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THE ROYAL ENGINEERS JOURNAL

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AGE

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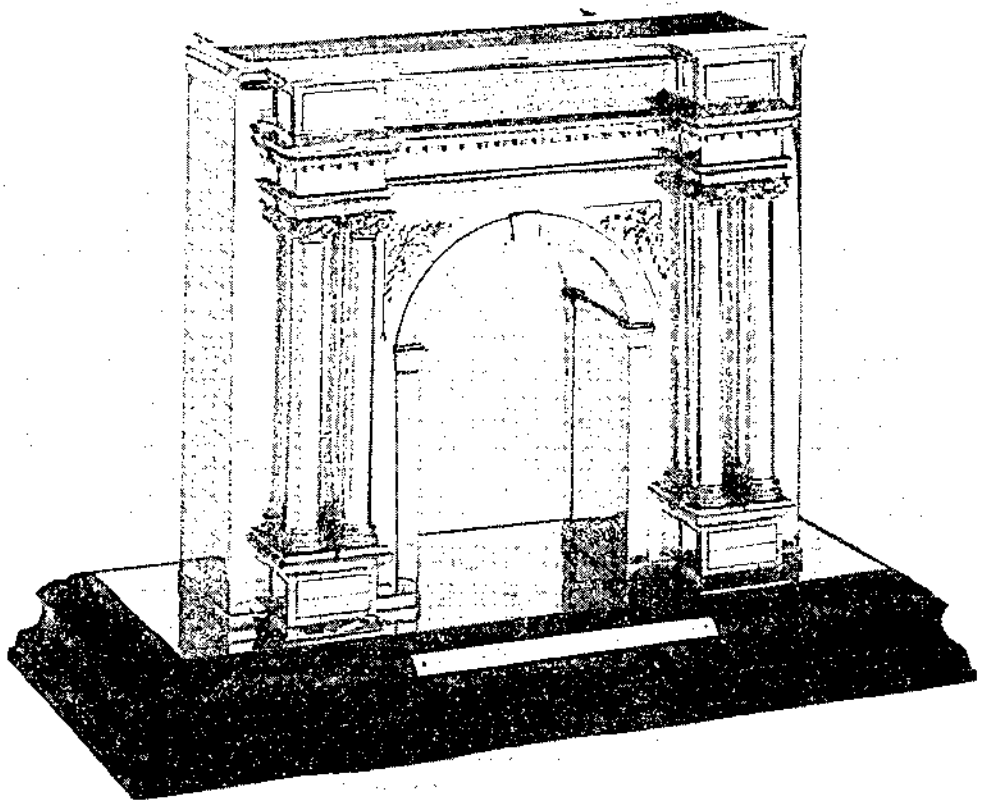


New silver centre-piece for 35 Corps Engr Regt

New Silver Centre-Piece for 35 Corps Engineer Regiment

THE 35 Corps Engineer Regiment was formed, in its present constitution of 16, 30 and 42 Field Squadrons, in 1950. It was natural, therefore, that in 1960 the officers were anxious to mark the first decade of the Regiment's life by the presentation of a silver centre-piece. Thanks to the generous help of the Corps Committee, we were able to embark on the project in 1961.

It proved easier to agree on the project, than to decide what it should be. The Regiment had indeed taken part in operations in Cyprus, and at Suez, but no aspect of these seemed to lend itself to commemoration in silver. Many ideas were put forward, only to be discarded; but at last a model of the Heger Tor, the Waterloo memorial gateway in Osnabrück, was suggested. With its inscription to the battle of Waterloo, it would not only constitute a link between Great Britain and North Germany, but would also serve to commemorate the beginning of what one hopes will be a long and fruitful association between the Armies of both countries; it would also mark the already not inconsiderable connexion between the Royal Engineers and Osnabrück, where there have been units of the Corps at all times since the war. 11 Engineer Group was formed there in 1951, and 35 Corps Engineer Regiment has been there since 1957.

The first design of the centre-piece was made in April 1961, by the then Second-in-Command, Major (now Lieut-Colonel) A. G. Townsend-Rose. Inspiration came to him at 4 am on an RHQ exercise, and the design was complete by 6 am. The final centre-piece follows it in all essentials. A German silversmith, Herr Matthäus, formerly of Berlin, undertook the work, and it was completed in October 1962. The centre-piece is made entirely of sterling silver, with the inscription inlaid in gold, and is remarkable in being entirely the work of one man. The gate itself measures 13½ in high, on a plan of 15 by 7 in. It is set on a mahogany plinth.

The history of the Heger Tor is interesting. It was originally called the Waterloo Tor (Gate), but as it leads to a popular pleasaunce, the Heger Holz, it became known as the Heger Tor. It carries the inscription:

"Den Osnabrücker Kriegern, die bei Waterloo den 18 Juni 1815 deutschen Mut bewiesen, widmet dieses Denkmal. G. F. v. Gülich D.R. DR."

Which may be translated as:

"To the warriors of Osnabruck, whose German bravery was manifest at Waterloo on 18th June 1815, this memorial was dedicated by G. F. von Gülich, Doctor of Laws."

It was built in 1817, into the mediaeval city wall. It has a pleasant classical style, which is echoed in a few good buildings in the town. Von Gülich was a prominent member of an old town family.

The fighting quality of the Hannoverians, during the Napoleonic wars, is well known. Most fought in the Royal German Legion, raised by George III in 1803. It was a considerable force, 16,000 strong at its zenith in 1813; its members took part in battles all over Europe—Copenhagen, Italy, Sicily; and with distinction in the Peninsula at Talavera, Barossa, Albuera and Salamanca. They were given the place of honour in the entry to Madrid, and their officers held permanent rank in the British Army. They played a distinguished part at Waterloo.

The Royal German Legion must have had many men from Osnabrück; but at Waterloo there was also a battalion specifically from the town. This was a second-line (Landwehr) battalion, one of thirty raised in 1813, when Napoleon withdrew from North Germany. It was part of the 3rd Landwehr Brigade, commanded by a Scot, Colonel Halkett. It went to Brussels in 1814, and found itself awaiting its baptism of fire at Waterloo on the right wing, behind Hougoumont Farm. They held firm throughout the day, perhaps not in the forefront of the fight; the history says they formed square several times against cavalry attacks, and once for fifteen minutes lay flat on the ground under heavy French artillery fire.

An account by one of their officers survives, of the end of their day; it was crowned by the capture of General Cambronne of the Imperial Guard, to whom is ascribed the great words "La garde meurt et ne se rend pas":

"When Wellington gave the order to advance at 8 pm, Colonel Halkett had only the Osnabrück battalion under his command. We crossed a wide depression, typical of the rolling battlefield. We went in silence, constrained by the endless exchange of cannon balls over our heads. Once up the slope at the far side, we found an enemy column 3–400 yards from us. It was a Regiment or Battalion of the Old Guard. 'Arms Ready' cried Colonel Halkett. On we went, to receive a volley from their front rank. We checked; it was the moment of crisis—then a sudden cry from Colonel Halkett: 'Hurrah brave Osnabrückers'; our bayonets flew to our hands, and we charged. The enemy couldn't face our bayonets; they stood for a moment, wavered a little, and then broke and fled. To a man, their officers tried to hold them, but we soon settled that. There was one particularly active senior officer, but at last his horse fell, hit by a cannon-ball. The moment Colonel Halkett saw this, he drew his sword and spurred his horse up to him. But when he got there, his opponent had risen, and was ready for him; I thought he'd run him through. We tried to protect our Colonel, and I rushed to the spot. He was in great danger; a shot or bayonet stroke could have got him from any side. But no Frenchman stayed to save his General; the sauve-qui-peut had spread all round, and even his aides deserted him. And so the General became our Colonel's prisoner; he got him by the collar and dragged him on his saddle-bow towards us. When he arrived, he let go the prisoner and asked him who he was: 'je suis le General Cambronne' was the reply."

The Osnabrück battalion earned high opinions for its performance that day. The great record of the Royal German Legion under Wellington is of course well known, and one hopes that the Memorial Gate was meant to honour the bravery of Osnabrückers serving in it, as well as the worthy efforts of the town battalion under its Scottish commander.

The centre-piece will, then, bear witness to a great comradeship in arms between Germany and England, 150 years ago. It will recall the present good relations of the Corps with the City of Osnabrück and, one hopes, will mark the beginning of an association between the British and German Armies worthy of the times which the Waterloo Gate commemorates.

Engineer-in-Chief's Address to the 1963 Annual General Meeting

Introduction

Major-General Foulkes opened his address by explaining that his appointment as Engineer-in-Chief had been extended for a few months to enable Major-General Duke to complete his work on the Nye Committee. It was good to know, he said, that General Duke was to be Engineer-in-Chief.

For the last three years he had reminded the meeting that the Corps, and in fact the whole Army, was in a period of evolution. This was still as true as ever and several committees were sitting now to consider the future organization of the armed forces. Whatever the outcome of their deliberations, he hoped that such changes as there might be would be confined to the higher levels and that units would be able to settle down and get on with their work. He was not, incidentally, one of those who believed that "what works well must be obsolete".

He then went on to explain that Sappers were well known for holding, and expressing, widely differing views on almost any subject. He in no way wished to discourage discussion. It was most important, however, that, when opinions about the future of the Corps were expressed, they should always take account of the Corps as a whole and never be dominated by any sectional interest. It could be most harmful to the Corps if they were.

Part I—Activities of the Corps at Home and Overseas

Starting in the Pacific Ocean, the Engineer-in-Chief said he hoped that 73rd (Christmas Island) Squadron would be joined at the end of this year or the beginning of 1964 by 20th Field Squadron from 36th Corps Engineer Regiment, reinforced by the POL Specialist Team. This additional force, which would be on the island for about five months, would replace the existing bulk petroleum installations and rehabilitate the camp structures and water supply systems. Apart from its direct value to the Government, this was just the sort of project which we want. It would provide excellent training and practical experience in exacting conditions.

Last year he had mentioned that the Administration of the Gilbert and Ellice Islands had asked for a small engineer party to blast gaps through the coral reefs surrounding the islands in order to facilitate the passage of government craft and boats engaged in the copra trade.

Although there was little previous experience on which to base our methods, some very successful techniques, including for instance the use of coconut husks for forming shaped charges, had been developed. The party were able to do much more than had been expected of them, and we had received letters of glowing appreciation from the civil authorities. He had mentioned this project for the second year running because he was convinced of the value of sending small detachments on unusual tasks where they gained confidence and enjoyed the element of adventure.

Since November 1962, the Chief Engineer, FARELF, had been heavily committed in supporting IS operations in Brunei and Sarawak. Sapper tasks had included the rehabilitation of public utilities, maintenance of airfields and the construction of forward airstrips in addition to such normal field engineer tasks as rafting and water supply. All this had been done very efficiently. The Director of Operations in Brunei was particularly pleased with the work of 425 Stevedore Troop of 10th Port Squadron RE at Labuan, and the Deputy High Commissioner of Brunei was enthusiastic in his praise for the achievements of our Works Sappers in support of the PWD.

Last year he had said that he hoped a CRE MELF would soon be established. This had now been done and the CRE arrived in Aden at the end of May. Our main tasks in that region were track construction and the building of camps with air conditioned Twynham huts. This was providing good experience for 32nd Field Squadron and our Works officers and other ranks employed on the project. The Independent (Aden) Field Troop had now been built up to a field squadron and the Commander of the Federal Regular Army had written to say how much he had appreciated the work that the Troop had done in the past in opening up some of the wildest country in Arabia.

The reorganization of the Engineers in the Near East was now complete. There was a CRE in Cyprus District and one had also been established in Malta (covering Malta and training in Libya).

The 1st Fortress Squadron was still on the Rock of Gibraltar where he hoped it would remain for many years to come. They were very busy with tunnelling and E & M duties.

RE units were continuing to maintain a very high standard of training in BAOR where they had unique opportunities of working in close co-operation with all arms. It was encouraging to see in BAOR the improved mobility resulting from new engineer equipments now coming into service, such as amphibious river crossing equipment, wheeled plant and the assault trackway. He was also particularly glad to see field squadrons taking on engineering projects. Second Divisional Engineers were to be congratulated on the success of their work on the Hameln bridging hard.

In the United Kingdom, Third Divisional Engineers and the Strategic Reserve Support Echelon had been very hard pressed with their world-wide commitments. 9th Parachute Squadron had also been busy in BAOR, Greece, Malaya, Canada and the Persian Gulf.

This year 36th Corps Engineer Regiment had had two good overseas training exercises. They had sent a troop to Norway for winter warfare training in February, and 24th Field Squadron had just returned from an excellent six weeks exercise in Canada. They had also done valuable rehabilitation work after the hurricane in British Honduras. 38th Corps Engineer Regiment, too, had a number of excellent projects in hand.

He was glad to say they were all in good heart, which was just as well since they might be even more heavily committed in future. One had only to glance at the papers to realize how many places there were in the world where trouble could start at a moment's notice.

At the RSME, after a series of delays, authority had now been given for the new building at Chattenden to start, and we had obtained approval to take over a useful area of land adjoining the new barracks for training.

The rebuilding of the Junior Leader's Regiment Barracks at Dover was also going well.

He said that the achievements of the Sappers of the Reserve Army were too numerous to mention, but often appeared in the Press; and morale was high. He would like to mention, particularly, 26th Engineer Group's most successful camp on Alderney last summer. He strongly recommended anyone who had not already done so to read Colonel Bloomer's article on this camp in last December's *Journal*.

PART II—SURVEY, TRANSPORTATION AND POSTAL

42nd Survey Engineer Regiment, which was formerly 19th Field Survey Regiment and before that 512th Army Field Survey Company, was returning to the United Kingdom this month, having been abroad since 1940. Quite apart from their achievements during the war, he would not like the occasion of their return to this country to pass without mentioning their remarkable work in the Near and Middle East since then. Their activities had covered Iraq, Kuwait, large parts of Muskat and Oman, the Aden Protectorate, Jordan, Cyprus and Kenya. Their field work had yielded maps covering more than 275,000 square miles at medium scales, and their triangulations had filled important gaps in the earth's coverage. 13th Survey Squadron would soon move from the UK to Aden. Survey units had been particularly busy during the year in Malaya and North Borneo, as well as the Near and Middle East. At home a troop of 13th Survey Squadron had been collaborating with the Ordnance Survey to connect the continental triangulation system with our own in the United Kingdom, for which there were of course historical precedents. Another troop of 13th Field Survey Squadron had been doing urgent work for the Government of Kenya on the Land Resettlement Survey, and individual RE Survey officers were, as usual, seconded to Commonwealth and Colonial countries.

During the last year there had been two important changes in the Movements and Transportation organization. We had now seen the start of a world-wide unification of Movements and Transportation. This, he thought, would prove beneficial to the Army as a whole and he hoped that by next year we would have gone one step further and formed a Joint Services Port Squadron in the Middle East. Secondly, sea trooping had come to an end in last December, and all trooping was now by air.

Ramped Powered Lighters were coming off production to replace and improve upon our venerable Z Craft. We were to receive nine of these. They could be lifted on to a ship having a 60-ton derrick, and so could be moved round the world.

The Armed Forces Courier and Postal Service was very efficient worldwide, and had done well in recent IS operations in Brunei and Sarawak. Next month the Postal Service would take over from the GPO the responsibility for handling Royal Navy mails in the United Kingdom and so would become completely tri-service. Ultimately field post offices overseas would replace the existing fleet mail offices.

PART III—EQUIPMENT, ORGANIZATION AND PERSONNEL MATTERS

The Engineer-in-Chief next spoke about developments in equipment: in particular, the German M2 amphibious river crossing equipment, the medium girder bridge, new armoured engineer equipment and the Class 30 assault trackway.

He then went on to speak about works services. General responsibility for works services for the Army had been transferred to the Ministry of Public Building and Works on 1 April 1963. There were still many important problems to be resolved as a result of the transfer. For example, the Army must obviously retain responsibility for works in war and certain emergencies, and in any circumstances where civilian procedures would not suffice and civilian contractors could not or would not work. Accordingly, the Corps must retain the necessary Works and Resources backing in peace to be trained, ready and balanced to meet their responsibilities whenever called upon to do so. The Engineer Specialist Service Establishment, ESSE, had risen splendidly to the occasion again and again in the last three years, but it had worked at a great disadvantage and now needed to be recast. The Army meanwhile had become more than ever dependent on its Sappers for works duties in war and emergencies, and for this and other reasons the works tide could be said to have turned.

Another reorganization of the AER 1 had been announced in April and would be complete by November this year. The Engineer-in-Chief said he was sorry to see the disappearance of some AER RE units, particularly on the Movements and Transportation side. These officers and men were a great asset to the country and although the overall redundancy was small we could ill-afford to lose any of them.

Redundancy for regular officers and other ranks was now over although some brigadiers and colonels were still being retired well before the age of 55. This would continue until 1967 and, though regrettable, was necessary to ensure an even flow of promotion for their successors.

Officer recruiting was still a major problem although it had improved slightly of late. We needed sixty-eight regular second lieutenants each year. In 1962 we received fifty-five and this year we might perhaps do a little better. This fifty-five in 1962 compared with an average of only thirty-five in the previous six years. We had a long way to go and it would take years for the great efforts which Chief Engineers and many members of the Corps had been making to bear fruit. It should be remembered that all recruiting was centrally controlled by the Director of Recruiting and that individual Corps had little freedom of action. Our grave problem was, however, being squarely faced in the War Office and certain new measures were expected soon, such as financing candidates for regular commissions while at universities, and much better advertising. Last year we had established seven new Quartermasters' appointments in field units and this would help, in a small way.

During the year the Corps had raised its other rank strength by 1,500 but in the last few months recruiting, in common with the rest of the Army, had fallen off badly, and all our efforts would still be required if we were to maintain our strength and meet our new commitments.

PART IV—CORPS MATTERS

The Engineer-in-Chief then mentioned the Seventh Engineer Standardization Conference, to be held at Chatham in September this year. Everyone would be glad to know that Australia was to be represented for the first time. All told, approximately forty United States, Canadian and Australian officers would be taking part and the Corps would be entertaining Lieut-General Wilson the US Army Chief of Engineers, Colonel Carson, Chief Engineer of the Canadian Army, and Brigadier Logan of the Royal Australian Engineers.

Our bands, he said, had continued to keep up their high standard, as everyone would know who had heard the Chatham Band play at the Shakespeare Birthday Festival at Stratford last April, or the Aldershot Band in BAOR in the autumn.

He then mentioned the excellent work of Colonel Fea and his team of authors as characteristic of the very valuable but inconspicuous effort that was being made in many fields.

The Engineer-in-Chief concluded his address by saying that in the short time available he had been able to do no more than touch on some of our many activities. He would, however, like to mention the magnificent work of individual members of the whole Corps, including his own staff, during the last three years. He was particularly conscious of the loyalty and zeal with which everyone had worked. He would also like to take this opportunity of acknowledging the great debt of kindness shown to him and his wife during his many journeys throughout the world, not omitting Commonwealth Sappers and our American friends.

He ended by saying: "I have made some effort to know and assist everyone. This has involved some travelling. Last year, for instance, I went all round the world. Call it swanning if you wish. But I am in a position to assure you, with some authority, that the old spirit—the genius of the Corps—is very much alive."

Royal Engineers Historical Society

THE Council of the Institution of Royal Engineers, in accordance with the terms of the Institution's Charter, has decided to form a Royal Engineers Historical Society.

The aims of the Society are to:—

Stimulate interest in the history and development of all activities of the Corps of Royal Engineers.

Take steps to preserve for permanent record obsolescent items of uniform, accoutrements, etc and engineer equipments or models, drawings or photographs of them.

Acquire further knowledge, in the form of study papers, reports, portraits, prints, uniforms, medals and relics, to supplement the incomplete records already held in the Corps Library and in the various RE Museums.

Disseminate the knowledge so acquired.

Membership of the Society, which will not demand a subscription, will at first be restricted to Members of the Institution of Royal Engineers. At a later date, however, when the Society is firmly established, all past and present other rank members of the Corps may become eligible to become Associates of the Society.

Serving and retired officers, experts in various fields, are invited to become founder Members of the Society and assist in the work undertaken by the Society.

In order to obtain detailed information on the diverse activities of the Corps, Associate Members are required, particularly officers serving in Survey, Movements and Transportation, Resources, Bomb Disposal, Courier and Postal Service, the Training organization and in Engineer War Office Directorates and Branches. The tasks of these Associate Members will be to deal with research, where required by the Society, into historical matters particular to their branch of the Corps, and also to keep the Society abreast of current important developments or historical happenings in their particular field.

In the case of the Reserve Army, Headquarters Army Emergency Reserve are requested to nominate Associate Members of the Society. Similarly Chief Engineers of Home Commands are asked to nominate Territorial Army Associate Members.

Commonwealth Corresponding Members of the Council of the Institution of Royal Engineers are being invited to become Associate Members of the Society.

The work of the Society will be organized by an Historical Society Committee, composed as follows:—

Chairman. The Chairman for the time being of the Publications and Library Committee of the Institution of Royal Engineers.

Members. Representatives from the E-in-C Directorate, Survey, Movements and Transportation, Bomb Disposal, Resources and Courier and Postal Services.

The Secretary of the Institution of Royal Engineers, the Corps Librarian and the Curator, RE Museum, Chatham.

Secretary. The Manager of Corps Publications.

The Committee will be represented on both the Publications and Library Committee and the Museums, Memorials and Scholarships Committee. The Chairman of the Committee will represent the Society on the Council of the Institution of Royal Engineers.

The Committee will recommend an annual programme of work for submission to the Council for approval. It will also undertake approved work on behalf of Institution Committees.

To assist study groups and individual officers in obtaining information on the work they undertake, arrangements will be made by the Society to provide, on loan, any appropriate literature which may be available from Military or other Libraries.

For the purpose of disseminating information acquired by the Society the normal publications of the Institution will be used.

In order that gaps in the incomplete records held in the Corps Library and in the various RE Museums may be filled, periodical lists of requirements will be issued so that Members and Associate Members of the Society may by inquiry, or by pure chance, be able to inform the Secretary of the location of wanted items, and whether they can be procured for the Corps.

Members of the Institution who wish to become Members or Associate Members of the Society should inform the Secretary, Royal Engineers Historical Society, Institution of Royal Engineers, Chatham, Kent.

Practical Photography for Military Engineers

By Lieut-Colonel D. F. Densham-Booth, OBE, RE, AIOB, ARSH

Introduction

The recent interest shown by the War Office in the application of photography to engineering tasks has prompted me to write this short article, in the hope that it may be of benefit to both the uninitiated and the enthusiastic amateur photographer alike. As some readers may know, a limited selection of cameras together with film developing, printing and enlarging equipment is at the present time undergoing field trials with certain engineer units. The purpose of these trials is to determine the suitability of standard production cameras and photographic equipment for field use and to examine the feasibility of processing films and obtaining useful pictures, rapidly, without the full scale paraphernalia of a comprehensive darkroom.

Although I have not officially participated in these trials, I am conscious of the fact that whatever equipment is finally provided for service use, it will be absolutely essential for those who are required to take photographs for military purposes to have rather more than a casual basic knowledge of the subject, if satisfactory results under adverse conditions are to be consistently obtained. This article is not a thesis on pictorial composition nor on how to prepare prints for exhibition purposes. Such subjects are adequately covered in the numerous manuals of photographic art readily available to the keen student. My intention is to demonstrate the need for sound technical performance, if photography is to be of serious use in military engineering, and to give some guidance as to how acceptable results may be achieved by relatively simple methods.

At the very outset, the photographer must be fully aware of the capability and limitations not only of the equipment available, but also of the materials and chemicals that he is using to produce the final picture. Speed, and a knowledge of what to take and how to take it, is of far greater importance than pictorial composition, when making exposures of engineering subjects. However, the need for good composition cannot always be overlooked particularly when the subject may have other than a technical application, such as for publicity displays, advertising media and so forth. Developing and printing processes must be standardized and simplified, if work is to be carried out in the field, and techniques must be developed that are readily understood and mastered by any Sapper of normal intelligence.

I make no apology for stating my own preference for certain equipment and photographic materials, and since I am familiar with their properties I will make reference to them throughout this article. The important point to stress is that, having standardized and gained experience of his equipment and materials, the photographer should adhere to his choice, and on no account attempt to change items in the middle of a process. In the past I have used a variety of proprietary brands, but at present am using Ilford products exclusively—films, papers, developers, and other chemicals. The advantage gained by such a choice is that all items are suitably matched in their performance, and once their properties have been assessed, photographic work can be accomplished giving highly satisfactory and consistent results.

In the sections which follow, the techniques of photography which may be applied to military engineering are described, together with recommendations concerning the selection and suitability of photographic equipment and materials. Details will also be given of the simple processes of film development, contact printing and photographic enlargement which can be relied upon to give the required results, even when working in the field with a makeshift or portable darkroom. Since for economic reasons the majority of military photography is likely to be confined to black and white film for the present time, all reference in this article will be restricted to monochrome photography.

Some Aspects of Military Photography

The first thought must be to consider the possible range of subjects which lend themselves to the application of photography for military purposes. The following list may be used as a framework on which to enlarge as further requirements present themselves:—

(*a*) Recce Reports—General views, details of installations, buildings, engineer structures, defensive positions.

(*b*) Aerial Photography—to supplement ground recce photographs. To photograph inaccessible locations or installations in enemy held territory.

(*c*) Technical Reports—possibly an extension of (*a*) above, but usually requiring greater detail, including internal work, machinery, plans, documents.

(*d*) Progress Photographs—taken at regular intervals throughout the duration of a construction project, such photographs may be used with great advantage to illustrate Works Progress Reports and will save much time by reducing written detail.

(*e*) Infra-Red Photography—for long distance photographs, penetration of haze, camouflage detection, arboreal surveys, covert photographs in total darkness.

(*f*) General Pictorial—views, personalities, sporting events, action. Possibly required for illustrative purposes in technical journals, magazines, press publicity, training aids, etc.

(*g*) Photo-copying—the reproduction of maps, photographs, documents, plans, manuscripts etc, to enable the original to be duplicated and if necessary enlarged, without defacement.

(*h*) Macrophotography—ultra close range (short focus) photography of small or even minute subjects, which on enlargement will reveal details not visible to the naked eye. Simple accessories will permit taking larger than life photographs of up to $\times$ 10 diameters.

(*i*) Film Strips/Slides—for technical presentations, general instruction and entertainment purposes. A simple reversal process permits a black and white negative film to be transposed into a monochrome positive transparency.

The conditions under which exposures for such subjects may have to be made are extremely variable, since military photography must be applicable to both peace and war. A vital picture may have to be obtained from a concealed vantage point, against the light, and with mist or haze partially obscuring a fast moving subject. On the other hand it may be a static subject under perfect conditions of light with unlimited time available to ensure a correct exposure. The photographer's skill and knowledge of his equipment and processes must be such that he can be certain of so recording the subject that it permits faithful reproduction in the finished print.

Lighting is a major factor in monochrome photography since the picture is entirely dependent on shades of black and white in order to provide the detail. It will be readily appreciated that both time and place are factors which affect natural light. According to the time of day, season of the year and geographical location, so will the intensity of light vary. Even if this were not enough, cloud conditions can further affect the degree of light within a few seconds, either momentarily or for long periods. It is sufficient to say that an accurate estimate of available light is necessary for good photography. This can be achieved either by reference to standard tables and calculators, a somewhat lengthy and not always reliable method but a good standby, or by the use of a high quality light meter.

When time is not important and the subject is available without restriction it is preferable to wait until natural lighting conditions are at their most favourable. As an alternative it may be an advantage to introduce artificial lighting in the form of "flash" or tungsten flood lamps to improve poor natural light and to avoid delay. However, such additional illuminations may not be available under field conditions, and in operational photography full use will have to be made of "available light". It is under such limiting circumstances that the photographer will have to make full use of his camera's flexibility and select the film most suited to his needs.

In addition to making exposures under normal conditions of daylight, military photography will often impose severe abnormalities which the photographer would usually seek to avoid. Such conditions may involve exposures made at dawn or dusk, in moonlight, in mist or haze, against strong light, in heavy shade (as in tropical jungle) or over highly reflective surfaces, such as silver sand, snow and water. That such photography is possible is amply demonstrated in the profusion of illustrations which professionals produce in ever increasing variety. However, only by careful study and practical application can the soldier photographer succeed in obtaining consistently good results under such adverse conditions.

In the more specialized fields of technical photography such as photo copying, macrophotography, interior stills, etc, the need for "controlled lighting" is of paramount importance. This means that not only must the amount of light be accurately measured, it must also be maintained at a consistent level for the required exposure time and be capable of being directed, or beamed, on to the subject. It is frequently possible for natural lighting to be used in conjunction with reflecting surfaces, although "flash" or tungsten photoflood lamps in suitable reflectors are usually more convenient. When taking close-up photographs of heavy equipment or machinery in strong natural light, it is often necessary to supplement the lighting with directional flash to eliminate heavy shadows and thus reveal the otherwise hidden details.

From the foregoing it will be appreciated that not only will the subject matter be different in character, but adverse conditions of light, atmosphere, terrain, and other factors may be unfavourable to the military photographer. One of the most important aspects of military photography is therefore a knowledge of the techniques which must be applied in order to overcome these disadvantages and to achieve acceptable results in all circumstances.

Before detailed consideration can be given to the application of photographic techniques, it is first necessary to evaluate and select the basic equipment required, together with the many essential accessories.

Cameras and Associated Equipment

Logically the first item to be considered is the basic camera. For the type of work envisaged in military photography, the 35 mm camera is probably the most suited to our needs for the following reasons:—

(*a*) It takes standard 35 mm. cinematograph film which is in ready supply in a wide variety of grades and qualities. As the standard material of the film industry, this type of film is constantly being improved. The film is available in preloaded casettes, or may be obtained in bulk reels of 100 ft or more.

(*b*) The 35 mm camera is compact, light in weight, and easily handled in confined circumstances.

(*c*) It is quick to use and exposures may be made in rapid succession. With the normal loading of a thirty-six exposure casette the necessity for constant reloading of the camera is reduced.

(*d*) By selecting the right type of 35 mm camera, all the advantages of a reflex or a larger plate camera can be obtained, together with an ability to interchange lenses of varying focal length.

Since space precludes elaborate detail it is sufficient to say that for consistently good results embracing rapid viewfinding, accurate focusing, freedom from parallax and the application of wide angle or telephoto lenses without recourse to special range or viewfinders, the modern single lens reflex camera appears to satisfy these requirements most adequately. With such a camera of reliable quality, fitted with a fast lens and an accurate variable speed shutter, virtually any photographic problems can be tackled and satisfactory results achieved.

The camera itself is of course only the basic item of equipment, and may be compared to a tractor without its ancillaries, such as dozer blade, power winch or shovel bucket. It works quite well without any additional items, but the photographer cannot progress very far unless he has certain specific accessories to supplement the base machine. Such accessories increase the range and flexibility of the camera, and under certain conditions of operation are absolutely essential if acceptable photographs are to be obtained.

Among the more essential accessories may be listed the following, not necessarily in order of priority:—

Lens hood. To be used at all times, not only to exclude unwanted direct rays of strong light from entering the lens thus causing "flare" but also to protect the lens surface from accidental damage.

Colour filters. Yellow, orange, red, blue, green. These filters are not used solely for the pictorial effect they may produce, but are required to penetrate mist or haze and more clearly to define certain coloured objects when rendered in monochrome in the finished print. Their values and application will be discussed in a later section.

Viewing filters. Panchromatic photographic vision and monochromatic vision viewing filters. These filters are useful for observation purposes when taking detailed photographs in monochrome. The former is a violet filter which converts the sensitivity of the eye to that of panchromatic emulsion, and when used in conjunction with a colour filter produces the final Photographic effect. The monochrome filter is brownish yellow, and eliminates all colour differences to the eye, leaving only the brightness range. By the use of these observation filters it is possible to determine before making the exposure whether the required detail will be clearly visible in the black and white print. They serve as a useful guide to the selection of colour filters for the required photographic effect and the direction and brilliance of lighting needed to provide the necessary contrast in monochrome.

Interchangeable lenses. To avoid taking composite photos for panoramic views, a wide angle lens of say 35 mm focal length having nearly twice the angle of acceptance of the 2-in (55 mm.) lens normally found on a 35 mm camera, is an advantage. A short focus lens of this nature is invaluable in a confined space, ie, a workshop filled with machinery. For long-range photography where a medium telephoto lens is required the choice may be either 135 or 200 mm focal length. This is the practical limit for hand-held telephotography at speeds up to 1/60 secs and gives $\times 3$ to $\times 4$ magnifications over the normal focal length lens at the same distance. The great advantage of using a single lens reflex camera in conjunction with lenses of different focal length is that viewfinding is by an arrangement of prisms direct through the objective (or taking lens). The range of focus is infinite from a few inches to infinity, and high power lenses of up to 1,000 mm ($\times 20$ magnifications) focal length are available. Such long focus lenses are of course somewhat bulky and must be securely supported on a tripod to ensure camera stability when making the exposure, unless lighting conditions permit use of high shutter speeds, 1/250 seconds and above.

Film casettes. If bulk 35 mm film is being used this will have to be cut to length in a darkroom, unless a daylight loader is available, and wound into lightproof casettes. These may be previously used proprietary film casettes or more robust specially constructed containers of plastic or metal designed for repeated use.

Tripod. This is an essential item if satisfactory exposures are to be made in poor lighting conditions where the shutter speed is lower than say 1/25 second. There are a number of variations on this equipment such as a unipod, chest-pod, chain-pod or simply an adjustable bracket which can be secured or clamped to a tree or other firm object. However, for the best results a robust, stable, tripod with adjustable-locking legs and a pan-tilt head, is the most reliable, since camera vibration can easily make a critical print quite unreadable. Camera steadiness with any telephoto lens is a prerequisite, and the photographer must beware of ground vibrations or movement caused by high wind. A cable release to operate the shutter provides flexible contact with the camera and must always be carried with the tripod.

Pistol-grip. Although some might consider this item superfluous, it has a very practical application particularly in military photography where subjects may be fast moving or present themselves unexpectedly. The grip is mounted under the base of the camera which is usually carried on a neck strap ready for immediate action. A long cable release is operated by pressing a trigger mechanism housed in the grip. The camera can be raised quickly to the eye for viewing, held firmly in one hand, and the shutter released leaving the other hand free to continuously focus the objective. With some practice the camera can be held very steadily with this type of grip permitting relatively slow exposures to be made, up to say 1/10 second, thus avoiding the necessity for a tripod in such circumstances.

Light meter. Although personal experience will often provide a sufficient

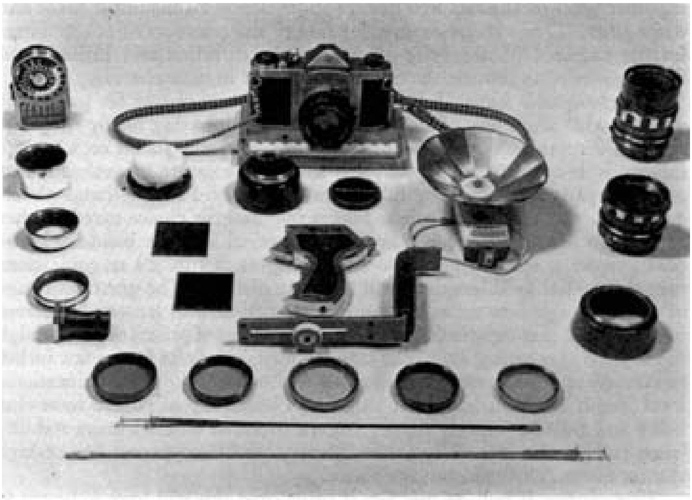


Photo 1. Typical contents of a camera bag

Photo 2. An example of macrophotography

Pratical Photography for Military Engineers 1,2

Photo 3a. Longmoor Downs Station in midday sunlight

Photo 3b. Longmoor Downs Station after lighting up time

Pratical Photography for Military Engineers 3a,3b

guide to calculating the required exposure (lens aperture × shutter speed), in conditions of poor or uncertain illumination an accurate estimate of available light is necessary. For this purpose a photo-electric exposure meter which actually measures the light falling on or reflected from the subject should be used. There is a very wide range of such instruments on the market, but the *Sangamo Weston* is among the most reliable and robust light meters in general use today. It is sufficiently sensitive to record dim light down to 0.1 candles per sq ft. If even lower light values are to be recorded such as pale moonlight, ultra sensitive meters like the "*Lunasix*" are available. For flexibility of method, and accuracy of calculation, it should be possible to adapt the exposure meter to give readings for both reflected and incident light. By the latter method the actual amount of light falling on the subject is measured, by placing a special translucent disfuser over the photo-electric cell. This provides a more accurate determination of exposure than the reflected light method, which may sometimes cause either under or over exposure, due to inconsistent readings.

Lighting equipment. A wide variety of artificial lighting set-ups are possible in modern photography. The equipment may vary from a simple battery-operated flash bulb to multiple electronic flash units. For normal purposes when flash illumination is used, a single light source mounted above the camera lens will suffice. Where additional detail or modelling is required, two or three flash units may be fired simultaneously by a synchronized camera fitted with a multiple adaptor. It should be particularly noted that cameras having focal plane shutters require the use of special focal plane bulbs with long flash peak when operated at speeds higher than 1/25 second.

Apart from flash equipment, which is the more portable and better suited to field conditions, normal household tungsten lighting, or photoflood lamps (overrun tungsten) can often be used to advantage for interior exposures. If such lighting is to be used effectively and to yield maximum light value, polished aluminium reflectors should be used to concentrate and direct light on to the subject. This type of lighting is particularly suitable for static subjects, photo-copying, and similar applications when the length of exposure can be extended at will.

Close-up adaptors. In military photography it may sometimes be necessary to take larger than life pictures. These may perhaps be small mechanical details, minute print on documents, or tiny insects which require to be identified. Some cameras use special close up attachment lenses, but with a single lens reflex the normal lens can be used by extending its nodal point from the film plane. This is accomplished by placing a variety of distance pieces between the lens mount and the lens assembly. Alternatively a bellows attachment provides an infinitely variable range of close focusing. By this method it is possible to focus down to say one to two inches from the subject and produce an oversize image direct on the film. The hairs on the leg of a fly photographed in this manner and then enlarged ×10 magnifications or so, can be seen quite clearly. Although this is perhaps an odd example it serves to illustrate that the ability to focus down to a few inches instead of being limited to the normal 3 ft subject distance, greatly increases the flexibility and usefulness of the camera.

Copying stand. When ultra-close focusing is employed the depth of field is critical and may be limited to less than 0.01 ft even at the smallest stop. For this reason it is essential to support the camera steadily, and accurately control the distance of the subject from the lens within very close limits. When distance rings are employed with a reflex camera the lens is set at infinity and focusing is achieved by moving the subject in relation to the lens. Purpose made copying stands therefore usually employ screw movements, with vernier adjustments to correctly align and focus the subject. Copying stands in simple form can be quickly improvized from wood or metal strip if they are required only for occasional use, fine focusing being achieved by placing shims under the subject.

The foregoing list is by no means exhaustive, but it serves as a guide to the type of equipment and accessories which are necessary if a comprehensive range of photographic work is to be undertaken. Experience will show that none of these items is superfluous, and although the list of accessories may seem numerous for field use, the majority can conveniently be carried in a small shoulder bag. Having reviewed the equipment required, it is appropriate now to consider the methods by which it can be employed in making satisfactory exposures.

Photographic Techniques

Before an exposure is made, certain techniques of photography must be clearly understood. This not only applies to the choice of camera equipment and its associated accessories, but also to the widely varying properties of film materials from which must be selected those most suited to the subject. The main factors which control the satisfactory combination of equipment and film are:—

Type of subject and picture required.
Lighting conditions—natural and artificial.
Use of colour filters for correction or special effects.
Depth of field—range of sharp focus.
Application of lenses of different focal lengths.
Shutter speed and lens aperture (stop value).
Speed and grain structure of film.
Method of film development.

Each of these factors is inter-related and the photographer must be conversant with all their restrictions and limitations if he is to obtain an acceptably sharp picture.

Subject. Irrespective of type of subject it must always be assumed that any military photograph should be critically sharp, that is to say all relevant detail should be in correct focus and as clearly defined as possible. A close-up photograph of machinery will call for a relatively small depth of field since the background scene may be out of focus. This will give greater prominence to the subject. On the other hand an open view of a panoramic subject such as a railway yard or port installation will require a great depth of field giving clarity in detail from the near foreground to infinity. Not only is sharp focusing a requirement, but also if there is a likelihood of the film being greatly enlarged to display particular detail, then the negative must be of sufficiently fine grain. Thus the subject matter and type of print required is the first factor for consideration.

Lighting. Lighting, whether natural or artificial, should be used to provide the most suitable degree of contrast, whenever this is possible. The effect of natural lighting can be previewed through a monochrome observation filter. This may indicate a more suitable angle from which to take the photo, or where heavy shadows need to be relieved, by reflecting natural light on the subject. Poor natural lighting can be supplemented with "fill-in" flash light, photofloods, or tungsten lighting. It may often be necessary to make exposures against the light, and in such cases special care must be taken to avoid light flare from the sun's rays reflecting on the lens surface. This may necessitate shading the camera entirely if the sun is low and the lens hood inadequate. When making exposures *contre jour*, the light falling on the subject must be accurately measured otherwise inflated light value readings will lead to under exposure and detail will be lost in the shadows of black silhouettes. Whenever possible, light values either natural or artificial should be measured with a reliable exposure meter set to the speed of the film in use. It is suggested that under these conditions incident light values are more accurate than those given by reflected light. By fitting a translucent "Invercone" attachment over the Weston meter the amount of light falling on the subject can be measured, the meter being directed at the light source.

Filters. If for the purpose of reducing haze or improving contrast, a colour filter is to be used, it is important to remember the increase required for a given filter factor, when determining the light value for any particular exposure. The common range of colour filters for practical use, and their relative exposure factors are as follows:—

Filters	*Exposure factor*	*Complementary colour*
Medium yellow	×2	Blue
Deep yellow	×3	
Pale blue	×2	Yellow
Green	×3	Red
Orange	×4	Violet
Red	×7	Green

When used with colour sensitive panchromatic film the filters mentioned above have the effect of absorbing the light reflected by complementary colours. Thus a yellow filter will darken blue sky, and a red filter will darken green foliage, whilst colours similar to that of the filter tend to be lightened. It will be seen that if any particular detail is to be emphasised in the photograph it may be possible to increase the contrast by darkening or lightening the subject by means of filters. Where haze is present and needs to be penetrated to expose for distant detail, an orange or red filter which absorbs the blue end of the spectrum heavily yet freely transmits the red end, should be used. As shown in the above table, each filter requires considerable increase in exposure due to its light absorbing properties.

Focus. The depth of field requirement must next be appreciated since this will affect the selection of the lens aperture at which the exposure is to be made. Even with a single lens reflex camera focusing by direct viewing, the exact depth of field of sharp focus will not always be apparent to the eye. However, most modern camera lenses incorporate a depth of field scale marked round the periphery of the lens mount. It is sufficient to say that the smaller the lens aperture the greater the depth of field, whilst the closer the camera is to the subject the smaller will be the depth of field. This important factor is best illustrated by two examples based on the properties of a standard 55 mm focal length lens such as may be found in a 35 mm camera:—

	Aperture setting	*Lens focus*	*Range of sharp focus*
"A" distant subject	*f* 2	30 ft	25 to 37 ft
	f 16	30 ft	11 ft to infinity
"B" Close subject	*f* 2	2 ft	1.98 to 2.02 ft
	f 16	2 ft	1.85 to 2.18 ft

It may not always be practical to constantly adjust the lens focus, ie, rapid action photography or fast moving objects, and for this reason the following two simple rules may be applied with good effect:—

"A"—*Distant subjects* for sharp focus from 12 ft to infinity set aperture at *f* 8 and focus at 30 ft.

"B"—*Close-up subjects* for sharp focus from 7 to 30 ft set aperture at *f* 8 and focus at 12 ft.

In ultra close-up (macrophotography) when extension tubes or bellows are fitted between the lens and camera body and the subject may be as close as 2-in or less, the depth of field even at the smallest aperture will probably be less than 1/8-in. Accurate focusing on the plane of detail is essential under such circumstances.

Interchangeable lenses. Mention has been made previously of the advantage of an interchangeable lens system, and this is particularly favourable in the case of a single lens reflex camera. With such cameras both viewfinding and focusing are performed through the viewfinder eyepiece and the object lens via a pentaprism and hinged mirror. There is no problem of parallax at short range and no need for a rangefinder over the longer distances. It is therefore possible to fit a lens of different focal length in a few seconds, view and focus instantly, and make the exposure. The relative advantages of short and long focal length lenses are shown in the following comparative table using a 55 mm focal length lens as standard:—

55 mm—angle of view 43 deg	Standard 2-in lens for 24 × 36 mm format
35 mm—angle of view 63 deg	Wide angle—50 per cent increase in area viewed with consequent reduction in scale
135 mm—angle of view 18 deg	Short telephoto—approximately ×2½ magnifications over standard lens
300 mm—angle of view 8 deg	Medium telephoto—approximately ×6 magnifications
500 mm—angle of view 5 deg	Long telephoto—approximately ×10 magnifications
1,000 mm—angle of view 2.5 deg	Extra long telephoto—approximately ×20 magnifications.

The two last mentioned telephoto lenses are bulky and heavy and only yield satisfactory performance if adequately supported on a firm tripod. Both 135 and 300 mm telephoto lenses may be hand held but shutter speeds must then be as high as 1/125 to 1/250 to avoid the blurring effect of camera shake. It should also be noted that the longer the focal length of lens the shorter the depth of field range. For example a 135 mm lens focused at 30 ft at *f* 16 has a depth of field from 24 to 45 ft, whilst a short focal length 35 mm lens at the same setting will give sharp focus over a range of 6 ft to infinity.

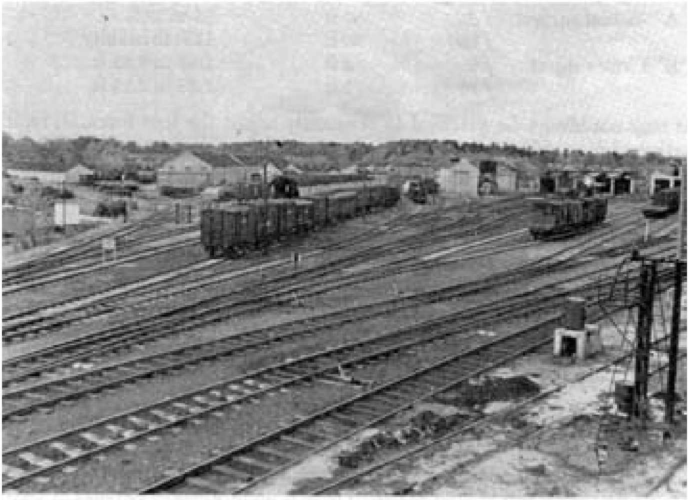


Photo 4a. Longmoor Military Railway Yard 35 mm wide angle lens

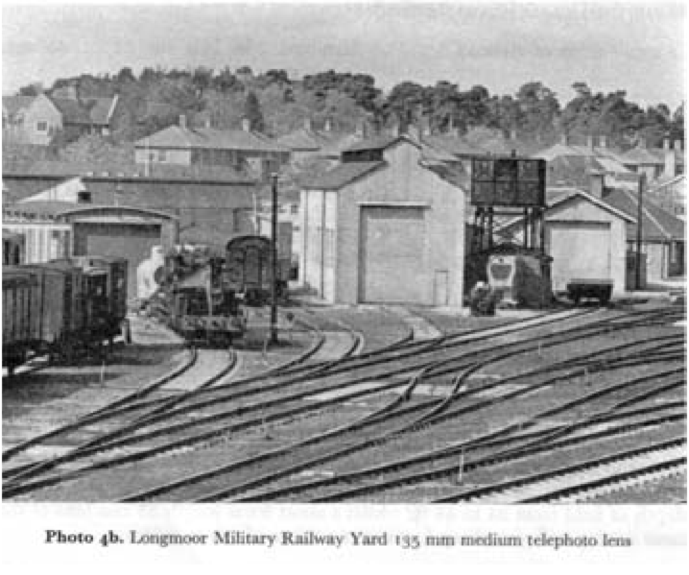


Photo 4b. Longmoor Military Railway Yard 135 mm medium telephoto lens

Pratical Photography for Military Engineers 4a,4b

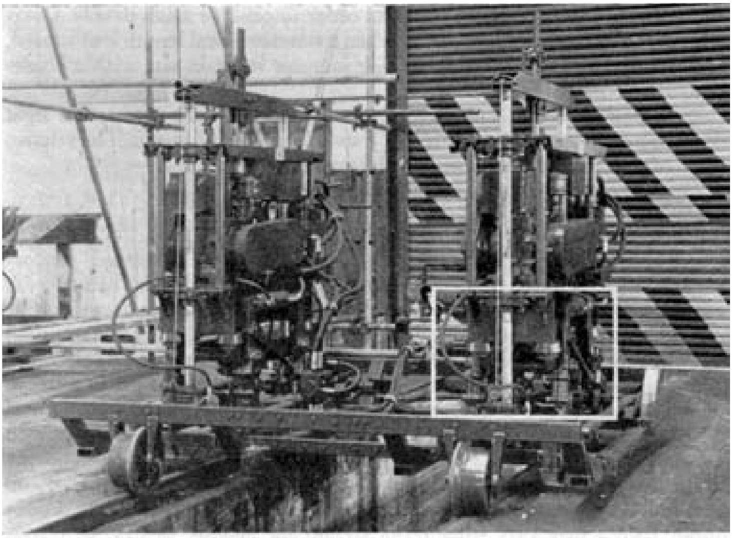


Photo 5a. Matisa Tamper; indoor natural lighting, extra fine grain film, green filter

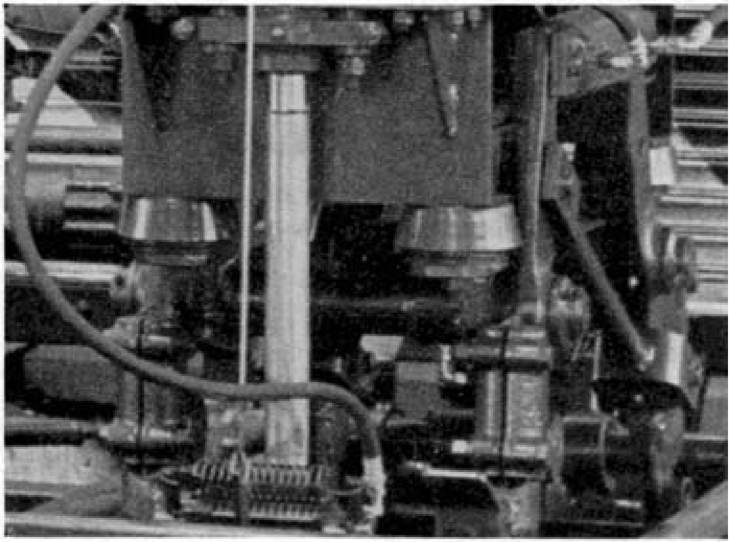


Photo 5b. Matisa Tamper; inset detail × 30 linear magnifications enlargement

Pratical Photography for Military Engineers 5a,5b

The great advantage of using telephoto lenses is that the film frame can be filled with the maximum amount of subject required, thus the negative is not dependent on over-enlargement in order to observe small details. Over-enlarging to bring out distant detail when a standard focal length lens is used, frequently results in very considerable increase in grain size with a consequent loss in definition.

Speed and aperture. The two factors which affect the amount of light admitted by the lens are aperture, or "*f* stop" and shutter speed. The relative values of standard stop numbers may be expressed as follows:—

Aperture/stop no	*f* 2	*f* 2.8	*f* 4	*f* 5.6	*f* 8	*f* 11	*f* 22
Relative exposure	4	8	16	32	64	128	256

It will thus be observed that exposure time must be increased proportionately as the aperture is decreased. At each stop from *f* 2 to the next, the amount of light passed is halved, and the exposure time therefore must be doubled. Although the choice of aperture may be dictated by the required depth of field, frequently shutter speed will be the more important factor. This is particularly true where the available light is poor and use of a tripod is not practical. Sharp photographs with an unsupported hand held camera normally require a shutter speed of at least 1/30 second, to avoid camera movement being recorded. For action photography involving subjects moving across the front of the camera much higher shutter speeds are necessary in order to freeze movement and record the subject in detail. In such conditions shutter speeds may vary from 1/125 second for moving figures, to 1/1000 second for fast moving vehicles at close range. It will be appreciated that the nearer the subject is to the camera the faster the required shutter speed.

Film types. The choice of film to be used will be influenced by two factors —available light and the degree of magnification required without loss of detail.

Without elaborating on the mechanical and chemical structure of the film base and its emulsion it is sufficient to say that 35 mm panchromatic film in general use today, may be divided into *four* categories:—

SLOW speed, EXTRA FINE grain	ASA 50 (Pan F)
MEDIUM speed, FINE grain	ASA 125 (FP 3)
FAST speed, MODERATE grain	ASA 400 (HP 3)
ULTRA FAST speed, COARSE grain	ASA 800 (HPS)

These examples are all Ilford films, but other manufacturers produce films of similar speed ratings.

It will be observed that the faster the film the more obvious will be the grain in the enlarged print. Whilst grain may be acceptable in a general illustration, if really sharp definition is required for the purpose of identifying all detail in the subject, then the finest grain film should be used compatible with speed. The ASA index number is used when setting the exposure meter prior to taking a light value reading, and it should be noted that these indexes apply to daylight conditions only. In tungsten lighting, the ASA index or speed rating is usually 20 per cent lower, ie, the film is *slower* in artificial light.

The effect of speed rating on camera technique is more clearly explained by an example:—

The subject is a mechanical detail requiring good depth of field at fairly close range, say 15 ft. Natural lighting is poor and supplementary lighting not available. A $\times$ 10 magnification enlargement is required to show clear detail.

"A"—Ultra Fast Film ASA 800, with lens stopped down to an aperture of *f* 8 requires a shutter speed of 1/125 seconds.

"B"—Slow Fine Grain Film ASA 50, under the same lighting conditions and stopped down to *f* 8 to allow sharp focus over a depth of field 10 to 25 ft requires a shutter speed of 1/10 seconds.

In the case of the slow film, speed must be sacrificed and a tripod or other firm support for the camera is necessary, the enlargement will however be free from grain and as technically perfect as possible. If the fast film is used, a hand held exposure is possible, but some detail will be lost due to the coarse grain structure which will be clearly visible in the print. At the same time shadows are likely to be dense and lacking in detail due to the lower range of contrast normally found in fast speed film emulsions.

Development. The last factor to be considered, but none-the-less important, is the proposed method of film development. By selecting the appropriate developing agent for the film in use, both film speed and emulsion grain can be improved. Universal developers are available which will treat a wide range of panchromatic films, but it may often be advantageous to improve the characteristics of a film by using a special purpose developer. Referring back to the Ilford films quoted above, if the slow, fine grain, types are developed in "Hyfin", not only is definition further improved by sharp edges, but the emulsion speed is increased by about 25 per cent. Thus Pan F ASA 50 becomes ASA 64, whilst FP 3 ASA 125, becomes ASA 160. Similar improvements may be gained by developing the faster coarse grained films, in "Microphen", a special fine grain developer, which has the effect of considerably reducing visible grain structure whilst at the same time enhancing emulsion speed by up to 50 per cent. The speed rating for HP 3 may be increased from ASA 400 to ASA 650, and HPS from ASA 800 to ASA 1200. Both these developers are supplied in powder form for mixing in cold water, are extremely simple to handle, and require 18 and 13 minutes development time respecitively at the normal standard temperature of 68°F.

It should be understood that other proprietary developers having similar properties are available, but it is good practice to relate special purpose agents to the materials for which they are specifically compounded. Allied to the type of developer used, is the actual method of development, which may be either by intermittent agitation in a tank or by open dish and continuous agitation. The final results will be similar and the only advantage to be found by the latter method is a slight reduction in development time. It does, however, call for a totally blacked out dark room which may be difficult to improvise under field conditions.

The foregoing paragraphs in this section may be summarized by stating the sequence of events which occur whenever the photographer makes an exposure:—

Consideration of subject type, and degree of enlargement, together with definition of detail required in the finished print.

Arrangement of lighting, whether artificial or natural, to provide the correct degree of contrast, and the application where necessary of the correct filter to reduce haze or improve contrast.

Accurate estimation of light value by means of an exposure meter or from pre-calculated exposure guide tables, combined with the ASA speed rating of the film available or selected.

Consideration of the two related factors—size of aperture (controlling depth of field) and speed of shutter (to compensate for camera or subject movement).

Where alternatives are available, the selection of a lens with the most suitable focal length: wide angle (short focal length) in restricted space, or telephoto (long focal length) for distant detail.

Fitting of a suitable lens hood.

Adequate support for the camera in relation to shutter speed selected.

With the subject correctly in focus and suitably illuminated, appropriate lens, filter and hood in position, aperture and shutter speed selected and set, the camera cocked and firmly supported, either manually or mechanically, the shutter is released and an exposure is made—provided of course that there is a film in the camera.

Some Special Techniques

The application of aerial and infra-red photography to military requirements are worthy of separate mention, and both aspects are therefore described briefly in this section. Reference is made to the Polaroid Land Camera which permits virtually instantaneous photographs to be exposed developed and printed in a period of 10 seconds. A simple method of producing film strips by a reversal process is also described.

Aerial photography. Assuming that a normal 35 mm camera is to be used for this purpose, the techniques of aerial photography are very similar to those employed at ground level. There are, however, a few points which need special consideration. The best type of photograph is usually an oblique, and even at a height of only 200 ft above the ground, haze will frequently be apparent and obscure the more distant detail. A special pale yellow haze cutting filter, such as Ilford "Auriol" having a factor of $\times 1\frac{1}{2}$, should invariably be employed, in conjunction with a medium or fine-grain film. Special aerial film is unnecessary, and extremely good results are obtainable with such films as Pan F or FP 3. Choice of film will, to a certain extent depend on lighting conditions, since aircraft movement will necessitate shutter speeds of 1/125 second or faster. In poor light, a film speed rating of at least ASA 200 will be required even when working at wide apertures.

Without doubt the helicopter has a very great advantage over the fixed wing aircraft for aerial photography since it is possible to pin point the subject, move around to arrange the best lighting conditions, compose and focus the picture. The Auster, or similar aircraft, even when flying at relatively low speeds, passes over the subject at about 60 mph. At low altitudes, which may be dictated by tactical considerations or by the need to move in close to the subject to photograph detail, it is difficult under such conditions to focus accurately and compose the subject correctly in the viewfinder.

When taking a light meter reading it is essential that the meter be directed down towards the ground to avoid an exaggerated light value from the sky. No altitude factors need be applied unless photographs are taken at a height greater than 1,000 ft above ground. At this altitude the exposure may be reduced by one-third; however, for most practical purposes it is likely that engineer recce photographs will be taken at between 10 ft and 100 to 200 ft above ground level.

To facilitate camera handling, focusing and film winding, it is an advantage to mount the camera on a pistol grip, with the added precaution of a neck strap. This arrangement permits easy panning of the camera and the shutter is under the positive control of the trigger finger.

Infra-red photography. Contrary to popular belief infra-red film does not have the power to penetrate fog, but when it is used in conjunction with an infra-red filter it has the ability of greatly reducing certain types of atmospheric haze in long distance photography. Unfortunately 35 mm infra-red film is not of particularly fine grain structure and is similar in this respect to the higher speed panchromatic films. For this reason it is not possible to greatly enlarge the necessary detail in a long range photograph, and to fully exploit the properties of infra-red film, lenses of long focal length must be used in order to obtain fine detail and good definition of distant objects. Although infra-red film possesses many of the characteristics of a high speed emulsion and may be developed with the same type of high speed fine grain developers, the ASA speed rating when used in conjunction with the prescribed infra-red filter may be as low as ASA 6. If an ultra rapid developer such as "Microphen" is used an improved speed rating of up to ASA 25 can however be applied.

Infra-red film is, as its name implies, sensitive above all to the invisible infra-red rays which penetrate atmospheric haze more easily than the light rays of other colours. When a filter which allows only infra-red rays to pass, is placed in front of the lens, the haze will not be photographed, and the film yields clear results of very distant views. It should be borne in mind however that the type of haze referred to is mainly that caused by heat, infra-red film being much less effective for mist penetration caused by water droplets, and totally ineffective photographically for water vapour cloud penetration. For this reason infra-red photography over long distances has a more particular application under dry tropical conditions. In more general circumstances, both red and orange contrast filters give a fair degree of haze penetration, when used in conjunction with normal panchromatic materials as previously described.

Another aspect of infra-red photography which has a military value is that from either the ground or from the air, grasses and the foliage of deciduous trees appear white. The result is that the infra-red contrast of a terrain will be quite different to the visual contrast, and in aerial reconnaissance this helps to distinguish deciduous trees and grass from coniferous, dead trees, and burnt grass which appear very dark in an infra-red photograph. In war time, infra-red photography is also of use in camouflage detection, since most green paints which match summer foliage visually, are strong absorbers of infra-red and appear dark in the photographs, while naturally green foliage is photographed as white.

A further possible military application is the taking of covert photographs by using an infra-red light source in total darkness. Such exposures may be made by normal flash equipment with the flash bulb screened by an infra-red filter bag, or preferably an infra-red dipped flash bulb should be used. No filter is used on the camera, and the infra-red light source is practically invisible to the eye during the duration of the flash. Photographs of installations and equipment, plans and documents, can be obtained in this manner, without the photographer being observed.

There are two main disadvantages to be overcome when working with

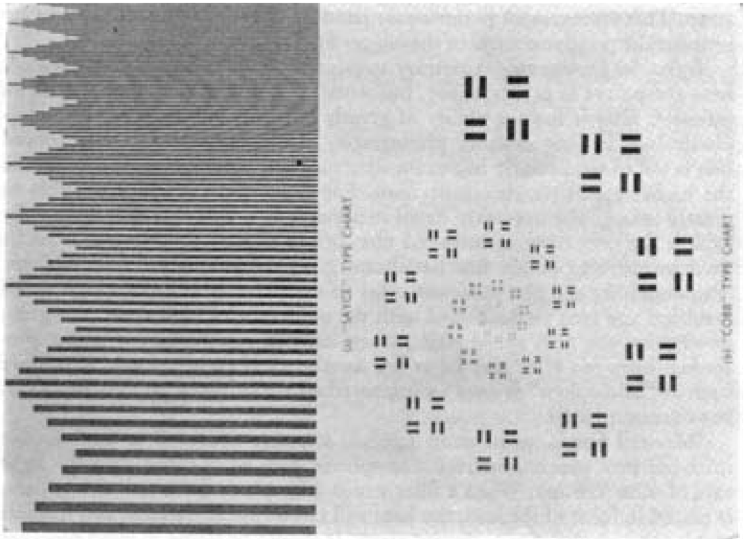


Photo 6a. Resolution Charts; fine grain film, fine grain developer, high quality lens

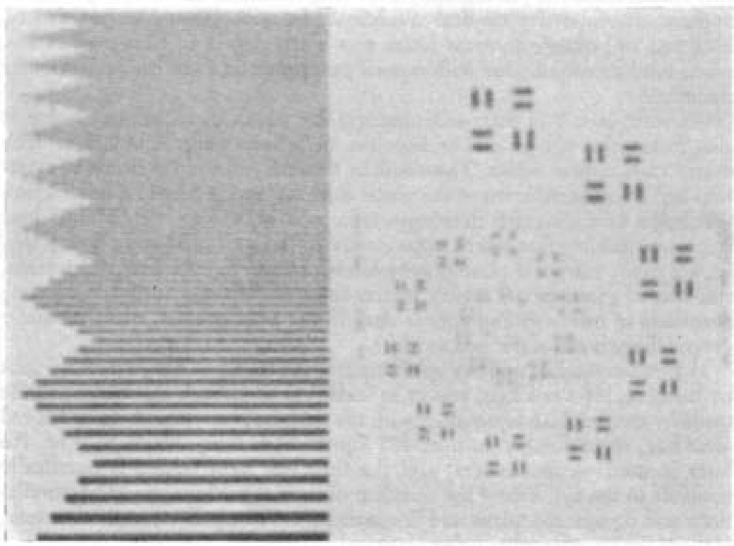


Photo 6b. Resolution Charts; medium grain film, universal developer, average quality lens

Pratical Photography for Military Engineers 6a, 6b

Photo 7a. Weaversdown; normal panchromatic film, yellow filter

Photo 7b. Weaversdown, infra-red film and filter. Deciduous foliage photographs as white

Pratical Photography for Military Engineers 7a, 7b

infra-red film. Firstly, the dense red filter cannot be observed through and if a single lens reflex camera is being used the filter must be removed before viewfinding and focusing. Secondly, the infra-red image formed by the camera lens does not come to focus in the same plane as an image formed by visible light. To obtain a sharp image it is necessary to increase the distance from lens to film after focusing by visible light by from 1 to 3 per cent of the focal length of the lens. With a lens of short focal length the correction is so small as to be of no practical importance, but for 500 mm or 1,000 mm telephoto lenses the required extension calls for special calibration.

Polaroid Land Camera. The one great military advantage of photographs taken with a polaroid camera is that a finished print size $4\frac{1}{4} \times 3\frac{1}{4}$ in is produced within 10 seconds of making the exposure. The positive image is formed directly on sensitized paper loaded within the camera in place of the normal gelatin film. Immediately after exposure, the image is fully developed during a 10-second dry processing period, following which the finished print is removed from the camera. There are, however, a number of distinct limitations and disadvantages which appear to militate against the normal use of such a camera for military purposes. No negative is produced in the process, and if further copies of the print or enlargements are required, the original picture has to be re-photographed in order to obtain a normal type negative. By this method a loss of detail is inevitable in big enlargements, and since there is no interchangeable lens system available for standard polaroid cameras the advantages of tele-photography are denied.

The camera itself is heavy and bulky, and although the finished print is reasonably sharp, it is necessary to move in close to the subject if good detail is to be recorded. Due to the coupled shutter and iris diaphragm device, the range of settings for special lighting conditions is somewhat limited. In order to preserve the photographic detail the print has to be coated with a special fixing and glazing solution as soon as it is removed from the camera. This produces a further problem in that the sticky print, which according to atmospheric conditions may take up to 30 minutes to harden, is difficult to handle and transport. Bearing in mind the obvious need for the duplication of any worth-while military photographs, the polaroid camera can only be considered as supplementary to the normal 35 mm camera, in that it has a strictly limited application under specific field conditions and requirements.

Film strips by reversal method. By this process monochrome transparencies can be obtained direct from normal negative film exposed in the usual way. The positive transparencies can either be retained as a continuous film strip, or if preferred the frames may be cut and separately mounted in slide mounts. Extra care has to be taken to ensure that the correct exposure is given as there is no latitude for compensation at the printing stage. Apart from this one limitation good results can be expected provided that the reversal process is carefully carried out.

The film is first developed in a standard developer to which has been added a quantity of hypo crystals. This produces the normal negative from the latent image on the emulsion. The negative image is then dissolved in a bleach bath of potassium permanganate, sulphuric acid and water, the remaining silver halide being re-exposed to white light and given a second development to produce the positive image. On completion of development the film is finally treated in a normal acid hardening-fixing bath.

An ordinary darkroom loading spiral tank is the most suitable for this process which is summarized as follows to indicate the simplicity of the operation:—

Wetting agent	soak film for 1 minute.
Developer	develop negative image for 12 minutes.
Wash	running water for 3 minutes.
Bleach negative	soak for 5 minutes in bleach solution with continuous agitation.
Wash	running water for 2 minutes.
Clearing agent	soak for 2 minutes in solution of sodium metabisulphite.
Wash	running water for 2 minutes.
Second exposure	expose film to white light from 100 watt tungsten lamp for 30 seconds at 18 inches.
Second development	develop positive image in original developer for 6 minutes or longer to obtain maximum density.
Rinse	running water for 30 seconds.
Hardening-fixer	soak film in acid hardening-fixing solution for 10 minutes.
Final wash	running water for 30 minutes.

When the film is dry and hard it is ready for projection in a suitable film-strip or slide projector. No special equipment is required and with a little practice very acceptable transparencies can quite easily be obtained, even under field conditions. A dark cupboard is of course necessary for the first stages of the process. This method of film strip production is particularly suitable for the preparation of unit visual training aids.

Developing the Film

A mass of technical literature exists on the subject of film development, and as with family washing powders, the manufacturer's instructions are enclosed with every packet of developer. The reason for including this section is to demonstrate the simplicity of the development process and the ability to carry out such work in the field under improvised conditions.

The basic requirements are as follows:—

Development tank—preferably daylight loading.

Supply of clean water and the means of maintaining fluid temperatures within the range of 65°F to 75°F.

Wetting agent for prewetting the film to avoid air bells from defacing the negative.

Suitable developer matched to the requirements of the film emulsion, and a means of mixing and measuring approximately 10 oz of fluid.

Fixing and hardening solution to fix the negative and harden the gelatin base.

Photographic thermometer for the control of fluid temperatures.

Watch or clock for timing processes.

Surgical or similar spirit for flash drying the negative and a dust free space in which to hang the film until dry.

If a daylight loading tank such as the "Rondinax" is available, the whole process could be carried out in a tent or the back of a truck. With the more common darkroom loading tanks, it is necessary to load the film from the casette into the tank spiral in complete darkness. This operation is best carried out in a properly blacked-out darkroom, or with some practice by means of a black cloth photographic changing bag, if a darkroom is not available.

Having transferred the film from casette to developing tank, a solution of wetting agent is poured in and 1 minute allowed for soaking. This thoroughly wets the film and allows the developer to act freely over the entire surface, without the formation of airbubbles. The wetting agent is poured off and is replaced by the required amount of prepared developing fluid, at the standard temperature of 68°F whenever possible. Higher temperatures speed up development times whilst lower temperatures will prolong them. Usually about 2½ per cent development time is subtracted or added for each degree Fahrenheit above or below the standard temperature of 68°F (20°C).

Development proceeds for the prescribed time, during which intermittent agitation is applied either by rotating the spiral or inverting the tank. Five seconds agitation every 30 seconds is normal practice. When development is completed the fluid is drained off rapidly and the tank flushed out with clean water for about one minute. A rapid working fixer with hardener added, such as "Hypam" which requires no stop bath is then poured into the tank, followed by initial rapid agitation and then intermittent agitation for a period of 5 minutes. The fixer will fix the negative in about one minute when the tank cover may be removed and the film examined in white light.

To permit the hardening agent to protect the gelatin base against abrasion and scratches, the film should be returned to the fluid and allowed to remain immersed for the full period. The final stage is the thorough washing of the film, for a period of 30 minutes in clean water. This is best done under slight pressure, forcing a jet of water into the bottom of the tank. If this is impractical, then frequent agitation in several changes of water in buckets will suffice. In cases of extreme urgency, a film can be sufficiently washed by vigorous agitation for 30 seconds in three changes of fresh water; the image may however deteriorate after a period of time.

When the film is ready for drying it may either be soaked again in the wetting agent to ensure the smooth run off of water, or more rapidly dried by immersion in a solution of four parts spirit to one of water, with a few drops of wetting agent added. This latter method has the advantage of drying the film so quickly that dust particles are less likely to collect on and adhere to the film surface. The film should be hung in a still, dust free, atmosphere, not subject to extreme temperatures, with a clip top and bottom to prevent curling.

As far as possible all fluids should be kept within the temperature range of 65°F to 75°F. If temperatures are too high the emulsion will melt and run and the gelatin base soften. On the other hand wide temperature differences between say the developer and fixer or washing water will cause reticulation of the emulsion and distort or disfigure the negative. Insufficient or sporadic agitation will lead to development streamers forming across the negative, whilst over vigorous or continuous agitation will cause overdevelopment, producing an over-dense negative with extreme contrast.

When it is necessary further to speed up the development process a combined rapid developer and fixer may be employed, such as "Monophen". This developer has a greater temperature latitude and may be used at between 65°F and 80°F. Processing is completed after 7 minutes immersion and intermittent agitation, over-development is not possible, and fixing action takes place automatically after development is complete. The film is washed continuously for 5 minutes, in water at the same temperature as the developing fluid, and is then hung to dry. The film surface must not be touched or wiped down until the emulsion is thoroughly hard. Although this process appears particularly attractive for military purposes, its limitations are that it cannot be satisfactorily applied to films of extra fine grain, or ultra fast emulsions. Since it is not a fine grain developer, it tends to give somewhat coarse resolution with resultant graininess when enlarging negatives of medium speed films.

In concluding this section it might be appropriate to mention that the so-called darkroom "safe light", normally deep red or brown in colour, is not in fact safe when handling panchromatic materials. The slower fine grain films may be exposed to very dark green light for the purpose of loading casettes or developing tanks, but the faster films of speed rating ASA 400 and upwards must at all times be handled in total darkness. One last recommendation concerns the partial use of spooled film and the practicability of changing films in a normal 35 mm camera. It may frequently happen that only a few exposures are made on one film and it is desired to change to a film of different speed rating. The exposed portion may either be cut off in a changing bag, loaded into a development tank, or rewound into its casette until the leader has just been released from the camera take-up spool. This permits the film to be reloaded into the camera at a later date when it can be wound on past the previously exposed frames and the rest of the film exposed in the normal manner. If short lengths are cut off from the spooled film, it is a simple matter to reshape a leader with knife or scissors before reloading the partially exhausted casette into the camera.

Whichever method of development is employed, after the film has been washed and allowed to dry hard, and it is to be hoped free from runs, blemishes and dust particles, the negatives are ready for printing down or enlarging as required.

Printing, Enlarging and Paper Development

For record purposes, and to provide a rapid means of assessing results, 35 mm film may be printed down by contact method. The normal length roll of thirty-six exposures is cut into six strips each of six frames and placed in contact with the sensitized surface of contact or bromide printing paper, size 8 × 10 in, under a clear glass. After an exposure to white light of known intensity for from two to ten seconds according to negative density, the paper will be ready for development in a bath of prepared developer. The image should begin to appear within twenty to thirty seconds, be fully formed after one minute, and continue to strengthen in the highlights for up to two minutes. If the paper has been correctly exposed the print is then ready for fixation. To arrest development and neutralize the alkali prior to fixing, the print should be passed through a stop bath solution of 1 per cent acetic acid and water. When using "Hypam" rapid fixer this intermediate stop bath is not essential, and the print may be fixed and ready for final washing after 30 seconds immersion and agitation in fresh fixing solution. The print is washed for 30 minutes in flowing water or alternatively passed through six changes of clean water allowing 5 minutes immersion at each stage.

It will be seen that the contact printing process is relatively simple, rapid to operate and requires very little equipment or material. The finished print

Photo 8a. Debris in sand pit; standard 55 mm lens

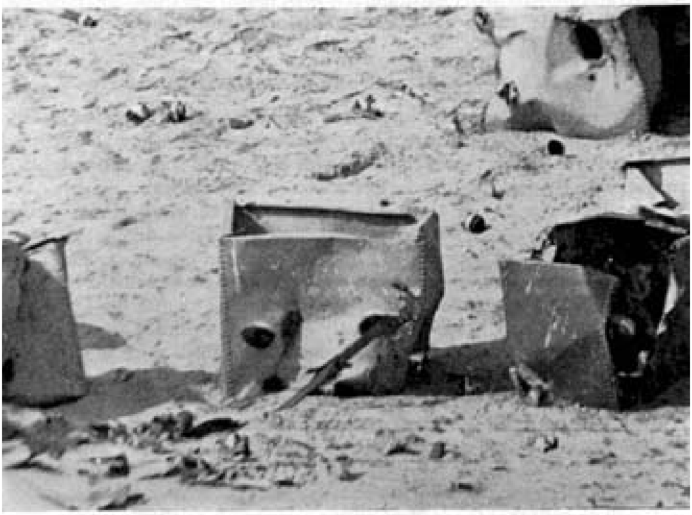


Photo 8b. Debris in sand pit; extra long focal length telephoto lens—835 mm

Pratical Photography for Military Engineers 8a, 8b

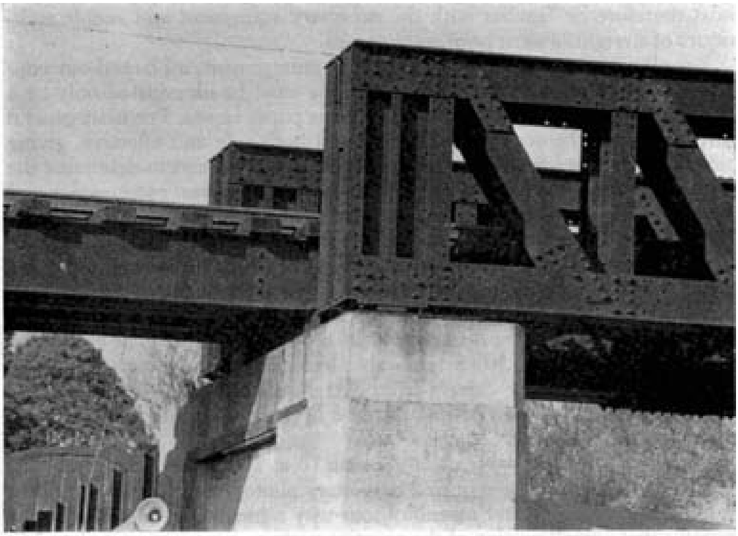


Photo 9. Close-up detail; inaccessible subject 135 mm medium focal length telephoto lens. Pan F

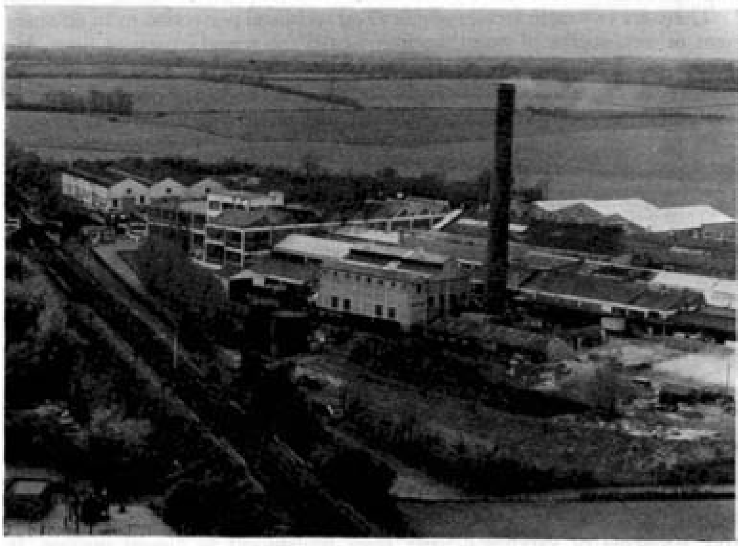


Photo 10. Overton Mill; aerial photo, fine grain film, pale yellow haze cut filter

Pratical Photography for Military Engineers 9, 10

of the $1\frac{1}{2} \times 1$ in frame is, however, of little practical use other than to ascertain if a satisfactory photo has been obtained. The military photographer must therefore be familiar with the necessary equipment and simple techniques of straightforward print enlargement.

For all printing work both contact and enlargement, a blacked-out cupboard, room, tent or truck is essential. This must be illuminated only by a safe light of the colour recommended for the paper in use. For most general purposes a pale brown light will be found both safe and effective, giving sufficient illumination to examine the developing print and to determine the required density. The next essential is an enlarger of robust construction and versatility. It is no more than a baseboard with a steel column up and down which slides a lamp house. The latter should be fitted with good quality double condensers to provide maximum light and even illumination over the negative area. Below the negative holder is the lens mount which racks up and down for focus adjustment and needs to be capable of very fine control for sharp images. The most important item on the enlarger is of course the lens, and if the camera has a removable lens system, the mount should be adaptable to receive the camera lens. Fine detail recorded on the negative by a high quality lens can be lost, if a lens of poor resolution is fitted to the enlarger.

Although prints probably no larger than 10×12-in taken from the whole negative will normally be required in military photography, it must be borne in mind that much greater magnifications may sometimes be necessary. It is possible that a small portion of the negative perhaps measuring only $\frac{1}{4} \times \frac{3}{8}$-in contains detail which requires enlarging to say 6×9-in. This calls for extra fine grain film and development, combined with high grade lens resolution and enlarger stability, if details are to be clearly defined at $\times 24$ lineal magnifications.

There are two main factors which affect technical perfection in an enlargement of any degree of magnification—sharp focus and exposure time. Although some enlargers are equipped with built-in range finder devices, the more reliable method of focusing is to examine the image on a white card pinned to the baseboard, through a large reading glass. If there are no sharp lines on which to focus or the negative is too dense, a specially prepared focusing negative scratched with fine lines may be placed in the film holder. The lens is then focused sharply at a wide aperture and then stopped down to about f 8 or f 5.6 prior to exposing the printing paper. It should be noted that enlarging lenses usually give better definition at the smaller apertures and only when the exposure time becomes excessive should stops larger than say f 4 be used.

The second factor, exposure time, is the more difficult to assess, and only by practical experience can consistent results be obtained. The practised eye, together with a thorough knowledge of the printing characteristics of the various grades of paper employed, can estimate the time of exposure from observation of the enlarged image on the baseboard. There are, however, two simple methods which may be applied with equal success, during the period that this knowledge is being acquired—the test strip and the test negative. In the former method, a strip of paper is exposed across part of the image in steps, 5 seconds at a time. In the latter method a circular negative comprising grey segments of varying density from translucent to almost opaque, is placed over a piece of printing paper located at the centre of detail of the image. An exposure of $\frac{1}{2}$ to 1 minute is then made. After the exposure has been completed in either case, the test print is developed for a standard period of 2 minutes, fixed, rinsed, and then examined in white light. Either method will give an indication of the correct degree of exposure required. The advantage of the test negative is that when used with a prepared set of tables, exposure times can be converted for printing papers of varying speeds, increase or decrease in aperture and degree of enlargement.

The final consideration to be given by the photographer when enlarging is the choice of printing paper. For normal military photography it can be assumed that a smooth gloss finish is required in order to preserve full detail. The more artistic finishes such as velvet stipple, grained matt, silk and rayon are applicable to illustrative work where the grain and texture lend body and depth to the picture and mask any slight imperfections or tendency to graininess. Even though attention can probably be confined to one type of finish, there will be a requirement for at least three grades of contrast. These are usually termed hard, normal and soft, the first and third being used for printing from negatives of the opposite quality. A thin weak negative lacking in contrast and detail (probably underexposed) is printed on hard paper, whilst a vigorous negative having a strong contrast between highlights and shadows should be printed on soft paper. By using the correct paper grade and carefully controlling exposure, an otherwise poor or unbalanced negative can be enlarged to give an acceptable print of near normal contrast.

Some manufacturers produce papers in five grades of contrast but it will be appreciated that carrying stocks of different grades particularly under field conditions may create difficulties. For this reason special reference is made to Ilford "Multigrade" paper. It is available in single or double weight, white glossy, or stipple finish, and in sizes up to 16 × 20-in. Only one base grade of paper is required, since the five graduations from very soft to very hard are achieved by a series of coloured gelatin filters placed directly under the enlarger lens. These filters varying from pale yellow to pale magenta are employed to alter the characteristics of the paper as dictated by the type of negative to be enlarged. Not only does this system reduce the holding of paper to one type, but it also speeds the printing process since the change of grade can be effected in a few seconds by replacing a filter. By using a combination of filters any range of intermediate grades can be achieved.

In concluding this section mention should be made for the necessity to select clean working fast action chemicals for the print development process, and precautions to be taken against contamination. The developer should of course be matched to the characteristics of the paper used. It will be strongly alkali and if carried over to the acid fix solution will cause the latter to deteriorate rapidly. An intermediate rinse in clean water followed by an acid stop bath (1 per cent solution of glacial acetic acid), will clear the print before it is placed in the acid fixing bath. Fixing time will vary from 30 seconds to 10 minutes according to the compound used and its state of exhaustion. When the fixing solution becomes stale and discoloured it must be replenished to avoid staining the finished print. Similarly if the print is not thoroughly washed free of chemicals after fixing, staining and discolouration will later become evident in the print. In order to produce the required glossy finish, the washed print should be soaked for 30 seconds in a glazing solution or wetting agent and then squeezed out onto a polished glass surface and left to dry. A more rapid alternative is to use an electric print drier incorporating a chromium plated glazing plate. All glazing surfaces must be thoroughly clean and free from finger marks if perfect results are to be obtained.

The field of practical monochrome photography has now been briefly covered and it remains only to summarize the main points in connexion with the application of this medium to military requirements.

Conclusion

In this article I have endeavoured to highlight certain practical aspects of photography as applied to military subjects. It has been necessary in my opinion to describe the basic principles and processes in order to stress the simplicity of the various techniques of photography. Given the right equipment and materials, all personnel with quite limited instruction should be capable of producing acceptable results. The main requirements of military photography may be stated as follows:—

Adequate briefing on the type of photograph required.

Camera equipment of sound construction and versatility, supplemented by the necessary accessories.

A reliable exposure meter, an understanding of light values, and the effects of colour and light contrasts in monochrome photography.

A brief knowledge of the characteristics of photographic materials—films, printing papers, developers and fixing compounds.

Simplification of developing and printing processes and the subsequent saving of time, by careful selection and standardization of equipment and chemicals.

The uninitiated may be interested in what can be achieved with limited amateur equipment in an improvised darkroom. A roll of 35 mm film (thirty-six frames), can be developed, washed and dried in 15 minutes; 10 × 8-in enlargements of all negatives printed and developed within the hour; all prints washed and dried within 1½ hours of the commencement of film development. This is by no means a unique example, but it serves to show that rapid results can be obtained even with relatively simple equipment.

I am convinced that there is an infinite requirement for photography in the sphere of military engineering, both in peace and in war, and that every Sapper Officer should have ready access to photographic equipment and materials. In this mechanical age, the camera should be used whenever possible to relieve the draughtsman, and by imaginative use the camera can save countless hours of field sketching and written detail. Photographs and film strips are invaluable as visual aids, and charts, diagrams, and drops, can often be photographed and more suitably displayed by means of slide projection. Perhaps it will one day be possible for the RSME to programme a series of short courses in practical photography; in the meantime I must confide that the Pitmans correspondence course in photography for beginners is very good value at the services rate of 15*s*.

Synopsis of Author's Photographs

Brief technical details of the photographs used to illustrate this article are as follows:—

Photo No. 1. Typical contents of a camera bag—single lens reflex camera, wide angle and short telephoto lenses, close up extension rings, filter glasses in mounts, observation filters, viewfinder enlarger, pistol grip, flash gun, light meter, lens hood. Taken on Ilford Pan F film, with two No 2 Photofloods.

Photo No 2. An example of *Macrophotography*. The stamp has been photographed at 3-in distance by the use of close-up extension rings. Inset right hand lower corner is the same stamp photographed at the normal camera focusing limit of 3 ft. Both stamps have been equally enlarged.

Photo No 3a. *Longmoor Downs Station*. Ilford Pan F film, midday, light value 300 candles per sq ft, 135 mm lens, ×2 yellow filter, 1/60 second at *f* 11.

Photo No 3b. *Longmoor Downs Station*. Ilford FP 3 film, after sunset, light value 0.1 candles per sq ft, 135 mm lens, 90 seconds at *f* 22. Same stance as Photo 3a. Comparison of lighting effects.

Photo No 4a. *LMR Yard*. Ilford Pan F film, midday, 35 mm lens, × 2 yellow filter, 1/60 second at *f* 11.

Photo No 4b. *LMR Yard*. Ilford Pan F film, midday, 135 mm lens ×2 yellow filter, 1/60 second at f 11. Same stance and lighting as Photo 4a. Comparison of lens focal lengths.

Photo No 5a. *Matisa Tamper*. Natural lighting, dark shed, midday, Ilford Pan F film, 55 mm lens, ×3 green filter, 15 seconds at *f* 16.

Photo No 5b. *Matisa Tamper*. Inset detail of Photo 5a enlarged ×30 linear magnifications to illustrate fine grain structure.

Photo No 6a. *Resolution Charts*. "Sayce" and "Cobb" type charts photographed with high resolution lens, fine grain film and developer.

Photo No. 6b. *Resolution Charts*. Medium quality lens, normal speed film and universal developer. Compared with Photo No 6a illustrates fall-off in definition.

Photo No 7a. *Weaversdown*. Normal panchromatic film, afternoon lighting, bright sunshine, ×2 yellow filter.

Photo No 7b. *Weaversdown*. Gevaert Infra-Red Film, same stance and lighting as Photo No 7a. Infra-Red Filter No R 719, speed rating ASA 6. Compare with 7a to illustrate foliage contrast and improved distant detail.

Photo No 8a. *Debris in Sand Pit*. Ilford FP 3 developed in Microphen, afternoon sunlight, 55 mm lens, 1/125 second at *f* 16.

Photo No 8b. *Debris in Sand Pit*. On same film, same stance and lighting, 835 mm long focal length lens. Compare with Photo No 8a to observe advantage of telephoto lens range.

Photo No 9. *Bridge Detail*. The application of medium telephoto lens (135 mm) to photograph inaccessible detail.

Photo No 10. *Overton Mill*. Aerial photograph on Ilford Pan F film ×1½ yellow haze filter, 1/125 second at *f* 5.6.

ACKNOWLEDGEMENTS

My thanks are due to Messrs Ilford Ltd, for permission to mention their products. It should be noted that "*Hyfin*", "*Microphen*", "*Hypam*", and "*Monophen*" are registered trade names.

Guillemont, 3 September 1916

An episode in the Somme Battle

By BRIGADIER J. A. C. PENNYCUICK, DSO

THE Engineer-in-Chief, in his 1962 annual address reminded the Corps: "that we remain in the unique and enviable position of being the only Corps of Officers who are wholly combatant and at the same time, fully technical."

It is an unusual distinction and the violence of battle does not always make it easy to see how the essential blend of military and technical qualities is achieved. From the days of Archimedes at the siege of Syracuse to present times, however, principles have remained steadfast though methods have greatly changed. The story that follows of co-operation between Divisional Engineers and assault troops, comes from that uncompromising military battle—the Somme in 1916.

There were 60,000 British casualties on the first day of the Somme in July 1916. To have some understanding of that desperate slogging match it is necessary to be dispassionate and to remember that there had been two years of trench warfare, of deadlock, during which our Army had been starved of guns and ammunition.

The arrival of both guns and ammunition in unlimited quantities appeared to herald a means to end the stalemate and from somewhere, perhaps from the French, the unsound doctrine came that a creeping or rolling barrage of shells was the complete answer. It was hoped that under the protection of such formidable artillery fire, the infantry would be able to emerge from their trenches and get through any obstacles; but the trouble was the plan was too rigid.

As soon as the terrific artillery fire started communications got severed and the fixed barrage could not be altered. Here and there enemy resistance would hold out and wire would remain uncut, but the barrage didn't wait, it left the infantry to be murdered by enemy machine-gun fire. At other points enemy resistance might temporarily give way, then the barrage held back the assaulting parties for a few vital minutes.

Above all, the shell fire was so intense that ground became impassable especially to heavily laden men and the excessive fire caused wear in the guns which affected their accuracy so that assault parties could not follow sufficiently closely behind the falling shells. In pre-1914 days the accuracy of guns became suspect after they had fired three or four thousand rounds, in 1916 individual guns were firing at the rate of 1,000 rounds per day!

The 50 per cent zone of a gun is lozenge shaped with its longer axis along the line of fire. As this became enlarged, because of wear, the accuracy for distance fell away although the accuracy for direction remained relatively unaffected. It was the recognition of this point by our CRE which proved decisive at Guillemont, he suggested a plan to take advantage of it and produced that rare thing in 1916—an original idea.

By the end of August the Somme Battle was still raging fiercely, there was still talk of a great break through and tanks were about to be used for the first time. The trench front had, however, advanced but little, our Army was held up by a series of salients from which the enemy brought deadly enfilade fire on our assaults. A straightening operation was planned to precede the great break through, that never was, Guillemont was one of the salients to be eliminated. It had been attacked several times and even partly overrun, but had remained in enemy possession. There had been a particularly costly failure on the 8 of August, there was a hoodoo about the wretched place.

The village of Guillemont was on the front of XIV Corps which then consisted of the Guards, 6 and 20 Divisions. I commanded 83 Field Company in 20 Division, a good Kitchener Army Division, whose field companies had earned a great reputation for work.

Our CRE was A. Rolland and he proposed that the field companies should lay out and superintend the digging of a grid of trenches in no man's land opposite to the north-west face of Guillemont (see diagram). The plan was for the assault to be made southwards from this grid under cover of an enfilade barrage.

The idea behind this being that assaulting troops could get within 40 to 50 yds of the enfilade barrage, though they would have to be double this distance from a line barrage. The passage in the Official History of the War that quotes Divisional orders of about this time instructing assault troops to keep within 25 yds of a line barrage sounds a note of almost hysterical unreality. They would have come into the 50 per cent zone of worn guns at most ranges without making allowance for ranging or minor gunlaying errors of any kind.

The digging of the grid of trenches with large working parties at night in no man's land required careful organization, but we ran into little trouble except from the weather. The grid was extensive and the enemy did not seem to suspect that it had any unusual significance.

Rain, however, made movement and work difficult, the assault had to be postponed twice and there were so many casualties from sickness in 60 Infantry Brigade of 20 Division, who had the task of planning the assault, that they were relieved at the last moment by 47 Infantry Brigade of 16 Irish Division. We were unlucky as we were not relieved.

"D" day was 3 September and such was the amazing faith placed in the protective barrage that zero hour was fixed for three minutes past 12 noon, no darkness, no mist, broad daylight. Early on the morning of 3 September, under cover of darkness, I took three sections of my Company, together with 100 men of the Durham Light Infantry (from 60 Infantry Brigade) as a working and carrying party, to a position just behind Trones Wood. We settled down to wait in shell holes and shallow trenches near a dug-out occupied by Brigade HQ. Our task was to consolidate Guillemont, which meant that we were to go there as soon as possible after the place was taken and construct three defended localities in its ruins.

Guillemont had entirely ceased to exist as a village and showed up as a mound 6 ft to 10 ft above surrounding flat country, it had not so much as one wall left standing.

There was a good deal of shell fire in the morning and at midday our barrage started up with impressive violence. As usual communications were cut immediately, so there was a pause as no one knew what had happened. After about an hour the Brigade Major came out of his dug-out and called me over to him to say that runners reported Guillemont as being definitely captured; we were to go forward at once to start our strong points.

By this time the enemy counter barrage was coming down in earnest along Trones Wood, which was a horrible place full of graves, both British and German. The wood always filled me with dread though the Sappers were very good about it and did not seem to mind it much.

At one place a pale hand dangled limply from a breastwork, largely composed of bodies, and I had seen each man from a small working party, stretch out to give the hand a shake as he passed. Further on a booted foot projected, toe upwards, from a parapet. This was used, as a matter of course, as a peg for someone to hang his equipment on.

German high explosive shells were crashing into the line of the wood and sending far up into the air fountains of black mud, broken trees and fragments of corpses of men and horses. Much of this came squelching down around us, but the wet ground had one advantage—many of the heavy howitzer shells got smothered, it was possible to be very near to a burst without coming to any harm.

I had an immediate decision to take; whether to go through the wood in line or in column, one of those decisions, if one chose wrong one would be forever reproaching one's self for not having done something else. For the sake of retaining best control I decided to go through in column. We set off, two and two, in straggly file, 20 yds between sections, Infantry party in rear. The path we followed had once been a French narrow gauge railway, it gave some hard core underfoot. The Brigadier and Brigade Major of 60 Infantry Brigade, who had come forward to see how the battle they had planned progressed, waved us a hearty send off.

After getting clear of the wood and the line of the enemy salvos we could see Guillemont mound sticking up before us, so No. 1 section was directed on to it and I waited to inquire about casualties. It was a great relief to learn that there were only two sapper casualties and none at all in the Infantry party.

Near Guillemont an enemy machine gun opened on us from the direction of Ginchy on our left. Everyone dived ignominously into the mud, but we were not caught in enfilade and the burst of fire started a furious bombing reaction, which ended the machine gun fire, we got to Guillemont without further trouble.

In Guillemont there was some confusion, officer casualties among the assault troops had been, as usual, severe and no staff came up either to find out what had happened or to co-ordinate what might be required. The Germans were not yet shelling the place and the irregular shaped mound more or less defiladed us from the front. Working conditions were, therefore, good, sections knew what to do and wasted no time.

The job consisted in the construction of three groups of short lengths of fire trench interspersed with machine-gun platforms, and connected up by sketchy communication trenches. A line of wire was run up round each locality.

The good company tradesmen, working in daylight, for a change, made surprisingly rapid progress with their revetments, using sandbags and splintered wood of unpromising appearance, from the remains of houses. We had of course, brought saws and cutting tools with us. Each RE section put out its own small covering piquet and look-out sentry.

THE BATTLE OF GUILLEMONT.

3rd September, 1916.

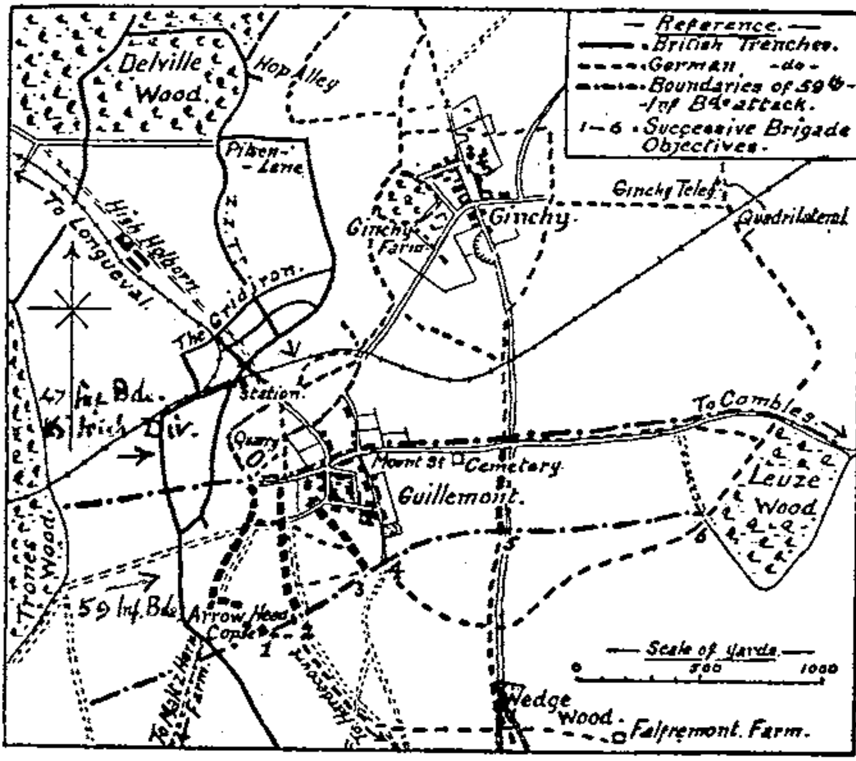
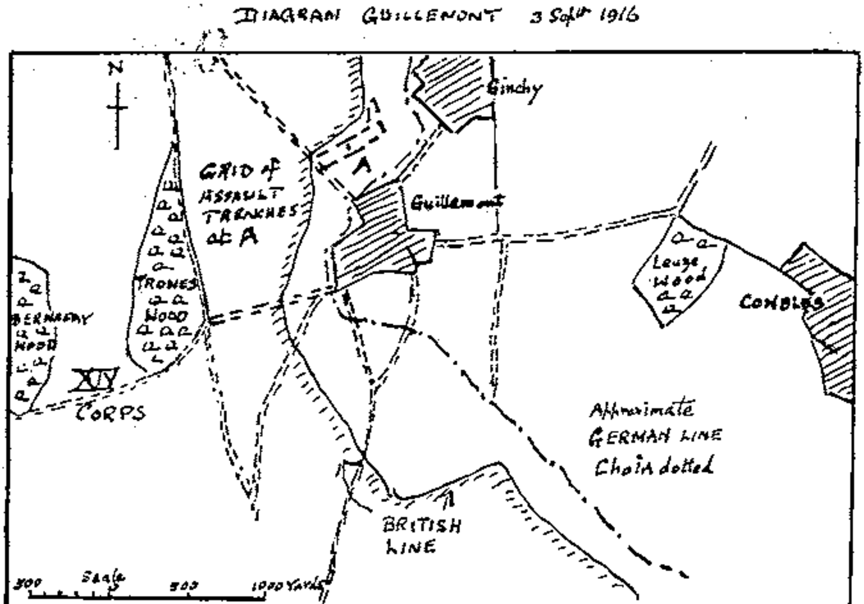


DIAGRAM GUILLEMONT 3 Sept 1916



The mound was honeycombed with mined dug-outs connected together by narrow galleries deep in the chalk. They were reached by numerous close-timbered entrance shafts dropping nearly vertically down 20 ft or more.

Mopping up was going on, which consisted in a chorus of shouts at the entrance to any shaft uncovered:

"Are you there Gerry?"

Then, without waiting for an answer, two or three Mills bombs would go hurtling down with further yells of:

"Take that yer shpalpeen."

I was moved to expostulate and pointed out that we should be going back, once work was finished, but that they (the Infantry) would have to live in Guillemont.

"Why spoil safe dug-outs?"

To humour me, therefore, a different procedure was adopted when the next entrance was uncovered. No bombs were thrown down, but a man with a fixed bayonet was posted on either side of the opening.

After some delay and much shouting, three Germans stumbled up the steep steps and came out. They held their hands above their heads, kept their fists tightly clenched and muttered:

"Kamerad. Kamerad."

One of them had been terribly wounded, the whole of his face was blown away and it made me quite sick to look at him as he tottered about. The Irish NCO turned to me indignantly and said: "What was the good of saving that man's life. It would be better to take him away and shoot him."

I could only feel foolish.

The German mined shelters were indescribably smelly and dirty, there was no doubt that this filth and stench caused prejudice against their use by our troops. Sometimes we were able to turn this prejudice to good account. We found unexpectedly good shelter for ourselves in Delville Wood a week or two later and the following year, near Arras; in another Company and another Division, we got safe shelter for all four sections in the unwanted, unoccupied mined dug-outs of a captured German battery position only 500 yds behind our front line.

It was from these deep shelters that the German machine gunners emerged to destroy our Infantry as the barrage lifted. At Guillemont I counted over twenty of their heavy machine guns in the short north-west face of the mound alone.

The CRE's plan had worked well because the assault parties had got out of their grid trenches and crept close beside the enfilade barrage—then, when it lifted, the gallant Irishmen had just had time to get across the last 40 to 50 yds to catch the Germans with hand grenades, before the machine-guns could be mounted and brought into action. This had disrupted the deadly fire from the corner of the mound and opened the way for success all along the front.

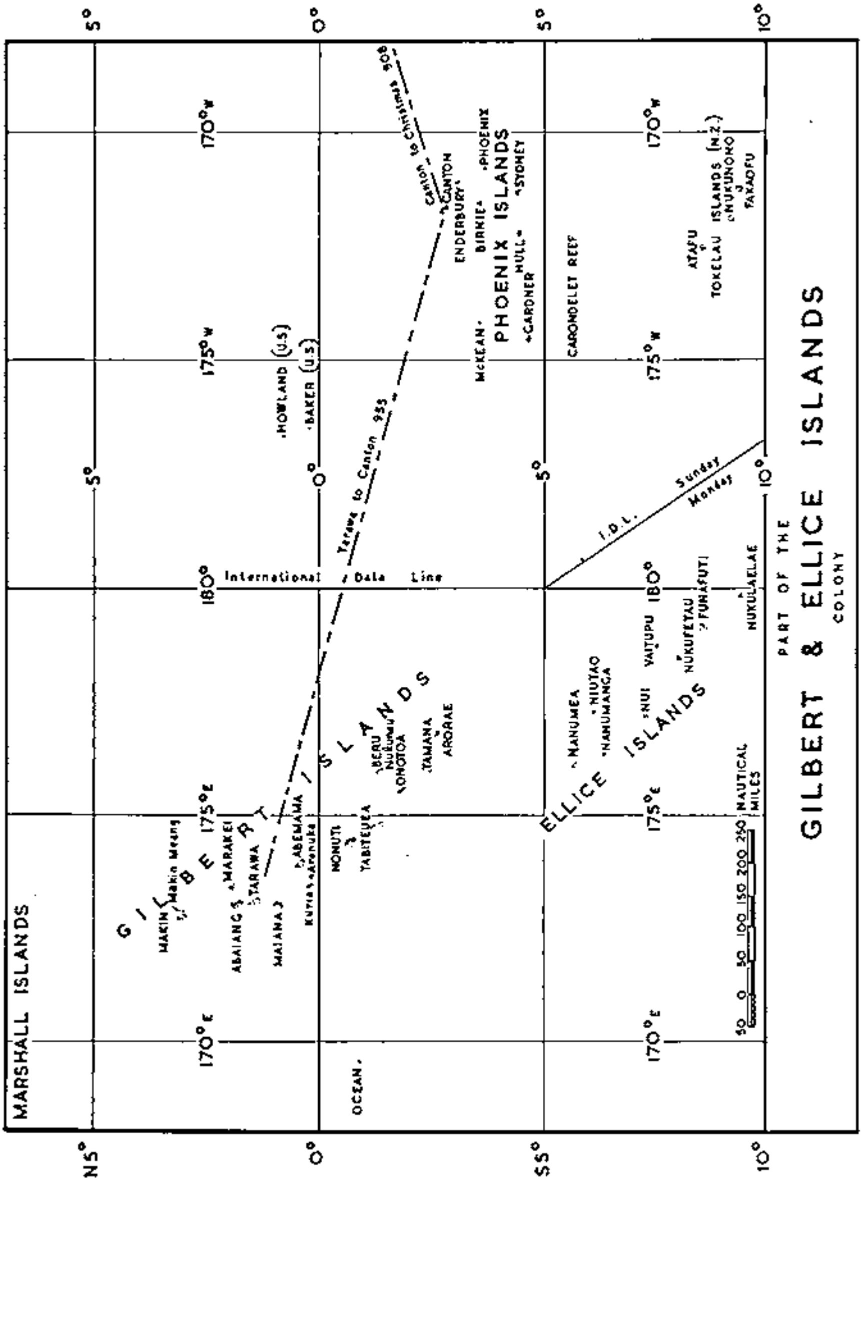
With work going well in Guillemont I started back for Brigade HQ to report. The enemy counter barrage on Trones Wood had eased, but I had had enough of that wood for one day and chose an alternative route which took me over the ground across which the frontal assaults on Guillemont had been made.

There were little groups of our dead everywhere, usually five or six together, but in one place a line of seventeen dead men showed where they had been caught in enfilade by machine-gun fire. Swarms of loathsome flies gave a warning which served to distinguish the earlier attacks and many of the men had so nearly got to their objective.

At the end of one little group a sergeant was standing crouched over his rifle, gazing absorbedly at the point of his bayonet which appeared to be embedded in the stump of a small tree. He was standing so still and had a look of such intense surprise on his face, that I turned back to ask him what it was that he was staring at. Then I saw that he was dead. He had no visible wound and some queer rigor of death had left him fixed in that strangely lifelike attitude.

It was clear that the tactical success, which gave us Guillemont had been won by the unquenchable valour of our Infantry. That they had been spared impossible casualties, in this last successful assault was due to help received from other arms. In some measure, at any rate, to help from their battle comrades, the Divisional Engineers.

The margin between success and failure—between life and death—had been very small. I have often wondered who realized how that slender vital margin was created.


PART OF THE
GILBERT & ELLICE ISLANDS
COLONY
MARSHALL ISLANDS
GILBERT ISLANDS
ELLICE ISLANDS
PHOENIX ISLANDS
TOKELAU ISLANDS (N.Z.)
International Date Line
I.D.L.
Sunday
Monday
Tarawa to Canton 953
Canton to Christmas 908
HOWLAND (U.S.)
BAKER (U.S.)
CANTON
ENDERBURY
BIRNIE
PHOENIX
SYDNEY
HULL
GARDNER
McKEAN
CARONDELET REEF
ATAFU
NUKUNONO
FAKAOFU
MAKIN
Makin Meang
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MARAKEI
TARAWA
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ABEMAMA
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Reef Blasting in the Gilbert and Ellice Islands Colony 1962

(The Reef Blasters)

By Captain T. P. Hardy RE

It was a pleasant and interesting surprise to be told by Lieut-Colonel A. E. Younger, the Commanding Officer of 36 Corps Engineer Regiment, that I was to be given the opportunity of volunteering to command a small party required to blast channels through coral reefs in the Gilbert and Ellice Islands during 1962.

I was passed a reconnaissance report that had been compiled by Major (now Lieut-Colonel) D. G. Raschen, on a visit to the Islands the previous year. From reading this report, for the first time I knew exactly where the Gilbert and Ellice Islands were and what the reef blasting project envisaged. This information was published by Lieut-Colonel D. G. Raschen in the September 1962 issue of the *RE Journal.*

The Colonial Office had approached the War Office to see if it was possible for an Army team to blast boat channels through the fringing reefs of islands in the Colony. The channels would make it possible for the small work boats that operate from Colony vessels over the reef of an island, to approach for a greater period of the tide, thus allowing a faster turn round schedule for shipping between the islands.

The only valuable export from the Colony, apart from rich phosphate deposits on Ocean Island, now a wasting asset, is copra the dried flesh of coconuts used in the margarine and cosmetic industries. It was with an idea to increase the export of copra from the Colony, that the Colonial Office wished the channels to be constructed, thus helping to increase economic stability.

The party required for the project was to be eight strong, two officers and six NCOs, for the majority of the time the party would be split into two groups of four, often working on different islands up to 100 miles apart. It was, therefore, necessary to select from the volunteers called for, NCOs of sound ability and character. A group of volunteers was assembled at Maidstone by the autumn of 1961 and selection commenced.

Stores for the project were becoming a major concern because it was necessary for them to leave London by sea during December so as to be in the Colony by early March, when the project was scheduled to start. Stores were consigned to No 2 ESD at Liphook, who had kindly agreed to prepare all items into man handleable size boxes to facilitate unloading on the islands. Three months later, when the stores were eventually unpacked, not one single item had become damaged nor deteriorated in transit, an achievement warranting a "Good Housekeeping Certificate" for the storemen involved.

The most difficult task remaining before leaving UK was the final selection of the party. On paper we had the men with all the necessary qualifications and it was now a matter of sorting out personalities. This was attempted in several ways. The party undertook the demolition of some pill boxes on Romney Marsh, where individual attitudes towards the handling of explosives could be observed. Then, just prior to Christmas, the party set off by road to Northern Spain and it was there in the mountains that those characters willing to get out of their sleeping bags to make tea in the mornings, and those not willing to get out at all, could be separated.

Immediately after Christmas a diving course had been arranged at the Army Diving School, Marchwood, for the party. At this stage there were some non-qualified divers; those already qualified went along for practice. All was well until we were met by the diving staff who insisted, whether a trained diver or not, one should crawl around the freezing cold bottom of Southampton harbour, until every last gasp of air had been used up in the aqualung before being allowed to surface; we all survived, but only just!

On our return to Maidstone the heart-breaking task of the final selection was made. This naturally meant leaving behind some good NCOs who had their hearts set on going with the party. The final party was to consist of myself, Captain W. M. R. Addison as 2IC, S/Sgt (now WO II) S. S. Thomas, S/Sgt F. E. J. Bartlett, Sgt L. Bourne, Cpls (now Sgts) S. R. Chadwick, J. S. McCabe and W. D. Edmonds. Once the final selection had been made there was a mad rush to draw tropical kit, to get all the necessary inoculations and vaccinations and to go and say farewell to envious friends and relations.

We were seen off by our new Commanding Officer, Lieut-Colonel G. T. E. Westbrook, from a very rainy and cloudy Stansted airport and at last our dream journey of the past few months was about to come true. Singapore appeared unchanged to those who had been lucky enough to visit there before, shopping expeditions and visits to places of Eastern culture were soon organized and only too quickly we were on our way to Australia.

The Royal Australian Engineers were waiting for us at Sydney where we were to spend a few hours before catching our next aircraft. In this time we were taken on a hurried tour of the city, being shown the harbour bridge, Bondi beach, and many other internationally famous Sydney landmarks. It was with regret, and after being called forward three or four times, that we left our new-found Australian Army friends, and the airport bar to board the plane for our flight to Fiji.

Fiji gave us our first real taste of the Pacific and, under the care of the RNZAF who were to fly us to Tarawa, we spent a most pleasant weekend. We were flown on the Sunday to a nearby island to visit the Captain of HMS *Cook*, the RN Survey Ship for the Pacific, who hoped we might be able to do some survey during our stay in the Islands. On the Monday morning before dawn we were briefed and loaded into a Sunderland flying boat for the ten hour, 1,200-mile journey to Tarawa and the start of our project.

Tarawa's main claim to fame is that it was the scene of some of America's fiercest fighting against the Japanese, and as we circled to land on the lagoon it was still possible to look down and see the invasion beaches littered with wrecked amphibians. Tarawa is now the seat of government for the Gilbert and Ellice Islands and it was to be our base of operations for the next ten months. The atoll was typical of all those we encountered during our tour—a chain of small, flat islands covered with coconut and pandanas palms; the highest elevation above sea level throughout the Colony, excluding Ocean Island, is only 12 ft. Wide reefs surround the atoll on which, even when the weather was calm, great white spumes of surf broke, setting a striking contrast to the beautiful deep blue of the sea and sky.

The temperature immediately struck one as pleasant; it remained between 80°F and 90°F during the day and never dropped below 70°F at night, the oceanic breeze helped to fan away the claminess that is encountered in such places as Malaya and Singapore.

The islanders on Tarawa were mixed, both Gilbertese and Ellice, this was due to the employment of a large number of Ellice Islanders in government posts. The people were full of smiles and friendship towards us and remained so throughout our stay, their willingness to work for us and to try and please us in any way they could, will always remain one of our happiest memories of the Islands.

We found that we had beaten our stores to Tarawa so we had an opportunity of accompanying *Moana Raoi*, a Colony ship, to the phosphate island of Nauru, where the stores were to be transferred from a British Phosphate Commission ship that had collected them from Australia. We travelled firstly to Ocean Island where we were taken for a tour of the phosphate workings and also had the opportunity of taking our first dive over the deepest moorings in the world, it was here also that we encountered our first sharks face to face. The sharks were large "White Tips", and, according to our book, "Dangerous Marine Animals" most ferocious; however they appeared well fed and never even came up to sniff us as a possible meal.

From Ocean Island we travelled on to Nauru, and after a wait of a few hours for the arrival of the phosphate ship, we transferred our stores, by ferrying in large barges.

Back in Tarawa the explosive which had been shipped separately and stored for some time on a small island in the lagoon was loaded into the Colony MV *Nivanga*. Our project stores were rapidly transferred on our return from *Moana Raoi* to *Nivanga* and at last we were off. For several days we sailed south, dumping explosive on each of the islands we should visit later, finally we reached Nui in the Ellice Islands which was to be the most southerly and the first island on which we were to work.

It was a rather cold and rainy dawn that saw us approaching the reef in loaded surf boats with a keen sense of apprehension as to whether all our work to date was going to be worthwhile. By midday all the stores and explosives were ashore.

We were accommodated in the mission transit quarters and the London Missionary Society Pastor had gone to great trouble with his family to have all prepared for us. Our beds were quickly made up and mosquito nets hung, when a party from the village arrived to take us to the Maneaba (village meeting house) for a welcoming feast. The islanders had prepared roast chickens and many other island delicacies for the party and these were served on woven coconut palm leaves as we sat crosslegged in line at one end of the Maneaba; local island beauties sat opposite brushing off the swarms of flies that were trying to beat us to it. As we feasted the islanders danced and sang for us, this treatment, which if one allowed, happened daily on nearly all the islands visited. It was often extremely embarrassing to explain that work had to take priority over revelry.

Nui presented most of the problems encountered on the other islands we later visited, and this might be a good time to describe our work.

At low water during spring tides the reef flat became exposed thus allowing us to work in the dry. The first problem was to establish a centre line for the proposed channel. This was done, after consultations with the

Photo 1. The channel at Nui, Ellice Islands. The first island visited by the party. In the foreground can be seen part of the channel blasted by a district officer in the 1930s

Reef Blasting In Gilbert and Ellice Island 1

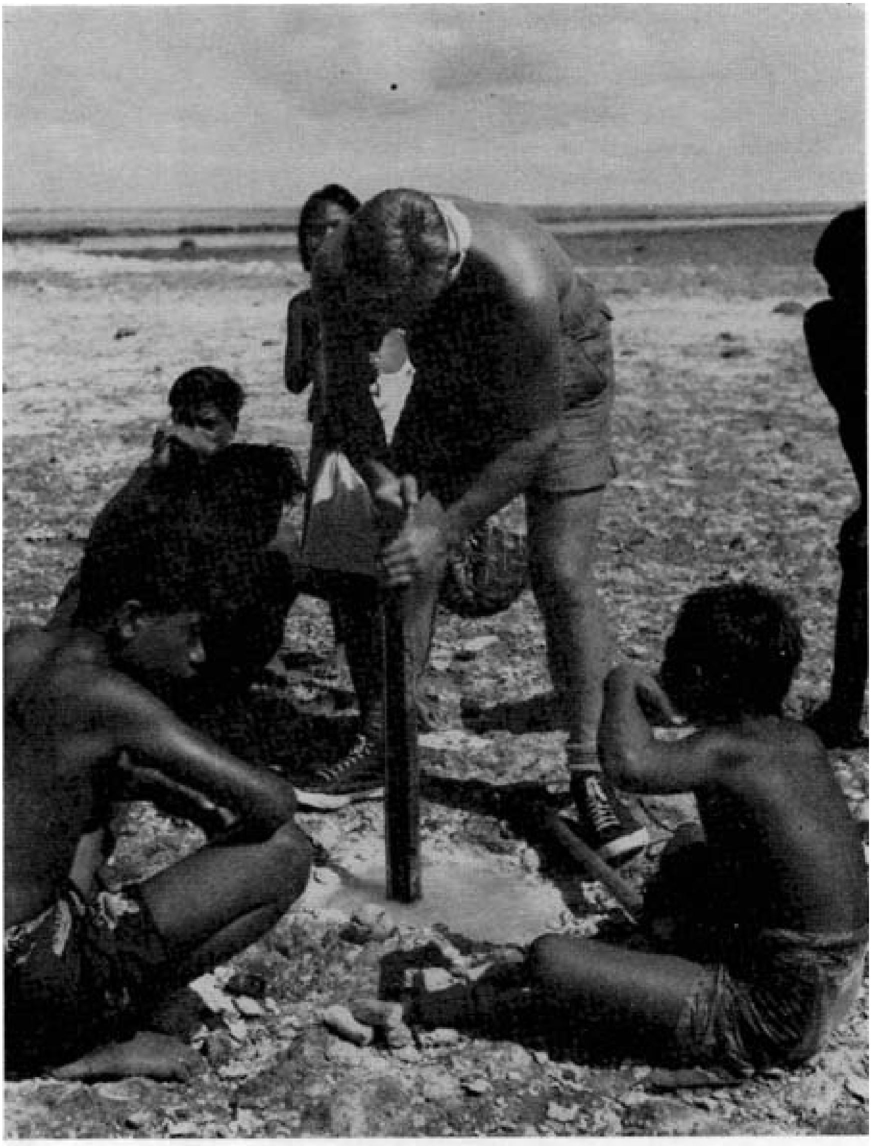


Photo 2. Sgt Chadwick charging a borehole made by a Beehive. The split tube being used is old water pipe. Beru, Gilbert Islands

Reef Blasting In Gilbert and Ellice Island 2

Photo 3. Sgt Chadwick supervises the clearing of a crater, the pulling strops are made from plaited signal cable. Beru, Gilbert Islands

Reef Blasting In Gilbert and Ellice Island 3

Photo 4. Types of coral:—top of picture, hard fuzed coral slab. Lower left, fuzed coral conglomerate. Right, upturned coral boulder showing the interface between the hard fuzed coral slab and the fuzed conglomerate

Reef Blasting In Gilbert and Ellice Island 4

village elders, by stretching a length of signal cable along the reef surface and fastening it in place with wires held into the reef by Ramset bolts. The channel presented three problems, the section crossing the reef edge, known as the chute, the inshore section, known as the turning pool, and the main channel.

The chute presented the greatest problem as it was invariably affected by surf. Placing and anchoring charges in this area required courage, skill and ingenuity. Two methods were found to be successful depending on conditions. The first was to work towards the reef edge using surface charges against the forward face of the channel; the second was to place surface charges over the reef edge and work shorewards. The first method gave a certain amount of protection to both workers and charges. The second method, where practicable, was more successful in that the rubble tended to be dispersed naturally by wave action. It was not sufficient simply to weight charges with rocks and sandbags as these were tossed around in even the mildest surf. The best method appeared to be to tie charges down with lengths of signal cable, either to natural protrusions or pitons and metal pins previously driven into the reef. It was, however, soon realized that charges could be placed only approximately in position and they, therefore, had to be increased in size to ensure that they did their task.

The party was equipped with aqualungs, but their use over the reef edge was found hazardous, the increase in weight causing a diver to lose his balance when trying to get in and out through the surf. We found, however that, with a little practice, it was possible to place charges in up to 20 ft of water using only a face mask and snorkel.

The construction of the chute was most uneconomical on explosive but possibly the most essential part of the whole channel. The average chute took from 200 to 500 lb of explosive and often many days of frustrating work. Native workers were of great assistance in placing reef edge charges as they could stand barefooted on small sharp coral pinnacles with surf breaking over their heads holding a sandbag containing 40 lb of explosive without being washed over, a feat never perfected by any member of our own party.

The main channel required to be from 3 to 4 ft deep below reef level and 15 to 20 ft wide. The methods used to achieve this varied with the type of reef coral and can be summarized as follows.

Hard fuzed coral rock was best dealt with by the use of boreholes, these were constructed using either "Warsop" portable rock drills or by hand, using bars jumping and boring and 7 lb hammers.

Surface charges had very little effect against this hard type of coral even when fired as progressive patterns.

Softer fuzed coral was best removed by using crater charges. One or two rows of craters were constructed along the line of the channel and blown when the reef was dry or nearly dry, to give maximum heaving effect. The initial crater was produced in various ways:—

(*a*) By using progressive patterns of surface charges to produce a deep crater.

(*b*) By using unlined beehive craters.

(*c*) By using beehive craters lined with steel tube.

(*d*) By using craters blasted by small charges placed in conventional boreholes.

(*e*) By using craters constructed with crowbars.

The spacing of craters to provide a desired channel depended on the hardness of the reef, the depth of the channel required, the profile required and the amount of explosive available for the run of the channel concerned.

Loosely fuzed coral was best removed by either crater charges or surface charges, surface charges only being used if time prevented the construction of craters. A table will be found later in this article comparing the explosive expenditure in lb per ft run required to construct a standard channel 15 to 20 ft wide and 3 to 4 ft deep.

All the tools on the project required to be man-sized loads so they could be transported over the reef by surf boat on to an island. This limited the party to wheelbarrows, picks and shovels for the removal of rubble. Luckily this very considerable problem was overcome by the willingness of the islanders to carry in small woven baskets the many hundreds of tons of rubble away from the channel and to dump it either over the reef edge or in piles 20 to 30 yds back from the sides of the channel.

After Nui the party split and working as separate groups constructed channels on Namumunga, Tamana, Arorae and Beru returning then for two weeks leave in Tarawa.

Everyone was extremely kind to us on our return and made this period a most memorable one. We managed to run a short diving course for the Marine Department and headed by our now well-established friend Captain Gerry Douglas, the Marine Superintendent, spent many happy hours diving in the lagoon.

It was during this period that the Americans were preparing to carry out a high altitude nuclear test from Johnson Island approximately 1,500 miles away from Tarawa. On the scheduled evening we were keeping watch for a possible distant flash on the skyline. What a surprise to all when the whole sky became alight with a bright red glow which lasted for fifteen minutes, some not-so-well-informed islanders turned out the Fire Engine and went looking for the fire, a noble but, I feel, inadequate gesture.

Leave behind us, we were off to the Phoenix Islands. Here confusion became supreme on the day we not only had to alter watches but also days, I'm sure we are still owed one day's pay by the Army but lack the mathematical ability to prove it.

The channels in the Phoenix Islands on Gardner, Sydney and Hull presented no major problems and we were soon on our way back to Tarawa via Canton Island where the Americans had established one of their satellite tracking stations. As MV *Nivanga* berthed we were met by a group of American technicians who gave us the equivalent to "the freedom of the city". The generosity of our American friends will long be remembered, we were led from house to house each overflowing with steaks and other beautiful home-cooked foods. Later we were taken on a visit to the actual tracking station and allowed to listen to the tape recording of Colonel Glenn's voice as he orbited over Canton in his space capsule Friendship 7, and shown the film on Project Mercury, the space project.

Back in Tarawa we collected the remaining explosive and restocked with rations before sailing to Aranuka to construct a channel through the fringing reef of the island into the lagoon.

This was somethig new, the fringing reef at the site chosen was formed by a mass of coral heads and fingers rising from the lagoon bed between 20 and 60 ft below water level. The reef was approximately 2,000 yds wide at this

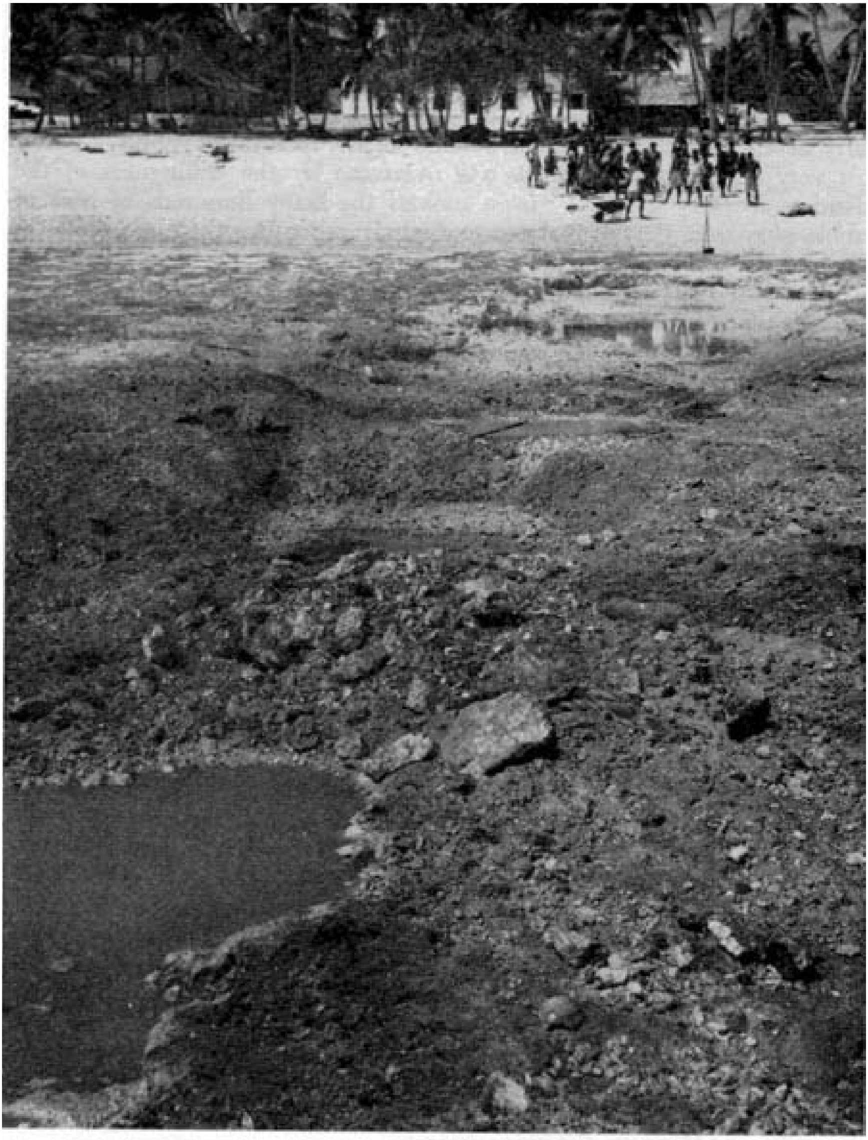


Photo 5. The result of 15 lb surface charges against the relatively soft reef at Nanumanga, Ellice Islands

Reef Blasting In Gilbert and Ellice Island 5

Photo 6. S/Sgt Bartlett's house, Makin, Gilbert Islands. This is a typical Gilbertese house

Reef Blasting In Gilbert and Ellice Island 6

Photo 7. A welcome addition to a native feast, S/Sgt Bartlett and Cpl Edmonds, Makin, Gilbert Islands

Reef Blasting In Gilbert and Ellice Island 7

point and, apart from slack tide periods, a tide race formed in this area through the draining and filling of the lagoon.

Diving conditions here were perfect, the water was clear and abounded with marine life, every corner one turned in this coral headed wonderland, produced new, dazzling-coloured fish and corals, giant killer clams on the lagoon bottom temptingly moved their brightly coloured mouths. We saw no sharks in this relatively shallow water but were soon surrounded by shoals of large-eyed, evil-looking barracuda. In size these closely resembled mackerel but their jaws seemed to represent most of the length of their bodies. These fish would swim everywhere with us keeping just out of arms distance away, by pushing a hand towards them they would back away, but as you pulled back your arm so they came back to their old position. Luckily, apart from watching us, we were left in peace.

At high tide we went over the proposed line of the channel in the ship's power launch and dropped a row of buoys and anchors interconnected by a length of signal cable. On completion of this task we found that we had covered a distance of 2,000 yds from the deep-water ocean end to the deep-water lagoon end of the channel, and had crossed more than 100 heads of coral that were obstructing the line of the channel.

The next task was preparing charges. This was done on the hatch cover of MV *Mivanga*, and over the next three days 7,000 lb of 808 and PE was loaded, 40 lb to a sandbag, complete with cordtex and primer lead; a signal cable harness was attached to each bag for fixing.

It had been decided that the end of the cordtex ring main would be made fast to the lagoon end buoy and anchor and that divers, as the ring main was paid out along the centre line, would request the number of bags of explosive they required to destroy each obstruction encountered. These charges were attached by a working party in a work boat to the ring main, which had been reinforced by a length of signal cable, and then lowered to the diver to place. In the next two days all the charges had been laid and secured along the centre line of the channel forming an uneven string of sausage-like charges.

Due to the amount of explosive and the distance over which it would be fired, a second cordtex lead was laid over the charges and attached by means of cordtex clips to the primary ring main. The ends of both ring mains were now brought back and attached to a raft made of empty cordtex drums, which had been anchored at the ocean end of the channel. A twin 10-minute safety fuze initiation set was attached to the ring main, the percussion igniters pulled and with crossed fingers we set off in the ship's launch to open sea and safety. The waterchute produced was impressive although not as large as had been imagined, mainly due to the depth of the water.

All the islanders had been warned out of the water for the blast and as the water subsided they could be seen rushing their canoes into the lagoon on their hunt for dead and stunned fish. Our powered launch won the race back to the site, and in a few minutes the bottom of the work boat we had in tow was filled with hundreds of fish, mainly our friends the barracuda. As the water cleared a great white strip could be seen along the lagoon bed where the blast had reduced to mud and sand the coral heads that had obstructed the entrance to Arunuka lagoon for generations.

On through the islands, Marakei, Miana, Nonuti and Makin, all were to feel the shakes and we hope the benefits of our explosions. With Christmas

SOME FACTS AND FIGURES

Island Visited	Task	Wt of HE used in lb	Length of channel in ft	Average weight of HE/ft run of channel including chute	Remarks
Nui	Extend existing channel shorewards and seawards. Boreholes and sapping charges used	2,440	1,140	2·4	Existing channel required less than normal weight of explosive to meet requirement
Nanumanga	Channel across reef flat. Single row of crater charges used	3,520	360	9.8	
Tamana	Channel across reef flat. Boreholes used	2,020	420	4·7	
Arorae	Channel across reef flat. Extra chute over reed edge. Two rows of crater charges used for channel	3,720	495	7·5	Average figure excludes 500 lb HE used on extra chute
Beru North	Channel across reef flat. Surface charges used	6,400	600	10.6	
Beru South	Channel across reef flat. Crater charges used	4,460	690	6.5	
Gardner	Channel across reef flat. Crater/borehole charges used	2,800	426	6.6	
Sydney	Improve existing US channel	820	225	3·7	
Hull	Channel across reef flat, crater charges used	2,000	315	6.4	
Marekei North	Clear obstructions over reef into natural channel, surface charges used	300	—	—	
Marekei South	Channel across reef, crater charges used	580	120	4.8	
Aranuka	Clearing underwater obstructions through ocean reef	7,000	3,600	2.0	All underwater demolition up to 30 ft
Maiana	Channel across reef, surface charges used	9,200	1,050	6.1	Additional task to original project
Makin	Channel across reef, borehole, crater and surface charges used	5,360	1,260	4·3	Additional task to original project, HE includes 500 lb of 1oz primers being used up on final task
Nonouti	Destruction of coral head in lagoon anchorage	80	—	—	Additional task to original project
Tarawa	Destruction of coral heads in lagoon to improve anchorage and seaplane alighting area. Training colony divers	400	—	—	Additional tasks to original project

approaching the team was now anxious with all the explosive used, to pack up and be on their way home. The stores were all to be handed over to the Colony so our main concern was to pack our personal kit and get it on its way. Our exploits were still not over however as the RNZAF had kindly undertaken to fly us to Auckland on our way home, which to our joy was agreed by the War Office. In the early dawn we were once more seated in a Sunderland flying boat, this time flying towards Fiji where we were to transfer to an RNZAF Hastings for our onward trip to Auckland. We landed in Auckland on a beautiful New Zealand spring day, we were met by members of the Royal New Zealand Engineers and taken to Fort Cautley which was to be our base for the next ten days. These days went by only too quickly, we were taken on a tour of North Island and amongst the more vivid memories, were New Zealand beer, hot springs, mud pools, great hospitality and even more beer.

Our visit corresponded with that of the Engineer-in-Chief Major-General T. H. F. Foulkes whom we were lucky to meet before leaving.

We were flown to Singapore, via Australia and joined the normal trooping flight from Singapore to UK. England of course was cold and foggy but there still remained in our minds the warm climates and warm hospitality we had encountered in the last ten months as "Reef Blasters"

The Development of Engineer Equipment for the Army

By Colonel W. G. A. Lawrie, MA, AMICE
(Deputy Commander, Engineer Stores Establishment)

A paper under the above heading, which was prepared by Brigadier Jarrett-Kerr for discussion at the first joint professional meeting of the Institution of Structural Engineers and the Institution of Royal Engineers, appeared in the *RE Journal* for September 1961. The greater part of the paper was devoted to the role of MEXE, since it would not have been appropriate at that meeting to explain in detail the full War Office procedure.

However, since the various processes which take place outside MEXE are of direct concern to many RE officers, it is thought that it would be of value to describe them in the *Journal*. These processes, moreover, do occupy the greater part of the time interval between the conception of an idea for a new equipment and its introduction into the service, and it is only by understanding the complete procedure that possible methods of accelerating it suggest themselves. The chart facing page 278 is an attempt to show on one sheet of paper the various stages in the development of engineer equipments of service design. Proprietary equipments or modified versions of them are introduced into the service along slightly different lines. When trying to piece this chart together it became apparent that, whereas every agency involved could describe the steps immediately before and after them, no one was able to see much further than this. But as soon as the whole picture became clear several possible improvements were immediately obvious, and have already been introduced.

The complete procedure can be split up into six stages:—

(*a*) Approval in principle—before any expenditure can be authorized for the project.

(*b*) Design—this includes troop trials and final acceptance, and is the stage covered by Brigadier Jarrett-Kerr's paper.

(*c*) Production—finance, contract procedure and actual manufacture.

(*d*) Scaling and cataloguing—a time-consuming but essential stage.

(*e*) Spares provision—it is always the aim to link this stage with production of the main equipment, but it has not always been possible in the past.

(*f*) Delivery—the process is only complete when the equipment is in the hands of the user, complete with spares backing, user handbooks and other technical literature.

These six stages will now be examined in greater detail:—

Approval in Principle

The DCIGS is responsible for the Army's weapon and equipment policy assisted by:—

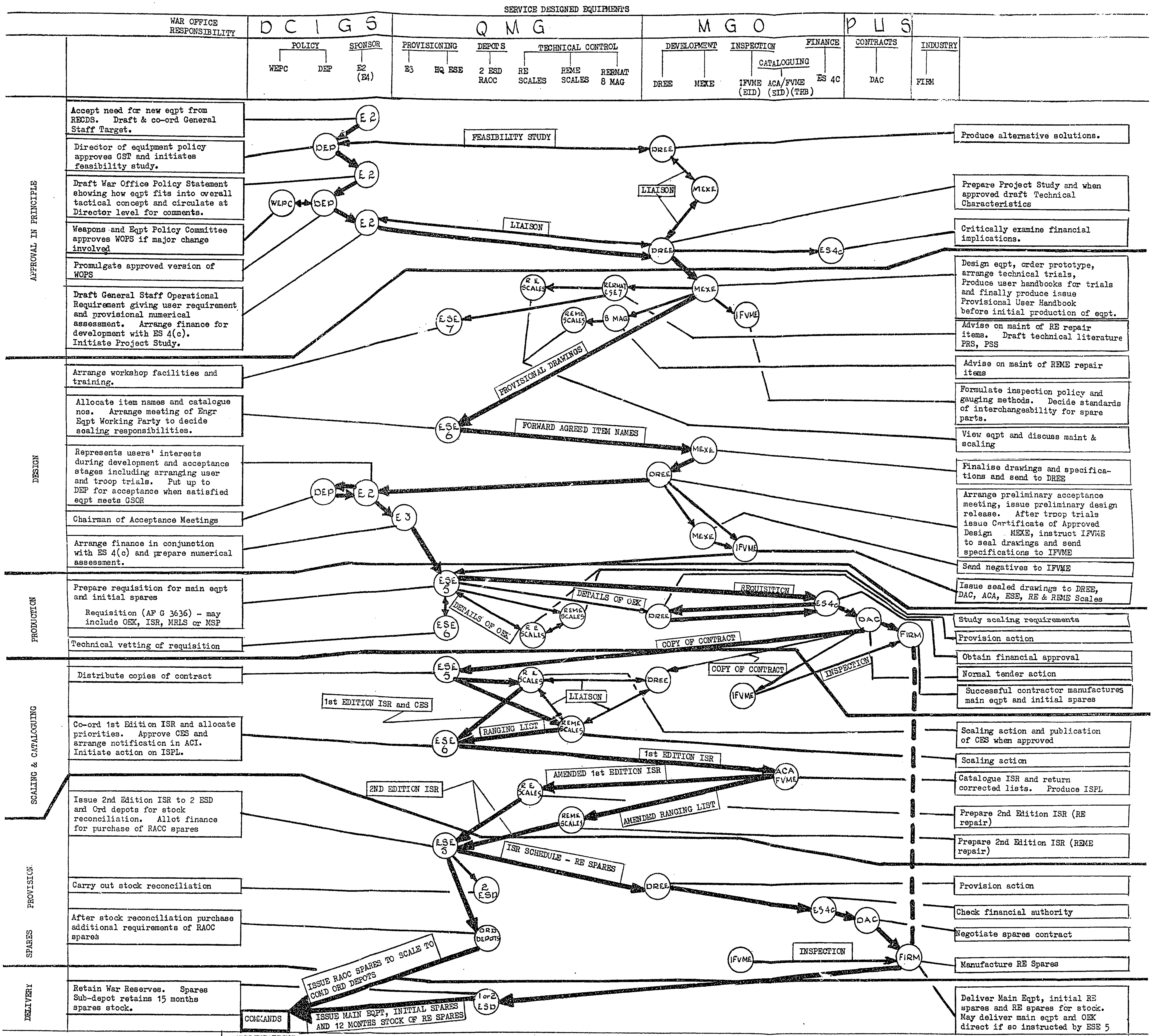
(ii) The Director of Equipment Policy, who is responsible for the implementation of this policy.

(ii) The Director of Combat Development, who is responsible for formulating future concepts for the conduct of the battle.

(iii) The Arms Director (E-in-C) who advises DEP and sponsors the development of engineer equipment.

When a new idea is put forward, possibly by the RE Combat Development Staff at the RSME, it is the job of E2 (or E4 for Transportation equipment) to draft and co-ordinate the "General Staff Target", a document which defines the actual requirement in broad terms and initiates a demand for a "Feasibility Study" to be carried out by DREE. If this is favourable, the next step is to write or revise the appropriate "War Office Policy Statement", a document covering a complete new weapon system or range of equipments. If the effect of any change is revolutionary or involves heavy expenditure DEP will have to submit it to the Weapons and Equipment Policy Committee of the Ministry of Defence for approval. This system has recently been simplified, to permit the GST and Feasibility Study to be omitted when there are no major technical or economic uncertainties. When the WOPS has been agreed and published E2 can draft a "General Staff Operational Requirement" which is written from the user's standpoint giving the main features of a particular equipment, an estimate of the numbers required and the date it is required to come into service. When this has been approved it is forwarded to DREE to carry out a "Project Study" which examines the financial and technical consequences of embarking on the project. If DREE's report is favourable DEP will authorize DREE to proceed with the development, and the first stage is over, having taken probably 12–18 months.

ENGINEER DEVELOPMENT PROCEDURE



ABBREVIATIONS

RECDS	RE Combat Development Staff	GSOR	General Staff Operational Requirement
GST	General Staff Target	PRS	Permissive Repair Schedule
WOPS	War Office Policy Statement	PSS	Plant Servicing Schedule
ISR	Initial Spares Requirement	MSP	Maker's spares pack
OEK	On Equipment Kit	CES	Complete equipment schedule
MRLS	Maker's recommended list of spares	ISPL	Illustrated spare parts list

Design

For the sake of simplicity it will be assumed in this paper that the equipment under consideration will be dealt with by DREE and MEXE, but it should be noted that some engineer equipments pass through DGFV, and that instead of MEXE, the other MGO Development Establishments may be involved—FVRDE, RARDE or SRDE. Design and acceptance are based on GSOR's but Sponsor Directors may order the preparation of Technical Characteristics as an addendum to the GSOR, in order to cover technical aspects which have not been clearly defined, or to include new requirements materializing since the GSOR was written.

DREE passes the GSOR, with TC's if required, to MEXE together with the result of the Project Studies and any other relevant data. This enables MEXE to produce the Plan of Engineering Design, and carry it out. As a result of this work provisional drawings are produced from which ESE6 are able to catalogue the actual equipment and its components and allot item names.

The Engineer-in-Chief, as sponsor, is kept fully in the picture by periodic reports and visits to ensure that the equipment is being developed to suit the needs of Engineer Units. Trials directives are written by E2 to this end.

MEXE then arrange for the production of a design prototype manufactured either by themselves or a selected firm and this prototype is then given Technical Evaluation Trials at MEXE. For some time REME have had a Maintenance Advisory Group (MAG) stationed at MEXE. They examine, dismantle and re-assemble at the prototype stage all items of equipment under development which are of REME repair, and comment on such matters as ease of access and spares scaling. Until now there has been no parallel RE organization, but this serious gap has now been filled by a section of ESE7 called the RE Repair and Maintenance Advisory Team (RERMAT) which started work in June 1963 in parallel with the REME MAG, keeping in close touch with the Engineer Stores Establishment, the RE Technical Wing at the Spares Sub-depot, Liphook and IFVME.

The prototype equipment is put through Technical Evaluation Trials at MEXE in order to establish:—

(i) that the equipment is designed on sound engineering principles;

(ii) that it is capable of reliable performance under service conditions;

(iii) that the design is suitable for manufacture;

(iv) that the requirements of the GSOR have been met.

This prototype is then further tested by user trials, normally carried out by the RSME, who assess the performance of the equipment in the hands of troops, and advise the E-in-C whether it is suitable for acceptance into service. If more than one design prototype has been made, the user trials may be carried out at the same time as the technical evaluation trials.

When these trials have been completed there will be a preliminary acceptance meeting arranged by DEP at which the results of all tests and trials are tabled and the GSOR reviewed item by item in the light of performance figures. If the equipment is approved for production a "Preliminary Design Release" is issued and the equipment is "accepted into service" subject to the incorporation of any modifications found necessary during trials. DREE now arrange the manufacture of production prototypes for troop trials, which are carried out on a world-wide basis and which inevitably lead to suggestions for further modifications and improvements, requiring amendments to drawings and parts lists.

At this stage the provisional user handbook is prepared to give guidance to the units carrying out troop trials. This is normally written by the MEXE project officers with assistance from RERMAT and REME MAG.

When all the modifications suggested on the troop trials have been approved by the sponsor and incorporated in the drawings, DREE issues a "Certificate of Approved Design" and the drawings are sealed and issued to all concerned by IFVME.

But before production can be started E3 have to arrange finance for the project, phased over a number of years, for the total number of equipments required. At this stage details of spare parts cannot be worked out but they are covered financially by adding $17\frac{1}{2}$ per cent to the cost of the equipment.

Scaling and cataloguing cannot in most cases be carried out until the contracts have been signed and the actual manufacturer known, but if the responsible agencies are brought into the picture at the design stage certain vital decisions can be taken and some preliminary work can be started.

In order to ensure that this takes place the Engineer Equipment Working Party was set up also in June 1963. All those concerned with the development, production, inspection, scaling, cataloguing and packaging of each equipment meet periodically round a table to decide exactly what is required and who is responsible. If it is obvious that certain spare parts will be required they can be identified and catalogued without waiting for the assessors to calculate how many of each will be needed.

This concludes the Design stage which may well take two to three years.

Production

There are still a number of steps to be gone through before a firm starts to manufacture the equipment. The E-in-C's branch (E3) instructs the provision authority (ESE) to prepare a requisition for the main equipment. The method of providing spares and scaling responsibilities will have been decided by the Engineer Equipment Working Party. It will be the aim to include a definite order for any spares or components that can be foreseen at this stage, and it is the responsibility of ESE5 to ensure that scaling requirements are studied by the appropriate scaling branches and that the requisition is vetted for technical accuracy by ESE6.

The requisition is forwarded to ES4(c) for financial approval. It is then passed to DREE who initiate a "Contract Action Request" which goes to the Director of Army Contracts. After normal tender action the contract is awarded to a particular firm and a copy of the contract is returned to ESE5. During manufacture IFVME will keep a check on standards. This stage and the actual process of manufacture may well extend over another 2 years.

Scaling and Cataloguing

The aim is clearly to ensure that this process is completed as soon as possible after the contract for the main equipment is let. The difficulty lies in the fact that it is not possible to get down to detail until the contract has been awarded to a particular firm, although certain preliminary action may already have been taken.

The steps involved in this complicated process are as follows:—

(i) Assessors study drawings of the equipment and from their knowledge and experience decide how many spare parts for each item are likely to be required over a period of twelve months in peace or war. A vital document required by the assessors is the Permissive Repair Schedule, which is prepared by the RE Repair and Maintenance Advisory Team at MEXE, since it is impossible to calculate the spares stock required at each echelon until it is known what scale of repair each type of unit is authorized to carry out.

(ii) This leads to the production of a document called the Initial Spares Requirement—first edition, which is simply a list of the spares required. This has to be examined by the cataloguing agency to determine which items are already in service and which are new. These are then separated into items of RE and RAOC provision responsibility. Every single item has to have an identification slip prepared for it. There are literally millions of items already catalogued, for which the Army Cataloguing Authority holds a library of identification slips.

Most items are now catalogued in accordance with the NATO cataloguing system, which describes an item for what it is, rather than what it is used for. This system involves the use of a thirteen-digit code number which enables any country using it to identify the precise item in question.

An example of the form used to introduce a new NATO stock number is illustrated on page 283.

(iii) The first edition ISR, corrected and catalogued, is returned to the scales branches, who prepare a second edition. At this stage the deployment of the equipments is considered and the primary packaged quantity of each spare, so that the breaking up of packets can be avoided. But before the spares can be purchased these lists are sent round to be checked by the RE Spares Sub-depot (for RE spares) and various Ordnance depots (for Ordnance spares required by RE or REME). The purpose of this is to ascertain the current level of holdings of each item. It may be that there was an excessive purchase of a particular part for a previous equipment which is identical with what is required for the equipment under development, and that large stocks are lying unissued in some depot. When this reconciliation has taken place ESE5 allots finance to Ordnance to purchase their requirements of spares through their own provisioning channels and at the same time puts up a bid for RE spares which goes through DREE, ES4 (c) and DAC to the firm. It is the intention that this bid should reach the firm while the main production run is still in progress. Unfortunately this has not always been possible, resulting in delay and extra expense.

(iv) To enable the unit in the field to demand the correct item another document is required—the Illustrated Spare Parts List. This is prepared by the staff of ACA/FVME who require drawings of each part, normally provided by the manufacturer, and facilities for photography.

The whole process of scaling and cataloguing which involves a tremendous amount of very detailed research may easily take another two years. This is partly due to shortage of staff. There is also a difficulty over priorities. There is only one cataloguing authority for the whole Army, and although it has a number of agencies, an urgent requirement for cataloguing a new weapon system may be allotted overriding priority, and cause long and unavoidable delays to engineer equipments.

One thing is perfectly clear, that a new equipment issued to troops in operational theatres is practically useless without technical literature and adequate spares backing.

There are several short cuts which can be taken, although none are perfectly satisfactory. Each equipment is issued with an "on-equipment kit". This is a first-aid kit of fast moving spares which is designed to enable a unit in the field to keep the equipment running. This is fine as far as it goes, but once a spare has been incorporated the unit cannot demand a replacement without an ISPL and a catalogue number. So this can only be a temporary expedient.

Another possibility is to issue a larger pack of spares recommended by the manufacturer. These can be ordered with the main equipment, and manufactured during the main production run, but two snags have been found—some manufacturers want to do as much business as they can and recommend excessive quantities, which is uneconomical, others fail to appreciate the ham-handedness of troops or the severity of service conditions and recommend too few spares.

In any case the holding of spares under manufacturers' part numbers defeats the whole object of cataloguing, which is to identify an item so precisely that there is no possibility of duplication. Spares held under various makers' part numbers have often in the past been found to be identical when eventually catalogued to the NATO system.

The only satisfactory answer seems to be to go through the whole process, but it does take time.

Spares Provision

Once the paperwork has been completed the actual production of the spares is a matter of routine. However, during this period user handbooks, training manuals and complete equipment schedules can be finalized. The CES is a document which lists all the tools, spares and literature accompanying each equipment and is the authority for demanding deficiencies and replacements. The repairs which are to be carried out in the unit or in the field may involve new equipment and tools and new techniques. These must be introduced into the training of tradesmen at the RSME. Establishments, and equipment and transport tables may have to be amended.

Delivery

This must be carefully planned and organized. Main equipments may be shipped direct to overseas commands through the movements section of ESE5. Those required for war reserves are stored in ESDs where a percentage will probably be packaged for air transport.

The packaging design authority is IFVME, but in practice the responsibility for deciding the composition of a tactical set falls on E2, and for designing containers or crates to hold it on ESE7. The work is carried out in the workshops of Nos. 1 or 2 ESD. To avoid delay now it is essential for the package designers to have attended the Engineer Equipment Working Party at the design stage and to have kept in touch with development subsequently.

Twelve months stock of RE spares is despatched to store-holding units in commands, the balance being held at the Spares Sub-depot. Ordnance spares for RE and REME workshops must be fed into the pipeline at the same time. Technical literature must be distributed to those who require it.

AGENCY FORM	ITEM NAME PROPELLER, OUTBOARD MOTOR	Type of Item Ident. 1b	Management Code ADMY .... W.O. ET .... A.M.	N.A.T.O. Stock Number 2010–99–931–9943
				Reason for Submission New item Auth:—
	Item Description 3 blade, 14 in od, constant pitch, aluminium	This issue No.&Date 1 16.10.62	Cat. Agency ESE	Supersedes/Superseded By
	Additional Information RH rotation, 12 in pitch	Last issue No&Date	Agency Ref. ESE	Original Domestic Number ADMY (U 1278).................... W.O. (U 1269).................... A.M. (U 1725)....................
VOCAB/NON VOCAB	First Used On/ Outboard Motor Set, 610 (Bermuda) ET/2805–99–931–9940	P'ty./Design Rights Held By BRD K 0961		Main Contractor/Supplier & Ref. MAN CODE K 0973 — Ref. Code / Var. Code
		Master Dwgs/Specs/Patterns Held By BRD K 0961		
	Distribution Code 20	Ranging List/Scaling List/ Service Parts List	N.A.T.O. Stock Number 2010–99–931–9943	Manfr. & Ref. or Standard Spec. Man Code K 0961 — Ref. Code 5, Var. Code B

Notes

1. This form is raised by ESE and distributed to all concerned.
2. Gives the "Approved Item Name" from the UK Codification Handbook, and a brief description.
3. The management code shown is the REVS prefix.
4. NATO Stock Number 2010–99–931–9943 indicates:—

2010	Group/Class Number—Group 20—Ship and Marine Equipment Class 10—Ship and Boat Propulsion Components.
99	Nation Code (Country of origin)—99 shows UK.
931–9943	NATO identification number, split into two groups for convenience.

Finally, plant record cards are made out for each item so that it is firmly taken on the central record maintained by ESE6 on which all subsequent spares buys are based.

*   *   *

Two points emerge from the explanation of this procedure:—

(i) It is difficult to see how a new equipment can be successfully launched into its service career in less than eight years from its inception. Any suggestions for reducing this time would be most welcome.

(ii) The one agency which is involved up to the hilt at every stage of the process from Approval in Principle to Delivery is the Engineer Stores Establishment. In these days of take over bids is it possible to imagine the same detailed and informed interest being taken in the development of Engineer equipment by an outside organization?

The Role of the Royal Engineers During the First Year of the British Occupation of Cyprus

By Lieutenant F. S. Walmsley RE (AER)

The acquisition of Cyprus for Great Britain was the direct result of the efforts of the Prime Minister, Disraeli, and the Foreign Minister, Lord Salisbury. Secret negotiations led, on 4 June 1878, to the signing of "A Convention of Defensive Alliance between Great Britain and Turkey", by which the island of Cyprus was to be occupied and administered by Great Britain in order to support Turkey against Russia. Supplementary agreements followed, among them the Annex to the Convention, dated 1 July 1878. On the conclusion of this a telegram was despatched to Vice-Admiral Lord John Hay in Suda Bay, Crete, instructing the Channel Squadron to sail for Cyprus.

At 5 pm on 12 July 1878, the Union Jack was flying over Nicosia. On 22 July the first British High Commissioner, Lieut-General Sir Garnet Wolseley arrived at Larnaca where an impressive array of ships had by this time collected. These included the Channel Squadron, a number of government troopships, ten hired transport steamers and seven hired sailing transports. Some ten thousand British and Indian troops eventually disembarked from this fleet. The units involved were:—

31st Field Company Royal Engineers.
F Battery, 2nd Brigade, Royal Artillery.
42nd Regiment, the Black Watch (Royal Highlanders).
71st Regiment, The Highland Light Infantry.
101st Regiment, the Royal Munster (late Bengal) Fusiliers.
Detachments of the Army Service and Army Hospital Corps.
3rd and 5th Companies Bombay Sappers and Miners.

"G" and "H" Companies Queen's Own Madras Sappers and Miners.
1st Bombay Lancers.
9th Bombay Native Infantry.
26th Bombay Native Infantry.
13th Bengal Native Infantry.
2nd Gurkha Regiment.
25th Madras Native Infantry.
31st Punjab Native Infantry.

The role of the engineer forces was to be vitally important in a country which had been subjected to three centuries of Turkish misrule. Their tasks included reconnaissance, survey, construction of roads and piers, the erection of hutments for troops and public works generally. When in need of reports and estimates on desirable public works the High Commissioner would consult the government engineer, while he in turn would contact his Sapper District Officers in Larnaca, Limassol and Nicosia for reports, plans and estimates. In addition the CRE acted as adviser to the High Commissioner on many other matters, ranging from afforestation and wage rates to the need for geological and revenue surveys.

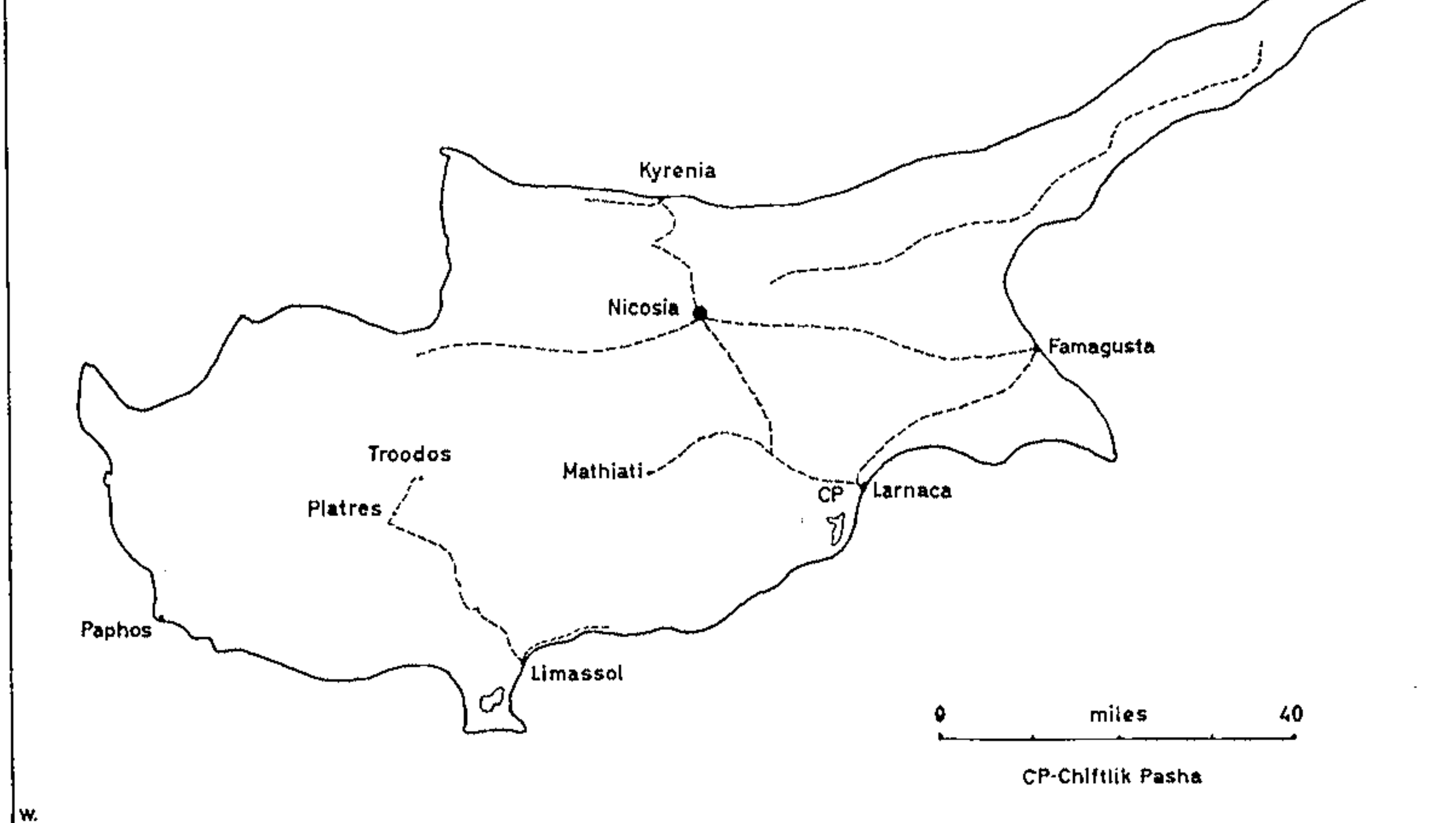
Chiftlik Pasha Camp

On 16 July the Madras and Bombay Sappers under the command of Brevet Colonel H. N. D. Prendergast, VC, CB,[1] went ashore and were employed in the construction of landing piers for the disembarkation of troops at Larnaca. The Bombay Sappers then moved on to Chiftlik Pasha camp, some five miles from the town between the aqueduct and the salt lake. There they laid on the water supply for horses and men. Meanwhile the Madras Sappers repaired the aqueduct, which supplied water to Larnaca, and began improvements to the only road in Cyprus, that to Nicosia. Communication between the naval signal station at Larnaca and the camp was at first effected by means of visual signal stations using flags and an heliostat. Later the 31st Field Company erected a telegraph wire and stations.

The 31st Field Company RE, under Major J. M. H. Maitland[2], landed at Larnaca on 27 July and proceeded to Chiftlik Pasha camp. However their stay was brief, for on 5 August they began the march of thirty miles to Nicosia where they were employed about the Headquarter or Monastery Camp, a mile outside the town and close to Kykko Metochi. Sir Garnet had preferred this site to the heat, dust and general discomfort of the enclosed town. From Monastery Camp sapper officers were despatched to all parts of Cyprus to undertake reconnaissances of roads and to search for suitable sites for a cantonment. Very great urgency attached to this last item for not only had the occupation taken place at the hottest time of the year, but the lower lying parts of Cyprus provided an ideal habitat for the mosquito. In consequence the troops suffered from malaria, especially the Indians, only half their number being fit for duty at one time. Indeed, all the officers of the 31st Field Company suffered attacks of fever on returning to Nicosia, where the company lost three men from sunstroke. Further, with the winter rains in prospect it was desirable to have the men out of tents before the season changed for the worse.

[1] Later General Sir Harry Prendergast, VC, GCB
[2] Later Major-General Sir James Maitland, KCB

THE ROADS OF CYPRUS IN 1881
after D. Christodoulou



The occupation had been carried out peacefully. There could, therefore, be little justification for tying down 10,000 troops among a total population of only 180,000. Thus the Indian Expeditionary Force began to leave the island at the end of August. Chiftlik Pasha camp was broken up, the 42nd Regiment embarking for Kyrenia, the 71st proceeding to Dhali, while the 101st moved into Larnaca.

The Mathiati Cantonment

This marks the beginning of a new stage in the military geography of Cyprus. It had been decided to erect the cantonment at Mathiati, some fifteen miles due south of Nicosia at 1,250 ft on the eastern foothills of the Troodos range. Provision of a good cart road from Larnaca to Mathiati was a first essential, for towards the end of the month huts were expected to begin arriving from England. With this in view the 31st Field Company moved to Nisou on 29 August, and five days later went to Mathiati to start construction of the road along this route. Assistance was provided by Cypriot labourers and by two companies of the 71st Regiment from Dhali. In order to make use of the existing roads as far as possible the road did not head directly for Larnaca but instead described a broad arc. Of a total length of 22 miles, eleven represented new construction, most of this being from the junction with the Larnaca to Nicosia road.

The Indian Sappers and Miners had been employed on improving the Larnaca–Nicosia road for the winter, being stationed at Larnaca with one company at Pyroi. They were now transferred to points on the line of the cart road, at Ayia Varvara, Nisou, Dhali, Goshi and Larnaca. Their work involved grading prior to metalling, the cutting of side drains, construction of culverts or Irish bridges at the water courses, and at some points wooden-framed bridges. Tools, stores and other materials for the working parties were supplied from Larnaca. The Madras and Bombay Sappers had each brought a third class seige park of tools and materials with them to Cyprus. These proved to be extremely useful and were retained in the island by order of the High Commissioner after the departure of the Indian sappers.

The CRE later paid tribute to the work of the senior officer of the Indian sappers, Major Hamilton RE[1] (who had replaced Colonel Prendergast) and in particular to his management of the stores and the supervision of engineer works in Larnaca. There the repair and alteration of buildings for both military and civil use was carried out under the supervision of RE officers. He went on to deal with the work and equipment of the Madras and Bombay Sappers, describing the former as only "well trained pioneers", but even so of more use than their counterparts who were of higher castes. Caste prejudices made the supply of rations to the Indian troops a difficult undertaking. The Indian sappers left Cyprus aboard HMS *Simoom* on 1 November.

Arrival and Erection of the Huts

The first shipload of huts arrived at Larnaca on the SS *Abbotsford* on 22 September. With the aid of the sailors of the Channel Squadron one hundred soldiers' huts and fifteen incomplete hospital huts had been discharged within six days. Transport up to Mathiati commenced immediately. On the 23rd the SS *Laconia* followed with nine iron store huts for the Commissariat and Ordnance departments at Larnaca. The glass for the windows had been badly packed and more than half arrived broken. One

[1] Later General A. F. Hamilton.

hundred and fifty soldiers' huts and materials for the hospital huts were discharged from SS *Durley* between 30 September and 5 October. This cargo had to be sorted on shore at Larnaca and reloaded for distribution to Kyrenia and Paphos by sea. Three other vessels completed the shipment of huts. The *Sestos* brought eighteen officers' huts, three mess huts, three guard room huts and more material for the hospital huts; *Craigforth* the High Commissioner's residence, the Brigadier-General's hut and the staff officers' hut; and the *Thessalia* four iron store huts.

The standard hut, designed for ten men, measured 33 ft by 16 ft by 6 ft 6 in at the eaves. Sides were of 1-in planks arranged vertically with fillets over the joints. Roofs were covered with felt and tarred, the gables being closed with oiled canvas and perforated zinc ventilators. The floors consisted of wood with the joists resting on longitudinal sleepers. The story of the High Commissioner's residence is well known and, if amusing almost a century later, it was by no means so in 1878. Reputed to have been diverted at Port Said to Cyprus when in transit to Ceylon, this wooden bungalow seemed singularly ill-adapted to the Cyprus climate but survived until burned down in the 1931 riots. For example, early in January 1880 the temperature in Nicosia fell to 23°F. There was a hard frost accompanied by sharp north winds and snow is said to have laid 3-in deep in the central plain. Inside Government House the water froze in the bedrooms and at mid-day the thermometer in the sitting-room registered only 40°F. Sir Robert Biddulph later wrote of how the wind blew through the crevices and round the doors and windows, compelling the occupants to sit throughout the day, meal times as well, in thick coats and rugs.

At Mathiati the cantonment was planned for a Battalion of Infantry and a Company of RE with detachments of the Army Service Corps and Army Hospital Corps. It was constructed by six companies of the 71st Regiment and the 31st Field Company. Transport of materials from Larnaca is reported to have taken three weeks, but the work was well on the way to completion by the end of October. In all eighty-two soldiers' huts and then hospital and officers' huts were erected. Roads were made within the cantonment and new wells dug. Subsequent additions included a fine polo ground and the occasional dog hunt is said to have been a popular pastime. At Kyrenia six companies of the 42nd assisted by a detachment of RE and a few local tradesmen erected the huts. Cypriot labourers also made a mile of road down to the small harbour. The soldiers occupied the huts on 2 November, but as the 42nd left Cyprus on the 20th to take part in the Afghan war, the cantonment never reached completion. Apparently the 42nd did not work anything like as well as the 71st, and in fact only put in a little over three hours work per day.

In her book *Our Home in Cyprus*, published in 1880, Mrs Scott-Stevenson, wife of a captain in the 42nd, describes the camp, built to house 900 men and with drains 3 sq ft in section between each row of huts. There is also a revealing paragraph on the morale of the regiment. "Is it any wonder that they got ill? They had no occupations, for it was too hot for parades; no recreations; nothing to do but lie dozing on their backs under the canvas, shifting their knapsacks occasionally to save their heads being blistered. They had plenty of time to reflect and most sensibly came to the conclusion that it was much better to be sick and sent to the cool hospital tent, with plenty of luxuries, even beer and pipes, than to lie idle in the shelterless tents. I believe they all got into the same frame of mind—that 'hospital' was the only relief from the intolerable monotony of their lives. Thus going sick was looked upon as quite the best thing that could happen."

Two companies of the 42nd were also employed in erecting huts at Paphos with the aid of sailors from the Channel Squadron, but again the departure of the Regiment prevented completion. Other huts were erected at Larnaca and at Nicosia, where local carpenters working under RE supervision erected the High Commissioner's residence between 14 November and 22 December, less than six weeks. The site chosen, named Snakes' Hill after the number seen by the Sappers when working there, is still occupied by the Presidential Palace, formerly Government House, at the present time.

The Hill Station and Military Road

During the late autumn of 1879 the search for a suitable site on which to erect an hill station and sanatorium began in earnest. This required a good water supply, easy access by road and proximity to a port. Eventually the choice fell upon a site above the village of Platres high on the southern side of the Troodos range and commanding a view over Limassol and the southern coast. There was a good supply of water throughout the year and gentle slopes and spurs afforded excellent sites for building. As at Mathiati communications presented the outstanding difficulty, the thirty or so miles from Limassol being covered only by mule tracks. The "Report of the Commanding Royal Engineer on Sites for Stationing Troops in the Hills of Cyprus" written by Colonel J. P. Maquay[1] at Nicosia on 4 January 1879, concludes "Platres seems to be the best site for an hill station, and can readily be put in communication with Limassol by a road, which would also open one of the most fertile and wine producing districts of the island." He proposed the construction of 26 miles of road, 15 ft in width and having gradients suitable to cart traffic, at a total cost of £9,100, inclusive of bridges.

The decisions concerning the hill station and road are of the utmost significance, not only from the military point of view, but also for the development of Cyprus itself. A third and final stage in the early military influence upon the landscape now follows. The pattern of activity based on the port of Larnaca and the cantonment at Mathiati fades in favour of one based on Limassol, Polemidhia and Troodos. It is in these decisions that the subsequent development of Troodos as a hill station for troops and as a resort for the civil administration in the summer months have their origin. Although with the passage of time the military road falls into disuse the patterns of settlement and population movement which it inaugurated have persisted and remain part of the way of life in the island to this day.

As a preliminary step to the construction of the road the 31st Field Company moved from Mathiati to Limassol, marching in one day, 23 December, to Larnaca, there embarking on HMS *Humber* the same evening. Once at Limassol they began the erection of temporary huts and undertook reconnaissances to seek out the best line for a road. There was no time to produce a detailed survey and the route had to be determined roughly by eye. Indeed, in fourteen days Major Maitland examined four alternative main lines of road with six to eight possible variations in each. He finally chose the route which seemed to present the fewest engineering difficulties, forwarding his proposals to the CRE on 14 January.

[1] Later Major-General J. P. Maquay.

The route was accepted and then divided into three sections of ten to eleven miles in length, each being placed under a Lieutenant assisted by one or more interpreters. Section 1 under Lieutenant Wisely[1], the District Officer Limassol, ran from Limassol to Zygos bridge on the Zygos river north-east of the village of Khalassa. Section 2, the most difficult, was assigned to the most experienced officer, Lieutenant Bagnold RE.[2] Unfortunately he was detained at Mathiati until January with consequent delay to this section. Further delay here arose from a scarcity of lime. The section terminated near the twenty-second milestone, not far from the village of Trimiklini on the Kouris river. Lieutenant N. J. Foster, RE[3] had charge of the third section, which included the formation of a mule track, 6 miles in length, from Platres to Troodos (Pasha Lewa).

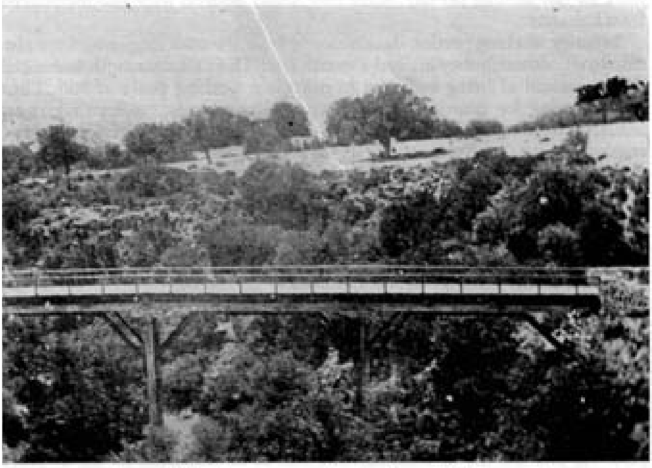
The officers had instructions to make the road 15 ft in width and to keep the gradient at 1 in 30. Metalling and ballasting had only to be carried out where absolutely essential. Orders to proceed with the work were received on 21 January and a detachment of the company set out to commence on No 1 section. A party of Greek Cypriots began work on No 3 section at Mandria on 23 January, although the Sappers did not arrive there until a week later. On 7 February a detachment marched up to No 2 section and began work on the 10th.

The road provided employment for a considerable amount of local labour, and at one time over 6,000 persons were employed. Each NCO or Sapper had charge of a gang of about 150 men, while Cypriot overseers were appointed one to every twenty-five workmen. To avoid incidents gangs consisted of Greeks or Turks, groups from the same village being kept together as far as practicable. The labour force included a considerable number of women, employed first in fetching stones for ballast and then in breaking them for metal. Children also collected stones, bringing them to the road in baskets.

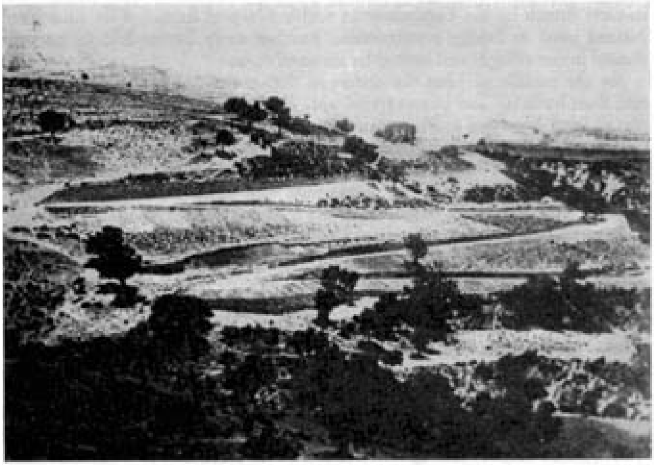
The following extract from Major Maitland's final report serves to illustrate how the habits and superstitions of the local people often acted as a barrier to the efficient execution of his plans. "The Turkish women as a rule brought up stones in panniers or on boards arranged on each side of donkeys. At one place, however, a gang from Silikou was employed in breaking stones which they did in a futile way with one hand, while with the other they held their veils over their faces. This was while their husbands were near, but Lieutenant Bagnold requiring to form a new gang sent the husbands to work about two miles away; very soon the yashmaks were abandoned and the women, squatting on the ground, hammered away in all their native ugliness."

It did not take long to discover that the labourers were lazy, requiring constant supervision. Feasts, Saints' Days and holidays interfered with the smooth progress of work. At Easter operations stopped for almost a fortnight. After heavy rains in March many workmen left to begin pruning their vines. Eventually it became necessary for the District Commissioner to make an ordinance requiring thirty days labour per year on government works from any adult Cypriot male to the extent of 300 labourers on sections 1 and 2. Zaptiehs (Turkish police) were despatched into distant villages to order in a proportion of the population from each. Incidents did arise. On a number

[1] Later Captain C. A. K. Wisley, RE.
[2] Later Colonel A. M. Bagnold, CB.
[3] Later Colonel N. J. Foster.



One of the bridges constructed on the Limassol–Platres road



Photograph, taken in 1879, of road built from Limassol to the Platres hill station

The role of the RE

of occasions the labourers attempted to impose their own terms of work. To counter this about seventy labourers were brought over from Mathiati to work for one shilling per day. Some fifty Arab labourers were also introduced from Lebanon.

Infantry working parties, drawn mostly from the 20th Regiment were also employed, although they arrived a month late. Their total strength amounted to 200 instead of being sufficient to provide a working party of 200. Thus after allowing for guards, duty, sick and prisoners only 140 men remained available for the road. These 200 men of the 20th had previously been employed, along with a Company of RE and 1,200 labourers, in constructing a military carriage road between Limassol and Paphos.

In a journey northwards across the mountains from Limassol Mrs Scott-Stevenson tells how she encountered the soldiers, coming upon a camp of the 20th at Zygos and then the Sappers near Monagri and Mandria. Major Maitland had a house in Pano Platres. Temporary post offices seem to have been established at Zygos and Silikou during the construction of the bridges there. Along the line of the road, and especially in the difficult second section, the soldiers named prominent features after English birds, hence Magpie Gorge Bridge, Nightingale Vale and Partridge Gorge to mention but a few.

The men of the 31st Field Company were employed in supervising the local labour, in making bridges and during the early stages, in handling the jumpers used in blasting works. Supplies of tools came from the Indian siege park. At first the use of wheelbarrows had to be restricted to one to every 2 miles of road until more had been purchased from a local merchant. Quarries had to be opened close to the sites of bridges, and where this did not prove possible stone had to be carried in on mules. Similarly, lime and cement had to be brought up to the site of works in bags carried on mule back. Beams for the bridges within easy reach of Limassol were transported in carts drawn by the Commissariat mules. Sleepers intended for huts were instead used in bridge construction. Further away beams had to be purchased in the villages and moved by teams of oxen.

By the middle of June the orders to "open the road for wheeled traffic and then leave it" had been carried out. A fair weather road had been completed from Limassol to Platres in five months. From Platres the mule track continued up to Troodos, giving a total length of 37 miles, rising from sea level at Limassol to 6,000 ft on Troodos. The total cost, inclusive of extra metalling and ballasting, came to £11,900, well under half the estimate put forward by various civil engineers at the outset. In a covering letter to Major Maitland's report on the Limassol-Platres road dated 14 July 1879, the new CRE and Government Engineer, Lieut-Colonel N. W. H. D. Dumaresq[1] wrote "The work having been virtually completed before my arrival, I send the report forward without comment further than to state that having been over the road I consider it to be the most admirable specimen of engineering, reflecting the highest credit on all concerned in its execution, but more especially on Major Maitland and the three officers, Lieutenants Bagnold, Foster and Wisely, who carried out the work under his direction."

During the construction of the road the huts at Kyrenia and Paphos had been taken down and brought round to Limassol ready to be erected on Troodos. A depot had been established at Limassol for Commissariat,

[1] Later Colonel N. W. H. D. Dumaresq.

Ordnance and Royal Engineers. It was enclosed by a wooden fence of about 200 yards each side and connected by a good road to a newly constructed pier in the harbour.

Early in September 1879 the CRE, in company with the Medical Officer, visited the Limassol area in response to a request from the High Commissioner, Colonel Sir Robert Biddulph, to report upon a site for a camp in the vicinity of the town. They chose a commanding position 3 miles to the north and close to the village of Pano Polemidhia where the hills begin to rise above the coastal plain. This offered a well drained site and easy access to the military road. A good water supply was available close by from a chain of wells being constructed to provide water for Limassol. Soon afterwards huts were erected and occupied by the 20th Regiment. For four months during the summer the troops moved up to the hill station by means of the military road.

The Triangulation and Kitchener's Map

For the occupation of Cyprus the Ordnance Survey had printed copies of M. L. de Mas Latrie's map, published in Paris in 1862 on a scale of 1 : 250,000. A number of inaccuracies in this map soon came to light, and served to emphasise the need for an accurate topographical survey of the island. At the same time the need for a revenue survey dealing with the registration and valuation of landed property had become apparent, and the High Commissioner had indeed suggested this to the Foreign Office as early as August 1878.

As a result two officers, Lieutenants Kitchener[1] and Hippisley[2], and four Sappers were sent out from England with instructions to begin work on a triangulation as a basis for the revenue survey. Mid-October found the party occupied in measuring a base line which Kitchener had laid out in the central plain north of Nicosia. This had been completed by 15 November and the triangulation was then put in hand, although Hippisley and two men were detached for the revenue survey. On 13 May 1879 a telegram arrived from Southampton stopping the work for financial reasons. The surveying party returned to England, but Kitchener succeeded in completing the triangulation, reporting this to Colonel Biddulph, later General Sir Robert Biddulph, GCB, GCMG (RA 1835–1918), in July. There the matter rested until a more detailed report on the methods of carrying out a revenue survey had been prepared.

Kitchener returned to Cyprus as Director of Survey and Land Registry Office in March 1880. A topographic survey on a scale of 1 : 31,680 (2-in to 1 mile) followed, using a few theodolite traverses along the principal roads and prismatic compass sketches. Field work was complete at the end of 1882. The map produced from this data, "A Trigonometrical Survey of the Island of Cyprus, executed and published under the direction of Captain H. H. Kitchener RE, Director of Survey, 1882" on a scale of 1 : 63,360 was drawn and printed by Stanfords of London in 1885 on fifteen sheets. A reduction on the scale of 1 : 348,480 (5½ miles—1-in) accompanied it.

By the first anniversary of the occupation in July 1879 the focus of attention had shifted from Cyprus. At home the initial enthusiasm for this new acquisition had waned as its potentialities had become more fully known.

[1] Later Field Marshal Earl Kitchener of Khartoum.
[2] Later Colonel R. L. Hippisley, CB.

The number of troops had been drastically reduced, Sir Garnet Wolseley had departed and the resignation and death of Lord Beaconsfield were not far off. With the occupation of Egypt in 1882 England found herself better placed to protect the isthmus of Suez and the route to India. This early period then is one of the most interesting in the whole eighty-two years of British administration in Cyprus. It is essentially a time of pioneering, of putting on the path to progress an island which had for too long known only the dead hand of the Turk. The role of the Royal Engineers and the Indian Sappers and Miners during this time is particularly notable and deserves to be more fully recorded not only in the annals of the Corps itself, but also in accounts of the period of British rule in Cyprus.

Postscript

Today Cyprus still retains its souvenirs of this early period. Diligent searching among the headstones in the cemeteries at Kyrenia, Mathiati, Nicosia and Troodos will still reveal reminders of the heat and malaria which afflicted the troops during the summer of 1878. Tucked away in a corner at Kyrenia is the grave of Sergeant S. McGaw, VC of the 42nd Regiment (The Black Watch) who died of heatstroke on the line of march to Chiftlik Pasha camp. It seems probable that his coffin was taken round to Kyrenia by sea after the break up of Chiftlik Pasha. Some parts of the military road may still be traced on the ground, and it is a rewarding exercise to locate the route on Sheets 5 and 6 of the Cyprus 1 : 50,000 map. Finally, it requires but little effort for the visitor to Nicosia to find Haydar Pasha Street, close to the Selimiye Mosque. There, high on a wall, a stone tablet,* now regrettably cracked down the centre, reveals that "Here lived Captain H. H. Kitchener RE, Director of Survey and Land Registry Office, 1881–1883."

* Placed there by Sir Ronald Storrs on 24th June 1927, the 77th anniversary of Kitchener's birth.

Air Cushion Vehicles in Limited War

By Colonel R. L. France, MC

Introduction

There are many problems in mounting a limited war operation as now envisaged, which the use of future ACV's might help to solve. Many of these problems have a strong sapper flavour and this article briefly indicates the sort of ACV designs which might be useful.

Some Problems

Limited war forces have to deal with trouble outbursts at short notice and attempt to smother them quickly before they build up momentum. A mobile balanced force of all arms must be transported to the scene of the trouble as quickly as possible complete with its logistic supplies and with the minimum of supporting troops. Lightly armed fighting elements must normally be flown in with self contained supplies for the first few days, the seaborne force following up with the heavy lifts of armour, engineer stores etc, and the logistic build up vehicles and stores. If the force meets opposition in the landing area armour and bridging stores may be required to enable the force to fight its way inland quickly. Unless the trouble outbreak is foreseen these essential elements may not arrive for some days. The air transportation of essential logistic build up stores will then have to compete with many important and conflicting calls on the available aircraft. The need to speed up the arrival of the seaborne elements is, therefore, the first problem that affects the Corps.

Another problem concerns the arrangements made to receive the seaborne forces, including any assaulting elements. Sapper tasks at this time may include the clearance of obstacles in the landing area; the construction of beach roadways and adequate tracks in the stores transhipment areas ashore; the establishment of the port task group elements to control and handle the movement ashore of stores and the construction of collapsible POL storage tank farms near the beach area to receive the fuels from tankers.

Further inland a likely task is the construction of a rear maintenance area airfield for transport aircraft not too distant from the transhipment area. More fuel storage tanks may be required to hold POL being moved forward by transport aircraft or other means. The movement of heavy vehicles and maintenance convoys inland may necessitate bridging and road work. A big sapper problem may be the construction of airfields or strengthening or extensions of existing airfields. Prefabricated surfacing and waterproofing materials may be required in large quantities early on in the operation and sufficient transport aircraft to do this may be difficult to find. Overall the sapper manpower and equipment bill is likely to be considerable and difficult to provide for on an adequate scale.

How ACV's Might Help

The advantages offered by ACV's over current methods of transportation in this situation are their speed and ability to traverse water and every type of unobstructed terrain together with their promise of lifting heavier loads than are ever likely with strategic aircraft. Their limitations for crossing certain types of obstacles will be discussed later. Suffice to say that in the area where limited wars are likely, the Far and Middle East, there are long, wide rivers which offer excellent routes for ACV's and in the case of the Middle East long stretches of unobstructed beach and routes inland.

ACV speeds of 80 to 100 knots offer big reductions of transportation delivery and turn round times. Thus the problem of the gap between the arrival of airborne forces and the essential elements of the seaborne tail such as armour can be reduced.

Once the seaborne forces have arrived at their destination it is possible for ACV's to cut down the times of ship to shore movement of stores and make it economical to carry them straight through to the rear maintenance area without the double handling in the transhipment area. The need for the construction and maintenance of beach roadways and long pontoon causeways would be obviated as would any work required on natural or artificial obstacles in the water. Tidal problems would disappear. Any obstacles on beaches such as mines would be ineffective unless sophisticated mines were used, which is unlikely.

The fitting of large ACV's with self supporting rubber storage tanks for the carriage of POL could ensure its economical delivery straight from mounting base or fleet tanker to the rear maintenance area or even beyond to the forward maintenance area. This could save the construction, maintenance and operation of a ship-to-shore fuel line or alternatively a dracone fuel barge system, together with the storage tank farms required on shore and pipeline to the airfield area.

The early arrival of airfield construction stores and plant would become more likely.

Sapper tasks in the port and communications zone area would thus be considerally reduced.

Problems of ACV Design

Design problems may include the large power and light weight construction requirements to achieve the necessary ACV clearance over wave and land obstacles; their width, which is directly related to this clearance and is necessary for stability; control problems in high winds, for turning and stopping quickly; the need for auxiliary propulsive power including power for retractable wheels where there are used to save fuel on road movement, give added traction on hills and better control in winds; high fuel requirements; creation of noise and spray/dust with associated engine/propeller wear problems.

With these disadvantages ACV's at the present early stage of development tend to be complex, costly and to require considerable maintenance. Much research work is being done and improvements to reduce these problems are likely. In particular the use of improved flexible skirts on the periphery and in compartments should lessen the free air gap and reduce power and/or width requirements and improve stability as well as improving the spray/dust problems.* The use of quickly adjustable folding sponsons should enable ACV widths to be reduced at critical times when being transported and moving on roads. ACV construction materials and methods should be simplified with increasing experience.

Some Possible Outline Designs

For the large tank carrying type of ACV mentioned above the main problem is to decide its operating hoverheight. Power weight ratios get better with increasing size but are likely to be large compared with conventional craft if ACV's are designed to be sea-going in all weathers. Power requirements would be much less if designed for operating, say, from a mounting base at Aden to the Persian Gulf and in-land by travelling in coastal waters in order to be able to quickly avoid monsoon conditions in the India Ocean. Passages from the UK would also be possible by using fuel staging posts and selecting the weather. Fully ocean going ACVs requiring a lot of power might be considered worth while if the savings in time, man power, etc, outlined above were set against the cost. The advent of cheap nuclear power would provide an ideal solution to this problem. Whatever type were adopted only small numbers would be required for the task.

The ship to shore transport ACV would be a simpler problem. Several would be required to operate from the many loading points on supply ships etc. Ideally it should be capable of being carried on or in the appropriate ship. With a maximum load capacity of a loaded three tonner and by using folding sponsons it should be possible to design an ACV which would pass through the "dock" doors of a landing ship assault or the ramp door of the

*This article was written nine months ago, advances in skirt design have reduced our requirements by a factor of 3 to 4.

landing ship supply or be carried on deck of other supply ships and be launched by derrick. Operation in sheltered waters only would be necessary and therefore a hoverheight of three or four feet should suffice. Even with sponsons its width might be of the order of twelve to fifteen feet and, therefore, any necessary road movement would have to be pre-planned and controlled, except in the Middle East where there would be little restriction to off route travel. Movement on canals and inland waterways would be possible and this size of ACV might, therefore, be suitable for use in Western Europe also.

Conclusion

The transportation ACVs outlined above would seem to offer savings in engineer effort as well as improving the all-round effectiveness of limited war forces. Though likely to be expensive a careful study of their potential in various parts of the world would probably show their use to be economic and that military development would be worthwhile.

Wellington's Peninsular Engineers

By Jac Weler

Introduction

Mr Jac Weller, the author of this article, is the Honorary Curator of the West Point Museum, a graduate and licenced engineer, a specialist in infantry weapons and firearm consultant and connected with Ordnance and historical research in the United States of America. His book *Wellington in the Peninsula 1801–1814* has recently been published in this country by Nicholas Vane Ltd, price 63*s*.

* * * * *

Napoleon entered Spain in 1807; Wellington finally drove the French back across the border in 1814. The British commander was undefeated in the remarkable series of battles; his campaigns contributed greatly to the first abdication of the French Emperor. Wellington's grand strategy and victorious battle tactics are well known.

The part played by his military engineers is not so dramatic, but the work that they did in Spain, Portugal, and Southern France in the Peninsular War was extremely important to the final victory. They accomplished scores of tasks quickly and efficiently, enabling Wellington to attain a remarkable flexibility throughout an area several times as large as England.

Continental European military engineers of 150 years ago were still mainly concerned with building fortresses and taking them by siege. In this specialized field, the French were good. Wellington's engineers did not entirely overcome their initial disadvantages in this field. For centuries, British sieges had been handled mainly by the Navy, but in Wellington's campaigns he took Ciudad Rodrigo, Badajoz, San Sebastián, and Pamplona without naval help.

Wellington and some of his men had served their apprenticeship in India where practical and immediate results were more important than theory. In the East, terrain and the forces of nature were sometimes more difficult to overcome than the opposing army. Civil and mechanical engineering problems had to be solved with relatively primitive means. This continued to be true in the Peninsula.

When Wellington's army was put ashore across open beaches in the summer of 1808, it was on its own. The Navy was used to landing horses, wagons, and even artillery in boats. It stood by to take off any British expeditionary force that might run into difficulties. But Wellington's army finally came back to Britain by way of Paris and the channel ports.

Roads, Maps, and Field Fortifications

Engineering problems began as soon as Wellington was ashore. Transportation was in part brought from Britain and the rest obtained locally. But the roads were atrocious and needed constant attention. Further, no one knew exactly where they went. Maps were so faulty as to be useless. As Wellington advanced on Lisbon, he still had to keep in touch with the fleet from which he was drawing supplies. His engineers were working from dawn to dark in making accurate maps and repairing roads sufficiently to stand up under the relatively light military traffic of that day.

The French were defeated at Rolica and Vimeiro and gave up Portugal under the Convention of Cintra in 1808. But Napoleon sent three armies to retake the country. Wellington and his engineers began in April 1809 to make plans that were the basis of their final victory. Accurate maps were made of Portugal and adjacent sections of Spain. Repairs were made to roads, bridges, and fords by British engineers directing gangs of local labour.

Lines of Torres Vedras. After the barren victory of Talavera in Spain, Wellington realized that he and his Allied army were going to have to defend Portugal against French forces. For the use of militia and other secondary troops the engineers constructed the lines of Torres Vedras. These lines, remarkable in conception, extended from the Atlantic coast to the Tagus River about 35 miles across the Lisbon Peninsula. British engineers might not be so adept as their French counterparts at building Vauban-type enclosed works of masonry and earth in scientific arrangements, but these lines were not so much for extended defence, as to enable the Allied field army to fight under advantageous circumstances in the open. The works were gigantic and included miles of trenches and scores of forts. They were rough, but fitted to the terrain, and could be held for a few hours by semi-trained men.

At each end of the lines, streams were dammed near their mouths so as to flood large areas upstream. This simple arrangement decreased by a third the length of the line which the Allies had to hold in the middle. The dams were protected by fortifications on the northern side facing the French. The approaches to them were controlled by batteries south of the streams. The French retreated all the way back into Spain rather than attack the lines of Torres Vedras.

Transportation

In the confused fighting of 1810 and 1811, the Allied army was dependent on overseas supplies which came into Lisbon and Oporto and were delivered many miles inland. Wellington and his staff did not try to bring significant

Photo 1. Mouth of stream dammed to augment the lines of Torres Vedras. The headland in the foreground on the Atlantic was occupied by a battery. There were other fortifications on this south side of the stream

numbers of wagons and draft animals from Britain, but used instead many small but sturdy ox carts and hundreds of pack mules. Maintenance problems were reduced to a minimum. The Portuguese drivers were usually the owners of their equipment; they proved trustworthy and courageous in most instances.

Even ox carts and pack animals could not always take supplies directly to where they were needed. Some new roads had to be cut. Occasionally, as a

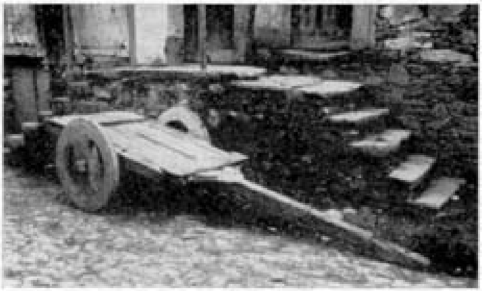


Photo 2. The peninsular solid-wheel ox cart

defensive measure, Wellington's engineers destroyed a road. When they did this, they did it thoroughly. They blasted the Estrada Nova between Guarda and Abrantes from the side of a mountain to the valley below so completely that it has never been replaced.

After the capture of the Spanish border fortresses of Ciudad Rodrigo and

Wellington's Peninsular Engineers 1,2

Badajoz in 1812, Wellington could operate in Central Spain, if he could supply his forces there. The area had been stripped by the French; there was no chance of obtaining anything locally. The nearest harbours were still Lisbon and Oporto. Transportation by ox cart and pack mule all the way across Portugal and into Spain would be slow and inefficient. But Wellington thought of another way. Lisbon is on the Tagus and Oporto on the Douro, both large rivers flowing roughly west across Portugal from Spain. He set his engineers to opening these rivers to navigation; this was done for the first time in history. Draglines attached to teams of oxen scooped out thousands of tons of sand. Tons of gunpowder were used to blast away rock. At least one canal was cut so that boats could be towed around a particularly tough stretch of river.

Bridges

The Tagus was extremely important to military operations in Central Spain and Andalusia. The stream is wide and deep flowing through a steep-sided gorge. If contending armies could not use the two great Roman bridges at Alcantara and Almaraz, days and even weeks were added to the time that it took to send fully equipped forces from one side to the other. These bridges were blown early in the Peninsula fighting. In each case a single arch was blasted into the river more than 100 feet below.

When Wellington took the offensive in 1812, he assigned Major Sturgeon, who had also served in India, to repair these spans with a temporary suspension arrangement. Sturgeon brought ship's hawsers and capstans from Lisbon, and had large eye-bolts and iron straps fabricated in the Portuguese arsenal of Elvas. Four heavy ropes were stretched along the roadway and across the gap, secured firmly at one end to the bridge, and tightened by means of capstans at the other. These cables were held rigidly in place laterally by cross members of oak and braced with spars to the bottoms of the blown arch. A solid floor was then placed on the cables across the missing span of the original bridge. This ingenious arrangement, installed first at Alcantara and later at Almaraz, was an enormous advantage in the next few months of fluctuating fighting. It could be taken up and removed to one side or the other in an hour if the French penetrated into the area. The whole thing could be reinstalled in two hours.

The wide, swift Douro farther north was spanned by a somewhat similar suspension bridge well inside Spain. This was not of a size to be used for supplies, but could carry a small load quickly in a kind of cable car. Wellington went from one flank of his army to the other in minutes by this means at the beginning of the crucial Vitoria campaign.

In an enormous area cut by many rivers, some means of getting an army across them was imperative. Pontoons had been used for a considerable time. These were usually drawn, however, by oxen attached to ponderous, unreliable, slow moving carts. Wellington or one of his engineers evolved a system by which lightweight pontoons, precut light flooring, and prepared cordage and anchors were drawn by artillery horses in carts made from axles and wheels of fieldpieces. The speed that this train made over primitive roads was several times faster than with the ox carts. The pontoon crew bridged the Garonne south of Toulouse in the spring of 1814, arriving at the stream after nightfall and installing the bridge in time for a division to get across by dawn.

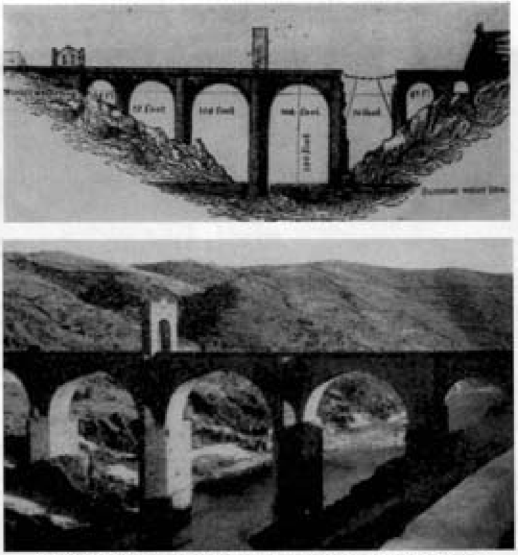


Photo 3. Roman bridge at Alcantara, built by the Emperor Trajan
Above: Major Sturgeon's temporary repairs of 1812. Below: The bridge as it now stands

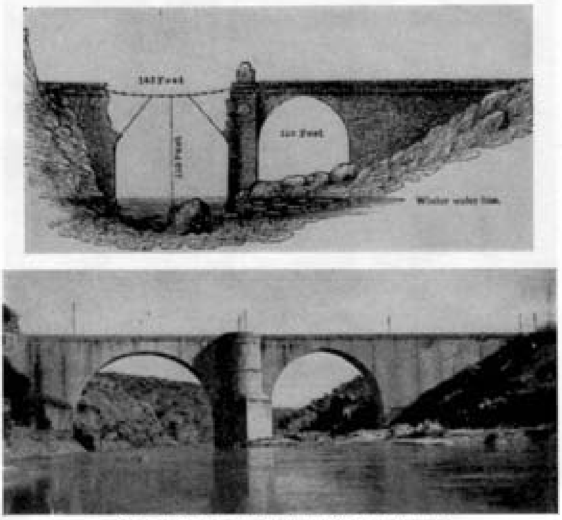


Photo 4. Bridge over the Tagus River at Almaraz
Above: Temporary suspension span by Wellington's engineers. Below: The bridge today

Wellington's Peninsular Engineers 3, 4

Photo 5. A road through rugged territory traversed at a speed of almost 20 miles a day by Wellington's Pontoon Train

Photo 6. A 68-pounder Carronade used at the Siege of San Sebastian

Siege Support and Communications

At the siege of San Sebastián, Wellington employed the greatest quantity of artillery ever to be assembled under a British command up to that time. He and his staff had specified every piece, every carriage, and every round of ammunition months before. There were even enormous 68-pounder carronades. This landing operation had to be handled by the Army; the Royal Navy was so fully occupied with American privateers that it could not even isolate San Sebastian from France by sea. By this time, however, the Army engineers had plenty of experience and comprised a versatile organization well equipped for that day. The material was brought into the small harbour at Passages, hoisted ashore, and transferred with astonishing speed to implacements in the sand dunes around the doomed city. A threat from France caused Wellington to re-embark all these pieces, even though the transports remained in the harbour. Less than a week later, everything was brought ashore and put back with a minimum of delay and no confusion. Enormous pairs of wheels drawn by great teams of oxen and assisted by gangs of skilled men could carry the biggest pieces slung beneath their axles, even through small streams and over soft sand.

San Sebastián had to be taken quickly; and besides, there was no chance of starving it out. Pamplona presented a different problem: it was enormously strong, but could not be resupplied from France except by a major field effort. Wellington and his engineers surrounded this bastion by a double set of earthworks which were garrisoned by Spaniards. Some of the vast quantity of French field artillery (nearly 300 pieces) taken at Vitoria was used to arm these fortifications. The French had to surrender one of the strongest places in Europe for a trifling price in Allied lives.

Throughout this entire offensive which ultimately covered more than 600 miles in ten months, British topographical engineers were making maps and gathering route data. Roads, bridges, and fords were being repaired, or even constructed from scratch. An excellent account by Schaumann, a German in the British Commissariat, tells of finding high up in the Pyrenees in the autumn of 1813, a gang of Spanish labourers under the direction of a British

Photo 7. A lonely section of "Chemin des Anglais". This road, cut in the Pyrenees under Wellington's instruction, made possible quick reinforcing and supply of the allied line

engineer cutting a new road suitable for transport in any weather. This road is still in use and called locally "Chemin des Anglais". Wellington never used a spadeful of earth to protect one of his regular soldiers in battle, but had hundreds of men working continuously on his communications.

Floating Bridge

The crowning achievement of the engineers under Wellington was the bridge across the Adour between Bayonne and the sea. This city was one of the most loyal in all of France to Bonaparte; it had been the main French supply base for their operations in Spain and Portugal and had to be taken or sealed off so that the Allied field army could continue its offensive to the east. Its position on both sides of a large river close to the ocean made operations against it most difficult. A floating bridge of some sort, properly defended, was one answer, but it would have to be at the mouth of the river to be out of range of French artillery on the walls. The Bay of Biscay is noted for heavy seas; there are regular 18-foot tides in this area. If a substantial bridge could be constructed there, it would not only cut off this Bonaparte stronghold from the rest of France, but also make possible easier subsistence of the Allied field army to the east. The road system north of the Adour was better than the south of it.

The usual light pontoons would not last even a few hours in these rough seas and high tides, but someone thought of using coasting vessels of about 70 tons instead. These ships were sailed across the bar at high tide when the wind was right. They brought in five great hawsers, timber spreaders, oak planking, capstans, and all the miscellaneous equipment needed for a structure sufficiently flexible to take the tidal changes and to withstand the waves from the Bay of Biscay, yet strong enough to carry siege artillery on travelling carriages drawn by oxen. The bridge was put together in hours and was in use

Photo 8. Site of the northern end of the Bridge of Boats across the Adour. The bridge was swung between the abutment, on which the author stands, and a similar one to the south

continuously until the end of the war in spite of strenuous French counter-efforts. Crews manned the capstans around the clock, for the hawsers changed their length with weather and stress, and had to be adjusted with the tide. The Adour bridge was the finest of its type ever constructed; it would be a difficult undertaking even today.

Military engineering was not so formal 150 years ago as today. Neither Wellington nor many of his staff had academic degrees. Their reading, informal training, and actual experience, however, were extensive. They used what they had to great advantage and excelled as practical engineers. They played a major part in the eventual victory.

Editor's note.

The following extract from Volume 1 of the *History of The Corps of Royal Engineers* describes the passage of the River Adour:—

The Passage of the Adour

Lord Wellington made his arrangements during the winter of 1813–14 for the prosecution of the war in France; and as a preliminary to that operation decided upon the siege of Bayonne, as soon as the weather became sufficiently open to enable him to act in the field.

In order to accomplish this, it was absolutely necessary that a bridge should be established across the Adour, although the difficulties attending such an operation were recognized as being extremely formidable. It was considered that such a bridge should be of sufficient stability and permanence to serve as the main line of communication for the army even after the reduction of the town, although, of course, its original purpose would be to facilitate that operation.

Bayonne is situated on the left bank of the Adour, at the point where the Nive flows into it, the distance to the sea being about four miles. After a careful reconnaissance, it was decided that the proposed bridge should be constructed between the town and the sea. A spot was selected, about two and a half miles from Bayonne, at a short distance below a bend in the river, which would to a certain extent screen it from the view of the garrison. At this point, the Adour had been embanked on both sides by high retaining walls, of a very massive character. The object of this embankment had been to increase the scour of the river, and if possible to sweep away the shifting sandbanks which formed a bar at its mouth, and rendered its navigation extremely difficult. This, however, it had failed to do, and at the time the construction of the bridge was decided on, the bar stretched away to the westward, rendering the crossing very dangerous, but to a large extent sheltering the river from the effects of the ocean swell. The rise of the tide was about fourteen feet at the springs, and on the right side the country in rear of the retaining wall was constantly flooded, and therefore extremely marshy. The breadth of the river at the point selected for the bridge was close upon 300 yards.

It was evident that in such a position the ordinary tin pontoons would prove utterly useless. The great width of the river, the current which at that time of the year ran with extreme violence from the rush of the mountain torrents, the opposing swell of the sea which often caused excessive agitation in the water, these difficulties united to render it necessary that stability should be combined with flexibility in the form the bridge ought to take. It was therefore decided to secure a number of the local coasting vessels, called *chasse-marées*. These ranged from forty to fifty feet in length, and being decked were of considerable strength. About fifty of them, with their crews, were hired at the ports of St Jean de Luz, Passages, and Socoa, at a daily cost of £125. The design for the bridge was as follows:—

The boats were to be anchored in a direct line across the river, at a distance of 30 ft apart from centre to centre.[1] There being an insufficiency of baulks to carry the superstructure, it was decided to use five 13-in cables in their stead. A stout sleeper spiked to the deck of each boat, running fore and aft, with five deep notches cut in it, at distances of 2 ft apart, would form a cradle for the cables. On the right bank they were to be anchored by being attached to 18-pounder guns. These being carried over the retaining wall, and dropped on the far side, would bury themselves in the morass, and thus give a good grip to the cables. On the left bank they were to be taken through double blocks attached to a framework constructed for the purpose, and hauled taut by means of capstans.

Lieut-Colonel Elphinstone, who was now Lord Wellington's Commanding Royal Engineer, had the general superintendence of the design, and carried out all the arrangements necessary for its execution. Socoa was made the point of assembly, and here all the stores necessary for the outfit of the boats were prepared.

Each *chasse-marée* carried its share of the superstructure of the bridge, together with an assortment of such stores and tools as seemed likely to be required during its construction. Five of the strongest and best boats were selected to form the central piers of the bridge, and on board these were

[1] The reason so many more boats were taken up than would be required to stretch across the river on this plan was that many casualties were anticipated in crossing the bar.

placed the five cables, so coiled that they could be payed out from both ends simultaneously.

When all was ready the flotilla was told off into five divisions, and placed under the command of Engineer officers as follows: Captain Slade took charge of the central division, Lieutenants Savage and West the two right, and Lieutenants Robe and Rivers the two left divisions. Lieutenant Reid was given the duty of securing the cables on the right bank, and Lieutenant Melhuish that of securing and hauling taut on the left bank. Two Sappers were placed in each boat to fix the sleepers and cut down the freeboard, so as to allow the cables to lie level when stretched. The construction of a boom, to protect the bridge from any hostile efforts on the part of the garrison of Bayonne, was undertaken by the Navy.

On the evening of 22 February, 1814, the flotilla put to sea from Socoa, escorted by a frigate, a brig, and five gunboats, the whole under the command of Admiral Penrose. Meanwhile, Lord Wellington had given orders that a passage across the river was to be forced, and the right bank taken possession of, in anticipation of the arrival of the flotilla and formation of the bridge. For this purpose six boats of the transports were to be conveyed, with eighteen pontoons, to the left bank, and two brigades, one of Guards and one of Germans, were marched to the river on the night of the 22nd. By morning only five of the pontoons and four of the boats had arrived, the road having proved very bad; but Sir John Hope, who had direction of the operation determined, nevertheless, to attempt the passage, as the remainder were hourly expected.

Burgoyne's Journal. "February 23rd. . . . The horses having had a few hours' rest, the whole of the pontoons were brought up, and collected under the nearest cover. The advanced party, of about fifty light infantry, was conveyed across by the six jolly boats. The French picket retired towards Bayonne. The six jolly boats continued passing reinforcements as fast as possible. Two rafts were constructed of three pontoons each; they could not be towed across by the small boats on account of the rapidity of the tide and their unwieldiness. A rope was therefore stretched across the river, and two or three turns made by the rafts at slack tide with some difficulty. At length the tide became very strong, and the raft, loaded with fifty men (with their packs, arms &c.), stuck in the middle of the stream, and could neither be got one way or the other till about 6 p.m., at slack tide. By the evening only one battalion of the Guards (about 600 men) and a few rockets were across. The enemy came out from the citadel side of Bayonne with about 1,200 men, and drove in our advanced parties, and advanced to very near our line. The battalion was drawn up near where they had crossed on the point from the river to the sea. On the advance of the enemy, with an apparent determination to attack, some guns were opened on them from the left bank, and the rockets fired very sharply on them from a short distance. They had great effect, and checked them completely. At night the enemy retired, and we continued passing troops, but very slowly. The rafts only took two or three turns at each slack tide. . . ." "February 24th.—By morning one brigade of Guards and one battalion of Germans only were across. The flotilla appeared off, but could not cross the bar. Our mode of passing the troops was so slow that it was necessary to try some other. We put four oars to each pontoon, and loading it besides with from twelve to twenty soldiers, they crossed well and quickly for about four hours of the six of each tide. Continued passing the troops by rowing them over in the jolly boats and pontoons, and to keep them going well obtained about 300 soldiers, who could row, to man them, formed three reliefs, and having a quantity of rum from the commissary, to give them half a ration before and after every tour of this duty, kept them going very well."

Meanwhile the flotilla was off the bar, but the wind had set in on shore with considerable violence, causing much surf and a heavy sea. To enter the river under such circumstances seemed extremely venturesome, and much difficulty was experienced in inducing, or rather in compelling, the native crews of the *chasse-marées* to persevere. In fact, but for the presence of the Engineer officers and Sappers, it is certain that none of them would have ventured to face the risk. As it was, thirty-four of them succeeded in passing the bar, and entering the river: two were lost in the attempt, and eleven returned to St Jean de Luz, having failed to cross. In one of the two vessels that were lost the Sappers on board were drowned with the rest of the crew. The other boat had safely crossed the bar, but was swamped by a sea as it entered the river. In this case the two Sappers succeeded in reaching the shore in a very exhausted condition.

Admiral Penrose, in his despatch of 25 February 1814, thus recorded his opinion of the services rendered by the Royal Engineers:—

"That so many *chasse-marées* ventured the experiment I attribute to there having been one or more Sappers placed in each of them, and a captain and eight lieutenants of Engineers commanding them in divisions. The zeal and science of these officers triumphed over the difficulties of the navigation, and I trust that none of their valuable lives have fallen a sacrifice to their spirited exertions."

As soon as the boats reached the spot selected for the bridge, they were anchored stem and stern in their places, the cables were payed out, secured, and hauled taut, and the superstructure laid down. The work was carried on so vigorously through the night that by noon on the succeeding day troops began to cross. Much difficulty was for some time experienced in keeping the cables sufficiently level, as they stretched under the strain of the weight placed on them. By degrees, however, this gradual expansion ceased, and it became possible to keep them fairly taut. Eventually, as baulks became available, they were fixed from boat to boat without disturbing the cable arrangements, and materially assisted in steadying the bridge. At times the violence of the swell made the vessels pitch so heavily that it was considered unsafe to cross: but the bridge was never broken or in any way injured by the action of the water. It continued to remain the principal line of communication for the army in France till the close of the war.

This work has been justly characterized by Sir W. Napier, in his description of the operation, as "a stupendous undertaking, which must always rank amongst the prodigies of war".[1] In fact, the very audacity of the project became one of the elements of its success. It was deemed so impracticable that the French made no effort to guard against it. They were consequently unable to offer any effectual opposition whilst it was being carried out.

[1] *War in the Peninsula*, Vol. vi. p. 94.

Sequel to Hurricane Hattie

By Captain N. H. Thompson, RE

Sappers returned to British Honduras last August to form the backbone of a construction force to rebuild the accommodation at Airport Camp, 9 miles from the city of Belize which was devastated by Hurricane Hattie in October 1961.

Very little of the original accommodation still stood, and temporary wooden huts served as sleeping quarters, messes and offices. The Company strength in the camp had recently been increased by a Garrison Headquarters Staff transferred from newly independent Jamaica.

The reconstruction project involved the building of barrack blocks, messes, offices and married quarters from Kingstrand Equipment produced by Coseley Buildings Ltd of Wolverhampton. The concrete bases for these were to be laid by contract before the arrival of the Sapper Troop. A swimming bath, complete new waterborne sewage system, roads, storage sheds and other buildings were also included in the overall project. These were all put out for tender by local contractors.

2 Troop of 20 Field Squadron was given more than its share of the squadron's building tradesmen and despatched to take on the Kingstrand part of the project. The troop numbered 34 in all including one officer and one sergeant. The Troop Commander's works responsibilities were to be very much like those of a contractor to the Superintending Works Officer from the War Office Works Department who controlled the whole scheme.

A very tight schedule had been specified, and as the project had been planned in a comparatively short time not a great deal was known about the particular problems likely to be encountered. Obviously the main ones to be expected were those of stores and labour, and this proved to be the case.

Technically the actual erection of the buildings was simple, and very soon an efficient procedure was worked out and adopted. Unlike many equipments the designs were not limited to one standard span; 10, 15, 20 and 25 ft spans were all used and there was similar flexibility in positioning of partitions and of course in length. This flexibility was one of the main reasons for choosing the particular equipment in the first place. The varied designs for the forty-four buildings meant that strict supervision of works was essential at all times.

Port facilities in the Colony were pitiful. Belize docks handled 3,000-odd crates from Coseleys alone, and many more for the other parts of the project. The ships anchored 2 miles out and all stores were cross loaded into lighters, and off-loaded by hand-operated crane on to a variety of ramshackle trucks. At the camp the Michigan LWT and manpower were the only means of lifting these stores around the site which stretched over about half a mile. Many of the crates weighed over a ton.

It was a great boost to the economy of the Colony when works started, and by the time full pressure was on 130 unskilled labourers and thirty tradesmen from the Public Works Department were employed on the Kingstrand project alone. This figure was easily doubled when those working on the other parts of the camp were counted.

Selection of these employees required only a little knowledge of the Colony and its people. There was no shortage of applicants ranging in age from 13 to 70 but the general standard was very low. Selection was made after a brief interview of the hopeful candidates each week. Pay started at £3 15*s* with increases for the conscientious and industrious. There were virtually no foremen or "gangers" to be had, and sappers filled these vital positions and were responsible for teams of up to a dozen locals. One hundred per cent supervision of all unskilled labour was maintained. A few of the better PWD tradesmen were the only workers who could be trusted to do a full day's work without someone goading them; these few were invaluable. Turnover of labour was rapid, but labour relations were generally good and the sappers thoroughly enjoyed exercising their responsibilities.

In the last two months help was given by the Company of the 1st Bn Duke of Wellington's Regiment who provided any men who were available from their Stand-by Platoon.

The Troop Commander was entirely responsible for the employment, dismissal, control, supervision and deployment of this large and mixed labour force totalling over 200. It was important to know the names and faces of all the Hondurans, and have a record of each man's exact job and the sapper he worked for. Every morning after reporting in they were collected by their "boss" who was then in a position to report anyone who disappeared. Pay was dealt with by the Executive Officer to the SWO.

The most ordinary stores, tools, and spares often became like gold. British Honduras is the end of the communications line. All too often delays of days, or even weeks occurred because of the lack of some small but vital item. Planned shipping schedules were far too tight in view of this, and consequent delays were most frustrating. Even air communications were not reliable, and local Customs and carriage procedures were unpredictable to say the least. Some special screws were 'lost' by the Customs for two weeks, brushes for power tools which were despatched from Jamaica never arrived, and other urgent packages were diverted through Guatemala. On several occasions the complete stock in the Colony of a particular type of tool was bought up by the AWO. Pilfering of tools by labourers was a perpetual problem and caused considerable trouble. It was not possible to make a complete search at the end of a day's work because there was no perimeter fence round the camp, only swamp and scrub.

The two visitors who came were most welcome. The Squadron Commander and a Director from Coseleys were both able to clear up many misunderstandings and queries. The Director arrived in time to sort out considerable stores difficulties and arrange the immediate despatch of the needs on his return to UK. This personal contact was of great value.

Health was excellent and the climate was not so fierce as had been expected. Maximum temperatures were only 95°F with very high humidity, and these dropped off to 75°F by December. Rain was a hindering factor, especially as it was considered dangerous by the locals to get wet. Even when there were plenty of indoor jobs the Hondurans made a point of getting stranded in the wrong building.

The average height of ground was only 13 ft above sea level and drainage was a major problem. The swamps which surrounded the camp varied in level, one of the closest being 2 ft above that of the camp. The area was so flat that sewage pipes had to be laid down to 11 ft and the sump of the pumping station was down to 14 ft, which was below sea level. In bad weather the open trenches filled to the top and unrevetted sides collapsed.

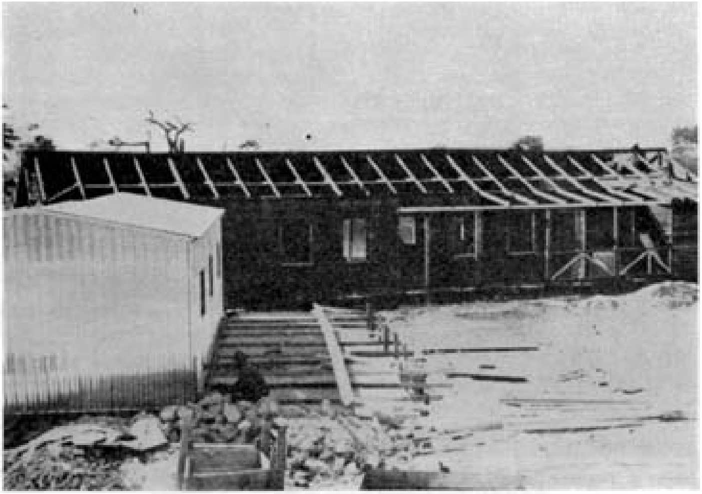


Photo 1. The Officers Mess of the old camp being demolished at the first opportunity while a Married Quarter is well under way almost on the same site

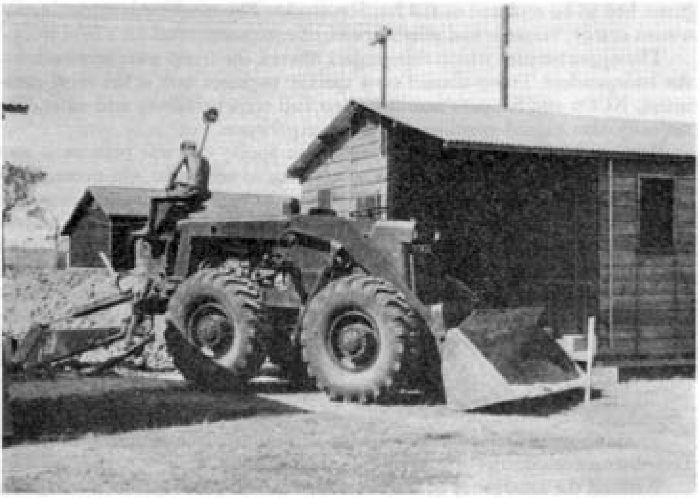


Photo 2. The Michigan trenching between huts. One end of this office had to be removed while the other part was still occupied before the new offices were complete

Sequel To Hurricane Hattie 1,2

Photo 3. The new Barrack Blocks, in blocks of four, with some of the older buildings on the right. The Airfield is seen in the middle distance

The Michigan and its operator were invaluable in trenching with the backactor, also levelling and clearing with the shovel. The machine was kept working throughout the 4½ months almost without a fault. The hydraulic hoses had to be replaced in the last few weeks. The machine is undoubtedly a most sturdy, versatile and reliable piece of equipment ideal for a field troop.

The opportunities which this project offered the troop were tremendous. An Independent Troop abroad on a specific engineer task is the ideal command. NCOs and Sappers assumed their full responsibilities and more, the majority also gained considerable trade experience.

Recreation was very limited especially in sport; this was because it was necessary to work very long hours to keep up to schedule. On average the sappers worked a 60-hour week including some weekends and two evenings per week. In a tropical climate this shows considerable stamina and determination to finish the task on time. Hours were arranged to coincide with the local labour times of work for obvious reasons. In spite of the pressure everyone saw something of the country including a trip to Mexico, another to the Guatemalan border and several visits to the Cayes, which are small islands just off the coast. The troop owned an old car and Belize was visited on most free evenings. A farewell dance held in Belize was a great success with 300 guests invited.

Summarizing the Project

Those things which affected works most were the communications, labour and obstructions on site caused by the existing camp.

Without the emergency of the hurricane and the priority which was given to relief the previous year the Colony had again become a backwater, especially in the field of communications.

Sequel To Hurricane Hattie 3

Photo 4. The inside of a Kingstrand building under construction showing partition frames and wiring

The work involved in erecting the buildings was more, and the technical skill greater than had been expected. The standard of labour was just as bad as feared and every source of tradesmen was tapped by the SWO.

Construction of a new camp on the site of an old one gives rise to many problems. In this case with a full complement of the Garrison in occupation every new building had to be 100 per cent complete before the corresponding old hut could be demolished. This in turn usually held up the works planned near the site of this old hut.

The Works command arrangement was most satisfactory. The relationship between the Superintending Works Officer and the Troop Commander was at all times excellent and there was the fullest co-operation.

The Kingstrand buildings themselves have so far proved very satisfactory both for climatic conditions and general military use in British Honduras. They have yet to be tested as hurricane-proof. The camp is attractive and comfortable. The variety of design is the most notable feature. The fittings outclass those of many modern houses.

Construction of Kingstrand is by no means the essence of simplicity and speed which its advocates might suggest. The basic shell is certainly simple. Lining and installing the electrical and plumbing systems needs tradesmen. Undoubtedly experience in handling the equipment counts for a great deal.

The troop's task was a most rewarding one. The squalor of the camp in August was changed to a reasonable standard of living by December when the troop departed, and this process continued as other aspects of the camp were completed. Certainly the Garrison in the Colony will have a comparative paradise to hand over when Independence is granted, whether it be in one year's time or ten.

Camp and the Squadron Commander

By Major B. R. White, TD, RE(TA)

Much has been written in recent months of the sudden and rapid movement of units from stations in the UK to centres of emergency in various parts of the world. The move of a TA unit to annual camp cannot be said to be sudden or rapid, but, nevertheless, the transition of 250 Northern Irish civilians into a reasonably operational unit somewhere in England is a feat not without its trials and emergencies which are not always fully appreciated by our brothers of the regular army.

The steps leading up to camp are slow and deliberate starting, as they do, with one letter in a clean file cover approximately twenty-one months before the date of camp asking for bids. The tempo increases as time passes, and by October or November of the year preceding camp the file is fairly thick and includes demands for stores and equipment required. This is augmented by copies of Camp Standing Orders, instructions regarding the drawing of rations and several lengthy treatises on the subject of pay, all issued by the Command it is intended to visit.

By March letters have gone out to employers asking them to release their men to attend annual camp, and it is about now that the OC decides to carry out his recce. The uncharitably minded view this as a pure "swan" as the OC usually knows the camp well, particularly if it is a bridging camp. However, the expedition is justified by the need to carry out a recce for the squadron exercise, and so four days are profitably and enjoyably spent by the OC and at least one other officer. It should be pointed out here that there is no Sunday sailing to Northern Ireland in March and camp regular staffs are only just prepared to be available on Saturday mornings. This accounts for the recce lasting from Friday night until Tuesday morning.

On return from the recce the OC can settle down to do two things. The first is to write a firm training programme, that is one which will not be altered more than three times before camp. This is certain to bring out the fact that all the stores and equipment required have not been asked for, and involves the Q staff in making out further demands accompanied by apologetic letters.

The second task is to go through the employers' replies and sort out the sheep from the goats. These replies can be in three forms:—

"Yes, for the whole period."

"Yes, for one week only" or

"No."

The first category can be filed away to await the influx of doctor's lines and individual excuses. The second and third categories demand more exhaustive action; has the individual approached his employer with a request to make him non-available, or available for one week only? If he can attend for one week only is it the right week? Can the employer not be persuaded to change his decision? And what does one do with Sapper Brown who employs Sapper Smith and refuses to release himself or his employee?

These problems are difficult enough when the unit camps by itself, but when accompanying Brigade, or when several other units share the same camping dates the situation becomes critical. All the bus drivers in the city are, apparently, in the TA, as are all the key staff of such undertakings as Gas and Electricity, and it is understandable that on these occasions some of the squadron cannot be released.

The third amendment to the movement order has by now been added to the file; berths on board ship have been booked; a band has been arranged to lead the squadron to the docks; all stores have been packed up and the advance party is ready to leave. It is at this time that the Unforeseen Factor appears. This is usually in the form of a national disaster such as a railway strike or a small-pox epidemic. With one week left before camp the OC is faced with a new recce of a local area, a new training programme and a completely fresh demand for entirely different stores. The surprising thing is that this deviation is usually worked out and organized in one evening, over a bottle of whisky, and shows much more promise of working smoothly than the original plan. Regrettably this has never been put to the test as the national disaster resolves itself at the eleventh hour. The advance party leaves and Phase I is complete.

Phase II begins with furious activity on the afternoon of the day on which the squadron assembles to go to camp. Baggage is dumped in troop dumps; the baggage party rounds it up and removes it and themselves to the docks; troop sergeants hold parades; troop officers hold parades; these are interrupted by pay parade following which an uneasy calm descends. Meanwhile the OC has been sitting glumly in his empty office gazing at a blank desk joined, from time to time, by such of his officers as are not engaged in holding parades, wishing that he'd had the good sense to stay away until much later and making such remarks as "Well, here we are off to camp again" and "Seems no time since last camp."

Time drags slowly by but finally the SSM falls in the squadron. As the OC intends to inspect the parade before it marches out there is another spate of troop sergeants inspections followed by troop officer's inspections. At last the OC is allowed on the parade ground. Up to this time he has not the faintest idea how many men he is going to take to camp and part of the time in his cheerless office has been spent in hoping he'd have a "decent turnout". On the parade ground he is overwhelmed by the size of his squadron. Men he hasn't seen since first interviews are there; men he doesn't ever remember seeing before are there. A hasty calculation to include advance and baggage parties assures him that he has indeed got a "decent turnout". Inspection over, the necessary orders are given; the band strikes up and the squadron marches out of the barracks to run the gauntlet of fond cries from admiring mums, wives and girl friends and the cheeky remarks of numerous small boys.

That is more or less the procedure when the squadron goes to camp on it's own, but once every three years the squadron camps with Brigade, and on these occasions the general melee multiplied fourteen times is so awful to contemplate that the OC hands over to his 2 i/c and leaves the night before "—to carry out a final recce of the training area."

Surprisingly, from the moment the squadron boards the ship it begins to resemble a military formation and to act as such. The fourteen days in camp usually go well and some useful training is achieved. Certain hazards, however, are present with each camp. These can roughly be classed as "How will the boys behave?" and "VIPs".

Fears as to the first are generally groundless and the squadron can revisit old camps with an easy conscience, but just occasionally odd incidents arise. Sappers from Northern Ireland are wont to look on cider as a kid's drink, and it is not surprising, therefore, when one of them finishes an evening on Guinness with a refreshing draught of Dorsetshire scrumpy, that he should wake in a police cell charged with several interesting and improbable offences. The outcome of these incidents occupies the Administrative Officer's time for quite a bit of Phase II and often spills over into Phase III.

Unfortunately, fears as to the second class of hazard are usually well grounded. Visiting VIPs include the GOC-in-C Northern Ireland Command, the Brigade Commander, the Engineer Group Commander, members of the TA Association, past OsC of the squadron, the Honorary Colonel and representatives of the command in which the camp is situated. It seems to be a rule that no two of these will visit at the same time and as a result the OC sees little of the training going on. It is inevitable, too, that some visits are on the least acceptable days of camp. A visit by the GOC–in–C Northern Ireland Command at 1100 hrs on the first day of camp and by the Group Commander on the last are situations not lightly met or easily forgotten.

With the end of camp comes the end of Phase II. Phase III begins on the penultimate day. All training has ceased and the day's occupation is the return of stores, those not so engaged being allowed out to shop for the presents their families are confidently expecting. The OC begins to feel unwanted again. A casual stroll into the Q store tent and an inquiry as to how things are going gains for him the information that amongst panel pins, transom clamps and lashings deficient there appears to be a size II dozer unaccounted for. Also the timber he wanted for an improvized bridge eight days ago has just arrived, and there are six RSJs awaiting collection in the local railway siding. Realizing that he should have had more sense than to ask, the OC commandeers the only remaining vehicle and drives into town to do his own shopping.

The final day of camp is the greatest trial of all. It begins so early as to make going to bed at all seem not worthwhile, and even earlier than that if a long train journey is involved. Batmen bringing tea round the officers' tents have to beat off the raids of the fatigue party detailed to collect and return officers' bedding. As the day wears on there are less and less places where one can sit down. For the squadron commander it is a day of sheer misery. He starts by packing up his own kit, wondering how it is possible to pack everything lying on the floor of his tent into the one suitcase and grip in which they came to camp. He is not helped by the fatigue party who have finally obtained entry and are noisily removing everything except the duckboards. Having packed his kit and issued orders to his batman as to its disposal he feels that it must be lunch time, only to find it is nearly 0900 hrs. Disconsolately he wanders round the lines to find that no one has time to talk to him. He tries to help by arranging some details with a member of the camp staff, but this turns out to be contrary to arrangements already made by his 2 i/c who is very annoyed. The OC comes to the conclusion that he should have gone home the night before and heads for the mess where he sits down to read the book he bought on the way to camp a fortnight earlier. He is barely seated before a fatigue party arrives to lift the carpet. Moving to another chair gains only a brief respite for now they are removing the furniture. He leans on the bar but the brewery men arrive to remove that. A kindly mess waiter points out that the dining tables and chairs are being left until after lunch, and it is there that his officers find him when they come seeking a mid morning coffee.

The morning improves after that for his officers are beginning to find that they too are in the way. Repeating an oft quoted statement that "it was the only thing that kept me from going mad in a transit camp at Port Swettenham" the OC produces his poker dice and a pleasant hour is spent with these and the unexpired portion of the day's liquor in the shape of the opened bottles the brewer would not take back. The remainder of the morning passes in happier circumstances when someone suggests walking down to the local for a drink before lunch. There is a danger, however, that a second farewell party will be held to follow the farewell party held the night before.

At sometime during the afternoon the OC regains contact with his squadron and is surprised to learn that:

(*a*) All training stores have been handed back, the only deficiencies being a broken boat hook and one transom clamp. (Where *was* that Size II dozer.)

(*b*) All accommodation stores have been returned, the only deficiency being one mattress. (Not the sort of thing that would fit in someone's small pack.)

(*c*) The camp has been handed over in good condition. He finds the squadron, with nowhere to lay their heads, placidly sitting round a pile of kitbags waiting for the buses to take them to the train or ship.

The journey home by sea is generally uneventful. The entire squadron goes to sleep as soon as they get on board. Even the officers retire after only two drinks and very little conversation. This is partly due to exhaustion and partly to a desire to present as normal an appearance as possible to the wives and mums awaiting their arrival at Belfast. The final problem of camp occurs in the morning when it is necessary to impress a reluctant baggage party to see unit baggage safely into the barracks, whilst the remainder of the squadron disperse from the docks.

The Squadron Commander, watching the last of his unit moving away, some in taxis, some in private cars, some with their families the junior members of which are already unwrapping their presents, contemplates the final stages of Phase III which await him; the writing of officer's confidential reports; deciding what to do with those who were absent without permission; the arranging of courses and attachments for those who were prevented from attending. Whilst these matters are being dealt with it is a sobering thought that Phase I of next year's camp is already nine months old.

The trials and emergencies of one camp are over. A reasonably operational unit of Royal Engineers has once more become 250 Northern Ireland civilians. The OC looks back over fifteen such camps and regretfully forward to his sixteenth and last.

Memoirs

COLONEL C. C. ADAMS, MC

Cecil Clare Adams was born in London on 4 March 1891, the eldest son of Percy Adams, a distinguished architect. He was educated at Winchester and the RMA Woolwich.

He was commissioned into the Royal Engineers on 23 December 1910. After completing his YO Course at Chatham he was posted to the RE Mounted Depot at Aldershot, whence he joined No 1 Signal Coy RE in February 1913.

In August 1914 he arrived in France with the BEF, his unit forming part of the 1st Division. He took part in the heavy fighting which ensued during 1914/15 until he was invalided to the UK in August 1915 due to ill health. For his services in France he was awarded the MC, and was mentioned in Despatches.

After a short period as Adjutant of the Depot Battalion at Chatham he was sent in November 1916 to the RMC Kingston, Canada as an instructor in Military Engineering. Whilst at RMC he was promoted Captain. After two and a half useful and interesting years at Kingston he returned to the SME Chatham, where he became an Assistant Instructor in Construction until October 1923.

Following a short period with the CRE London District he was appointed Adjutant to the 54th (East Anglian) Divisional RE. Shortly after his promotion to Major in 1926 he returned in September of that year.

From his earliest days as a YO at Chatham, Cecil Adams had always been a keen Mason, and it was through his connexions with Masonry that he was offered the post of Secretary to the Royal Masonic Benevolent Institution. This appointment he accepted on his retirement in 1926.

On the outbreak of hostilities in September 1939 he was recalled to the active list and was appointed DAAG (AG7) at the War Office. In 1940 he became AAG (Lieut-Colonel) AGI at the War Office and was later employed as AAG(AG14). In July 1943 he was promoted Colonel and became DDMP at the War Office, which appointment he held until he retired again in February 1945.

Cecil Adams was a well-known and well-loved figure in British Masonic circles, where his kindly and tactful handling of the Society's Benevolent Fund gained him many grateful friends.

In 1961 he relinquished his post with the Society, but remained an active and enthusiastic Mason until his death on 20 April 1963 after a short illness. A memorial service was held in St James's Piccadilly on 23 May 1963 at which a large number of distinguished Masons and other friends were present.

In 1917 he married Louisa Augusta, daughter of Alexander Kirkpatrick of Kingston, who survives him. There are two children, a son and a daughter.

H.A. J. de L.

LIEUT-COLONEL R. K. A. MACAULAY, DSO

ROBERT KEITH AGNEW was born on 26 March 1884, the eldest son of Mr and Mrs R. H. Macaulay of Belfast.

He was commissioned in the Royal Engineers on 17 January 1903, and passed through the School of Military Engineering at Chatham before being posted to Aldershot in the autumn of 1904. There he served with the 5th Balloon Section, renamed Balloom Company in 1905. On reorganization he became one of the staff of the Balloon School early in 1907, but left Aldershot later in that year to join 38 Field Company at Trawsfynydd.

From September 1908 until the end of 1913 he was at Gibraltar with 15 Fortress Company RE. During his last two years there he was also Regimental Acting Adjutant and Quartermaster. He then went to Chatham, where he was at first with D (Depot) Company and then with 2 Field Troop.

On 1 June 1914 he was appointed Adjutant, 1 Training Battalion RE, renamed Reserve Battalion in August 1914. On 24 January 1915 he left Chatham to become Adjutant 29 Divisional RE in the Midlands where the Division was mobilizing. In March they sailed for Alexandria and in April landed in Gallipoli. Macaulay took part in the Battles of Helles from April to June, in the Battles and Evacuation of Suvla, and in the final evacuation of Helles in January 1916. He was Acting CRE during June 1915.

He had been promoted Lieutenant on 1 September 1905; Captain on 17 January 1914 and Temporary Major on 7 June 1915. On 3 June 1916 he received a Brevet Majority for his services just after he was awarded a DSO in the *London Gazette* of 2 May 1916.

In March 1916 he accompanied his Division to France, where they concentrated on the Somme East of Pont Remy. On 24 July 1916 he was given command of 130 Field Company in 25 Division, and took part in the Battles of the Somme in 1916 and in the Battles of Messines and Ypres in 1917.

On 17 January 1918 he was promoted Major RE, and on 22 March 1918 he was appointed CRE 29 Division with the acting rank of Lieut-Colonel.

On 17 April 1918, 29 Division, which had been in the Ypres Sector since January 1918, was relieved by other divisions and ordered to embus for Merville. However, enemy attacks caused heavy casualties and communications between the CRE and his field companies was broken. Lieut-Colonel Macaulay had considerable difficulty in regaining control during the few days of the Battles of the Lys.

In September and October 1918 the Division formed part of II Corps of the Second Army in the final advance to victory, and fought at Ypres and Courtrai. A few days after the Armistice in November 1918 the Division marched to the Rhine crossing the old battle fields of Waterloo and Ramillies.

The Division remained in Germany until it ceased to exist by the middle of March 1919. Macaulay then became CRE Southern Division (formed from the 29 Division), Rhine Army. He was made a Brevet Lieut-Colonel on 3 June 1919 and, at the end of the year, returned to Chatham. In 1920 he passed through the Staff College, Camberley and was then appointed GSO2 in the Staff Duties Branch of the War Office. In March 1925 he joined HQ Eastern Command. At the end of the year he took command of 42 Field Company in Egypt and, while in this appointment, attended a course at the Senior Officers School, Sheerness.

Captain (director of Music) D.W Jones LRAM ARCH psm

In January 1929 he was promoted Lieut-Colonel RE and made CRE, Canal District in Egypt. In 1930 he returned to England and, by July, was appointed CRE Lancashire Area at Preston. On 1 January 1933 he was placed on the half-pay list, and retired on 1 July 1933. He died on 20 May 1963 aged 80 years.

CAPTAIN (DIRECTOR OF MUSIC) D. W. JONES, LRAM, ARCM, psm

CAPTAIN DAVID WILLIAM JONES, who was Director of Music Royal Engineers from November 1932 until January 1944, died at his home at Gillingham on 18 April 1963.

He was born on 1 February 1884 and began his Army career at the age of 14 as a Band Boy in the 1st Bn Northamptonshire Regiment. He obtained a certificate of merit at the Royal Military School of Music. He served with his Regiment in Burma, Aden and in India, becoming Band Sergeant in 1913. He was on active service on the Western Front with his Battalion throughout the First World War. In 1920, having graduated at Kneller Hall as a Warrant Officer Class I Bandmaster, he was appointed Bandmaster of the 1st Bn The Queen's Own Cameron Highlanders. In that appointment he gained diplomas at the Royal Academy of Music and the Royal College of Music and he also obtained the advanced certificate (psm) from the Royal Military School of Music, Kneller Hall.

He became our Director of Music on 15 November 1932, taking over the appointment from Captain Nevil Flux who had been Director of Music since March 1919. He was the first Kneller Hall trained Director of Music, Royal Engineers.

Shortly after taking up his duties he found the custom of wearing a sword with his frock coat an encumbrance when conducting at indoor concerts and the rules of the Band were altered, the wearing of the sword being restricted to outdoor occasions only. He was in command of the Corps Band at the funeral of King George V on 28 January 1936 and, although its performance drew favourable comment, the Band was mistaken for a Brigade of Guards Band on account of their bearskin head-dress. War Office approval was, therefore, sought for a change to the busbie and the Band wore that type of head-dress for King George VI's Coronation on 12 May 1937. On that occasion the Bugle Major's Mace, presented by Lieut-General Sir Ronald Charles, was used for the first time, replacing the Mace presented in 1889 by Major-General Dawson Scott.

On the outbreak of war in September 1939 the Band assisted the under-staffed Depot Battalion with the documentation of Reservists arriving in large numbers. The Band moved from Chatham to Ripon with the SME in 1941 and made frequent visits to units. Captain Jones retired in February 1944. By that time he had covered over 34,000 miles in tours with the Band since the outbreak of the war and played to Canadian, Australian and American troops in addition to countless RE units, including RE OCTUs for pass-off parades. The Band Concerts he gave reached a very high standard and Lieut-General John C. H. Lee, Chief Engineer of the US Land Forces, enthusiastically praised one he attended in 1942. On his retirement Captain Jones made his home in Gillingham and maintained for many years a lively interest in the Corps Band which he had served so well for many years.

Our sympathies are extended to his widow, son and daughter.

LIEUT-COLONEL R. E. STACE

RALPH EDWARD STACE was born on 9 December 1881. He was educated at Bath College and the RMA Woolwich, and was commissioned into the Corps on 8 August 1900.

After the usual courses at Chatham, and in submarine Mining and Searchlights at Portsmouth and Sheerness, he went to India and Aden in charge of seachlights in 1906.

In 1909–11, he undertook a full Electrical and Mechanical Course in the United Kingdom, and returned to Army Headquarters in India as Inspector of Machinery, and in charge of electrical work for the Army in India.

In 1913, he was selected for the Indian Mints, but in 1914 he volunteered for active service and was sent to Mesopotamia with a Searchlight Section of volunteers, raised by himself. He was with General Nixon's Army for the capture of Baghdad as E & M Officer, but, after the Battle of Ctesiphon, was in the seige of Kut, making and working trench mortars, laying land mines etc, and was taken prisoner by the Turks at the fall of Kut. He was twice mentioned in despatches.

He rejoined the Indian Mints in 1919, and in the next ten years designed and carried out the complete electrification of the Bombay Mint, and completed a large electrolytic silver refinery in Bombay, designed in collaberation with Messrs Johnson Matthey of London.

He served in the Home Guard on the South Coast in Sussex during the 1939–44 war, and died at Rustington on 11 June 1963 after a long illness.

The most kind and generous of men, Ralph Stace was at the same time unassuming and unambitious, and he had little use for the boastful and proud. A master of his profession, those who served under him admired and respected him, while those who were his associates after his retirement, valued his friendship very highly, and all surrended to his charm.

To those who asked, he gave; and to those who were in need, he gave help. There must have been many in India who took advantage of his kindness, but that was of no importance to Ralph, whose service was always for others.

He was twice a widower, and leaves no children. A.J.R.

Book Reviews

GENERAL OF FORTUNE

By Charles Drage

(Published by Heinemann. Price 30*s*)

The General of Fortune was a man named Frank Sutton who served in the Corps in the First World War. He won a Military Cross and lost an arm in Gallipoli, and later became a General in the Chinese Army. Only two other Englishmen have achieved that distinction: Charles Gordon who, by any standards, was an unusual person; a man named Cohen whom one may presume from his nickname, "Two-gun Cohen", to have been cast in an individual mould; and "One-arm Sutton", who was certainly what engineers would describe as a "one-off" production.

Born in 1882 or 1884—the dates in the *Peerage* and *Landed Gentry* differ—he was educated at Eton and University College, London, where he was awarded his Civil Engineering Diploma in 1905. He sailed for South America from Cardiff in 1906 with "a deep pity, not entirely unmixed with contempt" for those who toil daily to London to earn a living and whose only hope of change is the possibility of promotion in the Firm and the consequent privelege of travelling by a later train. Sutton never adopted such a life himself; but became a rolling stone in the grand manner—engineer, soldier, trader, inventor.

After being wounded in Gallipoli he became a brilliant but troublesome inventor in the War Office where he succeeded in provoking a row between Lloyd George and Churchill, in itself no mean achievement for a Staff Captain.

Between the wars he was a soldier of fortune in Bolshevik Siberia and China where he stormed the Great Wall, invented innumerable weapons, owned a famous race horse, made a fortune and nearly raised his Chinese master to the Imperial throne of China. The end of the story up to his internment in Hong Kong is sad but still spectacular. Sutton never did anything by halves.

His was a strange character; a mixture of energy, brashness, kindness, honesty and a neurotic streak that was his worst enemy. He was a devoted son, a loving husband and a true gentleman by the strict standards of his day. One cannot help admiring also the fortitude of his wife who followed him with admirable patience and endurance. Incidentally, he remained a very high class golfer, in spite of having no right arm.

The book is written in a straightforward enthusiastic way; making, your reviewer feels, little pretension to greatness, but none the less a well told tale. It is refreshing in these days of conformity to read of one who would not conform; and if the reader has a few hours leisure he may be sure of filling it agreeably by reading for himself "the fabulous story of One-arm Sutton". It is, indeed, fabulous; but it is well authenticated and written by an author who knew the Chinese background and has had access to letters, papers and other sources.

A good book in its own way.

M.C.A.H

ARMED FORCES IN PEACETIME BRITAIN 1918–39

By Robin Higham, Ph.D

(Published by A. T. Foulis & Co London. Price 63*s*)

Dr Higham tells us in a footnote that he served in the RAF "and enjoyed it", but now writes as an historian from Chapel Hill, NC, USA. It is not absolutely clear whether he writes as a British or American citizen—not that that makes much difference. The documentation is encyclopaedic in a manner that has come to be the fashion of the New World, but the style (omitting a few transatlantic lapses) is of the Old.

The book begins where World War I ended on 11th November 1918 and traces the fortunes of Britain's Armed Forces up to the outbreak of the Second War. All the old threads, so well known to a particular vintage of Regular Officers (now mostly retired) are brought from the warp and woof of history and examined again: the Dyer Incident in Amritsar, the Ten Year Rule, the Invergordon Mutiny, to mention only a few. They are studied objectively, quoting chapter and verse as reference. Moreover, the Author has not confined himself to dry-as-dust Command Papers; he has quoted freely from works depicting, if not the lighter side, at any rate the human side of the business. This makes the whole volume quite easy to read.

There are seven chapters and a general Conclusion, while each chapter dealing with a special branch of the history—Armed Forces and Civil Affairs, Reorganization, Disarmament, and so on—has a conclusion of its own. These chapters build up, as indeed the events did, to something of an inevitable catastrophe: Britain plunged into a war in 1939 that need never have happened; with Armed Forces that were ill equipped; with no very clear policy of what should be done; and certainly very little time in which to do it.

If the curious reader glances at the Conclusion first, your reviewer feels he will certainly be tempted to look at other sections of this work, and will end by reading it all from start to finish. Whether he will end with the feeling that many of the old mistakes are being made again; or whether he will end on a more confident note, depends mainly on how he views the contemporary scene. Certainly this book can be commended to anyone holding a position of responsibility for our affairs today. It will enable him to judge—dispassionately if he will—whether he is any wiser than his predecessors of a former generation, or whether he is just banking on muddling through as before.

M.C.A.H.

PRESTRESSED CONCRETE DESIGNER'S HANDBOOK

By P. W. Abeles, D.Sc (Vienna), MIStructE, FASCE and F. H. Turner, B.Sc(Eng), AMICE, AMIStructE, DIC

(Published by Concrete Publications Ltd. Price 28*s*)

As a designer's handbook, this publication has the primary aim of containing a large amount of prestress information and technical data for the practising engineer. Nevertheless, the author's have succeeded in including considerable detailed explanation, examples of design, and recommendations on design procedures, with the result that the book is also a valuable text book.

The first five chapters are concerned with materials, methods of prestressing, the behaviour of prestressed beams, types of prestressing steel, and losses of prestress. Although such information can be obtained from many other text books and technical reports, it forms a useful—indeed, essential—technological introduction to the book as a whole.

The next four chapters deal with the analysis of stresses and the design of beams, both at working load and ultimate load conditions, and many worked examples are included for the benefit of the reader. In the design of end blocks only the methods of Magnel, Guyon & Morsch, are described, and out of this limited field the last is especially recommended by the authors.

Further chapters in Part I cover the design of composite members, deflection, bending up of cables, shear, lateral stability, and statically indeterminate structures. Perhaps of particular interest are the final two chapters of Part I; the penultimate describes many applications of the use of prestressed concrete construction, and the last gives points of note in a prestressed concrete specification.

Part II of this book comprises forty-one design charts and data sheets to simplify the work of the designer. In brief, these charts contain the characteristics of various prestressing systems used in Great Britain, the USA, and on the Continent; properties and characteristics of wires, bar, and strand; losses in the steel in pretensioned and post-tensioned prestressed concrete; and properties of various types of sections met with in practice.

There has long been a need for a prestressed concrete design data handbook of the same kind as that already available to the reinforced concrete designer. This book should fill that need, and as such would be a most useful addition to the small, personal technical library held by every practising engineer involved in structural concrete design. J.R.J.

BASIC REINFORCED CONCRETE DESIGN, VOL II

By Chas E. Reynolds, BSc MICE

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

Vol I of this text book, which covers the elementary principles of design and properties of materials in Part I, and the design of foundations and simple structural members in Part II, has already been reviewed in a previous edition of the *RE Journal*.

Vol II, consisting of Part III of this text book, goes on to consider more complex structures, and is entirely complementary to the first.

The book begins by devising relevant formulae for the properties of, and primary stresses induced in, irregular sections. These formulae are then simplified for the various regular or symmetrical sections more generally used in structural concrete design. The author then goes on to consider secondary effects and combined stresses in members, covering the theory of cases such as combined forces and moments, curved beams, torsion, temperature changes, shrinkage, and so on.

By far the greater part of the book, however, is devoted to design considerations of many types of structure commonly met in civil engineering practice. Floors and flat roofs are dealt with in some detail, although only a small section is devoted to the increasingly popular yield line method. Hinged and fixed arches, single and multi-storey building frames, simple cylindrical and rectangular containers on the ground, and simple cantilever and counterforted retaining walls are dealt with fairly comprehensively, short design examples being worked out in most instances.

The chapter on non-planar roofs, however, is restricted to only the simplest cases of prismatic, cylindrical, and domical construction.

This volume concludes with a survey of some complete structures. Design considerations of each are discussed briefly, with the intention of stimulating the reader to appreciate the finer points of design when reading technical articles and books describing specific instances of construction.

Basic Concrete Design, Vols I and II are largely complementary to one another, and together form a reasonably comprehensive guide to reinforced concrete theory and design practice. As such, they should be a part of any technical library, and are a worthwhile purchase for any aspiring young engineer. The experienced practicing engineer will find little in these volumes that he does not either already know, or can find from the author's well-known and extremely popular *Reinforced Concrete Designers' Handbook*. J.R.J.

CONCRETE BEAM STRUCTURES

By E. Shepley BSc (Hons), MICE

(Published by Concrete Publications Ltd. Price 12*s*)

As in the first edition in 1942, this book comprises a collection of useful methods for the rapid determination of continuous beams and redundant frameworks. Errors in the first edition have been corrected and the layout of the book changed into a more acceptable form where thought necessary.

Basically the book describes two methods of rapid analysis; the Hardy Cross moment distribution method, and the more recent method of degree of fixity.

The first three chapters describe the degree-of-fixity method for symmetrical and non-symmetrical loading conditions. This method has the advantage of giving a precise solution directly, although it is always arguable that in design so many parameters are unknown that a precise solution is unnecessary anyway. Some useful tables, graphs, and examples are included to minimize the mathematical drudgery that so often occurs in indeterminate structure analysis, and a theoretical derivation of the method is given in an appendix.

The next two chapters set out the well-known moment distribution method of analysis. Multi-span beams, single storey frameworks, and multi-portal construction under symmetrical loading conditions, are considered. At the end of this section a hybrid method, using the degree of fixity method to find beam constants and moment distribution for fixed-end conditions, is developed.

The effects of sway and settlement of supports in continuous beams are well considered over a further two chapters, and at this stage the author makes some pertinent suggestions as to the superiority of one method of solution over the other in each of the many types of indeterminate problems likely to be met.

The final chapter gives illustrations of thirty-six types of loading conditions on beams. This data is perhaps common to every textbook published, but nevertheless the layout of the various bending moment diagram solutions to these loading conditions is exceptionally neat and easy to follow.

The analysis of redundant structures is such a familiar problem to all practicing engineers that few will need reminding of the various methods of solution available to them. However, for those engineers whose work requires only spasmodic recourse to analytical solution of structural frameworks, this book should be a useful reference.

Although primarily a concrete publication, the methods of analysis described in this book are, of course, equally applicable to welded steel structure design. J.R.J.

INTERNATIONAL SERIES OF MONOGRAPHS IN AERONAUTICS AND ASTRONAUTICS, VOLUME 3

THE BUCKLING OF PLATES AND SHELLS

By H. L. Cox

(Published by Pergamon Press Ltd., Headington Hill Road, Oxford. Price 40*s*)

This is a short treatise on the buckling of flat plates and of cylindrical and non-cylindrical shells. It is of general engineering application and not particularly devoted to aeronautical aspects. The book is valuable because it seeks to summarize the extensive bibliography on this subject, and to show the relationship between the various theoretical approaches made in the literature. It attempts to present the theory in such a way that practical use can be made of it, and this is achieved.

In this subject it is not difficult to develop the theory of buckling, based for example on energy considerations, but in order to arrive at an expression which is useful in the practical application of the theory, and is not too complicated to handle, simplifying assumptions are usually necessary. The author is at pains to show how far it is safe to make these assumptions, and he is clear and readable especially on this aspect.

In general, when the stability problem has an accessible solution it may be solved from the differential equations using the boundary conditions, or by the principle of minimum energy. The accuracy of the result depends entirely on the judicious choice of the assumptions. Both methods have advantages, but the energy method is the more straightforward. The author devotes most of the book to this method.

The behaviour of a flat plate before and after buckling is first discussed with simplifying assumptions, and finally with the effects of normal pressure distributed in a possible buckle pattern, together with the effects of initial irregularities taken into account. Examples of application of the Rayleigh-Ritz and Lagrangian multiplier method are given as applied to various modes of restraint of a rectangular flatplate. The buckling of a long plate under shear and combined loading is considered. The behaviour of a plate after buckling is then developed, again by energy methods, and finally the effects of initial irregularities are applied. Adequate practical conclusions are drawn from the theory as far as it goes.

The Euler buckling of thin cylindrical shells is next considered with suitable assumptions; the effects of axial loading, internal or external pressure and initial irregularities are considered for shells of various sections. The wave forms developed at the various stages of buckling are analysed. Finally, the stability of shells other than cylindrical is considered. Complexity of theory suggests that special cases only should be dealt with in this small book, and the conical shell with small apical angle and shallow spherical shell are examined.

A useful bibliography is included. G.C.S.M.

FRICTION AND WEAR IN MACHINERY
VOLUMES 11 and 14

PUBLISHED 1956 AND 1960

TRANSLATIONS FROM THE RUSSIAN EDITED BY G. HERRMANN

(Published by Pergamon Press Ltd., Headington Hill Road, Oxford.
Price 70s each)

These are a continuation of a series of translations of corresponding Russian volumes, which were begun with Volumes 12 and 13 and will eventually include Volume 15 and possibly other future volumes.

The translation and publication work was undertaken upon the initiative of the Research Committee on Lubrication (RCL) of The American Society of Mechanical Engineers, with the aid of a grant from the National Science Foundation.

The volumes consist of a number of separate studies by Soviet scientists relating to certain problems of friction and wear in machinery; the possession of all volumes is not, therefore, essential.

These advanced studies are not suitable for students, but designers and lubrication specialists will find plenty of information to interest them.

The studies range over the wear of metals and alloys due to abrasion in respect of mud pumps, water economizer tubes and railway wheels; the resistance to wear of enamel coatings and stainless steels; the change of structure and composition of surface layers of steel under the action of compressed gases at high temperatures; the determination of true contact areas, the porosity of chromium plating, and the anti-friction properties of bronzes and brasses, the origin of "white crust" formation, and motion studies of journals in bearings.

Each article is laid out in the same pattern. The problem is introduced, the equipment developed and used for laboratory investigations is described, details of tests made and results found are expounded, inferences are drawn, and finally specific recommendations are made for adoption by Soviet engineers. The studies are illustrated and contain a large number of figures, tables and graphs in support of the text.

Each volume contains some Russian bibliographical abbreviations, a transliteration of Cyrillic characters, and a large bibliography of international publications on the subject matter and lubrication.

The volumes are printed on good quality paper but, unfortunately, are provided with paper covers which could be easily torn.

When examining the equations, figures and tables readers would be well advised to remember the Editor's Note "that decimal points are replaced by commas and vice-versa". F.T.S.

THE INTERNATIONAL ENCYCLOPEDIA OF PHYSICAL CHEMISTRY AND CHEMICAL PHYSICS TOPIC I. MATRICES AND TENSORS

By G. G. Hall, MA, BSc, PhD

(Published by Pergamon Press, Headington Hill Hall, Oxford. Price 24*s*)

The complete Encyclopedia is a comprehensive and modern account of all aspects of the domain between chemistry and physics. Its subject matter is published in some twenty groups (General Topics) each having its own Editor. The work consists of about one hundred volumes, each volume being restricted to around two hundred pages and having a large measure of independence.

The book under review is Volume 4 of the Mathematical Techniques Group, and the author is Professor of Applied Mathematics in the University of Nottingham.

The aim of the book is to serve the needs of graduate chemists, physicists or engineers.

The five chapters of the book cover the theory of Vectors, Matrices, Linear Equations, Eigenvalues and Eigenvectors. Each chapter is laid out in a manner which will assist research beginners facing numerical problems to obtain enough background knowledge to enable them to follow through into the study of more specialized textbooks in order to solve their problems. The basic definition of each entity is given in detail, and its nature studied and manipulated in order to derive the mathematical properties needed in research application.

A number of exercise problems are given at the end of each chapter to illustrate the application of the text.

A list of text-books for further reading is included.

The book is easy to read, excellently produced and well bound. F.T.S.

Technical Notes

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, March 1963

Muskeg and the Quebec North Shore and Labrador Railway: This railway, 360 miles long, was the first surface transport route of any kind to serve the interior plateau of the Labrador—Ungava peninsula, a region of unnavigable rivers and rugged terrain with extensive areas of muskeg, and with a mainly sub-arctic climate. This concise and factual paper gives a clear picture of the engineering problems involved, and outlines the methods used in location, construction, and maintenance, and it is also a well deserved tribute to the skill and resolution of the engineers concerned.

Pollution control: This issue contains four short papers which were read during a panel discussion on "Industrial plant pollution control", a subject of rapidly increasing importance in all highly developed countries.

"*A pollution policy*" starts with a broad definition of the term "water pollution" and a clear exposition of the practical limitations of the BOD test. The measures undertaken by pulp and paper mills to improve mill effluents are described, and the author appeals for co-ordination of effort by municipalities, industry, and individuals.

"*Government's role in pollution control*". This paper develops the theme of co-ordination of policy and standards between government, both central and local, and industry. It includes examples of the need for co-operation at various levels, emphasizes the importance of research, and discusses briefly the aim and nature of control measures.

"*Results of a co-operative approach to a water survey*". The beneficial results of industrial collaboration are shown by this report of surveys undertaken by a voluntary Industrial Association formed to combat air and water pollution in a complex industrial area.

"*Industry's viewpoint on industrial water*". This author rounds off the symposium with an account of the work of a committee, set up by the Quebec Division of the Canadian Manufacturers' Association to study the subject of legislation for water pollution control. He cites evidence to show that responsible industry is keen to co-operate with a representative control authority, and records the principles of control enunciated by the committee in question.

PRODUCTIVITY AND ECONOMIC GROWTH: Much has been said and written about increased productivity, technological development, the importance of research, and the need for improved education and retraining. This paper contains facts and ideas that will clarify and stimulate individual thought.

THE DESIGN AND CONSTRUCTION OF A 345 kV TRANSMISSION LINE: Although of somewhat specialist appeal, this admirably set out and clearly illustrated paper includes many points of general interest to engineers. The conclusion reached is that guyed structures, commonly used for many years in Finland, are likely to be used increasingly in high voltage transmission lines in place of rigid type towers.

Notes from *The Engineering Journal of Canada*, April 1963

This issue is concerned mainly with programme details of the 1963 General Meeting of The Engineering Institute of Canada, with an interesting synopsis of the technical papers to be read and discussed. It also contains two papers which are well worth reading.

AN EXPERIMENT WITH OPERATIONAL PLANNING: Though it introduces nothing new in the way of technique, this description of properly planned control of rolling stock, during seasonal fluctuations of demand, shows how efficiency and economy can be improved by careful analysis of an apparently intractable problem. The study of available records, the collation of current data, and intelligent forecasting and control achieved a saving of 32 per cent in empty wagon days during the first traffic season after the introduction of a new system—an example of sound organization.

SPACE RESEARCH AND THE NATIONAL RESEARCH COUNCIL OF CANADA: Because of her geographical position Canada is ideally adapted for rocket sounding of the upper atmosphere, and this description of the scientific and engineering background of the NRC programme of experiments includes a lot of interesting information. Rockets are eminently suitable for obtaining measurements of the chemical composition and physical state of the upper atmosphere up to heights of about 125 miles, less than those which can be maintained by a satellite, and they will add much to man's knowledge of the earth's environment.

Notes from *The Engineering Journal of Canada*, May 1963

PERFORATED BREAKWATER-WHARF AT BAIE COMEAU: This paper is written in French, and it contains some terms not to be found in the ordinary dictionary. The principle described is not, however, difficult to understand. The structure described is 1,000 ft long, and is made up of nine rectangular reinforced concrete caissons, end to end. Circular perforations in the outer face allow the structure to fill and empty under the action of waves and swell, and this dissipates the energy of the advancing wave and reduces undertow and consequent erosion at the base. Under storm conditions it was found that, although normal solid breakwaters suffered damage, and heavy equipment on their surfaces was displaced, steel bars, timber baulks and light beams lying on the half-built new-type structure were not swept away.

DIAGNOSIS OF DISTRESS AND FAILURE IN STRUCTURES: This is a plea for the release to the profession of factual reports on engineering failures. As the author says, engineering practice depends not only on the application of scientific principles but also on the accumulation of successful experience, and he goes on to suggest that records of unsuccessful experience could prove even more valuable. He cites a comprehensive and most interesting range of serious failures, both during erection and after a period of years, many of them due to no error of design but to misinterpretation, faulty workmanship, or the incidence of unforeseen conditions. This paper should not fail to interest any practical engineer.

EDUCATION OF ELECTRICAL ENGINEERS: This is another French article with some unfamiliar phraseology, but it is not a technical dissertation. The author considers the broadening basis of knowledge required to enable the electrical engineer of the future to fulfil his professional function, and he writes as an individual who is "part scientist, part technician, and part professor".

SIMPLE READING MACHINES FOR THE BLIND: There is as yet no machine which really enables the blind to read direct from the printed page, but this paper summarizes different methods under trial, and the present state of research and development. The aim must, of course, be to produce a simple machine costing less than a paid reader, and one which does not involve a long and tedious period of training in interpretation. There is here a substantial challenge to the medical and engineering professions.

MAGNETOHYDRODYNAMIC POWER GENERATION: Ever-increasing demands for electrical energy have stimulated research into unconventional power generation. Conventional generators are based on the principle that an emf is induced in a solid conductor moving through a magnetic field: the concept of magnetohydrodynamics involves the motion of conducting gases, seeded with ionizable material, in the presence of magnetic fields. This somewhat technical paper sets out the basic principles of MHD generation, and summarizes the practical problems of this method of generation without moving parts. R.P.A.D.L.

THE MILITARY ENGINEER

MAY–JUNE 1963

"FALLOUT PROTECTION AT MILITARY INSTALLATIONS", by Colonel J. A. Smedlie, Corps of Engineers. A short account with construction details illustrated with photographs and diagrams of fallout shelter projects being constructed by the Chicago Army Engineer District at several military installations. The projects include shelters incorporated in the design of new buildings, both above and below ground; separate underground shelters; and shielding of existing buildings by construction of protective covers. The projects described represent initial efforts to protect the key personnel from radioactive fallout at military installations that must remain operational in the event of nuclear attack. It is not considered that they provide the final solution but they do represent the optimum balance between funds and operational mission with due consideration to given data concerning radioactive fallout.

"TRACING SEDIMENT MOVEMENT WITH RADIOISOTOPES", by R. S. Cummins and L. F. Ingram. For the past two years the Army Engineer Waterways Experimental Station has been conducting tests using radioisotopes for the tracing of sediment in rivers and harbours. The object is to trace the source of the sediment tending to silt up harbours and waterways so as to get guidance on the measures necessary to curb it.

The method followed is described in some detail with photographs and the results of various tests carried out, with charts of the harbours concerned, are given.

"DESIGN WITH THREADED NAILS", by E. George Stern. A brief article explaining the advantages to be gained by the use of threaded hardened-steel nails and spikes in structural design with wood. Illustrated with a table of allowable withdrawal and lateral loads for various sizes.

MILITARY ENGINEER FIELD NOTES

AVLB RAFT, by Captain Geoffry F. Blume, Corps of Engineers US Army. With a few modifications the 24 ton pneumatic floats from the M4T6 or Class 60 bridge sets can be used to support the Armoured Vehicle Launched Bridge (AVLB) providing a raft operational in forty minutes or less. This is a brief note giving technical details illustrated with photographs. Following it is an article "Instant Bridge" describing tests carried out in Germany.

"INVENTORY OF FREEWAYS BY AERIAL PHOTOGRAPHY", by Thomas N. Tamburri. Describes the uses to which vertical air photographs at a scale of 1-in to 200 ft of roads can be put by Traffic Engineers, planning engineers and for maintenance. The original idea was produced by the California Division of Highways and was intended to provide an inventory of most of the free ways in the State. It has proved so useful to so many people that the cover is being extended. This article, which is illustrated, describes the value of the survey to many different authorities.

"THE SOLAR DISC" by Guy W. Forney. The Solar Disc is a simple device which makes it possible to sight the centre of the sun's image directly by placing the image concentrically in a small circle drawn on a disc. This short article describes the apparatus and the method of using it.

"NAVY CRANE MOMENT INDICATOR", by John J. Bayles. This is a description of a system which has been developed by the Naval Civil Engineering Laboratory which provides a positive means of preventing the overloading of cranes or of warning the crane operator of an approaching overload condition in time to prevent an accident. There are photographs and diagrams.

"NUCLEAR POWER PLANT FIELD TESTS". In the March–April 1963 issue of the Military Engineer two new military portable nuclear power plants, the PMI (Air Force) and PM-3A (Navy) were described. Field Tests of the two plants have been conducted by the respective services and the results of the tests, their purposes and results are summarized in two reports by officers of the civil engineer branches of the two services concerned.

"NAVY MOBILE POWER RESERVE", by Lieut-Commander William D. Middleton, Civil Engineer Corps, US Navy. The Navy Mobile Power Reserve is a pool of mobile units maintained by the Bureau of Yards and Docks to provide emergency utility service to military installations throughout the world. The article describes the installation of a 10,000 kW mobile steam-electric generating plant to provide temporary shore power service for the first nuclear-powered aircraft carrier, the USS Enterprise at the Norfolk (Virginia) Naval Station. In addition there is a summary of the various mobile power units maintained by the organization.

"SALVAGING RIGID PAVEMENTS IN GEORGIA", by W. F. Abercrombie. The author is State Highway Materials Engineer of the State Highway Department in Georgia. In this article he discusses the experience he has had in the rehabilitation of old pavements. After describing the problem he goes on to recount the various methods tried out. Although the conditions of each project vary generally speaking he concludes that if a pavement is broken excessively it should be removed for the full depth and replaced with other material; and that a cement stabilized stone mixture, of which he gives the specification, is an economical material to use.

"GEOLOGY STUDY FOR NAVY PIER CONSTRUCTION", by John B. Stetson. In San Diego, the only satisfactory location for the new nuclear submarine facility was menaced by known earth movements. This article describes the methods employed to study these movements so that the best siting of the new piers could be selected. There is much technical detail given and there are photographs and diagrams in illustration.

J.S.W.S

CIVIL ENGINEERING

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

THE BUILDING OF NEW DISCOVERY HOUSE. New Discovery House is a combined hostel and hospital block built on the island of South Georgia in the Antarctic as a transit centre for scientists. The site conditions were extremely severe there being no building materials, plant, labour nor accommodation available on the island and extreme weather conditions with winds up to 120 m.p.h. and an almost continual drizzle during the short construction season. It is interesting that timber was chosen as the most suitable material in such conditions.

THE MARACAIBO BRIDGE. Describes the construction of the Maracaibo Bridge which has been built to connect Caracas and Maracaibo in Venezuela. The bridge is 5½ miles long, consisting of 135 spans and carries a four-lane motorway. In the construction, pre-cast pre-stressed concrete members were used wherever possible.

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

INFLUENCE COEFFICIENTS FOR BEAMS RESTING ON SOIL. In foundation design, the problem of the evaluation of the structure-soil contact pressure is often avoided by assuming a linear distribution of pressure. Alternatively, empirical formulae are used to give approximate values of the contact pressure. This article compares some of the different concepts on which the theories governing the distribution of pressure are based. It then describes the evaluation by a computer programme of a set of coefficients by which the contact pressures under flexible strip footing loaded with point loads can be found.

BUILDING A ROAD BRIDGE OVER A FUTURE CUTTING. A new three-span bridge is being constructed to carry a road over a railway cutting in Staffordshire. As the railway cutting does not yet exist the bridge is being constructed at its finished level on the existing ground. The piers and abutments consist of 3 ft 6 in diameter bored in-situ piles. Where the piles will eventually be exposed, cardboard tubes are used to line the holes before concreting. The cardboard tubes will eventually be removed to expose the concrete columns. One other interesting item is that the parapets are being constructed of glass fibre reinforced plastic.

ELECTRO-OSMOSIS AND CIVIL ENGINEER. There has been a great deal of interest recently in the use of electro-osmosis in de-watering. This article describes the use of electro-osmosis in preventing damp in buildings. Many buildings constructed a generation ago had poor quality DPCs which are now ineffective. By the method described in this article a waterproof membrane is formed round the foundation of the building. This is achieved by injecting a bentonite suspension into the soil around the building and causing a flow towards the building. The resulting gel seals off the building from "rising damp".

SOME ASPECTS OF THE PROBLEMS OF SHEAR REINFORCED CONCRETE BEAMS (Part 1). In the design of reinforced concrete to CP 114, where the concrete is incapable of carrying the whole of the complementary tension stress resulting from shear, this stress is catered for by bending up bars or by using stirrups. However, the maximum value of complementary stress allowed even with reinforcement is limited by limiting the maximum nominal shear stress (Q/bd) to four times that allowed with no reinforcement used to resist shear. Tests carried out by the Building Research Station indicate that the effects of the complementary compression are more serious than previously thought and that the four times rule is over-optimistic. The article also discusses the relative merits of vertical and inclined stirrups in reinforced concrete. It also describes tests on stirrups and links formed from high tensile steel. High tensile steel is rarely used for stirrups due to the loss of strength when subjected to concentrated loads and bent to small radii. The tests indicate that the reductions normally applied may be somewhat severe.

THE CONSTRUCTION OF BALDERHEAD RESERVOIR. The Balderhead Reservoir in Yorkshire will be formed by an earth dam 157 ft high and 3,000 ft long containing 3,000,000 cu yd of fill. The cut-off trench, up to 83 ft deep is filled with concrete. A grout curtain down to a maximum depth of 100 ft below the trench has been formed. This dam will be one of the largest in the British Isles. It was started in 1961 and is due to be completed in 1965.

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

DIRECT MOMENT DISTRIBUTION FOR RIGID FRAMEWORKS. This is the first of a series of articles which will outline a method by which the real stiffnesses of members in rigid frameworks can be determined and hence the real distribution factors can be written down. The advantage of the method is that it eliminates carry over of moments and thus shortens the work involved considerably. This article deals with "Structures without Sidesway" and later articles in the series will deal with Sidesway and Instability problems.

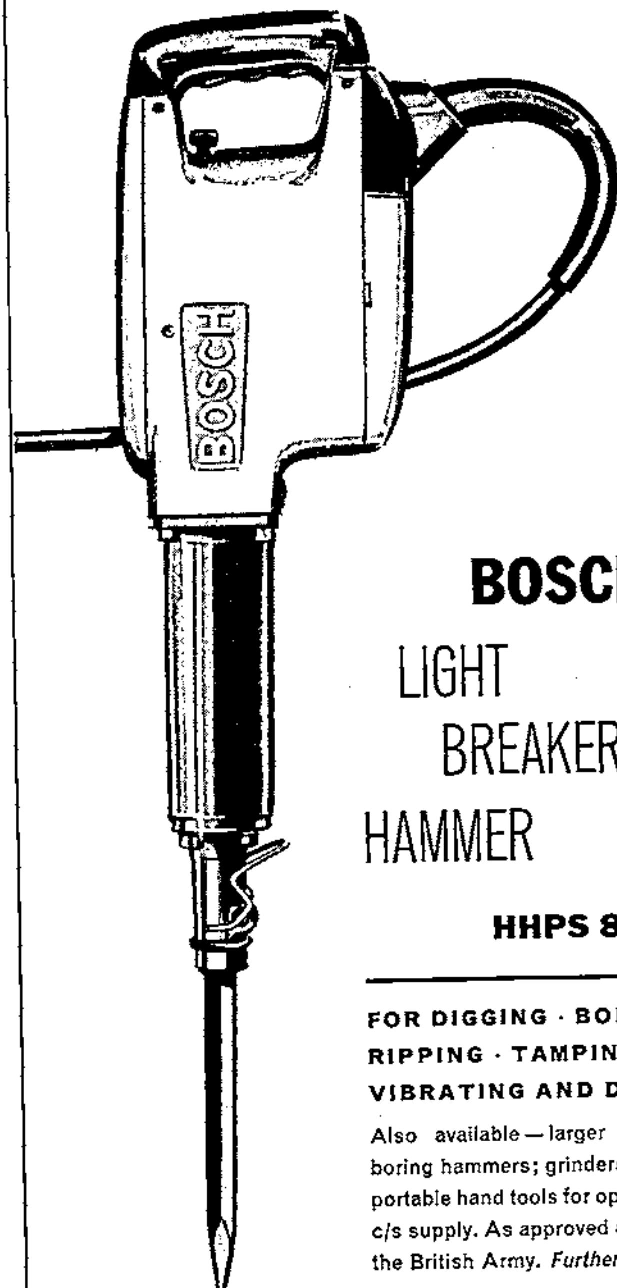
THE LOWER SWANSEA VALLEY PROJECT. The Lower Swansea Valley project covers an area of some 1,200 acres of derelict industrial ground, in the Lower Valley of the River Tawe, about half a mile from the city centre of Swansea. The project is being carried out by the University College of Swansea, and involves six university departments. The interest in the project lies mainly in the fact that an educational establishment is working, probably for the first time in this country, in conjunction with the local authority, on a project outside the University but of great local concern. They are thus pioneering a partnership which could be well developed in other parts of the country to the advantage of all. This article is concerned with the contributions made to the project by the Civil Engineering and Geological Departments of the University.

LOW COST BRIDGE CONSTRUCTION OVERSEAS. The Al Makin Bridge is situated at Dubai, some 250 miles from Bahrein in the Southern half of the Persian Gulf. It has five spans of 100 ft with a twin lane 24-ft carriage way and crosses the Dubai lagoon with a clearance of 22 ft above high water. The main item of interest is that, because of the remoteness of the site, the main features of the design and method of construction were largely determined by the items of plant already available in the area. These consisted only of one pile driving rig and hammer, one excavator, one face shovel, one crane, one vibrating roller, two concrete mixers, one 5-ton lorry and two pontoons. In spite of these limitations an interesting and serviceable structure was produced and the article thus provides a useful record of an economical project.

SHEAR IN REINFORCED CONCRETE BEAMS. This article is the second of two on this subject, and deals with the particular case of T beams. After discussing the results of various tests in which both different arrangements of reinforcement and manners of applying the load were compared, the author draws attention to various questions still awaiting solution before the problem of shear in reinforced concrete can be fully met.

SOME SYSTEMS OF PREFABRICATED CONSTRUCTION. The combination of the need for increased production of dwellings, rising costs and a decreasing labour force has resulted in a move away from traditional construction towards prefabrication techniques. This article, which is the first of two, surveys various systems of prefabrication construction at present available in this country. The range covers systems suitable for both single and multi-floor construction, factory and on-site manufactured components and a wide variety of materials. Finally the problem of adopting an agreed module is discussed with a brief summary of the organisations backing the two alternative proposed systems.

D.F.M.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