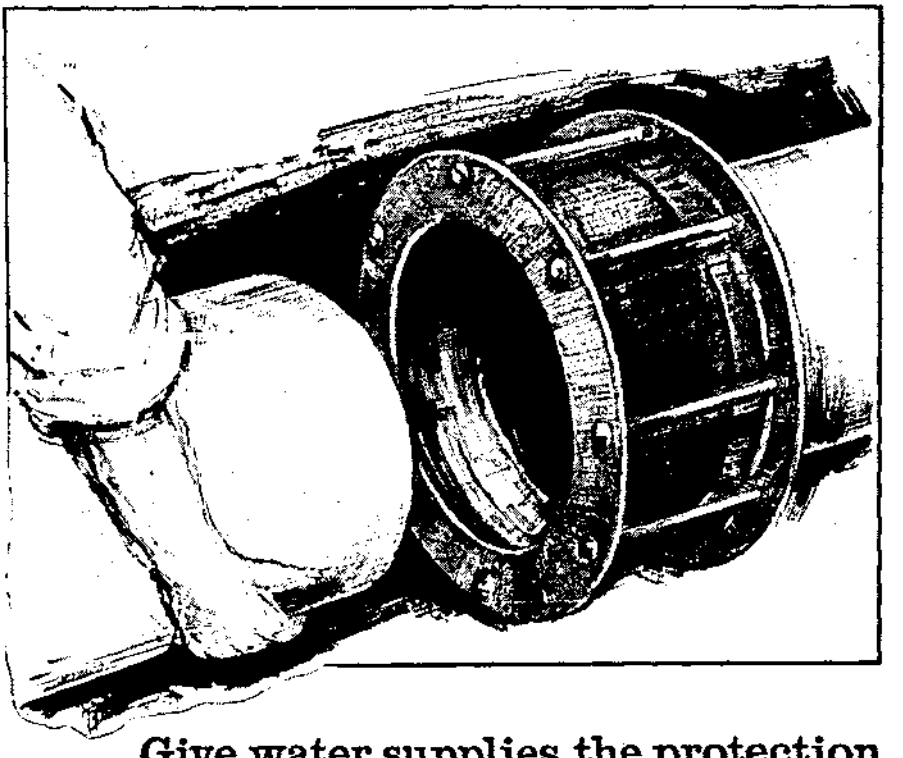
THE ROYAL ENGINEERS JOURNAL

Vol LXXXI MARCH 1967 No 1

CONTENTS

PUBLIS ERS

AGE M



Give water supplies the protection of flexible Viking Johnson couplings

These proven couplings allow both angular and axial displacements caused by misalignment of supports, and natural ground movements and settlements. They are equally suitable for use on gas, oil and sewage installations, guarding against pipe fracture. Viking Johnson couplings are available in sizes from 1½" to 144" for plain-ended pipes. Maximum deflection of the 144" coupling is 1° in any plane, increasing through the range to 6° for the 1½" size. Relative expansions and contractions of the pipes due to temperature changes are also accommodated.

When sizes up to 12" diameter are needed, costs can be reduced by taking advantage of Viking 'Quick-Fit' couplings. These are the same as the normal couplings, but supplied pre-assembled, saving up to 50 per cent laying time.

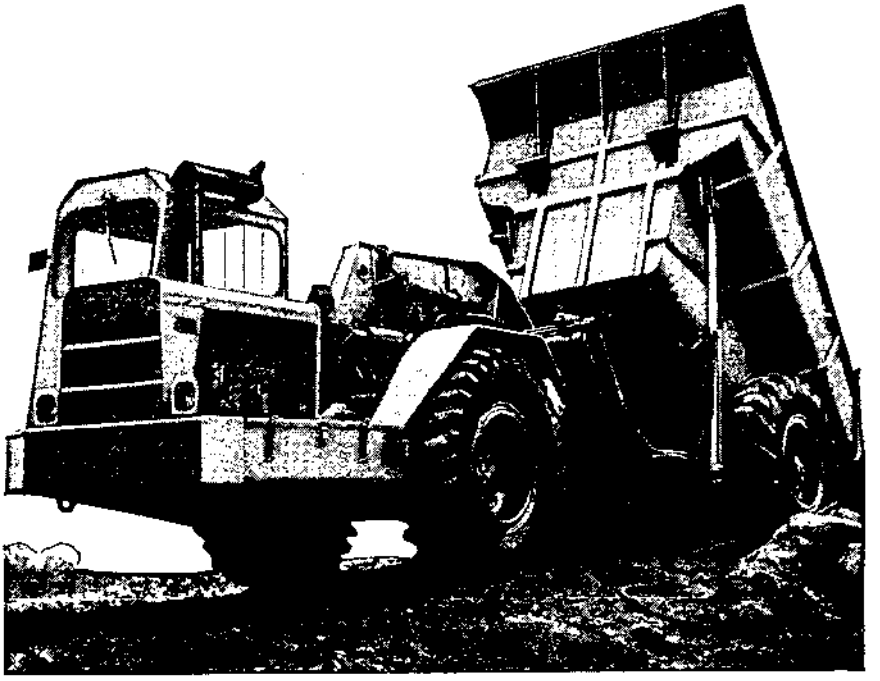
VICTAULIC

VICTAULIC VIKING

Makers of Victaulic Joints and Viking Johnson Couplings

THE VICTAULIC COMPANY LIMITED, PARK HOUSE, PARK STREET LONDON W1

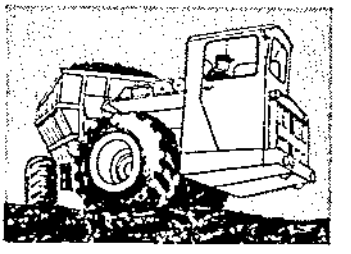
Telephone: Mayfair 6416 Telex: 24608 Telegrams: Victaulic London W1



NORTHFIELD

give you reliability where and when you need it!

Exceptionally reliable with an impressive service record under the toughest conditions, the F9 has proved itself again and again. It is a 96/120 HP, 12-13 ton capacity, 9 cu. yard machine with a turning circle of only 19'6"—less than the length of the vehicle. Top speed is 28 mph; lubrication points are easily accessible for fast maintenance on site. The unladen weight of 13,500 lb combined with its dimensions makes the F9 suitable for parachuting on two MSP's from Beverleys or Hercules.



Here is another fast mover from Northfield, the F12. This 12 yarder is one of the finest machines available, moving massive loads cheaply and quickly across the toughest terrain.

Write for full details under ref RE9

Northfield Industrial Fabrications Ltd.

PARK WORKS, OSSETT, YORKSHIRE. TELEPHONE 625/6/7 TELEX 55280

NF.9

THE COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

(Established 1895, Incorporated by Royal Charter, 1923)

Patron—HER MAJESTY THE QUEEN

President

Major-General T. H. F. Foulkes, CB, OBE, MA, MICE 1965

Vice-Presidents

Major-General J. H. S. Bowring, OBE, MC, MA, MICE 1965
Brigadier H. W. Kitson, CBE, MA 1965

Elected Members

Brigadier R. A. Lindsell, MC, MA, MIMechE, FIEE 1964
Brigadier R. W. C. Smales, MA, AMICE 1964
Colonel G. W. Shepherd, OBE, BA 1964
Brigadier D. J. Willison, OBE, MC 1964
Colonel R. F. N. Anderson, OBE, MC 1964
Lieut-Colonel B. H. Holloway, OBE, TD, DL, RE (AER) 1964
Colonel J. L. Osborne MBE, TD, FRIBA (TA) 1964
Captain P. D. Plant, AMIPlantE 1964
Colonel B. A. E. Maude, MBE, MA 1965
Captain M. J. Parsons, BSc(Eng), AMICE 1965
Colonel R. Bellingham-Smith, MBE, BSc 1966
Brigadier J. Constant, MA, MICE, AMIMechE, MIEE 1966
Lieut-Colonel B. J. Coombe, GM, BSc 1966

Ex-Officio Members

Brigadier J. C. Woollett, CBE, MC, MA ... ... D/E-in-C (A)
Colonel G. R. M. H. More, MC* ... ... AAG RE
Brigadier I. H. Lyall Grant, MC, MA, MBIM ... ... Comd RSME
Brigadier B. St. G. Irwin, MA, ARICS.. ... ... D Survey
Colonel G. T. E. Westbrook, OBE ... ...D/Comd, RSME
Brigadier L. Scott-Bowden, DSO, OBE, MC* ... ... Comd, Trg Bde, RE
Brigadier D. C. Cameron, CBE, ADC, BA ... ... Brig. Eng Plans

---

Corresponding Members

Lieut-Colonel K. C. Fenton, BE (Civ.), MNZIE
New Zealand Military Forces .. .. 12 May 1964
Colonel C. Linsell, OBE, MC, *Union Defence Force, South Africa* ... 1 February 1956
Brigadier E. Logan, *Australian Military Forces* ... ... 16 November 1963
Lieut-Colonel N. Sadlier-Brown, CD, RCE, *Canadian Armed Forces* ... 26 January 1965

Secretary and Editor RE Journal

Brigadier J. H. S. Lacey, CBE, BA ... ... 15 December 1958

Bankers

Lloyds Bank, Ltd, Cox's and King's Branch, 6 Pall Mall, SW1

4,000 1.8.67

THE ROYAL ENGINEERS JOURNAL

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

VOL. LXXXI **CONTENTS** MARCH, 1967

38 Engineer Regiment's Silver Centrepiece

THE new 38 Engineer Regiment silver centrepiece is of an Arab Dhow, and commemorates the service of the Regiment and its sub-units in Aden over the years 1959–67.

The idea for a new dhow centrepiece originated in 1961, but in 1963 this was changed to an Arab gambia. In 1964 the choice of subject returned to the dhow again, and later that year Brigadier T. H. Evill, DSO, then retired, was asked to execute the detailed design. In 1965 the Corps Committee approved the Regiment's plans and Brigadier Evill created the model from which Garrard, the Crown Jewellers, made the silver centrepiece. The silver dhow was ready in October 1966 and made its first public appearance at the Corps Guest Night held during the Engineer-in-Chief's conference last November.

Reproduced by kind permission of "Garrard"

38 Engineer Regiment's Silver Centrepiece 1

Reproduced by kind permission of 'Garrard'

The model itself is approximately twelve inches long by eight wide and eleven high, and the ebony plinth is mounted with the formation signs of Yorkshire District, 12 Engineer Brigade, Aden Brigade and the Federal Army. The inscription reads:

38th ENGINEER REGIMENT
TO COMMEMORATE THE SERVICE OF UNITS OF THE REGIMENT
IN ADEN BETWEEN OCTOBER 1959 AND FEBRUARY 1967
REGIMENTAL HEADQUARTERS 48th FIELD SQUADRON
12th FIELD SQUADRON 73rd FIELD SQUADRON
32nd FIELD SQUADRON INDEPENDENT (A.P.) FIELD TROOP
15th FIELD PARK SQUADRON

38 Engineer Regiment's Silver Centrepiece 2

Gold Medal and Trench Gascoigne Prize Essay—1965

The 1965 Gold Medal and Trench Gascoigne Prize was awarded to Major-General W. G. F. Jackson, OBE, MC. His prize-winning essay was published in the November 1965 issue of the *RUSI Journal*, and it is reprinted here by permission of the Council of the Royal United Service Institution.

"China has now exploded a nuclear device. France had already done so and is producing a nuclear weapon delivery system that may be operational by the end of the '60s. India and a number of other medium powers have, or will shortly have, the potentiality to produce nuclear weapons." Discuss the significance of this for the Great Powers.

Proliferation of Nuclear Weapons

At first sight the proliferation of nuclear weapons seems as inevitable as war itself. Their appearance at this moment in history fits so neatly into the evolutionary pattern of war; the scale of their destructive power can be co-related so ominously with the world's exploding population; and in confirmation of this thesis there is the cold fact that the United Kingdom, France, and now China have forced their way into the nuclear club at vast capital cost which they can ill afford. There is, however, another train of thought which it is the aim of this paper to explore. There has always been something illogical about war; now in the nuclear era its contradictions stand out in such sharp contrast that we should be able to discern ways of ending this waste of the world's wealth. What could be more irrational than rich nations squandering their resources on weapons whose destructive power renders them almost unusable, while two-thirds of the world's people live in abject poverty for want of the very capital used for bombs? Surely we should be able to isolate the catalyst in the world's equation of forces which makes this unhappy reaction possible, and having done so, find the antidote?

The Equation of Forces

The basic contradiction which we have to solve is simply stated: proliferation is both wasteful and dangerous, and yet nations which need all their resources to improve the standard of living of their people are driven to make great sacrifices to join the nuclear club. The equation setting out this contradiction is equally simple to formulate. It consists of one constant and two variables. The constant is a broad enough industrial base to develop and manufacture nuclear weapons and their delivery systems. The first variable is the intensity of nationalist feeling which drives a nation to put 'guns before butter'; and the second is the strength of its desire for a higher standard of living. The relationship between these three factors is straight forward. A country which has the necessary industrial base and in which the dictates of nationalism are stronger than its desire for prosperity will strive to make and to keep the bomb. Conversely, if its desire for prosperity outweighs its nationalist tendencies, or if its industrial base is inadequate, then such a country must either adopt a neutralist posture as India did under Nehru, or accept the status of a nuclear protectorate. Collective security treaties such

as NATO, CENTO, and SEATO may, however, be used to soften the indignity of protectorate status.

A quasi-mathematical rendering of the equation might be:

(i) Industrial base + (nationalism > prosperity) = the bomb
(ii) Industrial base + (prosperity > nationalism) = neutrality or protectorate status

The solution to this equation lies in the relationship between nationalism and desire for prosperity. Let us consider the relative values of these two variables in the policies of present and prospective members of the nuclear club.

Guns or Butter

The United States of America

A superficial assessment of the American equation suggests that she can afford both guns and butter, and still go ahead faster than the rest of the world. This is probably true, but the driving forces of American policy go deeper than this. She is, in spite of her appearance to the contrary, one of the most nationalist states in the world. She still feels the urge of all revolutionary powers to export the fruits of her success. Not only did she throw off the cramping yoke of British colonial rule; she has also been more successful than any other country in harnessing the forces of nature for the good of her people. Her dearest desire is to establish a Pax Americana which will go down into history as superior to the Pax Britannica which she has always admired. She has, however, three phobias which tend to cloud her judgment: anti-colonialism, born of her own colonial past; bitter hatred of Communism, the antithesis of her free enterprise system; and anti-appeasement, stemming from her conviction that British proneness to this sin led to the two world wars and the decline of British power. America would have liked to establish a world rule of law through American-sponsored international bodies such as the United Nations and by generous aid programmes like the Marshal Plan, but unfortunately her dealings with the Communist powers have soured her enlightenment. In consequence she has, in effect, rewritten the traditional directive to the British Admiralty in nuclear terms: America must have a second strike capability superior to any combination of nuclear powers. Thus, in spite of her desire to abandon old-fashioned British power politics, she has been forced by fear of world Communism to adopt a policy of deterring with nuclear "guns" while trying to buy friends with aid "butter". Fear is the catalyst in the American equation; fear of the implacable nature of Communism and fear that without nuclear weapons she and her Western allies could be swamped by the growing populations of the Communist world.

Soviet Russia

The Western view of Soviet policy is undergoing radical change. It used to be assumed without question that the Marxist doctrine of world revolution made Russia an aggressor state. Certainly her behaviour under Stalin supported this contention, but there is another explanation for her intransigence which is gaining ground. It now seems more likely that her actions were due to deep-seated fear and distrust of the West, and that, although the Stalinist aggressions were offensive in outward appearance, they were essentially defensive in purpose and aimed at protecting Mother Russia with

a *glacis* of Communist states. It is usually suggested that Khruschev's policy of co-existence stemmed from his realization of the meaning of a nuclear exchange in terms of destruction of Russian cities. The reverse may well be a truer explanation; the security afforded by the growing stockpile of Soviet nuclear weapons enabled the Russians to adopt a less truculent and more co-operative attitude to the West. Difficulties with China may have helped to soften Russia's western face, but the essential factor in the Soviet's policy of co-existence appears to have been increased confidence in the safety of the Soviet homelands from American nuclear attack. In the other words "fear" of the West rather than aggressive intent is probably the catalyst which has made Russia squander scarce resources and great scientific effort on nuclear weapons.

The United Kingdom

Great Britain's position is very different. As a great trading nation with few natural resources of her own, she knows that she must export to live and cannot allow the dictates of nationalism to gain the upper hand. Any excessive government expenditure, particularly on defence, has an adverse effect on her competitive position in world markets. She has, however, learned over the centuries that trade is unprofitable without stability and that stability depends on maintaining the balance of power. Except for her recent and short-lived imperial interlude of the Victorian and Edwardian eras, the United Kingdom has been a small country making her way in the world by her astute manipulation of alliances and commercial treaties. Her armed forces have always been small compared with those of her rivals, but they have been feared by foes and respected by allies for their crucial influence on the balance of power. Unlike America, Britain is not gripped by an unreasoning hatred of Communism; she knows its dogmas will mature and mellow like those of all other revolutionary creeds. On the other hand, her long experience in world politics has taught her to trust no one; the pendulum of history swings to and fro remorselessly and has tipped the balance of power against her so often. She has usually been able to rebuild her forces behind her sea walls in time to win the last battle, but at times it has been a close run thing. British Prime Ministers, both Conservative and Labour, have reiterated the United Kingdom's determination not to place the ultimate safety of the British Isles in the hands of an alien power, however friendly that power may seem today. A compromise has had to be struck between the United Kingdom's economic position and her strategic requirements. She has had to accept American Polaris delivery systems to save development and production costs, but she has retained her own nuclear warheads, thus keeping the ultimate decision to launch the British deterrent in her own hands. In the United Kingdom's equation it is not fear of Russia or America which makes her waste valuable resources on deterrence; it is fear that unless she has her own small nuclear capability she will not be able to redress the balance of power in her favour if it is upset by some unforeseen twist of fate, nor will she ever be able to rebuild her strength once she has lost her nuclear "know-how".

France

France's position is very similar to Britain's, with one outstanding difference. She is, like Britain, an old and worldly-wise power, but she is smarting

under four humiliating experiences: Waterloo, 1815; Sedan, 1870; mutiny on the Western Front, 1917; and the Blitzkreig, 1940. General de Gaulle mirrors the deep-seated resentment of the French people against the indignity of being rescued after 1917 and 1940 by the Anglo-Saxons. No catalyst is needed in the French equation; nationalism of the most rabid type overshadows economic considerations. "La Gloire" is stirring the minds of Frenchmen once more. France fears that unless she acquires nuclear status her interests will be ignored by her friends as well as her enemies.

Communist China

The assessment of Chinese motives is crucial to this study because China is the first Asian and first under-developed country to force her way into the nuclear club. If logic dominated men's councils, China would be ploughing back her savings into development projects and squeezing every possible ounce of aid out of East and West alike. Revolutionary powers rarely adopt such rational policies and China is no exception. She has three reasons for wasting precious scientific and industrial effort on nuclear weaopns: first, there is her orthodox Communist belief in the inevitability of war with the capitalist world; secondly, there is her deep-seated fear of America; and thirdly, and most important of all, there is her determination to lead the Afro-Asian and perhaps Latin-American "have nots" against the Western "haves". China can see no means of redressing the balance between the over-rich sections of the world and the pitifully poor without violent revolution. In her view the world is in France's position before the French Revolution. The rich are growing richer while the poor grow poorer. The United Nations is no more effective than the French States-General, and although the rich countries are as well intentioned as the French aristocracy, they are too preoccupied with their own problems to right the wrongs of the rest of the world. China has cast herself in the role of an international Robespierre, leading the Afro-Asian and Latin-American Jacobin club. In this guise she needs nuclear weapons to give her the mantle of power with which to win "have not" confidence and support. Thus in China's case fear of the West plays a part, but the real driving force is her determination to win a fairer share of the world's wealth for herself and, at the same time, for the poorer nations.

India

India presents the other side of the Afro-Asian coin. She is faced with the same grinding poverty, but by religion, culture, and inclination she is pacific although not pacifist. Nehru's policy of non-alignment fitted India's personality and was the classic example of the second half of the equation of forces. She has the industrial base but her desire for improved standards of living was strong enough to subdue the urgings of nationalism and hence she accepted neutralism as a national policy. Her conflict with China and Pakistan and the detonation of the Chinese nuclear devices have now made it very difficult for her liberal politicians and more level-headed economists to resist pressure from her fighting Services and her own nationalists to enter the nuclear field.

Other Powers

The lesser powers who might acquire nuclear weapons fall into three groups. First come Germany and Japan who have adequate industrial bases

but are both trying to work their way back into world society. They would like a finger on a deterrent trigger but neither is keen to cripple its resurgent economy with a costly nuclear weapons programme. Their inherent nationalist tendencies are, for the moment, submerged by the delights of prosperity. Canada and Australia form the second group. They have the potential to develop nuclear weapons but they are content to accept the U.S./U.K. nuclear umbrella. The third group comprises states who do not possess the necessary industrial base but who have an over-powering motive to acquire weapons by fair means or foul from other nuclear powers. Egypt and Israel are prominent in this group; "white" South Africa needs them to offset the numerical superiority of the "black" African states; and Indonesia would like them for her confrontation with Malaysia. (Note: this was written in September 1965.)

In the first two groups the catalyst of fear is, for the time being, absent and so these nations are not pressing to join the nuclear club. In the third group, however, fear is at work and may well lead to unscrupulous attempts to acquire nuclear status.

The Catalyst

Fear is the common thread which runs through all these case histories: American and Russian fear of each other's intentions; fears of middle powers like Britain and France that their interests will not be respected; and fear of the under-developed states that a fair share of the world's wealth will not be theirs without a fight. The antonym of fear is confidence, and in national affairs the antidote for fear has been found to be the establishment of confidence in the rule of law. For instance, as police forces became effective in England, so men ceased to carry swords; and as income-tax and death duties narrowed the gap between rich and poor, so the chances of violent revolution began to fade. On the international level there seems little reason to doubt that the establishment of confidence in the rule of law and in the fairer distribution of wealth should have similar results. Unfortunately this would mean the surrender of an unprecedented degree of national sovereignty to some form of supra-national authority with the power to centralize nuclear weapons and to impose a system of international development taxation to level the gap between the rich and poor states. So far no one has been able to devise a means of making the surrender of sufficient sovereignty palatable to the nations of the world, but it is in such a device that the key to success must utlimately lie.

Surrender of Sovereignty

There have been three attempts so far to create a world authority—Tsar Alexander's Holy Alliance, the League of Nations, and the United Nations—but none of these organizations infringed national sovereignty. All three lacked "teeth" and have depended for their authority on rallying world opinion against disturbers of the peace. We have thus no precedent to guide us in our search for the formula which would enable states to make a partial surrender of sovereignty. History does, however, abound with examples of political unions on a smaller scale. Let us analyze briefly the forces which have led, in the past, to the successful union of sovereign states.

Looking back over history it is possible to generalize the forces needed for successful political union into three elements: first, an external unifying

force is needed to drive the parties together; secondly, a practicable system of political checks and balances must be devised to cement the union; and thirdly obvious economic benefits must accrue from the union. If these forces become weaker than the disruptive influences of national sentiment and self interest, then the union will break up. An apt analogy is the creation of an alloy. Heat provides the unifying force by melting the constituent metals, enabling them to merge. The alloy, however, will not be stable unless the metals' molecular structures are such that they will interlock strongly as the alloy cools. And finally, the process will be of no avail unless the resulting product has some commercial value.

The application of these three principles vary with different types of union, and, in particular, between compulsory unions such as empires and voluntary unions such as federation and confederations. We have fought two world wars to prevent the compulsory union of the world under the unifying force of one imperial power, so we can discard one-power hegemony as a method of establishing a world authority. We need only consider voluntary unions of which the creation of the United States is the outstanding example. The combination of dislike of British rule, emotional desire to run their own affairs, and need to unite to defeat the British in the war of Independence gave the colonists a powerful unifying force. It was, however, far from easy to draw up a constitution whose political and economic checks and balances would satisfy all 13 of the original states. It was only after six years of hard bargaining that success was achieved. Even then the mutual economic benefit to the industrial North and to the slave-owning agrarian South was far from obvious and, in the end, the union could only be maintained by four years of bloody civil war.

Projecting these three principles onto the world stage, the unifying force would be provided by man's horror of nuclear destruction and his abhorrence of the inequalities of wealth and opportunity between peoples. The political bonds would need to be some form of constitution freely negotiated in much the same way as that of the United States. The mutual benefit would be the end of wasting precious resources on nuclear weapons and a beginning of more equitable sharing of the world's wealth. The question we now have to answer is whether there is any chance of such a unifying force becoming strong enough, of any system of checks and balances becoming palatable enough, and of the mutual benefits becoming obvious enough for nations to surrender voluntarily the degree of sovereignty needed to make the world rule of law a practicable possibility.

Steps Towards the Rule of Law

The world's attempts to create a supra-national authority have a discouraging and alarming ring about them. The Holy Alliance was born after the Napoleonic wars, the League of Nations after the First World War, and the United Nations after the Second. It seems to take the exhaustion and disillusion of a world conflict to soften the hard crust of nationalism sufficiently to let liberal humanist forces break through; and even then their breakthrough has so far proved short-lived. The only encouraging sign is the progressive improvement of the League over the Holy Alliance and of the United Nations over the League; but this encouragement is clouded by the disturbing thought that progress has only been made after a world war.

Waiting for the Third World War in the nuclear era is unthinkable. We must find some other way of taking progressive steps towards the world rule of law. Unfortunately, surrender of sovereignty only becomes attractive when the alternative is something approaching national suicide. Little progress is likely to be made unless nations are thoroughly frightened, and so paradoxically it may be through fear that we find a way out of this impasse. Brinkmanship has become part of the political way of life in the nuclear era. Each assay in this dangerous game affords an opportunity to persuade nations to take a further short step forward towards the rule of law. The abuse of the veto led to the "Uniting for Peace" resolution which enabled the General Assembly of the United Nations to outflank the Security Council. The Cuban crisis led to the "hot line" between Washington and Moscow. The Congo and Cyprus led to perceptible improvements in the United Nations peace-keeping organization. It may be that the Vietnam situation could lead to further advances, perhaps by the admission of Communist China to the Security Council, and the Indo-Pakistani dispute to some other improvement in the United Nations. As each fresh crisis occurs and fear rises in men's hearts, a new effort should be made to bring the rule of law one step nearer. This evolutionary process may be slow and at times discouraging, but it is better than waiting for the Third World War.

The negotiation of a constitution for a supra-national authority is fraught with even greater difficulties. One look at the distribution of the world's populations shows how difficult it would be to devise a voting system which would inspire confidence. The rich developed nations of the West can muster only 762 million people. The Afro-Asian bloc without China has 1,237 million; and the Communist bloc, including China's 686 million, has 1,151 million. Whether voting were to be based on the present General Assembly system of one government/one vote or on a card vote taking account of sizes of population, the richer and militarily stronger West could be hopelessly outvoted on crucial issues by the more populous but poorer and weaker East. The Western powers would find it difficult to accept the mandate of a world authority whose voting system was so clearly able to work against their interests. Conversely, the Communist and under-developed states would be equally unlikely to accept any system not based on universal franchise, because this, in their eyes, is the only way to offset the power and wealth of the West. One man/one vote is, after all, the system lauded so much by the Western powers as true democracy.

Is the constitutional picture really as gloomy as the voting problem would suggest? The same situation existed in the United Kingdom before the Reform Bills in the last century and in most other democracies as they approached universal franchise. The addition of a large working class vote did not destroy, as was feared, the traditional parties or make England the prey of irresponsible demagogues. On the contrary, politicians found that they had to work harder and argue more persuasively in order to win power. Dependence on patronage was no longer sufficient to ensure a political career; swaying the floating vote by well-founded arguments became crucial to political success. Is it not possible that the same thing may prove to be true in a world forum? The smaller and newer states are gaining political experience. There is less inclination to vote blindly with one or other of the extreme blocs. A healthy floating vote is already appearing as nations find that neither East nor West can provide the panacea for their troubles. The

great powers are having to work harder to win votes by the attractiveness of their policies, while the smaller nations are finding more opportunity to sway events by withholding their support. The growth of international political responsibility will take time to develop and may appear hopelessly utopian today, but what has proved possible on a national scale may well be possible on a world scale in due course.

The third ingredient for successful union, mutual economic benefit, should be readily apparent to the underdeveloped states who have everything to gain from a supra-national authority whose aim would be to narrow the gap between rich and poor by fiscal means. It is the developed states who are more likely to oppose such schemes. Fortunately for the world, most of the really rich countries are the most enlightened and are already trying to find ways for the channelling of aid through international organizations. Both America and Great Britain have found that international charity only breeds jealousy amongst the recipients and disillusion amongst the donors. International taxation of the rich to provide development capital for the poor would probably be welcomed by the West, which fully appreciates the danger of the widening gap between the rich and poor countries. It might, however, be more difficult, though not impossible, to persuade the Communist countries to stop using aid programmes as weapons of the cold war.

The key to all these steps towards the rule of law is time: time to gather small but cumulative improvements to the United Nations' peace-keeping potential; time to develop international political responsibility; and time to create world fiscal machinery for fairer distribution of wealth. Unhappily the march of events is unlikely to allow such well-ordered evolution unless we take active steps to buy the time which we need.

Buying Time

Whole-hearted support of the world disarmament negotiations is probably one of the best ways of buying time. Progress has not been spectacular, but such agreements as the Test Ban Treaty and the present negotiations for a non-proliferation agreement do keep both sides in touch with each other and help to damp down the nuclear arms race. Looked at from the point of view of quantitative disarmament, the results so far have been disappointing; but looked at as a means of buying time for the evolution of an effective world authority, they are more encouraging. Armaments are, after all, only the symptom and not the cause of the disease which afflicts the world. The cause is the deep-seated fear of the intentions of others bred by lack of confidence in the rule of law. Disarmament negotiations serve as a palliative to keep the disease in check until a permanent cure can be found. Unfortunately, we are dealing with a cancer for which there is, at present, no known cure. The ruthless behaviour of China shows that disarmament negotiations alone are not enough to keep the disease in check. We must also use the old fashioned remedies of power politics and their modern derivative, deterrence, to keep the world in balance until an effective cure can be found. The turning point in the history of the nuclear era may come when China accepts, as Russia has done already, that nuclear war is unthinkable and that co-existence is the only practicable policy. Once this happens, we may be able to make real progress toward the rule of law. In the meantime, negotiation from strength while at the same time pressing for partial disarmament must remain the basic western policy for buying time.

Conclusion

In conclusion, what form should British policy take in dealing with the problem of proliferation? As a great trading nation our paramount concern is world stability and the rule of law, which we tried to impose single-handed upon the world in the last century. We should not subscribe to the theory that nuclear weapons are part of the balance of nature and, hence, that proliferation is inevitable. Our aim should be to help in the evolution of a world authority able to inspire enough confidence for the nations to make a voluntary surrender of sovereignty. This will take time, and so, in the meanwhile, we must look to our own interests. We should adopt a boxer's stance. With our left, we should keep jabbing away at the creation of an effective supranational authority and at partial disarmament measures as each fleeting opportunity occurs. With our right, we should hold in reserve a strong and well-balanced military punch to protect our own interests until the rule of law is established. The title of our Minister for Disarmament should be changed to Minister for Development of World Government. It would then be clear that he is responsible for directing British policy towards the cause as well as the effect of proliferation of nuclear weapons.

Survey Work by RE Officers in Canada during the Past Century

Paper recently presented to the Canadian Institute of Surveying by Major-General R. C. A. Edge, MBE, BA, FRIC, *Director General of the Ordnance Survey and reprinted from the* Canadian Surveyor.

It was with much hesitation that I accepted your President's invitation to give a paper on the subject of the survey work done by the Royal Engineers in Canada during the century since Confederation, and it is with diffidence that I now present to you the result of my researches. For although in the course of my life I have spent many years in what used to be known as "The Empire", my visits to Canada have been few and brief, and my acquaintance with your country is much slighter than its size and fame warrant.

However, it is impossible to delve even slightly into the early history of Canada without immediately experiencing its fascination, and when, starting quite from scratch, I began the enquiries that were necessary even to decide whether it would be possible for me to present this paper, I quickly fell under its spell, and decided, come what may, to have a go. But let me make it plain, I am no expert; as a Sapper officer I am proud and grateful to have this opportunity of recounting some of the efforts of my fellow Sappers in the service of this great country, but at the same time I am humbled by the knowledge that many who are present here probably know much more about the places and events with which I deal than I do myself.

The part played by the Royal Engineers in the development of Canada is well known, not least, I imagine, here in Ottawa, where Lieut-Colonel John By, RE, founded a settlement so successful that it was chosen for the Dominion Capital—and, ironically, as a result had its name changed from "Bytown". The Sapper connection has already celebrated its centenary in this town, and more recently in British Columbia where a small party of Sappers clad in period uniforms and led by Captain G. R. Gathercole, RE, took part (Captain —now Major Gathercole is at present serving with the Ordnance Survey). But most of this British Sapper activity was before Confederation, at which time a withdrawal of Imperial troops began, and during the period which I cover the Royal Engineers played a much smaller part. However, the connexion has fortunately never been severed, and even today there are strong Sapper links, not least in the world of survey.

The survey work I deal with falls into three well defined periods. First there is the period lasting for some twenty years immediately following Confederation, when the operations were in the nature of a carry-over from the previous era. During this time occurred the last of the main Canada/US Boundary Surveys and the survey of various fortresses, some of which still had British Garrisons. Then, at the start of the new century, there was a period when public attention was focussed on the unsatisfactory state of Canadian Mapping, and, as part of the remedial operation, British Sappers, including men from the Ordnance Survey, were called in to help. This period lasted until the 1914 War. Finally, there is the period, starting in 1951 and still happily continuing, during which Royal Engineers, on exchange postings, have year by year assisted Canada in its present gigantic mapping tasks.

At the time of Confederation the mapping of Canada was sporadic and generally of dubious quality. There were a number of military reconnaissance sketches, Provincial settlement surveys and geological surveys, but these and other similar surveys were in general produced with strictly limited objectives. They lacked co-ordination, were topographically incomplete, and, being produced with scanty geodetic control or with no control at all, were of low accuracy. There were however exceptions, and among these were the surveys of Crown Lands carried out by the Royal Engineers. In an article in 1925, a Dominion Land Surveyor, G. H. Watt said of these:—

"they leave nothing to be desired being uniform as to scale, colouring and general completeness throughout and are fine specimens of working plans."[1]

At Confederation one such survey was in progress. In April 1864 a detachment consisting of Lieut Honorius Sisson Sitwell, RE, one sergeant, two corporals and eleven Sappers was sent from the Ordnance Survey to Canada to survey "sites for works at Quebec".[2] Until 1868 this party was engaged in producing a 1/2,500 scale survey of the area around Quebec, Montreal, Vandreuil, Longueil, Sorel, Lachine and Caughnawaga for the Director of Fortifications and Works. Sitwell's party increased later to two sergeants, two corporals and twenty Sappers, and during their stay in Canada they appear to have produced more than a hundred plans of the highest quality on the 1/2,500 scale with contours at 25 ft. Vertical Interval. These plans closely followed the Ordnance Survey practice of the day, and, although beautifully drawn, have letter sizes and line thicknesses which are rather large for the scale. This is because they were intended also for the preparation of 6-in scale maps by direct reduction. The maps were evidently fair drawn in Canada, but they were sent back to the Ordnance Survey for reproduction by zincography at the 1/2,500, 6-in and 1-in scales. The names of the draughtsmen responsible appear on some of the sheets preserved in the Public Record Office in London. They are Sergeant T. Barry, Corporal J. Kay, L/Corporal E. Clyne, Sapper J. Brophy, Sapper A. Brittain, and Sapper W. Wilson, all of them Royal Engineers. These were presumably members of Lieut Sitwell's party. On the index to the surveys and on some of the sheets themselves it is recorded that they were "surveyed under the direction of Lieut H. S. Sitwell" and "under the superintendence of Colonel William F. Drummond Jervois, RE, CB, Deputy Director of Works (Fortifications)" and that they were "Zincographed at Ordnance Survey Office, Southampton, under the direction of Captain Parsons, RE, FRAS, Colonel Sir Henry James, FRS, etc., Director, 1868". It was Captain Parsons who introduced zincography to the Ordnance Survey, and Sir Henry James who canvassed its merits with such enthusiasm, eventually persuading the authorities to allow him to produce a large number of the Nation's ancient manuscripts, including Domesday Book, by this revolutionary process. The fate of Sitwell's beautiful surveys in the land they portray is not known to me. The 6-in reductions are mentioned in an article by Colonel J. Sutherland Brown, which briefly summarises the mapping situation of Canada in 1904, as "Fortification Surveys about 1865. Scale—6-in to a mile. . . . Maps out of date."[3] Evidently they suffered the fate of many of their kind elsewhere.

A few years later another Fortress Survey was started by a Sapper, Lieut Valentine Francis Rowe, RE, this time a 2-in to the mile survey of an area of about forty miles square centred on Halifax, Nova Scotia. This was followed

by a 1/2,500 scale survey with a 10 ft contour interval, which comprised about fifteen to twenty large sheets and was carried out between 1877 and probably 1884, by a Sapper party headed by Sergeant E. Hopkins, RE. Fair drawing was completed by Sergeant Hopkins in 1886, and the Survey was reproduced between that date and 1891, once again by the Ordnance Survey, at the 1/2,500, 6-in and 1½-in scales. These surveys were also for military works use and are signed by "Chas. S. Akers, Colonel, CRE, 5th June, 1886". It is sad to record that the Municipality of Halifax was asked to bear a small share of the expense in return for the right to use the surveys, but declined the offer.[4] Evidently the spirit of the Home Country was still strong in Nova Scotia.

It is probable that the methods which at that time were standard in the Ordnance Survey were used for these surveys. A triangulation of about one to two mile sides was first completed, and then each side of each triangle was chained, detail encountered en route being plotted. Supplementary chain lines were added and the triangle was then filled in by the method of "shots", that is by alignment and taping. Bench marks were supplied by levelling, and (where they were provided) contours also.

In the year that the Halifax survey started, 1872, there also began the last of the three historic Commissions that determined the main boundary between Canada and the United States. The First Commission of 1843–5 demarcated the boundary from the Atlantic westwards to "the northwest angle of the Lake of the Woods", the Second of 1858–63 from the Pacific, along the 49th parallel, to the watershed of the Rocky Mountains, and the Third of 1872–6 filled in the remaining central section. Of these three Commissions the third alone occurred after Confederation, and therefore falls within the period covered by this paper.

It was undertaken, like the other two, because of the pressure of events. During the previous few years there had been trouble in the Red River area; and friction had developed between Canada and the US, especially in the vicinity of the Hudson Bay Trading post near Pembina. There had been the Red River troubles of 1869, and a raid on the Hudson Bay Store by Fenians under "General" O'Neill in 1871. The problem of dealing with these incidents had been complicated by uncertainty as to territorial responsibility, and the location of the 49th parallel on the Red River was in doubt by nearly a mile.

It is the object of this paper to recount the deeds of the Royal Engineers, and therefore in the brief account which follows I deal with the part they played, and rely mainly upon the accounts of two Sapper officers of the Commission, Captain Samuel Anderson[5] and Captain Albany Featherstonhaugh.[6] Time compels me to make but little mention of the activities of their Canadian colleagues or of the United States Commission. For those who want the full story I recommend the excellent work "West on the 49th Parallel" by John E. Parsons,[7] to which I also am indebted for some of my information.

In all three Commissions Sappers had played a leading part. As in the case of the Second Commission, in addition to professional officers, the Corps provided a strong party of other ranks whose participation had a threefold advantage. First they provided military protection which was very important in those unsettled days, secondly they provided engineering skills and a nucelus of disciplined labour, which was to prove of the greatest value to the

Photo. 1. British Commission. Standing L to R: Burpee, King, Coster, Herchmer, Anderson, Dawson, Russell, Ashe.
Seated L to R: Galway, Ward, Cameron, Featherstonhaugh, Burgess, Boswell.

Commission in its various trials, and last but by no means least, since their pay was not an extra charge, they kept the bill down.

The work of the third Commission owed much to the experiences of the second. The United States Commissioner, Archibald Campbell, filled this post on both, and Captain Samuel Anderson, RE, the Chief British Astronomer, had been British Secretary on the second Commission. The British Commissioner had then been Lieut-Colonel John Summerfield Hawkins, RE, but—unfortunately as it turned out—he declined to continue for the third Commission, although he took an important part in advising and assisting in its planning.

Another absentee was Lieut C. W. Wilson, RE, who had preceded Anderson as Secretary of the Second Commission, and who incidentally went on to a distinguished career, eventually becoming Major-General Sir Charles Wilson, KCB, KCMG, FRS, and Director General of the Ordnance Survey from 1886 to 1894.

Lieut-Colonel Hawkins' successor as Commissioner, Major Donald Roderick Cameron, was not a Sapper but a Gunner, and, quite apart from this serious disability, the choice seems to have been not an entirely happy one. He was less easy to get on with than his predecessor and on occasion found himself at loggerheads, not only with his American opposite number, but also his own colleagues. He seemed to them pettifogging and obstinate, though this may well have resulted from his commendable determination to get the best bargain he could for his country. At any rate he had one powerful recommendation; his father-in-law was a member of the Canadian Cabinet!

The Secretary to the British Commission was Captain Arthur Clitherow Ward, and he with the rest of the British Sapper party under Captain Anderson sailed from Liverpool for Canada on 22 May 1872. On 20 September 1872, after a journey by sea, lake, rail, road and finally, up the Red River by steamer, this party eventually reached Pembina, and joined forces with the United States Commission and the Canadian members of the British Commission. The British Commission consisted of three astronomical parties, and three surveying parties. The former were in the charge respectively of Captain Anderson, Captain Featherstonhaugh and Lieut William James Galwey, RE. Featherstonhaugh's Chief Assistant was W. F. King, who later became Canada's Chief Astronomer and founder of the Geodetic Survey. Of the surveying parties two were respectively under Colonel Forrest of the Canadian Militia and Mr A. L. Russell, both Provincial Land Surveyors, and the third under Sergeant James Kay, RE (who was possibly the Corporal J. Kay of Sitwell's party). There were also various other specialists, all Canadians, the two surgeons Dr T. J. W. Burgess and Dr Thos. Millman, a geologist Mr G. M. Dawson, a veterinary surgeon Mr W. G. Boswell and a commissary, Mr W. Hirchmer. The Sapper party consisted of some forty-four NCOs and men of whom ten were surveyors by trade—eight of these being from the Ordnance Survey. With these and the various other assistants, teamsters, labourers, and the rest, the whole Commission totalled some sixteen to eighteen officers and 240–50 others, with a large number of horses, ponies and oxen and vehicles.

The first task was to establish jointly the true position at which 49th parallel crossed the Red River. When the British arrived the Chief United States Astronomer, Captain Twyning, had already started observations for latitude, and he was joined by Featherstonhaugh. Their results differed by

Photo 2. Royal Engineer party.

only 32 ft which was halved, and confirmed, fortunately for the British, that the Hudson Bay trading post, which had been disputed, was in fact in Canada. The next task, which was undertaken jointly by Anderson and Twyning was to locate "the most north-western point of the Lake of the Woods" from which, under Article II of the Convention of 20 October 1818, the boundary ran due south until it struck the 49th parallel, which it then followed westwards to the Pacific coast. The reference mark, emplaced forty-six years earlier in 1826, was discovered at the head of a narrow estuary with the help of Indians after a three day search, and with its aid the "north-west point" was jointly established.

At this stage, however, difficulty arose. It had been apparent for some time that a line due south from the "North-west point" would cut off part of the western shore of the Lake of the Woods, and place it in the U.S., including the landing stage at the terminal point of the Dawson Road, which then provided the only access to Manitoba from the east. Probably for this reason Major Cameron refused to accept the agreed position of the "North-west point" without reference to the Foreign Office. He was however persuaded to agree meanwhile that clearing of the line southwards could proceed, but this incident bedevilled his relations both with his own Chief Astronomer and with the United States Commissioner; and to no purpose as it transpired, for in the end the Foreign Office did not support him. Meanwhile a tangent line had been traced for some distance east of Red River, and joint observations for latitude had been taken at Buffalo Point near the 49th parallel on the western shore of the Lake of the Woods. It being then the beginning of November the United States party "retired to winter quarters at Detroit", but the British party carried on. Having cut his way southwards to the Lake of the Woods shore, Anderson moved to North Pembina and there observed telegraphic longitude, making use of a recently laid 900 mile connection between the Red River settlement and Chicago Observatory. This took five nights and he complains of "great trouble and annoyance occasioned by the clerks at the numerous intermediate stations fighting for the wire, . . . they occasionally sent me abusive messages for occupying the wire with what appeared to them to be nonsense". Meanwhile latitude was observed at Lake Roseau and cutting along the parallel continued at various places to connect the Red River to the Lake of the Woods. A survey of the lake shore and a six mile belt north of the boundary was also carried out.

By their persistence in carrying on the British party evidently became the first to discover the advantages of winter survey in Canada. Anderson records: "Although it was generally supposed that as soon as winter set in, field operations would necessarily be suspended, it was found that the advent of the frost afforded the greatest assistance to the work, for both man and transport animals were spared the excessive fatigue of working through unfrozen swamps." But at first the trials of the parties in this unknown and difficult country were severe (though no doubt familiar enough to many in my audience). Early snow prevented the underlying swamp from freezing, and the Sappers "unskilled in the use of the axe" kept falling into the swamp holes between the trees and were constantly wet through. When the ground eventually froze matters improved, but it became very cold so that the slightest breeze made it "very difficult to pay proper attention to surveying operations". The men found their eyelids being frozen together, Featherstonhaugh remarking—and we may believe him—"the first realisation of this produces

unbounded surprise to the person concerned". Major Cameron had qualms about continuing, but on Anderson's advice they carried on. The latter may however have regretted his persuasive powers a few weeks later, when his party was struck "by the terrible storm of the 7, 8 and 9 January" in which eighty persons were frozen to death in Minnesota. He and his party took refuge in one of the small islands of poplars near the shores of Lake Roseau and escaped without harm, as also did two of his men who were caught for two days and nights inside their waggon without fire or food.

But this storm blew most of their troubles away, and thereafter, until the spring, although the temperature frequently fell to minus 40°F. and below the weather was fine. Featherstonhaugh writes almost lyrically: "the perfect stillness of the woods disarms the most extreme cold of half its severity, and the dark green foliage of the fir and pine is a pleasant relief to the eye where all else is an endless glare of white" and describes how "the Spruce boughs laid on waterproof sheets furnish dry and comfortable couches on the surface of the snow itself". His men were introduced to snow shoes, which however he regarded with less enthusiasm. He writes: "all that a snow shoe does is to enable a man to progress slowly where, without them, he would not get on at all."

By 1 April 1873 the cutting of this section was complete and the parties had all returned to North Pembina, or as it was now re-christened "Dufferin" in honour of the Governor General. The U.S. Commission arrived at the end of May (one seems to detect a reproachful note as Featherstonhaugh records the early departures and late arrivals of his American colleagues), and a joint plan was made for dealing with the long section of the boundary across the prairie west of the Red River. Between west longitudes 96 degrees and 99 degrees, then the limits of Manitoba, permanent marks consisting of iron pillars were to be placed every mile. West of this there were to be marks every three miles, consisting of mounds of stones or earth. Latitude was to be observed every twenty miles by the US and British parties alternately using 32-in zenith telescopes. From these stations the 49th parallel was to be located and marked by laying off a tangent line at right angles to the meridian, prolonging it by theodolite until it met the meridian of the next station to the west, and correcting it by laying off the necessary offsets. No attempt was made to allow for deviation of the vertical, and in this connexion Major Cameron once again found himself in conflict with the rest. On the Second Commission each point located astronomically on the 49th parallel had been joined to its neighbour by a straight line, but Cameron now wanted a mean parallel to be marked which would average out the discrepancies due to deviation of the vertical. He was eventually overruled as to the "mean parallel" but prevailed in his insistence that the line joining adjacent points should have the curve of the 49th parallel. No doubt he had it in mind that the curve, dipping slightly to the south, would give Canada a few additional acres of territory.

By the first week of June the survey had been resumed. Captain Anderson was in charge of the British operations, and led the mounted reconnaissance party consisting of half-breed scouts. He used a sextant and a pocket chronometer to establish the positions of the latitude stations, and made a sketch map of the country, marking sites for depots. The two astronomical parties followed. It was found that three clear nights at a station were required to complete latitude observations with a probable error of 10 ft or better. Then

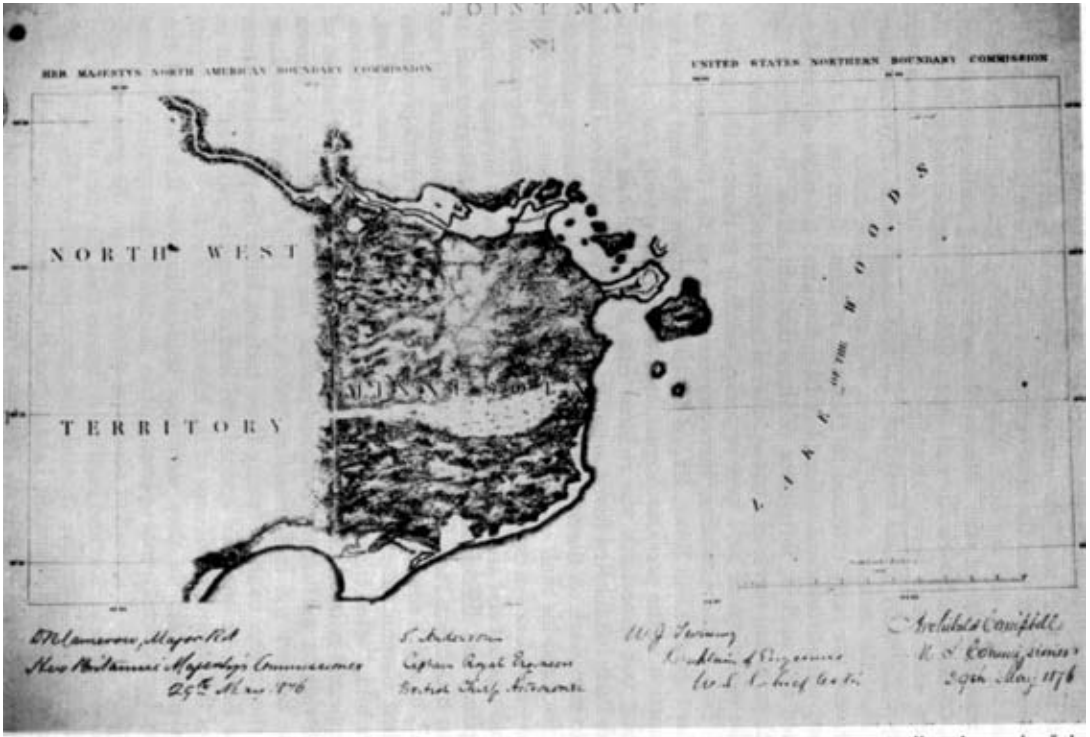


Photo 3. Joint Map No. 1. N.W. Point, Lake of the Woods. This is one of the series of joint maps recording the work of the Commission which were produced by the Ordance Survey. Each of these maps was signed by the two Commissioners, Cameron and Campbell, and the two Chief Astronomers, Anderson and Twyning. The map shows how the boundary defined under the Convention of 1818 created an enclave of U.S. territory on the western shore of the lake.

followed the survey parties, British and American, each mapping a belt six miles wide on its own side of the line. By the middle of July the parties had got to the wooded Turtle Mountain area. Here a depot was established and two detachments were left to cut their way through this difficult obstacle; the Americans worked from the western side and the British from the east. Fresh trials had now to be faced. Featherstonhaugh writes: "the plague of flies was almost intolerable" and "the number of mosquitoes quite incredible, . . . the reality is worse than the anticipation. . . . Oxen have been known to be choked by them, and the noise they make beating against the outside of a tent, resembles that of rain." Meanwhile the remaining parties pushed westward, crossing the Souris River at four points (the engineering skills of the Sappers were useful here), traversing the great Coteau (where some were nearly engulfed by prairie fires) and "the bad lands" south of Wood mountain. Here the summer season's work was ended, 430 miles west of Red River, and the party returned to Dufferin, reaching there on 31 October. Twenty-one astronomical stations had been fixed and 408 miles of boundary chained and marked, forty-three of them through woods. In addition the British party had surveyed 3,004 sq miles of country bordering the line.

The operations of 1874 were organised similarly to those of the previous year. Two of the Canadian surveyors retired from the Commission and another Sapper, Lieut Rowe, RE, of the Halifax Survey, who had joined the Commission in the previous August, took over the surveying parties; their mapping task henceforth was reduced from a six mile belt to three. The British Party left the Red River on 20 May and arrived in the Wood Mountain area to start work on the new section a month later, Rowe having unfortunately fractured his skull on the journey by a fall from his horse. They were joined—a week or ten days later—by the American party. At first the country covered was hot and arid, intersected by a number of rivers flowing through precipitous and difficult ravines, Frenchman's Creek, the Milk river and its various tributaries. Here for the first time buffalo were encountered "in vast herds", to which seemingly insignificant loss was caused by the depredations of "their constant attendants the Sioux and Assiniboines". These Indians, we are told, "asked numerous questions about the object of the expedition, and appeared relieved to hear that no idea of a railway lay at the bottom of it". Moving on westwards the parties passed "the three Buttes . . . known by the hunters and half-breeds as 'Sweet Grass Hills'." Here they came upon the corpses of about twenty Crow Indians, killed the previous autumn by the Blackfeet "stripped scalped and hacked about a good deal". But in spite of this daunting evidence of the hazards of life in the West, the spirits of the party rose, for they were now approaching the Rockies and the scenery became much more pleasing than the monotonous prairie. Featherstonhaugh writes: "instead of short and scanty herbage, the grass was now luxuriant and rich; clear and impetuous streams took the place of muddy and stagnant pools." The line crossed "the immense mass of Mount Wilson" which, with nearby Waterton Lake (upon the western shore of which the final station was to be placed), reminded Featherstonhaugh of Lucerne in Switzerland. He writes "the lake lying immediately below the feet of the spectator, lends its beauty to the scene, and a unique grandeur is derived from the reflection that the mountains extend in unbroken series to the Pacific Ocean, 400 miles away, while the plains, bare and treeless stretch for twice that distance in an opposite direction".

Eventually the terminal cairn of the Second Boundary Commission of 1861 was found by Captain Anderson, Mr Dawson and the recce party, in perfect condition and located in "a curious saddle-back, with precipitous sides". The survey was carried back from here, until on the 27 August 1874 it was met by a party under Mr Ashe, one of the Canadian Surveyors, bringing their traverse up from the plains. An historic moment it must have been, but the accounts are reticent about any celebration to mark the occasion, apart from a day or two taken off to fish and explore. The party may have been preoccupied with the problems of the 860 mile return march remembering "how suddenly and unmistakeably the winter might commence". However all went well, and, in spite of warnings of an intended attack by the Crees, the convoy reached Dufferin on the 11 October; glad to be home, but not without regret, for as Featherstonhaugh notes "despite the many disadvantages of the prairie and plains, there is no doubt that persons who have spent much time upon them, acquire a sort of attachment to them that more pleasing landscapes fail to inspire".

During the season seventeen principal astronomical stations had been observed and 339 miles of the boundary chained. It only remained to erect iron pillars at the sites previously marked temporarily along the southern boundary of Manitoba. Alternate pillars were erected by the British; the remainder by the Americans—a year later!

The value of the work done by the Commission needs no emphasis, and for the value of the contribution made by the Sappers I can perhaps best quote Campbell, the United States Commissioner, who, in complaining to Washington of his difficulties as compared with the British, wrote ". . . their detachment of Sappers alone gives them a great advantage over us."

It is satisfactory to record that both the Commissioner and the Chief Astronomer were rewarded for their services with the C.M.G.

The joint maps resulting from the Commission were reproduced by the Ordnance Survey. For many years they constituted the only reliable surveys of much of the territory they covered.

A good account of the events leading up to the second period of RE Survey assistance to Canada is to be found in the article written in 1924 by Colonel J. Sutherland Brown, that I have already mentioned. Briefly, the state of Canadian mapping in 1904 was little more satisfactory than it had been in the 1860s. There was still no regular system of geodetic control, and no co-ordination of the various surveying activities. The situation was brought to the notice of Sir Percy Lake, Chief of the General Staff in Canada, and he submitted a memorandum to the Militia Council on 27 November 1905, in which he pointed out that there were no topographical maps in Canada that could be used for military purposes. He asked for sanction to arrange with the War Office for the employment of skilled topographers from Britain to help remedy matters. It is evident that in making this request he was much guided by the advice of the War Office, which was tendered through Captain G. R. Frith, RE, himself a Canadian—ex RMC Kingston, who was at the time on leave from his post in the Mapping Section of the War Office, later the Geographical Section of the General Staff (GSGS) and now the Directorate of Military Survey. There seems to be some doubt about the exact course of events. The Head of the Mapping Section at that time was Major E. H. Hills, RE and the War Office published a

comprehensive report by him dated 30 December 1903 entitled "Report on the Survey of Canada", which is evidently based on a personal study of the situation. Its recommendations for the setting up of a substantial Survey Department under military control went further than the action requested by Sir Percy Lake, but there is much in common with the views both expressed. However it is not mentioned by Sutherland-Brown nor in the History of the Royal Canadian Engineers,[9] although it must surely have been much in the mind of Frith in 1905.

At any rate Sir Percy Lake's suggestion was adopted and, War Office agreement having been obtained, three Sappers and an NCO arrived from the Ordnance Survey in 1906. Their first task was to provide a satisfactory geodetic framework for subsequent surveys, connected to the United States geodetic system. They worked under the control of Captain Claude Russell-Brown, RE who was then the professor of Surveying at the RMC Kingston, where the cadets had in the past done some valuable sketch mapping of the area. Russell-Brown, as a matter of interest, was the half-brother of Major-General R. Ll. Brown, CB, CBE, lately Director General of the Ordnance Survey, who must be well known to some of you. Their father was Colonel F. D. M. Brown who won the Victoria Cross during the Indian Mutiny. Russell-Brown himself won the DSO in the 1914–18 war and the CB later in China. He retired in 1930 with the rank of Colonel and died in 1939. The distinguished services of the Brown family cover a long span!

But to return to Canada: from 1906 up to 1914, year by year, a party of from four to seven Sappers from the Ordnance Survey left Britain for Canada in the spring to continue their surveys of areas of military importance, they worked generally at a scale of $\frac{1}{2}$-in to 1 mile using the plane table and basing their work upon reliable geodetic control which they themselves supplied. In the winter they returned to the Ordnance Survey, where (until a Canadian Lithographic office was set up in 1913) the maps were reproduced and printed. These surveys laid the foundation for the systematic mapping of Canada, for upon the nucleus of this RE team a Military Survey—not unlike that recommended by Hills—gradually grew up. Some of the Sappers stayed to assist in its growth, and there is at least one interesting link with those times. Sapper F. J. Coldham, RE, joined the Ordnance Survey in December 1903, and was employed on the annual surveys in Canada in 1907, 1908, 1911 and 1912. In 1913 he returned to the RMC Kingston as Survey Instructor and remained there until he retired as a Warrant Officer Class I in April 1921. His son Lieut B. W. Coldham, RCE, is now a member of your Mapping and Charting Establishment.

We come now, finally, to the third phase of RE Survey Co-operation with Canada; the period of the present exchange postings. "Co-operation" now is the proper word because the benefits of this arrangement have been felt at least equally by the British.

Like so many good things, the exchange has its origins in the otherwise generally regrettable phenomenon of war. The great contribution to victory in the Second World War which was made by the Military Survey Service owed much to the close co-operation that existed between the Allies, not least between the Canadians and the British. After the war there was a natural desire to continue this co-operation; a desire reinforced by the evident fact that the military survey activities of the British and Canadians in peace time tended to be mutually complementary. The British, with their larger regular

army and wide military responsibilities, had continuing and substantial experience of operating a survey service in an essentially military environment. The Canadians, now happily at peace, but with their vast and rugged country, still largely unmapped, had virtually unlimited scope for providing practical experience of surveying. Each country had much to learn from the other, and it was therefore with great mutual satisfaction that the discussions between (then) Brigadier J. C. T. Willis, Director of Military Survey at the War Office, and his counterpart in the Canadian Ministry of Defence, Colonel C. H. Smith, were consummated in 1951 by a formal agreement to exchange officers in the rank of Captain for two year tours with the respective armies.

The first British officer to be exchanged was Captain W. Ker, RE, who arrived in Canada in October 1951 and remained until October 1953. His Canadian opposite number was Captain Bert Engler, RCE. Since then there has been an unbroken succession of exchanges, and today Major C. N. Thompson, RE, is in Canada preparing for his first job in the Yukon. In 1965 the arrangement was extended to include NCOs, and the first pair, Staff Sergeants P. Bryant and C. C. Everett are now nearing the end of their tour in Canada, while their opposite numbers Sergeants J. Houldsworth, RCE, and W. D. Sinclair, RCE, are serving with the British Army respectively in the United Kingdom and the Far East.

Over the years these Sapper Officers and NCOs have worked with survey parties in every part of Canada from Nova Scotia to Vancouver, and from Labrador to the Arctic Islands and the Yukon. It is impossible here to give even a brief summary of what they have all done, but it is interesting to compare their activities with those of their forebears, for it illustrates vividly the evolution of survey over the years. Their work, in the main, has been part of a great scheme to map the whole of Canada fully and accurately at the 1/250,000 scale, with certain areas at 1/50,000 and 1/25,000 in addition. The days of sporadic surveys to meet particular demands are finally over. The new mapping is tied to a continent-wide SHORAN geodetic network. The basic method is air survey, and no longer does the surveyor have to tread every area he maps. But ground control—both planimetric and for height—is still required, and it is in the provision of this that the parties have been mainly engaged. They have had to move over the ground, but the method of progression has itself progressed. Captain Ker (1951–53) used not only dog teams, like those of the 1870s, but tractor drawn sledges as well, and eventually the machine largely replaced the animal. Perhaps the moment of truth came when Captain Gardiner-Hill (1955–57) found that he had himself to drive his dog team because the Eskimo he had hired for that purpose insisted on piloting his motor toboggan!

Captain Ker was also an early exponent of the helicopter, now the routine method of transport, especially since the advent of the Tellurometer. The latter was first tried out on the job by Gardiner-Hill and since then it has revolutionised the technique of control survey. Samuel Anderson of the Boundary Commission would surely have envied Captain M. Sowton (1961–64) and his Canadian party their ability, with Tellurometer and helicopter, to traverse 2,695 miles in the Arctic Islands in forty-seven working days!

There have been other revolutionary developments with which Sapper exchange officers have been connected. For example Captain F. M. Sexton

(1953–55) did some of the early experimental work with the Airborne Profile Recorder, which is now the standard method of fixing photogrammetric height control.

But in spite of all these changes much has remained the same, for example, Canada's terrain and climate. The cold still freezes faces and limbs. Men and vehicles still plunge through breaking ice. The snow is still a hazard, and a helicopter journey can change suddenly from comfortable transportation to deadly peril, perhaps because of "White Out" or because of a mistake in map or photo reading. Then there is the wild life: herds of buffalo no longer roam, but there is the Grizzly bear and, in the Arctic, the Polar bear, reported on one occasion to have seized the helicopter of Captain H. C. Honeyman (1959–61) and worried it until the engine was started for take-off. Also the salmon fishing, highly spoken of by Captain Arnott (1964–66), although modern legend credits him with being the only officer ever to have been caught by a fish! And, of course, the flies and mosquitoes, described by Captain A. F. Prain (1957–59) in terms strikingly reminiscent of Featherstonhaugh eighty-six years earlier.

But above all there has been the satisfaction that these men have had in their jobs, and the pleasure that the experience of working closely with their Canadian colleagues has given them. The scanty details that I quote here are culled from accounts which the officers concerned have been good enough to send me. Time prevents my doing justice to their interesting and varied stories, but there is one constantly recurring theme, the kindness and helpfulness of Canadians, and especially of the Canadian officers under whom they have served and the colleagues with whom they have worked. I would like to conclude by expressing on behalf of my country our appreciation of the hospitality of Canada to Sapper surveyors over many generations, and of the benefits which we—certainly no less than you—have reaped from our collaboration in this field.

Acknowledgments

I must record my thanks for the great help I have received from many people in the compilation of this paper. They include Mr S. G. Gamble, Lieut-Colonel L. M. Sebert and Mr D. W. Thompson of the Department of Energy, Mines and Resources, and Colonel M. C. Sutherland-Brown of the Department of National Defence, all of whom gave valuable advice and sent material from Canada. In Britain I received much valuable assistance from Lieut-Colonel F. T. Stear, Secretary of the RE Historical Society and Mr A. E. Baggs of the RE Corps Library, from Brigadier B. St G. Irwin and the staff of the Directorate of Military Survey, especially Captain M. P. Henshaw and Captain D. E. Lyddall. Mr Ian Mumford of the Army Department Map Library in particular helped me greatly by locating references and contemporary maps. I must also thank Mr R. W. Place of the Army Records Centre, Mr P. A. Penfold of the Public Record Office and officials of the Foreign Office Library, the Army Dept. Library, and the Library of the Royal Geographical Society, for the facilities made available to me; also Mr John E. Parsons for supplying photographic negatives and allowing me to draw upon his work "West on the 49th Parallel". I am grateful to all the exchange officers mentioned who have sent me accounts of their activities and finally thank those members of the Ordnance Survey who have given me so much help, especially Mr G. E. Stewart, Information Officer, Mr D. Stagg and

CANADA-U.S.A BOUNDARY SURVEY
1872 — 1876
adapted from map annexed to
Capt. Featherstonhaugh's Narrative
Scale of Statute Miles
0 10 20 30 40 50 60 70 80 90 100
MANITOBA
MINNESOTA
M O N T A N A
D A K O T A
PLAINS
PLAINS
BAD LANDS
Red Deer River
South Saskatchewan River
Cypress Hills
Boundary Commission Trail
Grand Coteau
Woody Mountain
Frenchman's Ck.
Milk River
Milk River Ridge
North Branch
South Branch
Belly R.
Terminal Camp
The Three Buttes
or Sweet Grass Hills
West Fork
East Fork
Missouri River
Souris R.
Souris River
Turtle Mtn.
Pembina
Dufferin
Red River
Swamps
L. Roseau
Lake of the Woods
N.W. Angle
Dawson Road
Ft. Garry
Winnipeg
Lake Manitoba
Lake Winnipeg
50
49
48
115 114 113 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 96 95 94

Mr M. Hopper of the Archaeology Division, and Mr T. House of Air Photo Group, who prepared many of the slides.

References

[1] G. H. Watt, DLS "Ordnance and Admiralty Lands in Canada" Journal of the Dominion Land Surveyors Association (now "The Canadian Surveyor"), October 1925.

[2] Ordnance Survey Annual Reports 1865–68, HMSO.

[3] Colonel J. Sutherland-Brown, CMG, DSO, "The Military Survey of Canada", Canadian Defence Quarterly, October 1924.

[4] Harry Piers "The Evolution of the Halifax Fortress 1749–1928", Publication No. 7, Public Archives of Nova Scotia.

[5] Captain S. Anderson, RE. "The North-American Boundary from the Lake of the Woods to the Rocky Mountains", Journal of the Royal Geographical Society, 1876.

[6] Captain A. Featherstonhaugh, RE, "Narrative of the Operations of the British North American Boundary Commission 1872–76", Professional Papers of the Corps of RE, Vol. XXIII 1876.

[7] John E. Parsons "West on the 49th Parallel", Wm. Morrow & Co., New York.

[8] Major E. H. Hills, CMG, RE, "Report on the Survey of Canada", dated 30 December 1903, War Office, London, 058/2779.

[9] "The History of the Corps of Royal Canadian Engineers", Vol. I, Military Engineers Association of Canada.

Commanding a Territorial Army Field Squadron

By Major E. T. Boddye, TD, MA, AIM, RE(T)

Introduction

Little has been written in the past on the problems encountered in the peace-time command of a Territorial Army Field Squadron. There is obviously much in common on this score between the Regular Army and the Reserve Army, but there are less obvious differences, and some of these will be discussed. The author hopes this short article will be useful and provocative to younger TA officers and of interest to Regular Army officers, who may one day do a tour with the TA. Inevitably an article of this type draws heavily on personal experiences, on lessons learnt in time and those learnt tardily. In addition these experiences must necessarily relate to the TA pre-1967; however from examination of the new terms of service and policy statements regarding the T and AVR the problems and solutions will basically remain the same.

The aims of a Squadron Commander will include the following:

1. To raise the standard of training of all ranks to the highest possible.
2. To recruit effective numbers, to maintain discipline and the highest possible morale.
3. To keep on good terms with local authorities and employers and to maintain a good public image.

The Squadron Commander has necessarily to find his personnel locally. Within a few weeks an unfortunate series of changes of civilian jobs can lose him valuable officers and men. To this and other problems peculiar to the TA there are no easy answers, but pre-planning, intelligent day-to-day attention to administrative and training matters will cushion the impact of the unexpected.

The three headings under which the subject is discussed are:

1. Administration
2. Training
3. Morale and Recruiting

These headings are not in any order of priority, nor in practice are they in water-tight compartments. Frequently the Squadron Commander will find himself weighing factors from each before arriving at a decision.

Administration

It is essential that Squadron Headquarters is adequately manned and supervised, even if this on occasions may seem detrimental to other facets of Squadron activity. The requirement is for an active Second-in-Command, SQMS, Chief Clerk, RAPC Sergeant, MT Sergeant and Signals Sergeant. It is not possible to remain really viable unless these appointments are adequately filled. Though it may be necessary for periods to call in the services of a spare officer, the SSM or the PSI to fill a gap temporarily, this should be for the minimum period possible.

It would be misleading to give the impression that successfully filling these appointments is largely a matter of routine. In the Regular Army the

resources of the Corps are available for selection and posting; in the TA the choice is usually from existing volunteers. These in turn are recruited from a limited geographical area, which may or may not contain sufficient men with desirable job experience. Recruiting volunteers of sufficient technical potential requires the Squadron Commander's ear to be very close to the ground and this will be discussed later.

With the passing of National Service the recruitment of ready-trained TA volunteers has largely ceased. While it is inevitable that Officers, Warrant Officers and Senior NCOs in the TA will only rarely be at the same standard of training as their Regular counterparts, there is absolutely no reason why they should not be at least of similar calibre. Further to this, the tendency in the past has often been to underestimate the standard of training which really keen and encouraged senior ranks can attain. Underestimating the standard of training possible at these levels will reflect on the efficiency of the entire Squadron.

Few men consciously volunteer to administer, i.e. to type letters, to write up the POL Account, to indent for stores or to prepare pay sheets, but these and similar chores must be done efficiently and must be regarded as an integral part of the Squadron's training—as indeed they are. The mistaken but psychologically understandable attitude that the man who fires the gun or builds the bridge is in some intangible way contributing more than the man who processes a recruit's documents, must not be allowed to prevail.

Training

Given adequate numbers troop commanders should normally be in charge of training their own troops. However, if numbers are weak it is often more convenient to make field training the duty of one or two officers, one of whom is directly responsible to the OC for its detailed planning and execution. It will also be normally advisable to nominate officers to take a direct interest in MT and Signals, because for domestic or business reasons Senior and Junior NCOs are not always present to train in the desired quantity or distribution. While the burden of accounts and general administration usually falls on the Second-in-Command, where there are more than two accounts of any size other officers will have to take them on. These duties should unfailingly be circulated at about one year intervals around the Squadron officers for maximum training value so avoiding particular officers, however willing, being tied to chores they do particularly well to the detriment of their own development.

In practice officers tend to change their civilian job locations the most frequently so there may well be times of acute officer shortage and times of relative affluence. It is during the times of shortage that the ability of the Squadron to function effectively is really tested, and this depends on the remaining officers having been well-versed in as many aspects of military activity as are compatible with their length of service.

The training of potential officers bulks large as a problem in the reserve army. This can best be tackled by the use of the officer cadet system which with careful supervision allows a young man to be developed and mature under the best conditions attainable in the TA. The compulsory two weeks at an OCS are invaluable and these should be supplemented during the first two or three years of service by carefully selected courses. These latter depend, however, on the understanding and co-operation of his employers.

Units themselves should hold, at intervals of not more than three months, officer training week-ends to which it will often be found useful to invite Senior NCOs. Care must be taken that Officers and Senior NCOs do not lack that expertize which is appropriate to their rank; week-end or longer courses run by higher formations or organized at training centres should therefore be used as much as possible. The same reasoning also applies to Junior NCOs.

As it is usually very difficult to conduct training on more than two levels during the evening and week-ends, recruit training is unfortunately often neglected. The conclusion must be that in addition to what can be done out of Camp there must be a recruit's cadre of at least one week's duration during Annual Camp. If recruits are able to attend week-end courses or a week's cadre out of Camp this is obviously preferable, but the ever present problem of time off from work may be intractable in many cases as far as courses longer than a week-end are concerned.

Squadron training is normally at its most effective away from the TA Centre, either at a WETC or other suitable site. Tasks undertaken for local authorities, etc, can often be of good training value and in connexion with these tasks there are frequently bonuses to be had in public relations which can be a useful background to recruiting.

The proliferation of forms which must be completed before a recruit can be finally approved has long been a source of irritation to Squadron Commanders. Unfortunately, the same type of problem now occurs in obtaining permission to use land, even common land, for exercise purposes, and to undertake civilian tasks of good training value. While it is appreciated that safeguards are necessary, the advance notice of intentions which is now required coupled with the procedure laid down to obtain permission to undertake a task are such that they act as a deterrent rather than an encouragement. Serious thought is needed to ensure that only the simplest system with the minimum of paperwork is used.

Individual training records should always be kept which will enable the Officer and Senior NCOs responsible to see when a Sapper is ready for his next trade test. Trade testing boards must be convened whenever necessary to ensure candidates are not unduly delayed in having their proficiency assessed. Failure to provide tests at sufficiently frequent intervals will result in disillusionment and the loss of volunteers.

Annual Camp is the culmination of the previous year's training and it is regrettable that completely satisfactory attendances are not always obtained. It is not always appreciated that the balance of personnel who, before camp, signify their intention of not attending represent a challenge to the Squadron Commander. Personal contact with employers can help where obtaining leave from work is the source of the trouble. Dedication to this particular task often brings in big dividends. Failure to attend Annual Camp for whatever reason seems to break a link for a Sapper which is difficult to reforge. This is particularly true of the Sapper during his first two years when he is at his most impressionable. The experience of a Camp where the Squadron works well as a team is essential for a Sapper in his formative years.

While it is a platitude to say that all training should be made as interesting as possible, time to prepare for training is at a premium in the TA. In this connexion the PSI should be used to the full both in preparing training aids and in his advisory capacity. This in turn requires that the PSI must not be

saddled with administrative duties which should really be undertaken by TA soldiers.

Though every effort can be made to make training interesting, the TA has the disadvantage, unlike the Regular Army, that Sappers can select the evenings or week-ends on which they will attend. The tendency inevitably will be for better attendances for the ostensibly more interesting training periods. This can result in fewer Sappers being fully prepared for Trade Tests because of an inbalance in their training. Discipline can play very little, if any, part in alleviating this problem; the answer lies almost entirely in pure leadership and the powers of persuasion of the Squadron Commander, his Officers and Senior NCOs.

All ranks must be kept informed of what training there is to be each month. Details should be posted on notice-boards and it will be found of great value to distribute copies to individuals, not forgetting to ensure that those who are not present receive one either by hand or through the post. This training programme can also usefully be used to convey information on Squadron activities other than training.

Morale and Recruiting

The three props of morale are good training, good administration and an active social life in the Squadron. A Squadron will never attain the heights without all three. Whether the Squadron Officers' Mess, WO's and Sergeants' Mess and Junior Ranks' Club are Squadron based or shared with other sub-units because of location, it is essential that they are well run and equally important there is adequate officer interest. Where humanly possible mixed Senior Rank and Junior Rank Messes should be avoided for many reasons including status and discipline. Dances, socials and children's parties engender a spirit within the Squadron which helps to hold it together equally as well as a task well executed.

A Regular soldier has loyalties to his unit and to his family. A TA volunteer has his loyalties divided between his family, his job and the unit, usually in that order of priority. The demands of his civilian job, overtime, shift-work, etc, can sometimes cause a conflict of loyalties, but family demands are usually more important. If the wives and girl-friends of volunteers enjoy Squadron social life, maintaining high morale will be found to be much easier.

Irregular attendances of Officers and Senior NCOs can effect morale even though the standard of training and administration may not obviously be suffering at the time. The reaction of Junior Ranks perhaps can be roughly equated to the traditional attitude of the tenant farmer to the absentee landowner where lack of personal contact and interest bred indifference and misunderstanding. In any event failure by Officers and Senior NCOs regularly to take opportunities of getting to know their men, their backgrounds and problems, can only lead to Sappers lost to the Squadron. A commission in the TA or promotion to senior non-commissioned rank brings these responsibilities which cannot be shirked.

The inability of Squadron Commanders to promote NCOs and to recommend promotion for Junior Officers can be a problem where establishments are filled and the cases are deserving. More frequently perhaps, the reverse if the case, when difficulty can be experienced in filling key positions adequately. However, there are often periods lasting many years when the Squadron Commander can sense deserved promotions are stifled and morale is suffering.

This state of affairs can be avoided by keeping the age structure in mind when promoting and by ensuring retirements at the correct time. It may even be necessary under certain conditions to arrange for early retirements in order to safeguard healthy lines of promotion; diplomatic handling of the situation may well be called for.

Discipline has not been mentioned so far and it is not proposed to discuss the subject at any length. Cases of serious indiscipline are rare in the TA; this is not surprising in a volunteer force where any man who is disgruntled normally needs only to absent himself for a sufficiently long period of time in order to be discharged. In the context of the TA or the Regular Army there is something very seriously wrong with a Squadron with any sort of record for serious indiscipline.

It is generally accepted that serving Sappers bring in the majority of acceptable recruits. To get the maximum response, however, serving Sappers notoriously need constant chivvying to get on with it. While it is difficult to assess the effect of other influences on recruiting, there can be little doubt that TV and newspaper publicity, public parades and press advertising can only help create the right atmosphere for recruiting. It is well worth maintaining good relationships with the local press so as to obtain maximum coverage of Squadron activities of interest to the general public.

Personal contact with local employers has been mentioned in connexion with the releasing of volunteers to attend Annual Camp. This contact is also necessary to try and persuade firms, if not to encourage, at least not to dissuade their employees from enlisting. Normally attendance at Annual Camp is the stumbling block; employer's reactions range from a blank refusal to release a man at all without even allowing him to take his holiday at the time of Annual Camp, to an extra fortnight's leave of absence with pay. In many cases a more high-powered approach is required and these should be referred for action to the CO and local TA Association.

Recruits on arrival must be impressed by a smooth administrative procedure which deals with their initial documentation, attestation, medical examination and subsequent clothing and equipment issues. A disorganized or dilatory enlistment can at best create a bad impression and at worst a recruit can be lost.

Conclusion

The aims of the Regular and TA commanders regarding training, administration and morale are virtually identical but, from the very nature of the TA, it has been shown there are problems of recruiting, training and local liaison, which are rarely met by the Regular Officer. It would appear that commanding a TA Field Squadron is frequently more exacting than commanding a Regular counterpart, without taking into account that the TA Squadron Commander himself has job commitments and his own family to placate at week-ends!

Commanding a TA Field Squadron is a privilege which demands in return time, energy and a determination to succeed. The Territorial Army during the last decade and a half has become more and more professional in its outlook and the new T and AVR will continue this trend. Backed up by the traditional volunteer spirit and provided TA problems are understood, there are no difficulties the TA and its successor the T and AVR cannot overcome.

The Vanishing Castle

By Major B. C. R. Pollard, RE (TA)

Tourists and holiday makers visiting the Gateway to the Scottish Highlands will be puzzled as to why Polmaise Castle now lies in ruins—was it the victim of another Scottish/English skirmish, or was it struck by lighting? What actually happened to this once fine castle is a question which will be asked by many curious people. The answer is that its complete destruction came about not through war or act of God but quite deliberately by 115 (Hampshire Fortress) Engineer Regiment (TA) whilst at Annual Camp in July 1966.

In April the Commanding Officer, Lieut-Colonel J. F. Hill, TD, RE (TA) and Squadron Commanders made a flying visit to recce projects which had been offered by Scottish Command.

One task allocated to 578 Field Squadron, RE (TA) was the destruction of this 101-year-old granite castle in the Stirling area. The requirement was simply to reduce it to a height of not more than 3 ft above ground level.

As Polmaise Castle came into view, after a gentle climb up the drive meandering through a wooded hillside, one's first impression was of awe. There stood a magnificent granite building of 200 rooms now in semi-decay, but one's imagination easily drifted back to a century ago when its scale and beauty could only have been seen to be believed. Its siting was such that it commanded a magnificent view over the valley to Stirling—3½ miles away—and on to the horizon where the mountains stood out in all their splendour. In the valley on a small hill now stands a monument in memory of the Battle of Bannockburn. The actual site of the Castle is said to have been the location of Bruce's headquarters prior to the battle between Edward II and Robert Bruce on 24 June 1314, the day that the Scots gained their independence.

Information gleaned from local inhabitants revealed that the building was inhabited up to fourteen years ago and was kept in reasonable condition up to eight years ago. Since that time the structure had been left open to the elements and to vandals. On the ground floor everything salvageable had disappeared, window frames, doors, floors and, in parts, even floor joists. Where the weather had permeated through the upper storeys the timbers were riddled with dry and wet rot and woodworm. In places even part of the front facing stone had also been removed. From the outside the whole structure gave the impression of solidarity but from the inside a truer picture was formed—that of a decaying and highly dangerous structure. It was for this reason that the police and local authorities had requested its demolition.

The walls of the property were formidable. The average thickness was 3 ft but in places it went up to as much as 4 ft and consisted of an inner and outer wall of granite and a 6 in cavity filled with cement and flint grouting. Most of the internal walls were of similar construction, minus the cavity, but there was the odd wall of only 15 in thickness.

As the time limit of ten days had been imposed for the completion of the project the only possible safe method was demolition by explosives in the form of borehole charges. By calculation the quantity of explosive required came to 640 lb packed into 581 boreholes of 2 in diameter, average 24 in deep, in a double row 2 ft apart with alternate 3 ft centres.

The biggest problem now was that as the Regiment would be travelling to camp by train very few stores could be taken. This meant that all plant, vehicles and the majority of stores needed would have to be borrowed from Scottish Command and great credit is due to the permanent staff of 115 Regiment, Major L. J. Green (QM), Major B. W. W. Barrett (Training Major) and Captain L. J. Yeomans, MBE (Adjutant), for acquiring everything requested and to MEXE for their aid in providing their brand new 400cps electrical rock drilling equipment mounted on a Landrover. Incidentally this was a piece of equipment which made a very difficult job easy and one which completed twice as much work as the Army's standard air compressors.

Several possible demolition techniques were considered. One method was to complete it in one blow but this would have endangered local property, with considerable damage caused over a wide area. If it were to be done in four or five separate demolitions it could endanger personnel who would have to work in between blows in a property already in a precarious condition although the final result would be obtained with no or very little damage to the surrounding property.

The method eventually decided upon was to demolish the property by fourteen detonations initiated by an electrical ripple switch. This kept the size of each charge to a minimum (approximately 40 lb per detonation) and would endanger neither personnel nor surrounding property. Great care was necessary to ensure that during the actual demolition the electrical cables connecting the various charges would not be cut by previous explosions or falling masonry.

When the Regiment took up residence in Scotland and work finally started, test charges were carried out in old outbuildings using the calculated figures and as the result proved successful drilling immediately commenced on the main structure. This was a most arduous and dirty job especially when drilling the internal walls. The dust-filled rooms made the project hazardous as pieces of masonry and heavy timber fell unexpectedly and in places where the ceiling was dangerous a protective overhead covering had to be erected. Praise must be given to all the individuals who worked under the most appalling conditions and who found that even with face masks and goggles ten minutes was about the maximum time anybody could work in the thick dust without relief and fresh air. Although the site was plagued by many inquisitive visitors, young and old, who considered it impossible to complete the job in the time allocated, the "snowmen" soldiers completed all drilling in only five days and deserved the week-end respite before the packing of explosives began.

Extreme care was necessary when packing the large quantity of explosive, and particularly the laying of ring mains and siting initiation points.

Closer liaison with the police became necessary and their help was invaluable in warning local residents of the time and date of the "big bang"—as it became known. They did a grand job helping to keep away sightseers, closing roads and tracks on the day in question, and publicizing vantage points for people who wanted to watch the Castle's demise.

14 July 1966 dawned—a bright sunny and cloudless day—just right for the task ahead. As the clock drew nearer to 10.30 am—the fateful hour—tension mounted, so did the activity around the castle as VIP visitors, television cameramen and newspaper reporters all clamoured for pictures and information.

In the meantime the more important work of finally checking the electrical circuits was being made and by 10 am all systems were "go" except for connecting and inserting detonators into the circuit.

As the Honorary Colonel, Lord Porchester, and the Group Commander, Colonel R. F. Parker, MBE, disappeared towards the firing point after making their final visit the whole castle took on an air of expectancy, all went quiet, even the birds seemed to stop singing, and it became a very lonely place.

The crunching of boots on the hardpacked ground seemed to echo round the building as final connections were being made, while at the firing point the atmosphere was electric awaiting the moment of truth when a whistle blown by the Honorary Colonel would order "Fire".

The whistle blew, the ripple switch was swung, cameras whirred and clicked and in the distance a lone piper was playing his lament, when the whole area was shaken by a continuous roar which lasted approximately seven seconds. The castle became enveloped in a cloud of dust. When the dust drifted away the castle had disappeared out of sight below the tree line to be seen as a view no more.

It was a most satisfactory, even "copybook", demolition leaving a great pile of granite with debris lying no more than twenty feet away from what was the building and, thankfully, with no damage to surrounding property.

A successful demolition, just one part of a very successful last camp.

Introduction to a Corps Field Park Squadron

By MAJOR N. R. STURT, RE, MA, AMICE

"THERE's nothing like a dame" the song-writer tells us in South Pacific. Perhaps life in a Field Park isn't anything to sing a song about, but certainly it would be true to say "there's nothing like a Corps Field Park Squadron".

I was one of those rare birds who had never served in BAOR, when in the spring of last year I was warned for posting to 65 Corps Field Park Squadron. Consequently, I had little idea what was in store for me, and I was beginning to feel definitely uneasy when all my ex-BAOR contemporaries heard of my posting with remarks such as "65, eh? you'll find that—er—interesting . . ." But nobody could tell me in a few words quite what the Squadron did. Now I know why.

I arrived in Hameln one night, and was off early the next morning for Aschau in Bavaria, where my predecessor and the main body of the Squadron were on "exercise" (a convenient omnibus word that covers a multitude of sins). This particular exercise was primarily an excuse for getting everybody as far away as possible from barracks and the Brigade Headquarters, into the fresh mountain air and busy doing some fairly basic engineering—replacing log bridges on the forest tracks, clearing the site for the new village hall, making an access track, and so on. Most of us have the Boy Scout in us as well as the Old Adam—and both gentlemen had sport in Aschau. I have had quite a lot of difficulty ever since in keeping to reasonable proportions the number of follow-up exercises in Bavaria that somehow become essential.

On this, my first visit, I had to fit a lot into one day. But there was still time to make several firm friendships amongst the hospitable Bavarians, and that evening there was one of the regular parties that they love so much. The clapping and stamping of the Schuhplattler dances, splendid singing, music from the brass band, zithers and alpine horns, comic stories in the unintelligible local dialect and the inevitable speech-making filled the air; litre glasses and steins of beer from the village brewery followed each other in steady procession, until I for one was glad when the time came to get up and dance the Viennese waltzes and polkas.

That the beer was not entirely non-alcoholic was proved to me during the night when, after several hours of cold extremities and roasting middle, I discovered that the quilt (the only bed covering, of course) was folded in half and turned sideways. Sleep was much easier when this little matter had been corrected.

The rest of the week the departing OC and I spent on a tour round the headquarters and units with whom I would have to deal. Although I can hardly claim that I retained a clear impression of everything and everyone that I saw, at least I have been able since to say confidently to people on the phone "oh yes, we met during my take-over tour, didn't we?" The beautiful Rhine valley, with its romantic castles, busy river traffic and neat cross-hatching of vineyards, seen from the train and added to my memories of the breathtaking south Bavarian countryside, with its ever-present back-cloth

of the Alps, and the fine Weserbergland scenery around Hameln, made a wonderful introduction to Germany: almost good enough to erase the memory of the long, wet drive along a patchy autobahn crowded with enormous lorries belching smoke and spray, on my way to Hameln two days earlier.

After our whirlwind tour, we had a look at the Squadron back in Hameln, while it went through Ex *Quicktrain* drill—the "scramble" to survival areas that is practised periodically. I learnt then—and have had no reason to change my mind since—that I could never see the whole Squadron at once—in fact 50 per cent is about the best that can be hoped for. The rest are on leave, courses, Garrison duties, sick, in clink or on detachment—especially the last. Anyway, this exercise was my introduction into the difficulties of making Scammel trains, bridging cranes, lorry-mounted excavators and graders look like railway wagons or station buildings. I have learnt a lot on this subject since—and rediscovered a few facts, such as the amazing way a hundred or more soldiers vanish into a convoy of trucks to sleep, if not given a clear order to bed down clear of the vehicles.

By this stage in our hand-over I had a pretty good idea of what the Squadron is and does. We provide engineer support (plant, workshops and engineer stores) for the Corps troops, especially 11 Engineer Brigade of which we are part, and back-up support for the three divisional Field Park Squadrons. The basic organization is similar to other Field Park Squadrons—Plant, Workshop and Stores Troops—but with the addition of the Corps Lighting Troop, which has the primary role of providing electrical power for the Corps HQ in the field and, of course, is in great demand by everyone else who wants to get lit up. The Lighting Troop was—and still is—in the process of being strengthened to cope with the increasing requirements of Corps HQ with its closed circuit television, Thermofax duplicators and "curly pokers". I suppose that provision of electricity for HQs became a Field Park responsibility during the Second World War, although a Lighting Troop as such did not appear with the Corps Field Park Squadron until 1961. The troop now holds some sixteen 27½ KVA generators and appears to be a good example of a "growth industry". Provision of electricity is, of course, nothing new for the Corps. As far back as 1886 searchlight equipment was prepared for despatch to Suakin for the Sudan campaign, but eventually no unit was formed to operate it. From about 1895 Submarine Mining Companies RE were using searchlights, and in 1897 the Corps of Electrical Engineers was raised as a new Volunteer Corps to assist the Submarine Mining Service in working electric lights. In 1900 two Searchlight Sections were formed from personnel of this Corps for use in the field in South Africa—the direct ancestors of the Corps Lighting Troop, despite the divorce of thirty-five years later when the searchlights deserted us for the gunners.

The other Troops are straightforward. Plant Troop holds eight size II dozers available to supplement the Field Squadrons on bridging or other tasks, or for use on larger projects under the Troop's own control. It also holds four cranes and six excavators (four of them lorry-mounted), and the usual range of wheeled, towed and ancillary plant. There is usually a number of machines from the Chief Engineer's pool on our books—perhaps another eight dozers—to allow us to meet our commitments or run courses for operators. One of the very interesting tasks that Plant Troop lands periodically is to conduct Troop Trials on new equipments. Currently we have a rough terrain crane and two heavy wheeled tractors to play with.

The Workshops Troop has both static and mobile machinery and both soldiers and civilian tradesmen. The work they are required to do varies from repairing or making small machinery parts to keep plant running (without invoking the powerful but slow-moving REME organization), to major projects such as the adaptation of the infantry APC into an engineer vehicle or the manufacture of some hundreds of steel RDD crates to a special design. I mean sometime to carry out a study into what happens to the (literally) tons of tac signs and notice boards that are replaced by the Troop's annual output.

Stores Troop, again with military and civilian sections, has the job of providing engineer stores for the local units, accounting for all training stores used by the Engineer Brigade (a surprisingly large amount, too) and for controlling Vote 7 f materials and funds. Anyone who has ever required timber for trades continuation training (improving their Squadron bar) will know what I mean. Training for their war role is as vital to Stores Troop as for anyone else—but more difficult to do. The nearest we have come to it in my time has been on the occasions when the Troop has moved into the field for several weeks at a time to support one of the Engineer regiments on exercise. This service seems to be appreciated by our customers, and it certainly teaches us a lot. The message that engineering includes the proper planning, control and handling (and, in peacetime, recovering) of the necessary resources, seems to be getting over.

Of course, there is also a fairly large (and hard-working) HQ to control this diverse collection of specialist troops. For instance, the processing of spares for some 165 vehicles of various sorts is in itself quite a task. To improve the control of the transport, an MT Troop has now been formed as a separate entity; this would be a nice command for a young officer, with its seventy or so vehicles and same number of men, if there were only enough officers to fill the establishment.

It isn't all work and no play, of course. In the last year we have won a couple of cups for football, and one for cricket. We have regularly fielded respectable hockey and rugger teams, and had a go at basketball, cycling, athletics, and boxing; any unfortunate unable to think of a sport to train for finds himself running around this notoriously hilly area to the accompaniment of the SSMs strident urgings, or the MT S/Sgt's horrible puns; personally, I keep my breath for panting with. Last winter we had parties skiing in the Bayrischer Wald and the Harz Mountains, and this summer a team in the Nijmegen Marches and a party marching in Bavaria; all these jaunts, even with the strenuous training before-hand, seem to have been generally well enjoyed.

Some of the less usual tasks that have come our way have been digging an ancient Mammoth tusk out of a quarry (I don't think Sir Mortimer Wheeler uses Size II tractors for jobs like this); fitting permanent footwalks on a road bridge across the River Prien without drilling, cutting or welding the existing structure; helping to winch a flood-stranded Weser barge back into her natural element; and helping to convert a Weser steamer into a Gin Palace for an Officers' Mess party on the Queen's Birthday . . . on which happy memory I will end this brief description of life in that very odd unit, a Corps Field Park Squadron.

Aberfan

By Lieut-Colonel R. M. Merrell, MBE, RE
CRE 53 (Welsh) Division TA, Wales District

Introduction

Shortly after 0900 hrs on Friday 21 October part of the small Welsh mining village of Aberfan was engulfed in coal slurry which poured downhill from a mine tip half a mile above the village. The junior school was buried to the eaves, and a number of terraced houses were either swept away or submerged. A farm on the slopes above the village disappeared completely.

In the confusion which followed no accurate assessment of casualties was possible, but after immediate rescue efforts by those in the vicinity it was estimated that nearly two hundred people remained trapped or buried. Most of these were small children.

Early Military Measures

As soon as news of the disaster was received at Division/District Headquarters the normal twenty-four hour duty officer watch was reinforced in anticipation of calls for assistance from the civil authorities. Subsequently a liaison staff was also established at the central police station at Merthyr Tydfil, some five miles from the scene of the disaster, when the overall control of rescue and relief operations was assumed by the Chief Constable.

Initially the bid for military assistance was limited to radio communications for the Water Board, and the provision of water trucks and trailers for emergency water distribution. The former task was undertaken by the Parachute Regiment Battle School, and the latter jointly by RE and RCT.

The GOC nominated the CRE as Force Commander for Abervan, should such a force be required, and all units were required to report what men, equipment, and material assistance they could provide.

Force Headquarters Established

At 1400 hrs on 22 October the CRE at Swansea received instructions to report as soon as possible to Aberfan to attend a conference at the colliery. On arriving shortly after 1600 hrs he found the Deputy Commander of 160 Infantry Brigade from Cardiff already there with a summary of the troops and equipment available, but no conference materialized. It was learned that the Borough Engineer had assembled his subordinates elsewhere in the village to review the situation so the CRE left to offer advice and assistance in that quarter, whilst the Deputy Commander returned to Cardiff to brief the Brigade Commander.

The situation was still extremely confused, but the Borough Engineer was sure he had all the resources of men and material he required, and that an earlier fear that water supplies were contaminated had proved groundless. No major assistance with water supplies was, therefore, required although limited local distribution by truck and trailer was still necessary.

The CRE then toured the village and inspected the disaster area, visiting all civil authorities involved in rescue and relief operations. These included the Civil Police, the National Coal Board, Civil Defence, the Borough Engineer's Department and the Water Board, Medical Services, Welfare

Services, Salvation Army, WVS, Red Cross and other voluntary organizations.

The situation was this:

(*a*) The immediate area of the disaster was overcrowded with manual labour and plant.

(*b*) Traffic in the village was very congested, but the police were striving to enforce a one-way circuit and to restrict access to the village to essential vehicles.

(*c*) Effective overall control by one authority had not been established in the disaster area. Individual civil organizations continued to function separately as best they could on instructions from Merthr Tydfil and elsewhere.

(*d*) Bids for assistance were intended to be passed back to the central police station at Merthyr Tydfil, but this was not well known nor did many departments realize the sort of military assistance which was immediately available.

In these circumstances the CRE decided to remain, and by 1800 hrs had set up a small headquarters in the colliery to provide military advice to the various civil departments and to command all military forces which might as a result be deployed to Aberfan in their support.

Command and Communications

This decision was immediately confirmed by the divisional staff at the Chief Constable's headquarters in Merthr Tydfil. Command was then established as follows:

(*a*) Overall military control was exercised through the divisional staff at the Chief Constable's headquarters.

(*b*) HQ 160 Infantry Brigade in Cardiff deployed troops to Aberfan in response to demands from the divisional staff based on bids from Force HQ.

(*c*) Force HQ in Aberfan commanded all troops from the time they arrived in the disaster area until they were relieved.

(*d*) Commander 160 Infantry Brigade remained in overall command of military operations.

Communications were initially limited by overcrowded civil telephone lines. Radio links were later established between the divisional staff, HQ 160 Infantry Brigade, and Force HQ.

The system of command worked well once intercommunication could be guaranteed, and it remained virtually unchanged. It had the advantage that military advice was immediately available both at Police Headquarters and in Aberfan. It would have been very much more effective if Force HQ had been able to deal locally with one central authority rather than a multitude of separate organizations.

Force Build-up and Tasks

With Force HQ established the military advice offered on the site to the various civil authorities was that:

(*a*) Tired volunteer diggers should be replaced by formed military parties on a regular relief system.

(*b*) The number of people crowding the immediate disaster area should be reduced to that which could be properly controlled and employed—preferably by means of a military cordon operating in conjunction with the civil police.

(*c*) In any event, refreshments should be available at organized canteens away from the working areas, and should not be taken to individuals on the site thus delaying work and adding to the overcrowding.

(*d*) Working conditions could be improved by immediate assistance with traffic control, local communications, and illumination.

For various reasons associated with the particularly tragic nature of this disaster and the local feeling it had aroused, the civil authorities felt unable to accept much of this advice in the early stages, although it was implemented later when the time was thought appropriate.

The military build-up was, therefore, slower than it might otherwise have been, and during the evening of 22 October, and night 22/23 October, the following forces were employed and tasks undertaken:

(*a*) The Parachute Regiment Battle School continued to provide communications for the Water Board, and RE and RCT the crews to distribute water by military truck and trailer.

(*b*) Recce Pl 5 Welch (TA) established and maintained throughout the night a radio patrol net near the summit of the mine tip to provide early warning of any further movement.

(*c*) A digging party of forty men from 5 Welch (TA) reinforced the labour force in the area of the school in response to a bid from Civil Defence HQ. This party was subsequently withdrawn on instructions from the civil police because too many men were employed in this area and no others would fall out.

(*d*) Another working party was redeployed at 2340 hrs at the request of the local police to form two small cordons on the main approaches to the disaster area. These quickly took effect, but were withdrawn later the same night on instructions from the Chief Constable.

(*e*) 638 Lt AD Regt (TA) deployed three lighting detachments; one to supplement emergency lighting in the area of the school, one at the site two miles away to which spoil was being carried, and one in reserve.

(*f*) Parties from a variety of units provided load carrying transport and delivered stores from Army sources as civilian stocks ran out. 10,000 sandbags, 1,000 blankets, and 200 mattresses were delivered and distributed during the night.

By dawn on Sunday 23 October the situation was improving. The existence and location of Force HQ was becoming widely known. The presence of troops in the village had been accepted and was welcomed, and military advice was being sought on all sides. In fact Force HQ became a clearing house for requests of all natures, many of which had to be redirected to the police and other civil authorities whose concern they were. The result was a fairly rapid build-up of the military force.

Considerable progress was made possible by a decision taken at 0800 hrs that the area should be cordoned off by troops. After a joint reconnaissance by the Chief Constable and Force Commander at 0900 hrs the disaster area was sealed at 1030 hrs by a cordon found from elements of 5 and 6 Welch and 2 Mon, under CO 2 Mon as Cordon Commander. The cordon was established without difficulty, was immediately effective, and the police were at last able to take positive measures to reduce the over-crowding within it.

During the early afternoon further reinforcements arrived from RE, R Sigs, and 4 Welch, and a reserve was formed both under the Cordon Commander and at Force HQ. Reserves were employed on short-term tasks

for whichever civil authority required organized labour, whilst at the same time an immediate cordon reserve of one platoon was maintained. In the event the latter was not required.

In the same period TA Provost detachments reinforced the police under the direct command of the Chief Constable, assistance with stores continued, some help with transport for food distribution was provided, and limited wiring tasks were undertaken to strengthen the cordon. In all some three hundred troops were employed in Aberfan by the afternoon of 23 October.

At no stage after the initial reconnaissance did it seem likely that any major Engineer assistance would be required. During the first few days the use of earth moving plant was restricted because it was not known where the victims lay. The Coal Board had in any case more than adequate resources of plant and transport, and was quick to redeploy further resources from other pits if necessary. Skilled colliery labour was available for earthworks and shoring tasks, and there was no major water supply problem.

Hand-over

Shortly after noon on 23 October the GOC accompanied by Commander 160 Infantry Brigade arrived to review the situation and organize the relief of the Territorial force by Regular troops.

A mixed force comprising RN personnel from HMS *Tiger* which was docked at Cardiff, elements from the Welsh Brigade Depot and from the Army Apprentices College at Chepstow relieved TA units during the afternoon and early evening of 23 October pending the arrival of a Regular infantry battalion later on 24 October. During this relief an outer cordon was established on the approaches to Aberfan, and CO 2 Mon took over as Force Commander from the CRE.

Conclusions

The Territorial Army was particularly well-placed to render Service assistance at the Aberfan disaster because it occurred in an area in which a number of units are located, and shortly before many TA soldiers were due to report to their drill halls for training.

A great deal of valuable military assistance was in fact given, but much more could have been done earlier if the civil authorities had requested it. This would not have affected the loss of life but, in particular, it would have resulted in effective control being established more quickly.

Commanders and staff at all levels experienced an initial reluctance on the part of the civil authorities to ask for military help. The possibility that the presence of troops in the early stages might be resented may have been overemphasized, and the fact that the troops immediately available were local men may not have been sufficiently appreciated. In the event troops were everywhere welcomed and their efforts universally appreciated.

It is unwise to attempt to draw many lessons from one event. Those learned at Aberfan were in any case not new, but two stand out:

(*a*) The over-riding necessity for close civil and military control at the scene of the disaster itself.

(*b*) The continual requirement to instruct the civil authorities in the forms of assistance the Services can give in times of disaster and the wisdom of accepting military aid from the outset.

A Study of Cavities in the Ground

By Lieutenant G. R. Oxley, RE and Lieutenant M. D. P. Young, RE, BSc, BD Squadron RE

Introduction

The Authors were serving as reconnaissance officers of the BD Squadron RE, and were instructed to write this paper by their Commanding Officer. (Almost completed by the first author, the second has only put the final touches to this paper.)

The Bomb Disposal Squadron receives many calls each year to investigate holes in the ground which the local police and others believe to have been caused by wartime bombs. Although much information can be gained from a study of wartime bombing records and interviews with people who lived in the area during the war, no final decision can be made until the cavity has been investigated. The original holes of entry of many unexploded bombs have often long since been filled in, blast damage repaired and memories have become blurred, nevertheless after a period of time an unexploded bomb can cause a cavity or depression to appear on the ground. In many such cases however it eventually becomes obvious that a hole is due to natural causes and in some areas of the country these are well known. These cavities are called Swallow holes, Swallet or Dene holes, depending on the county, and are invariably caused by water action not far below the surface. The study on which this article is based was that of correlating the location of known Swallow holes and the geological strata, to help in the identification of natural cavities in the ground.

This study examined the smaller holes up to about ten feet in diameter, but depressions of up to two hundred feet in diameter are known.

Geology

Rocks are classified according to the way in which they were formed, their composition and their age. There are three main methods of rock formation. Sedimentary rocks are the remains of previously existing rocks being laid down in water or on land; igneous rocks are formed from the cooling of molten rock and metamorphic rocks are created by changing the character of the rock by heat, pressure or chemical reaction. Sedimentary rocks cover by far the largest part of Britain.

Igneous and metamorphic rocks are only to be found in Cornwall, North Wales and Scotland. These rocks, which are of the granite and greenstone type, have a light topsoil covering and in general they do not lead to the production of natural cavities.

Our chief concern therefore is with sedimentary rock formations. These were laid onto the country in layers or beds which may be a few inches or several hundred feet thick. Earth movement and natural erosion has since formed the present day structure of bedding planes split vertically by cracks and covered by a thin layer of topsoil. The lie of the beds is not as simple as Fig 1 might suggest, e.g. faults in bedding planes can occur and the beds may be displaced vertically by several feet on either side of the fault. As it is only intended to give a broad picture over the country these instances can only be mentioned here.

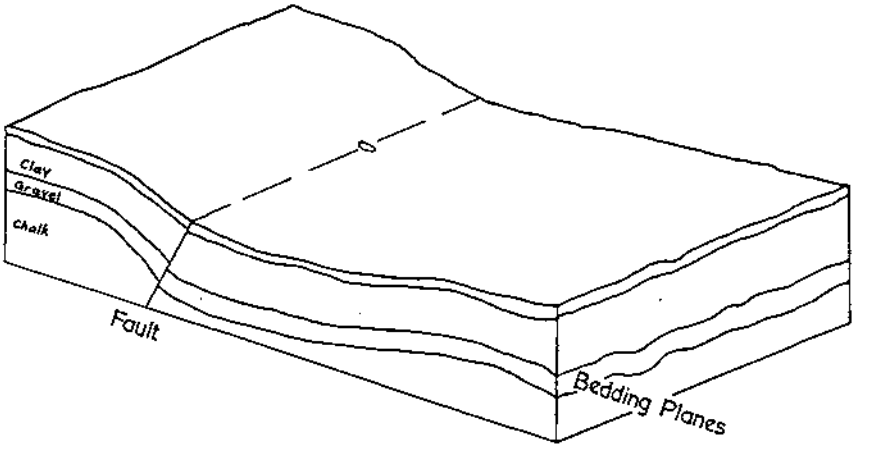
The main types of sedimentary rocks found in this country are clays, chalks, sandstones, limestones, gravels and grits. (They are listed by age, the first being the youngest.) There are many varieties of each of these and, although for excavation it is useful to know the detailed properties of each, for this study it is only essential to know whether or not they are permeable and the solutional effect of water on them. As a general rule only clays are impermeable and only chalks and limestones are soluble. There are of course, mixtures such as the Keuper Marls.

The vertical cracks in rock formation are instrumental in the forming of natural cavities. To understand why, it is necessary to know a little about hydrology.

Hydrology

Water percolates through the pores in the rocks and flows along cracks and bedding planes. Major Slip Planes are clearly shown on the 1-in OS Geological maps, and are denoted by lines on the maps themselves. Although some bedding planes are illustrated on the vertical sections drawn at the bottom of these maps, other bedding planes have to be worked out by a closer study of each map or the order in which rocks occur. Water moves downwards through what is known as the Vadose Zone until it reaches the zone where all spaces in the rock are filled with water. This level is known as the water table below which is the Phreatic Zone. The water table is liable to have seasonable changes being constant only when the supply of water through the Vadose Zone is equal to the discharge of water through the Phreatic Zone. There is also a close link between the water table and the level of rivers and streams; as a river cuts its way down through a valley so the water table is correspondingly lowered. It is the water travelling through the Vadose Zone that by solution and scouring is the chief cause of natural cavities. Generally speaking therefore, in permeable rocks, if the water table is on or near the surface, natural cavities would not be expected. The vertical cracks in rock formations form natural drainage channels for the water passing through the Vadose Zone. Water flows down the cracks and along the bedding planes, though this pattern can be upset by beds of impermeable rocks. It is where the cracks and planes meet that there is the greatest scouring effect. The action here will tend to form a cavity with the water carrying away the displaced material, and the probable development of this is shown in Fig 2. When the cavity is near the surface it can collapse as the weight of unsupported earth becomes too great, or it may be broken into by the wheels of a vehicle.

Natural cavities have a definite shape, similar to an upright circular bell in the ground. The bottom of the cavity is invariably full of topsoil. On the other hand when a bomb passes through the ground it it liable to jink leaving a small cavity in the ground which in time, due to successive roof collapse, comes to light. The depression or cavity formed will be more oval in shape than the natural cavities, and it is possible by careful probing to get an impression, by its shape, whether it could be a bomb hole or not. Broken land drains will give the same scouring effect in the surrounding soil as the natural joint between a crack and bedding plane, and they are therefore a common cause of cavities and depressions. This can be checked by digging out the bottom of the cavity.



Typical location of Swallow Hole at a fault.

Fig. 1

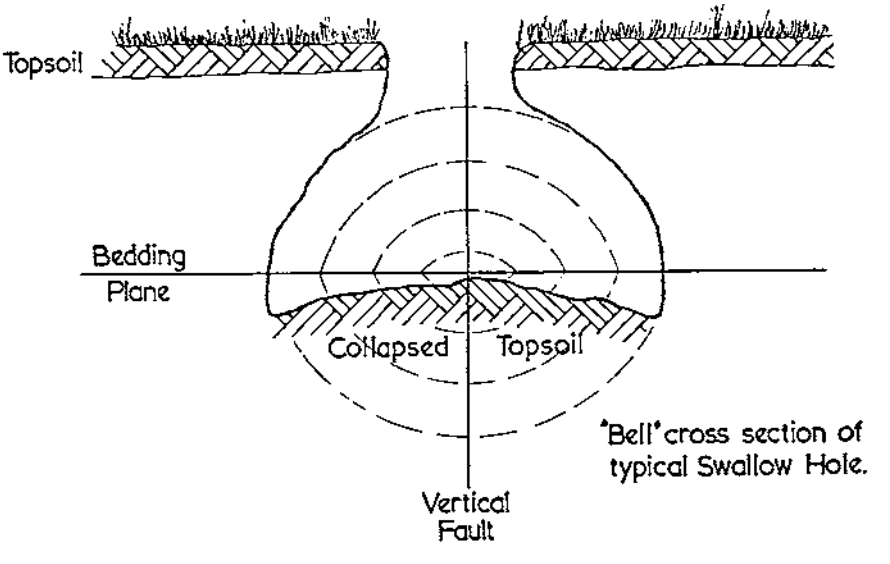


Fig. 2

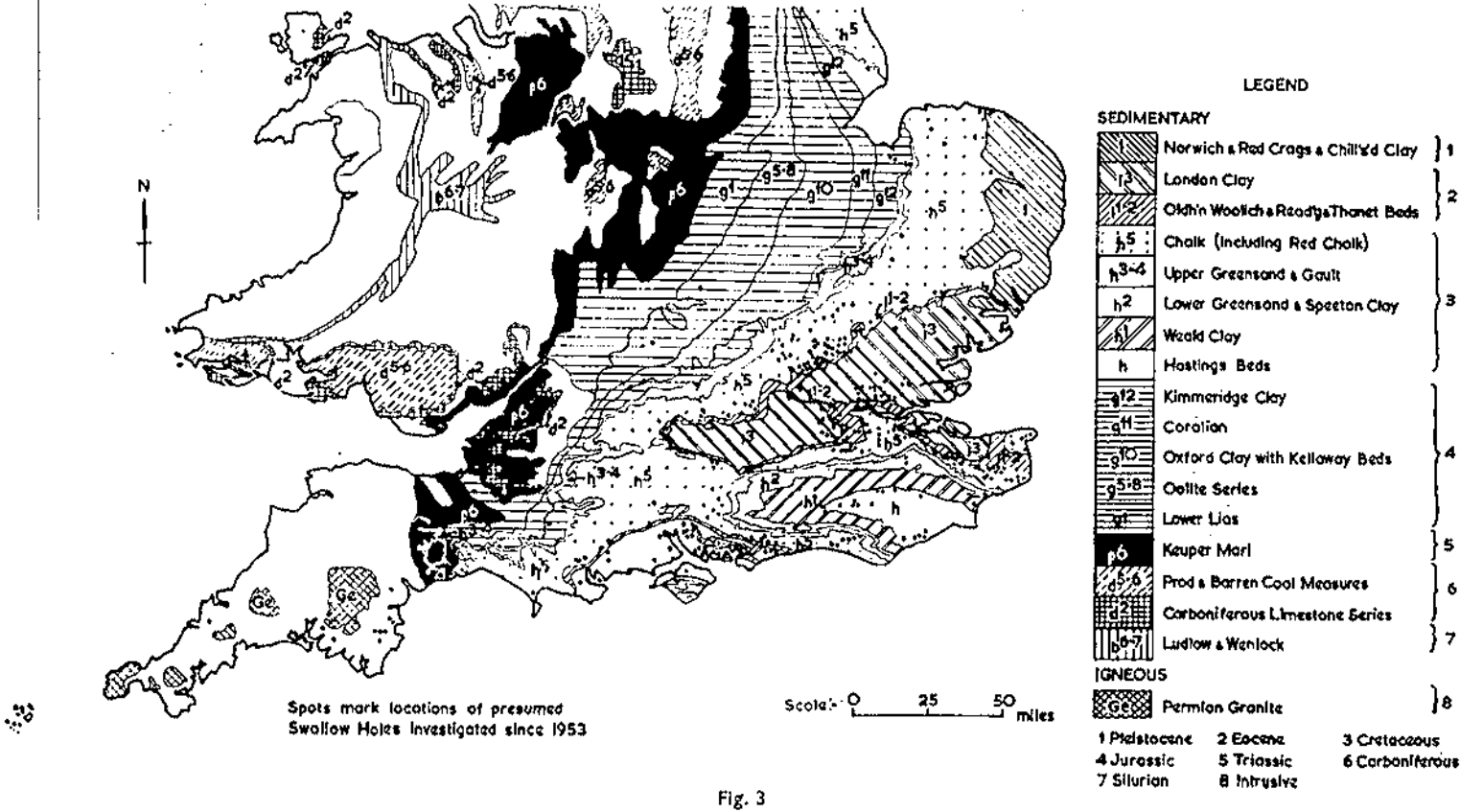

N
Spots mark locations of presumed Swallow Holes investigated since 1953
Scale:- 0 25 50 miles
LEGEND
SEDIMENTARY
Norwich & Red Crags & Chill'd Clay
London Clay
Oldh'n Woolwich & Reading Thanet Beds
Chalk (including Red Chalk)
Upper Greensand & Gault
Lower Greensand & Speeton Clay
Weald Clay
Hastings Beds
Kimmeridge Clay
Coralian
Oxford Clay with Kelloway Beds
Oolite Series
Lower Lias
Keuper Marl
Prod & Barren Coal Measures
Carboniferous Limestone Series
Ludlow & Wenlock
IGNEOUS
Permian Granite
1 Pleistocene 2 Eocene 3 Cretaceous
4 Jurassic 5 Triassic 6 Carboniferous
7 Silurian 8 Intrusive

Fig. 3

The Location of Natural Cavities

So far we have discussed in general the formation of natural cavities in sedimentary rock formations. There are however various factors influencing this process in different areas of the country, which must be discussed under the headings of the different rock types.

Cavities in Chalk

Fig 3 shows all suspected natural cavities visited by the BD Squadron since 1953. It is clear that they are commonly found on the line where clay beds start to overlie the chalk in Southern England. The reason for this is that water running off the impermeable clay is concentrated on to this line. The actions of forming the cavity are as described, but there is a far greater quantity of water involved and therefore many more holes appear. Quite large depressions have been found up to one hundred and seventy feet in diameter, six feet deep. Further information on Swallow holes in chalk is given in Reference E.

Cavities in Clay

It is unlikely that any hole could stand up in clay for twenty or more years. Wet clay is a plastic substance which under the pressures exerted by rain and topsoils will move into any hole and leave at the best a slight surface depression. However, if clay is lying thinly over chalks or limestones, a cavity may form in the chalk and the clay collapses into it. These are typical in the boulder clays overlying the chalks of N. Norfolk. Holes very similar to the one shown in Fig 2 are formed.

Another phenomenon to be found where the clay only lightly covers the chalk is a borrow pit. This is where, in the past, farmers have dug through acid clay into the chalk which they spread over their ground to improve its quality. The holes are usually fairly large and bear no resemblance to the bomb hole or spherical cavity of a camouflet. These are quite easy to recognize, for cart tracks are found leading to the pits and down into the large types.

Cavities in Limestone

The limestone areas of Great Britain are the Mendips, Pennines, Forest of Dean and South Wales and are shown clearly on the UK Geological Map. Cavities here are formed in the same way as before but there is one type peculiar to these areas. It is common for a stream to be completely swallowed by the limestone. The point of entry of the stream is known as a swallow. As the water table is lowered by the erosion of valleys, the stream may find another point of entry into the limestone at a point further upstream. This leaves a depression and hole in the ground at the original entry known as a swallet. These swallets are of great interest to "Pot Holers", and most swallets are well recorded by them.

Cavities in Sandstone

Cavities are found in sandstone which are formed by the methods described earlier, but no special form of cavity has been recorded for these areas.

Cavities in Gravels and Grits

Gravels, sands and grits could not support any hole for more than a few years. Where holes appear they are due to considerable underground water

flow, sweeping the gravels out of the region of a fault. Geological maps are available showing the sand and gravel beds useful for construction purposes. However, there does not seem to be any correlation between the location of these beds and the holes suspected to be due to natural causes.

Conclusions

Natural cavities have a peculiar underground shape and are found in easily identifiable rocks where the water table is not far below the surface. They are most common when the clay beds lie thinly over porous rocks such as in Norfolk and the Midlands and along the edges of the London clay. Carboniferous Limestone Areas are well known for "swallets".

Other causes of cavities in the ground are due to collapsed wells, leaking drains and sewers. These the authors have found occur in the areas of the heaviest bombing, with great frequency, and have led to several wild goose chases.

References

The Authors have studied the following:

A. Bomb Records BD Unit (UK) RE.
B. "Structure Surface and Drainage in SE England", by S. W. Wooldridge and D. L. Linton (Mimms holes).
C. "Polycyclic swallow holes in the R. Manifold Valley", by Jordan T. Warwick.
D. "British Caving", by Routledge & Kegan Paul, Ltd.
E. "Swallow Holes in Chalk", by Colonel W. Pett, RE, *RE Journal*, Volume IX, No 5, 1909.

Arctic Search Party

By Lieut-Colonel R. S. Hawkins, MA, AMIMechE, RE (ret'd)

Due to the persistent agitation of the Royal Geographical Society, the Admiralty, in 1845, has been persuaded to send a sea expedition to broach the "Northwest Passage", and so to find and chart for the first time a route from the Atlantic to the Pacific Ocean, through the waters of the American Arctic. Captain Sir John Franklin, RN, in HMS *Erebus* accompanied by Captain Francis Crozier in HMS *Terror* sailed from Greenhithe on 19 May 1845 on this expedition. It was considered that the lands and waters of that Arctic area had been sufficiently charted, albeit still very incompletely, by Ross, Parry, Franklin and others, for such an expedition to be successful. Nevertheless, few people had yet realized the magnitude of the hazards and terrors in those frozen waters, even under normal climatic conditions.

No effort had been spared in equiping the ships, which, for the first time in Arctic exploration, were fitted with auxiliary screws. The finest and most experienced Naval Officers and men were picked, most of whom had had previous Arctic experience. Franklin's instructions were to sail "to that portion of the land on which Cape Walker* is situated. . . . From that point, we desire that every effort be used to endeavour to penetrate to the Southward and Westward, in a course as direct as possible towards Bering Strait as the position and the extent of the ice, or the existence of land at present unknown, may admit". In July, a Danish Whaling Captain saw the

* Cape Walker, at about 74°N 98°W, is the northern tip of Russell Island, at the Western end of Barrow Strait.

ships moored to an iceberg, awaiting favourable conditions to penetrate the pack ice and enter Lancaster Sound. Eventually they sailed Westward, and forever vanished from the sight of civilized man. It was not till fourteen years later that any precise intelligence of the missing ships and crews came to light, and then only after an unprecedented series of official and private search expeditions.

By the end of 1846, the Admiralty were officially perturbed at receiving no news of the *Erebus* and *Terror*. The ships had been provisioned for thirty-six months, and, at the time, no undue alarm was felt at the ability of the experienced officers and crews to survive, even if progress was severely impeded by Arctic conditions. Nevertheless, early in 1847, the Admiralty laid plans for relief expeditions, of which there were to be three:—

1. Sir James Ross in the *Enterprise*, accompanied by Captain Bird in the *Investigator*, were to search for Franklin, following the course he had been instructed to take, i.e. by way of Lancaster Sound and Barrow Strait.

2. Captain Kellet in the *Herald*, accompanied by Captain Moore in the *Plover*, were to search the Bering Strait, and if possible sail along the North Coast of Alaska in the direction of the Mackenzie River. This expedition was based on the hypothesis that Franklin had penetrated the Northwest passage and might be heading for some Siberian port.

3. A land party was to travel to the Arctic Coast of America, and search in the area of the Mackenzie and Coppermine Rivers.

Arrangements were put in hand accordingly. For the land party, the plan was to ship them to York Factory in Hudson Bay, the ensuing journey to be overland, by way of the existing rivers and lakes. To aid their progress, and as a means of transporting their own and relief provisions, the Admiralty ordered four boats to be built at Portsmouth, suitable for river navigation, to be of small draught, of light weight and to carry two tons each. The boats were clinker built in Norway fir, and had bow and stern "sharp like a whale boat". To make them both suitable for river work and negotiating rapids, and also fully seaworthy, they had detachable keels, which could be bolted on for use in the open sea. Two boats were 30 ft in length, 6 ft in beam and 2 ft 10 in in depth, weighing 10 cwt each with all fittings. The other two boats were similar, but scaled down to 28 ft in length, so that the smaller could fit inside the larger for stowage on board ship.

At this stage a leader had not been nominated for the land party, but the Admiralty pondered carefully over the manning of this expedition. In due course, the Master General of Ordnance (MGO) received this letter, which he referred to Sir John Burgoyne, Inspector General of Fortifications (IGF) for report:—

Admiralty
4 Apr. 1847

Gentlemen,

It being the intention of my Lords Commissioners of the Admiralty immediately to prepare an expedition to be employed in tracing the progress of Sir John Franklin to the West of Cape Walker, and it being desirable that this expedition should comprise 15 Sappers and Miners (including the proper non-Commissioned Officers), men who have been trained to row in Boats, and among them a competent number of Carpenters and Blacksmiths, my Lords are anxious to be informed if such number of so trained Sappers & Miners could be detached from the Corps on this Service.

2. The above NCOs & men would have to leave this country in one of the

Hudson Bay Company's Ships, about the 1st June next, although they would not be joined by the Officers who are to take charge of the expedition nor be required to proceed in their actual search until the Summer of 1848, and my Lords could beg to suggest whether, in the event of its not being necessary eventually to proceed in such search, this body of Sappers & Miners might not prove a valuable addition to the Artillery Post on the Red River or to the other Posts in that Country, in the charge of HM Troops.

3. The Expedition will be embarked in 4 boats in Command of the proper Officers on the Mackenzie River and to winter the winter of 1847 on the Great Bear Lake, where steps are to be taken for erection of the necessary Winter House, and for preparing everything requisite for a Fishing Establishment &c.

I have the honour to be, etc.

Burgoyne evidently reported favourably on this proposal, and meanwhile, an old friend and associate of Franklin, Sir John Richardson, MD, had been appointed leader. He had been surgeon and naturalist on Franklin's polar expeditions of 1819 and 1825; on the latter occasion he explored the 900 miles of coast line from the Mackenzie to the Coppermine River, and named the Dolphin and Union Strait, from the names of his two boats. As his second-in-command, he had Dr John Rae, a qualified surgeon who had joined the Hudson Bay Company. In 1846, he explored and charted 700 miles of coastline in the vicinity of Repulse Bay, thus extending the surveys of James Ross and William Parry.

Burgoyne received a further communication from the Admiralty, dated 17 April, informing him of Richardson's appointment and continuing:—

"It has been deemed advisable that the party of Sappers & Miners, which my Lords trust will be allowed to volunteer for this Service, together with the entire charge of the Boats, Stores &c. should be under the management and control of Mr George Bell,* an experienced Chief Trader, who will meet the Party on its arrival at York Factory. With reference to that part of my letter of the 4th inst., requesting men might be selected accustomed to the management of boats, my Lords can hardly expect men would be found so qualified in the full sense of the term, and consider it would be sufficient if the men to be selected (& which would only be after examination by Sir John Richardson as to their bodily health and physical strength) are practised in the mean time to the use of the Oar."

Matters were in fact moving fast towards the launching of the first ever expedition for the relief of Franklin. Burgoyne had discussed matters verbally with the Admiralty, and he submitted the agreed proposals for the final approval of the MGO in a minute dated 27 April. These were briefly:—

(i) The men "of the trades of Carpenters, Joiners, Sawyers, Boatbuilders, Wheelwrights, Blacksmiths or Miners, who may be disposed to volunteer", should be discharged from the Corps on their embarkation, and be permitted to re-enlist in the RS & M on their return.

(ii) The men to be provided with "Slop clothing, Bedding & Wrappers, suitable to the Climate, and rations without spirits, free of charge by the Admiralty"—and paid at the rate of double their present Regimental Pay.

* A clerical error for John Bell of the Hudson Bay Company. He had explored the Bell River and found its connection with the Porcupine, thus opening up the route for the rich fur trade with the Yukon.

(iii) At the expiration of the Service, each man to receive, upon Sir J. Richardson's certificate of conduct, a gratuity of from £10 to £15.

(iv) Men to leave the country in early June for York Factory, and on arrival proceed to Winter Quarters under the direction of Mr Bell, until joined by Sir J. Richardson next year.

The Admiralty had formally agreed to these proposals and authorized pay at double rates, of which a six months advance of pay was to be paid on 1 June. To put this into effect, they requested the Secretary to "move the Board of Ordnance to authorize Messers. Cox & Co., the Ordnance Agents, to make the advance in question".

The Brigade Major, RS & M Depot Woolwich, meanwhile had circulated Units of the Corps asking for volunteers. There was a response of forty-eight eligible and suitable Sappers, who in due course assembled at Woolwich for examination by Sir John Richardson. The men finally selected were nominated in the Return dated 17 May and sent to the IGF (Plate I). Richardson later recorded, "5 Seamen and 15 Sappers & Miners were selected; they were all men of good physical powers, and, with one exception, bore excellent characters. The solitary exception was one of the Sappers & Miners, who had repeatedly appeared on the defaulters' list for drunkenness, but, as he was reported to be in other respects a good and willing workman, and I knew he would have no means of obtaining intoxicating drinks in Rupert's Land, I yielded to his request that I would allow him an opportunity of retrieving his character. Few Seamen were employed, since I knew from experience that as a class they march badly, particularly when carrying a load. The bulk of the party was composed of Sappers & Miners, because that Corps contains a large proportion of intelligent artizans. Of the men selected, 6 were joiners or sawyers, and 4 were blacksmiths, armourers or engineers, who could be useful for repairing boats, working up iron, constructing the buildings of our winter residence, or making furniture".

The selected Sappers realized that their pay would be of no use to them on the actual expedition, and asked the Brigade Major for it to be paid into the Regimental Savings Bank. This had to be refused, as, on embarkation, the men would be discharged from the Corps and hence not entitled to the advantages of the Saving's Bank. After further discussion on the method of payment, the Admiralty informed the Principal Officer of Ordnance (17 June) "Payments of men's wages will be made to their families or next of kin, and the risk incurred by such advances will be borne by the Naval Department".

The main body of the expedition, five Seamen and fifteen Sappers, embarked on the Hudson Bay Co's sailing ships *Prince of Wales* (351 tons) and *Westminster* (513 tons) at London. They were accompanied by all their equipment and provisions, which consisted of:—

Four Admiralty boats.
Towing lines, anchors, boat fittings, etc.
A percussion carbine and serrated bayonet (for use as a saw) for each man.
Four hundred rounds ball cartridge.
Ninety pounds small shot.
One hundred and twenty pounds fine powder.
A double set of tools for making or repairing a boat.
A tent for each boat's crew.

A Seine net.
Pemmican, flour, sugar, tea, chocolate, bacon and biscuit amounting to 14 tons in all.

Each man was issued with a "Flushing jacket and trowsers, a stout blue Guernsey frock, a waterproof overcoat and a pair of leggings". The two ships set sail from the Thames on 15 June 1847, and reached York Factory after much delay by ice in Hudson Bay. The *Prince of Wales* anchored on 25 August and the *Westminster* five days later.

The Governor of the Hudson Bay Co., Sir George Simpson, who co-operated magnificently with the Admiralty in this enterprise, had left London in April for Canada. On arrival he initiated arrangements for facilitating the journey of the search expedition to the Mackenzie River. He briefed Mr Bell in the task he was to undertake, procured indigenous products such as snow shoes and canoes, and engaged Canadian "voyageurs" to accompany the expedition and assist in building winter quarters. It was essential to get winter quarters established on the Great Bear Lake, before the winter of 1848/49 made travelling impossible.

Under the direction of Mr Bell, the seamen and sappers proceeded in their boats up the Nelson river to Norway House, at the North of Lake Winnipeg, thence by Cedar Lake and the Saskatchewan River to Cumberland House, where they occupied winter quarters. The journey by water involved continual "portages" to pass the rapids and other unnavigable reaches of the waterway. They were transporting a vast quantity of stores and seaworthy boats, for ultimate use in the Arctic Seas 2,400 miles away. For this stage Mr Bell's party consisted of:—

5 Seamen
15 Sappers
16 Canadian "voyageurs"
3 wives and 2 children of the above
2 children of Mr Bell.

There were four Admiralty boats and one extra provided by the Hudson Bay Company.

Early in 1848, they continued in a north westerly direction by Pelican Lake, the Churchill River, and Ile de la Crosse to Methy Lake where they encamped 27 June 1848, by which time they had journeyed over 1,000 miles along difficult waterways, involving considerable "portages".

Meanwhile, Richardson and Rae had left Liverpool on 25 March 1848 on the wooden paddle steamer *Hibernia* and arrived in New York on 10 April. They travelled by river steamer to Montreal, where they met Sir George Simpson, and learnt from him the detailed arrangements made by the Hudson Bay Company for the expedition. They then travelled by the St Lawrence and the Great Lakes to Sault Ste Marie, where on 29 April they took charge of two canoes arranged for their use by Simpson. On 29 May they entered Lake Winnipeg and proceeded via Norway House to Cumberland House where they learnt that Mr Bell was fourteen days ahead. He had left two of the Sappers, James McLaren and Robert Graham, behind. Richardson recorded "They were unequal to the labour, one due to a hand injury and the other due to recurrence of pains in the bones. After examining them, I sent them to York Factory and thence by Hudson Bay Co ship to England in September".

Richardson and Rae then followed the same route as Mr Bell, whom they met on Lake Methy on 28 June. The Methy Portage, between the Lake and the Clearwater River was about two miles, for which horses could normally be hired on the spot from an Indian. All the horses had died of murrain, and this long portage had to be carried out by manpower. Several of the men were "lame from fatigue of crossing the numerous carrying places on the

PLATE I

Return of Men of the Royal Sappers and Miners, who have been Medically Examined and Selected by Sir John Richardson from Volunteers, to accompany the Expedition for tracing the Progress of Captain Sir John Franklin to the West of Cape Walker.

Woolwich, 17th May 1837.

Rank.	Names.	Trade	Age. Years	Age. Months	Service. Years	Service. Months	Character	Remarks.
2d Corporal	James McLaren	Carpenter	28	1	6	11	V. Good	
	David Brodie	Carpenter	21	3	1	4	Good	
	Robert Graham	Carpenter	25	5	7	5	Good	
	Henry J. Ralph	Carpenter	26	7	6	9	V. Bad	
	Robert Mackie	Carpenter	24	4	6	6	V. Good	Lance Corporal
	Donald Fraser	Carpenter	25	1	1	4	Good	
	Edward Dodd	Lead & Iron Turner	20	6	1	4	Good	
	Hugh Geddes	Painter	19	5	1	5	Good	
Privates	Richard Webb	Millwright	24	4	1	4	Good	
	James Mitchell	Smith	25	4	7	-	V. Good	Lance Corporal
	Jacob Hobbs	Smith	23	9	1	2	Good	
	Thomas Bugbee	Smith	25	5	1	5	Good	
	John Salter	Smith	29	10	6	10	Good	
	James Waddell	Miner	20	9	1	9	Good	
	Robert Dall	Miner	23	9	1	5	Good	

H. Sandham
Brigade Major

Churchill River, and unfit for any labour on this long portage". Each fit man had to carry five 90 lb loads of stores, etc, as well as his own bedding and kit. The boats and fittings entailed two journeys of the whole party, and the portage took nine days in all. By 6 July all boats were loaded and on the Clearwater River, and on 11 July the party entered Athabasca Lake, where they encountered the "Mackenzie River Brigade of Boats", which supplied useful intelligence on the measures for supplying the expedition during the winter at Fort Confidence on the Great Bear Lake.

At Fort Chipewyan on Lake Athabasca, letters home were handed over to the Hudson Bay Co staff, and the expedition struck north along the Slave River to Fort Resolution, which was reached on 17 July. Here Richardson pushed ahead with the search party proper, which consisted of three of the Admiralty boats and a portable boat always referred to as "Lt Halkett's boat". The personnel, besides Richardson and Rae, comprised five seamen, thirteen Sappers and four Canadian guides. In addition to provisions, kit and cooking utensils, they carried tents, carbines, ammunition, snow shoes and trade goods as gifts to the Eskimos. From the Great Slave Lake, this party followed the Mackenzie River down stream, and progress was rapid for they reached the estuary on 3 August and were in sight of the open seas of the Arctic. No doubt Richardson recollected his instructions from the "Commissioners for executing the Office of Lord High Admiral", dated 16 March 1848, which were to examine the coast between the Mackenzie and Coppermine Rivers, and also the west and south shores of Wollaston Land. He had also to leave pemmican at various nominated points for the use of James Ross in the *Enterprise*. The search was not to be prolonged beyond the winter of 1849.

Mr Bell in his large boat with one Admiralty boat, heavily laden with provisions and equipment for winter at Fort Confidence, proceeded at a slower pace. He followed the Mackenzie River as far as Fort Norman, where he proceeded up the Great Bear River and across the Lake to Fort Confidence, at its extreme north. Here he set about preparing winter quarters, and establishing a fishery, for the return of the search party as winter set in.

At the estuary of the Mackenzie, Richardson first enquired at the Eskimo settlements for any news or information on the missing ships. None was forthcoming so the expedition sailed and rowed eastward along the coast, stopping at every sign of Eskimo habitation to enquire for news. They continued to row eastwards along the recently charted shore, until signs of Eskimo activity virtually ceased. There were worse portents, as they started to encounter small ice floes and then sheet ice; the Arctic winter was in fact setting in. At about 600 miles from the Mackenzie, ice conditions and snow storms became worse, and progress could only be maintained by climbing any high ground on the shore in an attempt to trace a route ever eastward, clear of impassable ice. They had to carry out innumerable "portages" along the rocky shore and across ice obstacles. Richardson abandoned any idea of crossing the Dolphin and Union Strait to Wollaston Land on 21 August owing to the extreme uncertainty of achieving such a journey and returning. A good day's journey was reduced to five miles or so, and on 27 August after covering only three and a half miles, one boat and her cargo was abandoned to lighten the labours, at a point about twelve miles north west of Cape Krusenstern.

In the following days the weather deteriorated further as they struggled

on towards the Coppermine River. On 1 September Richardson made the reluctant but inevitable decision that the search could not be continued, and they halted at Icy Cove about eight miles NE of Cape Kendall in the Coronation Gulf. They were stormbound for two days, and as there was no improvement in the weather, Richardson decided to abandon the boats, tents and a large quantity of provisions.

They now had a 150 mile march overland to Fort Confidence. Each man had to carry a 60 lb to 70 lb pack, and the loads so prepared comprised provisions for thirteen days, cooking utensils, bedding, snow shoes, carbines and ammunition, Lt Halkett's boat and fishing equipment. On 3 September they set out and covered 12 miles in the first day. Next day they encountered a small river, on which, Richardson recorded "I bestowed the name of my active, zealous and intelligent companion Mr Rae". Donald Frazer, one of the Sappers, sprained a knee and his load had to be lightened. On 5 September they crossed the Richardson River, 140 yds wide, using Lt Halkett's boat and dinner plates instead of the paddles, which had been left behind. For the next three days they struggled on in a continual snow storm and a freezing north wind. Richardson, then aged 59, later recorded "The effect of the last three days march showed I had over calculated my strength, in loading and clothing too heavily"; he had to transfer his gun and some clothing to one of the seamen.

On 10 September they came to the Kendall River, where the Sappers constructed a three-man raft which was towed to and fro across the river until all had crossed. On 15 September they reached the first rapid on the Dease River, where they found, as previously arranged with Mr Bell for their return, a large boat into which they all gratefully clambered; they arrived at Fort Confidence that evening.

The next three days were spent in warmth and comfort, writing despatches and letters home. In order to relieve the pressure on the accommodation at isolated Fort Confidence, Richardson decided to keep only three of the Sappers, David Brodie, Robert Mackie, and James Mitchell, and two seamen, with him during the winter. The remainder, with three Canadian voyageurs carrying letters and despatches, proceeded by river to Big Island on the Great Slave Lake, where they spent the winter of 1848/49. Of the party remaining at Fort Confidence, the Canadians were employed on the fisheries and cutting firewood, and the two Sapper carpenters, Mackie and Brodie, were employed in making tables and chairs. In this manner a snug winter and Christmas was spent.

On 7 May 1849, Richardson's party of three Sappers, two seamen, Mr Bell and some voyageurs set out by sledge across the ice of Great Bear Lake to Fort Franklin, arrving on 13 May. Mr Rae, in accordance with instructions, with a party of five, dragged a small boat back to the Kendall River and later searched the mouth of the Coppermine. He was unable to proceed northwards and cross to Wollaston Land owing to the impassable ice in Coronation Gulf, which persisted throughout that summer.

Richardson's party waited for three weeks at Fort Franklin, as the expected boat for the journey south was held up by ice at Fort Simpson, and the whole of the lower part of the Mackenzie was not navigable, due to ice, till 23 May. On 9 June Richardson and three others set out down the Great Bear River in a small fishing coble, Brodie and Mitchell being instructed to walk along the river bank carrying their own packs, to lighten the boat load.

They were warned against straying inland and becoming lost. Shortly afterwards the coble was stopped to pick up the two marchers, but Brodie had succeeded in losing himself by taking a short cut. Richardson waited an hour and then proceeded fourteen miles downstream to an established cache, where he left written instructions and provisions for Brodie. "He was a man of much personal activity and considerable intelligence", wrote Richardson, "he resolved on walking to the cache, having at last recognized a hill feature. He came to the Black River and swam across it carrying his clothes on his head. The stream was very tortuous, and he crossed it a second and a third time in the same manner; but his bundle slipping off, he gained the bank in a state of perfect nudity. He came to the conclusion that without clothes he must perish, so he plunged in again and fortunately landed this time safely with his habiliments". On the third day Brodie found the note and provisions, suspended from a pole for his use, and he made his way back along the Great Bear River to the Lake, and later joined another boat descending from Fort Franklin.

The whole party then journeyed from Fort Norman on the Mackenzie River to the west end of the Great Slave Lake, where they were joined by the remaining Sappers and seamen, but were delayed by ice till July. Following their previous route they reached Norway House on 13 August 1849. At this point, the time for parting had come. Mr Bell had already travelled north again on Company Business, and the seamen and Sappers were sent on to York Factory for the voyage to England. Richardson recorded not unkindly, "Crews better fitted for heavy portage work, and for the ordinary duties of a winter's residence in the north might doubtless have been selected in the country, but none that I could have depended upon with so much confidence in adverse circumstances".

On 31 October 1849, the Accountant General of the Navy wrote to the Secretary of Ordnance, Pall Mall:—

"The men named in the margin have returned to England by the *Prince Rupert*, and have been paid by this Department the amounts due to them respectively."

The men so named were thirteen of the fifteen Sappers of the RS & M Brigade Major's return of 17 May 1847, two of whom had been sent home from Cumberland House on medical grounds.

In 1859, Captain Leopold McClintock, RN, returned from a two year Arctic search in Lady Franklin's yacht *Fox*, bringing for the first time precise information on the crews of the *Erebus* and *Terror*, who had all perished under conditions of appalling privation in 1847/48, in the vicinity of King William Island. Thirty-nine expeditions by sea and land, official and private, had taken part in the search for Franklin over a period of twelve years. His Memorial lay in the vast fund of geographical knowledge and Arctic experience gained thereby. A party of Sappers set out in the first expedition ever to leave the shores of England in the search for Franklin. They carried out their allotted tasks, and so, with many hundreds of others, joined in this tremendous enterprise.

ACKNOWLEDGEMENT

Extracts have been freely quoted from "Arctic Searching Expedition" (Sir John Richardson, 1851).

Combined Services Expedition to South Georgia 1964-65

By Captain P. F. Fagan, MBE, RE

Every year the Royal Navy's Ice Patrol Ship, HMS *Protector*, spends the southern summer in Antarctic waters. Four years ago, during a visit to South Georgia, three of her officers narrowly failed in an attempt to climb the highest peak of this mountainous island, which rises to nearly 10,000 ft. One at least of them was so determined to return that he was able to persuade the Admiralty of the practicability of sending a full-scale expedition to the island. The expedition would attempt to climb the highest mountains, resolve doubts as to the exact route across the island taken by Sir Ernest Shackleton in 1916 and carry out a fairly detailed survey of an area of particular interest.

This officer, Lieut-Cmdr M. Burley, RN, was appointed leader, and was soon very busy working out the detailed plans of what was to be the largest and possibly the most ambitious expedition mounted by the three Services since the war. He was an experienced expedition leader and was also able to draw on the Navy's very considerable experience of exploration in Antarctica, so that these plans were well advanced by mid-1963 when details, including how to apply to join the expedition, were given in DCIs.

South Georgia is a very lonely island, a thousand miles east and south of the Falklands of which it is a Dependency. It is approximately 120 miles long in a NW–SE direction, averages about 20 miles in width, and is so indented with bays and fjords that no place on the island is more than seven miles from the sea. Yet there are many peaks of over 6,000 ft and the highest mountain—Mt Paget—rises to 9,625 ft. Its history really starts in 1775 when it was claimed for the British Crown and named by Captain Cook, though several others may have sighted it before this. Cook thought it was part of the Antarctic continent—which he was looking for—until he rounded the southern end of the island which he called Cape Disappointment in expression of his feelings. Since then its history is very closely concerned with whaling and sealing, but stocks of the former have been so reduced that only two companies—both Japanese—now man whaling factories on the island, and these may cease their operations when present leases run out in a year or two's time. There is a small community on the island, meteorologists, radio operators, etc, and an administrative officer and his wife. This group numbers about a dozen during the winter and probably doubles for the summer when the whaling fleets arrive.

In 1916 South Georgia saw part of one of the most extraordinary journeys ever made. Shackletons *Endurance* had sunk in the Weddell Sea six months earlier, and after terrible privations in appalling weather they reached Elephant Island near the tip of the Antarctic peninsular, but they were still no nearer rescue. Shackleton decided to sail for South Georgia, 1,000 miles away across perhaps the roughest seas in the world—south-east of Cape Horn, and seek help there. Five others accompanied him on this epic journey in a ships lifeboat from the *Endurance*. The weather lived up to its worst, but fine seamanship brought them to South Georgia where the wind blew them on to the lee shore of the western side of the island. They had still to get across to the other coast where the whaling stations were, but a very

rugged range of completely unexplored mountains stood in the way, and the men were worn out from their buffetings at sea. Three were left behind, while Shackleton and the two fittest set out with no maps or equipment apart from a carpenters adze and a coil of rope. They achieved this crossing and arrived at Stromness Whaling Station on the East coast to the utter amazement of the men working there. Rescue operations were immediately put into effect, though it was three months before a ship was able to find a way through the ice to Elephant Island, and bring out the men left behind there. As in all Shackleton's expeditions no lives were lost.

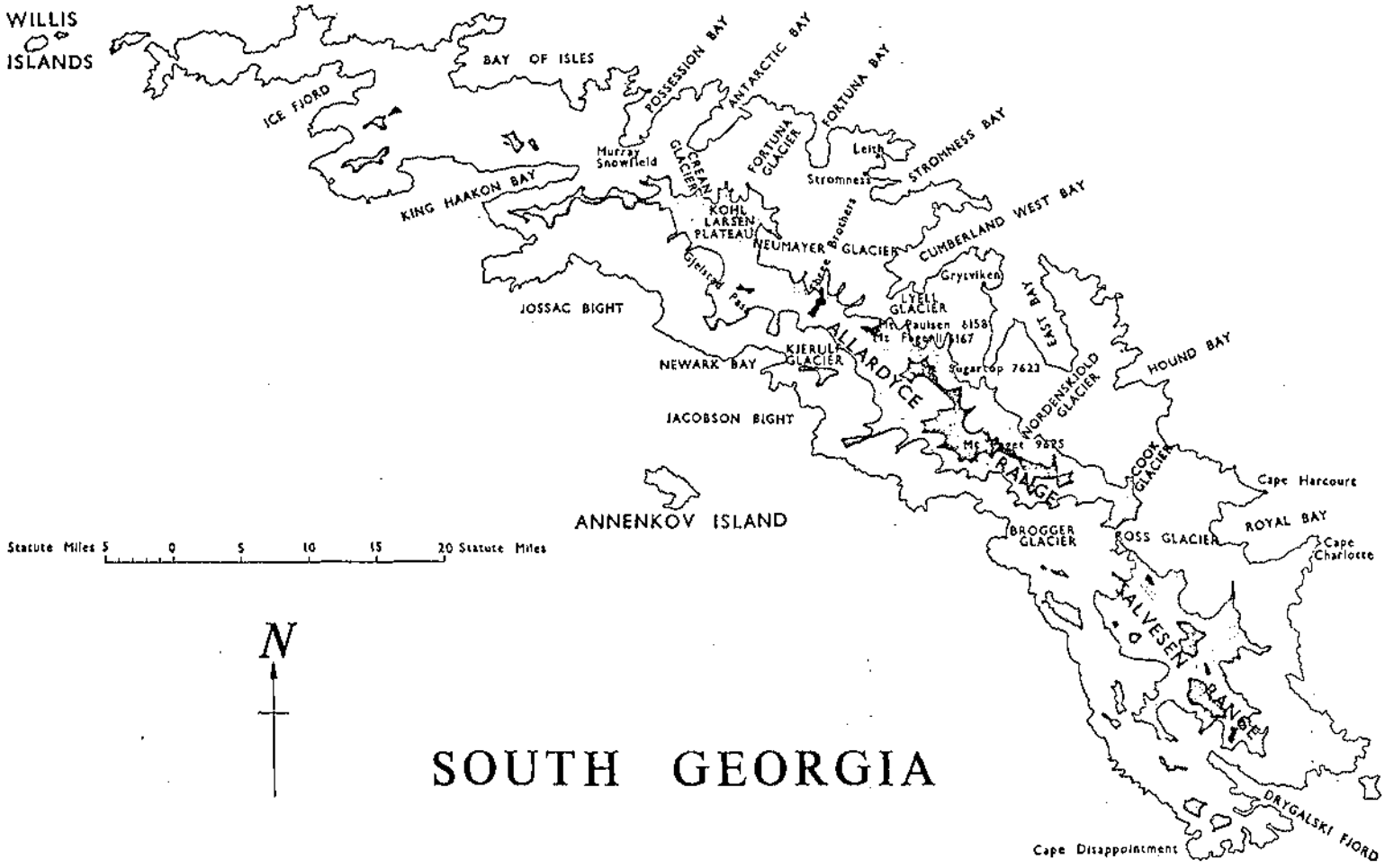
Early in 1964 the process of picking the expedition team began. Each Service had to reduce over 100 applications to a short list of twelve, and the resulting thirty-six suffered interviews with the Navy's senior Psychologist before attending a selection board at the Royal Geographical Society. I had the good fortune to find myself in the final team of ten, and was given responsibility for the survey. The party consisted of three each from the Army and RAF, and two each from the Navy and Royal Marines. There were five officers. During the spring and summer the team met up for climbing week-ends, and a weeks survey acquaintance course at the School of Military Survey. Individuals attended other courses in still and cine photography and visited Universities to learn as much as possible about their respective responsibilities—zoology, geology and cryptology (the study of mosses and lichens). In each case the person concerned was already a keen amateur at his subject. The time passed very rapidly into October when the expedition gave a Press Conference on board HMS *Discovery* by Waterloo Bridge. This was chaired by Lord Shackleton, son of the explorer, who had just been appointed MOD (Air) in the new Government. He also attended a farewell cocktail party that we gave on board that evening.

Three days later we gathered in the evening of a gloomy autumn day at the Cromwell Road Air Terminal and within hours found ourselves in the light sunny air of Montevideo in spring. We were hit by a tidal wave of hospitality from the Ambassador down, and revelled in a final fling of parties and nights out in this very gay and attractive city, before boarding HMS *Protector* for the journey south. Stores were broken down, issued and checked as we approached the Falkland Islands, where the expedition spent three energetic days regaining fitness after Montevideo, and trying out new equipment.

Soon after leaving Stanley the climate started to change. A fog descended bringing a damp cold with it. There was a considerable swell which affected most of the non-naval members of the expedition, but it was fortunately nothing like as rough as expected.

Four days later it dawned clear and we had our first sight of South Georgia —magnificently shaped mountains, beautifully clad in clean snow and ice, glistening many colours in the early sun. The sight was awe-inspiring enough to induce conversation to whispers as we made our way up the fjord to Grytviken, and many envious remarks were later passed. Once ashore we visited the memorial to Sir Ernest Shackleton at the entrance to the anchorage, and also the graveyard about a mile away where he is buried. The whaling station is passed on the way and is so old with grime and weathering that thoughts inevitably turned back to relive all what we had read of those events nearly fifty years before. That evening the small community welcomed us with the last and perhaps the best of all our send-off parties.

In the next three days dumps of food and other stores were made at four


WILLIS ISLANDS
BAY OF ISLES
ICE FJORD
KING HAAKON BAY
POSSESSION BAY
ANTARCTIC BAY
FORTUNA BAY
Murray Snowfield
CREAN GLACIER
FORTUNA GLACIER
Leith
Stromness
STROMNESS BAY
KOHL LARSEN PLATEAU
NEUMAYER GLACIER
Bjelcich Peak
Brothers
CUMBERLAND WEST BAY
Gryviken
JOSSAC BIGHT
LYELL GLACIER
Mt Paulsen 8158
Mt Flagstaff 3167
EAST BAY
NEWARK BAY
KJERULF GLACIER
ALLARDYCE RANGE
Sugartop 7623
NORDENSKIOLD GLACIER
HOUND BAY
JACOBSON BIGHT
Mt Hodges 9825
COOK GLACIER
Cape Harcourt
ANNENKOV ISLAND
BROGGER GLACIER
ROSS GLACIER
ROYAL BAY
Cape Charlotte
ALVESEN RANGE
DRYGALSKI FJORD
Cape Disappointment
Statute Miles 5 0 5 10 15 20 Statute Miles
N
SOUTH GEORGIA

places around the coast before the time came for us to leave the comfort of *Protector*. The weather was deteriorating fast when the last helicopter flight was completed, and then we were left alone on the shores of King Haakon Bay as Shackleton had been long ago. Snow was falling and the wind rising fast as we hurried into our tents for our first night ashore.

The ten of us were paired off into five tents of a design well proved in the South Georgia weather. They were wedge-shape and pitched blunt end into wind. Pitched in this manner the sides of the tent billowed out giving greatly increased room and making it more difficult for snow to accumulate. Li-los were then inflated, the primus started and rations investigated—these last were to prove extremely good. Our first thirty-six hours ashore were perhaps the most uncomfortable of the whole expedition. The wind and snow increased and within a very short time the tents were awash. Pools of water lay on the li-lo's, sleeping bags were soaked and bodies extremely cold. The wind was the dominating factor, continually changing direction and reaching 80–90 knots.

A very bedraggled team surfaced on the morning of the third day when the storm abated, but a very healthy respect for the weather had been born. The two sledges were loaded up and with five on each we started up the glacier behind the camp with the first load of stores. South Georgia is too mountainous for mechanical tractors and too crevassed for dogs to be worthwhile, and so manpower had to be employed. Initially five men were pulling about 400 lb, but depending on slope and snow conditions 400–700 lb could be carried. Harnesses were worn and designed so that the main pull came on the upper part of the thighs.

The first part of the route lay up a fairly gently sloping glacier to the Shackleton Gap, where we pitched our camp hurriedly as another storm hit us. We then sledged our stores in relays on to the Murray Snowfield at about 1,500 ft where a heavy snow fall was experienced. I woke in the early hours of the morning with a colossal weight on my legs where snow was drifting over the tent. The wind was blowing hard, and the snow was building up quicker than the two of us could dig it away. After half an hour we gave up and returned to our sleeping bags taking in quite a lot of snow with us. Throughout that day and night the snow fell and the tents were gradually crushed under its weight. Living space within became less and less despite the tent walls being propped up with rucsacs, etc. During the evening we were reduced to a squeezed up sitting position as the weight of snow gradually reduced space further, but fortunately both wind and snow stopped in the morning and we were then able to dig ourselves out. It took the full efforts of all in good conditions to get the tents out in five hours. This could never have been done in a blizzard, and burial was a real possibility in a prolonged storm. In future tents would have to be repitched on fresh snow every time it started to accumulate and this saved much futile digging. In time we became very proficient at these rapid repitchings.

Ahead was the first obstacle of the route where Shackleton had described four cols, or breaks, in the sharply serrated ridge. His party had climbed up all four cols and did not like the look of the descent on the other side of any of them, though circumstances finally forced them down the last. We agreed with him over the first two but decided ourselves to go down the third, and so prepared to lower the stores. This was done by having anchor men picketed in at the top of the slope and joined to the sledge by two 600 ft nylon ropes. Four men accompanied the sledge, which had turns of rope on its runners, to

provide extra braking and steerage. The slope was descended in bounds of 600 ft until a suitable site for unloading was found, and the sledge then returned for another load.

It was a long day carrying all the stores up one side of the col and then lowering them down the other on to the Crean Glacier, named after one of Shackletons companions. It was now ten days since we had landed in King Haakon Bay and still we had not seen the sun. That night the fiercest wind yet experienced got up and blew throughout the following day and night. Each gust could be heard approaching and then suddenly with a violent clap we were in the middle of the gale. Small particles of ice rasped hard against the walls, and the canvas flapped and banged in the wind like a drum. Speech at these times was impossible, and we just lay fully dressed in our sleeping bags expecting the tents to go at any moment. A ski stuck upright in the snow was snapped in two by the wind, and the top found later blown some distance away over soft snow.

At last the sun showed itself and our journey was continued in near perfect weather. Progress was excellent and we gained about ten miles to the second major obstacle in the next two days, covering over thirty with the relays.

We had a little difficulty initially in finding the exact route, at this point, of Shackletons crossing from his description, but eventually found his gap 'like an extracted tooth'. Reconnaissance showed this to be the best route over the ridge, but the latter half of our descent varied slightly from his. We used the same techniques in lowering as before. It was during a reconnaissance of this descent that three of the expedition were involved in an avalanche from which they luckily escaped with bruises, though rather shaken.

We were now back to sea level on the moraines of the König Glacier and for the first time had to forsake our sledges and resort to back-packing. Our camp was made on the König, and in the morning all bar overnight equipment was packed into a dump, and we set out on the last stage of about five miles to Stromness Whaling Station. It was snowing quite hard and the wind was rising again as we stumbled through deep wet snow over the pass. It was very difficult to find the route in the conditions and this short distance took nearly six hours to cover. We passed by the waterfall which Shackleton and his party had climbed down with difficulty and noticed that had they retraced their route back upwards only twenty feet their way down would have been far easier. We could now appreciate how the effort for even this could prove beyond them, as we plodded through a very wet and boggy plain to the now deserted whaling station, with vacant windows and doors slamming in the wind. But despite the appalling weather—a Force 11 gale was reported from a whale-catcher just off the coast—a small reception committee had gathered to meet us in the old Managers office, and a very happy group drank many toasts before going round to Leith by boat.

The first aim of the expedition was successfully concluded, but I think all were somewhat taken aback by the violence of the weather—despite previous indoctrination. It enhanced the respect for Shackletons achievements, even though his descriptions of heights and distances were a little exaggerated. It is interesting that the route they chose—of necessity in a hurry—was without doubt the only safe one, and their description of it, recalled later from memory and without the aid of a map, was particularly accurate and easy to follow.

A Japanese whaling company man the station at Leith and they were excellent hosts while we waited for the gale to blow itself out. The station was toured during the cutting up of a whale, and later we were given some whale

steaks which proved quite excellent to everyones surprise. In the evening shows were given of Japanese films, which were quite easy to follow when served with a liberal supply of Japanese "Scotch".

After two nights behind solid walls we set out once more with further supplies of food collected from the Leith dump. The Japanese saved us several days of back-packing over very unpleasant ground by taking us round to the König Glacier by sea in two sturdy launches. Their goodwill was ill-rewarded when one of these went hard aground while beaching stores, and it took several hours of heaving and pulling in icy water to free it.

The expedition was once more on its own and had now to transport itself complete with all its stores to a position from where it could attack Mounts Paget and Sugartop, the primary climbing aims of the expedition. The NE faces of these peaks were known in advance to be far too steep and avalanche-swept for an attempt to stand a good chance of being successful, and so the aim was to establish a base camp on the upper Kjerulf Glacier on the SW side of the island, giving easier slopes to these two, and many other unclimbed peaks should there be enough time.

The snow was softer this time as midsummer approached, and from now on we nearly always had to use skis while pulling the sledges. Initially this proved a source of many laughs as we stumbled over each others skis, but there were many advantages—not the least being that crevasses were more easily crossed, though this was still not enough to avoid falling into one as I found to my cost. It was very hard work and the strain fell on different muscles to those used previously. One man was quite badly frost-bitten, and so was towed Father Christmas-like on a sledge, paying for his journey by reading to us from one of the paperbacks that came with the rations.

Fewer days were lost due to the weather, but we worked long hours trying to gain time for the climbing later. Reveille, normally a loud shout from the leaders tent, was around seven (4 am in reality, but watches were advanced three hours for psychological reasons). Breakfast, the packing up of tents, etc, and loading of sledges took about an hour and a half, and from then until any time between six and nine pm depending on weather, the sledges travelled up with one load and back for another. Occasionally, if the slope was straight and not too steep, it was possible to toboggan down, though this once ended in a hair-raising spill. Loading the sledges had to be done carefully, and bounds could not be too long for fear of being caught away from tents and rucsacs by a sudden change in the weather.

My birthday occurred during this period and it was decided to celebrate the occasion with a party to break the possible monotony of continued sledging. That day we stopped at five, and a wind shelter was made using a tarpaulin supported by ski's stuck upright in the snow. For an hour we sang, drank carefully saved Pusser's rum and laughed at an excellent cabaret turn by the two marines before the increasing cold urged us to our tents. Very different from twelve months before when I had been sweating in the desert up-country from Aden.

The slopes now got steeper as we sledged up towards the Gjelstad Pass at about 4,500 ft. At the same time the weather clamped down into a thick cloud which persisted almost continuously for three weeks. The nights were very cold and the days extremely hot as the cloud was usually thin above us. Faces peeled very badly until a weird collection of protective masks appeared, and we stripped to underclothes while pulling the sledges; one hearty marine startling all with his dazzling red ballet tights which had previously been

concealed. Quite frequently the visibility dropped to a few yards. In these conditions a rope of three went on ahead to prove the route, the rear man placing the leading on the required bearing. The sledges then used the proving team as their mark in turn. Progress was painfully slow as we groped forwards over country which differed considerably from that expected from the map. Precious climbing time slipped away and we became worried about reaching our next food dump in time—not so much because we were that short of food, but because our special Christmas rations were there awaiting us.

After ten days a slight clearance came and allowed us to look back with some horror, on the route we had recently taken. It was very badly crevassed indeed and many large cracks had dangerous cornices facing towards us, which we might never have seen coming from the other direction. Our route had wandered through this labyrinth in a series of accidental loops, quite fortuitously the only safe route. To gain time we continued to travel until quite late at night, making the working day about fifteen hours long, and then a week before Christmas we reached an icefall just short of the Kjerulf Glacier. This came as a complete surprise and some time was lost in getting all the stores through the mass of crumpled ice and on to the relatively good going of the Kjerulf. Our base for the next three weeks or so was established in the middle of this glacier at about 2,700 ft and it was from here that the climbing assault parties were to be launched. But first our stocks of food had to be replenished from the dump established earlier at Jacobsen Bight, and our efforts were concentrated on this. It was an unpleasant job as the dump had been sited on the only safe, uncovered rock observed from the helicopter, and the route to it from the landward side lay across a two-mile steep snow traverse which had many crevasses, and was swept by frequent avalanches. Carrier parties roped into threes and stumbled through the soft snow of this slope to load up with crates from the dump. Naturally more trouble was experienced on the return crossing, with the extra weight causing previously safe snow bridges to collapse. Extrication is difficult for men encumbered with 60 lb loads or more.

All the special Christmas rations were brought out by Christmas Eve. Previously, members of the expedition had drawn lots to decide whose present they would make: each would then have something to unwrap on Christmas Day. The presents were to be appropriate to the receiver and had to be "manufactured". The last evenings before Christmas were marked by furtive scrounging and surreptitious activity until late at night, and the results showed ingenuity and considerable artisan skill. The day before Christmas one man stayed behind in camp to make an igloo, so that all ten could be together on the day rather than in their separate tents. This was dug into the glacier and roofed over with tarpaulins supported on upturned sledges.

A Christmas could not come much whiter. A blizzard grew up during the night, and by morning visibility was down to a hundred yards or so—at least this saved us the effort of spreading artificial snow as one wag pointed out. An energetic pair went carolling from tent to tent, but the remainder did not surface until after breakfast. Mid-morning all met in the igloo for carols and prayers, and then Father Christmas entered and distributed goodies for all. Traditional Christmas lunch followed with champagne, nicely chilled, and cigars after. Even some paper decorations had been included in the rations plus a Christmas card from the firm of packers. Eventually the cold was felt and benevolent and replete we staggered back to our bags to sleep it all off.

Boxing Day dawned clear and sunny and immediately preparations were

made to get the assault party of three off towards Mount Paget, our principal mountaineering objective. By the end of a long day the team had been left some six miles nearer their target with supplies for twelve days. Fortunately, the next four days were fine and after a final camp at nearly 9,000 ft, the first ascent of Mount Paget was completed. It was a fine, clear morning as they unfurled the Union Flag, and a snow petrel circled slowly above them—pure white against the blue of the sky over the highest point in South Georgia. The climb had not been too technically difficult, but was sufficiently long and steep to have defeated previous expeditions attempts. The good news of this success was denied to the rest of us for a further five days when bad weather delayed their return.

In the meantime another assault party had been established at a convenient base camp near Mount Sugartop, a very attractive peak of 7,623 ft, which was the second major peak we hoped to climb. This team, made up with one representative from each Service as was the other, had a further task—to reconnoitre a route across the main part of the Allardyce Range from West to East to enable the expedition to reach its next supply dump at Grytviken. The eastern side of the range is precipitous nearly everywhere, and the best chance of a route appeared to lie near Mount Sugartop.

The remaining four had the very necessary but unenviable job of back-packing the remaining food out of the Jacobsen Bight dump, across the snow traverse on to the Kjerulf Glacier. This was completed on 4 January when the support party and the successful Paget party met to celebrate. While celebrating the binoculars were turned towards Mount Sugartop, about four miles away, and the climbers were clearly seen just descending from the summit, so now there was a double toast. The weather had cleared beautifully about noon, and we later found that they had set out only on a reconnaissance, which went so well that it became the assault. Again a snow petrel was found flying high above the peak. The weather looked settled and so plans were rapidly made for two more assaults next day on Mounts Fagerli and Paulsen, thus giving the support party members the chance of a virgin peak.

We awoke at 1.30 am and the weather was clear and cold—ideal for the climb. Quickly we breakfasted and sorted out our climbing and bivouac gear and by three o'clock both parties were off—mine being to Mount Fagerli, 6,167 ft. For the first two hours we moved on ski's over excellent snow, climbing steadily all the while. By the time the sun appeared we had dumped the ski's, changed boots and were cramponing up a steep slab towards a narrow ice ridge which had seemed to be the only feasible route up this peak. This ridge was corniced and fairly broken which slowed down the ascent, and made step-cutting and belaying necessary. It was about eleven o'clock when we reached the final steep ice tower of the summit, but the ice was now well warmed by the sun on what was a particularly hot day, and there was no longer any security in a belay. Regretfully, and very disappointed we knew we were beaten only 75 ft from the top, and so turned round for the descent. At much the same time the other party on Mount Paulsen turned about for the same reason only 150 ft from that summit.

We knew also that there would be no second chance as no route across the Allardyce Range had yet been found and this was now our main concern. At this time there were still enough rations available for us to be able to take the return route back to Leith, but this was a more difficult route in the reverse direction and would have meant that the third phase of the expedition—surveying, etc, in Royal Bay—would be doomed to failure through lack of time.

Fortunately, on the descent from Mount Fagerli a possible route was seen and investigated. It looked hopeful and so the leader organized a reconnaissance party of three to prove the route all the way down until no element of doubt remained that Grytviken could be reached. Their start was delayed by a two-day blizzard.

It was now high summer and the snow was usually soft and wet making sledging almost impossible late in the day. Watches were advanced a further three hours (to six ahead of local time) so that getting up at 1 am to take advantage of the firm snow was made more reasonable by having 7 am showing on our watches. This extra three hours was not a success and we soon dispensed with it, as it is difficult to live so much out of phase with the sun. This was brought home to us when one man woke at 5 am by his watch and to his consternation the day became darker rather than lighter—the true time being 11 pm the previous day.

The reconnaissance party were away five days, three of which were marked by high winds and very heavy snowfalls—as much as six feet in a night. All were by this time on half rations to conserve food, and as the weather delayed the recce groups return the expedition escape route to Leith became less and less feasible since it would take too long. Very fortunately they had found a route, but it was a far from easy one and would take perhaps ten days to get to Grytviken, only eight miles away in a direct line.

Midsummer gales and heavy snow falls continued for much of the next eight days, but in the calmer spells every advantage was taken to move the camp up the Kjerulf Glacier from 2,700 ft to about 5,000 ft (just short of the top) even by sledging through the night until 4 am on one occasion.

One evening it cleared about 7.30 and the crossing was started. The first part was an ice wall, 600 ft high, at a slope of between 75 and 80 degrees, and with a 12 ft high lateral crevasse about halfway down. After 600 ft the slope eased gradually for a further 1,000 ft down to about 30 degrees. It was a formidable obstacle. A sledge was loaded with about 200 lb of stores and lowered over the edge while eight men held it on a rope. One man was given a belay from the top of the ridge and went down with the sledge on a separate rope, guiding it down until the slope eased sufficiently for it to be unloaded. Both sledge and man were then hauled up. Most of our stores, bar 48 hours emergency rations, were lowered in this way through the night, until finally the wind increased and snow fell once more, and we were forced to our tents.

This bad weather went on for five days during which time no further movement could take place, and we became increasingly worried about food—being now on one third rations. The wind continued to blow hard against the tents raising bedlam with the raps of spindrift against the walls and the accompanying flapping and banging of canvas. The primus was continually blown out and the noise was too distracting for either reading or sleep. Each successive gust could be heard approaching as it sung round the gullies of the peaks above us, and we braced ourselves against it as it arrived. Some prepared themselves for the worst by remaining fully booted and spurred when the storms were fiercest. There was little to do but lie and wait, and occasionally venture forth to clear an accumulation of snow, until finally the wind died away and a clear dawn enabled further progress. The prospect of food again caused men to move rapidly, but hopes took a severe blow as the first glance over the ridge showed that an avalanche had swept into all the stores we had previously lowered so carefully, and fragments of packing cases could be seen scattered down the slope.

The remaining stores were lowered as before and then the men loaded with ruesacs abseiled down for 600 ft towards the avalanche area. Luckily the damage was not as bad as feared, and nearly all the food was recovered. Sledges were loaded up once more and camp pitched clear of any further avalanches. The Allardyce Range had been crossed despite all previous belief that it was impossible, and that evening the expedition returned to full rations for the first time for over two weeks.

But another obstacle lay ahead in a 1,500 ft icefall, where the hanging glacier we were on tumbled on to the Geikie Glacier below. There was no place in the icefall where a camp could safely be made, and so this was left at the top of the icefall while the stores were progressively lowered to the top of the final section—two vertical pitches of about a hundred feet each. This took three days. Then with an early start camp was struck and the whole expedition moved from top to bottom, collecting stores en route, to camp on the Geikie. It was an eighteen hour day. While the stores were being brought down the icefall, a party of three under the leader went on ahead travelling light to Grytviken to warn of our arrival. It was as well they did for we were ten days overdue at this stage, and a few hours later HMS *Protector* would have been ordered back to South Georgia to organize a search. As they were enjoying a weeeks leave in Montevideo this move would have been highly unpopular and jeopardized good relations on the homeward run, but this time limit had been laid down in London despite our protestations, and Grytviken would have had to comply. However, this problem was averted and the returning party met us as we reached the bottom of the icefall. They now numbered four as one of the meteorologists was a climber and came out from the base camp to help. Three days later we were all back at Grytviken complete with stores and had a really wonderful reception from the tiny community there. Two days were spent in luxury while we sorted ourselves out for the last phase. This was now cut to four weeks by our recent delays, and plans for moving to Royal Bay in the comfort of a coastal sealer came to nothing delaying us further. Seven sealers had been sunk during the previous winter through the weight of snow accumulating on the decks and none was now available, which left us with an extra fifty miles of mountainous coastline to cover. It was at this point that a party of three splintered off from the other seven in order to spend two weeks on geological investigations in the Nordenskjold Glacier area. They successfully found what they wanted and more, and rejoined at Royal Bay. In the meantime the others split into a party of three which pressed ahead lightly laden to Royal Bay, and one of four to follow behind bringing up stores in relays; the first had the task of opening up the stores previously dumped there, establishing camp and of doing the initial reconnaissance of the area for mapping. Gradually the camp was built up and the "scientific" phase of the expedition embarked upon.

This was primarily a large scale survey, but some valuable geological and plant (primarily moss) specimens were collected and annotated, and studies were made of the birds and penguins there.

The island had been well surveyed in the mid-1950s by expeditions under Mr Duncan Carse, Captain A. G. Bomford, RE being his surveyor on one expedition (see *RE Journal* for June 1959). This map at a scale of 1:200,000 and with a vertical interval of 500 ft gave a good impression of the terrain in general, but was inadequate for the detail now required. In addition the Royal Bay area was accepted as being poor in reliability and so it was soon decided that the resurvey should be started afresh, and be linked to the

rest of the island through the best controlled stations nearest to Royal Bay.

On the good advice of Major P. Hunt, RE, whose experience in New Zealand Antarctic Territory proved most valuable (see *RE Journal* for June 1962), two Wild T.2 theodolites were prepared for cold weather operation and modified to accept F.102 Robot 35 mm cameras in attachment to the telescopes. The cameras themselves had corner marks etched on to glass screens forward of the film. This work was carried out by Technical Group, REME, Woolwich. The first modification allowed the optical axes of theodolite and camera to coincide, so that exact angles at which exposures were made could be recorded; the second enabled us readily to scale a photograph, and to locate its optical centre (since the etched marks showed up on the prints). The whole expedition gathered at the School of Military Survey for a weeks survey acquaintance course some months before departure and some of the mysteries of the task were revealed. The deputy leader of the expedition, Sqn Ldr A. H. Back, AFC, RAF, had done surveying at university and he became a second observer. This meant that two survey parties could always be mounted which greatly increased the scope of operations. As far as possible the two parties always worked from the same camp so that continuous liaison was possible. Each party was of two or three men depending on the difficulty of the routes to points, most of which had of necessity to be on summits to provide the view for the cameras. Complete panoramas were taken horizontally at every station at 30 degrees intervals, and further panoramas at fixed depression angles where necessary. Horizontal and vertical angles were recorded for all photographs taken. This was the first priority, but it was often very difficult because of obscurity due to cloud or sea mist. Angles were then read to the natural summits of the peaks in view and any other major points, and a cairn built to aid sightings back from other stations. Finally a panorama was taken using a Polaroid camera which gives a print on the spot, and the points observed to were marked on these. These were not adequate for detail to be plotted from them, but they did enable identification to be made later without doubt, and they also greatly helped liaison between the parties who could check frequently which areas were adequately covered. Abstracts of readings were done each evening and computations carried out as far as possible. Films from the F.102 cameras were developed when finished as a check on quality, despite the difficulties of temperature control and water cleanliness. The results were remarkably good.

This was the normal procedure, and in this manner a completely conventional trig system was built up. Height was brought in by co-ordinating rocks at sea level, a base measured, and position and azimuth determined from the stars. A few extra points in valleys or on glaciers were necessary for pictorial "fill-in" only, and these positions were resected from previously co-ordinated peaks.

The weather remained bad and in the end we were able to do useful field work on eight days out of the reduced time of four weeks. In the last week the weather was particularly bad with heavier and more frequent snow falls and every sign of the encroaching winter. The last vital station was occupied on the last afternoon on the island, and the party did not return to camp until well after dark.

During *Protectors* attractive voyage home along the coasts of South America the surveyors checked their work and finished the computations, ready to start the plotting on their return to England. This last proved fairly straightforward if long winded. The cameras had been calibrated for focal

length, and the distances between the corner marks were known accurately, so that by proportion the print could be scaled. This enabled horizontal angles to points of detail to be worked out by reference to the observation book and the optical centre of the print. The same detail point had then to be identified on a print from another station and the angles worked out again. The point could then be plotted from the intersecting rays. Similarly the heights could be worked out as the height of the trig station plus or minus the height difference taken off the photograph. Details of moraines, beaches, off-shore rocks, etc, could be taken off as desired, and the map built up quite regardless of weather conditions. The method proved to be extremely successful for this sort of task.

The two surveyors had to concentrate all their efforts on mapping, but the others were free for other things when not required as assistants—as each had to be at some time. The larder of "Compo" rations (plus expedition extras) which we were on now that we worked basically from one camp, and no longer required light rations, was supplemented occasionally with fresh reindeer meat. This was quite excellent and provided good sport for the huntsmen as the animals were very shy. The estimates for the numbers of reindeer vary but there may be as many as five thousand. They were introduced on to the cape running north from Royal Bay about forty years ago as an experiment for fresh meat for the whalers. This cape has little ground over 3,000 ft and the coastal areas became almost free of snow in the summer months, revealing an abundance of mosses underneath, on which the animals live. The three we killed were all in excellent condition with lovely coats and remarkably clean teeth. The reindeer have been kept to this part of the island by the Nordenskjold and Cook Glaciers in the past, but have now taken to glacier travel across the Cook Glacier at least as small numbers are found about Royal Bay.

The penguins afforded much amusement whenever we were near them, and within a mile or two of the Royal Bay camp there were at least ten thousand. These were mainly Gentoo's, a peace-loving species of medium size, who were very friendly and loved to investigate and introduce themselves. They showed almost human qualities at times; a sense of fun when sliding down a snow slope, or lying on their backs in the water and washing their white shirt fronts with their flippers, or of trepidation when inching their way slowly into the cold water like early season swimmers.

South Georgia is a natural centre for the wild life of the South, and most species can be studied within this very small area. It has been a centre of the whaling industry for a long time, and many varieties of seal live there too—from the enormous, ugly and noisy Elephant Seal to the voracious Leopard and valuable Fur Seal. Perhaps the Wedell is the most attractive with its quizzical expression and friendly attitudes. Many varieties of sea birds live there—species of albatross, tern, gull, petrel and so on, and the unbelievably truculent, marauding skua. Though no ornithologist I became captivated like the others by these creatures, and by their wonderful trust which enabled us to approach very close, and even to stroke them on their nests as I did with an albatross on one occasion.

Strangely, we viewed the ending of our time in South Georgia with more regret than excitement—at least until the urgency of the event took charge. This remote island of splendid mountains and glaciers, with the wild life that it has, and the history that surrounds it took hold of us all, as many before including Shackleton, and gave us each in every sense the time of our lives.

Sgt. T. Lynch (Para) gasping for breath after a hard sledge pull up the Gjelstad Pass

Combined Services Expedition to South Georgia 1

The author using the Wild T.2 Theodolite in Royal Bay

Combined Services Expedition to South Georgia 2

Members of the expedition in disguise

On the traverse to the Jacobson Bight Camp, with the Kjeruef ice fall on the left

Combined Services Expedition to South Georgia 3

A climbing team moving out

A helicopter returns to HMS *Protector* during the establishing of the supply dump at Jacobson Bight

Combined Services Expedition to South Georgia 4

Correspondence

THE BROKEN LINK

At a Corps Guest Night, held in the Headquarters Mess on 18 November 1965, Major-General G. S. Hatton, CB, DSO, OBE, deputizing for Lieut-General Sir Edward Grassett, KBE, CB, DSO, Colonel Commandant RE (Retd), presented to the Corps a silver centrepiece on behalf of the surviving officers, commissioned into the Royal Engineers from the Royal Military College, Kingston. A report by T.D.V. of the presentation and photographs of the centrepiece and a scroll containing the names of the 125 Kingston Cadets commissioned into the Sappers between 1880 and 1942 were published in the March 1966 issue of the Royal Engineers *Journal*.

Major-General Hatton has pointed out that there was an omission in the article by T.D.V. which, for historical accuracy, should be rectified. The omission was as follows:

"Colonel (later Lieut-General) E. O. Hewett, CMG, of the Royal Engineers was appointed the first Commandant of the RMC, Kingston in 1876 and served in that capacity for eleven years. It was he who chose the College motto: 'Truth, Duty, Valor', and with the first class of Gentlemen Cadets, 'The Old Eighteen', he established the sound foundation of self-discipline and integrity which has been proudly maintained through the years."

Lieut-General Hewett later became Governor (as Commandants were in those days called) of the Royal Military Academy, Woolwich and he thereby established a close personal link between Kingston and the Shop whose Gentlemen Cadets he infused with the same enduring spirit of probity, loyalty and boldness.

For historical accuracy also two amendments have been made to the scroll. The correct ranks for Major-General A. C. Joly de Lothbinière, CB, CSI, CIE (1885), and Major-General Sir Philip G. Twining, KCMG, CB, MVO (1886), have been inserted. Their ranks were erroneously shown as Brigadier-General.

The Editor,
RE Journal.

The Royal Aeronautical Society,
4 Hamilton Place, London, W.1.
5 December 1966.

Dear Sir,

Brigadier General Sir Osborne Mance, whose obituary you published in the December 1966 *Journal*, was an object of particular respect and affection at this Society since he was our oldest member. It was his sword that was used to cut the symbolic birthday cake at our Centenary celebrations in January this year. Sir Osborne was of course, present. As he said in a letter (in his own handwriting) when acknowledging our congratulations on his 90th birthday:

"I joined the Society in the last century at the request of Major Baden-Powell (BFS) as a result of a ballooning experience and a subsequent technical article in *The Field* and, although I did not take up practical aeronautics myself, my continued interest in aviation was a great help to me when I had to write a book on international aviation for Chatham House at the end of the last war."

Yours faithfully,
(Sgd) F. H. Smith,
Librarian.

Royal Engineers Combat Development Staff,
Headquarters E-in-C,
Royal School of Military Engineering,
Chatham, Kent.

The Editor,
Re Journal.

13 December 1966.

COMPUTERS FOR THE CORPS

Dear Sir,

Captain Brodley is quite right—we must get more computer conscious in the Corps. But, a word of warning, do not let us be too ambitious, too soon, in what we try to do with a computer. Walk first—run later.

The first essential is to learn to do simple things. We ought all to attempt to write simple programmes to solve problems appertaining to our own jobs, whether it is roads, airfields, minelaying, tactics, E and M, construction, or anything else. This really means having a computer on the spot to try our programme, see it rejected, correct it, try again, see it rejected again, correct it again and so on until it works. This can NOT be done by post with a remote computer.

Gradually we will learn to regard a computer like our fathers and grandfathers regarded slide rules—a useful bit of kit to have around the office.

Later we can be more ambitious, and do the sort of thing that Captain Brodley is advocating. This will take expert programming, and a lot of time.

We have already made a case for buying a computer for Chatham. A second-hand Elliott 803 can be had for only £10,000—a small enough sum by modern standards, considering that £10,000 is the annual salary of two major-generals, or of three full colonels. One is tempted to ask which is the more useful, three colonels or one computer, but this is not the point. The point is that we need both colonels *and* computers, but future colonels must know how to use computers.

An Elliot 803 will start us off. Within a few months officers and soldiers of all ranks will have learned how to use it for all sorts of things. Soon the Chatham computer will be used to capacity, night and day, and we will be making a case for a bigger, faster, more modern machine. We will also wonder how we ever did without one in the past.

Everything that one learns on the Elliott 803 one can use in the field. The Field Artillery Computing Equipment (FACE) will be held in the field army mounted in a battery APC. Though programmed mainly for Artillery work, it is an ordinary Elliott 920 computer, micro-miniaturized but with the same capacity as an Elliott 803, and can be used in exactly the same way, using the same languages, including Autocode, and ALGOL.

The RSME must run courses on programming at Chatham; indeed it has already started to do so. But no one need wait to come to Chatham to learn. Nearly every Technical College or College of Further Education runs courses now. Everyone in UK is within reach of evening classes if he makes the effort, and the Army Education Authorities will pay for the course.

The enemy is apathy. Despite the facilities available here in the Medway College of Technology in Chatham, only one officer in the last two years has made the effort to take their computer course. Like so many things in the Corps today, there is too much "natter" and too little "do". It isn't on the annual confidential report—yet—so no one bothers.

My advice to everyone is to give it a try. You will be surprised how easy it is, and how much useful work even a novice programmer can do.

Even Captain Brodley should have a go. Then next year he can write an even better article—with some practical knowledge of the subject behind him.

Yours, ALGOLically,

(Sgd) D. W. B. Williams.
Major RE

Major J. G. Gisby, RE,
HQ Southern Command,
Wilton, Salisbury,
Wilts.

The Editor,
RE Journal

16 January 1967

COMPUTERS FOR THE CORPS

Dear Sir,

In his article on Computers for the Corps I believe Captain Bradley has underemphasized several points and therefore suggested the wrong approach to an important problem.

Two or three man-years and much skilled effort would be needed to programme and load the computer he has envisaged. Furthermore, detail changes would require an extensive date collection and automatic transmission system, as the machine would be working in "real-time". Periodic sitreps and manual amendments of the programme would be futile.

In large commercial concerns computers are used as he describes. They will select the best course of action from many that are possible for the organization. But there are never many feasible solutions to military engineer problems. Orders, time, ground, enemy action, weather, etc, which are factors outside the Commanders control will always inhibit his choice. The aid of a machine to evaluate only a few possibilities cannot be justified.

It is true that this system would make much more data available before decisions were made. But this could also be done quite adequately with much less sophisticated equipment, which is cheaper and available now.

Good information will not usually increase the number of courses open for the reasons mentioned above. The great value of its provision lies in the reduction in number and size of unforseen problems. A more elegent professional approach to planning then becomes possible. Savings in time, men and materials can be achieved because estimates can be confidently made for finer limits.

Information processing in its widest context is a subject largely ignored by the Corps, with results that are sometimes embarrassing. There is a great need to improve the chances of making informed decisions at any level and in any situation.

Yours faithfully,
(Sgd) J. G. Gisby, Major RE.

---

2 Armoured Engineer Squadron,
British Forces Post Office 30.

The Editor,
RE Journal.

22 December 1966

SAPPERS OF THE SEVENTIES

Sir,

It is to be hoped that Captain Payne's interesting and provocative article "Sappers of the Seventies" will generate some argument in your correspondence columns.

Recently a most able armoured engineer troop commander himself, Captain Payne will not have expected to escape entirely unscathed for his outrageous suggestion that "Armoured Engineers . . . should be handed back to the Royal Armoured Corps".

Armoured Engineers, as Captain Payne says, are no longer specialists. Their equipment—which is mainly for gap crossing—is principally an aid to the maintenance of mobility on the battlefield. In other words it is just what the ordinary brigade field squadron needs in order to do its job. One day, perhaps, this will be understood and we shall have bridgelayers, for example, in the hands of divisional engineers, which is where they should be.

I sympathize very much with Captain Payne's theme, which is to offload the "routine" in order to make room for the "novel", but he must not emasculate his "Combat Support Squadrons" by denying them the equipment they need.

Lastly, Sir, may I say with all humility that articles of this type—though they may ruffle many feathers—will do the Corps nothing but good? Perhaps you will be able to persuade the author to write another.

Yours faithfully,
(Sgd) A. M. PYNE, Major RE.
Officer Commanding.

Lieut-Colonel J. O. Townsend-Rose, MC, RE,
1 Engineer Stores Depot and Workshop,
Long Marston,
Nr Stratford-upon-Avon,
Warwickshire.
29 January 1967

The Editor,
RE Journal

Dear Sir,

WHICH HUT?

Thank you for publishing the well-balanced comments of Lieut-Colonel Eddie Peel and Major Terry Tinsley on my article, Which Hut?

Some of Eddie Peel's comments would not have been made if there had been space to publish the article in full. Of course the Twynham (in whose construction he is probably more experienced than any of us) is versatile and can be rebuilt many times—but had Terry and I, during our respective tours of duty in Borneo, specified Twynham, we should have lost them at the end of Confrontation, and it remains to be seen what happens to the Deployment Camps in Aden; at about £1,000 each, the huts are a valuable asset. Political considerations must therefore be taken into account when doing a costing comparison for temporary camps.

I deliberately left out the cost of erection, since it varies so greatly throughout the world. Military labour is normally very expensive; it can often be disregarded when it is available "on a no cost basis", but if Sappers are brought into a theatre specifically for construction work, this cost should be added to the cost of a camp.

I sign this letter on the eve of retirement, and I am sure that in future I shall pay much greater regard to detailed costing of the kind described in Which Hut? than I have in the past.

Yours faithfully,
(Sgd) J. D. TOWNSEND-ROSE.

Memoirs

LIEUT-GENERAL SIR CHARLES KING, KBE, CB, MICE COLONEL COMMANDANT RE (Rtd)

LIEUT-GENERAL SIR CHARLES KING, who was the first Engineer-in-Chief at the War Office died on 7 January 1967 at the age of 76.

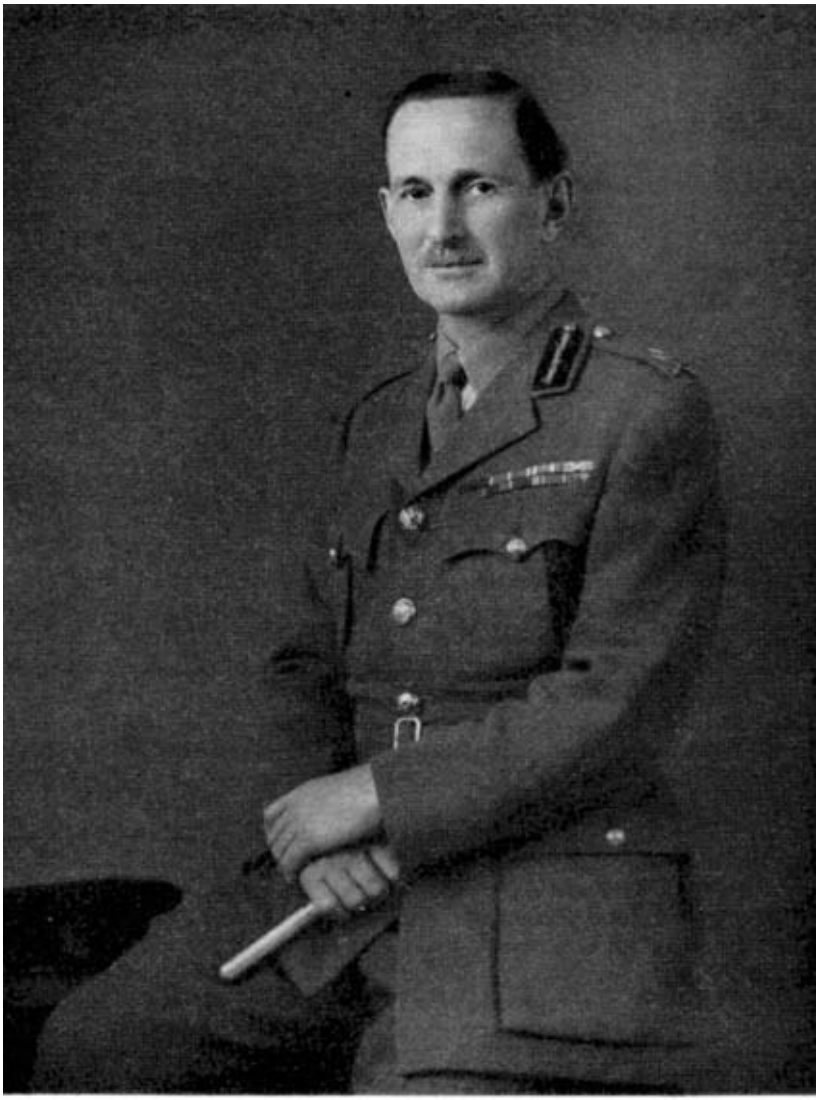
Born in Minesota, USA, on 13 October 1890, the son of Charles James Stuart King of Chardstock, Somerset, he was educated at Felsted School and the Royal Military Academy, Woolwich where he became the Senior Under Officer and was awarded the Sword of Honour, the King's Medal and the Pollock Medal. He was commissioned into the Royal Engineers on 29 July 1910, the top of his batch.

Whilst at Chatham on his YO Course he was awarded the Fowke Memorial Silver Medal and the Collinson Prize. After leaving the School of Military Engineering he spent two years training with the London and South-Western and the North-Western Railway Companies before being posted to India in 1913 where he continued his railway training at Lahore.

His service during the First World War was spent in India and he took part in the Mohmand-Swat campaign, for which he was mentioned in despatches, and he also served in the 3rd Afghan War of 1919 where he was again mentioned in despatches and was awarded the OBE. His service consisted of work on frontier communications and the construction of two railway bridges. From 1921 to 1923 he was Adjutant of the QVO Madras Sappers and Miners.

Returning to the home establishment in January 1924 he joined the Experimental Bridging Company (now MEXE) at Christchurch, and the following year he became DO Stanhope Lines, Aldershot. In March 1926 he was promoted major and took over the command of the 1st Field Squadron, then a mounted unit providing the engineer support for the two horsed Cavalry Brigades stationed respectively at Aldershot and on Salisbury Plain. After three years in command he was selected to become the Chief Instructor in Military Engineering and Geometrical Drawing at the Royal Military Academy, Woolwich. He was made brevet lieut-colonel in 1931.

Promoted substantive Lieut-Colonel in 1933 he returned to India as SOI RE at Army Headquarters. During the next two years he was largely responsible for the introduction of centralized mechanical accounting in the Military Engineer Services in India and for the infusion of Surveyors of Works into the establishment. The disastrous Quetta earthquake of 31 May 1935 resulted in his immediate appointment as CRE Reconstruction and later as Deputy Chief Engineer with the rank of Colonel in 1937 and Chief Engineer in 1938. This episode led to his lasting friendship with Sir James Grigg, then Finance Member of the Government of India.



Lieut-General Sir Charles King KBE CB MICE

He returned home in 1939 and was appointed Chief Engineer, Southern Command. On the outbreak of war in September he went to France as Deputy Chief Engineer of the British Expeditionary Force, being awarded the CBE in 1940.

After Dunkirk he became Chief Engineer Home Forces and was promoted Major-General in 1941. The major military preoccupation at the time was the defence of Britain, almost denuded of arms and equipment, against possible invasion. The result was a flood of concrete defences, from the beaches to lines far inland, anti-tank obstacles in the main. King was summoned to Chequers by Winston Churchill to report on the progress made, and during a moment of relaxation protested to the Prime Minister that the expression "anti-tank obstacle" was a tautology. Involved research into the niceties of the English language ensued, and later King received from Churchill a personally inscribed copy of Fowler's "Modern English Usage"—a most cherished possession.

More seriously, he became increasingly aware that the existing RE Works Organization was not geared to the vast programme of accommodation and defence works immediately demanded, let alone the immense future demands being bandied about. Typically forthright and repeated comment in the right places led to his being himself appointed Controller-General of Military Works in the War Office. His first action was to ascertain from the contracting industry the average value of the monthly output per man employed, and from the Ministry of Labour the maximum number of men who could be made available to that industry in the face of all other demands. Simple arithmetic then revealed that the work already in hand, or already approved, would take an alarming number of years to complete—and fresh demands were of almost daily occurrence. This led quickly to a much-needed and much-firmer control, confining work to only the stark and immediate needs of the situation, based on a proper War appreciation. Sir James Grigg was then PUS at the War Office and later Secretary of State for War.

It was also apparent that all facets of the inevitably enormous engineer future tasks at home and abroad needed scrutiny, and that one controlled plan for their execution was essential. After much argument and opposition King succeeded in obtaining Army Council agreement to the appointment of an Engineer-in-Chief, responsible to the Chief of the Imperial General Staff on questions relating to operational policy and planning, to the Quarter Master General for Works Services and having direct access to all other Members of the Army Council on matters affecting engineer policy and procurement. King was the first incumbent. The duties of the Inspector RE were absorbed, the Directorate of Fortifications and Works came under his general supervision, and he also held a watching brief in respect of the Survey, Transportation, Postal, and Bomb Disposal Directorates. Overhaul and reorganization throughout were pressed through at breakneck speed, the Engineer Stores Directorate was pushed forward, and at all levels an engineer staff was provided and trained capable of tackling the enormous problems soon to be faced. Not the least of these was the reception of one and a half million American troops, and the training of their engineer cadres in what modern war demanded. The key plan for this operation was rapidly drawn up and presented to the Treasury who demanded an estimate of cost. They had it, on half a sheet of foolscap, within half an hour, and approved the expenditure within the hour. The estimate was £50 million—the cost was

£49.9 million—and the organization King had built up completed it within schedule.

Concurrently came the provision of vast administrative depots, at Bicester, Chilwell, Corsham and elsewhere, including our own at Long Marston, and battle headquarters for the projected re-entry into France.

In addition there was the constant struggle to obtain and train the manpower required for the Corps to fulfil its ubiquitous duties, the development and procurement of special stores, earthmoving equipment and Bailey Bridging, the raising and equipping of new types of specialist RE units, together with advice, assistance and support to the RE formations already embattled overseas, and the planning to ensure the efficient discharge of Sapper tasks in new and larger ventures still to come. Few officers in the whole history of the Corps could have shouldered equal responsibilities and discharged them so well, at a time of the black-out, the blitz, and the doodle-bug, and the Corps could not have had a finer leader at a period when leadership was all important. His CB, awarded in 1943, could not have been better earned.

Towards the end of 1944 Sir Winston Churchill, disturbed by well-merited criticism, prised King out of the War Office to be his personal representative to deal with steps to be taken in India and South East Asia to improve and extend welfare facilities for the British troops there. Departing for the Far East with the rank of Lieut-General, he was created KBE in 1945 and on his retirement the following year, his task completed, he was appointed Colonel Commandant, Royal Engineers. This appointment he continued to hold for a ten-year period of office.

His retirement from active military service was but a beginning to a series of civilian tasks. In 1947 he joined John Lewis Partnership as financial adviser, and at the same time he served on the Board of R. G. Lane Ltd.

His engineering and administrative ability were in constant demand and he was invited to take over the affairs of Festival Gardens, Ltd at a time when it seemed doubtful whether the Gardens and the associated Fun Fair would be ready on time for the opening of the Festival of Britain. Undeterred by adverse and often unfair press criticism, he ensured that all work was completed four days before His Majesty King George VI declared the Festival open on 3 May 1951, and he steered the company through its first anxious months of operation as Chairman and Financial Adviser.

He was also actively connected with Stevenage and Crawley new towns and with many engineering concerns, notably Yeadon Engineering Works and Kinnear and Moodie, being Chairman of both for many years. On behalf of Lloyds Bank Ltd he undertook the reclamation of a number of concerns, every one with success. To the end of his life he served on the Board of the Eastern Region of Lloyds Bank.

Latterly he restricted his interests to those within easy reach of his Suffolk home. For many years he was Chairman of William Gaymer and Sons Ltd, cider manufacturers of Attleborough in Norfolk and he continued with them until failing health, coinciding with an amicable take-over bid from the Somerset firm of Showerings, offered a convenient time to retire.

He was a frequent contributor to the *Royal Engineers Journal*; amongst articles written by him were "RE Co-operation with Cavalry" (1930), reprinted from the *Cavalry Journal*, "Engineer Intelligence from Photographs" (1935), "Quetta Reconstruction" (1937), "Works Services and

Engineer Training" (1938) and the historical article "Cromwell's River Crossings", published in 1964.

General King was one of three remarkable brothers. The eldest, Admiral E. L. S. King, CB, MVO, had a distinguished Naval career, and the youngest, Sir Geoffrey King, KCB, KBE, MC, started life as a solicitor, joined the Treasury Solicitors Department and then converted to the administrative side of the Civil Service finishing as Permanent Secretary of the Ministry of Pensions and National Insurance. Both brothers survive him.

On 12 June 1920 he married Kathleen Margaret, only daughter of Lieut-Colonel T. W. Rudd, CBE, RAVC and Mrs Rudd. They had three sons. The eldest carries on a family tradition as Rector of Hinderwell in Yorkshire, the second, Major S. C. S. King, followed his father into the Corps and the third son is a school master in Madrid. There is a strong family connexion with the Church, the most notable examples being a Bishop and Archdeacon of Rochester and the famous Edward King, Bishop of Lincoln, who was the General's great uncle.

In his younger days General King played hockey for the Army; he was also a keen polo player and an excellent shot. He inherited the family talent for cabinet making and during the course of his life enriched his home with many beautiful pieces of furniture.

He had immense physical and mental energy, with a remarkable clarity of vision and ability to absorb and evaluate detail without allowing it to obscure the essential issue, the ultimate objective, decided upon with incredible speed. Once his master plan was conceived he was utterly flexible in approach and methods used to achieve it, but always ruthlessly determined that the essentials were not whittled away. Difficulties only created fresh inspiration, and always there was the drive which led and inspired his subordinates to their own share of achievement. His speed of intellect and appreciation, coupled with complete self-confidence, ensured that his advice was seldom, if ever, ignored and his decisions were avidly accepted.

Under an austere, and to his juniors sometimes an awe-inspiring, approach there was always real kindliness and a ready response to requests for help or advice. He was at all times approachable, even in moments of greatest stress. Not wholly patient with any form of inefficiency or slow-wittedness, he had the facility to produce searing and scathing, albeit witty, comments which did not always endear him to the recipients. Junior and superior senior officers, as well as tycoons in the business and financial world, all got the same treatment, but he was always equally generous with his praise for good work done.

In his private life he was a devoted husband and father. He was a religious man who contributed generously both by personal service and financially to the Diocese of St Edmundsbury and to his own parish. A country-lover and enthusiastic gardener, he even produced amateur plays. Nobody could have been a better host, nor a more pleasant companion in all circumstances, and his friends were legion and sincere.

We mourn one of the really great Royal Engineers, with pride in the memory of his achievements for his Corps and his virtues as a gentleman.

Major General R P Pakenham- Walsh, CB MC

MAJOR-GENERAL R. P. PAKENHAM-WALSH, CB, MC

MAJOR-GENERAL RIDLEY PAKENHAM PAKENHAM-WALSH, Engineer-in-Chief of the British Expeditionary Force in 1939 and 1940, and the Corps historian of the Second World War, died at Haslemere on 3 November 1966, aged 78 years.

Born in Kilkenny, the son of the Rt Rev W. Pakenham-Walsh, Bishop of Ossory, he was educated at Cheltenham College and the Royal Military Academy, Woolwich where he was awarded the Sword of Honour, The King's Gold Medal and the Pollock Medal. He was commissioned into the Royal Engineers in December 1908, top of his batch. After completing his initial training at Chatham he was posted to the 56th Field Company at Bulford.

In April 1914 he arrived as Instructor in Military Engineering and Surveying at the Royal Military College, Duntroon, Australia, and in May 1915 he married Mabel Smith, eldest daughter of Mr and Mrs Ernest Smith of Turramurra, Sydney, New South Wales. Shortly afterwards he was posted to Gallipoli, but did not arrive there in time to be present at the first of the now famous Royal Australian Engineer Annual "Waterloo Dinners", held in the Chief Engineers' Mess on 18 June 1915, the hundredth anniversary of the battle—the meal consisting almost entirely of bully-beef and biscuits. He remained however in Gallipoli until the final evacuation in January 1916.

Returning home, he was for a time with the Engineer Training Centre at Newark and in January 1917 he joined the 155th Field Company of the 16th Irish Division on the Western Front. He was awarded the Military Cross in January 1918 and made a brevet major. In August 1918, as an acting lieut-colonel, he became CRE 40th Division and in October that year CRE 3rd Division, having under command the 56th Field Company in which he had been a newly-joined subaltern only eight years before.

In October 1919 he was selected to be the British Military Representative on an International Commission sent to Teschen to resolve conflicting Czech and Polish territorial claims, a rare distinction for so young an acting lieut-colonel. The Commission successfully completed its task and in July 1920 Lieut-Colonel Pakenham-Walsh returned home, assumed his substantive rank of captain and reported for duty with the Directorate of Fortifications and Works in the War Office. The following year he entered the Staff College, Camberley as a student and on graduating therefrom in 1923 he became Instructor in Tactics and Brigade Major and Secretary of the School of Military Engineering, Chatham, a task that would have taxed the most outstanding officer's time and ability to the full. However he not only took all his onerous SME duties in his stride but found the time to produce two books—*An Outline History of the Russo-Japanese War* and *Elementary Tactics*—published respectively in 1924 and 1925—and to be Master of the Royal Engineers Beagles. The great hunting teas he and his wife gave were

feasts not to be forgotten by those who had all afternoon tried to keep up with him and his beagles screaming across the Shornemead Marshes or the Hoo uplands.

On leaving Chatham he joined the staff of the Military Training Directorate at the War Office, becoming in 1928 a brevet lieut-colonel. During his five years at the War Office, in his spare time, and finding spare time in an exigent posting was apparently never difficult for him, he helped Mr Winston Churchill, an exacting task master, in the preparation of material for his massive four volume work *Marlborough, His Life and Times,* particularly in those chapters dealing with Marlborough's nine campaigns on the Danube and in the Low Countries. Churchill wrote: "Together we have visited the battlefields and traversed the marches, and I enjoyed the advantages of his excellent professional opinion". Surely no finer tribute could have been paid by one dedicated, intellectual scholar of military history to another.

On leaving the War Office in April 1931 he became ACRE, Woolwich and in April 1932 he entered the higher realms of the Imperial Defence College. Two short postings as CRE Lancashire Area and as an AAG in the War Office followed his graduation from the IDC, and from October 1935 until June 1939 he held the appointment of Brigadier General Staff at Headquarters Eastern Command. It was a period of mounting international tension which witnessed the reoccupation of the Rhineland by German troops in 1936, the Nazification of Austria in 1938, the threat to Czecho-Slovakia in 1939 and Munich. The resulting introduction of compulsory service for young men in the Militia, the formation of fourteen new divisions in the Territorial Army and a vast increase in Anti-Aircraft Defence brought in its train immense problems of equipping, training, maintaining and accommodating the expanding armed forces of the country. Eastern Command bore more than its full share of those problems, and the Brigadier General Staff, as a principal staff officer, carried a heavy load of responsibility.

On promotion to Major-General in June 1939 Pakenham-Walsh became Commandant, The School of Military Engineering and Inspector Royal Engineers. His stay at Chatham this time was, however, to be a short one. Within three months he assumed his mobilization appointment of Engineer-in-Chief of the British Expeditionary Force on the outbreak of war on 3 September 1939.

When the British Expeditionary Force disembarked in France nothing was known of the role it was to play, and it was only after a realization of German inactivity that it was decided that the British troops should hold a sector from Valenciennes to Armentières which formed part of the French Frontier defences. Although the supposedly impregnable Maginot Line covered only the common frontier with Germany from Switzerland to Givet, certain defensive works had been carried out pre-war up to the coast, the scope and degree of completion decreasing as this extension ran further north. The defensive system had no depth and consisted merely of concrete pill boxes to house anti-tank weapons, spaced some three-quarters of a mile apart, enfilading straight stretches of a partially-dug anti-tank ditch. It was the task of the E-in-C of the BEF to convert this defence in embryo into a second Lines of Torres Vedras; anti-tank ditches had mostly to be excavated by hand due to an almost total absence of mechanical equipment, but an organization was set up for the mass production of sealed-pattern type

concrete pill boxes to be placed to augment the number already existing and to give depth to the defence. Considerable belts of wire were erected, mine fields were sited, bridges over river and canal lines were chambered for demolition and tunnelled headquarters were provided. A whole host of tasks were carried out for hutted accommodation, camouflage and the inevitable Sapper problems of improving road and rail communications. There was also a third dimension which Fletcher—the architect of Torres Vedras—never encountered. Airfields and satellite airfields had to be provided for the Air Component BEF and for the Advanced Air Striking Force.

The story of how Mr Hore-Belisha—the then War Minister—obtusely criticized the efforts the C-in-C BEF was making to improve the defences of his sector of the line, in what came to be known as the "Pill Box Row", is well known. It was a melancholy affair which led to the War Minister being asked by Mr Chamberlain to resign. General Pakenham-Walsh in a most balanced and lucid account of the incident, printed in the December 1960 issue of the *RE Journal*, gave the full story of the controversy to rebut the misleading statements contained in *The Private Papers of Hore Belisha* which were published during that year. At the time the unpleasant incident was soon to be cast from the mind when in May the Germans invaded the Low Countries and the BEF left its defences to advance to the River Dyle.

In the subsequent retreat of the BEF to the River Escaut Pakenham-Walsh had the task of organizing the employment of all GHQ and L of C engineer troops, the location of bridging equipment where bombing might cause bottlenecks on the routes of withdrawal and the over-all demolition and inundation schemes. Once in the Dunkirk beach head he was appointed to assist General Sir Ronald Adam in organizing the defences of the perimeter. In carrying out that task he was wounded.

For his service with the BEF he was made CB.

On his evacuation from Dunkirk he became General Officer Commanding Northern Ireland District, and in June the following year, as an acting lieut-general, he was given command of IX Corps in Home Forces. In 1942 he was appointed Commander Salisbury Plain District and from 1943 until 1946 he was Controller General of Army Provision, Eastern Group, an organization set up in New Delhi to co-ordinate the distribution of munitions and warlike stores between India, Ceylon and Burma, Australia, New Zealand and South and East Africa. He carried out these duties with great success until his retirement in 1946.

After retirement he was until 1950 Vice-Chairman of the Development Corporation, Harlow New Town, and he was President of the Cheltonian Society in 1948 and 1949.

It is, however, as a military author, and particularly as the Second World War historian of the Royal Engineers, that his name will be remembered in posterity by the Corps.

His first work was the official War Office publication: *The Second World War 1949-45 Army—Military Engineering (Field)*, published in 1952, a remarkable book in the first part of which he described how field engineers were employed in each major campaign of the war and how their work met the demands of the other arms they supported. The second part of the book was devoted to explaining and illustrating how engineer field units were organized and equipped to carry out their varied tasks, and a section dealt

with the development and production of the Bailey Bridge and other engineer equipments. The work should be compulsory reading for all Sapper officers.

His second historical work was the production of Volumes 8 and 9 of the *History of the Corps of Royal Engineers*, spanning the period 1938 to 1948, which was published by the Institution in 1958. Volume 8 covered the BEF campaign 1939–40, Norway, the Middle East, East Africa, the Western Desert, NW Africa and activities in the Home Base. Volume 9 covered the campaigns in Sicily and Italy, the war against Japan, NW Europe 1944–5, minor and non-operational areas and the post war period 1945–8. It was a vast undertaking that took him almost ten years to complete and, although greatly hampered by the pains of arthritis, he did not spare himself in any way until the last chapter was written, the last map drawn, the comprehensive index completed and the last printer's proof checked. To the end he remained devoted to the Corps in which he had served for almost forty years with such distinction, and he has left us a lasting and splendid account of the Royal Engineers during a most thrilling period of their great history.

Major-General and Mrs Pakenham-Walsh celebrated their Golden Wedding Anniversary last year, of their three children the elder son is now Assistant Accountant with Sir Alexander Gibb & Partners, Consulting Engineers, the younger a lieut-colonel in the Gunners commands the Oxford University OTC, and their daughter is the Administrative Officer to the Inner London Education Authority. To his widow and children our deepest sympathies are extended.

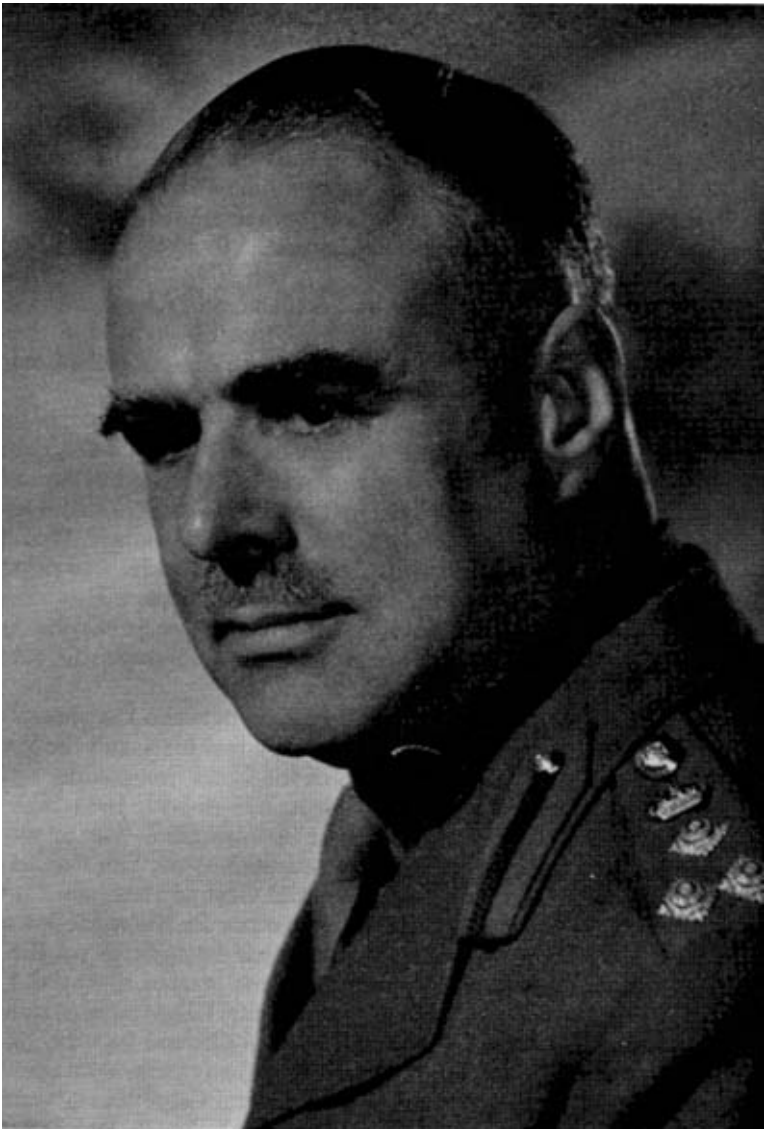
BRIGADIER A. MAC G. STEWART

ANDREW MACGREGOR STEWART was born in 1899 the son of Doctor Andrew Stewart of Birkenhead. He was educated at Cheltenham College and the Royal Military Academy, Woolwich, and commissioned into the Royal Engineers in 1919. On commissioning he was posted to 203rd Field Company serving in the Rhine Army of Occupation.

Returning home the following year he completed a Supplementary Course at Chatham and in April 1922 he was posted to India where, during a five year tour of duty, he served as a Company Officer in the 4th Field Company and later as Quartermaster of the Bengal Sappers and Miners.

In July 1927 he was posted to the RE Depot at Chatham. On promotion to Captain he became Adjutant of the Home Counties Divisional Engineers (TA) at Brighton. From there he was, in April 1933, posted as Second-in-Command of the Royal Engineers Mounted Depot at Aldershot. In October 1935 he became a Company Officer at the Royal Military Academy, Woolwich, where he spent three years and in the early part of 1939 he was posted to Gibraltar to become OC Fortress RE at that time comprising a Headquarters and the 1st and 32nd Fortress Companies employed respectively on the operation of defence electric lights and the engine rooms of the 9.2 inch batteries of the fortress and anti-aircraft searchlights.

At that time the flat, sandy isthmus stretching between the sheer North face of the Rock of Gibraltar, towering over 1,300 feet high, and the Spanish border town in La Linea, built on the site of the Lines occupied by Spanish troops during the Great Siege of 1779–1833, was divided by a high wire fence, considerably strengthened during the Spanish Civil War to stop the flow of refugees, which was regarded and accepted as the frontier between Gibraltar and Spain. On our half of this Neutral Ground there stood a small leper colony, the town's cemetery, a large incinerator for the reduction of the contents of dustbins, a slaughter house for cattle brought in on the hoof from Morocco, a small shipbuilding yard and huts erected during the Boer War which housed a company of infantry of the Gibraltar garrison that manned the border post. In addition the Neutral Ground was the garrison recreational area of the Rock. On it was a small, shady park, the race course with its paddock and stands, the kennels of the Royal Calpé Hunt, which had its hunting country in Spain, and excellent, baked-mud running track, tennis-courts, cricket fields and football and hockey grounds. The only use the Spaniards made of their thistles and weed-infested half of the Neutral Ground was to graze on it the half-starved horses and mules held on the strength of the Regimiento de Parvia, a Spanish infantry regiment which, tradition said, had been stationed in La Linea since the days of the Great Siege. The outbreak of war on 3 September 1939 was to alter for ever the face and character of the Neutral Ground, and MacG Stewart was the initial chief architect of this transformation. On 3 September 1939 his Sappers uprooted



Brigadier A MacG Stewart

the rails so that Royal Naval planes could base themselves on the grass-covered race course. Later, as stone excavated from the tunnels by Canadian and British Tunnelling Companies posted to Gibraltar became available, this small landing ground was surfaced and extended yard by yard into the ever-deepening waters of the Bay of Algeciras. The demand for stone soon outstripped the amount made available by the tunnellers and, by using high-pressure water jets, the great scree leading up to the Spanish Mine on the North face of the Rock was eroded away and the stone therefrom dumped into the sea at the head of the task by a never-ending stream of tippers and dumpers. As the runway increased in size, so did the RAF aircraft population and with it came the need for providing radar and navigational aids and control buildings, fuel storage, workshops and personnel accommodation. The work never stopped and the Sapper tasks never diminished. Starting at first with working parties from two RE Companies and local Spanish labour (whose brothers and cousins were building mass-concrete heavy gun emplacements and wire entanglements on the Spanish portion of the Neutral Ground) and no equipment, the construction force was later reinforced by units from home, an Artisan Works Company that had escaped after the fall of France through Marseilles, and a fleet of earthmoving equipment and vehicles. Day in and day out the Neutral Ground was a scene of constant activity as the runway was extended and widened and still kept open for operational use until the one-time Gibraltar recreational area had been converted into one of the most important strategic airfields of the War. Its contribution to the defence of Malta Convoys and later to the North African landings was vital. Although it cannot be said that he was responsible for its completion, the founding father of this airfield was, without doubt, Lieut-Colonel Stewart. He never spared himself and by his cheerful optimism and driving force he extracted willingly the utmost from all officers and soldiers serving under him and indeed from all civilian labourers both Gibraltarian and Spanish.

Returning home in August 1942 he became CRE 11th Armoured Division. Two years later he was posted to the Middle East where he served on the E-in-Cs staff and in the 31st Indian Armoured Division, first as CRE and later as AA & QMG. Posted to India in 1946, he served as an AAG at GHQ for a year before returning home on leave.

After a year as SOI RE (Ops) in Western Command he was posted in May 1948 to Germany to take up the appointment of Chief Engineer 7th Armoured Division District where once again he became closely involved in air matters —this time the Berlin Airlift of 1948–49. He wrote a most comprehensive account of this operation—Operation Plainfare—in the March 1951 issue of the *Royal Engineers Journal*. His object was to help Sapper officers, who might be involved in a similar operation, by stating the scope of the work required, showing the difficulties that arose and how they were overcome. Nowhere in the article was there the slightest reference to himself or what he personally had done. Through it, however, ran that unmistakeable silver thread of common sense, enthusiasm and dedication that so materially brought about the creation of the Gibraltar airfield from such small beginnings and to no mean extent ensured the success of the air supply to a beleaguered Berlin.

His final appointment was Chief Engineer, Singapore District with the rank of Brigadier. He retired in August 1952.

No one who had the great good fortune to serve under MacG Stewart will ever forget the experience. His kindness and that of his wife, his unbounded energy and his happy way of infusing confidence, when at times things did not seem to be going as they should, are things which cannot be erased from the memory. During the last five and a half years of his life the fire that once burned within him, which had been such a beacon light to his subordinates, grew dim. Nevertheless this Cross was born with great fortitude and patience by him and his family. He died peacefully on 13 December 1966. The many members of the Corps who served with him and a host of others, who did not ever wear the RE or any other military cap badge, will mourn his passing and extend their deepest sympathies to his wife, son and daughter.

LIEUT-COLONEL J. CHATTERTON, MC

(late the Duke of Wellington's Regiment)

MANY Sapper officers, both serving and retired, will have heard with very great regret of Jim Chatterton's death, which took place at Chatham on 13 December 1966. His time as Secretary of the RE Headquarters Mess covered the vital and difficult years after the War, when the Mess was being reinstated in its old quarters which had mercifully been very well treated by the Royal Navy during their occupation.

I arrived, its first post-war PMC, in 1948 and found Jim Chatterton installed as Mess Secretary. I remember thinking that whoever had chosen him for the job was a shrewed judge of character. He had no specialized experience in catering, or club or hotel management, but he had great gifts of commonsense, level headedness and the ability to delegate responsibility when necessary. Above all he was a man of the utmost integrity—loyal to his staff, who in turn were loyal to him and to the Mess.

Jim Chatterton was a handsome man and of a very distinguished appearance. Someone once said that he was "a better looking edition of the Iron Duke". He could assume a studied air of aloofness with great effect, and his manner towards young officers who "presumed" could be prickly. However, he and his wife soon had an established niche in the little society based on the SME, as it then was.

Mrs Chatterton's large scale flower arrangements proved immensely successful in the setting of the Brompton Mess, and the fine old rooms seemed to spring to life under the touch of her magic wand.

The Corps Mess owes her a large debt of gratitude, to which must now sadly be added our deep sympathy.

J.M.L.

Lieut Colonel J Chatterton MC, late the Duke of Wellington's Regiment

Book Reviews

THE MEDITERRANEAN AND MIDDLE EAST, Vol IV

By Major-General I. S. O. Playfair, Brigadier C. J. C. Molony, Captain F. C. Flynn, RN, and Group Captain T. P. Gleave

(Published by HMSO, London, 1966. Price 90s)

A sharp indisposition has recently reminded your aged reviewer that his reviewing days are nearly over and that he is perhaps fortunate to have this formidable book as a swan song. He has, as usual, read it carefully right through and tries here to set down for busy people what appear to be the salient points of the narrative.

Having won the defensive battle of Adam Halfa in the masterly fashion described in Volume III, Montgomery then laid down the tactics, which were to condition the attack against the line-up of Axis forces at El Alamein. Of these the most important was that Divisions were no longer to be carved up into private battle groups of varying composition for various objects in pale imitation of Rommel. They were to fight as proper Divisions, supported by classic style but still devastating concentrations of artillery fire, mostly from the new heavier mark of field gun, which could be laid on without excess regard for anti-tank measures, since the whole Army was at last well equipped with 6-in A/T guns.

Touching Divisions fighting as such, is the account of the "commando" kind of operation against Tobruk of 13/14 September 1942, which was favoured neither by the Army Commander nor by Tedder the Commander of the Allied Air Forces and which proved to be one of the last of its breed. In truth, commando combat seems to have lacked the professional touch and Montgomery was essentially a "pro" to whom experimentation expensive in lives was anathema. The Germans, who were also "pros", did not favour it either.

Some of the Divisions, who were now to fight in their proper role, were armoured and the supreme object of the attack was to get a sizeable mass of AFV clean through to the Elysian fields of thin skinned vehicles and diluted opposition which lay beyond the main battle zone. The Axis defences reckoned to counter tank irruptions of this kind by the adroit use of minefields covered by skilfully sited A/T guns.

Volume IV might have given more information about the A/T mines, which only receive rather a bare paragraph in Appendix 9 and no mention at all in the Index—what was the drill for "lifting" them and how were the Sapper working parties organized?

The A/T minefields were, in fact, deemed to be so deadly that they were the cause of another important tactic viz the night attack by the light of the moon. The date 23 October 1942 was fixed so as to catch its best phase. The open terrain of the desert favoured night movement and the darkness helped the Sappers in their all too conspicuous job of making mine-free tracks. Since minefields continued in constant use throughout the campaign, the night attack became such a feature of Montgomery's tactical repertoire, that on occasions an attack by day could be used with success to suprise the enemy.

The battle of Adam Halfa had already revealed a startling advance in British combat technique and that was in the air. After waiting for a very long time, the Army now found itself receiving that kind of support from the RAF which the Luftwaffe seemed to have given German troops from the very outset of the war. No doubt the RAF had to tackle first things first, yet the Army became rather wistful waiting for the correct reply to the Stukas and the dive bombers of the enemy. The air boot was at length firmly on the Anglo-American leg and remained there for the rest of the campaign. The authors were naturally at pains to describe in detail the

increasing air support of every brand which the RAF provided. How best to do so was clearly a thorny problem and one wonders whether more could not have been done with diagrams for each battle period. A notable and novel air plan of that epoch was an overwhelming concentration of aircraft on a narrow front at the battle of the Tebaka Gap which produced a barrage from the air far beyond that of the artillery and enabled 1st Armoured Division to get through the defile and end the struggle for Mareth by driving the German panzers helter-skelter through the night back into El Hamma forty miles further west.

The British artillery receives much praise in a general way so perhaps the artillery Appendix could usefully have given an account of an artillery plan for one of the attacks indicating how control at the top was effected and giving details of the barrages, counter battery and destructive fire or whatever the technical terms for these types of fire then were.

The reader will do well to study very carefully the twelve day battle of El Alamein. It bears the imprint of Montgomery's growing talent for the command of a new generation of British soldiers and for the control of a long drawn out modern battle. El Alamein also furnished the pattern for the remainder of the fighting in N. Africa including that of the First Army in Tunisia. The Axis Army on their forty mile defence line between the real and the sand seas fought with great skill and tenacity and the British victory was far from a walk-over in spite of the numerical and material advantages which helped it so much. After all "defence is the stronger form of war" and the position was a very strong one.

Montgomery's plan was to make the serious break-through in the North with its axis of advance about five miles south of the sea so as to make the best operational and logistic use of the coast road, the railway and sea power. He also laid on a strong subsidiary attack twenty miles further south to compel dispersion of the Axis panzers. Characteristically, he held on to the exact locality of his intended break-through in spite of the vicissitudes of the long battle. There was not much "give" in the Axis resistance until the nights of 28/29 October and 30/31 October when the magnificent 9th Aust. Div supported by armour did a right wheel to the coast west of the British bridge head position and attracted thither the last of Rommel's German formations which were not already withdrawing westwards. The stage was thus all set for operation "Supercharge", which Montgomery reckoned "would bring about the disintegration of the whole enemy army" as indeed it did. But such panzers and other vehicles of the Panzer armies as were still able to move, say 30–40 per cent, mostly escaped and with its losses partially replaced as it fell back, the Panzer armies continued to put up a dogged resistance at selected places for another 1,200 miles of "motoring" and combat all the way to Tunisia.

The countless famous retreats in the history of war show that a skilled leader with still unshaken troops can usually disengage and get away. Montgomery had thought of forming a special armoured formation to match Allenby's Desert Mounted Corps, which gave the coup de grace to the Turkish Army at Megiddo in 1918, but his battle at El Alamein was so fierce and so prolonged his idea never took shape. Another factor which assisted the escape of the Panzer armies was the quite unforeseen delay caused by the traffic confusion behind the British bridgehead on the dark and extremely dusty nights of "Supercharge".

For Montgomery himself, the crisis of the battle seems to have been during the lull of 26 October when the British casualties far exceeded the bag of Axis prisoners showing that the battle was not yet won. Moreover the momentum of the initial operation "Lightfoot" had waned and it had to be renewed. With what was to become his habitual resilience, Montgomery decided that the AFV situation was satisfactory, that he must watch his infantry casualties and that he would pull out some formations into reserve in order to be able to mount a fresh attack. These measures took time and caused some dismay in London where forming reserves in the middle of a pitched battle seemed to be an ominous procedure, whereas it was actually an essential grand tactic for a prolonged series of combats.

The victory of El Alamein came just pat for the "Torch" landings which started on 8 November 1942 and a wealth of tactical and operational experience became at once available for the new venture. The surprise of "Torch" spurred Hitler into the folly of pouring fresh troops and more armaments into Tunisia where they only added to the ultimate Allied bag of about 250,000 prisoners of war and an enormous unrecorded amount of war material.

Few personal clashes and dramas lend colour to the narrative. One such was the question whether the First or the Eighth Army was to deliver the final blow in Tunisia and a mere exchange of formal memoranda between Alexander and Montgomery provided the right answer—Alexander was at his very best in Algeria and Tunisia. With admirable tact he helped the inexperienced Americans so to find themselves that they quickly became magnificent troops and he co-ordinated the final phases of the war in North Africa with the utmost efficiency and distinction.

Until the USA capped it with their splendid defeat of Japan in the Pacific, the North African Campaign of 1942–3 took rank as the most brilliant example of combined sea, land and air operations that the world had ever seen. To turn such a crowded sequence of manifold events and intricate details into a readable official history is a task which would have daunted Napier or even Fortescue—the military authors of this large volume can therefore be proud of their achievement. Their prose style, however, does not seem quite so good as in the previous volumes which Major-General "Bungy" Playfair of our own Corps put together in his elegant way before his lamentable illness.

Worth a comment here is the immense part played in the campaign by Gibraltar and Malta which our Little Englanders of today reckon to be political nuisances of little worth in the atomic age.

Finally nobody can put away this history without a feeling of admiration for the manner in which the German troops fought on and on bravely and skillfully against the odds right up to their disciplined and orderly surrender. What a mercy it was for the Allies that Hitler was by then in supreme command of the Wehrmacht!

B.T.W.

ENGINEERING AT CAMBRIDGE UNIVERSITY 1783–1965

By Captain T. J. N. Hilken, DSO, MA, RN

(Published by the Cambridge University Press. Price 45*s*)

Captain Hilken is Secretary of the University Engineering Department and Fellow and Vice-President of University College and this most informative book was written by him at the suggestion of Sir John Baker, Professor of Mechanical Sciences at Cambridge since 1943.

The early chapters of the book deal with the Newtonian tradition at Cambridge and the genesis of the Engineering Department from "no more than a hobby of gifted and eccentric professors" up to the time when Engineering was established at the University as a discipline in its own right with the introduction of the Mechanical Sciences Tripos at the close of the nineteenth century.

The rest of the story is told by narrating the careers of four great men who directed the Engineering Department from then on: J. W. Ewing, Professor of Mechanism and Applied Mechanics 1890–1903; Bertram Hopkinson, Professor of Mechanism and Applied Mechanics 1903–18; C. E. Inglis, Professor of Mechanism and Applied Mechanics 1919–34, Professor of Mechanical Sciences 1934–40 and Head of the Department of Engineering 1919–43; and Sir John Baker, Professor of Mechanical Sciences from 1943. Other names, well known to Sapper officers who were at one time Undergadruates at Cambridge, occur notably Donald Portway (The Militant Don), Davenport, Dykes, Lambe, Landon, Phear and Thring.

Reference is made to the University OTC and to the Air Squadron, to the large

number of Royal Naval, Army and Royal Air Force officers who graduated through the Department of Engineering and the work done by the Department in important Defence research and development projects.

To those Sapper officers who were up at Cambridge between the wars that "most inspired and inspiring teacher" Professor Inglis must surely remain indelibly imprinted on their memory. His views on the education of the engineer, expounded in his Presidential Address to the Institution of Civil Engineers in 1941, are typical of the man and his wonderful command of the English language which so attracted the admiration of his undergraduates: "Premature specialization cramps the imagination and is destructive to the length and breadth of mental vision. Give me a youngster who has had his foundations of belief widely and deeply laid and I will back him, at long odds, to overtake and surpass at his own game one of equal native intelligence who has had his imagination cramped by premature specialization.

In a university course of engineering, instruction should primarily concentrate on teaching those essentials which, if not acquired at that stage, never will be acquired. Technicalities which will automatically be picked up in a student's subsequent career are useful as stimulating interest, but apart from this they are of secondary importance. Education does not consist in the memorization of a number of facts and formulae, useful as these may be when leavened with intelligence. Education at its best should aim at something deeper and more lasting, and the good of education is the power of reasoning, and the habit of mind which remains, when all efforts of memorization have faded into oblivion."

MILITARY DRAWINGS AND PAINTINGS IN THE COLLECTION OF HER MAJESTY THE QUEEN

By A. E. Haswell Miller and N. P. Dawnay

(Published by the Phaidon Press. Price 95s)

This volume contains 478 illustrations, twenty-eight of which are in colour, of The Queen's collection of military prints and drawings, some 3,000 in number, depicting the uniform of the British Army and the Armies of our Allies from the beginning of the eighteenth century, when the standardization of Army Dress in the United Kingdom was first introduced by George II, to the early part of the twentieth century.

Captain Haswell Miller is a former Keeper of the National Galleries of Scotland and Major Dawnay is a member of the Army Museums Ogilby Trust which has sponsored the publication of this Volume and most kindly presented a copy to the Royal Engineer Museum and to other Regimental Museums.

The most prolific of the artists represented are David Morier, who in the 1750s depicted every Regiment in the British Army and many of those of foreign armies that fought with the Allied Forces in the War of the Austrian Succession, the Dighton family (father and two sons) who flourished towards the end of the eighteenth and the beginning of the nineteenth centuries and Drahonet, commissioned by William IV in 1830 to record the uniforms of the British Army of that time. There are a few equestrian portraits by Henry Alken, better known as a painter of foxhunting and steeplechase scenes, which are little gems compared with the more formalized contemporary portraits.

The Royal Sappers and Miners are represented by a Second Corporal and a Sergeant. Between them is a full length portrait of Captain Lewis Alexander Hall, RE —all portraits by A. J. Dubois Drahonet. The dashing Royal Engineer captain not only achieved immortal fame by his presence in this collection, but he later rose to the rank of lieut-general.

A much later picture by Orlando Norie depicts the Governor's Bodyguard, Bombay and Madras Sappers and Miners, 1886.

THE PIRATE COAST

By Sir Charles Belgrave

(Published by Messrs G. Bell & Sons Ltd. Price 30s)

The great attraction of this absorbing book is that it is centred round the adventures of the frigate HMS *Eden* which left Plymouth for India in 1818 and became engaged for over 2½ years in the final extirpation of piracy in the Persian Gulf. Her commander, a certain Captain F. E. Loch, RN, kept private records of his operations in the Gulf and years later was convinced by his family that they were worthy of publication. Unfortunately the publishers of 1836 thought differently and it was not until the MSS came into the hands of Sir Charles Belgrave, well over a century later, that the heart's desire of Captain Loch has reached fruition. Escapists from the maelstrom of life, who still read *Peter Simple* and *Midshipman Easy* with passion, will particularly enjoy the extracts from the MSS since they recall very pleasingly the atmosphere of frigate warfare which Marryat so well portrays.

Sir Charles has also woven the main centrepiece most skilfully into a short account of the Persian Gulf from the beginning of history to the present day, so that the reader gets an admirable opportunity of brushing up his knowledge of one of the dwindling parts of Asia which will continue for a while to be under the protection of British arms. In 1968 the Middle East will probably be in a considerable turmoil and the intelligent onlooker must have some facts at his disposal.

The narrative reveals very clearly the quarrelsome propensities of Arab tribes, which explains how fundamentally difficult it is for Nasser or anyone else to create a united Arabia.

In conclusion the excellence of the bibliography, the index and especially the plates provides further evidence of the care which the author has lavished upon the Pirate Coast. The map, perhaps, might have had a few more names on it. B.T.W.

ELECTRONIC AUTOMATIC CONTROL DEVICES

By A. A. Bulgakov

Translated from the Russian by R. Grabiac and F. Immirzi

Edited by P. H. Walker

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price £6)

This book firstly explains the principles of automatic control and regulation which are applied in industrial processes; it then deals with electronic voltage amplifiers, elements of control-circuit couplings, indicator circuits and grid control devices. Thereafter the author explains in considerable detail the theory, design and application of the thyratron rectifier and inverter; and devotes a chapter to each of the following subjects—control of drives with induction motors; rotary amplifiers and electronic voltage regulators; electronic control in servo and follow-up drives; matched speed regulation for multi-motor drives; and programmed machine-tool control.

The emphasis given by the author to the application of thermionic and ionic devices was, of course, justifiable in 1958 when the first Russian version of the book was published, but since then the application of semi-conductor devices into the field of automatic control has grown considerably and the Editor has endeavoured to offset the omission of the latter devices from the author's text by including in the editorial introduction brief reviews of transistor amplifiers; semi-conductor switching elements; control of large power using solid-state devices; and the applications of silicon-controlled rectifiers. These reviews, however, are in no way comparable with the detailed explanations and descriptions of the control apparatus chosen by the author.

It is also unfortunate that the bibliography only refers to Russian and other works of pre-1958 vintage which are now outdated.

F.T.S.

APPLIED MECHANICS FOR ENGINEERS VOLUME I

By C. B. SMITH, BSc (ENG), C ENG, AMIMECHE, AMICE
Senior Lecturer in Mechanical Engineering, Norwich City College

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 17*s* 6*d*)

The object of the author is to present the first principles of the subject in a manner suitable for students doing the first year's work for the Ordinary National Certificate in Engineering.

The text is written in a simple concise style and supplemented by a large number of worked and unsolved calculations, which illustrate the application of each principle. The following *extract* is typical of the presentation:—

Mechanical Equivalent of Heat

The conversion of mechanical work into heat was first demonstrated by Joule in 1840 when he rotated a paddle wheel in a vessel of water and measured the work done in rotating the paddle wheel and the amount of heat generated. Since then further experiments have been carried out and it has been decided that 1 British thermal unit (Btu) is equivalent to 778 ft lbf of work. This is known as Joule's equivalent.

A British thermal unit (Btu) is the heat required to increase the temperature of 1 lb of water by 1°F at a mean temperature of 60°F.

A British thermal unit is also $\frac{1}{180}$ of the heat required to raise the temperature of 1 lb of water from 32°F to 212°F and this is the more usual definition.

Although the specific heat of water is approximately 1 at normal temperatures, it is found to vary with the temperature and allowance must be made for this variation when dealing with high temperatures.

Example 6.5. Find the horse power of a crane which lifts a load of 1 tonf at a speed of 20 ft/min.

$$\text{Horse power} = \frac{\text{force in lbf} \times \text{distance moved/min}}{33{,}000} = \frac{2240 \times 20}{33{,}000}$$
$$= 1.36 \text{ hp}$$

The actual horse power required to drive the crane will be greater than this because of the frictional losses in the crane mechanism.

If this is the standard of knowledge you seek, or wish to teach others, then I doubt if you will find a better primer for your purpose. F.T.S.

STRENGTH OF MATERIALS

By P. BLACK, BSc(ENG), AMIMECHE
Dept of Mechanical and Production Engineering
Mid-Essex Technical College, Chelmsford

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 45*s*)

This text book is intended for students who are approaching the final examination stage for Higher National Certificates and Diplomas in Mechanical Engineering who need only a brief revision of stress analysis theory but considerable practice in solving the types of problems they are likely to be confronted with when sitting their respective examinations.

The author has made no attempt to explain fundamental theory, the text of each section merely outlines the successive theoretical steps needed to solve calculations and then amplifies the guide with a number of worked examples of graduated difficulty. The worked examples, which cover the whole range of the subject matter and a good deal of the Mechanics of Machines as applicable to HNC and Diploma level, are well laid out and illustrated with explanatory diagrams. F.T.S.

BASIC THEORY OF STRUCTURES

By J. S. C. Browne, BSc(Eng)

Lecturer in Civil Engineering, Dundee College of Technology

(Published by Pergamon Press Ltd, Headington Hill Hall, Oxford. Price 21*s*)

This soft-covered text book is included in the Mechanical Engineering Division of the Commonwealth and International Library published by Pergamon Press Ltd. Its purpose is to explain the basic concepts of structural behaviour in a manner suitable for students following a civil engineering course up to Ordinary National Certificate level, and would be very suitable for the instruction of draughtsmen and Clerks of Works.

The author has taken considerable care to give students a thorough understanding of the fundamental principles, and in this respect has preceded the worked theoretical examples of each section with introductions which clearly define the concepts and amply qualify the usual bald definitions. The mathematical knowledge required by the student does not need to exceed that necessary to solve algebraic equations and elementary trigonometry.

The chapters cover: Equilibrium of Structures; Shearing Force and Bending Moment; Bending Stresses in Beams; Complex Stress; Statically Determinate Plane Trusses; Rolling Loads; Combined Bending and Direct Stress; Deflection of Beams; Buckling of Struts; Deflection of Trusses—Strain Energy Method and Graphical Method; Reinforced Concrete.

F.T.S.

SIX FIGURE TRIGONOMETRICAL TABLES: C1
SIX FIGURE LOGARITHMIC TABLES: C2

By C. Attwood

Principal: Apprentice Training Ford Motor Company Limited

(Published by Pergamon Press Ltd, Headington Hill Road, Oxford. Prices 17*s* 6*d* for C1; 25*s* for C2)

Pergamon Press Ltd have already separately published eight practical tables covering six-figure trigonometrical and logarithmic functions of angles to various values, and logarithms, cologarithms, antilogarithms, squares and roots, products of numbers, and compound interest.

These books—C1 and C2—combine the contents of previous editions as follows:—

C1

Six-figure trigonometrical functions of angles in degrees and minutes (which includes comprehensive notes on interpolation). *Practical Table Series No. 1.*

Six-figure trigonometrical functions of angles in hundreths of a degree. *Practical Table Series No. 2.*

C2

Six-figure logarithmetric trigonometrical functions of angles in degrees and minutes (which includes trigonometrical formulae). *Practical Tables Series No 3.*

Six-figure logarithmic trigonometrical functions of angles in hundreths of a degree. *Practical Table Series No. 4.*

Six-figure logarithms, cologarithms and antilogarithms. *Practical Table Series No 5.*

A future edition—C3—will combine squares and roots and products of numbers. *Practical Tables Series Nos 6 and 7.*

F.T.S.

Technical Notes

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review*, September 1966

COLLAPSE OF COOLING TOWERS AT FERRYBRIDGE. A review of the Final Report of the Committee of Inquiry examining the collapse of three cooling towers at Ferrybridge "C" Power Station appears. The review lists the errors and omissions in design, compensating design factors and the Committee's recommendations.

RIVER TAGUS BRIDGE. The September issue includes Part I of an article on the River Tagus Suspension Bridge, the centre span of which is 3,323 ft and thus, the longest outside the USA. The bridge is a continuous lattice truss designed to carry four lanes of heavy duty highway traffic. The article is well illustrated and deals with the design and construction of main piers, main towers, cables and anchorages.

ANALYSIS OF STATICALLY INDETERMINATE STRUCTURES EMPLOYING THE THEORY OF THE ELLIPSE OF ELASTICITY. Ellipse of Elasticity theory is applied to the analysis of rib sections in a "swing type" travelling shutter as used in the construction of large diameter sewers. The article is of general value in that the method may be applied to any statically indeterminate structure of varying section; its particular application is to fixed-end arches of constant section.

PULVERIZED FUEL ASH (PFA). PFA is a material the output of which is rapidly increasing; in 1970 it is estimated that it will exceed 12 million tons, only 7 million of which are likely to be put to economic use. Part I of the article includes sections on physical properties, shear characteristics, a specification for structural fill and active pressures on PFA retaining structures.

J.D.W.

Notes from *Civil Engineering and Public Works Review*, October 1966.

NEWS AND LEADERS. Once again the editorial page headlines the position of the Engineer in Society by giving prominence to the general compulsory paper of the examinations set by the Council of Engineering Institutions. This paper entitled the "Engineer in Society" is no doubt intended to demonstrate to the Council that the student is capable of writing sound English and of expressing his thoughts logically. Should the Council, however, hope to increase the standing of the engineer by such a paper, it is suggested that formal written examination in this particular subject is not perhaps the ideal way of achieving the objective.

River authorities pursuing improvement schemes to reduce pollution at such a fast pace without thought to economic considerations have given rise to a letter of concern being sent by the Confederation of British Industries to the Ministry of Housing and Local Government, the details of which are also covered in the leader page.

It is reported that the Quantity Surveying Department of MPBW is to be comprehensively reviewed by an independent consultant before a new Chief Quantity Surveyor is appointed consequent upon the retirement of the previous incumbent, Mr R. Menzies, OBE, FRIC.

WOOLWICH FERRY TERMINALS. A short article describes the construction of new terminals for the well known Woolwich Ferry. The necessary cofferdams were built in sheet piling of high yield stress steel supported by three horizontal frames made in steel beam walings with "Rendhex" struts. The design of these cofferdams catered for the accidental ramming of the dam by the ferry boat by incorporating internal raking struts. Fortunately during construction they were not called upon to resist

such a force. However, a forgotten wartime bomb had left a soft spot in the underlying chalk which caused the cofferdam to blow during dewatering, involving the failure of 40 ft of the sheet pile wall. The blow was finally sealed by placing concrete using a tremie before dewatering and after the precast concrete piles had been driven under water.

Reinforced Timber Beams. Timber is once again being increasingly used as a construction material, and this article by Dr D. Bond of Queen's University, Belfast highlights further uses of this versatile material. Wood fibre and plywood beams are described which are reinforced top and bottom with steel bars. It is shown that efficient reinforced plywood beams can be made if the top and bottom reinforcing bars are curved so that they meet at the beam support where they can be welded together. Thus, being inclined near the ends of the beam, the steel bars are able to resist a considerable part of the shearing forces, and so reducing the bond and shearing stresses in the beams.

In an attempt to simplify the methods of construction using this kind of reinforcement, four different types of such beams were investigated. The article presents a method of analysis, enabling the stresses to be calculated and goes on to compare and discuss the theoretical and experimental values obtained.

New Developments in Hydraulic Models. A new development in hydraulic model technique has been invented by the consulting engineers, Sir Bruce White Wolfe Barry and Partners, who have applied for a British Patent. For reproducing possible scouring or silting effects in a river or estuary, there are two types of model. In one, a scale model of the site is built in a fixed tray and uses a pump to simulate tide and current. This new development is, however, based on the second type, which utilizes a rocking tray to achieve tide effect. This interesting article describes how some of the problems inherent in a scale model are overcome to make a comparison with the actual likely conditions.

Graphical Method for Concrete Proportioning. A major article by a French roads and bridges engineer has been excellently translated by J. M. Hawkes, who will be well known to many readers from their days at the Royal Military College of Science. A graphical method is used to represent the composition of fresh concrete, and allows one to establish a border line for the consistency, enclosing all concretes which can be obtained with a given aggregate. The method enables the correct water content to be determined and introduces the description of a particular aggregate grading by means of a "grading point".

B.O.B.

Notes from the *Civil Engineering and Public Works*, December 1966. This edition contains interesting, if brief, articles on the New Mersey Tunnel Approaches and on Harbour Developments at Galway.

The main part is devoted to the Airports and Runways Feature a collection of eight articles dealing with various aspects of runway construction and the provision of airport facilities.

The introductory article, by a prominent airport consultant, Mr A. Geoffrey Edwards, FRICS, MICE, F ASCE, envisages a revolution in transport over the next ten years, in which the airport of tomorrow will assume the function of the railway junction of the last century. The author argues that the airport must be integrated into the planned transport system of every large city. By quoting the example of O'Hare Airport, which handles about twice the traffic as that at Heathrow, and is owned and controlled by the City of Chicago he shows that his proposal is financially feasible.

The second article deals with two problems arising from the presence of water on runways, skidding and aquaplanning. The authors, Messrs Martin and Judge, have been working on the problem for some ten years, first with the Air Ministry Direc-

torate General of Works and, since 1962, with the Ministry of Public Building and Works. They note that aquaplanning may occur initially when retained water reaches a depth of ¼ inch, a not uncommon condition on even the best-drained pavements, and that once started it can continue over considerably lesser depths of water. References are given which describe methods of measuring skid resistance. Clearly the skid resistance of a runway determines the length necessary for given aircraft and thus the cost-effectiveness of the airport. Methods and specifications for improving the skid resistance of both existing and newly-constructed runways are included and the authors conclude with the thought-provoking comment that, in the future, the civil engineer may well say what he can provide economically and that the aircraft should be designed to these ruling criteria.

P. J. Sims, BSc, MICE of Messrs L. G. Mouchel and Partners describes a new multi-storey car park, due to be opened in June 1967, and designed to meet the needs of users of the No 3 "Oceanic" Passenger Building at Heathrow. Limitations placed on the design were architectural, financial and dimensional (to comply with flight safety regulations). In-situ reinforced concrete construction was adopted, floor slabs designed to a uniformly distributed live loading of 60 lb/sq ft and beams to 50 lb/sq ft. The design allows for parking on five covered levels and the roof, and for maximum utilization of the available area.

Three further articles describe rehabilitation works at Coolidge Airport, Antigua and Owen Roberts Airfield, Grand Cayman, the construction of the new North-East Passenger Building at Heathrow, and the design of the new hangar at RAF Brize Norton.

Wing Commander G. R. Stroud, C Eng, AFRAeS, M Inst Nav, makes a valuable contribution to the education of the civil (and, indeed, the military) engineer. His subject is "airfield lighting", or, to be more accurate, the "airport visual ground aids system". He stresses the need for full consultation with all the specialists concerned, particularly the operators, at the planning stage of the airfield and runway design in order that potential dangers and unnecessary cost may be avoided. The article deals briefly with lighting in the landing, manoeuvring and approach areas.

The final article describes the design and construction of the runways for the new Baghdad International Airport. The pavements are designed for unlimited use by dual tandem aircraft having an all-up weight of 300,000 lb. The site is alluvial clay, soaked CBR about 1.0 per cent and the accepted construction is 17 in of mesh-reinforced concrete with dowelled load-transfer between slabs, on 6 in bitumen stabilized gravel on 6 in gravel sub-base on 12 in compacted fill. Problems occurred due to extremes of temperature. For example, in high summer, it was found that concrete placed in the afternoon failed in tension at night; that placed at night was put safely into compression during the day. In consequence concreting was restricted to the night. The author deals briefly with the performance of the Vögele spreader/finishers and final finishers.

J.D.W.

Notes from the *Civil Engineering and Public Works Review*, November 1966.

TEMPORARY FLYOVER AT BARKING. In 1965, the Ministry of Transport arranged a competition to find the best type of temporary flyover at Alfred's Way, Barking to avoid congestion on the A13, London to Tilbury road. It is reported in this month's edition that there were fifty entries. A development of the second prize winning design, submitted by Messrs Braithwaite and Co (Structural) Ltd, was selected by the Minister of Transport and their tender of £83,962 for the supply and erection of the temporary flyover has been accepted. A design was entered in the competition by a consortium of RE officers headed by Lieut-Colonel J. D. Towsend-Rose, MC, BSc, AMICE in conjunction with the Instructors of the Design Wing, RSME. The RE entry was based on the use of Bailey Bridge parts with some modifications. Unfortunately it was not one of the three prize winning designs.

NEW METHOD OF DESALINATION. The solution to the world-wide shortage of fresh water may lie in a new process known as reverse osmosis, in which sea water is forced under pressure through a thin plastic film or membrane. The membrane withholds the salt content and it is claimed that water suitable for drinking is obtained. The new process is being developed by a team of scientists, led by Dr Allan Sharples, at the British controlled Arthur D. Little Research Institute, near Edinburgh. Although comparatively simple, reverse osmosis is a recent discovery which at first sight appears to have the great advantage over distillation processes that small units are economic for isolated communities and the power supply necessary to carry out the process is much smaller. The research has not progressed far enough at present for the possible military applications of this discovery to be assessed.

PRESENTATION OF CRITICAL PATH ANALYSIS RESULTS USING THE CASCADE ACTIVITY NUMBERING (CAN) METHOD. The Authors of this article, P. F. Miller, LIOB and I. D. Cordiner, BSc, AMICE are the Development Project Manager and the Procedures Development Officer of John Laing Construction Ltd. They describe a system of presentation of Critical Path Analysis results using their Cascade Activity Numbering (CAN) Method. The purpose of developing this system is to attempt to present the conventional network diagram in a more disciplined way so that the finished result is in the form of a stepped diagram whose flow is from upper left to lower right of the chart. This gives the appearance of a waterfall or cascade, hence the name of the method. It is claimed by the Authors that this type of diagram is easier to use for progress purposes as it is more analogous to the Gantt (or Bar) Chart. In fact the system of cascade activity numbering of activities appears to have two disadvantages. Firstly it is complicated and introduces an additional step at the stage where the arrow diagram is drawn to a time base and scheduled but not levelled. Secondly the system does not permit zoning of like activities on the arrow diagram to the same extent as with the conventional arrow diagram.

The article will be of interest to those in the Corps who have tended to become experts in Critical Path Analysis but on balance there is little to recommend the method in preference to that detailed in RE Training Notes No 2—Engineer Planning. It is recommended that in the Service the general method of presenting Critical Path Analysis results given in the military publication is more appropriate.

GUMA DAM—SIERRA LEONE. Completion is reported, in this issue, of Guma Dam in Sierra Leone. The dam is in the mountainous forest reserve at about 2,000 ft above sea level and about 15 miles by road from Freetown. It completes a series of lesser water works which have been going on since the last century. The dam impounds about 4,800 million gallons when full. The rainy season in Sierra Leone lasts for about four to five months and in the past it has been necessary to restrict water supplies during the dry season in Freetown. The additional supply, made available by the completion of this dam, should make this unecessary in future and in addition will provide water for a nearby new hydroelectric power station. This gravity earth dam was designed by Messrs Howard Humphreys and Sons, Consulting Engineers. The main contractors were Taylor Woodrow of Sierra Leone Ltd, the value of whose work was over £3 million.

NUCLEAR EXCAVATION IN WATER RESOURCES DEVELOPMENT. A. K. BISWAS, M. Tech, AMASCE, who is a lecturer in civil engineering at the University of Strathclyde, gives an interesting account in this article of the development and potential of the use of nuclear demolition charges as a means of carrying out large scale excavations for water resources development. His paper gives details of nuclear cratering events and the results and parameters for cratering calculations. The problem of radioactivity, air blast and seismic effects are discussed. An evaluation is made of the use of nuclear demolition charges to construct a sea level canal across the Central American Isthmus at five possible sites between Nicaragua and Columbia. The author's conclusions are

that more research and development programmes are required before routine commercial use of nuclear excavation become practical.

HYDRAULIC DREDGING. Engineers concerned with the development of alluvial waterways are now increasingly employing hydraulic dredging as the principal improvement and maintenance technique. In this article A. R. SORENSEN, BSCD, MASCE, who is the Sales Manger for a principal manufacturer in the USA of hydraulic dredgers, gives an account of the principles of hydraulic dredging and describes a number of projects successfully carried out by this method.

A 600 TON MULTI-PURPOSE TESTING FRAME. A 600 ton testing frame, based on four interchangeable steel grillage units and designed to test a variety of structural elements including storey height well panals and floor and shell units up to 14 ft square, is described in this article by A. W. HENDRY, BSC, PHD, DSC, MICE, MI STRUCT E and R. E. BRADSHAW, MSC, AMICE, AMI STRUCT E. This testing frame has recently been installed at the Structural Ceramics Research Unit in Edinburgh University.

AUTOMATIC DATA PROCESSING TECHNIQUES IN CIVIL ENGINEERING LABORATORIES. This article is intended for civil engineers engaged in laboratory work at colleges and universities. It is a treatise on various aspects of the automatic recording and processing of data. It is well written, as the author has been careful to avoid using too technical terms, and is aimed at the reader who has no special knowledge of electronics. The article describes how a moderately priced, adaptable installation can be assembled in stages to embrace the work of various civil engineering laboratories without duplication of effort.

WESTERN AVENUE EXTENSION. Brief details are given of the scope of the Western Avenue Extension contract which has recently started. The project is expected to take three and a half years and will cost about £15.25 million.

THE CONSTRUCTION INDUSTRY TRAINING CENTRE. The new Construction Industry Training Centre is described in the November issue. The purpose of this Centre is to provide facilities for training operators of heavy plant and other skilled operatives in the Construction Industry. This is the first of its kind in this country and it will be of great interest to readers to know that the staff of the centre have been chiefly drawn from the Services. The Principal of the new centre is Lieut-Colonel K. M. BEAN (retd) who has recently retired from the Corps. He will be remembered as OC Stores Wing at 1 ESD and Wksps, Long Marston and previously as SI Bridging Wing at the RSME. The senior plant instructor is Flt Lieut J. Pollock (retd) who formerly commanded the RAF Airfield Construction Branch Plant Training School at Waterbeach.

The new centre has been established at a former RAF station at Bircham Newton, Norfolk, which has suitable soil conditions for plant operation throughout the year as well as providing extensive accommodation buildings, workshops and hangers. Courses at the new Centre started in September this year although the Centre will not be officially opened until spring 1967. The Centre is at present aiming at accommodating 500 trainees at any one time. A two week course at the centre costs about £60 for tuition while the cost of board and lodging is born by the Construction Industry Training Board. The fee is normally paid by the employer but there is a system whereby part of this can be reclaimed.

R.C.G.

THE MILITARY ENGINEER

SEPTEMBER–OCTOBER 1966

MILITARY CONSTRUCTION IN VIETNAM. This heading covers three articles. The Construction Agent by Rear Adm. H. N. Wallin. Civil Engineer Corps US Navy, A Contractor's View by W. Stuart Potter and Army Troop Construction by Colonel

J. H. Hottenroth Corps of Engineers. The Construction Agent is the Naval Facilities Engineering Command (formerly the Navy Bureau of Yards and Docks) acting for the Department of Defence. Under the accelerated build up of military construction in Vietnam the contract construction there is now about equal to the normal world wide construction programme of the Navy.

The first article describes the organization of the Works Service with its three large civilian firms under contract and gives a summarized account of the problems, planning, labour, provision of stores and equipment and the peculiar difficulties due to the activities of Vietcong. In the second article a contractor describes the special considerations which affected the provision of a full scale airfield at Cam Ranh Bay about which there have been articles in previous numbers of the magazine. The third article gives an account of the Civil and Military organization of Vietnam and then describes the part being played by the Army Engineers.

These three articles give an impressive picture of the size and importance of the engineer contribution to the Vietnam war and of the effort which is being put forth by the US.

A New Look at Water-Resources Development by Lieut-General William F. Cassidy, Chief of Engineers US Army. The reports of the Senate Select Committee on National Water Resources in 1960 and 1961 focussed attention on the indivisability of water resources. Anything done to the waters of a river basin for any one purpose affects their usefulness for all other purposes. There is an acute water problem in the United States both of shortage, flooding, and pollution. To solve the many problems which arise a co-ordinated effort is required. The Water Resources Planning Act of 1965 provides for this. The article under review states the overall problem particularly as it affects the Corps of Engineers. It is of great interest and makes one think whether some such centralized organization to deal with all uses of water would not be appropriate in the UK.

Development of Performance Standards by Bruce E. Foster. In the writing of specifications for materials an attempt is made to describe or identify the properties of a material or product that will give satisfactory performance under conditions of its intended use. In this article the author, who is chief of the Standards Section, Building Research Division, National Bureau of Standards, discusses the factors governing the performance testing of building materials and quotes examples of tests which have been carried out by the Bureau.

Navigation Satellite System by Captain H. S. Cole, US Environmental Science Services Administration. The Navy Navigation Satellite System consists of orbiting satellites, a ground control system, and a shipboard receiver system (equipment designated AN/SRN-9). Its application and use in problems of navigation and oceanographic surveys was a project of the United States Coast and Geodetic Survey. The system became available in May 1965 when a shipboard unit was installed in a ship of the Coast and Geodetic Survey. This article which is well illustrated describes in considerable detail the shipboard equipment and the principles of its use.

Roofing Research by Thomas H. Boone. A short article describing the studies of the engineering properties of built-up roofing at the Building Research Laboratories of the National Bureau of Standards. There is an interesting summary of various new roofing materials being examined and notes on various unusual roof shapes and the problems arising therefrom.

Mob-Eight in Vietnam by Lieut Roger G. Martin, Corps of Engineers. A short illustrated account of the works carried out by the Naval Mobile Construction Battalion Eight in Vietnam. A corroborative detail to the first article in this number.

Sword Without Shield by Comdr B. S. Merrill, Jr., Civil Engineer Corps US Navy. An eloquent plea that the provision of fallout protection should be increased throughout the US and that all new construction should cater for it.

PROJECT SLEDGE by Jack R. Kelso and Major James Choromokos, US Air Force. Economical simulation techniques for the study of blast effects from nuclear detonations have been sought for a long time. In the laboratory, shock tubes and blast load generators have been used with scale models and full sized targets have been exposed in large scale high-explosive field tests. This article describes, in considerable detail with illustrations and diagrams, research which is being conducted into the use of detonable gases for controlled explosions. The new test series called Project SLEDGE (Simulating Large Explosive Detonable Gas Experiment), is to study the feasibility of using detonable gas mixtures in lieu of TNT for simulating the blast effects of nuclear explosions. As an example of the advantages of the method at sea level the energy of 20 tons of TNT is released by a 78 ft diameter balloon of propane and oxygen or by an 88 ft diameter balloon of methane and oxygen.

MILITARY ENGINEER FIELD NOTES

MINERAL-INSULATED CABLE IN THE ARCTIC by Captain Richard W. Calhoun, Corps of Engineers. A brief note with technical details of the way in which water and sewer pipes are prevented from freezing in the extreme cold of the Arctic by using a combination of insulation and mineral insulated cable on the pipes installed above ground.

LAND MASS MOVEMENT DETECTION by Captain James R. Fry, Corps of Engineers. Extremely destructive and costly disasters have resulted from mass movements of earth. Several examples are quoted in this article which gives a brief account of the conditions leading to such movements and the indications which should be looked for when studying their possibility when planning or siting engineer works.

AIRLIFTED FLOAT BRIDGE, DOMINICAN REPUBLIC by Major Joseph L. Spruill, Corps of Engineers. This is a description of how a M4T6 bridge 500 ft long was constructed to replace a permanent bridge over the Haina River which had been swept away by floods. The permanent bridge was destroyed at 3 am on 28 May at 0300 hrs and the replacement, all the components of which had to be flown in from the States, was completed by 6.30 pm on 5 June. There are good photographs.

J.S.W.S.

NOVEMBER–DECEMBER 1966

BEAUTY AND POWER ON THE NIAGARA RIVER by Lieut-Colonel James M. Neill, Corps of Engineers. This is a well illustrated history of the development of the water power resources of the Niagara Falls and the steps which have been taken to preserve the natural beauty of the river and the Falls.

LINE OF COMMUNICATIONS BRIDGING by Captain F. C. Bidgood, Corps of Engineers. The Japan Logistical Command developed the Line of Communication (LOC) bridge to carry Cooper's E45 loads. Unfortunately the article does not give any further guide as to the specification of the load, except for the fact that it is a railroad bridge. The article describes a training exercise carried out in Korea which was the first time the bridge had been erected since the Korean war for which it had been designed. It remains a piece of standard US Army equipment. The article is illustrated but there are few details of design given. From the photographs it is a bridge made up of plate girders.

REHABILITATION OF BEACHES WITH THE HOPPER DREDGE by Louis J. Mauriello. The rehabilitation of beaches to withstand or reduce the eroding effect of waves and for their subsequent maintenance has been found to be a good substitute for protective structures such as groins. Large offshore deposits of excellent material for such rehabilitation were found within a few miles of several eroded beaches on the Atlantic coast of the US. This article describes a full size experiment carried out using a

hopper dredge, a self-propelled and self-sufficient hydraulic dredging plant that operates underway, specially adapted for the purpose so that the dredged material could be pumped direct through a submerged pipe line on to the beach. Many difficulties were encountered but the conclusion reached was that further experiments to study the particular needs and conditions of each project are needed before the design of a dredge plant for this particular purpose should be undertaken. There are good photographs and diagrams.

THE BRIDGE OVER THE EASTERN SCHELDT by H. J. M. Bekker. A very clear well illustrated article describing the design and method of construction of a road bridge over the Eastern Scheldt which forms part of the Netherlands government plan for the development of communications between Zeeland and the rest of the country. The bridge is a two lane bridge, three miles long with a 25 ft roadway and a 9 ft cycle track. The contract was awarded in May 1962 and the bridge opened to traffic on December 1965. There are many interesting features of design which are described in some detail.

DESALINIZATION: A VITAL NEED by Colonel Richard J. Hesse, Corps of Engineers. An article in general terms setting out the arguments for continuing vigorous research and development in the field of desalinization as a means to meet the increasing demands for fresh water throughout the world.

VIETNAMESE MILITARY CONTRACT CONSTRUCTION by Major Lawrence R. Smith and Captain Hubert C. Puscheck, Corps of Engineers. A brief account of the organization and method of working of the Works organization of the Vietnamese armed forces.

TELODYNAMIC POWER SYSTEM by Leonard C. Weston. Of historical interest this article describes how water power was used in the Rock Island Arsenal in the days before hydro-electric power had been developed. Telodynamic means a wire rope system which takes the power from the dam shaft by a 20 ft pulley wheel and a continuous wire rope over intermediate towers to a horizontal shaft transmitting power to each shop. Great detail and contemporary drawings are given.

PHAN RANG AIR BASE by Major Donald A. Haas, Corps of Engineers. One of the main American operational air bases is at Phan Rang and this article describes the construction work carried out by Corps of Engineers units in connection with it. Of particular interest is the detailed description of the specification for the sub base of the 10,000 ft AM-2 mat runway, taxiway, a PSP cargo apron and over 800,000 sq ft of AM-2 fighter apron and the steps that had to be taken to deal with the heavy rainfall. Apart from drainage this included covering the runway, etc, with nylon membrane before laying the AM-2 mat. Other works carried out include accommodation for the Air Force and for a brigade of an Airborne Division, and a POL installation served by submarine pipe line from offshore tankers.

CHEMICAL SOIL STABILIZATION by C. Martin Riedel. The method of soil solidification described in this article is effective for general foundation improvements to stop the settlement of buildings; for underpinning existing structures and for repairing and improving damaged pile foundations. The particular case illustrated is the underpinning of an existing structure threatened by deep excavations close to it for the foundations of a new building. The method consists in injecting into the ground to be treated a dilute silicate of soda solution (water glass) and a reactant which when mixed with calcium chloride controls the setting time. The correct combination of these three ingredients injected at a certain pump pressure at a rate of about 5 gallons a minute will fill the voids in the porous soil binding the loose particles together into a solid mass having the hardness and bearing capacity of sandstone. There is much interesting detail of equipment needed and of the characteristics of chemically solidified soil.

MAINTENANCE IN PROCUREMENT PLANNING by Colonel William V. Beach, Corps of Engineers. The high cost of military equipment makes it necessary that the cost of maintenance is considered at the same time as the initial cost when selecting an item. This article elaborates this point and describes some of the means the Department of Defence is taking to meet it.

ELECTRONIC POSITION FIXING IN HARBOURS by William M. Kennedy III. This is a detailed description of the Decca Hi-Fix System for providing horizontal control for hydrographic surveys which is not limited by line of sight and visibility yet provides the required accuracy and continuous presentation of position.

MILITARY ENGINEER FIELD NOTES

SURVIVAL WATER SUPPLY by Captain Paul E. Sammon, Corps of Engineers. A description of a simple survival kit for use in desert country. The combination of a piece of plastic sheeting and a hole in the ground and a container for the water are all that is necessary. The plastic sheeting, anchored around the edge, is stretched over the hole, sagging into it as far as possible without touching the sand. Water condenses on the underside of the plastic and drips off into the container. A bowl-shaped hole 3 ft in diameter and 1½ ft deep in the sand of the Arizona desert produced 5 quarts of water a day for 5 days.

FOXHOLES FOR AIRCRAFT by S. M. S. Robert C. Bueker, US Air Force. During 1965 the Air Force shipped steel revetments to Vietnam to protect parked aircraft from damage by enemy fire. These aircraft "foxholes" are structures of steel-copper alloy, 16 guage and 8 guage column sections filled with sand. The article, which is well illustrated, describes the method of erection.

J.S.W.S.

G. PERCY

TRENTHAM

LIMITED

BUILDING

AND

CIVIL ENGINEERING

CONTRACTORS

READING BIRMINGHAM
LONDON STOKE-ON-TRENT
CARDIFF GLOUCESTER

PANGBOURNE READING BERKS — MAIN OFFICE —	Pangbourne 2201
WOOD LANE BROMFORD BIRMINGHAM	Erdington 2491
NEW ROAD RAINHAM ESSEX	Rainham 52902
PARK HALL LONGTON STOKE-ON-TRENT	Stoke-on-Trent 39147
ROATH BASIN BUTE DOCK CARDIFF	Cardiff 30256
LAWRENCE DRIVE STOVER TRADING ESTATE YATE Nr. BRISTOL	Chipping Sodbury 2024 AND 2636
BRADMAN ROAD KIRKBY LIVERPOOL	Simonswood 3264