL WITH CLIFFS
ENEMY
FORLI
R MONTONE
BLOWN AND MINED CORNICHE RD
PUBLIC
GARDENS
TOWN OF
ROCCA SAN
CASCIANO
DIV ENGR
BRIDGE
FLORENCE
Feet 100
0 Yards
100
Yards 200

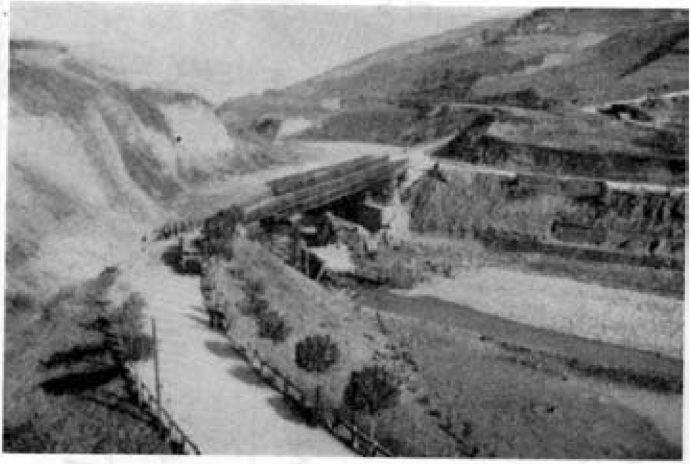


Photo 1. General view, taken half-way along the embankment.

Photo 2. The hauling wire attached. The vehicle in the foreground is a Leroi 250 c fm compressor of which we had three in constant use. In addition to the normal tools it had rip- and crosscut-saws, a pile-driver and a spike hammer.

Its not just Meccano 1, 2

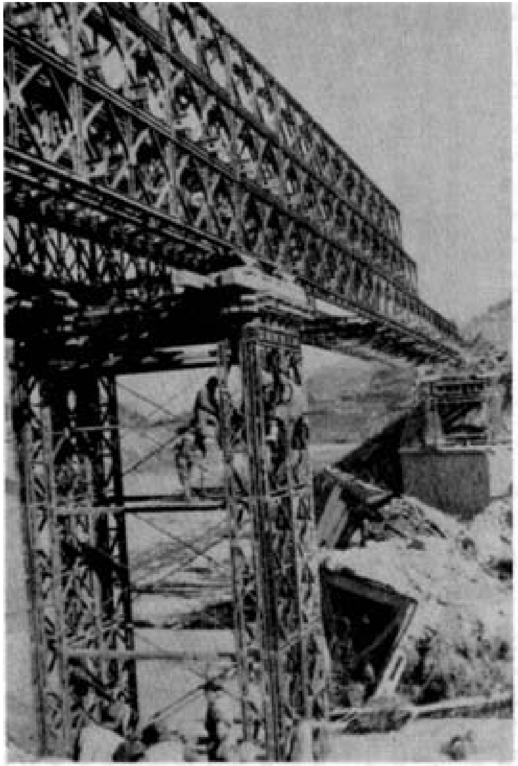


Photo 3. Checking for distortion in the pier and tightening bracing during a pause in launching.

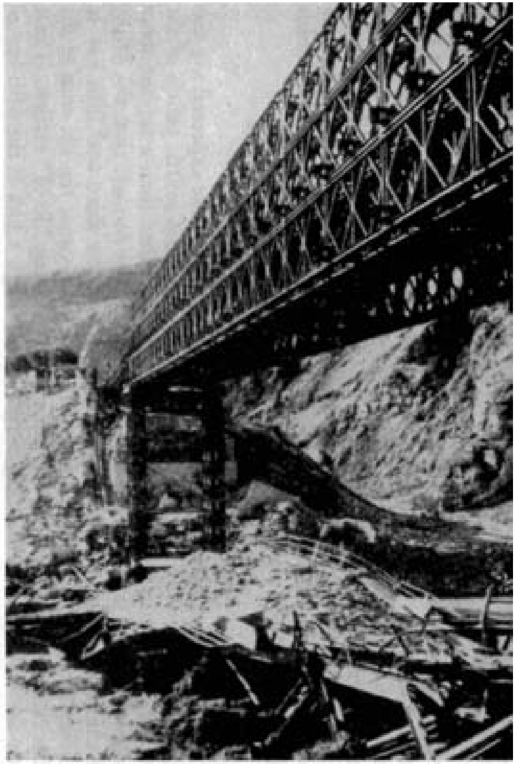


Photo 4. The main span. Note roadway in mid-storey.

Its not just Meccano 3 & 4

Enemy opposition now ceased, but during the final shift on the girder, the platoon commander was removed to another unit on promotion to captain.

His sergeant completed the task, using the crane to lift completely-decked bays of double-single and pinning them to the mid-storey of the double-triple.

As the far bank was now accessible, we planned to pull the bridge across with the winch of an anchored Scammel: the D7 would be used as a preventer, following the bridge on its tracks, because the winch speeds are incompatible. It is unsound practice to push a long bridge because the smallest error in line is magnified by jacknifing. Pulling a bridge corrects any lateral error and the "derrick and preventer" principle assits in controlling the vertical and longitudinal movement which gave such trouble near the point of balance at Clifton Bridge.

Rocca San Casciano—Fourth and Fifth Days

The launching weight was just under 100 tons and the expected sag was 4 ft 8 in, so links had been put behind the second and fourth panels of the nose. It is better to use two launching links rather than one; the more steeply-inclined final plane meets the landing roller sooner: thus the lifting of the nose-sag is started earlier. Links behind the third and fifth bay of Clifton Bridge might have been suitable. Also, because the lift ends at the fifth rather than the eighth bay, one starts running "level" earlier. These two factors minimize the "sag surge". (Although a link at the fifth bay of Clifton Bridge might be 18 in closer to the water when the nose first arrives above the landing roller, this would be nearly compensated by the unpredicted sag caused by the extra cantilever effect of the delayed touch-down with the link at the eighth bay: there are only inches in it.) Also the "flip up" should be delayed by using as much counter weight as possible on the tail of the bridge; at Rocca San Casciano we had a whole 80 ft double-single as counterweight (19 tons).

When 80 ft had passed the pier it became apparent that the nose was not rigid enough because of insufficient bracing. The bridge was withdrawn and extra transoms and every possible sway brace were added, after which the launch proceeded smoothly.

In this connexion of detailed design it should be remembered that we had only the original Bailey pamphlet dealing with simple spans. The later well-tabulated handbooks may have been available in BLA at this time, but our special constructions were worked out from hazy memories of Cambridge in Scuola Elementare notebooks. At one time we had a subaltern (recently Redbrick) who would apply the theorem of three moments to continuous spans. (I still possess one set of his calculations.) We never quite trusted his computations, however, because we could see that within certain limits a long span behaved more like a bicycle chain than an elastic girder. We believed that this provided a factor of safety to construction over piers, but we over-insured for bending moment between them, and broke span whenever feasible. We had simple rules of thumb for the proportions of piers and their exact height in relation to bank-seats. There were a few special parts for piers, some locally manufactured—not always accurately. We did a good deal of cutting and welding of mild steel parts on site ourselves. In spite of all this we never had a disaster either in launching or use.

Our six tippers now started replacing the embankment with a one-way road—and ran continuously for twenty-three hours. A "chinaman" was arranged about half a mile back where there was a retaining wall just higher than the tailboards, with a hillside above. The D7 collected the spoil and the D4 pushed it on: once the dozer landed on to the cab of a tipper, after which a cantilevered platform was improvised. The drivers worked for more than eleven hours each, for there were insufficient reliefs and the Tipper Coy Standing Orders would not allow sapper drivers to take over. There were no such difficulties with the plant: each dozer had two operators and the drivers of the transporters and the blade grader could "spell" them when necessary.

The time was not otherwise wasted. A rock-filled timber crib was built for the end dam and abutment pier of the 80 ft approach span. This construction was a technique learnt from the Americans and used extensively for the repair of blown corniche roads. As a pier, it is quicker than any other type up to about 12 ft. The bridge was broken, the rollers removed and the bridge jacked down and decked in succession from the far end. Incidentally, why can there be "no question of jacking" on an HGB pier? On this occasion we operated simultaneously, on top of the first pier, eight of the primitive Bailey "Down, down, ups". One had to get a matched set, because the ratchets had varying pitches. The end-posts of the approach spans were on the lower storey of one bay of inverted double-double. Junction stringers were cut and welded. A quarry was opened and stone prepared for soling and surfacing the approach. Skin decking was laid. The bridge was completed during the afternoon of the 5th day with an overall length of 340 ft and a total weight (excluding piers) of 120 tons.

Nine Sappers Bridge

That night the OC was summoned to Corps Headquarters to a gloomy conference consisting of the CE, CRE Crescowa Division and CRE POLCORPS Troops. He was shown a section of the gap for the next bridge, which divisional engineers were to build. This included a 60-ft stone arch, a pier with a dangerous crack in it and a blown gap of 110 ft. It was to be started at first light and the Corps Commander had ordered its completion by noon: what could the British sapper advise? Well obviously, he said, the arch must be demolished and the pier cut down to sound masonry; the job could hardly take less than eighteen hours. You could not argue with General Anders, they said; but the OC could not be shaken and finally suggested that his own CRE might come up to advise in the morning.

When the two British sappers visited the site together the next day, the Poles were at work, had not demolished anything, and had made matters worse by placing their launching rollers well outside the middle third of the pier. As they could do nothing, and suggest nothing, they left. Later that morning the pier collapsed and it took altogether far more than eighteen hours before the gap was spanned. The number of those killed in the accident is commemorated in the name of the bridge, which was written up both in Polish and English.

Swan Song

Our next bridge was in view of the enemy, so rollers were set out and spiked down in the dusk. It took us exactly seven hours on a pitch-black night in pouring rain to build that 130-ft double-double. It must be a record for these conditions. It was also my last bridge, for shortly afterwards I relinquished command of the Company to go to the Staff College.

Conclusions

Tactics change, bridges are twice as heavy for the equivalent span and ample machines replace ample men. Nevertheless I believe that the following observations are still worth consideration:—

1. Reconnaissance should be three-pronged:—

(*a*) The OC checks key dimensions, decides the general design, plans the traffic and keeps clear of detail.

(*b*) The Field Engineer makes detailed measurements and calculations under the direction of the OC.

(*c*) The 2 i/c ensures that the unit moves, arrives and is in the best possible state to tackle the task.

2. Transmission from a wireless set at a bridge site should be avoided.

3. The seven-hour overlapping shift is very efficient for sustained continuous work in the field.

4. There must be sufficient numbers of trained operators to keep machines working continuously round the clock.

5. If possible pull, rather than push, a long bridge.

6. If adequate pulling power is available use links in two positions in the nose of a long bridge. Also, as much kentledge as possible makes for a smooth launch.

7. Work on the approaches to a bridge can occupy a considerable proportion of the total time. This includes mine-clearing as well as road-making.

8. A Field Squadron can be diluted with local labour and a working force of 600–700 can be handled easily.

9. There should be enough University-trained engineers in Field Units to compete with the inevitable engineering problems not covered in manuals.

10. When he is absolutely certain of his facts, the Sapper must stand up to his Commander.

Post Mortem

With plentiful modern equipment what manpower and time would be involved in Rocca San Casciano bridge?

If 225 ft is the maximum class 30 HGB span, it would seem that the far bank pier could be dispensed with, but not the near bank pier because of the necessity of finding a sound masonry foundation at the right place. The bridge design might be: 62 ft 6 in (or 74 ft)—pier—225 ft: like Clifton Bridge reversed. The launching plane would be wider, but no longer and, as the rollers for Clifton Bridge were 5 ft above the earth, levels would be similar to 1944.

The first evening and night would be occupied by mine clearance, dozing, roller layout, pier foundation and delivery of the pier stores to the building area by crane.

Thereafter the pier might take twelve men in three shifts (thirty-six men) from eighteen to twenty-four hours.

Starting simultaneously the girder would take thirty-two men in three shifts (ninety-six men) from forty-eight to fifty hours (as I understand the article on Clifton Bridge and making no allowance for night work).

Seven hundred cubic yards of fill in twenty-three hours is one tipper every five minutes: this could be speed up, even on this restricted site, to one a minute; making thirty tippers (sixty drivers) and taking five hours for, say, 750 cu yds. Three to four face-shovels, or more dozers, would be required. A few hours would be spent on road work and finishing off.

Allowing eighteen men as plant operators and sixty as squadron overheads (but NOT, I trust, adding Regimental overheads, let alone the Chief Engineer) the job might take:—

Two hundred and seventy men, three days compared with 640 men, four days.

My only comment is that the sooner we develop a rapid device for re-opening skilfully-mined corniche roads the better.

Sappers on the New Frontier

By Major T. F. Watling, MBE, RE

When Sir Hugh Foot, Archbishop Makarios and Dr Kutchuk signed the Treaty of Establishment in Nicosia on the 15 August 1960 a new frontier between Cyprus and the Sovereign Base Areas of Akrotiri and Dhekelia was created. This in turn gave rise to an unusually interesting and satisfying sapper task.

The land boundary, because of differing service and Republican needs, is an intricate indented one, about 90 miles long. Within the Dhekelia Sovereign Base Area lie four enclaves of Republican territory. Due to the speed with which the treaty negotiations were finally concluded it would not have been possible to mark the boundaries on the ground before the treaty was signed. Consequently a detailed description of the boundary was included in the Treaty.

The boundary was defined by 233 points and by the lines joining them. Each point was pinpricked onto a stereographic pair of aerial photographs, whose scale was 1 : 5,000. The photographs were supplemented by a set of 1 : 10,000 maps, upon which the boundary was drawn, and by a written description. In the main, the boundary was described as following a direct line from point to point, but sometimes followed a land registry plot boundary, a road edge or municipal boundary. The production of all these documents in sufficient quantity and detail, had provided a "field day" for RE survey staffs and units both in the United Kingdom and in Cyprus.

The Treaty made provision for a Boundary Commission to "mark the boundary clearly and effectively on the ground". It was given discretion to "make minor deviations from the boundaries provided for . . . in order to take account of local administrative conditions." In the event, it was fortunate that this provision had been included. It enabled the Commission to make a number of alterations to the boundary to the advantage of both the Republic and the SBAs. The Treaty also provided for arbitration in the case of disagreement on the technical interpretation of the maps, air photographs or descriptions. A limit of nine months was laid down for the completion of the Commission's work.

The Secretary of State for Air, who is responsible for the Sovereign Base Area Administration, appointed two senior officials of the Administration, Major O. F. Muftizadé, OBE, and G. S. Savvides, Esq, OBE, to be the United Kingdom Representatives. They turned to Colonel (now Brigadier) R. C. A. Edge, Deputy Director of Survey Near East and Middle East for advice and assistance. He, with some experience of the results of ambiguously defined and disputed boundaries, had already made plans to help them. I was detailed to assist full time as Secretary and Surveyor and a small RE survey party under Sgt B. H. Reeder, which had been flown out from England, was put at their disposal. The Representatives in addition collected a team of advisers on the financial, legal and engineering aspects of their work.

The Republican Representatives, N. E. Metaxas, Esq, and E. N. M. Fellah, Esq, both permanent government officials of the Department of Lands and Surveys had similarly collected a team to advise them. A month after the signing of the Treaty, the inaugural meeting of the Commission was held at Headquarters, Near East Air Force, Episkopi. The Commission settled down amicably, and made sufficient decisions to enable field work to start. They wanted to keep the boundary, which is after all an open frontier between two Commonwealth countries, as unobtrusive as possible. None the less the Commission was required to mark the boundary "clearly and effectively on the ground". A decision was reached to erect reinforced concrete pillars of such size and at such intervals that a *compos mentis* villager would know when he crossed the boundary. A sub-committee was appointed to design the pillars. At an early stage in the field work it became clear that the pillars would only be intervisible if a very great number were erected. For reasons of economy, intervisibility was not insisted upon. As the work proceeded the *compos mentis* villager was gradually credited with more and more intelligence.

Other sub-committees were appointed to control the fieldwork; to draft enabling legislation; and to handle financial problems. The Commission then adjourned in good humour to the Officers Club for lunch. The minutes of this and the succeeding meetings were agreed by both sides before issue, to avoid misunderstanding.

The field work was started immediately after the inaugural meeting. Joint parties, each consisting of a Cypriot surveyor and a sapper NCO started at opposite ends of the Akrotiri SBA boundary and identified the "photo points" on the ground, marking them with an angle iron picket, driven flush with the ground. The archival quality photographs were very clear and considerable care had obviously been taken to select easily identified points wherever that was possible. One of the points had been carefully selected centrally over a deep well. This was easily forgiven if not forgotten. "Witness marks" were cut on trees or rocks and a description of each point and its witness marks was recorded so that if the picket were lost, it could be replaced quickly and easily.

When the parties had covered some of the boundary, they were followed by myself and the Chief Survey Officer of the Republic, George Avraamides Esq, ARICS. We checked the accuracy of the point identification; considered whether any minor change in position was required; whether any problem should be referred to the Commission; and how many intermediate pillars should be placed between turning points. The joint survey party then marked the intermediate points on the ground and prepared the description cards.

In the meantime, the Cyprus Public Works Department, as agent for the Commission, was precasting reinforced concrete pillars, for use as boundary markers. As soon as the pillars had been "cured", a party from the Republic's Forestry Department, again acting as the Commission's agent, started erecting them, each in a solid concrete base. The main pillars are 3 ft high and 5 in square. Subsidiary pillars, of the same cross section are 18 in high. The erection party was accompanied by a surveyor from each side, who ensured from the description card and witness marks that the pillars had been erected correctly in the agreed position. The pillars were then painted white with a black serial number. The final stage, an instrumental survey of the pillars by a joint party, was then started.

All the work of the Commission was done by joint Cypriot/UK teams. There was close and friendly consultation at every stage. This inevitably limited the pace of the work. It was soon clear that the nine months, allowed by the Treaty, would be insufficient to complete the work. The joint parties were increased and strengthened. We, on our side, were joined by a small party of airmen, who supervised pillar erection parties and helped with the survey. Colonel Edge obtained a set of 3 tellurometers (MRA 2) from the United Kingdom for loan to the Commission. Andreas Christofi, ARICS, one of the Cypriot survey officers and myself went to the Tellurometer Company Ltd in London for a week's instruction on the instruments. Finally, the two Governments agreed to extend the period, allowed for the work, to the end of 1961.

One of the thorniest and most time consuming problems arose because, in two places, the Commission decided that the boundary should follow natural features, which had been used to describe it in the Treaty. At Phassouri, sections of the boundary followed a hedge of Cypress trees, which marked the winding edge of the Cyprus Palestine Plantation Company's plantation. At Dhekelia, part of the boundary of the Power Station enclave followed the line of mean sea level. Legal advice was that the Commission had not placed these features on the ground, and that they had a clear duty to mark the boundary "clearly and effectively on the ground". It might be reasonable to imagine a straight line between pillars but an irregular line, No! Besides how would the *compos mentis* villager know when he had crossed the line. In a protracted succession of discussions a wide range of possibilities was canvassed—a triple dannert fence, a plain wire fastened to the trees, a kerbstone, even a white-washed line was suggested, though I think this was "aimed" at the soldiers working for the Commission. Some of the suggestions for marking the line of mean sea level were more imaginative, but less practicable. In the end the difficulty was overcome by placing descriptive brass plates, set in precast reinforced concrete blocks, on each "undefined" section of the boundary. A chain survey was also made of the plantation boundary. The brass plates were inscribed in English, Greek, and Turkish and the blocks weighed about 3 cwts each. None the less both sides were relieved to have reached an agreed solution.

Work continued throughout the winter of 1960/61 and as each phase of the work was completed at Akrotiri, the joint parties moved down to Dhekelia. This was, as expected, a more difficult boundary. It was twice as long as the

'hoto 1. One of the massive concrete pillars, carrying a brass plate inscribed in three languages, which was used to mark certain sections of the boundary.

Sappers on the new frontier 1

Photo 2. The open frontier. The main road from Episkopi to Limassol, Dhekelia and Nicosia crosses the frontier at this point. The boundary pillar can be seen on the right hand side of the road.

Photo 3. A closer view of the same boundary pillar. The wayfarer passes the frontier without let or hindrance. There is no customs check and no restriction of free movement across the frontier.

Photo 4. L/Cpl. Jago of the UK survey party observes a line in the Dhekelia area with a tellurometer set up over one of the boundary pillars. The party at the far end of the line is supplied by the Cyprus Department of Lands and Surveys.

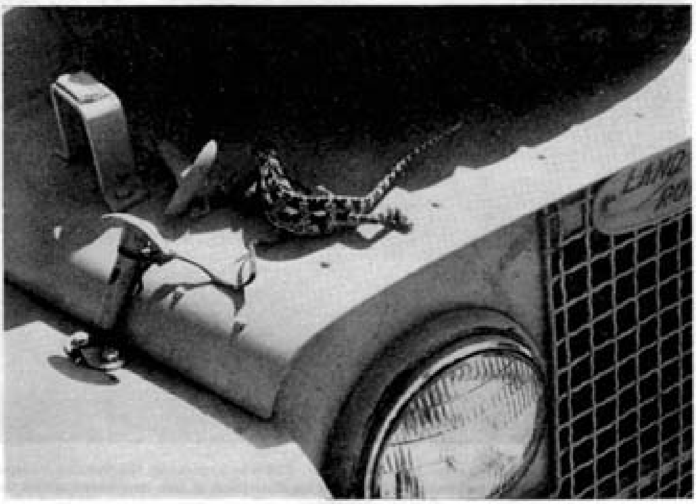


Photo 5. One of the parties carry an appropriate mascot. A chameleon.

Sappers on the new frontier 3 & 4

Akrotiri boundary. There were four enclaves. The number of "adjustments" required was considerably greater and finally the trig control was much less reliable.

We were able to enjoy the grape season, whilst working at Akrotiri and caught part of the orange season at Dhekelia. We became familiar figures in a succession of village coffee shops, and although the hours were long, they were taken at a Mediterranean pace.

Work nearly came to a halt several times during the summer of 1961, but there was sufficient goodwill to overcome each problem in turn. In the end the only stoppage was a fortnight's leave for the survey parties in the heat of August. Although laws to authorize the Commission to work on privately owned land were not enacted in the Republic and SBA's until late summer 1961, work was able to go ahead by local consent. This says a great deal for the good sense and friendliness of the local farmers.

In the Dhekelia area the tellurometers really came into their own. The area is flattish and the trig control sparse and in some cases of doubtful accuracy. So far as possible control was brought in by tellurometer traverse from the major triangulation and a number of 3rd and 4th order points were "refixed" and co-ordinated. The boundary pillars were also placed farther apart wherever possible, thus enabling a large part of the detail traversing to be done by tellurometer. Two of our national service airmen were trained to operate the tellurometers and did in fact operate them with very little direct supervision for several weeks. Some "survey" eyebrows were raised, but they did very well. The sapper surveyors learnt and had plenty of practice at some aspects of trades other than their own, and four of them learned to drive, which eased the pressure on our civilian drivers overtime ceiling.

As each stage of the field work was completed, the computers of the Republic carried out all the computations. They then passed them to the UK side for a 100 per cent check. When both sides agreed the answer, the co-ordinates were extracted into lists for incorporation in the Commission's report. All field books and records were prepared with carbon copies so that each side could have identical records.

When the Commission had agreed all field problems and the end of the field work was coming into sight, a drafting sub-committee was set up to produce a final report. Once the form and content of the report had been agreed, the involved and laborious task of producing it started. The survey parties on both sides had nightmares checking and cross checking the pages of co-ordinates of all triangulation points, and traverse points as well as the 774 pillars, which are used to mark the boundary.

Towards the end of the Commission's work and for a short while afterwards, our survey party co-operated with the Department of Lands and Surveys in some check observations on the island's major triangulation. Several tellurometer lines were measured and a number of azimuth observations made. This gave the surveyors a change from routine traversing and allowed them to see some parts of Cyprus, which they would not otherwise have seen. Lands and Surveys provided the donkeys, needed to reach the more inaccessible points. I gather their night in an Orthodox monastery was not an unqualified success. The UK Representatives and their field parties were more fortunate than many Boundary Commissions, in that they not only were given the full backing of the Administration, but were able to call freely for advice and help from Near East Air and Land Forces.

The report was at last produced, and was signed by the Representatives at a meeting held in Nicosia on 5 December 1961. The services of an independent Arbitrator had not been required. At the last of the series of Boundary Commission lunches, we were entertained on behalf of the Republic by the Ministers of Foreign Affairs and of Defence. There were several speeches and in the course of his, Mr Ian Williams, Chief Officer of the Sovereign Base Areas Administration expressed his thanks in generous terms to the Royal Engineers for their work in support of the Commission. So ended a pleasant and fruitful co-operation with what at the start of the task, had been the newest member of the Commonwealth.

A pleasant epilogue was the journey of the United Kingdom Representatives and their Secretary to London to present the Report to the Secretary of State for Air, Mr Julian Amery, architect of the Cyprus settlement.

The Ground Effect Machine in the Bridging Role

By Lieut-Colonel A. G. Towsend-Rose, RE

Introduction

Many officers will by now have read with interest the lecture by Mr W. H. Coulthard on the Military Use of Ground Effect Vehicles, printed in the September 1962 issue of this *Journal*.

It is true that the senior course at the Royal Military College of Science is designing a self-propelled bridge as an exercise, but they are not likely to make use of the Ground Effect principle, for reasons which will follow.

The "Ground Effect Machine" or GEM, sometimes called a hovercraft, is well suited for crossing water or soft ground at speed, and is therefore at an advantage with the amphibian which may require carefully built approach roads.

The preface to the article suggested that self-propelled amphibious units could be designed small enough for normal road and cross-country movement, and could be coupled together to form a bridge. They could use the ground-effect principle to improve their cross-country performance, and increase their buoyancy, with a corresponding reduction in their size and weight. I believe this to be wrong thinking.

Aim

To compare a possible ground-effect bridging unit with self-propelled amphibious units such as the Gillois and EWK M2, in the bridge and ferry roles.

Factors Concerning the Bridge

Buoyancy. An economic GEM can provide a lift of about 100 lb per sq ft of its plan area. Taking an installed engine weight of 2,000 lb on a plan area of 400 sq ft, about 0.65 lb per sq in remains as useful lift.

A pontoon, with no special lifting engine, and drawing 3 ft, will provide a useful lift of 1.3 lb/sq in. For a given lift therefore the pontoon drawing 3 ft, requires half the plan size of a GEM.

If it is argued that the ground effect is only superimposed on the pontoon to increase its lift, would it not be better to use side floats of half the size?

Shape. A GEM is only effective in proportion to its minimum dimension. A circular plan is theoretically the best. A pontoon, to give least resistance to a current, must be long and thin. It is obvious which will move down a road, or across country through trees, with the greatest ease.

Power. A boat requires about 1 hp per ton to propel it through the water. A tank uses about 15 hp per ton to achieve a limited speed. Lorries and cars require 20 or 30 hp per ton, and the current amphibians come within this range. GEMs need 70 to 130 hp per ton, and this of course results in greatly increased mobility. Hence an amphibian weighting 15 tons, to carry 60 tons, will require about 350 hp, whereas a GEM will need 1,200 hp as a vehicle, and much more when carrying a bridging load. Only gas turbines can provide this power within the weight limitations.

Speed. The GEM offers high speed economic transport. For instance the SRN 4 will probably carry over 50 tons at a speed in excess of 70 knots at a rate of under 2d a mile per passenger. The only comparisons one can make with this performance, is heavy traffic on the M1, and low-flying helicopters across country. In the former case the surface is perfect and the speed unmatched, and in the second case the load carried is unmatched and the height of flying is much greater than the 3 ft possible with the GEM! It would appear therefore that the greatest asset of the GEM will not be able to be used across country as we know it. On water, or over mud flats, it comes into its own.

Obstacle Crossing. Although the GEM has the ability to cross flat land at speed, dusty conditions may seriously restrict visibility, reduce camouflage or cause serious fan blade erosion. It is the problem of entering and leaving the water over banks which is the most serious. All Sappers know that the bigger the pontoon and the higher the bank the bigger the splash. Amphibians ease themselves in as best they can, but even so they often submerge forward during entry. A GEM would lose its cushion over a bank and it might be difficult to design a fan unit which could withstand submersion.

Economy and Silence. A GEM would have to be run continuously when afloat, unless the vehicle was a hybrid and buoyant. The fuel required for a bridging operation using twenty units, each consuming 100 gals per hr would in itself produce a considerable logistic problem. Nor would it be a silent bridge.

The amphibian, however, can lie quietly at anchor, camouflaged, or in bridge. Although the modern amphibian costs over £1,000 per ft of bridge using relatively cheap power units, the cost of a suitable GEM would be several times this.

The Ferry

The author can visualize a very definite requirement for large GEMs to cross wide rivers or estuary obstacles in the rear areas, and to operate from ship to shore.

Bridges such as were built over the River Po and River Rhine cannot survive in a future nuclear war. The GEM could provide a very flexible ferry, requiring nothing more than a smoothing of banks and the removal of minor obstacles, such as hedges or groynes, to operate from well short of the obstacle to well over it. Fuel could best be carried by pipeline, but the GEM could carry all else, including the main battle tank one at a time. The vehicle would be large and would take some time to assemble, but a large vehicle is required to gain a suitable hover height. It would be far quicker into action than any bridge, and would be much less vulnerable.

Summary

As a bridge unit, the GEM would have to have twice the plan area of an equivalent amphibian drawing 3 ft. Because its lift is a function of its minimum plan dimension, it would not be easy to manoeuvre on roads or between narrow obstacles such as trees. The enormous power requirement could only be met by an expensive gas turbine, and the fuel needed would present a serious logistic problem for any bridging operation. Nor would it be quiet. Although it would have an excellent soft ground crossing ability, it would find great difficulty in entering or leaving the water over anything but very low banks, or mud flats. There appears to be, however, a requirement for a heavy logistic ferry to cross wide river obstacles or estuaries in the rear areas, and for transport from ship to shore. Even in these roles, there will be many occasions when normal amphibians will operate perfectly satisfactorily, at a fraction the manufacturing, fuel and maintenance costs, but of course at a fraction the speed of the GEM.

A Novel Venture

A TA Camp in Alderney, CI

By Colonel B. G. Bloomer, OBE

The Birth of an Idea

During the summer of 1960 I was sitting on the deck of my yacht in Braye Harbour at Alderney contemplating my surroundings. As a Sapper officer there were a number of things which attracted my attention although they were given little serious thought at the time.

The quay had two ships abreast, the outer ones waiting for the inner ones to complete their loading, and yet there was vacant some 400 ft of quay of heavy steel construction built by the Germans during the war but unsuitable in its present state for small ships to lie alongside. Also it had obviously fallen into disrepair and was a horrible blot on the otherwise attractive setting.

There was a steep and narrow set of steps down the harbour wall with a clutter of local boats and yacht dinghies at their bottom vying with each other for space to land their passengers.

There were other things too which I had noted in my strolls round the delightful little island. They all seemed to be crying out for some engineers to get at them. Subconsciously a seed had been sown.

Shortly after this particular summer I was posted to command a TA Engineer Group in Southern Command, and very soon after taking up my appointment was asked for my plans for TA Camps in 1962, Wyke Regis being heavily subscribed. My mind harked back to that peaceful summer's day in Braye Harbour. From my knowledge of the island there was a shortage of labour and no trade union problems, and the Royal Navy, Royal Naval Reserve and even the Army often had small ships visiting the harbour during the summer as part of their training cruises.

To the ordinary individual it was abroad, and yet the currency was sterling. The Channel Islands are in the area covered by Southern Command. The seed was beginning to germinate. What an attractive idea for a TA summer camp!

Practical engineering work to do of benefit to a community and with no trades unions or financial ties. Their own camp to organize and set up. Abroad. Good bathing and boating in attractive surroundings. Normal entertainment facilities. A pleasant climate! And what is more the planning involved would be good training value throughout the year leading up to the camp.

From my previous appointment in E (Training) at the War Office I knew that Transportation normally hired a coaster each summer for AER training which they solemnly loaded with dummy cargo and then took it out again. How much more interesting and worthwhile training for them to load it to some purpose and then off-load it in a small strange port only a few hours' steaming away.

The seed had germinated, but could the Island Authorities, Transportation, the Navy, my Chief Engineer and others, be persuaded that it was a seed worth encouraging?

The States of Alderney

In order to properly understand the way the idea was tackled and planned a background knowledge of Alderney and its government is valuable, and anyway it is too delightful to miss out. Alderney is the most northerly of the Channel Islands, equidistant 90 miles from Southampton and Plymouth, some 25 miles from Guernsey, and only 8 miles from Cap la Hague on the Cherbourg peninsular. The population is about 1,500. It is 3½ miles long and just over one at its widest point. The countryside varies from a rather high agricultural area in the west to a low and rather more barren area in the east. It is surrounded by rocky islets, and the waters and tides in its vicinity are some of the most notorious in the world.

There is a central small town, St Anne's, on the high ground which contains all essential facilities, and there are a number of small habitations around the island, one of which is Braye alongside the harbour which has the same name.

There are numerous lovely bathing beaches which are perfectly safe provided one remains inside the bays in which they are situated. There is a small airfield on the high ground from which there is a frequent air service to Guernsey and Gatwick by the lighter types of aircraft.

The exports are varied and range from flowers to motor car silencers. It always seems a little odd to watch the latter being loaded into ships for export from this tiny little island.

The Government is perhaps the most delightful part of the island.

The Legislature, or States of Alderney, consists of an elected President (at present a retired Naval Officer) and nine elected members of equal status. This Legislature is completely democratic. At the time of writing, one member is a taxi driver. Except in major financial affairs this Legislature owes allegiance direct to the Queen through the Home Office.

The day-to-day administration of the Island is carried out by Standing Committees of the States, consisting normally of four members. There are half a dozen such committees and thus most of the nine members serve on several. The considerable work involved is entirely unpaid. Examples of these committees are the Harbour Committee and the Water Board.

Financial matters are within the overall supervision of the States of Guernsey, but it is a matter of great pride in Alderney that they have never asked Guernsey for a penny.

The following quotation from a distinguished authority on Commonwealth Institutions sums it up very nicely:

"I also found, quite strange to my experience, the elected representatives of a self-governing people sitting in deliberate assemblies in which there were neither political parties nor even 'Government' and 'Opposition', but all bent on deciding every question on its merits, and at the same time serving gratis, both in the Governing Legislature and on the innumerable all-the-year-round States Committees controlling, subject to the Legislature, practically every branch of the administration. What more ideal conditions than those could be desired by any community? To quote Macaulay's famous lines:—

'Then none was for a party,
Then all were for the State.' "

Development of the Idea

It was in March 1961, more than a year before the actual camps, when with the help of the Army Air Corps I arranged to meet the President and sound him on my idea. The response was immediate and overwhelming.

I was given the promise of every assistance in the way of States land for camp sites, water and electricity, and the use of any engineer facilities existing on the island.

The States would also provide any materials required for the tasks carried out. There appeared to be enough tasks to warrant both regiments under my command going there.

I returned to England much heartened, but took the precaution of writing for confirmation of what was said at my meeting with the President, since it was conducted over a number of glasses of gin! However, I need not have worried. I did not know the States so well then as I do now. In everything that happened subsequently they fully lived up to that original promise, in fact, they exceeded it.

The answer to my first problem was obviously favourable, but before I could go to my Chief Engineer and that very important gentleman, the Command Secretary, I must also have an indication of how the transportation of the men, plant, equipment and stores might be carried out. In order to find this out it was necessary to have some idea of the tonnage.

My Brigade Major, at that time Major Eric Moss, once admitted to having taken an interest in sailing. He was therefore ordered to be my crew on a trip to Alderney in my yacht. We spent two days there, during which time the President arranged a meeting of the States Legislature which we attended, and I outlined my proposal to the members. They fully supported their President's original statement to me. We also discussed various possible tasks.

This gave us enough information for my BM to wrap a wet towel round his head and produce some idea of the tonnages involved. This initial estimate proved surprisingly accurate. The actual tonnage loaded was only 1 per cent different, a great credit to him and also those on the staffs of the various HQs who so kindly assisted him, particularly in respect of tonnage of accommodation stores and tentage.

The next move was to make contact with the Port Regiment, and possibly the Navy. The former liked the idea, and thought it might make a good exercise for them and/or the AER stevedores. The tonnages looked practical to them, but they could not handle the personnel other than small advance or recce parties. DO approaches were made to the Royal Navy and Royal Naval Reserve. It was early days, but they thought they could help but would like Admiralty blessing.

The seed was now beginning to shoot and become visible. It was therefore time to obtain official recognition, and the Chief Engineer's and Command Secretary's blessing. The former passed it on to the Command Secretary with his strong support, and the latter, subject to War Office SD1 approval (this was in accordance with ACI 59/59 now superseded by 135/62) gave his blessing and dubbed it "A Novel Venture".

War Office SD1, and through them the Home Office, who are responsible for the Channel Islands, gave their approval.

In this somewhat lighthearted account of the events leading up to official recognition and support to the idea, I should make it clear that because it was such a novel venture, and so many major problems would arise, I thought it was essential to have some idea on a DO basis of how they might be met before I put pen to paper to anyone officially. The seed was obviously now well established, and from then on, whatever the difficulties, it had to grow and burst into flower. The Chief Engineer on my behalf now made an official approach to HQ Transportation Centre and the Admiralty, the latter through the E-in-C's Directorate at the War Office.

Transportation Centre accepted the idea for a combined AER/17 Port Regiment exercise. They would also ask 46 Sqn RASC (LCT) to help them. This was in the autumn of 1961, and from then on the Port Regiment was brought in on all planning and exercises. I made it clear to the Port Regiment that as long as the stores arrived in Alderney by the required date they could run the exercise to suit themselves, and that I would arrange for the stores to be available to them at Marchwood as and when they required. It was also agreed that we should arrange for the stores to arrive packed ready for shipment. This latter point subsequently proved one of the most difficult things as far as Ordnance stores were concerned. The CO of the Port Regiment said that his only worry would be to persuade the AER stevedores that this year the stores really mattered, and they could not just drop them into the sea!

The approach to the Navy took longer, and it was not until the following March that I received any firm reply, fortunately extremely helpful.

It was already September and since all bids for stores, equipment, etc, for TA camps have to be submitted in December/January it was time for serious planning.

Detailed planning of this quite major operation was obviously going to be beyond the capabilities of myself and one staff officer and in any case one of the objects was to provide winter training for the TA, particularly the officers and senior NCOs.

I had already decided that each of the two regiments should go separately and not together as a Group Camp. The Annual Camp is the one occasion in the year when a TA CO can really command his regiment, and I think that it is terribly important that it should be his own camp and that he should be left to do this without his Group Commander sitting on top of him.

Detailed Planning

A weekend early in October was set aside for detailed reconnaissance by the TA. The passage over there was planned as a joint Army Air Corps/ 17 Port Regiment exercise. The idea was that the party from 115 (Hampshire Fortress) Corps Engineer Regiment should embark on the MFV *Marchwood Mariner* at Marchwood on the Friday evening arriving at Alderney the following morning. 116 (Devon & Cornwall) Corps Engineer Regiment were to emplane at Exeter on the Saturday morning in a Beaver ferry service run by the Army Air Corps. For the return journey on the Sunday the reverse was to take place, ie "115" by Beaver to Hurn Airport, "116" by MFV to Plymouth.

This had the advantage of giving both regiments a more varied and interesting trip as well as flying experience in light aircraft. In the event the chosen weekend clashed with one of the worst gales of the winter.

Some got there and could not get back till several days later by devious means. Some put to sea and after some exciting moments finished up in Yarmouth, Isle of Wight. Some never left terra firma in England.

Fortunately the Command Paymaster was very helpful, and on a consolidated report from me met unusual claims for extra detention, civil air fares, etc.

In fairness to both 17 Port Regiment and the Army Air Corps I should say that the Commander of a Naval MFV which was in Alderney at the time offered to bring back those marooned on the Island, but in the end could not sail for three days because of the weather. In spite of the chaos caused by the weather sufficient reconnaissance was completed to enable planning to proceed so all was not lost. In any case most of the officers and NCOs thoroughly enjoyed themselves particularly when recounting their stories afterwards.

The information collected on the reconnaissance was sifted and coordinated at Group HQ during the following weeks and a compendium on each task compiled. This included the setting up of the camp as well as the engineer tasks for the Island Authorities.

In early December a Group weekend was organized, Exercise "Castaway". Its main object was to produce lists of stores and equipment required. To achieve this it was necessary for all tasks, including day to day administration, to be studied in detail and a project for each prepared. Mixed syndicates of the two regiments were each given one problem to study and produce a project. The project had to include, where applicable: Design or lay-out, Stores lists, Plant requirements and Work tables.

This part was carried out on the Saturday morning and afternoon. On Sunday morning each syndicate presented its answer to the rest for comment and criticism. By this means I hoped that everyone would be well briefed on every aspect of the camp, and also the more criticisms there were the more chance there was that nothing would be forgotten. This latter point was most important since there are no great stocks of anything on Alderney and everything had to be ordered in advance or taken with us.

The States of Alderney kindly sent over their Clerk of Works, Bob Neish, to attend the weekend and answer the many points which the reconnaissance had not cleared or which arose during study of the problems.

The weekend was quite the most successful TA weekend it has been my lot to attend. I think that the following extract from Bob Neish's report to the Clerk to the States on his return describes it as well as anything:—

"At the conference the tremendous enthusiasm and technical skill applied to the projects was indicative of the great amount of preparatory work put in by HQ Staff and various syndicates. The constant vein of good humour that ran throughout the conference augurs well for the success of Operation Castaway. All Departments of the States of Alderney and residents should match effort for effort to ensure that we are in no way lacking during this most welcome invasion of our Island."

There were subsequent amendments to the engineer tasks to be carried out, but in the main the problems confronting us were now clear and we knew what we wanted in the way of stores, equipment and plant, and help of all sorts from the Chief Engineer and staffs of the various Headquarters.

All the demands were extracted from the syndicate projects jointly by my Brigade Major and the Quartermasters of the two regiments. There was a slight variation at this period because the Dorset Regiment (TA) then asked to follow us in the camp. This called for minor alterations to the stores shipping plans during the return period but gave us no serious problems.

The number of administrative problems which arose were very considerable. Unfortunately space does not allow them to be enlarged on. However, for the benefit of anyone carrying out a similar operation I have given at Annexure "A" the headings of the more important and unexpected ones. It took the remaining six months after Exercise Castaway to sort them out.

Then began for me personally the worst period of all. The show had to go on, but for peace time soldiering the problems were immense, or at least so they seemed to me; would the Navy finally play all right? Could the Port Regiment carry out their part of the programme? Would the States get the engineer stores in time? And so on. I began to have cold feet at least once a week, and many a time wished that I had never thought of the idea.

Whenever I felt really down in the dumps the only answer was to ask the Army Air Corps to fly me out to Alderney, which No 6 Flight in particular were very good about, and I always came back much cheered as a result of the enthusiasm and co-operation shown to me both by the States Authorities and private individuals.

During the rest of the winter the various details, particularly administrative, began to take shape and fit in. Again with the help of the Army Air Corps various visits to Alderney took place to sort out details. 17 Port Regiment and 46 Squadron RASC also did a recce of the beach and port facilities.

During February, as a result of an approach to the Marine Commandos by 116 Regiment for assistance with instructors during Outward Bound type training at camp, 41 Royal Marine Commando went one better and asked if they could attach a party of fifty to the Regiment and learn some sapper work as well. This proposal was warmly welcomed by everyone from the Chief Engineer downwards. It did not produce any administrative difficulties since 116 Regiment is a smaller regiment than 115, and the facilities laid on for the former easily covered these additions to 116 Regiment's camp strength. Also about this time as Affiliated Formation Commander for the Wiltshire Cadet Forces I offered a small party of twenty a weekend in Alderney, travel, subject to the Royal Navy agreeing, to be on HMS *Plover*, which would otherwise have been travelling empty once each way. The Navy kindly agreed and, like the Royal Marines, went one better and asked if a similar sized party of sea cadets could join them. My BM was given the task of co-ordinating the arrangements for them and organizing their administration on the Island.

It was my aim to have a co-ordinating, and I hoped final, conference in March and then leave it to the Regiments to get on with. This was two and a half months before the first regiment was due to sail, but with the limitations of TA training time, and the difficulties they have in getting together and carrying out detailed planning, it was none too early.

A date in mid-March was fixed for the Conference, but it nearly had to be postponed as the Admiralty approval and allotment of ships had only come through a few days before. Fortunately the Navy did us proud, and although there was a certain amount of difficulty in planning the change round of the two regiments in the middle of the period I could not really have hoped for better co-operation. When both I and the COs of the Regiments were able to contact the captains of the ships allotted we found great enthusiasm and keenness to help in every possible way.

The conference was attended by representatives of Q Movements, HQ Southern Command, Q Staff of Divisional/District, 17 Port Regiment, and the OC of 46 Squadron RASC, and the Dorset Regiment, as well, of course, as my own two regiments. I went through every aspect of the camp almost day by day from the first move of stores and Advance parties to the point of embarkation to the return of the last man and store. It took us all day, but it ensured that all concerned were on net and, I hoped, all the main problems which might arise were covered. The Minutes of the conference which took my poor BM nearly three weeks to prepare were then the executive orders and instructions for everyone to work on. Some alterations had, of necessity, to be made later, but they were all of a minor nature.

EXECUTION

Timetable. The timetable which had now emerged was as follows:—

27 May	All stores, vehicles and plant to be at 17 Port Regiment, Marchwood, ready for loading.
27 May–3 June	Stores, other than vehicles and mobile plant, loaded in coaster by AER stevedores as part of their annual camp.
3 June	Advance Party 115 Regiment embark on LCT and load vehicles and plant.
4 June	Coaster and LCT arrive Alderney.
4–9 June	Advance Party unload LCT and erect camp. 17 Port Regiment stevedores unload the coaster.
9 June	Main body 115 Regiment embark at Portsmouth on HMS *Virago*, 2,000-ton frigate, and sail for Alderney.
23 June	HMS *Plover*, 800-ton minelayer and HMS *Thames*, RNR mine-

sweeper, embark 115 Regiment at Alderney and disembark at Portland and Southampton respectively.

24 June 116 Regiment and detachment 41 Marine Commando embark on HMS *Plover* at Portland and sail to Alderney.

7 July 116 Regiment and Royal Marines embark on HMS *Venus*, 2,000-ton frigate, and sail to Devonport.

Because of its subsequent occupation by the Dorsets, whose strength was much smaller than ours, the camp was to be dismantled and packed up in stages by a small rear party of 116 Regiment helped by the Dorsets.

The LCT sailed for Marchwood on 16 July, and the coaster the same day.

Advance Party

The Advance Party from 115 Regiment had a major task and a detailed account of its work is given by OC Advance Party, Major Cook, Training Major of 115 Regiment at Annexure "B".

They were fortunate in that their sailing date coincided with the first real day of summer and this obviously set them off in the right mood. As will be seen from the Annexure, the party included many arms and services, and even civilian employees, but all "mucked in" together and, for example, Medical Corps personnel were to be seen putting up camp structures alongside a Sapper and a civilian.

On paper the task was more than the Advance Party could really achieve, and it was always recognized that the main body might well have to erect its own tents. However, such was the enthusiasm with which everyone worked that there was very little left indeed for the main body. It only shows what can be achieved if the spirit is right.

I think that the only complaint the Advance Party had was that they suffered from sunburn.

Transportation Aspects

I received terrific co-operation and assistance from HQ Tn Centre and 17 Port Regiment, and I have asked them to give a summary of the exercise as it affected them and have included it at Annexure "C".

Works Tasks and Training

Tasks for the States of Alderney

Construction of a small boat slipway. The slipway, 10 ft wide and 250 ft long, was required to enable small craft to land their passengers and be hauled up at any stage of the tide. This provided good training in planning and organization of work since it had to be planned to fit in with the tides.

The task was finished on time, including the setting up of a block of granite engraved "Sapper Slipway". The average working party employed on the task was twenty-five NCOs and men, of which a few were Carpenters and Joiners and the balance Combat Engineers.

The Slipway project was perhaps the most striking of all projects carried out at Alderney, because of its prominent position, size, and the fact that it was built from scratch in four weeks. It was fitting therefore that it was opened with a ceremony, symbolizing the handing over of all the projects. A Guard of Honour was drawn up beside the Slipway, speeches were made, and Mrs Herivel, wife of the President of the States, cut the tape and declared "Sapper Slipway" formally open.

Surfacing of the quay. Part of the existing quay had been surfaced with reinforced concrete some years ago, but some 6,000 sq ft still remained to be done. This task did not involve any great design problems, but, like the slipway, it required considerable thought as to the best method of tackling since the quay had to be kept open for use at all times.

Island Hall. The existing annexe which housed the bar of the Island Hall was too small, and the States wished to replace it with a considerably larger one on the same site. The design and bills of quantities were prepared by Captain E. C. Williams RE (TA), of Group HQ for States approval. The Public Works Department of the States prepared the foundations and our task was to construct the walls and roof, at the same time of course putting in the various windows and doors. The training provided by this task proved to be more varied and valuable than I expected.

Quarry. Allied to the above tasks was the working of the States quarry in order to provide the necessary aggregate for all the concrete work. This gave training with compressors, explosives, excavators and dozers as well as the operation of the States owned stone crusher. This incidentally had to be repaired on more than one occasion calling for considerable improvization and some quite ingenious stick and string engineering to remove the heavy parts. A total of some 300 tons of aggregate was produced.

Burhou. This is a small island approximately 500 yds long about 1½ miles from the main island. A small hut is maintained on it with supplies and provisions as a refuge to fishermen and also for visitors who want to spend a day or two on the island bird watching. The landing is not easy, and makes it difficult to put stores on shore or carry out any improvements to the hut. The Army Air Corps was keen to do some practical stores carrying with an Alouette helicopter, so they were asked to combine this with providing an interesting little exercise for a troop of each regiment in turn. The general idea was that the helicopter should come for two days with each regiment, taking a party and necessary stores over there on the first day, and returning them on the next. Due to technical reasons the helicopter for 115 Regiment could only appear for one day and therefore a local fisherman brought off some of the party the next day and also escorted an assault boat party. The second regiment were lucky and had a helicopter for two full days. General improvements to the landing were made by the use of explosives, two 5-ft crevasses bridged and minor repairs done to the hut.

Miscellaneous Tasks. In addition to the above pre-planned main tasks, each regiment undertook a large variety of minor combat engineer, plant and tradesmen's tasks for the States. Examples are: demolition of old fortifications, dozing in an unsightly rubbish dump, using a compressor to lay a new water pipe under a concrete road, breaking up wrecks in the harbour with small cutting charges and oxy-acetylene equipment.

Military Training

Each regiment carried out a large variety of military training, including recruits courses, cadre courses, wireless training, watermanship and outward bound type training.

115 Regiment had an officer of their own who was an experienced cliff climber and he ran courses in this which were extremely popular. 116 Regiment used the Royal Marines as instructors in the same sort of training.

Photo 1. The Slipway work in progress

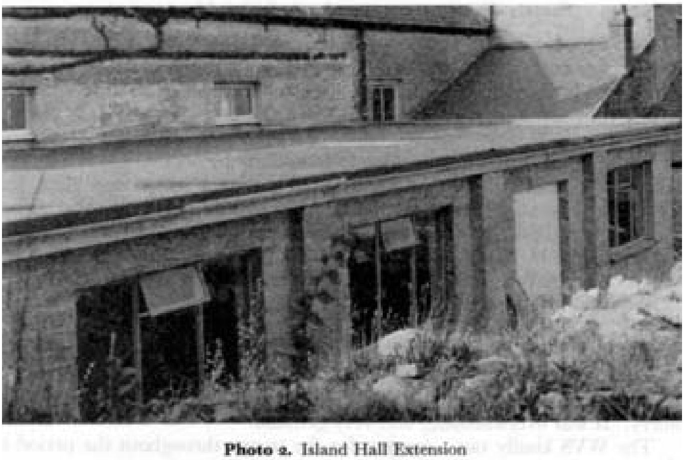


Photo 2. Island Hall Extension

By kind permission of The Times

Photo 3. Helicopter assistance for the Burhou Island project

Eight assault boats with outboard motors, and three RNSA dinghies which had been taken with us, were used for watermanship training. The RNSA dinghies also took part in races with some of the locally owned dinghies.

We were fortunate in being able to resuscitate for limited use an old WD range in the eastern end of the Island. The target frames had gone, but the butts were still sound and figure targets could be used. War Office waived the full procedure for resuscitating a range as laid down in Infantry Training, Vol II, Pamphlet 32 and, for the period of camp only, accepted the recommendations of our reconnaissance party which had also been agreed by the Clerk to the States.

Social and Welfare

The welcome given by the Island officials and private individuals to all ranks is something which I do not think either regiment will forget in a hurry. It was overwhelming and very genuine.

The WVS kindly ran a canteen for the troops throughout the period of the camp. It was very much appreciated and fully used.

By kind permission of The Times

Photo 4. Cliff-climbing training

The officers of each regiment were invited to a cocktail party given by the States shortly after their arrival and, of course, the States officials were invited to various functions by the Regiments.

I believe that the Guest Night held by one of the regiments at which the members of the States Legislature were the principal guests will go down in history: certainly the White Horse sign of 26 Engineer Group has become part of the history of the States of Alderney since each member of the Legislature was presented at this dinner with the Group tie bearing this emblem, and it is now proudly worn by them at States meetings as I myself witnessed on one occasion. The emblem is also firmly embedded in concrete on the various works.

The other regiment organized an enormous barbecue with hot dogs for everyone on the Island. They were all eaten.

Previous to the camp the Governor of Guernsey, who is responsible for the provision of police in Alderney, wrote to me expressing concern since he was only able to produce two policemen and he feared that they might not be sufficient to cope with the trouble he seemed to expect. I had always been very conscious of the large proportion of troops to inhabitants and also the availability of cheap drink, but firmly believe that provided the troops are made to think about this before they get into trouble then the trouble will not arise. I therefore laid down that every soldier on the Island was to be addressed on this subject by an officer on the day of his arrival.

The Governor of Guernsey need not have worried. His two policemen occupied themselves joining in the fun with the regiments. They had nothing else to do.

There are numerous highlights of the social side of the visit by the regiments, particularly those concerning short weekend visits during the period by other Arms and the RNR. There are also the stories of each regiment's trips over with the Royal Navy, of the troops lining the ships, visits to Cherbourg and Jersey, etc, but these would fill a book by themselves.

The underlying note throughout was the wonderful spirit shown by all ranks, all Arms and Services, the Royal Navy, and the civilian population.

The Future

Before looking at the future I think I should enumerate what we got out of this camp. I listed some of the things that I expected in my opening remarks. These all proved true, and a great many more were added. In very general terms they can be summed up as follows:—

(1) First class planning and organization training for all officers and NCOs for the whole year leading up to the camp. This included administrative as well as technical engineer planning.

(2) Training for All Ranks in a very wide range of subjects:—

Cadre Courses
Range Firing
Infantry and Outward Bound type training
Transportation by RN, including embarkation/disembarkation overside
Beach landings from LCT
RE Transportation work
Movement of stores and personnel by helicopter
Combat engineer training
Trade training covering a wide field
Watermanship and diving.

All this training was carried out with a background, which each man felt, of doing something worthwhile for the benefit of a community. This naturally gave a tremendous fillip and interest to the training.

One great advantage from the TA point of view with their limited time was that it did not matter to the States Authorities if the engineer work was not completed that year. In fact all tasks were finished.

There were others who benefitted as a by-product of the operation. For example, 17 Port Regiment and the AER Stevedores who helped to transport our stores assured me that it was quite the most interesting training they had carried out for some time. It was so obviously more worthwhile to be loading stores which mattered rather than boxes filled with sand or wrecked vehicles.

The detachment from an RASC Supply Platoon which came to Alderney to help us had a practical job of work to do which was an exact replica of what they might be required to do when a Limited War Force lands in a friendly country.

There were others also, too numerous to list.

Before the camp took place there were a considerable number of officers and others who had misgivings as to how the troops would like camping on a small island, and what they would do in the evenings. They underestimated the friendliness and spirit of the Islanders. I do not believe that there is a single man who did not thoroughly enjoy himself, and also at the same time leave behind a reputation with the Islanders of impeccable behaviour.

At my various meetings with the President and States Members the attitude was always one of immense thanks to us for the work we were doing. This point was picked on by some of the national press who criticized the fact that the army was carrying out improvements to Alderney at little cost to the States. This was true, but to my mind was purely a resulting bonus. As I said to the President, "I am quite selfish in the matter. My object is to have a good camp for the TA, one which is first class training value, is a change from the usual, and one which they will enjoy. This I have achieved. If the States of Alderney have benefitted as a result so much the better."

Is not the future quite clear therefore? A chance to plan and execute practical engineering, almost unfettered by time or finance problems, in congenial surroundings, with all the glamour of "abroad": All the facilities for normal military training available in the same locality.

The process of moving to Alderney and living there, forming as a by-product good training for other Arms and Services, liaison and co-operation with the Royal Navy. The whole business backed up by a very real desire by the civilian population that it should happen. In my humble opinion the Corps would be foolish not to adopt Alderney as a Sapper training ground.

The flower has turned to seed—is it too much to hope that it is ready to reproduce once more?

ANNEXURE A

A AND Q PROBLEMS

Pay and Bounty—Difficulties due to travelling time exceeding one day.

Travel for Honorary Colonels and T and AFA officials—Special dispensation to travel in aircraft of the Army Air Corps.

Welfare—WVS canteen. Trips to other islands and France.

Engineer Stores—Provision by Island authorities. Camp structures and Scales. Packing and planning of movement to port.

Water supply—plastic piping and fittings purchased.

Electricity supply—offices, stores, messes, street lighting, and refrigerators but not living accommodation.

Plant—Provision and movement to and from port.

AFG 1098—Scales to be taken.

B Vehicles—Scales to be taken.

Stores for training other than on projects—Watermanship; Demolitions; Range Firing; Outward Bound Training.

Tentage—Special scales worked out.

Accommodation Stores—Special scales worked out. Packing for shipment raised many problems.

Conservancy—Clearance of latrine buckets and rubbish.

POL—Provision by local purchase. Separate accounting for Works and Training.

Rations—Local purchase arrangements for fresh items. RASC Supply Det.
Medical—Provision of hospital facilities. Air evacuation.
Civilian Employees—Special scale. Authority for movement on HM ships.
Movement—Phasing of stores movement to port. Small parties of men, eg, 8-day campers.
Customs—Notification of all stores and personnel movements to HM Customs.
Communications—Provision of wireless link to UK.

ANNEXURE B

THE ADVANCE PARTY

INTRODUCTION

PLANNING for the exercise and recces of sites on Alderney had been going on for some time. The camp was sited astride the road running to the north-east round Braye Bay and was to be in two parts with Officers' mess and lines, Sergeants' mess and lines, and troop lines to the north or seaward side of the road and the Administrative area, troops cookhouse, dining tents and junior ranks club on the landward side. Living accommodation, messes, stores and offices were to be tented, while cookhouse, latrines and ablutions were to be of the usual camp structures with water and electricity installed to messes, etc. The final planning conference was held by the Group Commander on 14 March, when orders were given to plan the advance party.

Aim

The aim of the advance party was to unload the stores required by the Group for the exercise and erect the camp before the arrival of the main body on 9 June.

PREPARATION OF PLAN

Composition of Main Advance Party

TA Regulations provide for volunteers attending a camp of up to fifteen days annually, hence special authority was required to exceed this for members of the advance party. Authority was given for forty men for an additional seven days. The main advance party, therefore, consisted of:—

Permanent Staff—	Training Major
	Quartermaster
	Adjutant
	RSM
	4 PSIs
TA Volunteers	40

In the TA there is a great tendency for vacancies for tasks of this sort to be filled by the older and more senior ranks. As it was obvious from the very beginning that the advance party would need working numbers, Sergeants and above were purposely excluded. With the exception of vital appointments, such as RQMS, the volunteer element was either junior NCOs or Sappers.

Attached Personnel

This was an exercise outside the normal scope of a TA Engineer Group which had to be supplemented by various detachments and individuals who joined the advance party. These attached personnel were detachments from:—

17 Port Regt RE	2 and 32
142 Sup Pl RASC	1 and 6
63 Sigs Regt (TA)	1 and 5
23 Para Fd Amb RAMC	2
HQ 26 Engr Gp (TA)	1
Civilian Staff from 115 Corps Engr Regt (TA)	9

This gave a total of seven Officers, ninety Rank and File, nine civilians or 106 in all.

Stores

There are no military units on the island nor is the island able to maintain a military force from its own resources, therefore everything had to be imported and a formidable list of stores and equipment had been compiled. While the ordering of these stores was no direct concern of the advance party their dispatch from stores depots, loading, unloading and subsequent use concerned them. Cargo to be shipped is summarized as follows:—

Engr Stores	100 Shipping Tons
Ord Stores	260
Misc Stores	26
Rations	36
Dinghies, aslt boats, etc	26
AVTUR (30 × 45 gallon drums)	8
2 Concrete Mixers	30

Vehicles

Based on the exercise requirement and the capacity of one LCT the vehicles were limited to:—

Motor Cycles	10
Trucks ¼ Ton	2
Trucks 1 Ton	1
Trucks 3 Ton GS	2
Trucks 3 Ton Tipping	2
Tlr ½ Ton	1
Tlr 1 Ton	1
Michigan 175 Rough terrain fork-lifts	2 (One returning with LCT)
Tractor Size II	1
Excavators tracked 5 cu yd	1
Tlr 2 Ton Compressor 315 cfm	3

The carrying space available in the vehicles could be used for advance party kits, bedding, G1098 eqpt and vital stores. This meant that as soon as the vehicles were unloaded from the beached LCT the advance party was well on the way to being established on the island.

Tides

Both Marchwood Slip, where the LCT was to load, and Braye Bay, where the LCT was to beach and where the coaster was to unload, are tidal. The tidal range at Braye is about 18 ft. In addition the highest tide of the month was due at Marchwood the morning the LCT loaded. High water at Braye Bay on 4 June was at 1000 hrs. It followed that the LCT would be very wary of being left aground on Marchwood Slip and would not be able to beach until 1000 hrs on Monday 4 June. The tidal range at Braye is such that ships gear could not be used at low tide because of the height of lift. This would in turn impose limits on the times that ships could be unloaded.

Sea Movements

Three ships were to move the advance party, vehicles and stores to Alderney. MV *Frisian Coast,* a coaster which carried the stores, MFV *Yarmouth Navigator* which transported and housed 17 Port Regt detachment, and LCT 4074 which carried the vehicles and remainder of the advance party. The coaster was available at Marchwood from 28 May until 1 June for loading and at Alderney from 4 to 7 June for unloading. The MFV moved with 17 Port Regt detachment am 3 June and was available until the coaster was unloaded when she would return with the 17 Port Regt detachment to Marchwood. LCT 4074 was available at Marchwood from 0930 hrs until 1200 hrs Sunday 3 June for loading, and for unloading at Alderney from 1000 hrs 4 June, when she proposed to beach until the next high tide. This meant that the advance party had four full days and two half days to complete its task.

The Plan

General

The plan fell neatly into three phases:—

Collection and loading of stores, vehicles and men.
The sea move.
The unloading and erection of the Camp.

Phase 1

Loading plans for LCT and MFV provided no problem. The vehicles to be carried had been tailored to the LCTs capacity very early on in the exercise planning. The loading plans for the coaster were different and took some time: they involved stores depots of all sorts in Southern Command, British Railways, Customs, and 17 Port Regt, as well as ourselves. No stores could be held at Marchwood, therefore everything had to be brought in between 28 May and 1 June, when the coaster was alongside. On arrival at Alderney the requirement was for advance party stores, equipment and rations to be first out of the hold, therefore last in, followed by a balanced amount of tentage, camp structures and general stores each day thereafter. This would allow work on all items of camp erection to progress smoothly. Based on this a priority list was drawn up, which was turned into a daily loading list: stores depots and British Railways were asked to rail their stores to Marchwood on the day allotted. The stores were loaded in the coaster by 81 Port Regt RE(AER) on annual training. A Regimental representative was there throughout the loading to act as a movement controller and to ensure that priorities were observed.

Phase 2 and 3

Three days before embarkation on the 31 May, the final "O" Group was held, attended by QM, Adjt, RSM and 4 PSIs. Everyone was briefed on his particular task and issued with the plans, or pamphlets necessary for its completion. The pamphlets used were:—

WO Code 1635—Regs for Army Ord Services Part 8, Pamphlet 44, Handbook of Tentage. This gave setting out details, working parties etc, for erection of tents.

WO Code 8436 Handbook of EF Camp Structures.

WO Code 9663 Field Engineering and Mine Warfare, Pamphlet No 1, Part II.

The latter two books give details for the erection of camp structures.

The tasks were:—

Clear LCT
Set out camp site
Unload coaster and move stores to camp site
Check and segregate stores
Erect tentage
Erect camp structures
Install electricity
Install piped water supply

The priorities allowed these tasks were:—

Priority 1	Offload LCT and Coaster	
2	Erect tentage	
3	Erect camp structures	
4	Install electricity and water	

A general guide was given on how the task was to be completed so that the WO/NCO in charge of the task had his own priority list. For example, apart from living tents for the advance party, priority was given to the erection of store tents to provide cover for blankets and other items liable to damage from rain. Appx 1 gives the targets set.

The Execution

General

The exercise went as planned apart from a few minor problems, and the stores were unloaded and the camp nearly completed when the Regiment arrived on Saturday 9 June.

LCT Loading

Marchwood slip proved very unsatisfactory. The LCT could not get close enough inshore, and vehicles had to load through 4 ft of water, resulting in many vehicles "drowning". Loading over a convenient beach would have been preferable.

Stores Packaging

The packaging of Engineer Stores was excellent, but this could not be said for Ordnance Stores. Little attempt had been made to prepare stores for a sea voyage. Individual items were sent loose, or in small cardboard boxes instead of being packed in crates or other containers. Some cardboard boxes containing crockery were marked "Not Suitable for Shipping Overseas".

Camp Structures

New camp structures are clearly marked with individual part numbers. Second-hand structures appear to be creosote dipped after use but are not re-marked. Unfortunately the first camp structures out of the ship were old ones, and much valuable time was wasted identifying parts and trying to fit the structures together.

Tentage

This was shipped in large bundles with no indication of contents and again much time was wasted on part identification.

Unloading Ships

The coaster had two hatches serving the holds. Steps had been taken to see that the ship's gear was capable of lifting the heaviest load in the hold, and it was appreciated that the ship could not be worked at the bottom of the tide. What was not appreciated, however, was the fact that at Alderney the coaster would be moored in such a way that the fore-hatch could not be used. This was caused by island traffic mooring inshore of the coaster leaving the coaster's bows protruding beyond the end of the jetty. As all the camp structures were stowed in this forward hold no structures could be erected until Wednesday 6 June when the ship was finally unloaded.

Conclusion

This was an interesting exercise, the planning and execution of which provided excellent training for a TA Regiment. No new lessons were learnt, but the old one of keeping plans simple and flexible was shown yet again to be essential.

Appendix I

Proposed Target

Day	Unload Stores	160-lb Tents	Marquees	Store Tent	Cook-house	Latrines	Ablu-tions	Water	Elec-tricity
1	25%	18	2	2	1	1	1	10%	10%
2	50%		4	3	2	1	2	30%	30%
3	75%		4	3		1	4	50%	50%
4	100%	32	3			2	4	70%	70%
5		50			2		2	90%	90%
6								100%	100%
Total		100	13	8	5	5	13		

Target Achieved

Day	Unload Stores	160-lb Tents	Marquees	Store Tent	Cook-house	Latrines	Ablu-tions	Water	Elec-tricity
1	50%	9	1	3				20%	10%
2	80%	20	1	1		1		50%	30%
3	100%	21	3	2				75%	50%
4			2	2	1	1	4	90%	65%
5		16	1		1½	1	5	90%	75%
6		10	2		1½	1	4	100%	90%
Total	100%	76	10	8	4	4	13	100%	90%
Remaining	—	24	3	—	1	1	—	—	10%

Annexure C

RE (TN) ASPECTS OF EXERCISE CASTAWAY

Introduction

The movement of plant, vehicles and stores to and from Alderney, Channel Islands, was mounted as an exercise by 17 Port Regt RE. This was an ideal opportunity to exercise Tn units with live cargo on an operational task.

Three Tn units shared the Tn aspects of the exercise, viz, 17 Port Regt RE, 81 Port Regt RE (AER) and 80 (Scottish) Port Regt RE (TA).

The Tn recce and plan were made in May 62 but amended later owing to the difficulty of moving Tn personnel on the chartered coaster and the decision of the 4 Dorset (TA) to retain a large proportion of the accommodation stores on the island for their camp.

The Task

To load and discharge plant, vehicles, equipment and stores of 26 Engr Gp (TA) and the Dorset Regt (TA) at Marchwood and Alderney during the period 28 May–22 July 62.

The Overall Plan

In addition to the physical handling of the freight, RE (Tn) was responsible for the movement of RE (Tn) personnel to and from the island and the preparation of the LCT beach exit in Braye Bay.

The movement of TA personnel was undertaken by RASC LCT, the Royal Navy, and civil agencies under the aegis of HQ Southern Command.

The operation was divided into nine phases:—

Phase I	Loading the coaster.	81 Port Regt RE (AER)
Phase II	Loading the LCT.	51 Port Sqn RE
Phase III	LCT to Alderney to discharge—lay beach exit.	53 Port Sqn RE
Phase IV	Coaster to Alderney to discharge and return.	51 Port Sqn RE
Phase V	Coaster to Alderney to load and return.	51 Port Sqn RE
Phase VI	Load LCT at Marchwood and sail to Alderney to discharge (4 Dorset vehs).	51 Port Sqn RE
Phase VII	Discharge coaster.	80 (Scottish) Port Regt RE (TA)
Phase VIII	Discharge LCT Marchwood.	51 Port Sqn RE
Phase IX	LCT to Alderney and return to discharge 4 Dorset vehs.	80 (Scottish) Port Regt RE (TA)

Total consignment:—

Vehs and Plant	39 items.
General Cargo	517 measurement tons, including some 30 tons carried for the Dorset Regiment and 17 Port Regiment stevedores (excluding personnel and baggage).

Shipping and Plant

The coaster MV *Frisian Coast* DWt 978 was chartered from Coast Lines Ltd to carry the bulk of the stores and some of the plant. The LCTs *Antwerp* and *Abbeville* of 46 Sqn RASC(LCT) carried vehicles, the heavier items of plant and some passengers. RASC MV *Mull* and MFV *Yarmouth Navigator* of 43 Coy RASC(WT) transported RE(Tn) personnel to and from the island and acted as tenders to RN ships in Braye Bay to disembark passengers. In phases III and IV two Michigan 175A fork lift trucks were taken to Alderney by 53 Port Sqn RE to prepare the beach exit and help with the discharge of the *Frisian Coast*. Crane and bucket attachments were taken for the machine which remained on *Alderney*.

Braye Harbour Facilities

The *Frisian Coast* discharged in Braye Harbour which consists of two parts; a pre-war concrete walled jetty with piled footings and a war-time steel extension now in disuse, built by the German occupying forces. The pre-war jetty, which is 30 ft wide and stands 10 ft above HWS, is in the form of a shallow dog leg and provides two Type F alongside berths (200 ft). The inshore berth can only accommodate a small coaster (draught 12 ft), two days either side of the top of neaps. Two German crawler cranes, one 5 ton and the other 7 ton capacity at 25 ft radius provide craneage on the jetty.

There is no covered warehouse or transit shed and no railway line on the jetty. Road access was reasonable but became difficult at times when local imports were being landed on the jetty from the weekly coaster. The local practice being to discharge the whole of the mixed cargo on to the jetty in the minimum of time where it awaited piece-meal collection by individual importers. No agent appeared to be employed and it was interesting to note that the beer, wines and spirits were always awarded top priority when a consignment was cleared.

The confined jetty space and the spring range (18.4 ft), proved to be the greatest limiting factors to speed of discharge.

The Move to Alderney

On the 28 May 1962 the first rail wagons arrived at Marchwood and 81 Port Regt RE(AER) started to load the MV *Frisian Coast*. Loading continued until 1 June 1962 and the cargo finally included two concrete mixers, three compressors and 30 × 45 gallon drums of AVTUR stowed as deck cargo. Five railway containers loaded with bedsteads were stowed in No 2 lower hold.

The MV *Frisian Coast* sailed for Alderney at 0800 hrs 3 June 1962 closely followed by the MFV *Yarmouth Navigator* carrying the 17 Port Regt RE detachment which consisted of OIC 483 Port Maint Tp and twelve OR, and OIC 426 Stevedore Tp and twenty OR.

At 0930 hrs LCT 4079 *Antwerp* came on to Marchwood slip on a rising tide to take on 26 Engr Gp(TA) vehicles and plant. Christchurch ramps were put down and loading commenced. The Christchurch ramps were out of sight below water and vehicles had to wade through 3 ft of water. These difficulties coupled with the drivers' inexperience led to three vehicles being drowned. Two champs and eight MC were eventually loaded overside by crane from the jetty.

LCT *Antwerp* arrived at Alderney at 2000 hrs on 3 June 1962 and swung at her anchor overnight. The coaster and the MFV had arrived earlier and were tied up alongside in Braye Harbour.

As soon as LCT *Antwerp* beached in Braye Harbour on the morning of 4 June two fork lift trucks waded ashore, discharged the Sommerfeld track and work on the beach exit started immediately. This consisted of levelling a road through the sand dunes, involving cuts of up to 3 ft, and laying the trackway. The FLT rigged with a bucket was set to work shifting the hard packed sand and gravel. This proved to be too slow and the job was handed over to the size II angle-dozer as soon as it came off the LCT. The dozer made short work of the job and the trackway was complete by 1400 hrs.

In the meantime plant was being discharged from the coaster on to the jetty.

When 26 Engr Gp(TA) vehicles were available, discharge from the coaster was speeded up. To move the cargo from the jetty to the camp site, a distance of 1 mile, 3 × 3 ton vehicles, 2 × 4½ cu yd dumpers and 2 × FLTs were available. Sets were loaded on to the vehicles in cargo nets and cleared from the nets at the camp site. The shortage of labour at the camp site slowed down the rate of discharge to 5 tons/hook/hour at times. Discharge continued on

5 June working both hatches without incident and the cargo was cleared by 1700 hrs. Two gangs of five worked each hold supported by two gangs of four on the jetty.

When swung overside No 1 hold's derrick plumbed over a pile of aggregate and No 2 hold's derrick over an open stairway. The Harbour Master was unable to allocate another berth or allow the coaster to turn around.

These difficulties were overcome by covering the stairway well with hatch boards, moving, and "losing" some of the aggregate with the FLT and by pulling the coaster inshore whenever the tides and other shipping allowed. The constant movement of the coaster along the jetty face kept the ship's mate busy, and if it were not for his willing co-operation the discharge would have been considerably slower.

On the second day of discharge the railway containers in No 2 lower hold became a problem. They could only be lifted by jumbo derrick about an hour either side of high water and then with only a bare 3 in drift above the jetty. Once landed the FLT with crane attachment found it difficult to shuffle them into position for unloading. To take them to the camp site was out of the question as they weighed 5 tons. The FLT could just lift them on its forks but the road through Braye was too narrow to take the wide load with any safety.

When the third container had been discharged it became obvious that a better solution would be to leave the remaining two in the hold and make up sets from them. Most of the loose cargo was palletized which made it easy to handle and stow. It is of interest to note that two 56 lb anchors were palletized individually. They weighed little more than the steel pallet and of course would not stack. The value of palletizing this type of store is questionable.

Despite the fact that the majority of the cased and packaged cargo was not packed for export, the total of 450 measurement tons was discharged without serious damage or loss in two 8-hr working days at an average rate of 12.5 measurement tons/hook/hr. During this period the stevedores lived on board the MFV alongside the coaster and fed ashore.

The MFV slipped out of Braye Harbour bound for Marchwood in the early hours of the morning on 6 June, the coaster following later.

The first four phases of the operation had been successfully completed.

The Return from Alderney

OIC 426 Stevedore Tp plus twenty OR boarded the RASC MV *Mull* at 109 Berth Southampton at 0900 hrs 11 July and, after a 20-minutes delay to repair the ship's siren, set sail for Alderney.

On arrival at Braye Harbour the OIC 426 Stevedore Tp was delighted to find that the Harbour Master had given the *Frisian Coast* the inshore berth, where she was tied up bow on to shore, and had banned the two crawler cranes from the "green" concrete on this berth.

This meant that RE(Tn) would be the first to use the new facilities built by 26 Engr Gp(TA) and have a clear jetty.

This time the stevedores lived with the 4 Dorsets (TA) ashore who looked after them extremely well and RASC MV *Mull* returned to Marchwood on 12 July.

The loading of the coaster started at 0900 hrs on 12 July and was complete by 1700 hrs on 14 July 1962. Only three railway containers were taken this time and were loaded as they stood in No 2 lower hold.

Cargo nets were taken to the camp site where sets were made up in the vehicles, or made up on the ground and lifted on to the vehicle using the FLT with a crane hook fitted.

The return cargo of 250 measurement tons consisted of 35 per cent of the Ordnance Stores taken out, all the engineer stores and the G 1098 equipment of 26 Engr Gp (TA). All last-minute requests to accept cargo from the RASC, R Sigs and 4 Dorsets (TA) were granted as the coaster was returning light.

To lighten the load for the LCT, three compressors, two concrete mixers and eight crated assault boats were also accepted. The States of Alderney made good use of all the WD plant until the last possible moment. When the last compressor was loaded it was still hot from being used to dig a cable trench on the quayside.

LCT 4041 *Abbeville* anchored in Braye Bay at 1900 hrs 14 July and dried out on the beach at 1000 hrs the next day. The 4 Dorsets (TA) vehicles on board drove off, as they drove on at Marchwood, almost dry-shod. This proved that the Marchwood slip was not such a formidable obstruction to shipping as had been previously supposed.

Getting 26 Engr Gp(TA) plant and vehicles on board was not so straight forward. By this time, one track clutch on the size II angle-dozer had become unserviceable and the machine was limited to travelling in tight circles. The LCT recovery gear was rigged in the tank deck and using this as an anchorage the dozer winched itself on with ease. After several runs at the ramp, at 2 mph, the 10 RB face shovel got on board using an improvized trackway of dunnage to span the last few feet of wet sand.

The remaining vehicles were loaded and the LCT retracted at 1700 hrs. The last piece of cargo accepted at 1655 hrs was a RNSA 14 ft dinghy which was sailed through the bow doors by OIC 426 Tp who had borrowed it for an afternoon sail.

The RASC MV *Mull* berthed at 1800 hrs on 15 July to take the stevedores back. The skipper came ashore mumbling about . . . yachts! Later in the evening he gave a full nautical account in "The Harbour Lights" of how he steamed through the whole fleet of the Round the Island race between Yarmouth and the Needles.

The *Mull* and the *Frisian Coast* sailed early for Marchwood the next morning.

80 (Scottish) Port Regt RE(TA) discharged the coaster in two days at Marchwood and sent a small party of stevedores back to Alderney on the empty *Abbeville* to assist the 4 Dorsets (TA) to load 200 measurement tons of accommodation stores and their unit vehicles on the final lift.

To speed up the loading of the LCT much of the remaining stores were palletized. Unfortunately the remaining FLT developed a fault in the control valve of the hydraulically-operated gear box which locked the gear box into a neutral position.

The cargo was rapidly de-palletized and with the whole of the 4 Dorsets (TA) as porterage the stores were loaded and the FLT towed on board. It was a tight squeeze but nothing was left behind.

80 (Scottish) Port Regt RE(TA) completed the last phase of the operation by discharging the cargo at Marchwood. LCT *Abbeville* arrived 4 hours late because the captain had gone to the aid of a dismasted French ketch in the Cowes-Dinard race and taken her in tow to Guernsey.

The LCT came well up the slip, discharged the vehicles "dry shod" again, retracted and tied up alongside the Marchwood jetty.

The loose cargo was craned off by the Stothert and Pitt 6 ton quay crane and a lorry mounted Jones 10/6 rough terrain crane working into rail wagons.

Lessons Learnt

In this and all operations of its type it pays dividends to make a point of keeping the closest possible liaison with Masters of vessels, the Harbour Master and the Island authorities. Once a mutual trust had been established and each other's problems understood every hitch was ironed out and changes of plan accepted without query.

During the discharge of stores at Alderney it became obvious that advance party stores were not clearly marked and were not top stow.

A classic example of this was the consignment of latrine seats which the advance party needed urgently; they were finally found as bottom stow on the ceiling of No 2 hold.

Although the whole cargo was consigned to one unit at one port more care should have been taken in planning the stowage and marking priority items.

Once the railway containers were put on board the coaster they became a liability and in future operations in Alderney their utility must be measured against the facilities to handle them at their destination.

All cargo consigned to Alderney should have been export packaged. During the exercise several stores were spoilt or damaged owing to inadequate packaging. Examples were, 1-pint glasses in flimsy cardboard cartons, protective clothing in unbanded cardboard boxes, and 2-pint jars of pickles in lidless carboard containers.

In future operations of this kind a radio link should be established between the military radio station on the island and LCTs and shipping to pass information on delays, pilotage and berthing parties.

Conclusions

An exercise of this type is an ideal opportunity for Tn units to handle live cargo and Exercise Castaway proved to be of great training value.

The usefulness of a military container which will fit into a Dukw and a 3-ton GS vehicle and can be handled by a fork lift truck is apparent. Properly designed it would serve the following purposes.

a. Covered transport (for perishable weather sensitive goods).
b. Export packaging.
c. Cargo handling gear (only slings required).
d. Covered warehousing.
e. No pilferage.
f. Security.

More important it would eliminate the extremely inefficient double handling of cargo which is the current WD practice.

Once loaded at depots, cargo stowed in containers of this type need not be broken out until it reaches its destination regardless of the method of discharge or transport employed.

Time and manpower savings could be effected in the documentation, handling and clearance of cargo stowed in this way.

A design study should be started at once to establish the optimum size and payload and the most suitable construction for a WD container.

Photogrammetry

By Professor E. H. Thompson, obe, frics

Paper to be discussed at a professional meeting to be held conjointly with the Royal Institution of Chartered Surveyors at their London Headquarters on 28 January 1963.

It is not difficult to accept an invitation to prepare a paper for an instructed audience of members of two very distinguished Institutions. It is flattering and it is a long way off; but there always remains a small doubt, which grows bigger as the time approaches, about one's ability to go even a short way towards reaching an acceptable standard. The subject matter is not the least of the difficulties, particularly in this instance when an outline of photogrammetry is obviously unnecessary and when a detailed discussion of some specific technical problem is out of place. Neither of these subjects would present great difficulty, but something else is obviously required. It is now more than twenty-five years since I began to work seriously at photogrammetry: in fact almost exactly a quarter of a century of work, if time spent away from the subject is discounted. Traditionally, this gives an excuse for reviewing progress, criticizing the present position and attempting to forecast the future, and I will, without necessarily committing myself to covering every aspect systematically, do this and try to raise a number of points within this framework that seem to me to have some importance.

In the early Thirties the word *photogrammetry* was itself not a word much used in this country: it certainly did not have official approval when I started my serious work as Research Officer to the War Office Air Survey Committee in 1934; and, although some word is presumably necessary to cover the science of the measurement of photographs, not only those taken in the air, *photogrammetry* has not, in my opinion, been an unqualified success. I am going to make no excuse for spending some time on this point. All modern technologies are full of jargon and I am sorry that *photogrammetry* has become jargon. It has, of course, all the qualifications for it. It is long enough, it sounds slightly foreign, and, while only the relatively few in the know understand what is meant by it, the ignorant are somewhat impressed by it, academicwise and scientificwise. I have three specific objections to it. First, it does not cover all aspects of photographic measurement. I am at the moment designing and building a portable zenith camera for field observation of latitude and longitude; and I think it would be generally agreed on all sides that I am engaged not in photogrammetry but in geodesy. On the other hand, and second, it seems to cover all activities that require the use of air photographs whether they involve measurement or not. Thus a soil survey carried out with the help of air photographs would be classed by many as a photogrammetric activity; although a photographic survey of a cathedral, in the absence of measurement, would certainly not be so described. These last notions have had and are having particularly undesirable effects and I will return later to the problem of the interpretation of air photographs. Third, the word is exclusive in a way that can be justified only at the lower levels of the technology. The present very high development of photogrammetry would have been quite impossible had it not been such a very valuable tool for the preparation of maps; and only for this reason have very large sums of money been spent on the development of instruments and methods over a period of at least half a century. And yet there are those who would feel somewhat put out by being described as surveyors but flattered at being called photogrammetrists. What is worse, there is certainly a view that a man can take a relatively important part in map making without knowing anything at all about what he, as a photogrammetrist, would call surveying. The word *engineer* has had, up to recent times, if it has not still, a slightly low level implication in this country, due to its original use during the Industrial Revolution for the man who tended the machine. It would be considerably more healthy for our subject if *photogrammetrist* were to be applied only to the tender of the plotting machine and not to those, who aspire, by education and experience, to apply photogrammetry in an intelligent way to the various problems for which it is suited. After a quarter of a century I have reached the point when I can write *photogrammetry* without too much difficulty, but when I am asked what I am, I still find the word *photogrammetrist* sticks in my gullet, as someone said on a famous occasion. It was encouraging to see these, perhaps at one time exclusively British, prejudices recognized on the Continent when the now well-known school at Delft in the Netherlands was founded by Professor Schermerhorn under the title *The International Training Centre for Aerial Survey*. If I had been asked to bet on what the title might have been I would have lost my money.

Looking back on the pre-war years I do not think I am exaggerating when I say that the word *photogrammetry* has done us positive harm, through our own fault. *Air survey* on the one hand and *photogrammetry* on the other became identified in our minds with the practical and the academic (they are still so identified, I think, which is why those with no academic knowledge like being called photogrammetrists). This view undoubtedly influenced us in our estimation of the importance of the more elaborate instruments that were being developed on the Continent under the term photogrammetry. On a short view we were right: on a long view we have suffered for it. I would hope that, if we continue to use the words photogrammetry and photogrammetrist (and we will, for we do need them) we will try to use them in an honest way and not as a means of giving a spurious importance to activities, people and organizations.

Private Enterprise

One of the phenomena of the air survey era has been the entry of private organizations into the field of surveying. Someone must have thought there was money in it, although conversations, before the war, with those actually engaged, never convinced me that they, at any rate, thought so. However that may be, the private companies have flourished and are still with us and there are a number of reasons, some political, some technical and some economic, why it would be most unfortunate if the reputable companies were to disappear. Politically, the position can be summed up quite simply: the flag is somewhat faded and it would now be truer to say that in the undeveloped and under-developed countries trade not only follows the air-photograph but can be its direct result. Technically, we owe much to the private companies. Throughout the history of surveying from the air, the companies have shown us that an extremely high standard of flying and photography can be achieved with the right organization; and it is a pity that it seems beyond the ability of Defence Departments and Civil Government organizations to follow suit. The explanation is quite simple: good results are achieved only when the air crews and photographic units feel themselves part of the whole mapping organization and when there is considerable specialization by pilots and navigators in the particular tasks involved. The years have shown that no high class work can be produced by a flying organization in which training, promotion and cross-posting are in the hands of an authority that has no responsibility for (even if it has any interest in) the quality of the ultimate product. If a Civil Government organization feels that it cannot justify the maintenance of a flight under its own control then I seriously suggest that the only possible way to obtain satisfactory photography is to place contracts with the private companies. It is, of course, otherwise with the Defence Departments who must solve the problem differently; but, for them, financial considerations should not be paramount and more freedom for re-organization should be possible.

The contributions of the private companies to mapping techniques have been complementary to those of the Government departments. The private company is concerned with doing all it possibly can to complete any task as cheaply as possible, while, of course, meeting the specification demanded. They are very quick, therefore, to try out ideas that are likely to have an immediate effect on output and cost. The considerable effort made by one company in the development of devices for automatic contouring is a case in point; and many of the refinements that make the modern plotting instrument rapid and efficient are a result of the demands and suggestions of the private company. On the other hand developments that are more fundamental, whose economic advantages are not proved or whose successful outcome is problematical have been largely neglected, for obvious reasons. Thus, a very considerable amount of work has been done in the past ten years on analytical methods of aerial triangulation, most, if not all, by institutions and Government departments. Perhaps this is understandable, but it should not be inevitable.

If I may risk a criticism of the techniques of private companies, based on a general impression rather than on a deliberate investigation, it is that they appear to favour any method of carrying out a task that avoids calculation however simple. I do not believe that this is because calculation is rejected as being inefficient, but simply because, broadly speaking, training in calculation does not form part of the education of their employees. Could this be due to preconceived ideas about what a "photogrammetrist" is? The lack of interest in analytical methods may arise partly from this and the time may soon come when something will have to be done about it.

At one time it was the aim of national mapping organizations to satisfy all public demands for new surveys, if not for drawn maps. If this aim was never achieved, it was squarely attributed to the obtuseness of Governments who would not vote sufficient supplies for the purpose. The air photograph has caused a revolution in map making and one of the effects of this revolution is to make it even less possible for national organizations to satisfy all our mapping needs. I am not sure whether the implications of this revolution in map-making are altogether clear. Contrary to early predictions, the air-photograph can now be used to produce maps, particularly contoured maps, that are, at all but the largest scales, more accurate than those surveyed by the conventional methods, but, while this is gratifying, it does not constitute a revolution and its effects are not highly significant. It is even possible that maps surveyed from the air are cheaper than those surveyed on the ground, but I would not be prepared to argue the point, certainly not to discuss it as it was discussed at length in the years between the wars, for again it is not of the highest importance. What constitutes the revolution is that the air photograph can give us a map in time to make some use of it; and it can do this even in areas where no map was possible by conventional methods. The military, in spite of its reputation for fighting earlier wars, saw this immediately: it took rather longer before all its peaceful implications were realized. Conventional mapping is slow, in fact so slow that it is not worth making maps for specific development purposes, unless of very limited extent. The development cannot await the maps and must therefore suffer, as, indeed, it has suffered on many occasions in the past. From this consideration arises the notion of the planned national map: it may take ten years, or twenty years or fifty years, but when it is finished it is available for all to use for any purpose. In the circumstances, it is the best that can be done and it is to this policy that we owe the 25-in and 6-in plans of the United Kingdom and the 1-in series of the Survey of India, among many others. A policy of attempting to meet special requirements as they arose would have been disastrous, for the results would have served no useful purpose at the time and nothing lasting would have been achieved. The disadvantages of a National Survey are, first, that a national map is to a greater or lesser extent always out of date; second, that by trying, inevitably, to satisfy all requirements within the bounds of its scale, it satisfies none properly; third, and perhaps most important of all, that economic reasons prevent it satisfying engineers' requirements even when the scale is sufficiently large, which it is often not. For example, the Ordnance Survey 25-in plans carry no contours; and British Railways require plans at scales of 1/480 which the Ordnance Survey cannot supply.

The speed with which a map can be produced from air photographs has changed the whole situation. It is now no longer impossible to make maps for specific development projects, and which will be ready, not only for construction, but planning. The survey of the basin of the Kariba lake is an example: 11,000 square miles were surveyed at a scale of 1/25,000 with contours at 25 ft vertical interval in a period of fifteen months. The possibility of carrying out such surveys usefully does not make the national map unnecessary. For a number of purposes, mainly administrative and military, a continuous map of part or of the whole of a country is required and the national survey must obviously continue, with the help, one hopes, of the air photograph. But if the national survey is well organized to carry out this work efficiently it is not going to be the best instrument for *ad hoc* surveys required in the shortest possible time, in many cases virtually regardless of cost. This is a requirement that can be very well satisfied by a private organization which has, in any event, the political advantage of being able to work in a foreign country without an official label round its neck. That *ad hoc* surveys are necessary even in a well-mapped area and can be provided in time is illustrated by the fact that air surveys at a scale of 1/500 with contours at 1 ft vertical interval have been, and are being, carried out over projected motorways in this country.

This is perhaps the place to add that, when all is said and done, the photogrammetric map is still only a map and that, while the air photograph has uses in addition to this, e.g. for estimating the properties of the soils and subsoils, it is too much to say that these methods have caused a complete revolution in civil engineering. There were great men before Agamemnon and there were great arteries of communication before the motorway.

Before the war it was one of the contentions of Government surveyors that the profit motive in surveying would be disastrous. A map can look the same whether it is accurate or inaccurate, and a contractor has a good chance of pulling wool over his clients' eyes if, for any reason, he wishes to do so. Fortunately this outlook seems to have vanished with other prejudices against the private contractors; and they have achieved a position of which they can be proud, but which I suggest they must be careful to safeguard. It is encouraging that it appears to be the companies themselves who are most concerned about maintaining a high standard, and from time to time professional safeguards have been suggested. I would, myself, be against a professional organization attempting to control the standards of work by maintaining a list of satisfactory contractors. This would place an intolerable responsibility on the organization and would lead to endless bickering, or worse. It is surely a case to which the principal of *caveat emptor* can be applied with reason. The clients are not gullible private citizens; they are Government Departments, engineering consultants or contractors, or local Government Departments, all of whom are continually placing contracts. All have enough experience to be suspicious, among other things, of a tender that is very much below the rest; and it must be presumed that they would make suitable inquiries before accepting it. Clients have not yet begun to employ consultant photogrammetrists in large contracts in the way that architects or consultant engineers are used, and it might be advantageous if they would do so. Unfortunately the tendency in the engineering world is for contractors to take on more and more of the work that was, at one time, thought to be the responsibility of the consultant; and the air survey companies have always acted as advisers as well as contractors. It might be difficult to reverse this trend, though the International Training Centre for Aerial Survey at Delft has announced that it is prepared to act as a consultant on photogrammetric matters. In the absence of independent consultants, clients can take the simple precaution of asking for references from previous clients or asking the advice of such bodies as the Ordnance Survey or the Directorate of Overseas Surveys.

Reverting for a moment to tenders that are very much lower than the rest, I would say that a cheap price does not necessarily mean bad work. Good work can be done cheaply by organizations that are not too ambitious. A firm that is prepared to take on small contracts in accessible areas will carry very much smaller overheads than one that is organized for work in any part of the world. A large, well equipped organization may be capable of a very wide variety of tasks, but it is not thereby necessarily any more efficient for small, simple well defined jobs than a firm whose capabilities are severely limited: in fact the contrary.

We should not forget that all the private companies owe their existence to the fact that, for better or worse, we live in a world in which private enterprise is allowed to flourish; and the only possible justification for its continuation is that its efficiency is ensured by competition. We should not support any steps to remove the competition without very good reason.

These remarks have not so far been very constructive and I suggest that the following might relieve the situation, even if it will not cure it. While it is certain that the client should be on his guard, there is no reason why we should not help him to judge the merits of any tenders submitted to him. I suggest that all interested parties might form a committee to consider the problem and that this committee should prepare and issue a pamphlet setting out the characteristics of mapping from air photographs. This pamphlet will state, among other things, what the photograph can and cannot do; the accuracies to be expected with different types of equipment; the photography that is required to give desired results and the types of map that are needed for different purposes. The pamphlet would be given the widest possible circulation in this country (where one imagines that the situation is most acute) and should do something to make potential clients aware of the pitfalls. The committee could go beyond this by being prepared, for example, to answer technical questions, but I think this would be premature and the preparation of a pamphlet is likely to be less controversial and easier to organize. If agreement cannot be reached about the contents of a pamphlet it is not likely that it could be reached about anything else.

PHOTO-INTERPRETATION

Earlier in this paper I mentioned that certain non-metrical uses of air photographs were generally included within the science of photogrammetry. Commission VII of the International Society of Photogrammetry deals exclusively with problems of air-photographic interpretation. I have always thought this to have been inadvisable, though, if it were simply a matter of giving a roof to a homeless offspring there would be no harm done. My objection is that photo-interpretation is not an offspring of photogrammetry and has no business at all to pretend that it is, and that it does a service neither to interpretation nor to photogrammetry to confuse the two broad subjects.

The only important connexion between photogrammetry and photo-interpretation is that both make use of air-photography, the latter (in the usually accepted sense of the word) almost exclusively but the former by no means always. Of course photo-interpretation sometimes involves a little elementary photogrammetry: the dips of strata are sometimes measurable on the photographs; the heights of trees can be estimated with some precision; and a photo-interpreter may have to use the photographs to prepare a base map for his work. But there is nothing very new about this. Geologists have often had to face the problem of preparing base maps; foresters have always had to measure the heights of trees; and dips have had to be determined in the field. These activities have never had the effect of describing geologists and foresters as surveyors, or, more seriously, of supposing that surveyors could do their work. We had to await the arrival of the air-photograph before we heard such nonsense.

The difficulties of photo-interpretation are primarily difficulties inherent in the subject that the photograph is intended to help. An interpreter of geological information must be a geologist who has learned to use the photograph; a military interpreter must be someone whose first knowledge is of military matters, not photographs; and so on. I suppose archaeology is the only subject in which the interpretation has always been left severely to the expert; and, although one would like to feel that this is due to a becoming modesty on the part of the "photogrammetrist", I fear it is because there is no money or publicity in it. I hope there is no one who will think I am overstating my case, but, if there is, let him consider for a moment the value to the Army of a photo-interpreter who cannot immediately recognize a type of tank or gun when he sees it in the village street, never mind on an air photograph. I am probably out of date, I hope I am, but in my time photo-interpretation was a branch of intelligence work that the services felt could be safely left to amateur warriors and expert "photogrammetrists": I would have thought that it was essentially an occupation for the professional officer. The man who recognises all military equipment, who knows the kind of dispositions military formations can take up on roads or deployed, who knows the kinds of camouflage precautions that are usually adopted will take to the photograph with very little instruction.

Having thus castigated self-appointed "photogrammetric" interpreters, I must be fair and say that, if they exist, it is partly because (apart again from archaeologists who were pioneers) the value of the air photograph to several professions was not very quickly recognized by members of those professions. The virtual neglect of air-photographic intelligence by the Services until it was forced on them by those who, in my opinion, had no business to be doing it, is well-known. The fault lay, and I am afraid still tends to lie, with the professions themselves though they are discouraged from doing very much about it by the aura of expertise that the "professional" interpreter spreads around him. This is one of the disadvantages of setting up photo-interpretation as a profession. The other is that the interpreter has an axe to grind and inevitably tends to overstate the value of the air-photograph. A geologist who can handle a photograph will know when it is useful and when it is not; and he will know what information it can give and how reliable that is: he has no vested interest in being anything but completely objective about the matter and if he thinks he can do better with a hammer he will use one. Ironically, with the exception of archaeology, it is photogrammetry (using the word in its true sense) that has had no use for the professional interpreter. The surveyor has always taken the view that if he measures the photograph he must also interpret it, for how, otherwise, will he know what to measure?

I think that the help we can give to the other professions is to encourage them to use photographs and to point out that, while there may be many difficulties in using photographs for qualitative information, these difficulties can only be overcome by highly trained members of the particular profession and not by outsiders who think they know all about photographs. There is no doubt that we are experts in extracting quantitative information from pictures and we should help the less qualified professions by devising methods to solve their problems and training their members to carry out the work.

In conclusion I should not like it to be thought that these opinions are in any way an attack on those private organizations that have photo-interpretation divisions. These organizations take air-photographs as a main part of their business—and they are entitled to use them as fully as possible. My plea is simply for having the right type of man to do the interpretation; and to treat interpretation, not as a branch of "photogrammetry", but as a part of whatever subject the interpretation is supposed to be helping.

Non-Topographical Photogrammetry

A branch of photogrammetry that has been very much neglected in this country is what is called non-topographical, in that it deals with all applications other than the making of maps. The reasons are fairly obvious and arise in the first place from the lack of interest shown in photogrammetry in the past by our academic institutions. The professional surveyor has had no interest in the problems and there is no reason why he should have had. But there are a number of applications that are useful and, as a person whose interest must extend to all aspects of the subject, I am always asking myself how these can be fostered.

Let me start by saying that overstating the case can be of no help to anyone. Photogrammetry can be useful only if direct measurement is impossible, impractical or uneconomical. As a method of measurement, as such, it has very little to recommend it. One has only to compare the simplicity of the principles and tools of plane-tabling with what is involved in solving the same problem with air photographs to have an illustration of this. We did not adopt photogrammetry for topographical surveying because it was technically easier than plane-tabling. To reduce the dimensions of a large object many times to the scale of a photograph with all its defects, such as its grain, the instability of the base, if this is a film, the instability of the emulsion on the base, if this is a glass plate, and the relatively poor optical imagery (which is considerably worse than that of a telescope) is not exactly a good way to begin accurate measurements. However, there are times when it is of some advantage to do this and worth while to put up with the consequent troubles. Broadly speaking photogrammetric methods of measurement are useful in the following conditions: first, when the object to be measured is inaccessible or difficult of access; second, when the object is not rigid and its instantaneous dimensions are required; third, when it is not certain that the measures will be required at all; fourth, when it is not certain, at the time of measurement, what measures are required; fifth, when contours of the surface of the object are required; and sixth, when the object is very small, especially when it is microscopically small. I will take each of these six categories in turn and give examples in which, I think, photogrammetric methods have been usefully employed. I should, of course, say that all photographic measurement is not photogrammetry (as I mentioned earlier in this paper) and I will confine myself only to examples in which the dimensions of solid objects are required.

The inaccessibility of much of the Earth's land surface is one obvious reason why topographical photogrammetry is so valuable. Large objects such as cathedrals and aerials for radio telescopes are also inaccessible and cannot be measured without the erection of elaborate scaffolding or the employment of tedious and uneconomical optical methods. The value of instantaneous measurements of flexible objects has possibly been underestimated owing to the difficulties in carrying out direct measurements. Examples in which photogrammetry has been usefully employed are measurements of the shape of deep sea waves, and, more recently, measurements of the surface dimensions of beef cattle with the idea of correlating these with the quality and quantity of the meat.

It seems perhaps a little peculiar that we might have to make measures that may not be required, but this is a common occurrence in the recording of ancient monuments of all kinds. Cathedrals and houses that can be damaged in war or destroyed by fire in peace, are all objects whose dimensions may be required at some time, but not necessarily. If they are photographed under proper conditions, the photographs will be measured only when the need arises. In this way much labour and cost is saved.

Again, the photograph allows the measurer quite a bit of hindsight. Can one be quite sure at the time that direct measures are being made that these are complete? It is difficult, but much less difficult, to ensure that the object has been adequately covered by photography. In an example quoted by the Belgian Commission Royale des Monuments et Sites, 250 pairs of photographs were required to cover completely a moderately-sized medieval church. It is asking a good deal of a man on the ground that he should take off, at the time, the dimensions of all the details that might be required for a reconstruction.

Photogrammetric plotting machinery, developed mainly as a result of topographical demands, is chiefly of value in non-topographical problems if contours are required. In other cases it is very often more accurate and generally more satisfactory to make rather simpler measurements from which the three rectangular coordinates of discreet points can be calculated. If an object is not too large and not too small it would not be difficult to devise a relatively simple apparatus for contouring its surface directly. However, the fact remains that no such apparatus is, so far as I know, available and if it were, it would doubtless be somewhat inflexible. On the other hand, any object that can be photographed can be contoured with apparatus that exists and which can be used with relatively little instruction by those who do not call themselves photogrammetrists. Even as I write these words I am being asked, by the Department of Zoology at University College London, for my views on the possibility of plotting the contours of teeth having a length of 1 mm.

In the sixth category I have placed the measurement of very small objects. Here, contrary to what I stated above, the photograph should certainly lead to considerably better accuracy than direct measurement. The conventional microscope objective and the modern electron microscope objective allow us to obtain photographs that can be measured relatively crudely. Direct measurements would be, at best, very difficult, and, in the case of the finest structures that require the electron microscope, impossible.

Thus a reasoned case can be made for non-topographical photogrammetry, but it is not always easy to see how it can be applied in practice. The problem is, to some extent, similar to that of photo-interpretation. In almost all cases a knowledge of the subject to which the objects under scrutiny belong is necessary, and yet, at the same time, a greater or lesser degree of photogrammetric knowledge is essential. On the whole much more photogrammetric knowledge is required than for interpretation. At one end of the scale, such as in the photogrammetry of ancient monuments, the work must be carried out by men trained in photographic and non-photographic surveying. At the other end, such as in the photogrammetry of standard objects like teeth, it should be possible to train a zoologist, who is already a competent photographer, to handle apparatus sufficiently well under fixed conditions to give him what he wants.

One of the difficulties is to disseminate the knowledge without overstating the case and then to help interested people to apply the techniques. As the Head of a University Department I feel that my task is to train students in the basic techniques, which will principally be those of topographical photogrammetry. However, if a non-topographical problem crops up of sufficient difficulty, and is one that is likely to lead to the setting up of a permanent unit or to involve useful research, trained students can be encouraged to take an interest. I have some hope that it is going to be possible to set up an experimental unit on these lines for the Royal Commission on Historical Monuments. For the problems of less technical difficulty, we are prepared to devise methods and help in the design and construction of any special apparatus that may be necessary. In such cases the work, possibly even the experimental work, will have to be done by someone from the body interested in the application; though we would, of course, undertake limited training. In fact, if non-topographical photogrammetry is to become more widely used in science and industry, those interested must be prepared to do the work themselves, relying on the professional for advice, development and training. A commercial organization might be prepared to undertake work in special cases, but it is doubtful if it would think it worth while spending the time on the development of apparatus and methods, unless a large amount of routine work followed.

Some problems seem to have a relatively easy solution. Since I learned that the Royal Commission on Historical Monuments was interested in detailed surveys of hill forts, I have been wondering why the work cannot be done by the Ordnance Survey (which has suitable equipment and trained men) under the technical direction of its own Archaeological Officer. I suppose it is another case of the left hand not knowing what the right hand wants.

Technical Developments

I feel I cannot conclude this paper without a few remarks on two recent technical developments, since this should not only be of general interest but has been my own particular concern during my working life. It has for long been contended in this country, by some of us since about 1936, that the problem of aerial triangulation is best solved by digital computers and not by analogue methods. The, so called, photogrammetric plotting instrument is an analogue computer and, while no one would contend that it is not an extremely efficient and accurate instrument, there are reasons why it is not, on the face of it, the best tool for the work. There are, to all intents and purposes, no limits to the accuracy which is desirable in an aerial triangulation, for increases in accuracy can always be usefully absorbed by a reduction in the density of the control on the ground. The analogue computer has reached a very high state of mechanical and optical development, but it is a complicated instrument and, other things being equal, it cannot be as accurate as a simpler instrument. The alternative is to use the simplest possible instrument to measure the pictures, in practice to obtain rectangular co-ordinates of points on the photographs, and then to reduce these measures by digital computation which does not introduce further error, though it can introduce mistakes. The measures can be carried out in two ways, either on pairs of photographs simultaneously, or, monocularly on each photograph separately. I would hesitate at this stage to say which method will ultimately prove the most accurate and convenient, but it is worth considering the characteristics of both.

I think it is not being too rash to say that an aerial triangulation cannot be carried out in practice without marking some points on the photographs. In 1938 I designed an optical marker for use with a stereocomparator and which enabled a strip of unmarked pictures to be triangulated, but it was not very practical and would certainly have been even less practical had it been used between strips. It is necessary that points should be marked to enable scale and position to be transferred through a strip and between strips and, what is more obvious but less often stated, to record the points that have been measured and whose map co-ordinates will ultimately be known from the aerial triangulation. As a result, it is now being argued, particularly in the United States, that if all points are marked on all photographs as a preliminary and separate operation to measurement, the latter is considerably facilitated not only because it then requires only a monocular measuring instrument, but because artificial, man-made marks can be measured automatically or with the aid of photo-electric cells that will increase accuracy and reduce fatigue. There is also the argument that a monocular instrument is cheaper than a stereocomparator, though this can be of interest only if there is very little otherwise to choose between the methods.

These arguments do, I feel, over simplify the problem somewhat. They tacitly assume that points can be marked without loss of accuracy; and at the moment this is not true. A stereoscopic measurement of unmarked points is certainly better than that of physical marking and subsequent monocular measurement; and the modern developments in aerial triangulation have accuracy as their goal. The fact of the matter is that the most important measures, i.e. those within a strip that are required for relative orientation and the transfer of tilts, can be made, and are best made, on unmarked points. Time will undoubtedly show which method is most economical and which can give us the best accuracy, but for the moment it seems to me to be somewhat illogical to strive after ever increasing accuracy and, at the same time, introduce a new method of observation that tends to reduce the accuracy, at any rate of the most important measures. It is difficult to know how much weight to give to psychological points, but one disadvantage of complete pre-marking is that the marking operator has no direct contact with the measures and may therefore tend to be less conscientious, particularly if he is pressed to work as fast as possible.

An alternative method is to mark simultaneously with measurement. We have designed a point marking device at University College that can be fitted to the Hilger and Watts Recording Stereocomparator. It was constructed under the supervision of Mr. Ian Harley who has carried out a number of tests with it, although it has not been possible, as yet, to fit it to the stereocomparator. The device makes a good circular mark about 30–40μ in diameter, with the position of its centre repeatable with a standard deviation of $\pm 4\mu$ from the mean: and there seems to be no reason why this should not be reduced to $\pm 1\mu$. Unless, and until, the device is tried out in practice it will be difficult to say whether it is a practical proposition to mix the measures with the marking. The technical advantage of the device is that, where it is possible and advantageous to measure an unmarked photograph, the marking can be done after the measures have been recorded.

Apart from the increased accuracy that arises from the use of very much simpler measuring equipment which may have standard errors of as little as a quarter of the best analogue plotting instruments, the advantage of the digital method is that geometrical photographic defects can be corrected in a way that is difficult, if not impossible, in plotting instruments. It is, for example, difficult to compensate for the distortions of a particular lens, the usual practice being to introduce devices that correct for the average distortion of the particular *type* of lens. Lenses, especially modern wide-angle lenses, tend to have asymmetrical distortions that are relatively serious and it is impracticable to correct for these in an analogue plotter. Defects of this type (including, for example, errors due to atmospheric refraction which can be considered constant for a set of photographs taken with one camera) can be eliminated in a type of plotting instrument now being constructed by the National Research Council of Canada. Here a relatively simple measuring instrument of the type of a stereocomparator is joined to a digital computer with suitable feed-back devices and servo mechanisms that transform the stereocomparator movements into ground co-ordinates and heights and, so far as the operator is concerned, allow the equipment to be used as an analogue plotter. Whether this instrument will be sufficiently cheap to compete with the analogue plotter, where a graphical output is required, and with independent digital computation for aerial triangulation, remains to be seen. Such an instrument on the other hand, unless it is used simply as a stereocomparator, does not seem capable of allowing for those defects that vary from one picture to the next. These are geometrical errors arising from deformations of the film base and flatness of the film itself. The only way in which it seems possible to reduce the effect of these is to introduce into the camera an accurately calibrated grid and to make measurements of photographic points in relation to the nearest lines of the grid. This grid, which was suggested in this country and introduced into a British camera before the war, has at long last found its way into a camera having a modern, high-resolution lens; and we are all awaiting the first results to see what improvement in accuracy, if any, will result.

Before leaving the problem of accuracy it might be of interest to consider what limits if any, there are to this. In principle, though perhaps chemists will contradict me, there seems no limit to the speed and resolution of photographic emulsions; and there are certainly optical systems in existence with better performances than the best camera lenses available. Fast emulsions can, again in principle, be used to counteract the effect of aircraft movement during exposure and make to this effect arbitrarily small: but this is where we get into trouble. Air turbulence causes erratic movement of all optical imagery, as any surveyor will confirm, and, the shorter the exposure, the more likely it is that the mean image position will be in the wrong place. The reason why ground theodolite observations can be made to give such good results is because, first, each visual pointing occupies an appreciable time and the observer bisects the mean position of a moving image, and, second, because he can repeat his observations a number of times. Neither of these considerations apply in photographic surveying from a moving vehicle and it is, therefore, air turbulence that will in my opinion put the limit on the accuracy of photogrammetry from the air.

Another recent development in photogrammetry that is likely to have some far reaching effects, is the ever-increasing employment of high speed digital computers in the adjustment of blocks of air photographs. In principle there is nothing in this problem that makes it different from the classical problem of adjusting geodetic triangulation networks: in fact the geometrical regularity of aerial triangulation can be turned to advantage. What makes the problem difficult is its magnitude. For example a block comprising ten strips each of twenty photographs will have not much fewer than six hundred unknowns to be determined in plan alone, and, although it is certainly true that the matrix of the normal equations tends to have a special form, the problem is formidable. There is no digital computer in existence that has a sufficiently large capacity to solve such a set of equations by direct methods and we are having to employ iterative or step by step methods of solution. The theory of these methods, such as, for example, the theory of their rate of convergence, is not simple and it is regrettable but true that surveyors interested in these problems will have to learn a good deal more about the theory of linear equations than has been thought necessary in the past.

The high-speed digital computer is of the greatest value to surveyors once the relevant programme has been written; and this is the snag. Some programmes may take as long as six months to devise and test and this is not of much value for a single computation that could be completed in four months on a desk calculator. Another trouble is that, for the very special computations that concern us, not much help, in my experience, is likely to be offered by the professional computers. Furthermore, a really efficient programme can be devised only by someone conversant with the problem itself. Thus it looks as if the surveyor will have to begin to include programming instruction in his education; though this, of course, can be obtained in many places, such as the University of London Computer Unit. I am glad to learn that all RE officers attending the Long Survey Course now spend some time on high-speed digital computation.

Conclusion

A variety of topics have been touched upon in this paper in a way that I hope will start some discussions when the joint meeting of the Institutions of Royal Engineers and Chartered Surveyors is held in the New Year. I hope that I will not then have to repeat much of what I have written and I will endeavour to exemplify some of my points with illustrated examples.

I am grateful to Brigadier L. J. Harris for having read this paper and for having made a number of useful suggestions.

Correspondence

Major G. Horne, AMICE,
Ditchling, Sussex.
7 August 1962

To The Editor,
The RE Journal.

THE OPPORTUNITIES FOR "CIVIL ENGINEERS" IN THE CORPS

Dear Sir,

Colonel Cartwright-Taylor's article on "The Opportunities for Civil Engineering Graduates in the Army" tends to give a false impression unless one is careful not to confuse "Civil Engineering Graduates" with "Civil Engineers".

For "Graduates" there are opportunities, as they are still young enough to forsake engineering and concentrate on obtaining a vacancy at the Staff College. For "Civil Engineers", and by that I mean officers who are Corporate Members of the Institution of Civil Engineering or who have passed the Long Course, there are now practically no opportunities above the rank of Major.

Whilst agreeing with the main theme of Colonel Cartwright-Taylor regarding the wide range of experience available to Junior officers of the Corps I disagree that, at thirty, an officer should "have little difficulty in obtaining an Associate Membership of the Professional Institution of his choice". In the present day Corps hardly any officer is likely to obtain the necessary experience to become an "Associate Member" unless he has been on a Long Course and once he has been on such a course he cannot, as a general rule, go to Staff College and without "*psc*" his ceiling is extremely limited.

May I "prove" my last statement by referring to the *RE List* for May and the qualifications of the seventy-three Lieut-Colonels:

Staff trained	49
Tn Postings	7 (2 of these also *psc* and 1 also "C").
SVY Postings	8
ptsc	3
E & M	1
C and AMICE	3
C	2 (1 on a Tn posting).
No special qualifications	4 (2 of these were promoted in "Works" before civilianization).

One might go farther and consider the twenty-eight temporary Lieut-Colonels:

Staff trained	15
Tn Postings	2 (1 of these also *psc*).
SVY Postings	7
ptsc	2 (1 of these also E & M and 1 also *psc*).
E & M	2
C and AMICE	1
C	Nil
No special qualifications	2

From the above it will be seen exactly what opportunities are, at present, offered to "Civil Engineers" also bearing in mind that in the few available senior ESSE postings there are one Colonel and five Lieut-Colonels, all staff trained, as opposed to only three Lieut-Colonels with the qualification "C".

I do not presume to criticize the above postings and accept that they may well be to the advantage of the present-day Corps, but I do feel that it is high time that we "got our heads out of the sand" and accepted the fact that there is now practically no future for the purely technically trained Sapper officer.

Some time ago considerable correspondence was sparked off by Brigadier Brown's article "Wither the Corps". We now have the answer to that query in that civilianization of "Works", carried out with indecent haste, has turned us into the "Royal Field Engineers and Staff Corps" and all "career" officers should be told, at all stages of their service, to concentrate on *psc*. We must stop the present practice of pretending that there is still a future for the "pure engineer" and then, at the vital stage of their lives, leaving officers with the alternatives either of no further prospects or of entering civilian life at a total income which is likely to be lower than in the Service, even allowing for their pensions.

I feel that this letter is long overdue and I would respectfully suggest that the above facts are faced up to, that the Long Engineering Courses are stopped as a waste of money and effort (how many students from the early courses are still serving?) and that attachments to civil firms are given wholly to Staff trained officers as they only have any incentive to stay in the Corps.

I would conclude by saying that the true future of "Civil Engineers in the Corps" seems to be indicated by the fact that there is now no Civil Engineer School at Chatham.

Yours faithfully,
G. Horne, Major, RE (retd).

Brigadier A. P. Lavies, CBE, ADC.
Brigadier General Staff RE
War Office, London, SW1
26 October, 1962

To The Editor,
The RE Journal.

Dear Sir,

Major Horne has expressed serious misgivings about the Civil Engineer prospects the Corps has to offer today and in the future. Although he has based his arguments on fact he has drawn most misleading conclusions.

Any examination of future prospects ought to compare the career choices of those now at the stage of choice (ie Senior Captains) with the high posts in the line of their choice. Forecast based on *psc* or other qualifications borne by those who are now Lieut-Colonels or Colonels is seriously misleading, because a large proportion were nominated to attend short War Staff Courses which were later recognized as qualifying for the *psc* symbol, and because many who would have appeared as Works or E & M qualified Lieut-Colonels have left the Service on redundancy.

It is true that the theoretical prospects of the outstanding Staff College graduate may be Field Marshal and that of the Long Course graduate only Major-General (two recent Engineers-in-Chief were not *psc*), but this can hardly be regarded as grounds for serious misgiving!

No RE Officer should expect to serve his whole career in one line of employment. Thus, although the higher posts—Brigadier, Colonel, Lieut-Colonel—specifically requiring Long Course knowledge of one kind or another may not seem to offer as good numerical opportunity as those apparently open to field/*psc*, when they are combined with the high non-technical posts also open to Long Course graduates a very reasonable career prospect unfolds. No one pretends that all is as well as we would like it to be. Much thought in the War Office is being devoted to careers of all types as the shape of the Long Term Army slowly evolves. There are hopes of further improvement.

There is a personal angle in all this too; many officers prefer, or indeed may be much more suitable for, specialized work quite regardless of the rank ceiling of their preference. Competitive performance is always a factor; not every starter can win a race. Sickness or misfortune can strike at any time; graduation from a Long Course may well provide much needed security for those so placed.

The old Civil Engineer School has not disappeared. It has been reorganized and its functions remain unchanged except in name.

Whatever shortcomings there may be can only properly be measured against what we hope to achieve and this should show us what improvements are needed. Because he finds grounds for present dissatisfaction Major Horne concludes that we should forsake the principles so clearly set forth by the Engineer-in-Chief in "Signpost for Royal Engineers" in the March 1961 *Journal*.

I emphatically disagree with him.

Yours faithfully,
A. P. Lavies, Brigadier, RE.

Captain S. R. Arnold, RE
Joint School, Nuclear & Chemical Ground Defence,
Winterbourne Gunner,
Salisbury, Wilts.,
4 October, 1962

To The Editor,
The RE Journal.

Dear Sir,

Major Linton's letter on Civil Engineering Graduates in the Army expressed views held by many officers of the Corps, both serving and retired, and somehow symbolizes the frustration felt by many would-be Civil Engineers now busily engaged on regimental duty.

Your answers to his letter, although mentioning some very real civil engineering tasks, included many which did not demand a university degree at all. Indeed, to suggest that a Chatham-trained officer could not tackle them is a strong criticism of the standard of instruction in the Civil Engineer School.

Maybe it is not widely realized what is studied at Shrivenham, but it must be remembered that a London University external degree is the hardest academic degree in the world to pass. After three years, a student is qualified to design and build a motorway including its bridges, and indeed, the last year's work includes the design of a motorway bridge. However, most of this knowledge is lost after a few years of soldiering since no opportunity has been offered to consolidate all that has been learned.

Major Linton, however, made no mention of the equal frustration felt by our rank and file tradesmen, who study for six months at Chatham and then go to a unit to forget it all.

These two problems are often discussed separately but never, usually, together. The solution to both problems does, of course, lie in the employment of whole units instead of individual officer attachments.

If a unit can efficiently run a major civil engineering project, then that unit will itself be efficient, and its reversion to a military role will present little problem to officers who have a knowledge of combat engineering.

Furthermore, the present officer shortage is only worsened by detachments to civilian firms. If these detachments are to be maintained, then why not send the whole troop, squadron, or even regiment as well.

Too much of a problem is made of the question of union agreement. All too often, the problem is shelved as "Too Difficult" instead of being tackled on a hard bargaining basis. I am also sure, that Major Linton would have no objection as an employer to competing with the Corps.

Another hobbyhorse of a totally different nature which I would like to get off my chest is the question of the use of Engineers in disaster relief.

We can proudly boast to having two great assets in the Royal Engineers. The first is a pool of well trained, highly skilled, civil engineers, and in this context I again include our tradesmen. The second is that our training for war produces units willing to, and capable of, moving long distances in a very short time, complete with equipment.

Surely, these are two assets which were urgently required at the time of the Persian earthquake disaster, and it was only a few days ago that BBC TV was describing ninety people killed, 3 million acres of land flooded, and 2,000 head of cattle lost in India, a country whose "meagre resources for rescue were stretched to the limit" and who "can ill afford to loose the food when already millions are threatened with starvation". This was followed closely by disaster in Spain, again with flood waters claiming hundreds of lives.

. The consequences of a move of, say, one corps engineer regiment to a stricken area would have been:—

(*a*) Redundancy amongst special RE recruiters.
(*b*) An increase in political prestige in a part of the world where it is most needed.
(*c*) An enormous boost in the morale of the Corps.
(*d*) The foundation of an ideal from which the United Nations Organization could take the lead in providing for an emergency force to deal with disaster anywhere in the world.

One is reminded here of the song in which a Medical Officer is likened to a sergeant—"Just a dissolutioned idealist". There have been many idealists in the history of the Corps, and it would be another great feat if a new organization could spring from the wealth of skill and talent being wasted away in a peacetime army.

Why should not Britain take the lead by extending the manpower ceiling for the Corps and forming a new organization designed, trained, and equipped to meet disaster anywhere in the world. What higher ideal can there be than that of saving lives and alleviating suffering?

Since such a regiment would require considerable medical and signals backing, I recommend that action is taken quickly, before we find that it is a case of sappers being attached to a Field Ambulance or Signals Regiment.

Yours faithfully,

S. R. Arnold, Captain, RE.

Military Engineering
Experimental Establishment
Barrack Road, Christchurch, Hants.
29 October 1962

The Editor,
RE Journal

Dear Sir,

E & M ENGINEERING IN THE CORPS, 400 CPS POWER SUPPLIES

I was very pleased to see that Major McDowell had replied to my letter published in the March issue of the *Journal*, and I was about to dismiss it as an end to the correspondence on this subject when I realized how misguided and ill-informed he was on a matter which is becoming of increasing importance to every Sapper in the Corps. It also occurred to me that his views regarding 400 cycle power supplies may be shared by others, and that it was necessary to reply to his letter in an effort to correct these misguided impressions.

I must first of all repeat what I have said previously, and that is, in the future; mobility and the need for compact, light, and highly reliable equipment will be of paramount importance, and for these reasons alone the changeover to 400 cycles power supplies and equipment, is, I consider, a vitally necessary and battle winning factor.

I must also point out that a 400 cycle power supply is not necessarily "exotic" and in fact need be no more precise than a 50 cycle supply for a similar purpose. To automatically designate all 400 cycle supplies as "exotic" is both misleading and incorrect.

The characteristics of a 400 cycle power supply can be provided to suit the requirements of the consuming equipment in exactly the same way as it is for 50 cycle equipment, and when the precise power requirement is a small proportion of the total load, the necessary "black box" can be provided to regulate and filter the coarse power supply to the degree of precision required for the equipment, a function, which incidentally, is more easily accomplished at much less weight than would be possible for 50 cycle supplies.

The advantages of reduced weight and size to be gained by the adoption of 400 cycle power supplies is not confined to transformers, chokes and other electromagnetic devices, indeed if it was for these items alone that 400 cycle power was being adopted, it would be far more economical to use very much higher frequencies. As it is however, it is not yet possible to make use of these very high frequencies with rotating machines, and 400 cycles is the fairly close to optimum frequency at the present time taking into account all the factors involved.

Where it is possible to take advantage of the high rotation speeds obtainable by using 400 cycle power, the savings in weight can be very considerable, for example a 2 pole 50 cycle 5 kVA generator rotating at its maximum speed of 3,000 rpm will, in its lightest form, weigh between 250–300 lbs. A 5 kVA 6 pole 400 cycle alternator rotating at 18,000 rpm (one-third of its maximum speed) will weigh 50–60 lbs. When the weight of typical voltage regulators is included the saving with 400 cps is even greater.

Power supplies at 400 cycles can be used equally well for heating and lighting without any penalties, in fact the efficiency of fluorescent lighting is substantially increased at this frequency and control gear is smaller and lighter.

Air conditioning, refrigeration, and any equipment driven by electric motors, present no real problems, 400 cycle motors can be obtained which are dimensionally interchangeable with 50 cycle motors, and where it is possible to take advantage of the higher speeds obtainable with 400 cycle power, there is frequently a saving in weight of the driven equipment as well.

I will not dwell on John McDowells reference to communications equipment, but say that Royal Signals Research and Development is at least parallel with, if not ahead of industry, and that modern communications and electronic equipment takes full advantage of the advances made in the development of semi-conductors and other components and materials, nevertheless there are still limitations to these devices, and it is not yet possible to dispense entirely with thermionic values for certain applications.

To quote a phrase in John McDowells' letter "we have entered the new generation of electronic devices" and here it must be pointed out that some of this highly sophisticated electronic equipment, by its very nature, demands extremely precise power supplies. These precise power supplies are necessary for the efficient operation of the equipment, to enable full advantage to be taken of the performance of all components, and to eliminate the need for complex and costly filter networks which inevitably increase size and weight of equipment and produce unwanted heat.

We can no longer compare the military need with the industrial need in fact it would be wrong ever to do so, but we must now anticipate the needs of the future, and aim to have the equipment when it is wanted, not wait until the last minute to buy inadequate and unsuitable equipment "off the shelf". Moreover there is no logical reason for associating military voltages and frequencies with U.K. Public Supply Systems unless the assumption is made that all military operations will take place in U.K. The statement that 50/60 cps 415/240 volt as a standard "is compatible with those of nearly every other country in the world" is a pious hope quite irreconcilable with the facts which are that this standard is unique to UK and to some parts of the Commonwealth. It is out of line with America, Europe most of the Arab countries and probably Russia.

I am convinced that 400 cycle power supplies and equipment will be in wide industrial use within a decade. Already the more enlightened and progressive industries and civil engineering companies have recognized the advantages to be gained by using higher frequency power supplies and have equipped some of their factories and sites with high frequency power tools. These tools are safer and more robust than universal tools, they require less maintenance and are generally lighter, more efficient and more reliable.

The electrical power tool system is very much more flexible than the comparative pneumatic system and can be brought into service, operated and dismantled much more quickly.

The use of air as a means of conveying power is notoriously inefficient and uneconomic, both in capital cost and running cost. For example a lightweight rotary vane compressor weighing 1,000 lb and costing £800–£1,000 would require about 1.4 gallons of fuel per hr to operate two 70 lb pneumatic hammers, whilst a 5 kVA generating set weighing 250 lb and costing approximately £300 will run two 70 lb electric breakers on 0.45 gallons of fuel per hr.

A further example of weight saving is shown by comparing a skid mounted lightweight 10 kVA generating set, which for 50 cycles would weigh just under a ton, and for 400 cycles could be carried by two men. Surely these advantages should be exploited.

I cannot agree that all equipment likely to be required in the combat zone is likely to be obtainable either readily or cheaply from the commercial market, particularly if the combat zone is anywhere where normal temperate climate conditions do not prevail. This lesson has been learned in the past at considerable cost.

However, much of the 400 cycle equipment is becoming commercially available, and more important it is based on military requirements, so that industry buys what is good enough for the army and not vice-versa, which is a refreshing change, and has advantages which industry is beginning to appreciate.

Four hundred cycle equipment is not more complex than 50 cycle equipment and it is very wrong to think that the increase in frequency implies increased complexity, in certain instances it is in fact the reverse. Nor is there any reason why 400 cycle equipment should be appreciably more expensive, and as more manufacturers enter the field, competition will bring prices to compare with 50 cycle equipment though of course the lower volume of production will introduce a minor penalty.

I do not pretend that the introduction of 400 cycle power will solve all standardization problems, but I am convinced it will solve many. It is not a new standard, it already exists on a wide scale whether we like it or not, it has many advantages, let us then exploit them to the full, and the soldier in the field, not least of all the Sapper, will have more power at his elbow than has ever before been possible.

Yours faithfully,

A. T. Tree, Major RE.

British Liaison Office
US Army Engineer Research and Development Laboratories
Fort Belvoir, Virginia.
31 October 1962.

To the Editor,
The RE Journal

Dear Sir,

MILITARY ELECTRICAL POWER SUPPLIES

It is with some trepidation that I enter the learned discussion on the subject of the introduction of 400 cps equipment into the combat zone. However, I am concerned lest Major McDowell should confuse the issue and create a wrong impression in this most important and sensible decision.

As Major Tree pointed out, the reasons for this decision to standardize our electrical equipment at 400 cps are principally those of saving weight and meeting the requirements of new equipment being introduced into our weapon and communication systems. It is incorrect to say that the retention of thermionic valves causes unnecessary increases in precision power requirements and a change to transistors would not materially affect the situation. The principal reason for the increase in the precise power requirements is the more wide-spread use of electronic apparatus in weapons, communications and surveillance devices. Furthermore, as the range of discrimination, etc. of these devices are increased, they invariably demand greater quantities of power of more precise nature.

It is an established fact that equipment generating at 400 cps is very much lighter than our present equipment which generates at 50/60 cps. It is also a fact that the cost of this 400 cps equipment will not be all that much more expensive than 50 to 60 cps.

Why then does Major McDowell advocate a policy of continuing to use 50/60 cps equipment which can never approach the weights of 400 cps equipment and which requires additional conversion equipment in order to meet the requirements of our communications and weapon systems. There may well be times when it will be necessary to provide power for 60/60 cps equipment which finds its way into the combat zone but this can be quite easily done using solid state converters which have high efficiency and are not likely to be unduly expensive.

Many engineers and scientists believe that 400 cps is only the beginning and there are many who advocate generation of power at even higher frequency. For instance, the United States Army is now planning to generate electricity using direct coupled gas turbines at frequencies as high as 3,200 cps and the weight savings which can be achieved are quite staggering. They are at the present testing solid state frequency converters of 75 to 90 kVA capacity and are proposing to develop one for 300 kVA

As for Major McDowell's remark about deploring the loss of his pneumatic tools, I can only say that all engineers should welcome the elimination of an unnecessary system particularly as we are told that the electrical tools which the Corps are developing have proved themselves on trials to be more efficient and easier to handle than pneumatic tools. We shall at last be able to do away with the compressor truck, and in its place have a power source in most combat vehicles.

No Sir, I believe that Major McDowell, in spite of his desire to keep abreast of the times, is looking back over his shoulder and this we cannot afford to do.

Yours faithfully,

STEPHEN GOODALL, Lieut-Colonel RE.

Major-General G Cheetham, CB DSO MC FRICS

Memoirs

MAJOR-GENERAL G. CHEETHAM, CB, DSO, MC, FRICS

MAJOR-GENERAL G. CHEETHAM, who was Director General of Ordnance Survey from 1943 until his retirement in 1949, died at his home in Hermitage, Newbury on 4 August 1962, aged 71 years.

He was educated at Wellington College and the Royal Military Academy, Woolwich, being commissioned into the Corps of Royal Engineers on 21 July 1911. After completing his Chatham courses he was posted to 11 Field Company at Aldershot in August 1913 and the following year he went with his Company as part of the British Expeditionary Force to France. Except for two short periods, one of which due to wounds received, he served continuously in France and Flanders throughout the war. In 1915 he served with 90 Field Company in 9 Division and the following year he became Adjutant to the CRE 24 Division. Because of his linguistic ability he was attached for a period of several months in 1917 to the Portuguese Division, then serving alongside the BEF. In September of that year he was promoted Acting Major and in 1918 he was made an Acting Lieut.-Colonel. From October 1918 until May 1919 he was an instructor at the RE School of Instruction with the BEF. For his war services he was mentioned in despatches, and awarded the MC in 1916 and the DSO in 1918.

After a short posting at Aldershot, Cheetham was sent in 1920 to the Gold Coast where he spent four years on survey work. On returning from the Gold Coast he spent a short time as an Assistant Instructor in Fieldworks and Bridging at the School of Military Engineering, Chatham before being posted in July 1925 to the MI4 Branch of the War Office as a GSO3 where he remained until October 1928, becoming a GSO2 in that Branch on promotion to substantive major in 1927.

In February 1929 he joined the Ordnance Survey at Southampton where he spent two years before becoming Chief Instructor in Survey at the School of Military Engineering. On promotion to substantive Lieut-Colonel in March 1935 he returned to the Ordnance Survey. In 1939 he was promoted Colonel and in February 1940 he was appointed Deputy Director General of Ordnance Survey with the rank of Brigadier. Finally in May 1943 he became Director General and promoted to Major-General, and remained in that appointment until his retirement in June 1949. For his services he was made CB in 1946.

In 1950, after his retirement, he was appointed Chairman of the Inland Water Survey Committee.

During the period September 1961 to May 1962, Major-General Cheetham served as Chairman of an Indian Survey Commission appointed by the Government of India. The task of the Commission was to evaluate the work done by the Survey of India and the National Atlas Organization, to make suggestions for improvements and to recommend the methods, equipment and staffs required to implement them. All other members of the Commission were Indians and Cheetham had never served in India before but, despite that, he was quickly accepted and the work of the Commission was most successful.

He married, in 1930, Constance Margaret, daughter of A. C. Roberts, Esq. They had one son and two daughters.

R. Ll. B. writes:—

"It would be a pity if Geoffrey Cheetham's passing were not marked in the *Journal* by something more than a factual record of his services, which must of necessity be impersonal. The thought of him arouses in me feelings of gratitude and delight, and if I write it is in the hope of stirring in others their own memories, which must be many, of quite a remarkable man.

I first met him when I entered Wellington in the *Hopetoun*. To my young eyes then he seemed to be a man of overwhelming distinction; a college prefect, a rugger cap, and one of the gym pair. Yet he was far from being unapproachable and I recall the pleasant way he treated the 'squealers', encouraging rather than driving or dominating us, and we in return admired him and respected him enormously.

"Our paths did not cross again until 1921 on topographical survey in the Gold Coast, when a long friendship began. He was always good company and a splendid person to be with in all circumstances. His friends will remember many occasions when either his chuckle or his rock-like imperturbability have improved the occasion. The annual voyage to and from The Coast was always fun with him—and always energetic. From then on I saw a good deal of him, both in periods of leave and at work, for he and I remained in the RE Survey Service for most of our time in the Corps. He took his work seriously and was intensely interested in it, accomplishing a great deal. If he did not shine in verbal conflict, which he rather disliked, his judgements were deeply considered and correspondingly sound. But in the midst of serious preoccupations and growing responsibilities he was always game for some light relief. I recall floor games in the sanctity of the War Office, visits to the Spanish Club, rides on the tops of taxis, insistence on finding a flat-topped table for the maps on a battlefield tour—only to be found in estaminets, and many hours of golf or tennis and the warm hospitality in the circle of his home.

"During the late war he was at the Ordnance Survey and I was far away abroad, so that I saw little of him. Yet I must have benefited at the time, as I now know I did, from the work he was doing there. Our association was renewed when the war ended. Five years later, when I came to take over from him at the Ordnance Survey, I was soon aware of the immense amount of ground work and thought that had been put into planning for the future, particularly for three important projects which came to fruition in my time, the new One-Inch map of Great Britain, the resurvey of the towns at 1/1250, and the introduction of 'continuous revision' of the large-scale plans. The difficult tasks of re-absorbing staff returning from the war and of recruiting and training new men also fell to his lot. The Ordnance Survey has much for which to thank him.

Towards the end of his service he presided at the Commonwealth Survey Officers Conference of 1947 at which was discussed, amongst other things, the formation of a land-survey division of the Royal Institution of Chartered Surveyors. He did much to bring about the existence of that division and continued for some time after he retired to guide its formative years from a seat on the Council of the Institution, where his wide experience and unique personality were much respected and had considerable influence.

"Looking back now I can still see the man whose distinction overwhelmed me; but I see too something much more and am no longer overwhelmed: a true friend and a man with a record of solid achievement, such as his own modesty would never have admitted, whom the Corps can be happy to have numbered among its members."

BRIGADIER F. I. DE LA P. GARFORTH

FREDERICK IVOR DE LA POER GARFORTH was born on 31 March 1897, the son of Frederick Garforth, of Dukinfield and South Africa. He was educated at Rugby and the Royal Military Academy, Woolwich. In April 1915 he was commissioned in the Royal Engineers and completed a war-time course at the SME, Chatham, and a course at the Signal Service Training Centre.

He went to France in January 1916 and served with the Expeditionary Force with 17 Corps Signal Company and later with a Cable Section. He was wounded and returned home in July 1917, after which he was specially employed at the War Office in Staff Duties Branches until moved to the Signal Service Training Centre in April 1919. From there in March 1920 he returned to the War Office for six months in AG7.

In September 1920 he went to Pembroke College, Cambridge and then to the SME, Chatham to complete his post-war Supplementary Course, remaining at Chatham for a few months as Assistant Adjutant to the Depot Battalion before leaving for India and Burma early in 1923. He was Garrison Engineer at Maymyo for three years until, in 1926 he became Garrison Engineer at Bareilly and then officiated as a Staff Captain at Army Headquarters in India.

In 1928 he joined 23 Field Company at Aldershot, and next year became a student at the Staff College, Camberley. In 1931 he went to 1 AA Searchlight Battalion at Blackdown for a year, then to London District as a Staff Captain to 56 (1 London) Division.

In August 1933 he was appointed Brigade Major to the SME at Chatham. After this three-year appointment he went to Roorkee in India as Superintendent of Instruction, KGO Bengal Sappers and Miners.

In October 1937 he was sent to Army Headquarters, India as DAAG. Soon after the outbreak of war in 1939 he became a SORE, then in February 1941 as an Acting Colonel he was appointed AA and QMG and then specially employed at Home. In April 1942 he joined the British Army Staff at Washington as a Colonel of the General Staff until made President of the Selection Board at the War Office in December 1942. A year later he became Colonel-in-Charge of Administration, Salisbury Plain District.

After the war, in 1946, he was back in India as Chief Engineer, Eastern Command and a Temporary Brigadier, covering the transition period due to the partition of India. He retired in March 1948.

He married Irene, daughter of Major the Hon Adolphus Graves on 29 March 1921 and had two daughters.

He died on 8 June 1962 at Syston Court, Magotsfield in Gloucestershire.

Book Reviews

ALAMEIN

By Brigadier C. E. Lucas-Phillips

(Published by William Heinemann Ltd. Price 30*s*)

This book deals with that part of the Eighth Army's campaign in Africa from the withdrawal to Alamein (June 1942) to the conclusion of the Battle of Alamein (November 1942). The battle itself is described in considerable detail.

A good deal has been written about these events but mainly from the general's point of view, and much of it in furtherance of a tiresome controversy about "credits". ("Victory is the child of many fathers" says the proverb "but Defeat is an orphan.")

In *Alamein* the author aims at telling the story from the point of view of the regimental officer; he is qualified to do so for he was in command of a gunner regiment at the battle.

The first part of the book gives a general and most readable account of the Eighth Army at that time—of its formation, its operations and the ways it conducted them; and of the events which led up to the big battle. There are good pen portraits of some of the commanders, and excellent descriptions of the way of life of the troops. There are references to the seldom mentioned minor operations carried out during the six months the army was holding the Alamein position. Most of them were disastrous, but they provided experience, which was to be invaluable later, in how (and how not) to attack an enemy who was dug-in behind continuous minefields which could not be by-passed or out-flanked. From these bitter experiences there evolved the new tactics and methods for "operational mine clearance". The difficulties of this operation are given due weight by Brigadier Phillips, who writes, "Perhaps the most vital of all the preparations for the battle was the technique evolved for clearing enemy mines. We cannot appreciate the hazards with which the Army was faced at Alamein without an understanding of the nature of those hazards and the courage of the men who had to tackle them. Official and popular accounts pass lightly over this fundamental operation and the generals who have written their memoirs scarcely mention it." He also recognises—again probably the first author to do so—how these difficulties and hazards were intensified by the month's delay in our attack which Montgomery insisted on and which "Alexander pressed upon an impatient Mr Churchill". How many mines the enemy managed to lay during that month is not known but it must have been a prodigious number. According to the official estimate in this book enemy mines at the time of the battle numbered 460,000. This was not far short of 500 mines for each tank we possessed. They were disposed in mine-belts and mine "marshes" covering the entire enemy position to a depth of five to seven miles; a depth sufficient to permit further deepening where necessary when under attack.

This changed situation was probably a factor in the change which Montgomery made in his plan only a fortnight before the battle; a change which, according to his Memoirs, "altered the whole conception of how the battle was to be fought". This new plan called firstly for the destruction of the enemy fortress (for such in effect it had become) by means of a frontal attack carried out mainly by the engineers and infantry; and only then was the main body of our armour to be brought in. With the hind-sight we now possess it seems plain that no other plan could have succeeded; but it was entirely at variance with accepted military thinking at the time.

This first part of the book, called "The Desert Battlefield", seemed to be admirably done—succinct, vivid and authentic—and most of it bearing the unmistakable imprint of first-hand reporting.

The remainder of the book is taken up with a narrative of the two operations, "Lightfoot" and "Supercharge", which constituted what is now known as the Battle of Alamein. Unfortunately the author has chosen to dovetail into his account a number of stories of individual actions and heroic deeds. These stories tend to slow up the main narrative, which is complex enough already. There is a good deal of journalistic cliché—(bullets "whine" and shells "crack viciously") and a certain amount of legend. A divisional commander visiting his front line "roars up with tremendous panache, sitting on top of his command tank in a white poshteen and black beret, looking larger than ever and intentionally conspicuous". Another, "wearing his red and blue cap walked the whole length of his divisional front, shot at by every kind of weapon but returned unscathed". They can't have been popular visitors. (In at least one infantry division—there was a wise rule that visiting officers going forward of brigade HQ had to disguise their rank with ground sheet and tin hat, and carry a rifle). That there were many deeds of great heroism during twelve days is beyond question; and we must be grateful to the author for putting at least some of them on record. But the right place for them would seem to be in Divisional or Regimental histories, not in a book which is claimed, by the publishers, to be a "definitive history".

Among the Sappers mentioned by name one is glad to see the Eighth Army's great Chief Engineer, the late Brigadier F. H. Kisch, CBE, DSO. Kisch was a very brave man and much loved. His influence on events, which was considerable, has had scant acknowledgement (he is not mentioned in Montgomery's Memoirs). But when he was killed at the Battle of Akarit (April 1943) the Prime Minister, who had known him well, sent a personal message of condolence to the Engineers of Eighth Army. It described him, in a memorable Churchillian phrase, as "your beloved Chief whom you have followed for so long into the teeth of danger".

J.M.L.

THE WORLD'S ARMOURED FIGHTING VEHICLES

By DR F. M. VON SENGER UND ETTERLIN

(Published by Macdonald & Co Ltd, London. Price 40*s*)

This catalogue of AFVs is of particular interest and fulfills the same function for AFVs as *Jane's Fighting Ships* does for warships.

It has been edited and translated from the German by Richard Ogorkiewicz, an expert on AFVs and author of the well-reviewed *Armour*. In translating it from *Taschenbuch der Panzer*, Ogorkiewicz has adapted it for the British reader, and has added additional information and also simplified the method of classification of armoured vehicles.

The volume describes the AFVs of the leading military powers from 1943 to date, country by country. Each AFV is classified by its function, and its development, general characteristics, employment and special features are considered. In addition detailed tables are included at the end. Considering the obvious difficulty of obtaining detailed information due to security, the information is very accurate and estimated data, where given, is so marked.

The book should be of great value and interest to all students of tactics and weapon development.

J.P.M.W.

THE MAN ON HORSEBACK

By S. E. Finer

(The Pall Mall Press Limited, Rood End, Dunmore, Essex. Price 27*s* 6*d*)

This book is not, as its title might lead one to suppose, a book on equitation but a study of military intervention in politics which throughout history has been frequent and widespread and is particularly so today. The author, a well-known writer on political science, states in the opening chapter of his book that there is in this country a common but erroneous and unreflecting belief that it is somehow natural for the Armed Forces to obey the civil power, and he goes on to disprove this unhesitating confidence by pointing out that the political advantages of the military *vis-à-vis* the civilian groupings are in fact overwhelming. The military possess vastly superior organization and an unassailable superiority in the means of applying coercion, force, or the threat of force, to achieve a political aim of their choosing. And on many occasions they have not been reluctant to do just that.

His study is world wide and covers not only the petty *caudillos* of South and Central America, culminating in Castro, but he writes of Oliver Cromwell, Napoleon and the Armies of the Revolution to General de Gaulle, Hindenburg, the Marmelukes to Colonel Nasser, Colonel Kassim, Nuri es Said, Generals Primo de Rivera and Franco, Brigadier Ayub Khan and a host of other military men who have impressed their will on a people and often instituted a form of democracy to justify and legalize their position.

It is a fascinating work and should be read by all interested in contemporary history.

J.L.

FRONTIERS AND WARS

By Winston S. Churchill

(Published by Eyre & Spottiswoode. Price 42*s* net)

This book contains an abridged edition of the first four books written by Sir Winston Churchill whilst still a serving soldier. Frontier wars in India, expeditions in Egypt and the Sudan and the war in South Africa are described in his inimitable vigorous style, and the events he writes about are from first-hand, personal experience. In each of the campaigns covered, the Corps of Royal Engineers produced leading characters who dominated events. In the story of the Malakand Field Force, Sir Bindon Blood, our first Chief Royal Engineer, played a predominant part. The account of the River War covers the history of the Sudan. It begins with the rise of the Mahdi, Gordon's impossible task and his murder which was followed by the slave trading, plundering, fanatical régime of the Dervish Empire. Then follows a description of Kitchener's advance up the Nile and the breaking of the Dervish power at the battle of Omdurman, described by Sir Winston as: "the most signal triumph ever gained by the arms of science over barbarians", and Kitchener, after the Dervishes had expended themselves against the disciplined fire of his army, remarked that the enemy had been given a "good dusting". His losses had been twenty officers and 462 men; the Dervishes had lost 9,700 killed, 16,000 wounded and 5,000 prisoners. A complete chapter is devoted to the Desert Railway and to Lieut Girouard, RE, Kitchener's Director of Railways, and his band of young Sapper officers who built this war winning railway, to Lieut Manifold, RE, who built the telegraph communications, and to the construction of fortified camps along the axis of advance. Sir Winston writes: "On the day that the first troop train steamed into the fortified camp at the confluence of the Nile and the Atbara rivers the doom of the Dervishes was sealed". The strong hand of steam and the swiftness of the train had, despite almost unbelievable difficulties, replaced the toilsome plodding of the age-old desert caravan, and the unpredictable navigation of the River Nile.

The final chapters of the book deal with the fighting in South Africa where once again Kitchener brought the war to a victorious conclusion.

It is a work that all Sappers should read with pride.

J.L.

EAGLE BOOK OF BRITAIN'S FIGHTING SERVICES

(Published by Longacre Press Limited, Fleet St, EC4. Price 15*s*)

This excellently illustrated book would be an ideal Christmas present for any boy with a bent towards a future career in any of the Armed Services, and it is primarily written for a juvenile reading public. Nevertheless, many an officer of several years' service would learn much from reading through the chapters describing the origins, developments and present-day organization and way of working of the Royal Navy, the Army and the Royal Air Force. The authors of the three sections were Charles Gibson, Robert G. Blackman and John W. R. Taylor respectively, assisted by the Service Ministries concerned. In the section dealing with the Army two Sapper faces appear in a photograph of the Army Council "in session". In the chapter devoted exclusively to the Royal Engineers the description of our origin and early history is not strictly accurate, but a telescoped history of the officer and soldier side of our Corps until they became one in 1856 is not an easy thing to write. Perhaps the field and survey aspect have been given rather too much prominence at the expense of transportation, resources and bomb disposal. Airborne engineers are not described and there is no reference to the RE operated Army Postal Service. However, these minor points do not materially detract from a most excellent, instructive and readable book. J.L.

A MILITARY APPRECIATION OF BRITISH INDUSTRY

Brigadier Sir Mark Henniker, CBE, DSO, MC, a distinguished Sapper officer who retired about five years ago, has written a most interesting and amusing account in the August 1962 edition of Blackwood's Magazine of his experiences in civil employment and of his observations on the organization and management of big business.

He points out that many civilians who served for a period, seldom exceeding five or six years, in the Armed Forces during the two World Wars, or as National Servicemen, have written critical, stimulating and often useful books about all aspects of the Army. These works by amateur soldiers have not been discountenanced by the professional military authorities who, after sifting the chaff from the wheat, have often made use of what was left, and he hopes that these reflections of a "short service industrialist" may be of some value to established captains of industry. They are certainly penetrating and to the point. He describes his experiences and lessons learned as a free lance writer, as a purchasing manager in a big concern and as a manufacturer's agent operating on his own.

Serving officers about to face the prospects of entering the civilian lists themselves would be well advised to read Brigadier Henniker's article. J.L.

MARINE AIR CONDITIONING, HEATING AND VENTILATION

Compiled by THERMOTANK LTD

(Published by Pergamon Press Ltd, Oxford. Price 50*s*)

This book, prepared by a firm well known in the air conditioning field, sets out to present to shipowners a brief outline of the various marine air conditioning, heating and ventilating systems now available, to enable them to determine which is most suitable for their ships. In this it appears to succeed very well.

It does not go deeply into the theory and practice of design of complete systems. For example, all details of the types of refrigeration machinery which might be used in the air conditioning systems described are purposely omitted since the writers regard these as standard machines, installed to perform a designed duty.

In brief, the book deals with the air handling systems of marine air conditioning by way of a series of excellent coloured plates and outline specification of each. The advantages and disadvantages of each type are faithfully presented. It illustrates the principles of air handling systems very well and should therefore appeal to the Construction School.

It may have limited application in Transportation but for military engineers, it is most likely to be of use to those concerned with the design of underground installations, particularly where space is limited and large heat gains from personnel and installed plant must be removed. J. McD.

THE DESIGN AND PLACING OF HIGH QUALITY CONCRETE

By D. A. Stewart, mbe, mice, amiee, mconse

(Published by E. & F. Spon Ltd. Price 50*s*)

The first edition of this book was published in 1951, since which time much of the theory of concrete technology and its derived techniques have been developed by further research, expanded by further theory, or improved upon by more ingenious methods.

This new material has been incorporated in the second edition, and in addition many examples taken from recent site work have been included to illustrate and substantiate the theory enunciated. The text has been altered or revised as necessary; new line drawings have been incorporated, as well as two new chapters on "Mix Design and Structural Economics" and "High Density Concrete".

The book begins with a short chapter reviewing the past, present, and future of concrete technology, and then goes on to consider the properties, characteristics, workability, and mixing of concrete. Vibration of concrete is considered in three further chapters, covering many aspects of theory, application, plant, and site problems in great detail. The remaining chapters consider mix design, specifications, and high density concrete for radioactive shielding.

The author has expressed himself simply and clearly, and in consequence the book should appeal even to those who only have a limited knowledge of the subject of modern concrete technology. J.R.J.

REINFORCED CONCRETE MEMBERS SUBJECTED TO BENDING AND DIRECT FORCE

By J. D. Bennett, beng, amistructe

(Published by Concrete Publications Ltd. Price 10*s*)

The British Standard Code of Practice No 114 (1957) permitted the design of members by load factor methods for the first time, and in consequence, the author published in 1958 a booklet of graphs for the design of rectangular columns by ultimate load methods, using symmetrrical and unsymmetrical reinforcement in both cold-worked and in mild steel. These graphs were well received by the profession and used extensively in design offices.

The book has now been enlarged, however, into its present form. All the original graphs, with explanations and examples of their use, are included, together with additional design charts for circular members using mild steel and cold-worked steel, and again these charts are explained and illustrated by examples. The derivation of formulae used for the design of circular members are included in two useful appendices.

Finally, a further chapter is included giving a load-factor method of design for rectangular, T, and L-beams, and an example of the use of the method is given in each case.

This book is the most recent addition to the "Concrete Series" of publications, and is yet another example of the excellence of this series. It is a most valuable reference book for the reinforced concrete designer and should form part of the small personal library of technical publications that every practicing engineer holds. J.R.J.

BASIC REINFORCED CONCRETE DESIGN—VOL I

By Chas. E. Reynolds, BSC, MICE

(Published by Concrete Publications Ltd. Price 24*s*)

The author's renowned book *R C Designers Handbook* (revised and republished in its sixth edition in 1961) has, of course, long been one of the most popular reference books for all civil engineers involved in R C design. The publication of his two new books, *Basic Reinforced Concrete Design* Volumes I and II, when considered in conjunction with his other books on design practise, complete a study of R C, ranging from simply theory of design through concrete technology, to the more complex and practical studies of actual design, that has probably not been paralleled by any other single author.

The book under review is the most elementary of the series. It is divided into two parts; Part I covering basic theoretical analysis, and Part II covering the design of simple members.

Part I deals with working stresses, the properties of reinforced concrete, and the basic theoretical analyses of members subjected to bending, axial compression, and eccentric compression, both by the modular-ratio method and by the load factor method. The theory of shear and bond is also discussed.

Part II begins with a chapter on loads, bending moments, and forces in simple structural members and continuous beams. Thereafter this part of the book is devoted to the design of simple members such as slabs, rectangular and flanged beams, columns, and simple foundations.

In common with other books written by the author, the design examples in this book are very well illustrated, and give the student many useful practical details on the arrangement of steel reinforcement in the simple members discussed. Another refreshing point of this book is the use of symbols which almost wholly agree with those used in the Codes of Practice—a system which, if universally adopted by all text books, would help to alleviate some of the confusion and minor difficulties which beset the designer.

In short, *Basic Reinforced Concrete Design* Volume I is clearly written and well illustrated. It is the most elementary of the series of books written by the author, and as such, is particularly suited to the university student, or perhaps even more particularly to the part-time technical college student who must mix practical work with theoretical learning. It will doubtless also appeal to the many qualified engineers who hold the author's books in such high esteem; who wish to maintain a small, comprehensive library on R C design; and who insist that the library that they hold is both consistent in its approach and in its symbols. J.R.J.

TABLES OF INTEGRAL ERROR FUNCTIONS AND HERMITE-POLYNOMIALS

By O. S. Berlyand, R. I. Gavrilova and A. P. Prudnikov

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 100*s*)

This book is Volume 19 of the Mathematical Tables Series produced by the publishers. The tables were calculated and prepared for publication on the initiative of Academician A. V. Lykov of the Byelorussian Academy of Sciences. They are among the first tables devoted to the subject matter.

The fundamental properties of the tabulated functions, the method of calculation and special features of the tables, and the arrangement of the tables and rules for using them are all covered in the introduction.

Part I of the book gives the tables of Integral Error Functions and tables of Coefficients An. Part 2 covers tables of Hermite Polynomials and tables of the Coefficients B2n.

The tables are well printed on good paper and provided with an excellent cloth cover. This book would be a worthy acquisition for the reference libraries of universities and colleges of technology for the use of students and others dealing with advanced problems on the theory of heat conduction, diffusion, hydrodynamics and certain problems of quantum mechanics F.T.S.

ORDINARY DIFFERENTIAL EQUATIONS

By L. S. Pontryagin

Translated from the Russian by the Library of Congress, USA

(Published by Addison-Wesley Publishing Company, Inc, Reading, Massachusetts, and Pergamon Press London. Price 55*s*)

The author offers a six-months course in differential equations, designed for engineer students who have already completed the course in calculas.

The theory of ordinary differential equations finds applications in various fields of engineering; it is applied in electrical engineering and in particular in radio engineering. This relationship is explained by theory and examples in the section of the book dealing with electrical circuits and formulaters, among other matters, *Kirchhoff's Laws* which govern the performance of electrical networks. A similar application is made to the Watts centrifugal governor.

Other chapters explain first-order differential equations, linear equations with constant and variable coefficients, existence theorems, stability of periodic solutions and linear algebra.

The average student will find this treatise rather advanced, but the volume would be useful for reference purposes in technical libraries. F.T.S.

NON-LINEAR CONTROL SYSTEMS ANALYSIS

By R. H. Macmillan, MA

(Publishers—Pergamon Press, 1962. Price 17*s* 6*d* net)

This book is the first volume of a 1,000 volume series, all of which will be published by 1967. This series, part of the Commonwealth and International Library of Science, Technology and Engineering, is designed to provide an inexpensive, up-to-date library of high technical standard.

This first volume is written by a number of experts, each dealing with a separate section of the book. As with any subject of this kind, it is an essentially mathematical presentation, and is divided into the following principal sections: Non Linear Control System; The Phase Line Method; The Describing Function Technique; The Application of the Describing Function; Computation of Transients and Autonomic Control Systems.

The opening Section deals with the fundamental concept of control systems, both linear and non-linear. The conclusions drawn show clearly that non-linearities provide complex solutions, especially if occurring in the feedback or load. Some of these complex solutions are impossible to apply, and so the book gave little guidance to the would-be designer under these conditions.

However, the following Sections dealt very adequately with the approximate designs of non-linear systems for simpler cases. The object of this book is to provide engineers with a means of avoiding transient or sustained oscillation in a control system, by designing accordingly. The book achieves this object very well, at the expense of sustained study.

The final Section on automatic process controls and servomechanisms has a decidedly more practical approach, and it was felt that this chapter should be read first in order to create a mental picture of the processes involved.

This book should prove invaluable to advanced students of control systems. but someone new to the subject would undoubtedly prefer a more simple introduction.

D.R.T.

GENERALIZED ANALYTIC FUNCTIONS

By I. N. Vekua

English Translation Editor: Ian N. Sneddon

(Professor of Mathematics in the University of Glasgow)

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 105*s*)

This book is Volume 25 in the International Series of Monographs in Pure and Applied Mathematics. It is intended for students of advanced courses in mechanico —mathematical faculties, post-graduates and research workers.

Part I of the book is devoted to classes of functions and operators, positive differential quadratic form, foundations of general theory and boundary value problems. Part II deals with the applications of the results of Part I to the problems of the infinitesimal theory of surfaces, and the membrane theory of shells.

It was first published by Fizmatgiz, Moscow in 1959. It is well printed on good paper, and its 668 pages are excellently bound. A comprehensive list of international references is included.

F.T.S.

THE APPLICATION OF DIGITAL COMPUTERS TO STRUCTURAL ENGINEERING PROBLEMS

By D. M. Brotton, BSC(ENG), PHD, AMISTRUCTE

(Published by E. & F. N. Spon Ltd, 22 Henrietta Street, Strand, WC2
Price 57*s* 6*d* net (in UK only))

Since the introduction of the first Electronic Numerical Integrater and Calculator at the University of Pennsylvania in 1946, considerable developments have been made and the range of computer types extended. There is no doubt that the modern computer, a complicated and impressive machine, is still regarded with suspicion by many engineers, and by some, as a threat to their future employment on design work. Nevertheless, computers have many advantages to offer. Long calculations are speeded up, leaving time for engineers to devote more thought to their designs. They also open the door to the solution of problems which have been intractable by hand without the use of approximations to simplify the arithmetic. In the investigation of new phenomenon the computer can take engineers nearer to a true mathematical representation of the physical behaviour of their structures.

The object of this book is to introduce engineers possessing the basic academic qualification of the Higher National Certificate in Civil Engineering, to the use of computers. To this end a glossary of computing terms is detailed at the beginning of the book, and the reader is then progressed through chapters dealing with development, the arithmetical operations possible by electronics, types of circuits, a description of electronic digital computers, programming and coding, numerical analysis and the solution of linear algebraic equations, structural matrices and vectors, and the flexibility and stiffness analyses of structural frameworks. A chapter is devoted to computers for structural design, and another to erection calculations for suspension bridges. A bibliography and further reading section is also included.

Much of the text is given over to mathematical examples and the solution of associated problems. There is also a good deal of descriptive matter which would enable the layman to obtain a superficial knowledge of computers and their operation.

Military engineers should not treat the subject matter of this book as something unlikely to be adopted by the Services—after all—digital computers are already in use at the RAPC Training Centre.

F.T.S.

TABLE OF SINES AND COSINES TO TEN DECIMAL PLACES AT THOUSANDTHS OF A DEGREE

By Herbert E. Salzer and Norman Levine

(Published by Pergamon Press Ltd. Price 70*s* net)

Messrs H. E. Salzer and N. Levine and the Publishers proffer no apologies for the publication of this table to join the large number of tables of trigonometrical functions which already exist. They claim, correctly, that it will facilitate the work of those persons engaged in scientific and technological fields such as basic computation work, navigation, astronomy, geodesy, mathematical physics, electronics, engineering and space travel technology.

The table is naturally more accurate than the widely used 7-decimal places table of J. Peters and this will be appreciated in the astronautical field.

The layout of the table differs from the usual format by having the sine and cosine tabulated side by side, thus the user need not look in two different parts of the book for both functions. Each entry shows all digits at a glance thus eliminating the previous need to explore the page to find the initial three digits. Entries run vertically instead of horizontally and, in consequence, the table is easier to employ, especially in interpolation.

Unfortunately this form of layout results in added space and, in order to keep the volume from becoming too bulky, the other functions tan x, cot x of Peters' table are not included. Sin x and cos x, are however, by far the most fundamental of the six trigonometric functions when computing, and tan x or cot x can be obtained by a single division on a desk calculator and sec x or cosec x by taking a reciprocal.

The methods of direct and inverse interpolation are explained and five examples of each are given.

The table in its present form is not particularly suited for field use, but would be a useful acquisition to the libraries of military technical schools. F.T.S.

PROGRESS IN AERONAUTICAL SCIENCES—VOL III

Edited by A. Ferri, D. Küchemann and L. H. G. Sterne

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

This volume, like its predecessors, is essentially a collection of articles dealing with various specialized subjects associated with the study of aerodynamics. The individual articles are not interconnected and may be described as surveys of the state of knowledge which now exists on the subjects presented.

The appointments of the Editors, Messrs Antonio Ferri, Professor of Aerodynamics, Polytechnic Institute of Brooklyn, USA; D. Küchemann, Royal Aircraft Establishment, Farnborough, Eng, and L. H. G. Sterne, Training Center for Experimental Aerodynamics, Belgium, are well suited to ensure an international interpretation of the advances which have been made in the broad field of aerodynamics.

The four articles of this volume are:—

"Some Aerodynamic Principles for the Design of Swept Wings", by J. A. Bagley (Aerodynamic Dept, Royal Aircraft Establishment, Farnborough).

"Ducted Propellers", a critical review of the state of the art—by A. H. Sacks, PhD, and J. A. Burnell, the Asst Director and Senior Scientist respectively of the Applied Mechanics Division, Vidya Incorporated.

"Experimental Facilities for Hypersonic Research", by Dr R. N. Cox, War Office, Armament Research and Development Establishment, Fort Halstead, Kent.

"Meteorological and Aeronautical Aspects of Atmospheric Turbulence", by Hans A. Panofsky and Harry Press of the State College, Penns, and National Aeronautics and Space Administration, Washington, respectively.

The articles are highly technical and intended for the specialist. They are not suitable for student beginners. Informed readers are undoubtedly presented with satisfying appreciations of the latest advances in these fields of science. Such readers may also appreciate, as an aid to their reading, the list of additional references given with each chapter.

The volume, comprising 241 pages, printed in Monotype Modern No 7 11/12 point, includes numerous diagrams and charts, and is well bound. F.T.S.

CARBON OXIDATION IN THE WELD POOL

By Arne Apold

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

This book details a series of laboratory tests which were made by the author in continuation of his earlier studies of the causes of weld porosity. These tests were made to specifically determine, by measurement, the amount of carbon which is oxidized during the metal-arc welding of plain carbon steels; and to establish the relationship between the carbon balance and the composition of the base metal and test electrodes.

Explanations are given of the experiments carried out to obtain correct results from a variety of base metals, electrodes and electric currents. Measuring methods are discussed in great detail, and the process of metal deposition and solidification explained.

The tests were made in the laboratories of FONAS Fabrickker a-s, Oslo, and the translated manuscript revised by Mr J. L. Saunders, The Institute of Welding, London.

This is a specialized work suitable for use by manufacturers of welding equipment, laboratory engineers and teachers in colleges of technology. It is not suitable for students. F.T.S.

Technical Notes

ENGINEERING JOURNAL OF CANADA

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

This issue, marking the 75th anniversary of the foundation of the Engineering Institute of Canada, differs from normal issues in both format and content. The opening feature is a series of very brief summaries of important engineering developments between 1887 and the present day, illustrated by photographs supplied by the Public Archives of Canada. Little imagination is needed to appreciate the determination and resourcefulness of the early Canadian engineers.

The opening feature is followed by seven short and mainly historical papers covering the development of the asbestos, iron ore, nickel, and petroleum industries; the Trans-Canada microwave link; the St Lawrence Seaway; and the chronological story of the Engineering Institute. The four raw material industries reviewed all appear to be assured of a prosperous future, after varying periods of depression in the past. The rather surprising omission of the aluminium industry is perhaps explained by its less promising situation at the present time.

The story of the *Trans-Canada microwave link* is remarkable for the great speed which characterized the design, survey, and construction of this eminently modern coast-to-coast network, the achievement of which bears comparison with the amazing accomplishments of the nineteenth century.

Much has been written about the *St Lawrence Seaway*, but the reader seeking an over-all summary of this vast engineering project could scarcely do better than study the concise and interesting paper on page 65 of this issue. The predominance of the

Canadian contribution to this international development is apparent from the figures quoted, and the diversity of the major problems solved is adequately stressed by purely factual narrative.

The *Story of the Engineering Institute* is a record of development through periods of comparative stagnation and of enthusiastic expansion. Canadian engineers are justifiably proud of their professional organization.

LANDSLIDES IN OVER-CONSOLIDATED CLAYS: Shale deposits formed and highly consolidated by the weight of glaciers tend to revert to clays of medium or high plasticity if overburden pressures are reduced, and subsoil water seepage into fissures created by changing stress conditions hastens the process of deterioration. Engineering construction in such areas may cause changes in stability sufficient to precipitate large-scale landslides.

Two serious failures are described in this paper, one of them involving a slide covering some 50 acres. Site investigations revealed that conventional methods of subsoil exploration and stability analysis are inadequate for the assessment of slope stability in such cases. The special investigations undertaken as a result of the failures are fully described, and the authors present a suggested modification of stability analysis procedure. This is a paper for specialists, but it will interest those concerned with soil mechanics.

COMMENTARY ON CSA STANDARD S16–1961: This new publication by the Canadian Standards Association is the fifth edition of standards relating to "Steel structures for buildings". It incorporates major revisions of the 1954 edition, as a result of research and technological progress since that date. The paper sets out to analyse the reasons for revision, for the benefit of structural designers, and it is well worth reading.

URGENT TASKS IN ENGINEERING EDUCATION: Engineering education is being widely, and sometimes rather wildly, discussed from many angles. This paper, by the Dean of Applied Science, University of British Columbia, is not only exceptionally well written, but it discloses an eminently sane, practical, and human point of view. Administrative convenience must to some extent be considered, but regimentation should be accepted only with a bad grace. As the author says, "A student is entitled to wear a tailor-made gown."

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

BUILDING HEMISPHERES OF HIGH EXPLOSIVE: Precast blocks of TNT were used to build large hemispherical charges for the investigation of detonation shock waves in free air. A 500-lb charge was constructed first, for comparison with results previously obtained with a solid cast charge, and 20-ton and 100-ton charges were then built. The paper describes the casting and cooling of the TNT blocks, initiation and booster arrangements, and the precautions taken at each stage. The measurement of detonation velocities and wave symmetry are briefly described.

SOIL SHRINKAGE DAMAGES SHALLOW FOUNDATIONS: Severe damage has been caused to some buildings, roads, and footways in the city of Ottawa as a result of soil shrinkage. The very thorough investigation here described points to the influence of large trees and pavements as a prime cause of interference with the moisture content of fine grained soils and marine clay.

MINING ENGINEERING EDUCATION: This short paper is confused by some peculiar phraseology, a proportion of which must surely be due to printing errors. A mining project demands the co-ordinated efforts of a team of specialists: the mining engineer, responsible for the application of machines and labour, must be trained to interpret data of varying degrees of reliability.

MAGNETIC INVERTERS: Those interested in the technicalities of automation and control engineering will find much of value in this discussion of switching processes and description of developments in self-locking polyphase inverters. The generation of both rectangular voltage wave-forms and of stepped approximations to sinusoidal wave-forms is described.

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

NON-DESTRUCTIVE TESTING AND QUALITY CONTROL FOR WELDED STEEL STRUCTURES: Modern welding techniques have made possible the fabrication of many devices which could not have been constructed a few years ago, and the knowledge and experience acquired have led to the more confident use of welding in structural work. Improved methods of testing and quality control have resulted in economy and higher production speeds as well as raising the general quality of welded products.

This interesting and authoritative paper describes the established systems of non-destructive weld testing, and evaluates the particular uses and limitations of each. These systems are visual inspection, X-ray and Gamma-ray, and magnetic particle, matter in motion, and ultrasonic techniques. None of these alone can detect, define, and exactly locate all possible weld faults, and the value of the results obtained depends largely upon the skill and experience of the technician. The author explains the need for realistic quality control, and cites three examples of its application to structural work. His paper is well worth reading.

KEMANO TUNNEL OPERATION AND MAINTENANCE: The Kemano tunnel, part of the huge Nechako-Kitimat hydro-electric project opened in 1954, carries water for a distance of 10 miles to the Kemano power station. During the first seven years of operation the tunnel performed adequately but by the second year, when additional load came on, a significant lowering of pressure became apparent and a considerable programme of testing and study was initiated. From this it was deduced that a very large rockfall had occurred in a particular area of the unlined portion of the tunnel, and the decision was taken to drain, clear, and repair in June 1961, when closing down would cause minimum interference with aluminium production and the least possible hardship to individuals.

The careful planning of this large and difficult project, and the steps taken as regards preliminary design and stock-piling of equipment and materials were, in the event, proved to be well conceived and entirely adequate, although the magnitude of the task was even greater than anticipated. This is a fine example of the solution of an unusual engineering project, and the value of a notably clear and interesting paper is enhanced by the succeeding reports of a very full discussion of it.

R.P.A.D.L.

CIVIL ENGINEERING

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

"THE DESIGN AND ANALYSIS OF DOUBLY REINFORCED CONCRETE BEAMS." The design of RC beams by the elastic theory, on the usual principles of no tension and straight line distribution of compressive stress, leads to a cubic equation. Certain assumptions are usually made regarding the stresses in the concrete and the steel, and the depth of the neutral axis, and suitable factors are looked up in tables, to simplify the design work (for example, "Q" and "a" in the expressions $M = Qbd^2$, and $M = t \times A_{st} \times a$ can be obtained from design tables). This usual method is not strictly accurate and theoretically the cubic equations should be solved every time a change of section, reinforcement or moment is made in the trial design. The article gives three graphs from which certain functions can be obtained, related to the amount of tensile and compressive steel in the beam, and their relative positions. These functions, in conjunction with the trial dimensions of the beam, and the amounts of reinforcement, are used to obtain the actual stresses for a given applied moment, or the permissible moment with given working stresses. The method is relatively simple, and the graphs are large enough to give reasonable accuracy. Four worked examples are given, but these are only very briefly explained, so that it takes considerable effort to follow the working. A final paragraph explains the derivation of the graphs, the values for which were computed on the Manchester University Ferranti Mercury electronic digital computor.

"RECONSTRUCTING THE VICTORIA TOWER IN THE HOUSE OF LORDS." The Victoria Tower was built over 100 years ago to the design of Sir Charles Barry. The tower is used primarily for the storage of records, the quantity of which has been steadily increasing; even during construction it was necessary to add more floors to give extra storage space, and since then the whole structure has been heavily loaded, to well over the amounts contemplated at the design stage. The tower has recently been reconstructed to give further additional storage capacity, and at the same time to allow for the installation of air-conditioning and other improvements. Much of the original structure was in cast iron, and it was calculated that some members were already stressed to 6 tons/in^2 against their calculated strength of 7 tons/in^2. Work on the building had therefore to be carried out with extreme caution to prevent any adverse effects and overstressing, and at the same time the opportunity was taken of transferring some of the load away from the more heavily loaded members. The weight of the roof, some 276 tons, was transferred from a system of CI columns onto a large steel frame which was built to transmit the reactions straight onto the 4 corner towers. This steel frame, as were also the steel beams for the additional floors, was built up in position by welding. The weight was then slowly transferred by jacking and a system of wedges until the old columns could safely be removed, thus giving further space below. A major difficulty encountered was that the only access for the new beams into the tower was through a small aperture in the vaulted roof over the Royal entrance; each section had to be lifted up on end and then swung into position within the tower.

"A PRESTRESSED CONCRETE CHIMNEY AT LONDON AIRPORT." The article describes an 80-ft high cylindrical chimney. It was designed to be built from precast sections, with the intention of reducing cracking caused by thermal stresses, thus maintaining an aesthetic appearance. The actual concrete construction was however carried out *in situ* with no adverse effects. Prestressing was considered to be the most suitable method of controlling the stresses in the structural concrete. In order to prevent excessive loss of prestress due to the high temperatures involved, a layer of insulating brickwork was incorporated to reduce the temperature of the steel from about 200°C to 60°C. The cylindrical base and foundation slab are of reinforced concrete.

"SLOPE DEFLECTION METHOD IN THE ANALYSIS OF A RIGID FRAMED STRUCTURE WITH ELASTIC SUPPORTS." When it is considered that the supports of a rigid framed structure cannot reasonably be treated as either rigid or hinged, but have some intermediate condition, the calculation of the moments can be troublesome. The author of this article has developed a method for calculating them by the slope deflection or moment distribution principles, in which he makes use of auxiliary members added below the original supporting members under consideration. The flexibility of the auxiliary members is dependent on the fixity of the original support, and a table is included which gives the corresponding factors for different conditions at the supports.

"THE PROGRESS AND DESIGN OF NUCLEAR POWER STATIONS IN GREAT BRITAIN." The article describes the current state of construction of the nuclear power stations being built at Hinkley Point, Sizewell, Dungeness, Trawsfynydd, Hunterston, Berkeley and Bradwell. It also gives descriptions of the major characteristics of the first two of these stations.

"THIXOTROPIC CLAY SUSPENSIONS." This is the last of Professor Billig's series of articles on the subject. The majority of it consists of a most lucid description of the ICOS-Veder system for constructing underground walls, with particular reference to the use of this system in building the underground railway in Milan. Basically, a trench is excavated whilst being kept full of a Bentonite suspension which prevents its collapse; when it has been dug to the required depth a reinforcement cage is inserted and it is concreted by using a tremie. The chief advantages of the method are:—the low plant working areas required; the avoidance of the noise and vibration, with consequent danger of damage to near-by buildings, which would occur with the more conventional sheet piling; and the capability of working without need for soil dewatering which might otherwise cause danger of ground failure. The system has been used successfully on the Hyde Park Corner development scheme, although in this case the engineers were not prepared to accept the concrete walls made as the final structural members, and they were used only to support the sides of the excavation whilst the main walls were built between them. In Milan the walls were used directly as structural members, and they appear to have been more than adequate.

J.C.P.

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

THE NEW ROAD BRIDGE OVER THE MEDWAY. This article gives an interesting account of the design and construction of the new Medway Towns Motor Road bridge over the River Medway. Several Long Engineer Course officers have been attached to the consultant and contracting firms involved on this project.

There are three spans over the river: a central span of 500 ft believed to be the longest span of its kind in the world, and two side spans of 312 ft 6 in. The bridge has an overall length of 3,272 ft 6 in (nearly 2/3 mile) made up of eighteen viaduct spans and the three main river spans mentioned.

The viaduct superstructure is of composite beam and slab construction, simply supported for dead load and continuous for live load, the spans varying in length from 100 ft to 135 ft. The precast prestressed concrete viaduct beams vary in weight up to a maximum of 190 tons.

The two main river piers consist of reinforced concrete shafts founded on reinforced spread footings, 31 ft wide and 106 ft long. From these piers the three main spans are of balanced cantilever construction with a simply supported central span approximately 100 ft length.

The article goes on to discuss some interesting design and construction details which afford excellent examples of the type of problems met in major bridge works.

TIMBER ENGINEERING FEATURE. A series of articles on the use of timber in structural engineering is included in this issue. Some of the main subjects discussed are as follows:—

(*a*) "The Use of Timber as a Structural Material." The possibility of making glued laminated structural members from spruce is discussed, and the conclusions drawn from a series of tensile tests on scarved joints in fabricated glulam members are recorded. It is significant to mention that none of the specimens tested was as strong as expected, although actual strengths varied with the scarf profile, slope of grain, end-matching, and the planing off of end steps. No significant differences in strength were detected between casein and resorcinol glued specimens.

(*b*) "Engineering in Round Timber." The growth of preservative treatment over the last few years has led to an expectancy of structural life for round timber members such as piles, poles, bridge stringers, etc, of 30 to 35 years, when adequately impregnated. This article lists the causes of reduction of strength of round timber, and suggests means of prolonging structural life. A table of basic working stresses for round timbers is also given.

(*c*) "Using Aluminium Alloy Nails for Fixing Timber and Other Materials." The advantages of using aluminium alloy nails compared with galvanized or sherardized iron nails in timber and other construction is discussed.

J.R.J.

THE MILITARY ENGINEER

MARCH–APRIL 1962

RAILROADS THROUGH THE AGES, by Captain C. J. Merdinger, Civil Engineer Corps, United States Navy. This condensed history of railway development throughout the world is in five parts, two of which, "Railroads in England" and "Development of the Locomotive" are in this number of the magazine. The other parts which will be published subsequently, are "Development of the Rail and Roadbed", "Railroads in the United States" and "Railroads in Other Countries".

The article is well illustrated and gives a very clear and interesting picture of the growth of the railways in England from the early days when they were horse-drawn until now. More attention is given to the early developments, which is also the case of the part dealing with the locomotive. The effect is a useful summary of the essential parts of the story.

PROJECT PRESS ON ROI-NAMUR, by Major Roy P. Beatty, Corps of Engineers. This is a description of the construction work carried out on an atoll in the Marshall Islands for the installation of an observation post in connexion with the Nike-Zeus antimissile missile tests. The article deals more with the organization of the project than with the details of design and construction but it is well illustrated and contains a great deal of practical interest from the point of view of works in relatively remote sites. It also emphasizes the enormous effort which is being sustained by the US in the missile field.

MILITARY ENGINEER FIELD NOTES

REPAIRING A "TEREDO" DAMAGED PIER, by Alfred M. Gieseke. The *Teredo,* which is also called the shipworm, attacks wooden objects such as ships, piles, bulkheads, etc, especially in tropical waters. This article describes the *Teredo* and its action on timber and the repair of a timber pier at Palm Beach Florida which had been attacked. The repair was achieved by the use of a reinforced concrete slieve. The design and construction of the slieve are described in some detail.

EPOXY ROAD SURFACING, by C. V. Wittenwyler. Epoxy resins are thermosetting resins, which means that once they have hardened, they will not resoften with heat or from exposure to solvents. This article describes performance tests of epoxy cements used as seal coating, primarily on portland cement bridge decks. As the resin hardens a tightly bonded sandpaper like surface is created with wear and skid resistance. There are good illustrations and technical details.

HURRICANE PROTECTION OF NARRANGANSETT BAY, by John B. McAleer. Major hurricanes have been responsible for tidal floods and wave destruction in exposed coastal areas involving much loss of life and damage. Congress directed surveys to secure data on the behaviour and frequency of hurricanes and to determine methods of protection by breakwaters, seawalls, dykes and dams, by forecasts and improved warning services, or by some other measures. As a result of the surveys in the Narragansett Bay area of Rhode Island and Massachusetts, where particularly severe tidal flood damages have occurred, the Fox Point Hurricane Barrier at Providence is under construction and a system of Lower Bay barriers is being studied. This article, which is well illustrated, describes the problem set by the hurricanes and the methods in hand or projected to cope with them.

AUTOMATIC MAPPING PROCESSES, by Lieut-Colonel S. Presser, Corps of Engineers Reserve. *GIMRADA*, which is the code name for The Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency established at Fort Belvoir in August 1960, is the principle field agency of the army for research and development of equipment and techniques in combat surveying and geodesy, combat mapping, global mapping and geodesy and map reproduction and distributon. This article, which is illustrated with photographs, gives short descriptions of systems and equipments which *GIMRADA* has provided and designed to furnish within a relatively short time precise data for rapid combat mapping in support of target location, not only in the "area of domination" of the field army but also in the potential target area.

MAY–JUNE 1962

THE GLEN CANYON RECLAMATION PROJECT, by Arthur R. Fyfe. This is a description with good photographs of one of the greatest dams under construction in the world. It forms part of the regulation and control of the Colorado River. There is enough detail to give a clear picture of the technical aspects of the design and of the organization of the project.

THE RUSH ROLL, by P. J. Rush and Robert Easton. The Rush Roll is a piece of equipment designed in the first place to provide a roadway over mud, marshy ground or quicksands, which is mobile and easily laid. The roll is a cylinder 6 ft in diameter, $13\frac{1}{2}$ ft wide composed of six separate pontoon segments hinged together by four $\frac{7}{8}$-in diameter pins. The article describes in considerable detail the construction of the roll and the results of trials which have been carried out. In addition to its primary use, providing a causeway over marshy ground, it can be used as a pontoon bridge, by linking as many rolls together as may be needed, and as a raft. The trials were so successful that the roll has been accepted as standard equipment in the US Army.

MAPPING TRAFFICABILITY, by Major S. J. Knight, United States Army Reserve and M. P. Meyer. After pointing out the importance of cross country mobility in the conditions of modern war the authors describe a method of indicating the passability of the terrain on a map with a specimen sheet in illustration. The emphasis is on general soil conditions in wet and dry seasons and the information on which the map has been prepared has been obtained from official publications including the Atlas of American Agriculture.

The article provokes thought about how such information can be got for other theatres in which war may have to be waged but the system of showing the traffic ability is worth study.

WATER RESEARCH BY THE GEOLOGICAL SURVEY, by Lieut-Colonel Herbert A. Swensen, United States Army Reserve. A short but interesting account of the many headings under which the Water Resources Division of the United States Geological Survey carry out their research into the question of water as a resource in the United States.

RAILROADS THROUGH THE AGES, by Captain Charles J. Merdinger, Civil Engineer Corps, US Navy. This is the second instalment of the paper and consists of Part III, Development of the Rail and Roadbed. A very detailed description of the way in which the present practices grew.

CHAIN OF ROCKS ACROSS THE MISSISSIPPI, by Colonel Alfred J. D'Arezzo, Corps of Engineers. A well illustrated account of the design and construction of a low level dam across the Mississippi. The chief interest of the dam is that it is the first dam ever undertaken on a major water-way without the use of coffer dams, without de-watering and without river diversion.

SITE LOCATION IN THE ARCTIC REGION BY AIRPHOTO ANALYSIS, by Captain Stanley M. Needleman, United States Air Force Reserve, and Albert E. Presman. During 1960–1 a photo interpretation study was conducted within the Canadian Arctic north of the 65th parallel. The primary object was the location and preliminary terrain analysis of the most promising ice-free areas suitable for natural landing-sites for heavy aircraft. This article describes the methods followed and gives examples of the reports received and their confirmation by ground reconnaissance. The article is illustrated with maps and photographs.

JULY–AUGUST 1962

This number is largely devoted to articles on Space Engineering, Satellites and Rockets.

SPACE ENGINEERING, by James E. Webb, Administrator National Aeronautics and Space Administration. The National Aeronautics and Space Administration was set up in 1958. This article describes briefly the work carried out in this field before then but the greater part deals with the future plans for further development. Details are given of the progressive stages by which the power of rockets is to be increased culminating in Nova with a lift of 200 tons. Nova will be a general purpose vehicle providing efficient means of transporting heavy payloads to the moon. Other subjects dealt with are Test Stands, Launch facilities and Nuclear Rockets.

Satellites, lunar probes, and space probes, from February 1957–June 1962: This is a table giving dates and performance details of all satellite, etc, launchings by the USSR and the US since Explorer I, 1 February 1957.

Engineering for space: The subject of the Symposium of the Society of American Military Engineers held on 22/23 May. This article is a summary of the papers presented. There are twenty-one altogether covering almost every facet of the subject.

Space logistics from earth to Mars, by Brigadier-General William R. Woodward, US Army (retd). Although the project for exploring Mars is long range, maintenance in space is a problem that man must soon face. General Woodward describes the essentials of the problem and forecasts some of the means for their solution. The article is impressive in the picture given of the immense effort which will be called for and for the imaginative manner in which the question is being tackled.

Missile test ranges: industry's role in their development, by G. T. Smiley and F. E. Lowther. The authors belong to the General Electric Company and in this article discuss the work of the company in connexion with world wide networks for tracking satellites and with plans for future research and development.

Railroads through the ages, by Captain Charles J. Merdinger, Civil Engineer Corps United States Navy. This completes the brief account of railways, Part IV, Railroads in the United States. It shows that development followed similar lines to that in England in the early stages but the vast distances to be covered in America produced significant variations. Part V is a very short note and contains little detail.

September–October 1962

Aerospace Ground Equipment: By Colonel B. F. Rose, United States Army Reserve Retired. The author discusses the problems of providing launching facilities for the next range of space vehicles. It is probable that the vehicle will be assembled and checked in an assembly building and transported in the vertical position to the launch pad. He describes various methods of transportation, track or water. He then goes on to different kinds of launch platforms including a planetary rocket ocean platform which is being studied. There is also a scheme proposed for fabricating and assembling vehicles in the horizontal position in dry docks. The vehicles could then be floated to the launch location. Successful test launchings of a liquid propellant rocket floating in an upright position in the sea have been made. The article is well illustrated.

Engineers in Anti-guerrilla Warfare: By Major General Alden K. Sibley, United States Army. A very interesting article describing the terrain and nature of the operations in South Vietnam. The importance of the support which can be provided by the engineers is well brought out by the examples given. The author, who is an Engineer officer, served in the Military Assistance Advisory Group to Vietnam before becoming Deputy Chief of Engineers for Military Operations so he writes with first hand knowledge.

Dew Line Canada–Iceland Link: By Harold B. Goyette. DEW stands for Distant Early Warning and is a chain of radar stations across Northern Canada. It was decided in May 1957 to extend the line across Greenland to Iceland. This article gives details of the design of the various structures and the organization of the work of construction. To overcome the accumulation of snow through drifting which quickly buries any obstructing body during the winter the buildings are carried on massive columns projecting above the icecap. These columns contain jacks capable of raising the whole building 30 feet or the equivalent of ten years anticipated ice build up. There is much technical detail and the article is liberally illustrated.

Talking to Timbuctu. Project Telstar: By Claude M. Blair. This article was written before the launching of Telstar took place. It contains much general information about US communication systems and many details of the design and construction of Telstar itself. Telstar is a Bell Telephone System project and the author of the article was, until recently, vice-president of the Pacific Northwest Bell Telephone Company and has been with the Bell System since 1930.

NAVY PONTOON CAUSEWAY: By R. C. Towne and Robert Easton. This article gives the specification and design of the new Navy Pontoon Causeway which has been developed by the US Naval Civil Engineering Laboratory. The specification called for a moving 60-ton track vehicle as maximum load; length 1 mile; width 18½ to 21 ft; and anchorages adequate to provide stability in a 40 mph wind, 6 ft waves and a 3-knot tidal current parallel to the shore line. Speedy assembly and dis-assembly were also required as well as a section length convenient for handling by LST. The specification has been met and the details are well illustrated by photographs.

THE NATIONAL FALLOUT SHELTER SURVEY: By Colonel A. D. Chaffin jun, Corps of Engineers, US Army and Captain W. M. McLellon, Engineer Corps, US Navy. This is an account of the organization set up to make a survey of the availability of suitable shelters in existing buildings in the United States. The Army Corps of Engineers and the Navy Bureau of Yards and Docks with their wide-spread organization are being employed as the contracting agencies with the architect—engineer firms which survey shelter areas. The article is an indication of the seriousness with which the US is approaching Civil Defence.

FIRST ARMY JUMP THE RHINE: By Abe Bortz. This is a well written well illustrated account of the bridging operations carried out by the US First Army Engineers on the Rhine in March 1945. The Army front was between Coblenz and Bonn and included the Remagen Bridge. The article gives details of the engineer's part in the seizing of the Remagen Bridge before it could be destroyed by the Germans and of its subsequentcol lapse while under repair in which disaster many engineers lost their lives.

RAILROADS THROUGH THE AGES. Part V. Railroads in Other Countries (continued): By Captain Charles J. Merdinger, Civil Engineer Corps, US Army. In this concluding instalment the discussion of railroads in countries other than England and America is continued. Interesting though short summaries are given of the development of the railway systems in France, Germany, Russia, and Switzerland. The rest of the world is covered more summarily and the article ends with a brief resumé.

WIDENING THE PANAMA CANAL: By Charles McG Brandl. After a short review of the measures which have been taken to improve the capacity of the Panama Canal a detailed account, with illustrations, is given of the widening of the Gaillard Cut.

SPACE LOGISTICS FROM EARTH TO MARS. Part II: By Brigadier William R. Woodward, US Army Retired. In Part I the author considered the problems of travel in space to Mars and the planning needed to support such a venture. An essential part was said to be a space station from which the final launching of the vehicle would take place and which would act as a sort of advanced base for the expedition. In this article he goes into a good deal of detail on the food and other stores and the equipment needed to maintain life throughout the long journey. He also gives a picture and brief description of a space tug which would be needed to manoeuvre the components of the space ship during its build up in space and a machine called the Centipede, a tracked vehicle for moving about on Mars with manipulators controlled from inside. The two articles are very interesting as showing the immensity of any project designed to despatch a manned vehicle to land on Mars and the need for careful planning of all the necessary support facilities concurrently with the actual vehicle and its launching. There is no hint in the article that any official practical work has been initiated in the United States on these lines, but in the author's opinion the urgency of the need to travel to Mars is such that no time should be wasted before a beginning is made.

LAND MINES PAST AND PRESENT: By Lieut-Colonel Jackson M. Abbot, Corps of Engineers Reserve and Captain Logen Cassidy, United States Marine Corps. A short useful summary of the history of anti-tank and anti-personal mines in the major armies with a list of US mines. J.S.W.S.