THE ROYAL ENGINEERS JOURNAL

Vol LXXVI JUNE 1962 No 2

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THE ROYAL ENGINEERS JOURNAL

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JUNE, 1962

Corps Notes

A new type of unit has been formed in the Corps to operate amphibious river crossing equipment. In May 1962 23 Independent Field Squadron ceased to exist as a field squadron and formed 23 Amphibious River Crossing Squadron (Cadre), from which this new unit will expand as soon as the equipment is available.

* * * * *

The amalgamation of 1 Training Regiment and 4 Training Regiment became official on 31 March 1962.

* * * * *

68 Gurkha Field Squadron is due to arrive in the UK in May 1962 and will join the 3 Divisional Engineers in Mooltan Barracks Tidworth as part of the Strategic Reserve.

* * * * *

During the early months of this year units of the Corps have been exceptionally busy in meeting demands for help arising from storm and flood damage.

At the beginning of February 24 Field Squadron (of 36 Corps Engineer Regiment) returned from Kenya, leaving a troop behind for a further month to finish the work they had been doing in providing flood relief.

Assistance was given to the local authorities in Sheffield and the West Riding of Yorkshire by 12 Field Squadron (of 38 Corps Engineer Regiment) after the serious storm damage which removed many roofs and caused great havoc over a wide area in late February.

In Penzance similar help was provided by a troop of 116 Corps Engineer Regiment (TA).

In Germany, 1 Divisional Engineers, assisted by 11 Engineer Group, took part in the life saving and other emergency operations in Hamburg after the unique floods which occurred there during late February 1962.

In March 1962 HQ 12 Engineer Group returned from hurricane relief operations in British Honduras.

The Engineer-in-Chief has received letters of grateful thanks for this assistance and for the efficient and enthusiastic way in which the many and varied tasks, often of an extremely arduous and trying nature, were carried out by both Regular and Territorial Sappers and the credit they have brought upon their Corps and the Army in general.

* * * * *

A Works Section RE, supported by 3 troop of 9 Independant Parachute Squadron, were deployed onto a construction task in Bahrein in January 1962.

* * * * *

At the request of the Colonial Office a small party of two officers and ten other ranks, selected from units in the United Kingdom, flew to the Gilbert and Ellice Islands in February 1962. Their task is to blast passages through coral reefs to facilitate the passage of fishing vessels between the islands. The work involves a considerable amount of skin diving, drilling and blasting. The presence of sharks is lending excitement to the operation.

* * * * *

The Engineer-in-Chief visited Headquarters and Engineer Units in the Middle East and Near East Land Forces in April 1962.

* * * * *

General R. M. Thuaire, The Inspector of the French Engineers, visited the Engineer-in-Chief and certain units of the Corps in January 1962.

* * * * *

The Chatham and Aldershot Bands and the Band of the Junior Leaders Regiment beat Retreat at Chatham and Aldershot on the 14 and 15 March 1962 respectively.

* * * * *

Recruiting during the early months of the year has been very good for the Army as a whole, and the Corps has continued to get its fair share of these recruits. A new RE Mobile Recruiting Display has been built at 2 Engineer Stores Depot and Workshops at Liphook to replace the previous RE Recruiting Trailer. It is due to visit all commands, except Northern Ireland, this Summer.

* * * * *

From 27 February to 5 March 54 Independent Field Squadron provided the Ceremonial Guards at Government House and Flagstaff House, Hong Kong, this being the first time that a Sapper unit had found such guards for very many years.

The photograph shows HE the Governor Sir Robert Black, GCMG, OBE inspecting the Government House Guard on 2 March 1962.

Recruiting

Presentation of Silver Centrepiece to the Gurkha Engineers

By Major-General L. E. C. M. Perowne, CB, CBE
(*Colonel The Gurkha Engineers*)

On the occasion of a Corps guest night in the Headquarter Mess at Chatham on 2 November 1961, the Chief Royal Engineer, General Sir Frank Simpson, handed over to Brigadier J. H. S. Bowring, a former Commandant of the Gurkha Engineers, a magnificent silver centrepiece made by Garrard and Company Limited to the original design of Major J. R. Radford RE. In the words engraved upon it, this centrepiece was:—

Presented
by the
Corps of Royal Engineers
to the
Officers of the Regiment
to commemorate the raising of
Gurkha Engineers
and their incorporation as a component part of
The Brigade of Gurkhas

Three dates engraved at the foot of the presentation plate refer respectively to the constitution of the Corps of Engineers by Royal Warrant of George I, 26 May 1716 (Corps Day); the raising of the first Gurkha Field Squadron, Royal Engineers (67 Squadron), 23 October 1949 (Gurkha Engineers' Day); and the creation by Royal Warrant of the Gurkha Engineers as a separate Regiment within the Corps of the Brigade of Gurkhas, 28 September 1955.

In making the presentation the Chief Royal Engineer said that there were doubtless still many present who had served in the Sappers and Miners in India and therefore knew the Gurkha soldier well. The Corps, he said, were very proud to be Officering Gurkha sappers and watched their progress with parental interest. The centrepiece was presented to them with the best wishes of all in the Corps.

The central feature of the design is developed from the Regimental badge comprising the Royal Engineers grenade supported on the crossed kukris of the Brigade of Gurkhas, all rendered in solid silver. In his reply, Brigadier Bowring referred to this combination as illustrating very well the character of Gurkha Engineers—"military engineering solidly based on the sharpest and most formidable soldierly qualities". In thanking the Chief Royal Engineer he expressed the appreciation of all ranks of the Regiment for the consistent support of the Corps at every stage of its development.

By kind permission of Messrs Garrard & Co Ltd, London, W1

Presentation Of Silver Centrepiece 1

By kind permission of Messrs Garrard & Co Ltd, London, W

Presentation Of Silver Centrepiece 2

The inclusion in the badge of the Royal Engineers grenade and the motto "Ubique" derives from the authority granted to the Regiment on its formation and conveyed by the then Chief Royal Engineer by letter dated 28 February 1956, in the following words:—

"The Corps of Royal Engineers is proud to have sponsored the formation of Gurkha Engineers and, as a lasting recognition of their association, they would be pleased if they would accept the right to use the Corps colours and to retain in perpetuity such Royal Engineers devices on their regimental property as have been granted to them whilst serving as a unit of the Corps of Royal Engineers."

The formal affiliation of the Gurkha Engineers to the Corps of Royal Engineers was approved by Her Majesty and made known in Army Order No 1 dated 31 January 1958.

Surrounding the central feature of interlocked badges stand four solid silver figures depicting respectively a Queen's Gurkha Officer in No 1 Dress, a piper in ceremonial order, a sapper in tropical drill order, and another in battle order. On either side of the ebony plinth are affixed engraved plates setting out the story of Gurkhas as sappers, first within the Corps, and latterly in the Gurkha Engineers. These read as follows:—

"ROYAL ENGINEERS

The enlistment of Gurkhas in the Service of the Crown was begun in 1815; and, in 1947, four of the Gurkha Rifle Regiments were incorporated in the Brigade of Gurkhas as part of the British Army. The first Gurkha soldiers to be trained as Sappers were drafted from 2nd King Edward VII's Own, 6th, and 10th Princess Mary's Own Gurkha Rifles to the Engineer Training Centre at Kluang, Malaya, on 4th October, 1948, and these formed the nucleus of 67 (Gurkha) Field Squadron, Royal Engineers, raised in that place on 23rd October, 1949. 68 (Gurkha) Field Squadron, Royal Engineers, was raised at Kluang on 1st April, 1950; and 50 Field Engineer Regiment, Royal Engineers, formed in Hong Kong on 5th April, 1951, to furnish these Squadrons with a Regimental Headquarters.

GURKHA ENGINEERS

The Gurkha Engineers were created by Royal Warrant dated 28th September, 1955, taking precedence within the Brigade of Gurkhas after 10th Princess Mary's Own Gurkha Rifles. The titles of the existing units were then altered and the Regiment at first comprised, Headquarters 50 Gurkha Field Engineer Regiment, 67 Gurkha Field Squadron and 68 Gurkha Field Squadron, Gurkha Engineers.

On 2nd April, 1960, Headquarters, The Gurkha Engineers, replaced Headquarters, 50 Field Engineer Regiment; and, on the same date, 70 Gurkha Field Park Squadron was raised at Sungei Besi, Malaya. The Regimental establishment was completed by the raising of 69 Gurkha Field Squadron at that place on 1st April, 1961."

What of the earlier history of the Squadron numbers bequeathed to the Gurkha Engineers by the parent Corps on formation? There were no Companies[1] in the Royal Engineers bearing these numbers prior to 1914.

[1] In 1947–48 the term "Company" was replaced throughout the Corps of Royal Engineers by the term "Squadron".

In the First World War they made their first appearance as the Field Companies RE raised for 11 (Northern) and 12 (Eastern) Divisions of the New Army. The War Establishments at that time provided for two Field Companies only per Division, a third being added later in the war.

With other units of these Divisions these Companies began to assemble in August 1914, and were completed by October of that year. 67 and 68 Field Companies thus comprised the original Divisional Engineers of 11 (Northern) Division and first saw service at Gallipoli, where they took part in the operations of IX Corps on the Suvla front from August to December 1915. After the evacuation from Gallipoli, 19 December 1915, 11 Division formed part of the Egyptian Expeditionary Force (EEF) and was employed in the defence of the Canal Zone in XV Corps area from February to June 1916. These Companies then moved with 11 Division to France where they first came into action in the Arras sector of the line and then took part in the Battle of the Somme, September 1916. They were subsequently engaged on the Ancre and at Messines and Langemarck (Third Battle of Ypres) during 1917, the Division being at that time part of XVIII Corps. On 16 August 1917, at Langemarck 67 Company gained two MC's and two MMs in one bridging operation.

Meanwhile, 69 and 70 Field Companies arrived in BEF in May 1915, with 12 Division and were present at the Battle of Loos in October. In the attack on the Hohenzollern Redoubt 70 Field Company earned for itself a unit citation in dispatches. Both Companies were engaged at the Somme, 1916, and Arras, 1917; and 69 Field Company were with III Corps at the Battle of Cambrai, in November 1917, where they became engaged as infantry.

Throughout 1918 all four Companies continued to operate in France and Belgium; 67 and 68 Field Companies, with 11 Division in XXII Corps area (First Army), taking part in the Second Battle of Arras, at Cambrai, the Canal du Nord and at the Sambre; and 69 and 70 Field Companies with 12 Division in III Corps area (Fourth Army) at the Somme and the breaching of the Hindenburg Line.

After the cessation of hostilities all four Companies were disbanded, being reduced to cadre and dispersed in May/June 1919.

There were no Companies bearing these numbers in the years between the wars. All four of them were, however, once more raised in August/September 1940, at Barton Stacey as Chemical Warfare Companies. Of these, 67 Company went to India in April 1942, and at Chittagong in May 1943, was re-designated a Field Company and allocated for work under CRE 108 Works in Assam before being withdrawn to India where it was once more disbanded in February 1946. Of its activities in the period 1943–46 we have no record. 68 Company was re-designated a Chemical Warfare Mortar Company in March 1942, and as such joined First Army in North Africa in November 1942, but was disbanded there in June 1943.

69 and 70 Companies were converted in March 1943, into Field Companies and assigned to 6 Army Troops Engineers in the Order of Battle of 21 Army Group. From May 1944, onwards they took part in the assault landings in Normandy and the ensuing operations in North-West Europe, culminating in the assault crossing of the Rhine in XXX Corps Sector on 24 March, and the passage of the Elbe in April 1945. These two Companies were also subsequently disbanded, in Germany, in September 1945.

Service on the Seventh Continent

By CAPTAIN P. J. HUNT, RE

Captain Hunt was seconded to HQ NZ Army and attached to the Antarctic Division of the New Zealand Department of Scientific and Industrial Research from October 1959 to August 1961 to serve with the New Zealand Antarctic Expedition. During the summer of 1959/60 he took part in the Geological and Topographical Survey Expedition, and after spending the following winter at Scott Base, he led the Southern Party of the 1960/61 Summer Expedition.

The work of these field parties covered about 12,000 square miles of previously unexplored land in the Ross Dependency from Cape Parr (80° 30′ S) to the Beardmore Glacier (84° S), about 400 miles south of Scott Base.
EDITOR.

PRESENT ACTIVITIES IN ANTARCTICA

THE co-ordination of activities in Antarctica is vested in the Special Committee on Antarctic Research (SCAR) of the International Congress of Scientific Unions.

SCAR was set up in September 1957 to consider the desirability of continuing scientific activities of all kinds as extensions of the International Geophysical Year (IGY) Programme which was commenced in July 1957. This committee now meets annually to review such matters as:—

1. Meteorological Research.
2. Radio Communications.
3. The World Magnetic Survey.
4. The Conservation of Nature in Antarctica.
5. Mapping programmes.
6. The dissemination of information on newly discovered geographical features.

There are standing sub-committees in the following subjects:—

Biology, Communications, Geodesy and Cartography, Geology, Geomagnetism, Glaciology, Meteorology, Oceanography, Solid Earth Physics, Upper Atmosphere Physics, and Logistics.

Since December 1959 a treaty has been signed by the twelve nations which are engaged in Antarctic work. These are—Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the Soviet Union, the United Kingdom and the United States of America.

The major terms of agreement are:—

1. To continue peaceful scientific co-operation.
2. To ban the use of Antarctica for military purposes—with an inspection and control system to ensure compliance.
3. To prohibit nuclear tests and the disposal of radioactive waste.
4. To "freeze" territorial claims—without renunciation of previously asserted claims.

There are now thirty-five permanently occupied (summer and winter) bases in Antarctica, south of Latitude 60° S, besides several others at which summer observations are made and which serve as "inland" bases for expeditions. These are listed in Annexure "A" and their locations are shown on the accompanying Sketch Map No 3.

Administration of the Ross Dependency

The responsibilities for the administration of the Ross Dependency, which was established in 1923, and for activities within the sector (between Longitude 160° E and 150° W) are indicated by the following diagram:—

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                    Governor-General of New Zealand
                 ┌──────────────────┴──────────────────┐
           Administrator                         NZ Government
(Nautical Adviser to the Marine Dept)   (Minister in charge of Dept of
                                        Scientific and Industrial research)
                                                       │
 Superintendent ______ Secretary, DSIR ________________│
Antarctic Division     (Science Executive)             │
      DSIR                                     Ross Dependency
        │                                     Research Committee
Leader, Scott Base                                  (RDRC)
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Directly responsible to the Governor-General is the Administrator. His authority and responsibility is jurisdictional only. The Minister in charge of Scientific and Industrial Research is responsible to the Government for all New Zealand scientific activities. To advise and assist the Minister and to formulate and co-ordinate plans for research programmes there is the RDRC whose membership represents the Dept of External Affairs, the Chiefs of Staffs Committee and all scientific institutions with Antarctic interests. These comprise DSIR, the University of New Zealand and the Royal Society of NZ. The RDRC is responsible for the co-ordination of New Zealand's scientific and technical efforts with those of other nations and for the publication of the results of research. Executive action is the responsibility of the Antarctic Division of the DSIR and the Leader, Scott Base is responsible to the Superintendent of this Division for the implementation of the scientific programmes and hence for the operational control of all field parties.

Role of Services

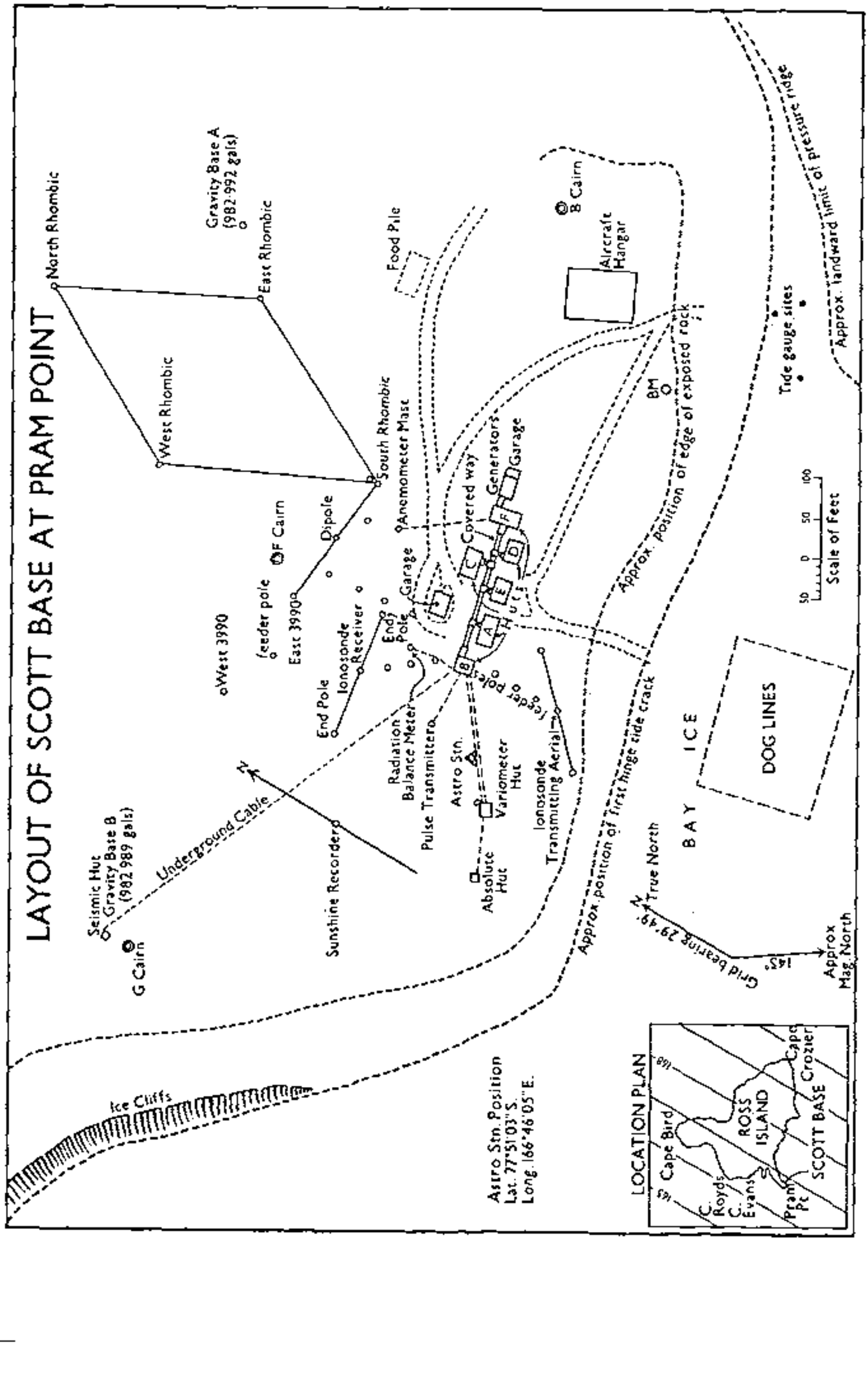
Important assistance is provided by all three Services.

The RNZN till 1961 operated HMNZS *Endeavour* (previously the *John Biscoe*) for the annual relief and replenishment of Scott Base as well as for oceanographic cruises. Since *Endeavour* has become unfit for work in ice-bound waters, the Navy in future are likely to crew a tanker/supply ship loaned by the United States Navy. The NZ Army provide specialists for base and field parties and tradesmen (from Royal NZ Engineers) to implement the Ministry of Works building programmes and to carry out maintenance work at Scott. The RNZAF have the Antarctic Flight which operates light aircraft ("Auster", "Beaver" and "Otter") in support of parties in the field.

Scott Base

Scott Base was established at Pram Point on Ross Island to house scientists working in support of the IGY programmes and also, under Sir Edmund Hillary, the Ross Sea Party whose task it was to support the Commonwealth Trans-Antarctic Expedition (TAE). For Base layout, see Sketch Map No 1.

The buildings for the base were designed by architects of the New



LAYOUT OF SCOTT BASE AT PRAM POINT
North Rhombic
East Rhombic
West Rhombic
South Rhombic
Gravity Base A (982·992 gals)
Food Pile
B Cairn
Aircraft Hangar
Approx. landward limit of pressure ridge
Tide gauge sites
BM
Approx. position of edge of exposed rock
Garage
Generators
Covered way
Anemometer Mast
Dipole
F Cairn
feeder pole
East 3990
West 3990
Garage
End Pole
Ionosonde Receiver
End Pole
Huts
A
B
C
D
E
F
feeder poles
Radiation Balance Meter
Pulse Transmitter
Astro Stn.
Variometer Hut
Ionosonde Transmitting Aerial
Absolute Hut
Sunshine Recorder
Underground Cable
Seismic Hut
Gravity Base B (982·989 gals)
G Cairn
N
Approx. position of first hinge tide crack
BAY ICE
DOG LINES
True North
Grid bearing 29°49'
145°
Approx Mag. North
Scale of Feet
50 0 50 100
SKETCH MAP No. 1
Ice Cliffs
Astro Stn. Position
Lat. 77°51'03"S.
Long. 166°46'05"E.
LOCATION PLAN
165
168
Cape Bird
C. Royds
C. Evans
ROSS ISLAND
Pram Pt
SCOTT BASE
Cape Crozier

Zealand Ministry of Works. They were prefabricated by Australian and New Zealand firms. The wall, roof and floor panels, each 3-in thick, have almost 100 per cent efficient insulation. The Australian made panels, constructed from materials like those used at Mawson (the major Australian Base), consist of onozote insulation between an interior sheet of asbestolux and an exterior of Hiduminium metal. The NZ built panels have an asbestolux and hardboard interior with the outer skin of specially glued fireproof plywood sealed on the outside with bonded glass fabric and with 1½-in of fibreglass insulation between. All timbers in the huts were pre-treated with fire proofing chemicals and, in each hut, are installed automatic temperature-controlled fire alarm systems. Each building was erected on timber grillages on rock and "permafrost" (frozen soil and rock) as normal concrete and pile foundations were impracticable. The panels, forming floors, walls and roofs, are locked together with tie rods. From the rods across the roofs, guy wires of SWR connect to ground anchorages to ensure stability in high winds. Windows, 1 ft square, are specially designed also to prevent heat loss. They are made up of two sheets of glass substitute enclosing a sealed layer of dry air. At the entrance to each of the main buildings is a "cold porch" connected to a central tunnel. Both doors of the porches are insulated. The 7 ft high tunnel or "covered way" connects these porches. It consists of curved sheets of heavy gauge CGI bolted together and anchored down with SWR which passes over the top every 10 ft. Thus, even during the most severe blizzard, it is possible to move from one hut to another without having to don extra protective clothing.

There are now seven main buildings in the Base—a scientific laboratory; a kitchen and mess building which also houses the radio room and office; two sleeping huts for twenty-two men with partitions giving some privacy to the occupants; a hut divided between the washroom (including a bathroom!), space for the maintenance and repair of field equipment, and a survey office; a hut housing two photographic darkrooms, toilets, and a stand-by generator; and a hut housing the main power supply (two diesel-driven 48 kVA generators), the main snow-melting installation, and a mechanics' workshop plus garage space for one vehicle. All these huts are heated by thermostat-controlled air heaters burning kerosene. Water is provided by three snow-melters. The larger unit, adjacent to the washroom, utilizes the exhaust gases from the generator diesels, in a complicated heat-exchange system, to melt the snow blocks. These are fed in through an outside hatchway. The other two melters, which provide for the kitchen and darkrooms, have kerosene heaters.

Apart from the central group are several other huts—a garage for five vehicles; a hangar large enough for two light aircraft; the nursery for the husky pups; three small scientific huts (Magnetic, Seismic and Variometer Hut); and the "Auroral tower" which is an elevated hut re-built after being transported from the US Base "Little America V". Also, two miles away from Scott, on "Arrival Heights", there is an Auroral Radar Station.

There has been little or no deterioration of the original seven buildings erected in January 1957 and much credit must go to the designers at the Ministry of Works. There has been less accumulation of snow and ice round the huts than was thought likely and, even in winter, no snow accumulates on the flat roofs. The buildings so far have proved quite strong enough to withstand all gales and blizzards.

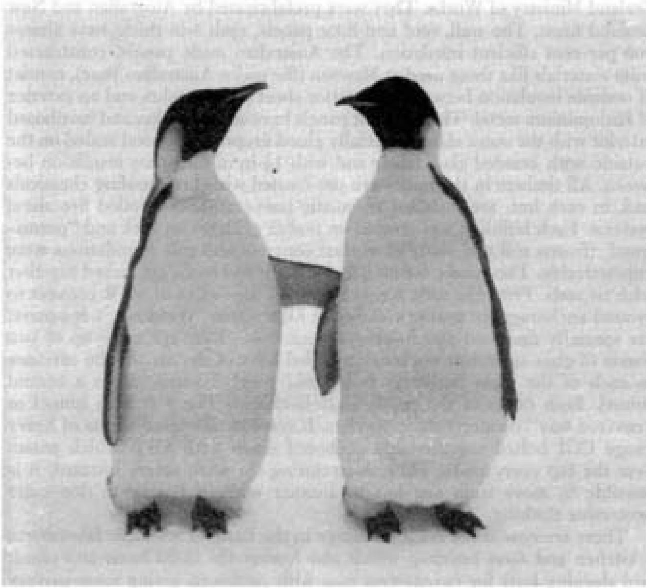


Photo 1. "I say old man—who are these strange people who do not dress for dinner?"

Photo 2. Below Scott Base at the dog lines—"Home" for the huskies.

Service On The Seventh Continent 1,2

Photo 3. Scott Base—in summer conditions 1961.

Photo 4. Sno-Cat "Able" which crossed the continent with the Trans-Antarctic Expedition and which is still in daily use at Scott Base.

Service On The Seventh Continent 3, 4

Manning of Scott Base

The strength of the "wintering-over" parties is about fourteen while for summer periods there might be as many as forty men accommodated.

There are normally five scientists or technicians stationed at the Base. The remainder of the fourteen comprise the Base Leader, radio operator, engineer, electrician, carpenter, cook and, as a normal policy, two men from the previous summer's field survey party to work up survey data, look after the fifty-odd dogs and to prepare equipment for the following season's expeditions.

Radio Communications

Radio contact is maintained with the New Zealand Post and Telegraph Office System, using morse and voice circuits, with two 350-watt transmitters operating on several crystal controlled frequencies. There are usually two morse contacts each day with Wellington and on three nights per week, conditions permitting, individuals can speak to any part of NZ through the national telephone system. Calls to England have been accomplished. Field parties retain contact with battery operated transmitter/receivers on both C/W and R/T.

Transport at Scott Base

Two Weasels and a Land Rover provide transport for Base members while haulage is done with a Tucker Sno-cat, a D-4 tractor-dozer, and four Fergusson tractors fitted with light steel tracks and extra bogies. The dog team sledges, with a maximum capacity of about 1,000 lb (with nine dogs in harness) have little use at Base but are used extensively for the summer expeditions. Man-hauling sledges of the "Nansen" type are also used.

Much assistance in air support for field parties has been given by the Antarctic Flight of the RNZAF. But at present (1961) there are no aircraft available and field parties rely on the willing assistance given by the VX-6 Squadron of the US Navy stationed at McMurdo Base.

Scientific Work

The main purpose of Scott Base parties is simply to obtain scientific data. This is done in two ways—by parties working at the Base and by small expeditions, either mobile or static, in the field. The mobile field parties are chiefly engaged in geological and topographical surveys. The static parties have been working during recent summers on such research as Soil Surveys in the foothills of the Royal Society Range, which lies to the west of McMurdo Sound, and Bird Biology at Cape Royds and Cape Evans where respectively Shackleton (in 1907–09) and Scott (in 1910–13) had their headquarters.

Research at Scott Base covers Seismology, Meteorology, Geomagnetism and Ionospherics. Radio, radar and optical techniques are used. Brief descriptions of equipment are as follows:—

Geomagnetism. There are three independent recording systems: a wide-range and a quick-run magnetograph operating on the three-component La Cour System; also Fluxgate magnetometers reading declination.

Seismology. One three-component Benioff variable-reluctance Seismometer is installed. This records local disturbances and tremors located as far distant as the Aleutian Islands.

Ionospherics. A New Zealand designed panoramic ionosonde recorder, working on the frequency range 1–25 mc/s, is in operation.

Meteorology. Standard meteorological observations of temperatures, barometric pressure, wind speed and direction, visibility and cloud data records are made twice a day. There are continuous recordings of pressures and wind speeds. Also, solar radiation studies are made.

The observations in these sciences are extensions of the IGY programmes, as already mentioned. But besides these, which provide basic data for long-term investigations, the particular aspects of the ionospheric and auroral research programmes that are examined with additional equipment are as follows:—

D-Region observations. The recorder used is a high power (25 kW) single frequency (2.3 mc/s) transmitter-receiver which measures the absorption and reflection by the D-region of the ionosphere of radio signals passing through it. This so-called D-region, in the lower ionosphere, lies about fifty-five miles above the earth's surface. The important feature of the region is the continuous reflection of radio waves at this height. This reflection is believed to be one means of radio communication over distances of the order of 1,200 miles which are unaffected by magnetic storms and ionospheric disturbances.

"*Whistlers*". Recordings, synchronized with a world-wide pattern of stations, have been made of VLF radio signals propagated over paths reaching 8,000 miles into the outer ionosphere. These observations of short and long whistlers, whistler trains, tweeks, bonks and hisses, combined with the results from other countries, have led to determinations of the electron density distribution in the outer ionosphere.

Failure to hear the "dawn chorus", common in middle latitudes, has caused some puzzlement.

Auroral Zone Absorption Equipment. A pulse transmitter operates hourly on four frequencies (12, 16, 20 and 24 mc/s). Signals are picked up in New Zealand and elsewhere. The experiments are designed to study the effects of the Auroral Zone on radio communications.

Auroral Studies. Special optical equipment is installed in the Tower to record the occasional auroral displays which occur during the hours of darkness. The photographic units used are "All-Sky" cameras and spectographs using both black and white and colour films.

Practically all the displays observed at Scott are yellow/green in colour. However, during periods of magnetic storms and intense ionospheric absorption, faint red colourings are seen. But these occasions are rare.

Auroral Radar. Equipment located at "Arrival Heights" records echoes caused by disturbances of the ionospheric current systems which are associated with the Aurorae. Two aerials bracket the South Magnetic Pole (at approximately Latitude 70° S, Longitude 140° E) in order to study the circulating currents around it.

As the majority of all this equipment requires electric power (both AC and DC) for operation, much depends on the generators. Two stand-by sets are always kept ready for use during unexpected breakdowns and the ingenuity of the mechanics is often tested. The major trial during the winter of 1960 was the frequent breaking of fan belts which had eventually to be improvised as all spares sent down from New Zealand were 1-in too short!

The photographic darkrooms are also important subsidiaries to the scientific work. They are in constant use for film and photo processing to obtain the recorded data from instruments for transmission to New Zealand.

Minor Studies. Besides those already mentioned, several other scientific activities are undertaken from Scott Base. These include Gravimetry, Glaciology and Oceanography. A Worden gravity meter is carried by survey parties who also undertake measurements of flow of glaciers and the Ross Ice Shelf. Since the end of HMNZS *Endeavour*'s employment in Antarctic waters, the oceanographic work has been confined to "under-ice" studies of sea currents and tide measurements near the Base.

United States Activities

This account would be incomplete without mention of American work in the Ross Dependency. The parent US Base, termed "Naval Air Facility McMurdo", is situated two miles from Scott Base near Hut Point. There, about 100 men spend the winter and during the summer months (October to March) the total strength rises to as many as 600. The Base is administered by the US Naval Support Force, Antarctica—commanded at present by Rear Admiral David M. Tyree.

Scientific, research and field work is carried out by the US Antarctic Research Program (USARP) organization under the auspices of the National Science Foundation in Washington. This body also arranges for other scientific institutions such as University Groups, the Coast and Geodetic Survey and the Department of Geological Survey to participate. The activities are various with emphasis on Meteorology, Glaciology, Survey work and Cosmic Ray research.

Unlike the New Zealand field expeditions, which prefer sledging with dogs and by man-hauling—the traditional forms of transport—the USARP parties have Sno-cats of various designs, small two-men motor sledges, and helicopters.

The present main interest at McMurdo is centred round the installation of a nuclear reactor which will supply electric power generators. As about 70 per cent of the material transported by sea to McMurdo is fuel, the subsequent economies will be enormous. When in operation the reactor will produce from 40 lb of enriched uranium fuel, the energy equivalent of over 1½ million gallons of diesel oil. This 1,500-Kilowatt reactor is of the pressurized water type; moderated and cooled by light water. It is planned to provide later a second reactor for McMurdo and one each for the satellite bases of Byrd Station and the Amundsen-Scott Station at the South Pole. These small bases, and the combined US/NZ Base at Cape Hallett, are also occupied throughout the year and are within aircraft range of McMurdo's Williams Field during the summer.

The "New Byrd" Station, of a type that has been proved in Greenland at the US Army's "Camp Century",[1] is now being constructed to replace the old IGY Base which has become uninhabitable because of the damage caused by snow pressure on the hut walls and roofs. Trenches to a depth of 30 ft have been cut in the snow and these have been roofed with steel arched structures to carry the accumulation of snow on top. Within the eight interconnected tunnels, varying in length from 300–1,200 ft, well insulated, prefabricated buildings have been erected. The difficulties of ventilation and sewage disposal have been overcome by ingenious methods and all normal

[1] See article "Camp Century, Greenland" by WOI P. W. James, RE—published in the *RE Journal* of December 1961.

Photo 5. On Hut Point, near the present American Base, stands the old timber hut built by Captain Scott and his companions in 1902.

Photo 6. Part of McMurdo—the United States Base on Ross Island.

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base facilities are provided. Water supply comes from melting the surrounding snow by utilizing the cooling systems of four 150 kW diesel generators. When these are replaced in 1965 by the nuclear power plant, water will come from "Rodriquez Wells". The procedure, devised in Greenland, is to create wells to a depth of approximately 200 ft, and of about the same diameter, by use of steam jets. The water is then simply pumped up to the Base distribution system. This new Base then, lying in snow, on 8,000 ft of ice, will be far different in appearance from NAF McMurdo which comprises dozens of huts, buildings and hangars with rock beneath.

Communications by Air

In support of all United States and New Zealand activities the US Navy and the US Air Force both operate several types of aircraft from Harewood—the airport of Christchurch—2,300 miles and 7–10 hrs flying time from McMurdo Sound.

These types are: Globemaster (C-124): Hercules (C-130): Constellation.

The first two have payloads of 35,000 lb and 32,000 lb respectively while the "Connies" are used for passenger carrying. During the spring and summer the aircraft maintain a frequent service to transport men and materials to and from Williams Field till the ice runways break up or the worsening weather and low temperatures of the autumn prohibit flying. The location of the runways on the 10–15 ft thick sea ice of the Sound varies from year to year and much care is taken to inspect cracks and weaknesses before the dozers and graders are put to work to skim off the hard-packed snow. From early September the airfield, 3–4 miles out from Hut Point, becomes a busy community in itself with many facilities of a normal air base—huts and repair shops (some mounted on skids for easy removal), radar installations including a ground control approach system, and even a cinema. From this airfield, and also from neighbouring snow runways, the VX-6 Squadron of the US Navy operate their aircraft for flights within the territory.

The following are used: Hercules (C-130): Neptune (P2V-7): Skymaster (R5D): Skytrain (R4D)—("Dakota"): Otter (VC-1): Sikorsky helicopters.

The turbo-prop. Hercules, with both wheels and skis fitted, are able to use orthodox runways, ice or snow; so carry the bulk of supplies to the Pole and Byrd Stations. The Neptunes are used almost exclusively for aerial photography. The ski-fitted Skymasters, Skytrains and Otters, when supporting field parties, invariably use snow runways and have wheels removed so as to reduce the drag for take-off. To assist the take-off from soft snow the heavier aircraft have "JATO" bottles (jet-assisted take-off) slung beneath the fuselage. These are fired electrically and jettisoned when the plane is airborne.

The larger aircraft are not protected in hangars. In winter, when not in use, they are well anchored down in a sheltered position and left to become drifted up. When temperatures are low the engines must be preheated with hot air blowers before starting. This operation itself often takes several hours.

Communications by Sea

There are normally four US Navy ice breakers operating in the Ross Sea from early December to March. All have helicopters for ice-spotting and

Photo 7. An icebreaker of the US Navy lodged at the end of the channel in the sea ice of McMurdo Sound. Behind, on Ross Island, is the active volcano—Mt. Erebus.

reconnaissance. These ships carry out programmes in oceanography and hydrography; but their primary task is to form and keep open a channel in the ice of McMurdo Sound so that the supply ships are able to unload within ½ to 1 mile of Hut Point. Stores and provisions are ferried by tractor trains over the ice from ship to shore. The lumbering D8 tractors fitted with extra-wide tracks work continuously, towing one or two 20-ton sledges, to ensure a quick turn-round for the ships. They fear always the possibility of being caught at the end of the channel during a blizzard or a heavy swell. The ice takes a constant toll in plate damage and broken propellers and many a "Breaker" has limped back to New Zealand on one screw.

Midway between New Zealand and Antarctica a ship of either the US Navy or RNZN is stationed during the summer flying months to inform aircraft of weather conditions and to relay radio messages between Christchurch and McMurdo Base if necessary.

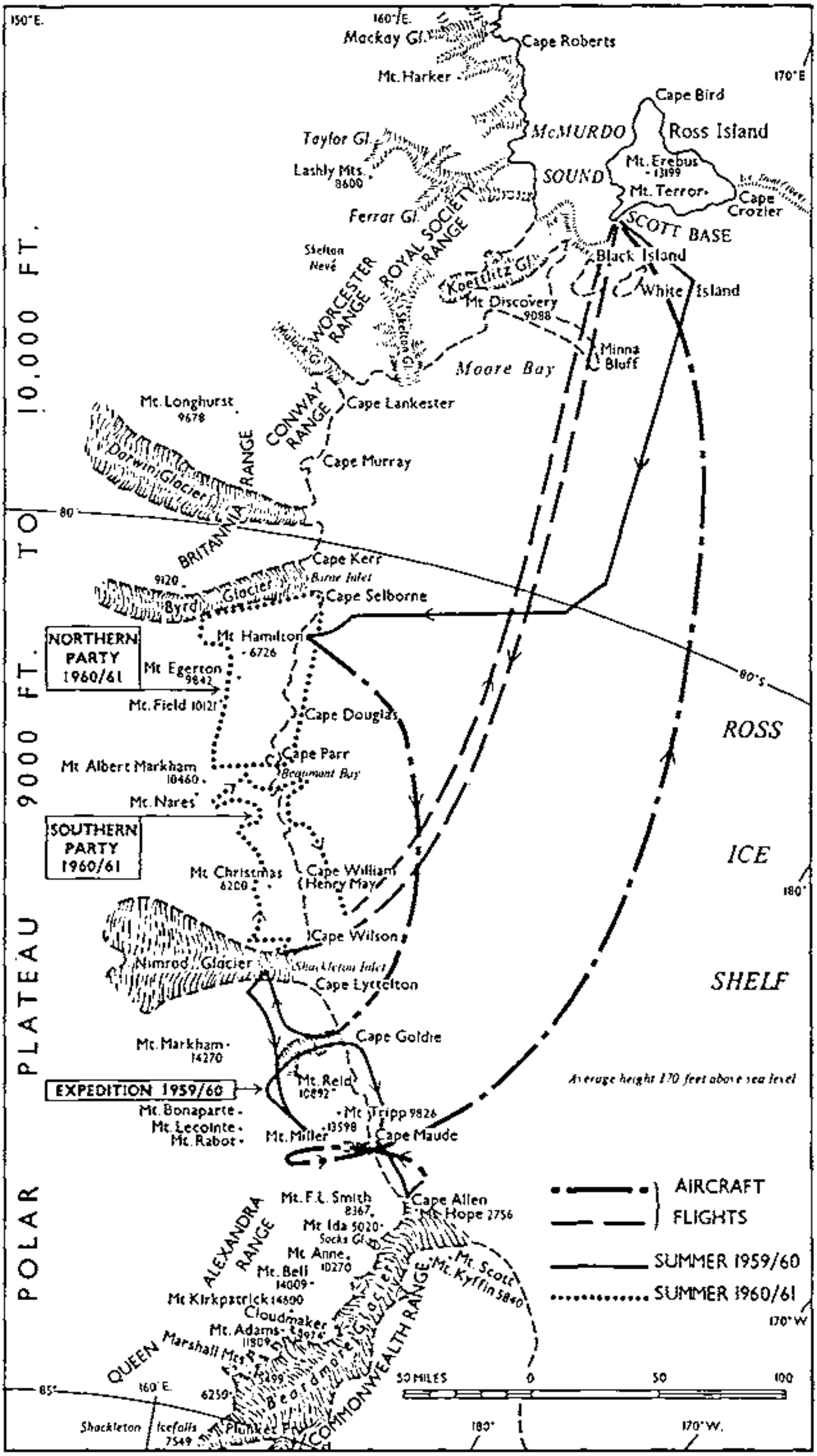
The Summer Expedition of 1959/60

Two separate parties were organized. One, composed of four men—a geologist, two surveyors (including myself) and an assistant—was to travel with three dog-teams; and the other, also with four men—a geologist, a surveyor and two driver-mechanics—were to have two Sno-cats (ex TAE) for transport. The plan was for the dog-team party to sledge south from Scott Base to Cape Selborne (see Sketch Map No 2) and then to carry out geological and topographical surveying work "inland" and eventually to emerge at Cape Wilson; while the Sno-cat party was to do similar work on the coastline operating from the vehicles and into the ranges with a man-hauling sledge.

After 2–3 weeks acclimatization and training at Scott Base during which time the dogs and men had become fit, sledges and Sno-cats overhauled, and all equipment made ready, we set out with the dogs on 2 November for the Ice Shelf journey. Fortunately for the two of us who were new to sledging, the going was good for the first two days; so we were able to become accustomed to sk-ing beside the sledges. Temperatures during the day averaged −15° C and −30° C at night when the sun was low. As the snow conditions worsened, with the sastrugi[1] lying south-west into the prevailing wind and oblique to our route, shoulder, arm and groin muscles suffered. It requires practice to retain one's balance on the ski while holding a rein with one hand and the sledge handle-bar with the other and at the same time guiding the sledge between the sastrugi to avoid capsizing. After five days we were out of sight of land navigating with sun-compass and the sledge wheel milometer—with theodolite or sextant sun shots every second day or so to check the estimated positions. Nine days after leaving Base, having travelled 155 miles, we met the Sno-cat party who had covered the distance in four days. Then we moved farther south and turned in towards the coast together to arrive at Cape Selborne—290 miles and 16 days out from Scott Base.

The following day—19 November—tragedy befell us. One of the Sno-cats with three men aboard fell 90 ft to the bottom of a hidden crevasse. The driver, Lieutenant T. Couzens, RNZAC, was killed and the two others—the Expedition Leader, B. M. Gunn and J. H. Lowery, both geologists, were badly injured. They were trapped unable to move in the cab of the Sno-cat,

[1] Sastrugi—from the Russian "Zastrugas"—or, as the Norwegians say—"Skavler".



SKETCH MAP No. 2

which was lying upside down, for several hours. It took six hours to get them out and they were evacuated in a long-range helicopter escorted by an Otter of VX-6 Squadron after a radio call to Base for assistance; and 48 hrs later were in hospital in New Zealand. Gunn recovered from broken ribs and partially frost bitten feet but Lowery was less fortunate having, besides back injuries and a broken jaw, severe frostbite which necessitated amputation of one leg and part of a foot.

With this sad blow the Expedition then numbered only six men—including a replacement student-geologist, R. I. Walcott. It was decided to abandon temporarily the surviving Sno-cat and, as thorough geological experience was lacking, to switch to an area farther south which was thought to be less important in this respect. On 25 November the six of us, with the three dog-teams, were flown by Dakota in two lifts 170 miles to Cape Goldie. From there we commenced our work; moving inland and westwards to the foothills of Mt Markham (see Sketch Map No 2), then north to the Nimrod Glacier before turning south and sledging to the vicinity of Mt Miller. Returning to the Ross Ice Shelf after survey observations at twelve stations situated an average of 12 miles apart and at heights from 200–6,000 ft, we were camped again near Cape Goldie on Christmas Eve. Till that date, during the 250 miles of inland travel, only two days had been lost through bad weather and often, with no wind blowing, we were sledging or climbing in shirt-sleeves. Christmas Day, however, brought a howling blizzard. Quiet snowfalls followed and nothing could be done for a week in the "white-out" conditions, except repair equipment, compute survey observations and occasionally dig out the tents, sledges and dogs from the deep snow. On 2 January, 1960 we moved south, continuing to site the survey stations every 10–15 miles, and ventured close in to the ranges periodically to obtain geological specimens. The total weight of rock samples had risen to 150 lb and we were pleased to hand them over to the RNZAF who by that time were flying the "Beaver" aircraft to support us. Two members of the party—M. R. Robb, who had become the Expedition Leader after the November accident, and D. R. Goldschmidt were flown out to recover the abandoned Sno-cat. The Beaver returned on request to our camp near Mt Hope, at the foot of the Beardmore Glacier, to lift us over the 10,000 ft coastal ranges so that the inland survey could be completed. There was no sledgable route in. On 15 January Walcott and I were flown 50 miles to the edge of the polar plateau at 6,000 ft and the plane later returned with our sledge and dogs. On its way back to the other pair—K. C. Wise and G. J. Matterson—the plane flew into low cloud, which had gathered in the space of an hour, and crashed in a high glacier-valley. Pilot and co-pilot were unhurt but the Beaver was wrecked. With this mishap the Expedition was declared over and, from the two camps, the four members with dogs and all equipment were evacuated by Dakota on 19 January. Four days later the stranded airmen were rescued by Flight-Lieutenant Cranfield, RNZAF, who flew solo in the small "Auster" 400 miles from Scott Base, refuelling by himself at an isolated depot on the way.

During the eleven weeks work we had collected a mass of survey data, geological specimens (including coal but no minerals), lichens, mosses and soil samples to satisfy all concerned. But the price was dear—one death, severe injuries to two members and one aircraft and a Sno-cat vehicle lost.

Photo 8. The Beaver aircraft of the RNZAF which was lost in the mountains in the background of the photograph.

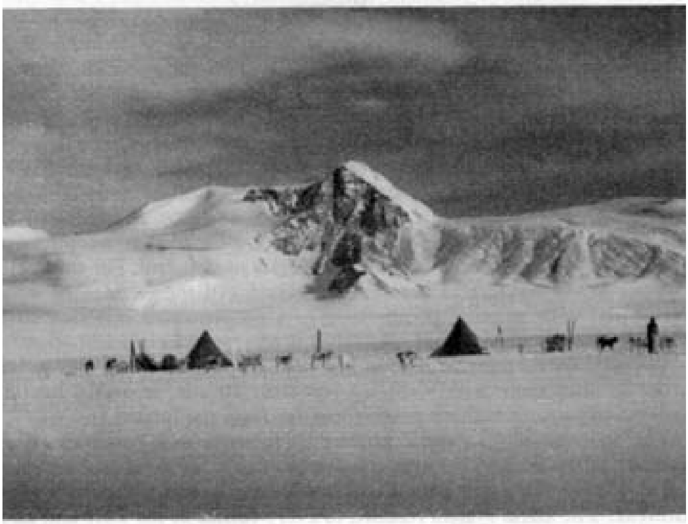


Photo 9. The most southerly field camp of the 1959/60 season near Mt. Ida, 5050 feet, Latitude 83° 35′ 20″ S, Longitude 170° 33′ E.

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Autumn

At Scott Base, from the end of January till the last ship left for New Zealand on 12 March, all men were busily employed in assisting the Ministry of Works and RNZE tradesmen to complete the summer building programme. We spent many days scrambling over the steel framework of the aircraft hangar in an all-out effort to finish adding the plywood panels and outer covering of heavy canvas—hoping all the while that a blizzard would not come to demolish the structure before it was well anchored down. A new hut had to be completed to house the two new generators and snow melter system. The maternity home was another addition finished just in time to receive the first litter of eight pups. Away from the Base at Arrival Heights yet another small hut was built, new auroral-radar equipment installed and the aerials erected outside.

With the arrival by ship of five more dogs, born in the Wellington Zoo, the husky strength rose above fifty. Their staple diet at Base was local seal meat and mutton from New Zealand. Seventy seals were killed at near-by colonies, gutted and the carcasses towed to the dog lines behind a tractor or weasel. They were then quartered and left to freeze before being cut into blocks with a circular power saw driven from a tractor. Including the 6 tons of mutton, which also had to be cut up, the winter stockpile contained about 30,000 lb of meat. A 6–8 lb frozen block, chopped into small pieces with an axe, was fed to each dog every second day. During storms, and on Sundays, the hours work of chopping was dispensed with; the dogs being given two 1-lb blocks of the expensive trail-ration pemmican.

When the sun dipped below the horizon on 4 April the flag was lowered and some felt alone for the first time.

Winter

Throughout the months of darkness there was much to be done. The fourteen men each had their specialist work to do and, besides, there were communal tasks such as refuelling generator tanks and heater units from the dump of 40-gallon drums, keeping the buildings free of snow drifts, watch-keeping at "night", collecting snow blocks for water supply, and many other minor domestic duties. Difficulties were experienced with fuel supplies when temperatures were low. The kerosene, used for heaters and the modified "diesel" generator engines, started to congeal at −37° and below −60° F could not be pumped from the drums. The D4 Caterpillar tractor was run on special "Arctic diesel" while other vehicles used petrol. For the radiators a strong glycol mixture of kerosene was used. All the engines of vehicles were fitted with priming pumps to give a concentrated injection to each cylinder prior to starting and sometimes it was necessary to add ether.

We were by no means confined indoors except during bad storms when, in the driving snow with visibility less than 10 yds, it would have been madness to venture without guide ropes far from the huts.

The main danger in a small community, living in such conditions with no moisture in the air and the ever present possibility of spontaneous ignition, is that of fire; and every precaution was taken to ensure that there was no outbreak. The alarm system reached to every corner of the Base and all huts normally occupied were connected by a telephone circuit.

On one occasion only did the air temperature drop below −70° F

(−57° C).[1] There was no wind that day and, with a full moon giving adequate light, we took several dog-teams out on a 12-mile run for much needed exercise (for dogs and ourselves). Although the sledges were lightly laden the teams had much difficulty in pulling them. This, it was realized, was due to there being no melting at all of the snow beneath the runners. We might have been sledging on sand.

The reinstatement of the pressure-type tide gauge was one small outside job of interest. A hole in the ice below the Base had to be cut in order to lower to the sea bed an anchor-block and the pressure unit which was connected to the recorder above by a long flexible copper tube. Thirty-pound "Beehive" charges were unsuccessful as, although the 10 ft thick ice was penetrated, the holes filled with small pieces of ice and froze up quickly. A 6 ft deep pit was dug and, after the remaining ice was pierced with a long chisel, the water rose to fill it. A pressure charge of 5 lb of PE placed at the bottom of the pit beneath the water shattered the ice and the resulting "brash" was lifted out before it froze solid.

There were two of us from the summer expedition to compute the survey observations, develop the films exposed in the theodolite cameras at each field station, and produce enlargements from which detail plotting was then done. Many hours had to be spent in the darkroom to process these 900 photographs. With other tasks, mainly to do with the dogs, taking priority the plotting was not completed till we returned to Wellington.

For relaxation there was an adequate library of books and gramophone records; but in fact few of us had much spare time for reading. There were also cinema shows—the films being obtained from McMurdo Base, and occasional parties to celebrate such events as birthdays and mid-winter's night. An international event was the chess game with Lazarev—the small Soviet Base 2,200 miles distant on the other side of the continent. For this tussle radio communications were maintained through American and Australian Bases till we retired after twenty moves!

Life was never dull but always busy.

Spring

By the time we had the first sight of the returning sun from the top of Castle Hill on 22 August the plans for the coming summer were taking shape. There was much to be done in preparation for the field work. The dogs were exercised more frequently, new harnesses and traces made for them, tents repaired, sledges dismantled and rebuilt with new wire, cord and raw-hide lashings, fifty 20 man/day ration boxes packed; and resupply lists were transmitted to Wellington so that urgent stores could be sent down by early aircraft.

Two long training runs were made in September; one to Cape Evans and Cape Royds, 30 miles down McMurdo Sound, and the other 50 miles to Cape Crozier. Bad weather and a raging blizzard, which kept us to our tents for four days, prevented our visiting the Emperor Penguin rookery. Cape Crozier—"one of the windiest places on earth"—described so vividly in Cherry-Garrard's book *The Worst Journey in the World*, did not spare us or our dogs some of whom had to be chipped from the ice before we set out on the return journey to Base.

[1] The lowest temperature recorded on the continent during the winter was at the Soviet Base "Vostok", −127.54° F.

(Official US Navy photograph)

Photo 10. The Southern Party being delivered to their field of operations on 30 November 1960. In the background are the Cape Wilson ranges.

The first plane of the new season flew down from Christchurch on 4 October, later than usual, and from that date the tempo of life increased. There were the new items of equipment to unpack and assemble, ski to lacquer and bindings to replace, and the field radios to test. The old manila traces for sledges were replaced with lighter and stronger terylene rope—nylon, with too much stretch, being unsuitable for this purpose.

Because of in-breeding over the previous four years it was decided to better the husky strain by bringing in new young dogs. Mr W. W. Herbert (ex Sergeant RE) travelled from England to Greenland and purchased twelve dogs in the Disco Bay area from the Eskimos. He then was flown, with the dogs in special aluminium crates, all the way to Antarctica via the States, Hawaii, Fiji and New Zealand in aircraft of the US Military Air Transport Service (MATS) and VX-6 Squadron. These high-spirited dogs, answering to such names as "Apolotok", Singarnasuak" and "Kari", were all used to being harnessed in a fan formation. They had therefore to be trained to run in pairs from a single main-trace before they were fit for the summer's work. Initially fights were frequent and many wounds had to be stitched. But they soon settled down to work well. Delays in the arrival of these dogs and of stores, due to a freak radio blackout lasting ten days, during which time no aircraft could fly, meant that we had a late start to the season.

Captain L. D. Bridge, MBE, RNZE arrived from Wellington to assume the duties of Base Leader from Lieut-Commander J. Lennox King, RNZN.

The Summer Expedition of 1960/61

There were two separate parties each of four men with two dog teams. The Northern Party was flown south on 10 November and worked in the area between Cape Selborne and Cape Parr and up to 40 miles inland while we in the Southern Party—M. G. Laird, C. N. Cooper, Herbert and myself, were set down with dogs, sledges and all equipment 20 miles inland from Cape Wilson on 30 November to carry out our work between the Nimrod Glacier and Beaumont Bay. (See Sketch Map No 2). Both parties had food and fuel for a month and therefore expected to be resupplied by VX-6 Squadron twice during the summer. With the loss of the Beaver earlier in the year the RNZAF were operating no aircraft to support us.

Annexure "B" gives lists of the sledge loads.

From the north bank of the Nimrod we visited the Cape Wilson ranges and then travelled as far west as was possible before being halted by the great icefall of the glacier which tumbled down through the mountains from the polar plateau. Overlooking the icefall on the 6,000 ft bluff, which we climbed to inspect the exposed bands of limestone and marble, much was found of geological importance—fluorspar and quartz besides rare specimens of sponge-fossils and copper ore in the form of azurite.

We then sledged north up a tributary glacier over smooth ice and hard sastrugi and, after six days, were camped at over 5,000 ft. It was there that our first successful theodolite observations of stars in daylight were made. Having failed to find a route through the main ranges we dropped 3,000 ft to a lower glacier valley to receive the first resupply by air.

On Christmas Eve an Otter flew south with our stores but had to turn back with engine trouble and crash-landed on the Ice Shelf half-way back to McMurdo. The pilot, passenger (Captain Bridge) and a dog were rescued by helicopter and the plane was recovered a week later. After several days of bad weather we were eventually resupplied by Dakota on 29 December.

We sledged over a high pass to drop down into the upper reaches of Beaumont Bay; then turned north once more to find a new glacier which flowed 40 miles from the plateau through a mountain ravine to the Ice Shelf just south of Cape Parr. This we named "Star Shot Glacier". On its south bank was a lone, prominent feature 3,300 ft. in height which we climbed on 9 January, 1961. The cairn, marking Station L on top, was observed from two survey stations of the Northern Party and from nine of ours—the greatest distance being over 40 miles; so the feature was named "Mt Ubique".[1] On 18 January while camped on the Star Shot Glacier we learned by radio that we should expect to be lifted back to Base on 5 February—ten days earlier than was anticipated. Therefore the plans to journey farther westward through the mountains were revised and we sledged out into Beaumont Bay, received there the second resupply of stores on 24 January and then moved down the Ice Shelf inside the coastal crevasses.

The geological and survey work was continued till 9 February when, from our last camp 15 miles out from Cape Wilson, we were flown back to Base.

Of the ten weeks spent in the field no less than a total of twenty days were lost through bad weather. All programmes suffered that season.

Survey Work

During the two summer seasons enough data was collected to produce 1:250,000 maps of about 15,000 square miles of the Dependency (including Australian territory also).

The methods employed in the field were to fix Survey Station positions by sun observations for latitude and longitude. Sun azimuths were also taken. Only one measured baseline was used for the control of the first summer's network. This fact, combined with errors due to terrestrial refraction anomalies, poor chronometers and variable theodolite bubble movement, meant that Stations did not fit easily into well-braced plot positions. For the second season, however, we had small miniature valve radios with which to obtain on-the-spot time checks; the theodolite was shaded from the sun to obviate the bubble troubles and more frequent baselines were laid out. Stars were observed when there was no cloud present and helped also to give more accurate fixes. Mounted on the theodolites were 35 mm cameras with which panorama photographs were taken every 15°. From the subsequent enlargements azimuths to detail points were determined either graphically or with a Wilson photoalidade and the plots were thus built up. This "office plane-tabling" was tedious work but accurate for the scale required. Stereoscopic pairs of ground photos were used too as well as trimetrogon aerial photographs, exposed at 20,000 ft, flown by the Neptune aircraft of VX-6 Squadron.

Paulin and Precision Aneroid barometers gave checks on trigonometrical heights determined to ± 30 ft.

Eight map sheets of a Provisional Edition have been published by the Department of Lands and Survey in New Zealand and two sheets of the Final Edition which will show more detail with the use of new hill-shading techniques.

[1] The name "Mt Ubique", among others, has been accepted by the Antarctic Place Names Committee of the New Zealand Geographic Board.

Photo 12. Surveying on the north bank of the Nimrod Glacier. A piece of leather is used to shade the theodolite from direct rays of the sun—thus obviating excessive temperature differences of the metal parts.

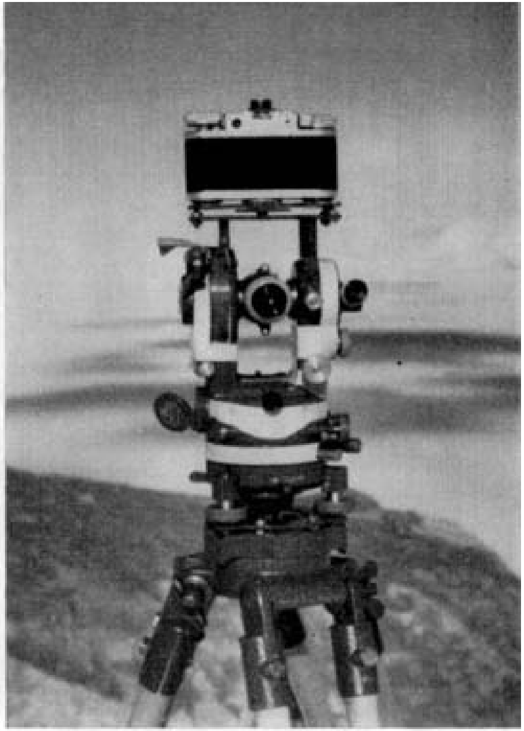


Photo 11. A Watts No. 1 theodolite, with 35 mm. camera mounted was used for survey observations. Bare metal parts are covere with tape to prevent frostbite.

Service On The Seventh Continent 11 & 12

Photo 13. Mt. Ubique, 3,300 feet, which lies at the head of Beaumont Bay.

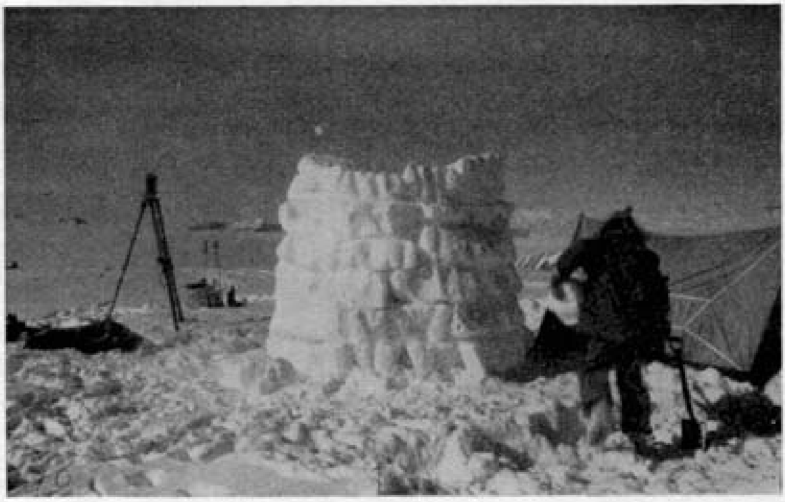
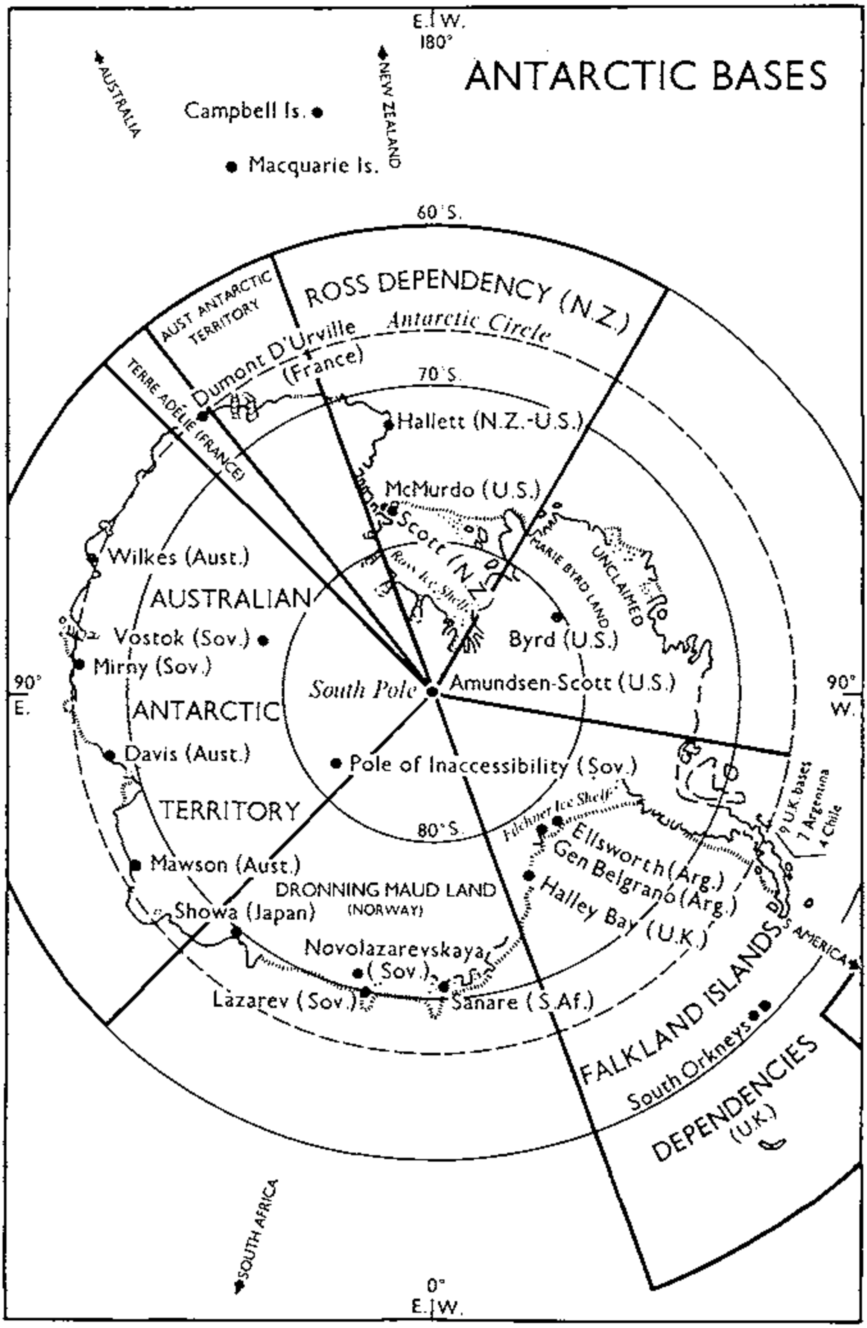


Photo 14. Building a survey cairn of snow blocks.

Service On The Seventh Continent 13 & 14

Photo 15. *Queen Alexander Range.* Part of a trimetrogon aerial oblique (60°) photograph exposed from a Neptune aircraft of VX-6 Sqn. US Navy, flying at 20,000 feet up the Beardmore Glacier. A tributary glacier is shown flowing into the Beardmore from the vicinity of Mt. Bell (the centre feature) 14,010 feet in height.



SKETCH MAP No. 3

Conclusion

To say that many of us were a trifle baffled and perhaps sorry to be back in civilization at the end of the summer would not be untrue. The lessons learned were many—not least in importance being those of self-discipline and tolerance. But simply to have taken part in exploration on a continent,[1] friendly when treated with respect, has been a privilege and an experience of great value.

The search for knowledge in Antarctica continues. Activities will increase during "The Year of the Quiet Sun" in 1964/65 and most countries expect to maintain their interest for years to come.

Acknowledgement

To the Superintendent, Antarctic Division NZ Department of Scientific and Industrial Research for permission to publish this narrative.

Annexure A

STATIONS OCCUPIED IN THE ANTARCTIC, WINTER 1961

Argentina

Decepcion, lat. 62° 59′ S., long. 60° 43′ W.
Melchior, lat. 64° 20′ S., long. 62° 59′ W.
General Belgrano, lat. 77° 58′ S., long. 38° 48′ W.
Esperanza, lat. 63° 23′ S., long. 56° 59′ W.
Orcadas, lat. 60° 45′ S., long. 44° 43′ W.
Teniente Matienza, lat. 64° 58′ S., long. 60° 03′ W.
Ellsworth, lat. 77° 43′ S., long. 41° 07′ W.

Australia

Mawson, lat. 67° 36′ S., long. 62° 53′ E.
Davis, lat. 68° 34′ S., long. 77° 57′ E.
Wilkes, lat. 66° 15′ S., long. 110° 31′ E.

Chile

Arturo Prat, lat. 62° 29′ S., long. 59° 38′ W.
Pedro Aguirre Cerda, lat. 62° 56′ S., long. 60° 36′ W.
General Bernardo O'Higgins, lat. 63° 19′ S., long. 59° 38′ W.
Presidente Gabriel Gonzalez Videla, lat. 64° 49′ S., long. 62° 51′ W.

France

Dumont d'Urville, lat. 66° 40′ S., long. 140° 01′ E.

Japan

Syowa, lat. 69° S., long. 39° 35′ E.

New Zealand

Scott, lat. 77° 51′ S., long. 166° 46′ E.

New Zealand/United States

Hallett, lat. 72° 18′ S., long. 170° 18′ E.

South Africa

Sanare (S.A. Nat. Antarctic Expedition)—formerly "Norway Station", lat. 70° 30′ S., long. 2° 52′ W.

United Kingdom (Br. Antarctic Survey Bases)

Port Lockroy (Base A), lat. 64° 50′ S., long. 63° 31′ W.
Deception Island (Base B), lat. 62° 59′ S., long. 60° 34′ W.
Hope Bay (Base D), lat. 63° 24′ S., long. 56° 59′ W.
Stonington Island (Base E), lat. 68° 11′ S., long. 67° 00′ W.
Fossil Bluff, lat. 71° 20′ S., long. 68° 17′ W.
Argentine Islands (Base F), lat. 65° 15′ S., long. 64° 15′ W.
Signy Island (Base H), lat. 60° 43′ S., long. 45° 36′ W.
Adelaide Island (Base T), lat. 67° 46′ S., long. 68° 54′ W.
View Point (Base V), lat. 63° 32′ S., long. 57° 23′ W.
Halley Bay (Base Z), lat. 75° 31′ S., long. 26° 36′ W.

United States

Amundsen-Scott, South Geographical Pole.
Byrd, lat. 79° 59′ S., long. 120° 01′ W.
Naval Air Facility—McMurdo, lat. 77° 51′ S., long. 166° 37′ E.

Union of Soviet Socialist Republics

Mirny, lat. 66° 33′ S., long. 93° 00′ E.
Vostok, lat. 78° 27′ S., long. 106° 52′ E. (near South Geomagnetic Pole).
Novolazarevskaya, lat. 70° 45′ S., long. 11° 58′ E.

(List supplied by the Scott Polar Research Institute, Cambridge.)

[1] It is not yet known what really is the shape of Antarctica. Theories differ. Some say there is a small continent plus many islands welded together by ice cover while others say that there is no archipelago but a single continent.

Annexure B

Sledge Loads for One Month
(for 4 man/2 team party)

	lb		lb
5 Ration boxes	300	4 Sleeping bags	60
14 Pemmican tins	700	4 Pairs of ski and sticks	40
2 Jerry cans of fuel	90	4 Packs and personal gear	120
2 2-gallon cans fuel	40	4 Ice axes	20
1 Accessories box	45	1 Sledge repair box	40
2 Polar tents	110	2 Kitchen boxes	60
1 Alpine tent and poles	20	1 Pair of spare ski	10
1 Medical kit	15	Bamboo poles	10
1 No. 557 radio	80	1 Ice chisel	10
1 "Commander" radio	20	2 Shovels	20
1 "Diplomat" radio	10	2 Sledge bags and contents	80
2 Dog spans	40	1 Survey box	60
Geology and met. equip.	10	Theodolite tripod	10
		Total	2,020

That is, 1,010 lb per sledge

Miscellaneous Equipment Carried on each Sledge
(or in Sledge bag)

Smoke canisters—6	Sledge hammer
Signalling mirror	Sledge pickets—2
Thermos flasks—2	Ice axes
Ice pitons	Sledge rope-breaks
Karabiners—1 large, 1 small	Spare harnesses
Snatch block (for crevasse rescue)	Spare side-traces
Magnetic compass	Aureomycin powder (for dog bites)
Sun compass and azimuth tables	Ski skins and sticks
Nylon ropes—1 heavy, 1 light	Ice chisel
Prussic slings and waistloops (personal)	Ski waxes
Nylon lead trace (30 ft)—for leading dogs in crevasse country	Binoculars
Spare ski, Bamboos } lashed beneath sledge tank	

Twice as Many Recruits

By Colonel R. L. Clutterbuck, OBE

"Building up a professional army is not a matter of 'salesmanship', cajolery and bribery. It is a matter of establishing, slowly and painstakingly, a force which attracts recruits by its sense of purpose and its ability to offer a worthwhile life to those who join it."

The Times 14 September 1961

The Task

We need roughly 180 RE recruits a month during 1962 and 1963 if we are to achieve our share of the All Regular Army by the time the last National Servicemen leave. In 1960, we were averaging well under half this figure—eighty a month so the Engineer-in-Chief launched a campaign to double our recruiting in 1961. In the event we more than doubled it. Our 1961 average was 179 a month.

The net loss of soldiers from the Corps is about sixty a month. This is made up by the balance between all losses (run out and wastage, including wastage of new recruits) and all gains (boys maturing, prolongations etc) other than the gain of new recruits. The intake of new recruits must replace these sixty, and at the same time build us up to a higher all regular strength. In other words, our requirement of 180 per month—for these two years—means recruiting at three times our wastage rate.

We have now proved that we can do this—which is very encouraging for the future, and the all time record of 326 RE recruits in January 1962 strengthens this optimism. This is a decisive answer to people who say that we cannot recruit an adequate Army without National Service.

In our 1960 showing, however, the picture was very different. The extent of our failure in that year is shown in Fig 1. In 1960 the Army as a whole got many fewer recruits than it needed, but of these we did not even get our fair share. With so much to offer this was indeed humiliating.

In the last four months of 1960, our average dropped to sixty-five a month—scarcely enough to replace wastage.

In December 1960, the Engineer-in-Chief announced that our future manpower prospects were so serious that recruiting must be given priority over training. During the next few months, various measures were introduced which have more than doubled our recruiting rate. I will describe these measures, then discuss what alternatives will face us when we do reach our target strength, and finally touch on some of the things which seem to me most important in making the life we offer an attractive and enjoyable one.

The Anatomy of a Recruiting Campaign

This last point is, of course, by far the most important. If regular soldiers do not enjoy soldiering they will neither sign on for more nor advise their friends to join. Why should they?

The anatomy of a recruiting campaign can, therefore, be regarded as follows:—

(*a*) *Making Army life attractive.*

(*b*) *Public relations.* Public relations have many functions. Their most important in the recruiting world is to bring an "image" of Army life to the notice of eligible young men so that they will make further inquiries at an Army Information Office (AIO).

(*c*) *The Recruiting Sergeant's Battle.* To give the Sergeant in the AIO the cards he needs to convince the young man his life in the Army will live up to this image, and to persuade him to take the plunge.

(*d*) *Handling the Recruit* in such a way that his confidence in his choice is reinforced. This leads back to (*a*).

Making life in the Corps attractive is everyone's business and will take time. I will deal with that last, and then only briefly, because the "image" we had to present was of life as it is now, and it was on this that our Public Relations campaign was based.

Public Relations

The "image" we present must be an honest one. A discontented soldier may turn away two others, but one who feels he has been tricked will turn away a dozen. Whatever the temptation, it will never pay to be dishonest. This must be the first rule of any PR campaign if it is to have any lasting effect.

The second rule is to present the image where eligible young men are likely to see it, and in conditions where they have time and inclination to absorb it.

The mass media are of course the most profitable—Television, Cinema and the Popular Press. The War Office advertises commercially on two of these, with excellent proved results, but at a price far too high for any Corps or Regimental recruiter to consider. For example:—

(*a*) Fifteen seconds of Television time at a peak period costs £750—apart from the cost of making the film. The Engineer-in-Chief's total recruiting funds for a year could thus be spent in half a minute.

(*b*) A good 35 mm film costs about £1,000 a minute to make.

(*c*) A page of a popular paper costs about £5,000.

We are, therefore, generally left with the alternatives of:—

(*a*) Getting our image displayed free as a feature or a news item.

(*b*) Joint advertising, where we provide prestige and our partner provides the money—like an impoverished Peer marrying an heiress. Some would rather see the title die, but most of us—given the right heiress—would not.

In our 1961 campaign, we used (*a*) on all three media, and (*b*) on one.

Television. It is surprisingly easy for an Army unit to appear on Television. The BBC and ITV companies have accredited agents—cameramen and reporters—all over the country, and units should get to know them. These agents' earnings depend on their getting material which can win a place in the programme time. They welcome anything original, provided that it has a human touch. We can, when we turn our minds to it, give them just this, with a large cast, props, and stage management provided free. As technicians they are delighted by the efficiency of our organization compared with that of most subjects they have to film, and they will always come back if we can offer them anything worth filming. But it is no use just giving them permission to film. Positive co-operation is needed—for example, in helping them to get their cameras close up, within a few feet of men's faces etc, and if necessary pausing until they are ready; also, sometimes, doing things over again for their benefit.

This positive co-operation is all it costs us to show part of our image for, say, a minute to an audience of perhaps 10 million. True, it will not be a minute of calculated salesmanship, but it will be trusted more than a commercial, will be watched more, and will not cost us £3,000.

Many RE units did this in 1961. The surprising thing is that more did not.

Cinema. One pair of eyes out of every five in a cinema belongs to a young male aged 16–24. He is there because it is worth 2*s* 6*d* to him to get away from home even though television is free. He seeks colour and adventure. Fifteen seconds of the colour and adventure of the soldier's life overseas can be screened before the captive eyes of fourteen people for a penny—three of them being particularly eligible young males. The War Office do not advertise in the cinema. For the time being, therefore, any advertising in the cinema must be a Corps effort.

The Royal Navy have for a long time been reaching the eyes of these young men in the cinemas through an excellent series of films financed by Senior Service cigarettes. So in 1961 we followed suit. We approached a young director who had produced some very good films of this type, and offered him three subjects. He chose one—twenty junior leaders canoeing across the Channel—as suitable for advertising Ovaltine. Ovaltine were interested and co-operative. At no time did he or they press us to go beyond our own judgement of taste and ethics. We on our side respected their right to expect a fair return for spending £3,000. The Junior Leaders Regiment—from the

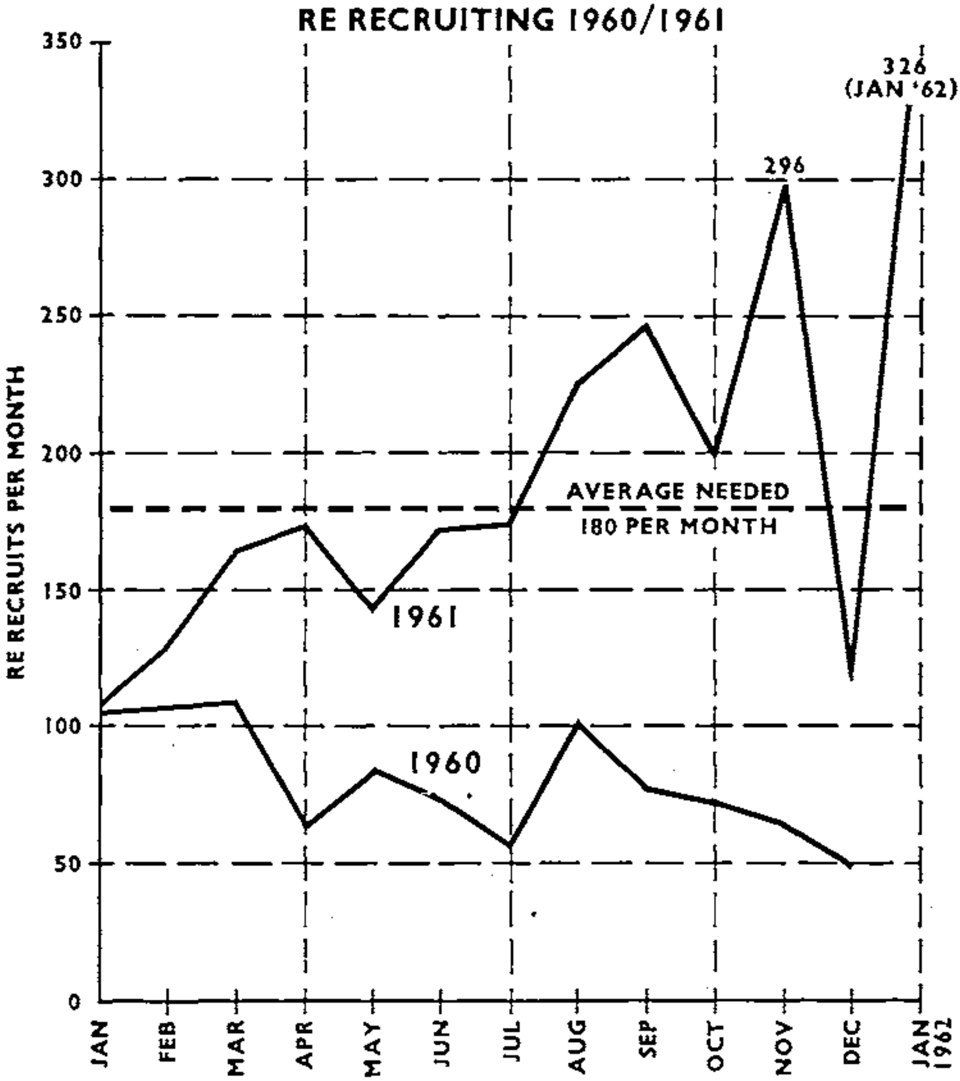


FIG. 1 RE MONTHLY RECRUITING

CO to the youngest canoeist—responded with enthusiasm. The result was a fine two-minute film, showing 1 min. 55 secs. of boy soldiers undergoing vigorous training, canoeing through the waves and landing in France, and 5 secs of them drinking Ovaltine. The boys looked as if they enjoyed it, as indeed they did.

We found the right heiress and the right man to perform the ceremony. It is estimated that, between 8 October 1961 and 28 April 1962 the film was seen by 7,250,000 people, of whom 1,885,000 were young males aged 16–24. It should be seen by many more in the coming months.

The Popular Press. The *Daily Mirror* is read by over 14 million people every day, including a large proportion of our potential recruits and their parents. There is a popular misconception that it is "anti-Army". I never found it so, neither as a regimental officer nor as a recruiter. It is more interested than most papers in the Army, and is generally fair. It does sometimes criticise pompous officers, but this may be no bad thing.

In May 1961, the Public Relations Officer of 1 Training Regiment RE invited the *Mirror* to come and see for themselves how our recruits were trained—and why our recruiting figures were rising so fast.

Their response was, I think, typical of the paper. They asked if they could send one of their feature writers—Roy Blackman—to the Regiment incognito as a recruit. Permission was obtained from the War Office, with the reasonable proviso that his superior officers must know that they had a "Man from the Mirror" in their party.

Roy Blackman, after a reconnaissance visit, duly arrived as a "re-enlistment", which was plausible as he had done National Service. He was treated the same as his fellow recruits, and collected his fair share of rockets—notably from the cookhouse staff. No restrictions whatever were placed on him, either on or off duty.

This was a calculated risk, but one heavily weighted in our favour because:—

(*a*) 1 Training Regiments handling of recruits really is impressive.

(*b*) The *Daily Mirror* had been invited to see why we were getting recruits, not the reverse. Roy Blackman knew that our figures for April 1961 were nearly three times those for April 1960 before he ever came.

(*c*) Any pressman who is given a really free hand in getting his news will usually respond as generously as he can.

All the same, we bit our fingers for nearly three weeks after he had gone—because nothing happened. Then the article appeared—"The Happy Story of Spr Roy Blackman of the Royal Engineers—and the Mirror—THIS is the kind of Army Britain Needs". The story took the whole of page 13 (£5,000 worth!) which was 95 per cent complementary.

We telephoned the *Mirror* at once and bought up their remaining stocks—2,000 copies. Copies were circulated to every Army Information Office by RE Liaison Officers. The School of Survey designed and printed a striking cover "The Man from the Daily Mirror joins the Royal Engineers—read his report yourself". These were circulated not only in AIOs, but also in barbers shops and other places where young men go. Thousands of leaflets were printed on similar lines, ending "read his report for yourself. There is a copy in your nearest Army Information Office".

The War Office was delighted. A letter was sent to the *Mirror* thanking them for taking the trouble to see for themselves, and for their fair reporting.

Roy Blackman was congratulated by the editor, and our recruiting continued to rise.

This was not the last we heard from the *Mirror*. They plunged into our lives again in October, and you will find the story of that occasion under the unlikely heading of "Beer mats".

The Local Press. The local newspaper will not be read by as many potential recruits as a national daily, but it is, nevertheless, important because:—

(*a*) It is much easier to get into—particularly for units overseas.
(*b*) Used wisely, its accumulated dividend is large.
(*c*) It often leads to bigger things.

The best entry is, of course, the "local boy story". The technique is to photograph a photogenic soldier doing something exciting, purposeful or enjoyable, preferably in an overseas setting. Send three prints of this to the Army Information Office in his home town, with background story attached. They will keep one for their own use, deliver one to the soldier's home, and will offer the other to the local press.

This is well worth the effort involved, and units overseas can give tremendous help to the recruiting campaign by going on doing it all the time. Units at home can and do, of course, also get the local press to cover their functions and events, and many run a weekly column.

The journalist who handles material for the local press will earn more if he can also sell it to a national daily, so if it is interesting enough he will try. National papers, television agencies, etc, also sift the local papers themselves. For example, in December 1960, a local press account of the doings of a Sapper regiment reappeared, out of the blue, in shortened form both in the *Daily Mirror* and the *Daily Express*—the former under the heading "Variety is the Spice of Army Life". One or other of those two papers is read by the vast majority of our potential recruits and their families.

Posters and pamphlets. At the end of 1960, there were no general RE pamphlets printed more recently than 1957, and these were very rarely found in Army Information Offices, which are rightly reluctant to display out of date information.

This was serious, because many potential recruits enter the AIO "just to look around". They go away with a fistful of pamphlets—which in 1960 included everything but Sapper ones.

The quickest hope seemed to be to reprint the pamphlet produced by 38 Corps Engineer Regiment in September, 1960. Plates existed, and the original printer could have given us 6,000 copies in two weeks. Unfortunately it was decided that the reprint had to go out to tender, £50 was saved—and the pamphlets appeared five months later. Just how much is a delay of 4½ months worth in a recruiting campaign? This kind of thing makes anyone in the advertising world doubt if we seriously want a win. They think we are mad.

Meanwhile, we could not wait, so we turned for help to the School of Survey. Their response has been magnificent, and the Corps owes them a great deal. Luckily our needs covered a wide range, and were suitable for training both artists and printers. Between March and August 1961, they turned out some 100,000 copies of various pamphlets and posters, in colour, with a very high standard of design and finish.

I will not describe these pamphlets in detail. Four of the slogans we used will indicate the theme.

FOR TRAVEL AND A TRADE JOIN THE ROYAL ENGINEERS

EVERY ROYAL ENGINEER IS TAUGHT A TRADE

OVER HALF THE ROYAL ENGINEERS ARE OVERSEAS

THE MEN YOU WANT TO MEET ARE IN THE ROYAL ENGINEERS

Some of the leaflets were topical—for example we exploited the *Daily Mirror* article, as described above; we also exploited our recruiting successes in a display card which showed our rising figures from January to June and asked "Why? It's a good life—it must be!"

Our biggest production, which should be out by now, is a 100-page booklet, mainly of photographs. This is being financed entirely by the advertisements at the beginning and end. A major part of it is an outline of the careers of thirty serving Sappers—varying from a Sapper of 20 operating a dozer to an ex-boy who is now a Brigadier.

Beer Mats. Publicity breeds publicity. An example of this came from 5,000 RE beer mats which we distributed around the pubs, containing three of the above slogans, and inviting the reader to fill in his name and address and to post the beer mat to us to ask for more information.

The producers laughed at our paltry 5,000, saying that most advertisers ordered 250,000 or more. But even our 5,000 cost us over £40, and we were afraid we had spent rather more than the venture was worth.

But the *Daily Mirror* and the *Daily Herald* picked one up. On 9 October, our beer mat appeared, with all the lettering on both sides legible, on over 5 million breakfast tables, with a lively and friendly blurb. Letters began to roll in, the BBC asked for an interview and . . . it is still too early to say what else this particular cast may land.

Our £40 has gone a long way.

16 mm Films. These are of limited value for recruiting, as they cannot generally be shown in public cinemas. They are necessary, however, for displays, open days etc, and for use in schools, boys clubs etc. There is a film of the RE demonstration, and two regimental films—36 Regiment on Christmas Island and 38 Regiment in UK. Material is also being obtained from units overseas for a job introduction film, financed out of training funds, to show recruits under training something of the life ahead of them. This will also be of value for potential recruits.

Displays and Shows. A large proportion of the Army's recruiting funds and effort are allotted to shows and displays. These will only give a reasonable return for the effort expended on them if they are sited in the right places. Displays should go where young men go—the young men who are likely to consider joining the Army. Football, motor racing, motor-cycling and cycle meetings are obvious fields. The foyers of cinemas and dance halls are others. The parks or squares of large towns are also suitable if the displays on show at the time the young men are likely to be lounging around—at lunch time or in the evenings or weekends.

The following ingredients are essential for a show or a display:—

(*a*) A foreground to attract attention.

(*b*) Large photographs with bold brief captions, spaciously and professionally displayed.

(*c*) Interesting things for young men and boys to handle.

(*d*) Pleasant *young* soldiers to answer their questions.

(*e*) Plenty of leaflets for them to take away.

Many of the old displays lacked the necessary foreground, so the wretched soldiers stood all day with only a trickle of customers. The most successful foreground is something high—a tower or a mast.

The new corps mobile display, a model of its kind, has been designed with all these precepts in view.

Keeping the Army in the Public Eye (KAPE) tours proved of some value where the above principles were followed. If these tours are overdone, however, the soldiers who take part will be bored and irritated by the needless separation from their families and friends. If the soldiers or the public get the idea that the Army has nothing better to do *all* the time, the small-dividend would be more than cancelled out. Sappers in UK, in particular, would generally do better to build useful things—things which both the public and the soldiers themselves can see are useful.

All the displays and shows in which Sappers took part in 1961 (except for visitors week-ends and open days—see below) may have brought us five recruits a month who would not otherwise have joined. Personally, I doubt even that. We would lose little by dropping this form of recruiting, but, if we must do it, we should at least do it in the right places.

Visitors Weekends. Visitors weekends can be of far more value than public displays if they are done the right way—by getting young men who really are considering joining the Army to meet and talk to other young men who have already done so.

The Greenjackets have perfected the method. They have a visitors weekend at their Depot every month. The visitors must all be aged 17 or over, and are invited individually by the Greenjackets Recruiting Sergeants.

They are given a very easy programme—Saturday tea to Sunday lunch—and no elaborate displays are put on for them. They are looked after all the time by volunteer recruits, with whom they shoot, do the assault course, eat, drink and—*talk*. The sole aim is that they should go home knowing that the Greenjackets are a pleasant and efficient crowd with whom it would be fun to live. Even those who do not join can tell this to their friends—and they do.

This simple monthly effort has had a big effect in the Greenjackets recruiting. So far, we in the Corps have got little further than making rather ponderous plans for the full works—with displays and all—about once a year. If we followed the Greenjackets method, we could dispense with all the trailers, KAPE tours and displays and still get more recruits.

Regimental Open Days and Tattoos. Regimental Open Days, where families and friends and the local population come in to see what our life is like, are of excellent value. The visitors are almost always favourably impressed by what they see.

If parents can be put up in barracks for the week-end and feed with their sons in the cookhouse, so much the better. Our standards are far higher than most people think and we have nothing to fear.

Displays and miniature tattoos at such gatherings are well worth doing, and no-one will expect a performance like the Royal Tournament—any more than parents expect to see a 4-minute mile at the school sports.

The "in-between" tattoo or parade, however—ie, neither a family show nor a truly professional performance—in my opinion does more harm than good. I am personally not sorry to see the end of the Aldershot Tattoo.

THE RECRUITING SERGEANT'S TASK

The Key Man and the Key Moment. Public Relations may get the horse to the water but that alone won't make him drink. The key man in the Recruiting business is the Recruiting Sergeant, and the key moment is when a boy—a boy whose extravagant dress and confident coiffure seldom conceals the shaking in his winkle picker shoes—is seated at a table with the Sergeant, trying to decide whether to sign away what may seem to him to be his freedom for the next six years. For such a boy—with his head full of many strange misconceptions about the Army which loom larger than ever at this moment—it is a big plunge.

Sometimes the boy may have walked in with his boats already burned behind him, after a row with his family or his girl—"To hell with you—I'm off to join the Army". In such cases, the recruiting Sergeant must show the greatest judgement and sense of duty. For a Sergeant who feels that his Confidential Report depends on the number of recruits he gets, the temptation is great. Such recruits as these are easily signed up, but they are of course the likeliest to buy themselves out, and to unsettle their fellow recruits before they do so.

But the majority, of course, are not like this. They have come in with their guard up "to look around". At the first sign of high pressure salesmanship they will back away and run. The Sergeant must play his cards with skill. Sometimes the best approach will be just to send the boy away with a handful of leaflets, and avoid any impression of wanting to hurry him. "Take it away and think about it. If you think it's your kind of life, call back. Then we can give you some tests to see if you come up to our standards." For others, it may be best to offer to call next week and talk it over with the boy's parents or girl friend. If the boy's instinct has led him to like and trust the Sergeant he will probably welcome such a visit. But all this takes time and patience, and the Sergeant must not only be skillful and well-informed—he must also be a sincere and likeable man. None but the best will do for the recruiting Sergeant's job. The Corps stands or falls by the number and the quality of its recruits, and these depend on just three dozen key men—our recruiting sergeants.

One Recruit per Sergeant per Week. The Army recruits about 500 men each week. It employs about 500 recruiting Sergeants. In other words, each sergeant has about one success each week. Of the 500 recruiting sergeants, there are fourteen Royal Engineers in established posts as Army recruiters, and they are in duty bound to be impartial between arms. There are also a number of RE special recruiters, provided at the expense of the units of the Corps—all Arms have a number of these. These recruiters are allowed to recruit with a bias for their own Arm, but, of course, if they do this in a cut-throat manner, they will soon lose the co-operation of their fellow recruiters, and will do worse in the end.

Our Special Recruiters, as can be expected, averaged slightly more than one RE recruit per week, and the RE Army Recruiters rather less. Overall, even in what has proved to be a most successful year for RE recruiting, the average number of RE recruits passing through the hands of each RE Recruiter was slightly less than one per week. (In 1960 they had averaged only one per fortnight.)

On average, each recruiter probably interviews about twenty boys per week. Some he visits on "hoax" requests from their friends. Many others have no serious intention of considering the Army, and he never sees them again. To others, however, he devotes many hours of time and patient endeavour. He visits their homes, meets their parents, reassures their girlfriends, and discusses the Army far into the night. There is no end to his working hours. Out of all these twenty or so he has one success.

Seventy-five per cent of our recruits came from half the Army Information Offices—those in which there was a RE Army or Special Recruiter. But the other half were just as important—where there was no RE representative at all. We relied upon them for the remaining 25 per cent of our recruits, and this last 25 per cent was naturally the hardest to get.

So our first and most urgent task in January 1961 was to provide these devoted and frustrated ambassadors of ours—and the hundreds of "neutral" sergeants of all arms who also worked for us—with a reasonable set of cards in their hands for the crucial interview with the boy at their recruiting table.

"*I Want to Learn a Trade*". Our recruiters in 1960 were crippled by one thing above all others—they could not offer a recruit any kind of reassurance that he would learn the trade of his choice, or that he would learn one even remotely allied to it. The great majority of potential recruits have no preconceived idea of what regiment they want to join. But they do know what they want to *do*. "I want to join the Army to drive" or "to be a fitter".

The Royal Armoured Corps recognizes this, and one of their best recruiting draws has for a long time been a signed and crested card guaranteeing Mr So-and-So that if he joined them he will be taught to drive.

Signals and REME recognize it too, and their trade structure is geared to this.

Ours, in 1960, was appalling. And this was the biggest single cause of our failure.

1959 had been a good recruiting year for the whole Army, and for the Corps in particular. In a fit of over-optimism, the Corps decided to channel its recruits for 1960 in such a way that all the trades in 1963 would be correctly filled—no more and no less—and that the Corps would retain the right to switch its recruits into whatever trade suited it best—regardless of whether this trade bore any resemblance to the trade the recruits had asked for. This looked good on the calculating machines. But it ignored the personal factor and so—in the strictly personal discussion which precedes the signing up of each recruit—it got what it deserved. The recruits gave it the bird. They walked over to the REME or Signals Table—or out into the street.

The sergeants gave it the bird too—except for our devoted Specials, who battled on as best they could. The others were unwilling to frighten their prospects away, so they kept off the subject of Sappers. This wasn't difficult as they didn't have any Sapper pamphlets anyway.

The Trade Training Scheme. I will not describe our crazy trade structure for 1960. It is dead, and anyone who conceives anything similar in the future will presumably read up the records and think again. I will just give two examples. A potential recruit who wished to be a clerk could only be enlisted into a group in which he could be switched at the whim of the Corps into the trade of concretor. And anyone who wanted to be a carpenter wasn't allowed to join the Corps at all, because the calculating machines said we would have enough of them by 1963.

We rewrote our recruiting trade structure completely in January, 1961. The War Office accepted and printed the revised version and had it out to every recruiting office in the country within a week. The War Office may often seem slow, but in 1961 it was superb. The improvement in Army recruiting as a whole in 1961 is further proof of this. The Corps in particular owes them a lot.

Briefly, we offered every RE recruit who wanted it a guarantee of training in a trade—either the trade of his choice, or in one of a group of trades closely allied to each other. To get a guarantee of an individual trade, he had to achieve a score in his Intelligence Test high enough to ensure that he had enough in hand to master it. If, in the fuller aptitude tests that preceded his training this hope proved false, the Personnel Selection Officer had little trouble in persuading him to agree to switch to a trade he really could master.

Most recruits, however, were satisfied with a guarantee of training in one of the allied group of trades, and for this a lower score was acceptable. To reassure readers on two sensitive points:—

(*a*) We made it clear to every recruit that we would guarantee *training* in the trade, but that we could NOT guarantee *employment* in that trade.

(*b*) To those to whom it applied we stressed that they would also be trained as Combat Engineers and spend part of their time employed as such. May I ask anyone who doubts this reassurance to read our recruiting literature for 1961. We were all Regimental Officers and we knew what we were doing. And we were honest. It would have been mad to be otherwise.

We watched progress carefully. But any fear that we would be flooded out with men in unwanted trades was soon set at rest. We had guarded against this by pitching the qualifying score for such trades high enough to keep the guarantees down. In the event, the numbers electing individual guarantees for any one trade has been small. The only slight embarrassment towards the end of the year was in the trade of Vehicle Mechanic, and this only because we do not train them ourselves, but must rely on REME for vacancies.

The Recruiting Organization was using this Trade Structure and Guarantee Scheme from 27 January 1961. From that moment on recruiting began to rise. I am personally convinced that this was the primary cause of our success, and that, even if we had done nothing else at all, the graph for 1961 would have been much the same shape as that for 1960, even if not quite the same size.

Guarantee of Service Overseas. "Over half the Royal Engineers are Overseas". That was one of our slogans. It also means, of course, that half the recruits coming out of the training machine *would* go overseas (including BAOR as overseas) whether they wanted to or not. So we issued Recruiters with a form—at first strictly controlled—by which they could give a recruit a *guarantee* of an overseas posting immediately after his training, if he so desired. Fears of a flood were soon set at rest, and the number electing this guarantee was small. But it was a useful card in the hands of recruiters, and undoubtedly helped to make the Royal Engineers a profitable suit in which to play.

Keeping Friends Together. A soldier on leave may find it easier to persuade a friend to enlist if he can promise him that he will be posted to his own unit. We offered to guarantee such a promise, provided that both the recruit and the serving soldier wanted it so. Once again, the numbers proved no embarrassment. Although each such case does obviously provide more worries for RE Records, the dividends are worthwhile and widespread, because it shows that the Corps is not too big to be human. I believe that this approach to comradeship—and encouragement of it—means far more than any trite phrases about it, and that it is worth almost any trouble, not only in the recruiting stage, but afterwards. Of course every good CO knows this and does it whenever he can, and so do RE Records. More power to their elbow.

The Intelligence Test. Every potential recruit does an "R-Test" which takes 15 mins and is notoriously unreliable. Depending on the number of questions he gets right, he qualifies for a particular Corps, or a particular trade or group of trades. In 1960, he needed 13 to get into the Infantry and 21 to be a Sapper. We lowered this to 18 in 1961. This was a risk, and the chief aim was to convince all Arms recruiters that we really did need recruits. In the event, the numbers coming in with low R Test scores (18 to 20) was minute—only a very small proportion of our increase. So far, there has been no indication that they will be an embarrassment—indeed some COs prefer a wider intelligence range to allow for the less inspiring chores—but it is too early yet to give a final verdict. If we do find we can reduce our intake in the latter stages of 1962, a readjustment here is certainly the first step.

The Place of the Personnel Selection Officer. Some doubts were cast on the reliability of the R Test, and a scheme was afoot to remove PSOs from Corps and Regimental Training Units, and to post them to Army Information Offices. We opposed this, as did nearly every other arm and service, and our view prevailed. The work of the PSO is outside the scope of this report—but he plays a vital role in personally placing recruits to the best advantage, and thereby in reducing discharge by purchase. To do this he must be in close touch with the trade requirements and with the trade training vacancies. No man can do this for the whole Army. The PSO is also a most important adviser to the Engineer-in-Chief, to his recruiting staffs, and to the CO and Officers of the Training Regiment. He must live and work with the Corps, and may it never be otherwise.

Recruiting Staff and Liaison Officers. I have included this under the general heading of "The Recruiting Sergeant's Task", because every recruiting activity must be focussed on that crucial moment in the AIO, and must be aimed at bringing suitable boys to the Sergeant's table, and to giving him the means to clinch the deal.

To this end, the Engineer-in-Chief made the following appointments:—

(*a*) The Engineer-in-Chief's Recruiting Liaison Officer (ERLO). This was my job from December 1960 to September 1961 and will continue to be done as long as it is needed, by a Lieut-Colonel or Major between permanent postings. The ERLO acts as the Engineer-in-Chief's executive Officer for recruiting (including publicity) and is based on 1 Training Regiment RE. ERLO is concerned both with other rank and officer recruiting (the latter is not covered in this article).

(*b*) Command Recruiting Teams (an officer, a sergeant and a ¼-ton truck) were appointed, primarily to assist Chief Engineers in publicity in the Home Commands.

(*c*) RE Liaison Officers (part-time) were appointed from local units to keep contact with every AIO in the country, and were briefed to explain our new system (eg the trade training scheme, guarantee of overseas service etc), to recruiting sergeants, to keep them provided with RE posters and pamphlets, and to seek out and suggest new ideas.

(*d*) The number of RE special recruiters was increased. The new ones were generally placed in large cities where the population and number of Army recruits was high and the number of RE recruits was low.

Handling the Recruit

I hope that Colonel J. H. S. Read will put on paper what he did as CO of No 1 Training Regiment RE in 1960–61. It is a success story that all the Officers of the Corps should read. I will say only that the recruits were received and treated as human beings, were trained hard but not bullied, and that they enjoyed themselves. I lived there during this campaign, and saw for myself what a happy unit it was—both amongst the recruits and the staff. This did more than just reduce the wastage—the word of it got around, and drew in more recruits. The *Daily Mirror*'s full page worm's eye report in June 1961 was its just reward, and was read by 14 million people. Every RE Recruiter will tell you what an influence this had.

The Future

As we Approach our Target. The Corps is now getting its fair share of the Army's recruits. As we approach our target there may well be pressure to reduce our intake and redirect it into other Arms. This must be resisted because it would, in fact, damage the Army. Certain Corps and Regiments, ourselves included, are recruiting well. Until the Army has enough soldiers, it would be madness to order the very people who are getting soldiers to lay off. Far better, even if this leads to unbalance, to reinforce success by allowing the leaders to recruit over their target, and temporarily to take on extra commitments from others who lack the men to do them. We, for example, could find our own cooks, or our LADs, and even C vehicle workshops, and could provide bridge companies. All this, of course, assumes that we can and do outstrip our target. Certainly let us not be afraid of doing so, and certainly let us not call off our recruiting drive if we do. We can help the Army, and do ourselves a lot of good.

It's a Good Life—It Must Be. "More and More and More, the Men are rolling in to the Royal Engineers. Why? It's a Good Life—It must be!"

That was one of our recruiting posters in the late summer of 1961. Is it true? If not, our success will soon turn sour on us.

The end of a long article is no place to deal with this question. It is the every day business of every Officer in the Corps. Most of us know what makes for a contented soldier—adult treatment, hard training, plenty of adventure, plenty of sport, plenty of engineering, and above all, a really worthwhile task. Whatever our difficulties, we have far more scope for giving our men a varied and stimulating life than, say, the manager of a factory mass producing nuts and bolts or nylon stockings. It's no good just blaming the financiers—Officers can get over most of the obstacles if they are really determined to do so—otherwise they have no right to be Officers.

Of course, this is far more important than all the recruiting techniques put together. I will repeat what I said near the start. Do our regular soldiers enjoy soldiering? If not, they will neither sign on for more, nor advise their friends to join. Why should they?

Clifton Bridge, York

By Lieut-Colonel D. J. Willison, OBE, MC, RE

Introduction

For nearly a generation there has been talk of building a bridge across the River Ouse opposite Clifton on the northern outskirts of the city of York. For a variety of reasons, no progress on site other than some preliminary earthwork on the west bank had ever been carried out until 1961. In the office of the City Engineer planning had gone some way towards the design of a high level bridge. Early in 1961 three new factors led to a decision that 38 Corps Engineer Regiment should construct a temporary low level two span Heavy Girder Bridge across the river.

These factors were first and foremost and the Chief Engineer Northern Command was anxious to find a suitable training site to practice the construction of a long span Heavy Girder bridge (HGB) supported on the special HGB pier which had recently been produced. His suggestion that the Clifton site should be used for a training exercise by 38 Corps Engineer Regiment met with an immediate response in the York City Council. The latter were anxious to obtain practical statistics on the resulting summer traffic patterns in York so as to prove that the Clifton site was the best one available for a permanent bridge in and around the city. This would aid their case for a grant of money from the Central Government. They were also apprehensive of the traffic jams likely to result in the centre of York during the period of the Royal Wedding at the Cathedral on 8 June. After much negotiation and some unfortunate publicity, approval to proceed was finally given towards the end of April. Reason finally triumphed over sectional interests.

While these negotiations were in progress, the Regiment was busily engaged in preparing the detailed design and demanding the large amount of stores required for a temporary bridge. Two months earlier a Regimental Officer's Day had been held to discuss the design of a pontoon bridge on the Clifton site. So the difficulties of bank shape, swift current and rapidly changing water level were already known. The surveyors of 513 Specialist Team soon carried out an accurate plot of the site and the proposed centre line was fixed. The Chief Engineer arranged for technical advice to be given from the Bridging Wing of the School of Military Engineering, with reference to MEXE at Christchurch if considered necessary. It soon became apparent that a two-span heavy girder bridge could be built without using a piled pier.

Planning was still at the backs of envelopes stage when word came from the City Council that they would definitely like the bridge open for traffic by 8 June. In addition, they proposed that the bridge should be used until early October. The Chief Engineer's Resources staff were, therefore, forced to order stores piecemeal as bridge design and stores ordering progressed. Prolongation of the time for which the bridge would have to take traffic simultaneously converted the task from a temporary to a semi-permanent project. This had its effect later on bankseat design.

By 20 April the bridge design was confirmed by the Chief Engineer. At a meeting with the City Engineer of York on 24 April joint responsibilities were agreed. The City would lay the approach roads after Regimental plant had done the preliminary earthwork. The Regiment would build the bridge and supporting pier. The stage was therefore set for constructing the largest HGB span yet attempted on a field site.

This paper seeks to describe the technical problems met with both during construction and in the dismantling phase. OC Bridge construction was the second in command of 38 Corps Engineer Regiment. His party consisted of detachments from 12 and 48 Field Squadrons and 15 Corps Field Park Squadron with RHQ Officers as his assistants. OC Bridge dismantling was OC 48 Field Squadron using a strong troop of his own and plant operators from 15 Corps Field Park Squadron.

The Gap

At Annexure "A" is a cross section of the gap showing the final bridge design of two spans supported on an HGB pier: the major span finally selected was 225 feet of Triple Single Reinforced HGB and the minor span 62 ft 6-in of Double Single Reinforced.

The width of the river at the Clifton site is about 200 ft at normal summer water level. The west bank from which the bridge was launched had fairly flat and level banks at a height of about 9 ft above mean summer water level. About 160 ft back from the water's edge the ground rose sharply by about 6 ft where refuse had been tipped for many years past. The river bank itself drops steeply into the water. The bearing value of the ground was estimated by the City Engineer as ½ ton per sq ft.

The Clifton side of the gap presents more difficulties. The ground rises gradually from the water's edge until it reaches the same height as the west bank on a towpath. It then rises steeply. A dead end road runs down to the river as far as the towpath at a gradient of one in eight and a half. This road was to be the east bank approach. It has a high wall on both sides and the average width between the walls was 33 ft including raised pathways on either side.

Bridge Design and Launching Methods

Design of Spans. It was clear right from the start that the bridge could only be launched from the west bank. Allowing for an adequate distance back for the bankseat on this side and a maximum allowable HGB span of 225 ft, it was necessary for the pier to be constructed just in the water on the Clifton or east side. A second span was needed of 62 ft 6-in to reach the towpath for a level bridge throughout. By building up the roadway to the end of bridge the slope on the approach road was to be reduced to one in ten.

York City insisted that there must be a minimum clearance of 12 ft 6-in for river traffic above mean summer level. This meant that the bankseat, including an allowance for sag at mid span, had to be raised on the east bank some 5 ft above the natural bank height. The road approach on this bank therefore had to be raised by the same height.

The Pier. The pier, after many rethinks about design, was finally a half panel HGB pier with a crib cross beam. On the pier there could be no question of jacking so the bridge was designed to stay on heavy duty rollers. The ground under the pier was found to be hard gravel and sand. After some test digging the bearing pressure was estimated to be 2 tons per sq ft. An additional complication was the presence of a 14-in water main crossing the river just below the ground almost on the centre line of the proposed pier.

The centre line and footings could only be fixed after the most exhaustive tests on the exact alignment of this pipe.

The pier footings excavation was below water level so a sandbag coffer dam was built surrounding the area some 4 ft thick and up to 4 ft high in its deepest part. The bags were filled with a small amount of old condemned cement in the sand. This wall worked admirably so that the area of the footings could be pumped dry and kept that way with a No 4 pumping set after initial bad leaks had been stopped.

Grillages. The bridge was designed for Class 30 two-way traffic with certain restrictions on the density of individual heavy vehicles crossing at one time. The bridge design was triple single reinforced in the main span of 225 ft and double single reinforced in the east bank approach span. The reactions at the pier footings were estimated at 107 tons at each side. The pier was footed on to reinforcing chords under which were steel sleepers and then 10-in by 5-in RSJs on timber. This gave a bearing area of 90 sq ft per side, which was well within the permitted margin for 2 tons per sq ft bearing pressure.

The heaviest load on the home bank grillage was reckoned to come during launching when it would have to take about 104 tons each side. The design chosen was HGB Type three grillage on a type "F" EWBB grillage which, with additional layers of chesses, gave a 225 sq ft bearing area.

The Clifton end grillages were small in comparison. Reinforcing chords on top of steel sleepers resting on timber were used.

Piling. After advance party and plant work had started on site, as an additional precaution it was decided that boreholes should be sunk in the west bank grillages area. These showed a depth of 6 ft of alluvial soil and under this an unknown depth of running silt. Test boreholes of the site were then unearthed in the City Engineer's office. These showed the existence of a considerable layer of silt. Further test boreholes were drilled and the silt under soils laboratory test showed zero bearing strength. The geology of the area was investigated and it was found that there had been an earth slip on this bank previously. As a precaution for a semi permanent bridge it was therefore decided to put in a box sheet piling round the grillage area. Larsen sheet piles were driven to a depth of 25 ft all round the whole grillage area. The piling was done with a 19 RB drop hammer rig while other advance party work proceeded.

Roller Layout. Roller Layout as recommended in the *Provisional User Handbook* consists of launching and building rollers 75 ft apart. Each set consists of eight rollers under each side of the bridge into two groups of four contained in rocking roller frames.

In practice these sets of rollers were found to be inadequate for the earlier stages of bridge construction. Further ghost rollers were therefore installed at 110, 135 and 165 ft behind the launching rollers. The full layout is shown in the diagrams at Annexure B.

Launching Details. At an early stage in design it was discovered that double single construction will take Class 30 loads over a 225-ft span. On checking the sag, however, it was found that the lowest point of the nose during the launch would almost touch the water. Therefore to stiffen the bridge and reduce the hog over launching rollers, MEXE advised triple single construction. A further complication arose from launching a continuous two-span HGB. The designed launching nose, because part of it was to become the approach span on the far side, had reinforcing chords on the last four double single bays and had an extra bay of end posts on it. The doubt was whether the extra weight would make the nose sag more or whether the extra stiffness of the reinforcing chords would make it sag less. Not even MEXE could predict the answer with certainty. The link was therefore put in at eight bays back. This gave 12 ft lift to play with. In practice this proved too much and the sag was only a little over 7 ft.

The tail sag at its maximum was 41-in. There were no problems here as to get the designed 12 ft 6-in clearance above the water the west bank grillages were so high that the launching plane was 5 ft above the original ground level.

The bridge was pushed across using a bridging crane. Because of the height of the tail of the bridge an improvized pushbar of 9-in by 9-in timber was used. Two size 2 tractors were used as preventers with their Hyster winch cables attached to the back of each truss. Coming up over the launching link on the landing rollers the crane was not sufficiently powerful and the two size 2 tractors had to push with their blades against the endposts with a scammel winch as preventer.

The elevation of the bridge at the critical time of launching is shown at Annexure B.

Breaking Span. The two spans of the bridge had to be broken over the pier during launching. At first it was thought that the pins could be taken out at the point of contraflexion. In fact, with so great a weight of bridge, it was a nuisance to keep stopping every few inches to try the pins when the point of contraflexion was near. The solution adopted was to complete the launch with top pins still in over the pier and subsequently to jack up the far end of the smaller span from its bankseat until an artificial point of contraflexion was achieved, thus allowing the pins to be removed. With the new HGB assault jacks this proved simple and quick.

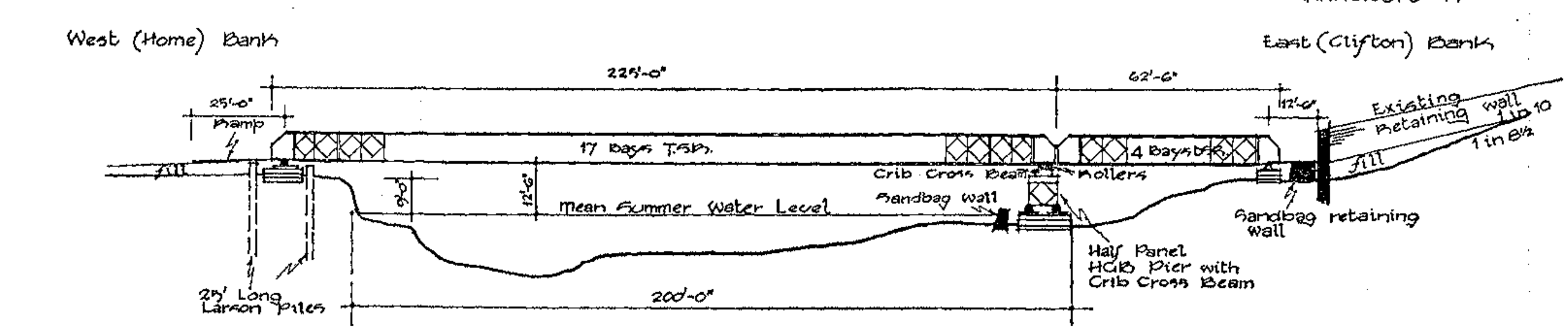
Labour and Time

Preliminary Work. A party consisting of one WO and two surveyors of 513 Specialist Team did a complete survey and set out the centre line in one day. Next came a plant team of one NCO and five men with three Size 2 dozers, two 8-yd scrapers, one grader and one crane. They worked on site from 24 April until 6 June. When their machines were not in use they worked as general labour. For the first ten days they levelled the site, moved 2,000 yds of consolidated refuse from the area needed to give a level construction site for the tail of the bridge and cleared about 800 yds of soil for the approach road to be built by the City on the west bank. The underlying mud was so unstable that the whole area trembled while heavy machines were working; a most disconcerting sensation which caused many a ribald comment of a morning.

The original works table allowed for a small party of twelve men to do all the preliminary work on the pier and all grillages between 5 and 25 May. In fact after the work had started and it was decided to pile the west side bankseat area, this party was doubled.

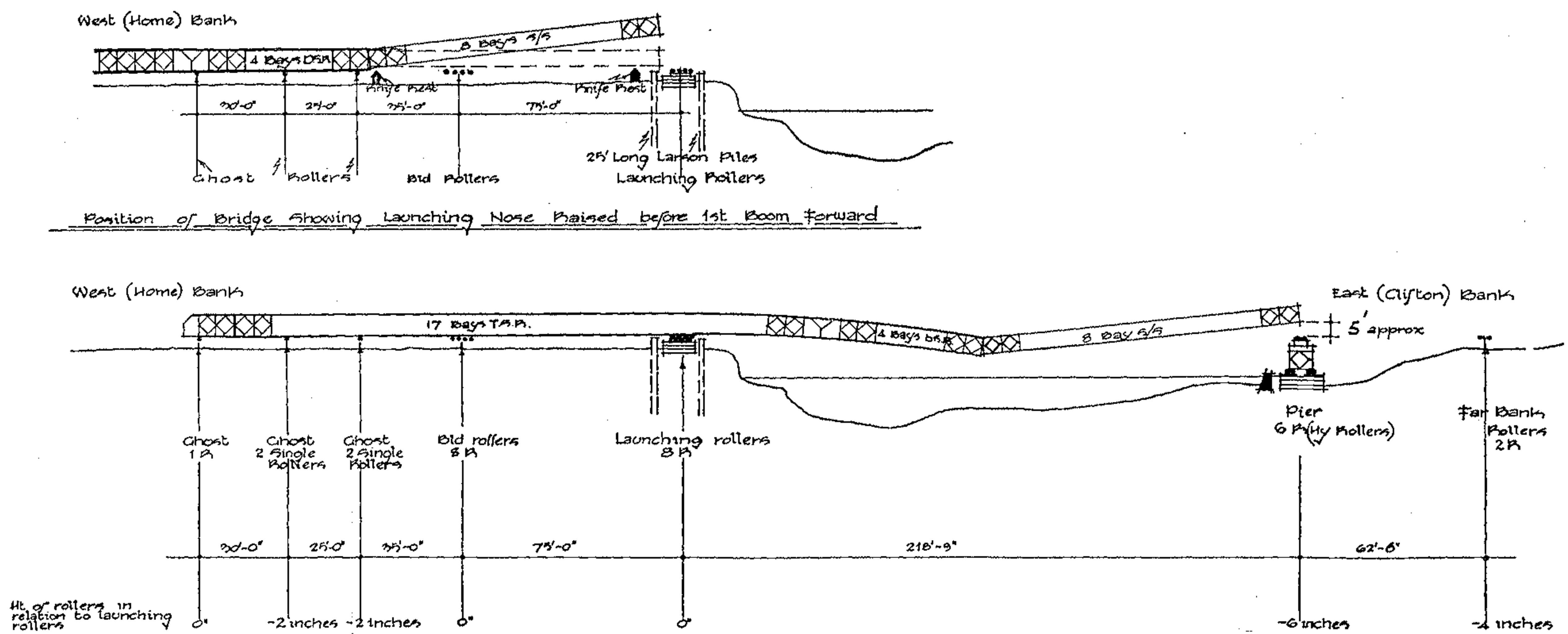
During this preliminary period the whole Regiment was attending a bridging camp at Chatham and all the preliminary work including the construction of the pier had, therefore, to be undertaken by 15 Field Park Squadron Plant Troop and a few men left behind by the Field Squadrons.

Annexure A



HGB at Clifton, York.

Annexure B



Position of Bridge Showing Launching Nose Raised before 1st Boom Forward

Elevation Showing Position of Bridge with Launching Nose over Pier Rollers.

Even the draughtsman who produced the drawings of the bridge found himself humping sandbags between drawings. This party worked very long hours and through two weekends and more than achieved their target by 25 May when bridge construction was sheduled to start.

Construction. Two parties came back from Chatham by road immediately after the Regimental regatta at Upnor to be ready for work on 25 May. One was twenty-five strong from 12 Field Squadron and the other twelve strong from 48 Squadron. With the addition of the men already on site for advance party work this gave two construction parties of an officer, a sergeant and thirty men including crane and dozer operators.

Work was organized on a shift basis, one party being on site from 0600 to 1230 hrs and the other from 1230 to 1900 hrs. The first few bays of launching nose had been built by the advance party before 25 May so on the morning of that day work got away to a good start. Bridge construction was completed and the bridge launched across the gap late on 26 May. By 2230 hrs the second shift of the day were able to secure the bridge on the rollers on top of the pier and to knock off after a particularly arduous 10 hrs of work. On 27 May the launching nose was dismantled and the bridge pushed forward into its final position. Jacking down at the Clifton bank end was completed. On 28 May both shifts worked normal hours in finishing off decking, exchanging the light nose girders for proper cross girders in the approach span and jacking down the main span.

The party was then reduced to the original advance party for the final tidying up which included footwalks wired with chain link fencing and a sand bag end dam for the Clifton side. The back wall of the sheet pile box round the west bank grillage was left 4 ft above ground level to provide an end dam on this side and to which anchorages were welded for preventing longitudinal movement of the bridge.

Stores Handling

General. It was decided early in the planning stage to avoid double handling of equipment by building the bridge direct from transport. This meant that as the grillages were constructed well in advance of the actual bridge and as the bridge was to be launched undecked, it was not practicable to use the standard loading tables. A revised loading table was therefore made up, and when the bridge construction started, the loading sequence was four 3 tonners with three reinforced panels each, followed by one 3 tonner with four cross girders with the necessary small stores.

The reinforcing of all panels was carried out by the staff of 51 CESD who, with the aid of a fork lift truck, soon developed an efficient team of three labourers who could attach both reinforcing chords to a panel in 4½ min.

42 Company RASC provided fourteen 3 ton GS lorries, of which eight had the sides removed to facilitate the handling of reinforced panels and had timber bolsters fitted to take the cross girders. These vehicles ran a continuous shuttle service during the construction period picking up their predetermined loads and delivering them to site in their correct order.

All stores required for the bridge were assembled in 51 CESD at Hessay, some four miles from the site. Stores were laid out in the Depot in accordance with the loading table and when the empty trucks returned to the Depot, it only required a storekeeper and a crane operator to keep the wheels turning.

The Resources team at Northern Command and the staff of 51 CESD did a very efficient job in collecting the stores on time. Everything arrived including the many "specials". The Half Panel HGB Pier was already erected at Chatham: it was dismantled and sent direct to the site on a 10-ton vehicle provided by 15 Corps Field Park Squadron.

It says a great deal for the stores organization that construction at no time exceeded the availability of stores. The RASC drivers worked long hours and no load was lost through taking the wrong turning. The Regimental Signals Officer found himself in charge of stores organization and made a very good job of it.

Cranes. HGB above all requires cranes and more cranes to handle the equipment, including the fitting of the reinforcing chords. In 51 CESD a 2-ton Neales crane and a 7-ton Coles Bridging Crane were used to load vehicles after securing the reinforcing chords to the panels. On the west bank of the river from which the bridge was launched two 7-ton Coles cranes were deployed. One of these was continuously in use for both advance party work and bridge construction. A reserve crane was supplied for a short period by 336 Crane Operating Squadron (TA) and then from regimental sources on return from Chatham. At the height of triple single construction both cranes were used on each bay. This entailed very close supervision by the officer in charge of construction to see that every item in one bay was secured before the next bay was started.

On the east bank an RB 19 rigged as a crane was most valuable. This machine both built the HGB pier and dismantled the launching nose.

Special Points of Interest

General. The actual building of the bridge was a straight forward standard double and then triple single reinforced. There were no difficulties here and the party of twenty-five men plus plant operators was just right. Construction drills using cranes proved successful and quick on a structure which measured nearly 400 ft long at the time of launch. The Regimental Training Officer was in charge of construction throughout.

Launching Nose and Roller Layout. Construction of the Launching Nose (eight bays SS and four bays DSR) started 10 ft behind the launching rollers on "knife" rests. The position of the launching link (eight bays back) was therefore 35 ft behind the building rollers. At this point a ghost roller set-up of two single rollers was inserted to support the DSR part of the nose as the bottom pins at this point were left out for the insertion of the launching link at a later stage. Building then continued to the commencement of the first bay of bridge, which by this time was on the third set of ghost rollers. As the centre of gravity was now behind the launching link position, the first eight bays of the nose (13¼ tons) was lifted using two bridging cranes, one on either side of the bridge. As the nose had to be lifted 12 ft this was rather a delicate operation, but in spite of ringing bells in the cranes it was achieved fairly easily. Before the weight of the bridge came on to the launching rollers there were fourteen bays behind the building rollers; therefore with a weight of over 8 tons per bay it was considered better to insert more ghost rollers using this method of construction for so enormous a span.

Touching Down on Pier. The plan here was to launch out until almost at the point of balance and then to pull the nose down with tackles on to the rollers on the pier. By this means it was hoped to prevent a dangerous "flip up" of the tail with consequent tendency for the whole structure to take charge and run on until the nose sag was taken up over the pier. Four tackles were used, two from the nose to convenient trees at the sides to give means of correcting alignment and controlling sideways swing in the nose, and two directly down to the pier footings for hauling down the nose on to the rollers at the point of balance.

A lot of time was consumed in getting these tackles fixed. They were 3/3 cordage tackles and getting them fastened to the nose swaying some seven feet above the pier, itself 14 ft above ground level, was by no means easy.

When the great moment came for the launching nose to arrive above the pier rollers it was found that during the launch the bridge had run a few inches off line. The tackles could not correct this as the nose was too springy and unstable and when the tackles were pulled merely swayed and dipped and returned to its former place. The solution adopted for this problem was to jack up the tail on the assault jacks and to traverse in the opposite direction. The ability to traverse under load is yet another enormous benefit accruing from the cunning design of the assault hydraulic jacks.

Having got the alignment right, the bridge was boomed forward inches at a time until it was possible to pull it down on to the rollers. It took a long time but with over 200 tons of bridge swinging about on the point of balance it needed all the care in the world to complete the launch. For hours on end the Chief Engineer and the Commanding Officer watched in trepidation until the great moment when the nose touched the landing rollers. Memories of the Festival of Britain kept crowding in as each laden minute passed.

Even then the difficulties and dangers were not over. As the bridge moved forward over the rollers on top of the pier, the tail rose considerably. To the alarm of all technically minded on-lookers the whole structure gathered momentum and ran forward for about a bay until the nose sag over the pier was substantially taken up. This is a hazard which must be carefully watched on very large spans of this size. One further danger point of the bridge taking charge occurred when the tail of the bridge taper chord ran down over the launching rollers actually dragging the preventor Scammell forward.

Organization for Launching. All signals were visual. A wireless control net was considered but discarded as the Bridge Commander thought the encumbrance would outweigh the advantages. The Bridge Commander stood on the home bank opposite the launching rollers where he could see the point of balance indicator. This indicator was re-set after suitable calculations each time before the bridge was moved forward. His Second in Command stood on the top chord of the bridge above him and gave signals to an officer on the tail of the bridge. This officer controlled the crane, or dozers pushing and the dozers or scammel acting as preventers. A fourth officer stood on the far bank where he could watch the pier and see the Bridge Commander. Senior NCOs were detailed to watch all rollers. All officers had a whistle which when blown signified stop. This system, though elementary and slow, worked well.

Dismantling Launching Nose. The last four bays of double single reinforced launching nose became the approach span on the Clifton or east bank side. The leading eight bays of single construction nose were cocked up by the launching link at a slope which was greater than the slope of the road leading down to the water so as launching proceeded the nose ran up the road. It was dismantled from the road direct into lorries by crane.

Photo 1. Home bank roller layout with the nose and DSR for span complete.

Photo 2. The nose nearing the landing rollers.

Clifton Bridge 1,2, York

Photo 3. Last stages of the launch.

Photo 4. The first traffic across headed by "Mothers Pride".

Clifton Bridge 3, 4 York

Jacking. The greatest jacking load was on the home or west bank where the load was 80 tons on each side of the bridge. The assault jacks used were excellent. Only one minor snag arose, in that under load, the maximum lift on the jack proved to be 14 in instead of 16 in. These jacks are designed for lifting a maximum of 100 short tons so they were very near their limit.

Handing Over to the City Authorities

The bridge was test loaded on Friday 2 June in the presence of the City Engineer. A 50-ton load was driven on to the centre of the main span. It consisted of a Size 2 dozer on a low loader and a bridging crane. All grillage levels were finally checked and a record of levels handed over to the City Engineer. He formally signed for the bridge including all stores contained therein over a 6*d* stamp.

It carried traffic from the morning of 3 June and was formally opened by the Mayor of York on 6 June. The GOC-in-C Northern Command was present with the Chief Engineer for the opening ceremony. All officers and men who had been connected with the construction of the bridge were also present at the formal opening with their wives. Afterwards all ranks were entertained by Councillor Bridge of the York City Council to a luncheon party.

Delaunching

The bridge took traffic without incident throughout the busy months of the summer. Maintenance instructions prepared by the Regiment were carried out meticulously by the City Engineer's department. Particular attention was paid to greasing all pins, bolts, etc. which might give trouble when the time came to delaunch in early October. Some local residents complained about the noise of the decking panels when traffic was crossing, but this agitation rapidly died down. Police control of traffic crossing the bridge was soon withdrawn and some civilian cars and lorries tended to speed across the bridge, especially when descending the steep eastern bank approach. No damage or appreciable movement of the bridge fortunately occurred.

Design Factors. Preparatory planning for the ruling factors which would govern the method of dismantling started within the Regiment in August. A summary was submitted to Chief Engineer Northern Command for approval. The main argument revolved around the placing of the launching link. After a new survey of the eastern bank it was shown conclusively that if the link was inserted seven bays back from the nose, major excavation of the approach roadway, laid since the bridge was finished, would be needed. At eight bays back no excavation was needed but the "flip up" at the point of balance would be that much higher as weight was transferred finally to the homebank. After much anxious debate in the light of experience gained during the long drawn out agony of the similar "flip up" during launching, it was decided to put the link eight bays back with no retaining tackles on the end bay of the nose. Because of the configuration of the approach road it was necessary to take several bites at the cherry in constructing the nose and booming the whole bridge back.

The main reason why it was essential to delaunch the bridge in October was that it was not designed to withstand winter floods down the Ouse. The launching plane was in fact a foot or two below the worst winter flood level recorded. The river rises with great rapidity and only 24 hrs notice of severe flooding could be expected. The Chief Engineer, therefore, stipulated that delaunching was not to be attempted if a flood warning was received. This meant that the delaunching plan must allow for the preparation to be completed within 24 hrs of jacking up on to rollers.

Much debate took place on whether the tail sag would be so great as to knock over the ghost rollers on the home bank or whether the sag would decrease sufficiently as the delaunch proceeded to clear all these rollers. It was finally decided to install all such rollers back to 175 feet before delaunching started. Grillages were much smaller than for launching as they could now be laid on the new tarmac approach road.

Remembering the sudden onrush of the bridge soon after touching down on the landing rollers during the launch, steps had to be taken to prevent another surge during the delaunching. A heavy pull was expected on to the home bank rollers as the link effects were straightened out. Getting the taper chord up on to the home bank rocking rollers would also need a big tractive effort. A combined pulling and preventive system had, therefore, to be designed to connect with the tail of the bridge. The system used consisted of two size II angle dozers using their hyster winches to give a central pulling effort on the bridge centre line by passing their cables through a snatch-block hooked to strops of equal length from the end pin hole of each inner truss. Preventer effort was provided by putting a third size II machine inside the strops with its blade against baulks of timber protecting the end cross girder of the bridge. This cross-girder was braced to the next in bridge by the end bay strut used for launching.

The Delaunch. The Troop of 48 Field Squadron deployed early on Monday 2 October to be met by representatives of the City Engineer. The bridge was formally handed back and the Electricity Board soon stripped off the street lighting and wiring. The odd plaintive motorist slipped through the police net but was forced to retire whence he came. Stripping the decking and ramps went like clockwork. Exchanging cross girders in the short span and adding the nose went smoothly, so did jacking up and the removal of end posts.

Stops off, the signal to pull back was given and the bridge, all 380 ft of it, started to roll smoothly backwards. The first hitch occurred when the junction between the spans passed the point of contraflexion and the top chord came under compression. The half chords joining the tops of the end posts took the pressure but above them were half chords pinned to quarter chords on top of the end posts themselves and in line with the chord reinforcement. These had not been properly bolted down with chord bolts and one of them popped up. The bridge had to be boomed out again so that chord bolts could be fixed. At the same time the launching nose was completed. The second thing to go wrong after delaunching was resumed was caused by the strong tendency to run back that had been expected. As the taper chord ran off the pier and as the launching link passed it, the force on the preventer dozer was such as to distort the end cross girder and bend the end bay strut. An efficient means of prevention in these circumstances therefore still needs to be evolved.

Thenceforth the delaunch went smoothly. The tail cleared the construction rollers by about 1 ft, the "flip up" lifted the nose by about 2 ft 6 in and no difficulty in control was experienced at this critical point. The nearest the tail sag came to fouling a roller was at the final ghost roller, which it cleared with inches to spare as the taper chord lifted the tail at the penultimate roller. The launching link happily did not foul the ground between roller positions.

It was interesting to note the "humping" of the bridge as it passed back over the various sets of ghost rollers. Due to the sag, the bottom chord at any given time would be resting on the first ghost roller, be clear of the next one and be resting on the third.

Stripping. Two cranes were used and the system soon got into its stride. Difficulty was experienced in removing pins in triple truss construction when reinforced because the pin in the chord reinforcement may push against the pin in the panel. A tip worth remembering is to keep a chord bolt spanner handy to slacken off chord bolts which will usually free difficult pins.

Another point of interest was reached when the junction between triple truss and double truss construction was reached. If care is not taken the centre end post and panel attached to it may be left unsupported except by a cross girder bolt while the outer truss is removed. Here two cranes were used on each side but there may be a less clumsy way of doing it.

Removal of the launching link had been foreseen as a problem. It was not possible to extract the link by lifting the launching nose until the pins were freed as lifting merely tended to straighten out the "humps" referred to earlier. A very long and strong lift would have been needed—far beyond the capacities of available cranes or jacks. In fact the only method of removing the link was to make use of the long roller layout and continue stripping the bridge until the point of balance was reached when the launching nose gently dropped on to the rollers. Once the tail is in the air it is impossible to fit a pushbar to boom back until stripping reached the launching link. At this point the centre of gravity must still be inside the roller layout; hence the necessity for a long roller layout and careful calculations of "flip up" points.

Organization. As with so many engineering tasks, the organization is as important (if not more so) as the technical plan. On this task four small sections were used and the men remained in the same sections throughout the operation. In addition to these sections there was a separate stores party who checked and listed all stores on each truck before it left for 51 CESD. They were also responsible for transport organization and turn round.

Transport consisted of sixteen 3 tonners from 42 Company RASC who worked extremely long hours and to such effect that work was never held up for lack of transport.

The success of the organization may be gauged from the fact that the bridge and pier were both dismantled and backloaded to the CESD by one field troop and a strong plant detachment in three and a half days of effort, working 12 hrs a day.

Conclusions

Clifton Bridge, York provided 38 Corps Engineer Regiment with a major task which required both careful design and a complicated organization to complete the task. Four parties were concerned in design, namely the Regiment, the Chief Engineer, the SME and MEXE for those details of HGB design which are not covered by the existing handbook. Co-ordination was vital and this task was undertaken by the Chief Engineer Northern Command.

The organization for construction was complicated by two major factors.

First, the task could only be controlled by officers from RHQ as squadrons were fully committed elsewhere. Secondly, the Regiment as a whole was away in the Chatham area for the three weeks before bridge construction actually started when the design was being worked out and advance party work was in progress. Despite these difficulties the bridge was completed on time and the design has withstood the buffetting of civilian traffic both ways for four months.

The bridge has shown that long span HGB launched as a continuous bridge over an HGB pier is a thoroughly practical design well within the capabilities of an Engineer Regiment. There can be no doubt however that these longer span two-way HGB bridges demand of the RE officer a much more intimate knowledge of the real engineering factors involved and of the much more serious consequences of a failure in design or execution than in the past.

Dismantling went smoothly and quickly because there was plenty of time to design and organize the task which could then be sub-allotted to a Field Squadron to carry out.

Chemical Warfare now, and in 1915

By Major-General C. H. Foulkes, CB, CMG, DSO

This article originally appeared in the Armed Forces Chemical Journal, *USA, November–December* 1961 *and is published by kind permission of the Editor.*

Part I

By tradition, the Corps of Royal Engineers has been charged with the responsibility for developing almost every innovation in the history of the British Army, from battering rams to mechanical transport, wireless, aircraft and armoured vehicles; so that when Sir John French was given belated permission by the Cabinet[1] to retaliate against the Germans for their use of gas in April 1915, he turned to his Engineer Adviser (as the Engineer-in-Chief was then called) and asked him to choose an officer to undertake the necessary preparations—preferably one with an intimate acquaintance of front-line conditions—and he nominated me. I was a very junior Major at the time, but had commanded a Field Company for the previous nine months in the most active sections of the British front, from Ist Ypres onwards; and it was in this rather haphazard manner that I became "Gas Adviser" to the Commander-in-Chief, though it was known that I had but an elementary knowledge of chemistry, and, of course, no experience whatever of poison gases. I was promoted to Lieut-Colonel, and given a free hand, and told to stage a gas attack in about six weeks' time as a preliminary to a joint Anglo-French offensive that was planned for 10 July.

On visiting London I soon realized the toughness of this assignment. I learned that before the war Germany had enjoyed a monopoly of the chemical

[1] With the proviso that the use of such deadly substances as Prussic acid was forbidden!

industry in Europe, and that the only gas that it was then possible for us to use, and that was manufactured in small quantities in England, chiefly in the Castner-Kellner factory at Runcorn on the Manchester Ship Canal, was chlorine (which the Germans were believed to have used) and that it could be liquified for storage. But there was no practical method of discharging it into the open air, and the containers in commercial use were far too unwieldy for installation in narrow trenches. A week later a method of discharge on the soda-water syphon principle had been improvized and I witnessed a demonstration at Runcorn at which a few cylinders were emptied. This showed the behaviour of the gas as it was carried forward by the wind, the shape of the cones from the point of discharge and the distance at which they combined to form a continuous cloud; and it was from this simple demonstration that I had to plan our first gas attack. But the output of the factory had to be greatly increased and portable containers designed and manufactured, as well as suitable discharge pipes, all of which presented formidable difficulties in the circumstances.

I decided on cylinders without hesitation, though when I visited the French chemical establishment near Paris I found that they were proposing to generate their gas actually in the front line trenches, in iron receptacles built into the parapet. The gas formed by a mixture of chemicals was to be forced out to the front through a pipe by means of rotary blowers. Such an apparatus, besides being immobile, would have been very vulnerable to bombardment, but it was interesting to note how an entirely novel problem was being approached by our allies and ourselves from quite different directions.

Personnel had also to be specially enlisted—largely from University graduates and students—and organized into Engineer units, and trained in handling the cylinders as soon as the first consignments arrived in France.

It was also evident, from the contempt with which the employés at Runcorn treated slight concentrations of chlorine, that some much more lethal agent had to be found, and an intensive research for it organized. A meteorological unit had to be formed for forecasting weather, and all my officers were trained in taking wind measurements. A small field chemical laboratory was also established, chiefly for intelligence purposes. (The Royal Army Medical Corps was providing protective masks, and training the troops in their use, but this responsibility, too, was transferred to me later in the war).

As might be imagined, I was faced with many difficulties in procedure, some of them amusing. For instance, there was an indignant protest from the Quartermaster-General's branch when my request for 300 watches (with which to synchronize the commencement of the gas discharge) was stated to be unprecedented. However, General Robertson, French's Chief of Staff, supported me wholeheartedly and issued peremptory orders for first priority to be given for everything I demanded.

Gas cylinders trickled across the Channel very slowly, but other circumstances caused a postponement of our offensive, from July to August, and finally, from 15 September when the wind was very favourable, to the 25th when it was not. At this last date the organization and instruction of the "Special Companies" had been almost completed, and a highly successful demonstration of a cloud attack in our training area, attended by every senior commander in the Expeditionary Force, had inspired confidence in the gas and in the technique adopted. For the attack on the 25th, 5,500 cylinders containing 150 tons of Chlorine were installed and protected with sandbags along a front of 24½ miles, together with 46,000 phosphorous smoke candles and bombs that had been improvized in order to prolong the discharge of gas with intervals of smoke, to simulate gas on fronts not assaulted, to supply the deficiency of cylinders and to conceal the approach of our troops. As an example of the pressure during the last few days, the final batch of cylinders to reach us left Runcorn by special train on 22 September, arrived at Boulogne on the 24th and was put into lorries and carried into the trenches the same night.

I had sixty officers in action, of whom only one, Captain Eddis RE, was a regular soldier, and 1,400 men, recruited mostly straight from civil life, and who were now about to come under fire for the first time: one of them, a bespectacled chemist's assistant, was awarded the Victoria Cross for gallantry on 25 September.

My readers may like to be reminded of the result of all this improvized effort. Briefly, the gas attack was much more successful than was generally supposed. The cylinder installation in 400 emplacements by infantry carrying-parties had been accomplished in complete secrecy and without a hitch, but infantry commanders had refused categorically to vacate their front line trenches, as I had planned, to avoid exposing them to gas leakages and to the inevitable artillery bombardment that the discharge would attract. It was considered unthinkable in those days to abandon a trench for even half an hour, though it became common practice in gas attacks later in the war.

I had circulated to everyone concerned the conditions in which gas could be discharged safely—within certain limits as to the direction of the wind in relation to the line of the trenches, and with a minimum velocity of 4 to 6 miles per hour.

I controlled the operation from the Army Commander's (Sir Douglas Haig) advanced headquarters at Hinges. There I had a detailed trench map of the whole front laid out on a trestle table, and on it were marked with flag pins the locations of every gas officer in charge of a section, each of whom sent me in code, every hour of the night, a report of the direction and velocity of the wind in his area. The Signal Corps had been ordered to give first priority to these messages, and as each one came in the appropriate flag was pointed in the direction of the wind, as reported, and the velocity was pencilled on it. General Butler, Haig's Chief of Staff, came in to examine the map at frequent intervals during the night and he was aware of the conditions in the front line trenches up to almost the last moment before the attack began. The wind was light and variable everywhere and it did not conform to my minimum requirements, but Butler and Haig decided, after considerable hesitation, that the operation was to proceed according to the arranged schedule.

The first aeroplane reports that came in at dawn were to the effect that a dense gas cloud was rolling steadily towards the German lines. Some of my officers had refused, as instructed by me, to open their cylinders if the conditions were such as to endanger our own troops, but when this was reported they were over-ruled, the decision coming, it was said, from the Army Commander himself.

The fact was that Sir Douglas had been ordered to attack at a definite time and date, and on a front not of his own choice, but one dictated by the requirement of the French on our right flank. He felt that, without reinforcement from our new armies—which was imminent—and with inadequate artillery preparation—in the absence of high explosive shells—his attack would fail unless the gas discharge was successful, and he was willing to take a risk.

Perhaps he was justified. As it happened, the Germans were taken completely by surprise and they were demoralized when they found that their masks gave them little or no protection: this we had expected, from examination of those found on men previously taken prisoner.

Five of the six divisions that took part in the main attack captured the German trench systems without much difficulty, and only the 2nd (in which I had served) failed to advance on our extreme left, opposite La Bassée, though some of its elements entered the German front line. All the Commanders concerned were convinced that, with very little damage having been done to the barbed wire entanglements by the artillery bombardment, no advance would have been possible anywhere without the gas. The 9th Division, next in the line to the 2nd, walked over the famous Hohenzollern Redoubt with hardly any loss and advanced for a mile in the first rush, and similar progress was made by the 7th Division farther south. On our extreme right the gas attack was an unqualified success and the whole of the IV Corps, consisting of the 1st, 15th and 47th Divisions, captured the first two German lines in fifteen minutes, and then took the village of Loos and advanced a mile beyond it, though much of this ground, including the Hohenzollern Redoubt, was lost in the next few days in counter-attacks, mainly through the superiority of the German hand grenades. This redoubt was taken again, very easily, after another gas attack on 13 October, but was lost a second time by counter-attack. Eighteen German guns were captured on the 25th and more than 3,000 prisoners were taken.

In his official dispatch Sir John French wrote "our gas attack met with marked success and produced a demoralizing effect in some of the opposing units, of which ample evidence was forthcoming in the captured trenches". And the German communiqué of 25 September contained these words: "Even this retirement was not the result of the English Commander's abilities, but was the consequence of a successful surprise attack with intoxicating gases".

Our first year of the gas war had been a period of improvization and experiment, and all developments were very slow. It was only in July 1916 that we were able to use phosgene in our cloud attacks, though its value had been recognized and an urgent demand made for it a year earlier. Gas fillings for shells, projectors and the 4-in Stokes mortar were used for the first time in April 1917, and mustard gas only became available in September 1918—fourteen months after the Germans used it.

At a meeting of a chemical committee in the Second World War, at which I was present, a new rifled mortar was being discussed which the Ordnance Board had pronounced unsafe, and I was asked what factor of safety I considered sufficient in 1915. I replied that we never used one, though we took care not to endanger our own troops. As an example of the expedients to which we resorted I might mention the beginnings of what became known as the Livens projector. For lack of anything that looked more like a mortar Captain Livens used ordinary petrol drums, well tamped into the ground and set at an angle of 45 degrees. The bomb consisted of a slightly smaller drum which contained various fillings, and the amount of the cordite propellant charge varied with the range. At one demonstration at which a number of senior commanders were present, he fired a salvo of twenty of these drums filled with high explosive, to discover their effect on a barbed wire entanglement. After the discharge, when the spectators had almost reached the target area to see what damage had been done, Livens noticed that one of the drums containing 50 lb of T.N.T. had failed to explode, and, shouting "Run for it", he led an undignified retreat. He may recall this as the highlight of his military career—the occasion when he barked out an order to an Army Commander (Gough), and was promptly obeyed.

PART II

In contrast to the circumstances I have described a future Commander-in-Chief would have no difficulty in finding a ready-made gas adviser, especially in any army that included chemical formations. He would be trained already for the duty, and have at his disposal, stored and in quantity, substances considerably more dangerous than phosgene and mustard gas, as well as greater variety in the means of delivering them—for example, in aerial bombs of several types, and sprays—and he would have tested his tactics on the experimental field. (In the first war the British and German Air Forces had refused to have anything to do with gas).

But we must avoid the error, of which I am giving several instances, of exaggerating the effects of new weapons before they have been proved.

(*a*) A week or two ago Don Iddon, in the British *Daily Mail*, quoted an opinion expressed in the American magazine, "Look", which estimated that if Russia launched an all-out nuclear attack on the United States only four out of a hundred Americans would survive. In the case of a direct hit on a city, perhaps, but this seems a pessimistic forecast to make in regard to the scattered population of a whole Continent trained in protective measures.

(*b*) Soon after the end of the first war a prominent public man, and an amateur chemist, wrote a letter to *The Times* in which he said that a bomb containing one of the new arsenic compounds, if dropped in Piccadilly Circus, would destroy all life between that area and the Thames—perhaps a million people. In questioning the accuracy of this statement I pointed out that the substance referred to was not new, and had been used against our troops in France (in the German "Blue Cross" shells) for the last year of the war with very little effect; and I expressed the opinion[1] that an HE bomb of the same size would probably be much more destructive.

(*c*) And quite recently I have seen a similar statement made by an American authority whose views are entitled to the greatest respect. He is reported to have said that a single enemy missile could dispense enough "GB" (the "nerve" gas, Sarin) to produce 33 per cent of casualties among *all unmasked personnel in the open* over an area one mile in diameter. The italics are mine.

(*d*) Between the two wars a group of scientists in one of our Universities published a paper that gave the results of a series of experiments they had made on the protection afforded by air raid shelters against gas, which had shown that even a two foot thickness of concrete wall was insufficient to

[1] The Correspondence Editor of *The Times* called me on the telephone to say that he proposed to publish my letter, except for one remark. "What", I said, "Has *The Times* no courage?" "Lots of it" he answered, "but also due respect for the law of libel". The writer of the letter referred to was a King's Counsel!

prevent penetration. *Nature* asked me to review this publication, and in doing so I expressed disbelief, and remarked that two old army blankets, hung on a wooden frame at the entrance to a dugout in France, had been found to give its occupants sufficient protection for all practical purposes.

It is only with diffidence that I am now venturing to speculate on the future possibilities of chemical warfare, in view of the fact that I am in possession of no official secrets. I have, however, seen a good deal that has been openly published here and in the United States about the chemical and biological agents that have been investigated recently, of which the "nerve" gases seem to be considered the most dangerous. Perhaps Mr Ian Fleming, the novelist, is better informed; for in one of his books he introduces a nerve gas, as a narcotic, into the reservoirs supplying water to the whole district round Fort Knox, to enable a gang of super-criminals to put the entire population out of action for three days, the time required to empty the vaults of their tons of gold.

1. It is generally supposed that there is now such a balance in nuclear equipment between East and West that a stalemate has been created; and that unless a war "happens" through accident or miscalculation—for example, as a consequence of providing fighter protection for our approaches to Berlin—mutual fear has made war between any of the Great Powers unthinkable. If this is true no armaments will come into use except psychological broadsides, a "nerve" weapon in a different sense.

But after such near miracles of achievement as photographing the back of the Moon, nuclear fission and television, *no* scientific discovery is inconceivable. It is already possible to trigger off, from the ground, mechanisms carried in space vehicles, and it would only be a step further to find a really effective "death ray", more deadly than gamma radiation, or one that could explode nuclear missiles from a distance. It may be still more fanciful to suggest that even better thermo-nuclear devices can be developed—for instance, from Helium or from still another hydrogen isotope. In such a case —and if the secret could be kept—some nation might be tempted to go to war in the belief that the balance of nuclear potential had been disturbed in its favour.

I think, too, that it is dangerous to assume that any such balance actually exists, and the Russians, who seem to have an advantage at present in the range and guidance of their intercontinental ballistic missiles, may not agree. The number and weight of their nuclear devices—their megatonnage, to coin an expression—can only be estimated, and they may not believe, as we seem to do, in the theory of total destruction throughout the vast area they occupy. In any case the same number of explosions in their country would cause far less destruction, in proportion, than, say, in our crowded islands which, as an American advanced base, is likely to invite special attention. They are not familiar with the spirit of compromise and, in the absence of any expression of public opinion, they would be more willing than we would to suffer the loss of a few millions of their people.

2. It was disappointing to find, in the First World War, difficulties in putting to effective use the most lethal substances in existence, the cyanides, and the properties of such quick killers, as curare and snake venom, or their derivatives, and thousands of others, have no doubt been fully investigated

[1] When Stalin was once told of the Pope's intervention in some dispute he is said to have asked, "How many Divisions does he have?"

since then. The so-called "incapacitant" chemical compounds resemble, in one effect, the particulate arsenic cloud we were preparing to use when the war ended; and although they have been shown to cause remarkable character changes in human beings and animals I would not rate them highly as war weapons. And, as a cat lover, it distresses me to think that these dignified creatures can be made to tremble with fear at the sight of a mouse, after exposure to one of them.

Better nerve gases may be found, but they will probably be only more dangerous in degree—that is, in producing similar effects when in lower concentrations; but after nearly fifty years of intensive effort, in which all the Great Powers must have made considerable progress in chemical and biological research, it is reasonable to suppose that none of them holds secrets that have not been stolen or that are not shared by the rest. They would therefore be reluctant to use them in a conventional war for fear of retaliation in kind, so it may be that a stalemate has been reached here also. There are indications that this has happened, for it is known that the Germans (and the Japanese) accumulated stocks of a nerve gas in the Second World War, but refrained from using it because they did not believe that we did not have it too, on account of its resemblance in molecular structure to that of certain well-known insecticides.

Even so, the necessity for research remains, on the chance that something still more formidable will emerge to give one side an overwhelming, if temporary, advantage. To neglect its civil defence a nation invites attack, and opportunity is an important element in power politics. Besides, the knowledge gained from this type of research is likely to be of benefit to human welfare in its peaceful applications.

3. A war between any of the Great Powers, starting with conventional weapons, seems almost certain to develop, sooner or later, into nuclear rocketry, and this is almost inevitable if nuclear "tactical" war heads are used with bombs, ground missiles or shells, as seems to have been decided, because differentiation between tactical and nuclear weapons is not practicable. In such an event all other weapons, chemical, bacteriological, and even high explosives, would be futile in comparison.

4. But even if the war *could* be confined by mutual restraint to conventional weapons only, its probable character would be such that no worthwhile *targets* would be presented for this admittedly formidable weapon.

The original object of using gas was to help to break through the almost insuperable obstacle constituted by a combination of barbed wire and machine guns; but actually it was employed most of the time for inflicting casualties in the war of attrition into which the campaign deteriorated. The Germans made their first gas attack in ideal conditions and they had an opportunity of a break-through that we were never given, and that can never recur. Gas was a new weapon and its use came as a great surprise. The enemy was able to wait for favourable wind conditions, and he had a well-marked static target consisting of a trench system crowded with African troops who were provided with no protection whatsoever. That they did not recognize this opportunity and exploit it fully was probably due to lack of confidence in the civilian Professor technically responsible for the innovation.

I imagine that in a future war it will be impossible, without air superiority, and because of the vulnerability of their communications, to maintain armies overseas comparable in numbers and equipment with those engaged in the two first world wars. Mine-fields will constitute a more formidable obstacle than machine guns and barbed wire, and it may well be that the supremacy established by armoured vehicles and low-flying aircraft in the last war will be challenged through the improvement that has taken place in missiles. Self-contained ground forces will be far more mobile and dispersed than ever before, and they will move for the purpose of concentration under cover of darkness, so that when marked down for attack they will not be found where they were last located a few hours earlier. In these circumstances it is hard to see how chemical agents can be used effectively against such elusive targets.

To summarize the reasons that incline me to the view that, in spite of its cheapness, chemical warfare has had its day:—

1. Because of the apparent existence of a balance in nuclear equipment between East and West, mutual fear has created a deadlock, and no chemical or other weapon will be used unless this balance is disturbed.

2. The abstention from the employment of nerve gases in the Second World War appears to suggest that a similar deadlock has been reached in regard to chemical weapons.

3. If war breaks out inadvertently with conventional weapons it seems almost certain to develop, sooner or later, into all-out nuclear conflict; in which case all other weapons would be futile in comparison.

4. Finally, if the conflict *could* be confined to conventional weapons ground forces would be so mobile and dispersed that they would offer no *targets* for the employment of chemicals.

As for attacks on civil populations, cities have been bombed with high explosives almost to the verge of obliteration, but, apart from the casualties inflicted and interference with armament production, this policy resulted in no public intimidation, nor did it affect the leaders in their determination to continue hostilities, though the bombing of Rotterdam probably hastened the surrender of Holland. And, in my opinion *no* gas would have been more successful.

But with nuclear weapons the damage would be catastrophic and one can only speculate which side would have to call a halt to the senseless devastation. It might well happen for a nation's armed forces, even when victorious in the field, to have less influence in enforcing its policy than the demands of the situation on the home front: especially in the case of Russia, where revolutionary tendencies are endemic. In the confusion caused by the breakdown of communications and central control, half a dozen satellite countries, as well as a predatory neighbour in the Far East, and, perhaps, some of her own provinces, might be expected to welcome such an opportunity to terminate the present regime.

Punched Cards for Terrain Intelligence

By Captain P. H. T. Beckett, Int Corps (AER)

There has always been a need for terrain intelligence. Moses shrewdly led Pharaoh's AFVs into patches of bad going on the Suez isthmus. At Poitiers the Black Prince pushed forward his light troops on to ground too soft for the French Armour. By manoeuvre and deception Montgomery caused 15 and 21 Panzer Divisions to deploy on soft ground at Alam Halfa. The times were different, but the principle was the same. The effects of terrain on field engineering and health have been equally important. To make the best use of ground, commanders and troops must know how to recognize the different types of terrain in their theatre, and must know what they are good for.

At Poitiers and in many other skirmishes of the French and Continental wars the commanders knew their terrain because of its close similarity to ground in England over which they had hunted and ridden to manage their estates. Yet even in closely similar landscapes there is always the possibility that terrain which superficially resembles land in Britain may conceal important differences. In 1945 a group of boffins visiting BAOR commented on the number of drivers that had bogged their tanks in the deep peat of the North German plain because of the resemblance of its grassy covering to English pastures. Given time, the troops on the ground would have learnt the differences; for example it is unlikely that the Irish garrisons of Queen Elizabeth I failed to become acquainted with the significance of the subtle variations in the vegetation covering peat bogs. In the same way many newly joined staff officers must have acquired a good grounding in the realities of Iberian terrain by following the Duke of Wellington's Hounds across country behind the Lines of Torres Vedras.

What has changed is the speed with which terrain intelligence is required, and its complexity. There may be too much at stake for it to be possible to learn about the vagaries of local landscapes in the hard way by personal experience. Now that troops can be transported almost overnight from one theatre to another, and deployed in action a few days later, they must be able to make use of terrain without delays for trial and error. The need to know going conditions over Korean paddy fields, probable signals interference in bamboo forest, or the scale of plant needed to build an airstrip on a coral atoll, may arise overnight. Major X—— did a recce there five years ago, but the present crisis wasn't expected and so Major X—— is now elsewhere.

Again, in the to and fro of mobile warfare knowledge of ground conditions on the other side of the hill may give a tactical advantage, particularly important for the weaker force. Yet the distances, and the speed with which the battle changes, are likely to be so great that very few officers will have a sufficiently wide personal knowledge of the potentialities of all the ground to be encountered, to be able to make its complexities an ally rather than an added hazard. For example the first army so to organize its terrain intelligence that sites picked off the map to be Divisional Headquarters never lie on peat bogs will presumably have an advantage over the others. There is a need for intelligence on types of terrain, their effect on operations and their response to rain, frost or snow; such intelligence must be in such form that it can be made available very rapidly when required.

Another change is in the complexity of the information required. When the Army consisted more or less of men on foot, men on horseback and the guns and wagons on wheels, any officer looking about at the agricultural scene would soon learn to recognize the ground on which the different arms could operate. In the same way the sappers quickly learnt to apply to military traffic the bridging and road techniques locally found suitable for agricultural traffic. It was in fact possible to infer the military potentialities of different types of terrain by observing their use for non-military purposes. But the mobility of new weapons, unrelated to anything that has gone before or to non-military vehicles, cannot be assessed by rule of thumb or simple observation. If every user made his own trials there would be long delays, so the weapon has to be tried out on as many kinds of terrain as possible, and the results of trials then have to be made available to those concerned. Again in modern war terrain properties such as soil shear strength, CBR, absorption of radioactive isotopes, signals interference, and micro-relief all seem to be important. Yet these are not quantities that can be learnt by just keeping one's eyes open. Someone has to measure them with more or less complicated apparatus, and then their values for different types of terrain must be disseminated to the troops who need to know.

There is in fact an ever increasing need for the storage of information on terrain, because troops in the field may have neither the time nor the opportunity to acquire the information by personal trial. The information may describe the limitations imposed by terrain on the use of equipment, the results of measurements and trials on terrain, summaries of engineers' experience when building roads and bridges on particular types of terrain, the effects of terrain on tactics, or how to recognize particularly hazardous terrain, etc. It must be stored in such a way that briefing or the answers to specific problems can be laid on at no notice. The information has to be collated and stored ready for use; bibliographic references may take too long to follow up. To provide this information is the function of several agencies and bureaux, who act as sieves, sorters and disseminators of terrain intelligence.

The purpose of this paper is to describe some tentative investigations being made to find out whether the information could be stored on punched cards, and if so, whether the advantages in doing so outweigh the disadvantages of changing over to a new system. The principles of punched cards are well known. We are here concerned with the type known as item cards,[1] which, briefly, are blank cards on the centre of which may be recorded the information to be stored. Round the edge of the card is a row of holes, each representing some feature which describes the nature of the record or the terrain to which it refers. There may be one set of holes to indicate what sort of information is carried by each card, so that for example all records on Going may be segregated when required. There may be other sets of holes to indicate the climate, location, topography, etc, of the site to which the observation on each card refers. On each card the particular holes which describe the information it carries, and the sort of terrain to which the information refers, are punched to the edge of the card, eg, A, B and C in Fig 1, so that when a needle is passed by hand or machine through position A

[1] This presentation is somewhat over-simplified. In practice a quicker selection could be achieved by the judicious use of both Item cards, as above, and different "Feature" cards. The over-simplification does not affect the subsequent discussion.

in the whole pack of cards, and then raised, any cards with feature A will drop, and the remainder will be removed on the needle. A subsequent pass through the dropped cards with the needle in position B will drop only records characterized by both A and B, and a third pass through hole C will leave behind only records characterised by A, B and C.

There is no question of Holleriths on the beach head, or pocket computers for intelligence officers. What is being investigated is firstly whether terrain intelligence can be stored on a standard-sized card, say 6 × 9 in. The answer seems to be "yes". In fact there are considerable advantages in doing so. If in order to preserve summaries on cards the raw material of terrain intelligence—the results of trials and exercises, route reports, measurements, and extracts of the world's technical literature—are abstracted and sorted when fresh, there is much less likelihood than at present of items of valuable but unabstracted information being overlooked in the files because files are indexed only for their major topic.

A central store of terrain intelligence, which had already been summarized on to punched cards, would have the great advantage that in many cases the information required to answer a specific question could be made available in the form of photostat copies of the relevant cards. There would be no delay for the location of the books or reports from which the information came in the first place.

Stereo-pairs of air photographs could also be stored, annotated to draw attention to the features by which different types of terrain or constructional materials might be located. The stereo-pairs might either be fixed to the cards, or in a library to which punched cards provided the index. The system might also be used to store annotations of geological and soil maps. In this case one card for each map sheet would bear the geological or soil legend, tabulated against explanatory notes on the ease of digging, drainage, possible uses for road fill, going, etc. There could also be cards recording constructional problems that had arisen on particular types of terrain, and the solutions developed; such cards might be of considerable use to field squadrons RE moving to new areas. In fact there seem to be no limits to the kinds of information that can be recorded: the main difficulty is to find out what sort of information the users want.

If such a system of punched cards were established each card would presumably be annotated with punch holes for the location of the site to which the record referred, and the type of information recorded, so that, for example, to answer the question—"What are the factors affecting Going at X?"—it would be necessary to sort the cards by needle or machine only for Subject: Going, and Location: X, to produce summaries of all the observations so far recorded on going conditions in the area of X. If the question were an urgent one, photostats of the records of going together with photostats of stereo-pairs (to show how to recognize ground on which bad going had been encountered) could be distributed, without further processing. In due course records of this sort would provide the data from which to compile going maps. But in this simplest form the system would produce nothing if there were no information yet recorded for going at point X.

In this simple form a record system of punched cards has some merits. However, the greatest merit of a punch card system, the implications of which are at present being actively pursued, is that instead of replying "no information available" to a question such as, "What are ground conditions, at site Z?" for example in Rhodesia, it can be made to produce an answer in the form "There is no information for site Z itself, but site Z is to all practical purposes equivalent to sites A in Australia, B in India, and C in Venezuela, for which we have the following information, which with due precautions you can therefore apply to site Z". It enormously increases the value of any individual item of information if the system can turn it up not only for the site to which it originally referred, but also for all other sites with analogous or similar terrain.

It is not impossible to identify and make use of analogues if the information is stored by conventional means, but it is more difficult. In a punched card system items of information do not have to be grouped. Every item of information may be annotated with all the features of the terrain and all items with specified features in common may be located by one operation with the needle for each feature. Items of intelligence if stored in files, must be stored in groups, one group to each file. To store the items in groups, if there is any system at all, they must be classified or indexed by a system resembling in its essentials the Dewey Decimal system used by librarians. But this system only works satisfactorily if the subdivisions at each level of classification are all different—if not all combinations of the lower subdivisions are possible. Such a classification works very well for example in most schemes for the grouping of biological species, in which a natural hierarchical grouping of this sort is the inevitable consequence of the evolutionary divergence of species.

But the terrain at any point is the result of the inter-action of several independent factors. Each type of terrain represents the result of the action of a particular climate, over a period of time, on a particular rock, in an area where the relief is the result of a particular kind of succession of earth movements. All these factors are independent, and any permutations can occur. So hierarchical classification is not at all easy.

In fact in most situations one will almost invariably have to locate known analogues of unknown areas by matching a minimum of five or six attributes, each of which might be described in terms of up to twenty alternatives. On a punch card system this would require only that each card contain about 120 punch holes, which presents no problems. With a filing system $(20)^5$ files would be needed if every combination was to be stored separately. Furthermore the recording of one more attribute, in terms of perhaps five alternatives, would require only five more punch holes, but would raise the number of files to $5 \times (20)^5$. Grouping of records in files on only two features would require a manual search to pick out records with correct values of the remaining features. Grouping on more than two features might require an impossible number of files.

The research in progress accepts, at least as a working hypothesis, the conclusion that sooner or later some form of punched cards will come to be used to store terrain information, certainly in the civil, if not in the military field. The problem is to decide in terms of what features should the cards be annotated in order to emphasize analogues. Clearly if site X is on granite in a hot desert region, when we use the system to answer the question "What are the probable sources of potable water in the environs of X, and how may they be recognized on air photographs and on the ground?" we want all the records on possible sources of water from granite in desert regions to drop out, together with photographs of springs on or near granite in desert

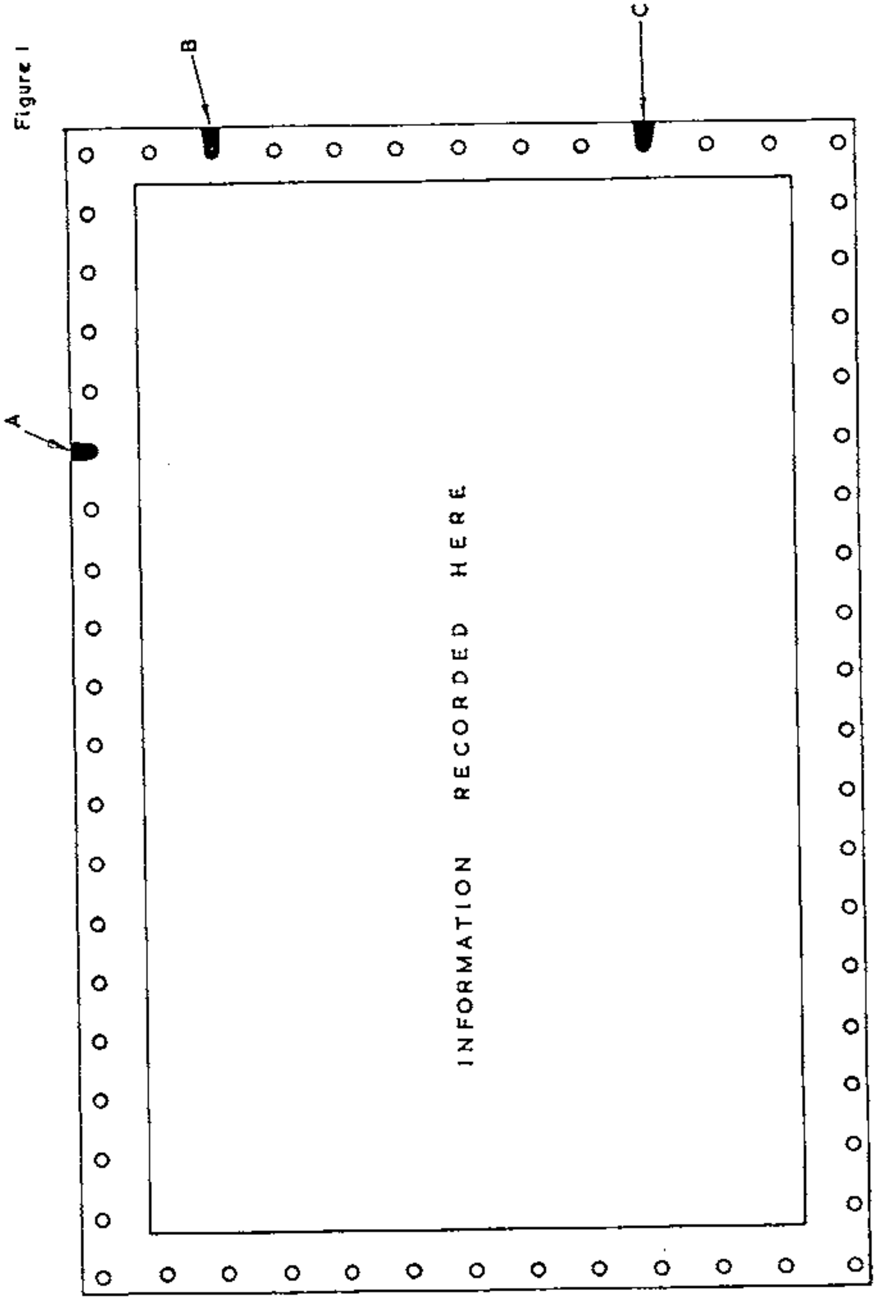


Figure I

Figure 2

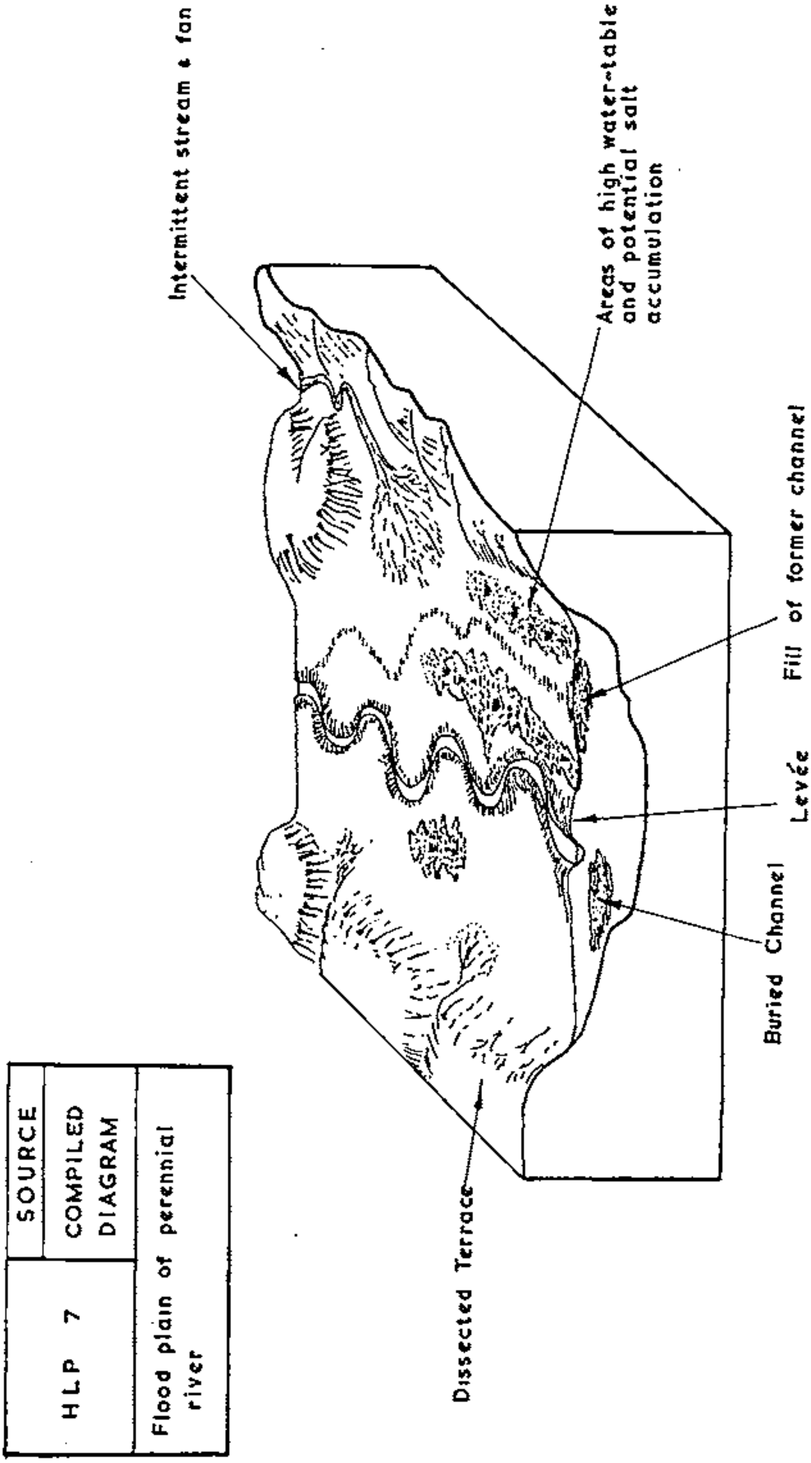
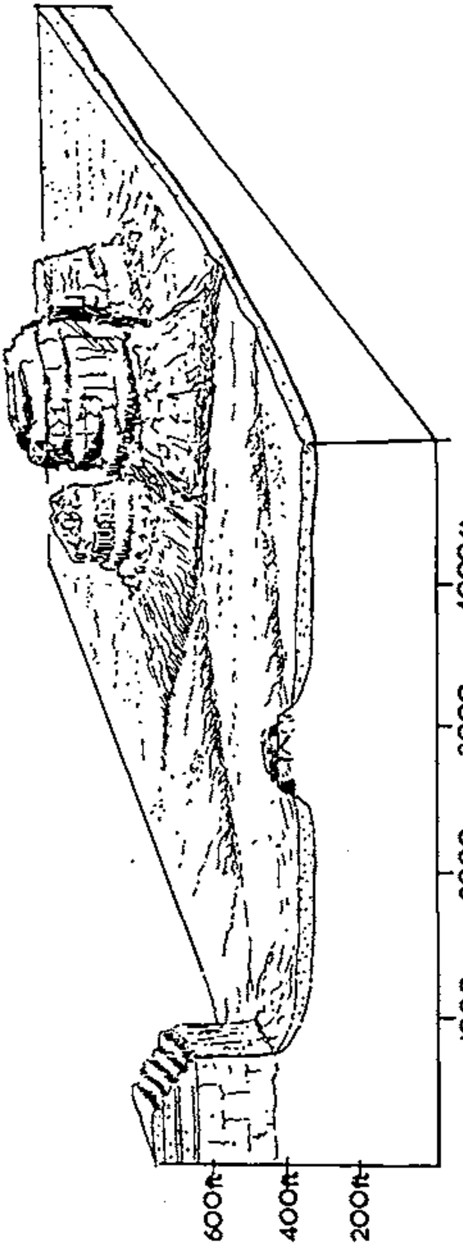

Intermittent stream & fan
Areas of high water-table
and potential salt
accumulation
Fill of former channel
Levée
Buried Channel
Dissected Terrace
HLP 7
SOURCE
COMPILED
DIAGRAM
Flood plain of perennial
river

Figure 3

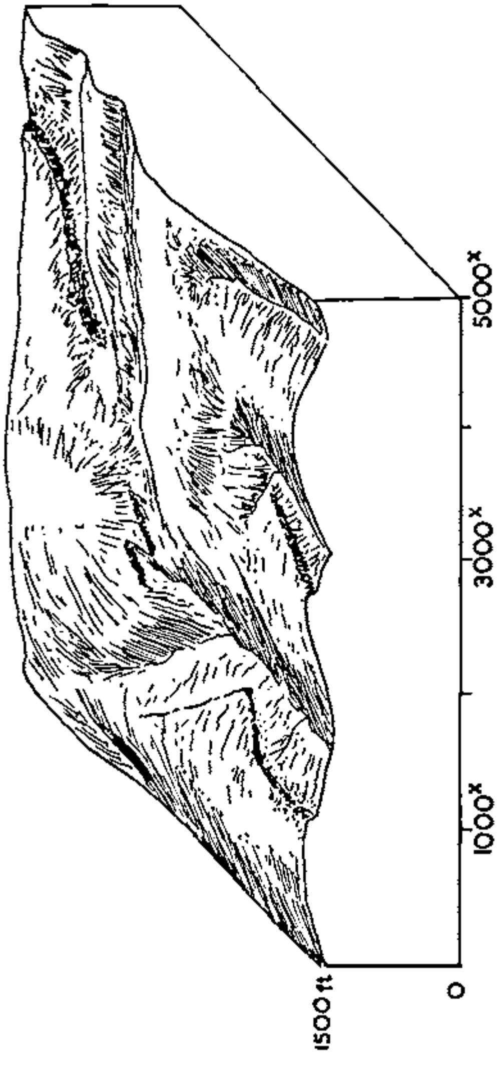
H.L.P. 4	SOURCE
	JORDAN
Part of area in which alluvial fan predominates	



Vertical
exaggeration x 3

Figure 4

H.L.P. 2	SOURCE
	SOMALILAND 138/2 10 DEC 47 5080/5081
Mainly gentle slopes	



regions. This is simple enough, and annotations for rock and climate will be extremely important. But as everyone knows, there are deserts and deserts. A rock which gives rise to arid mountains in Somaliland or Chile, produces a stony desert with isolated hills in Jordan or Sinkiang, and a flat waste with salt flats in Libya. The landscapes differ because of their previous geologic history. Their effects on operations are very different and water supply problems of the three types of landscape may have little in common.

The problem then is how are our items of information to be annotated so that when we want to know about, eg, Sinkiang, we automatically locate information upon analogous areas in Jordan, and automatically reject the items of information which though relating to the same rock and climate are for different types of landscape. Also we should try to avoid having to use the terminology of the physical geologists whose job it is to *explain* landscapes, because in order to use the terminology to locate information relating to site X we would have first to deduce the past geological history at site X, which would often be difficult, and is not relevant to our purpose.

The Engineer-in-Chief's Pool of AER Geologists is considering the problem of annotation. A preliminary study on desert terrain in 1960 has been followed by a more detailed study on savanna terrain in 1961. So far it seems that the difficulty of annotation can be overcome. It seems that most of the surface of the earth can be described in terms of a repetition of one or other of a not unlimited number of repeated patterns of terrain units. As an illustration of the idea we might take an old-fashioned hand-painted floral wallpaper. The buds and leaves in each nosegay of flowers on the wall paper all differ from each other, but they always occur in roughly the same relation to each other. Similarly the world's terrain is infinitely variable, but certain types always occur together in landscape patterns. The number of landscape patterns is apparently not unlimited—the Pool of Geologists could find only about ten for the desert regions of the world—and each is the result of a particular combination of rock, climate and geological history. The patterns can be defined in terms of relatively simple block diagrams and verbal descriptions: some examples from Desert regions are: Landscape pattern No 7 (Flood Plain of perennial river) Fig 2; pattern No 4 (areas in which alluvial fans predominate), Fig 3; pattern No 2 (areas with predominantly gentle slopes) Fig 4.

If we accept the reasonable *a priori* assumption that the same pattern in different parts of the world has the same effect on land use and operations (this is already assumed by soil surveyors and road engineers in parts of East Africa and North Australia), then we can annotate our cards for pattern as well as for rock and climate, etc, and the question put in the form "are there likely to be any special difficulties in maintaining earth roads at site X?" is translated by the specialist in charge of the, so far hypothetical, storage system into the form

"Site X is apparently on granitic rock,[1] in a region with a Mediterranean climate, in a landscape of type 16: are there likely to be any special difficulties in maintaining earth roads?"

The answer produced by the system might be "Here is a report on an earth road which was maintained for two years at site X". More probably the answer would be something like: "There are no records of road-

[1] The character of the rock can now be stated in broad units for practically any part of the earth's surface.

maintenance at site X, but here are photostat copies of records of road maintenance problems at analogous sites A, B and C elsewhere. The terrain at site X is in fact particularly unsuitable for roads, but there is usually terrain providing good subgrade a short distance upslope of sites similar to X. Here is a photostat copy of a stereo-pair of air photographs annotated to show how you may recognize both types of terrain and check alignment before making a detailed ground recce".

The propositions put forward in this paper are not yet even in the prototype phase. However, preliminary research results are quite promising.

Organization and Training for Air Transported Operations

A Professional Meeting of the Institution of Royal Engineers was held in the RE Theatre, the School of Military Engineering, Chatham on Tuesday 23 January 1962. Major-General D. C. T. Swan, CB, CBE, the President of the Institution, took the chair. The subject for discussion was: "The organization and training for air-transported operations". The Chairman welcomed the large number of Members present. He explained that there would be a nominated opening speaker followed by an informal discussion. There would be no summing-up at the end of the Meeting, nor would any official policy be laid down.

Colonel H. C. G. Cartwright-Taylor, in opening the discussion, said that up to a few years ago the concept of the British Army had been that of a sea-transported force and, as a result, its organization, training and equipment, and indeed its whole habit of thought, had been conditioned by the basic advantages and limitations of sea transport. The Army had been designed to operate from a sea-fed base over a land L of C; much time had been spent on perfecting techniques of combined operations and assaults over beaches, engineer equipments could be robust without great need for lightness and the basic military concept had been that of a "front" and a "rear", or "base", resting on the sea.

During the Second World War, following the developments by the Russians and the Germans, we also had developed airborne forces, designed primarily as a tactical weapon. Since the war, and particularly as a result of the loss of overseas bases, we had learned that airborne troops were a powerful strategic, as well as a specialized tactical, weapon. Hence the greater part of the British Army was now being converted into an air-transportable force. Almost overnight air-transported operations had ceased to be the exclusive province of a highly trained, intensely specialized and expensively equipped force and had become the day-to-day activity of the normal field and administrative units of the Army.

This change had not been unforeseen and much thought and money had been expended in preparing for it. A great deal of research and development had been devoted to the production of air-portable equipment. A vast fund of knowledge had been assembled on the problems of weight reduction without loss of robustness and efficiency and much valuable experience had been gained in methods of loading and delivery. Nevertheless, much of this work had been done against a background of uncertainty. For instance—how were units to be organized in this new strategic role; how was the force to be commanded; would there be in fact a "front" and a "rear" in the old accepted sense; were the detailed methods, developed for a highly specialized force necessarily applicable to a whole Army? Did we perhaps: "Rationalize to avoid change?"

The speaker then explained that the aeroplane, as a military vehicle, had three principle characteristics, namely it was extremely fast by any previous standards. It almost achieved 100 per cent mobility between two fixed points, and it was far more sensitive to cargo weight than any other military vehicle.

In referring to the third characteristic Colonel Cartwright-Taylor mentioned the article "Moving by Air" by Major T. C. White, RE, published in the June 1961 edition of the RE Journal, in which the author had pointed out that the employment of specially designed equipment was not the only, nor indeed the most productive, way of reducing the total weight to be moved in an air-transported operation, and that much more could be achieved by not transporting such things as heavy packing materials, than by lightening the equipment actually taken.

When considering the characteristic of speed the speaker explained that, in the days of surface transport, if a force had to be concentrated rapidly at a distant place, it had to be transported in one lift; if this were not done the force would never be able to concentrate at its destination in time. The speed of human reaction had not, however, materially altered with the introduction of the aeroplane, and the same political effect, and the same speed of concentration, could now be achieved in steps or "waves" lifting only a part of the force at a time by air. Such a method of ferrying, however, introduced the risks associated with the problem typified by the "missionary, the cannibal and the canoe" river crossing situation propounded to schoolboys. Furthermore, the aeroplane, although an ideal vehicle for the rapid transportation of men and small packages, was a bad carrier of heavy and bulky loads. Hence it was inevitable that any force transported over a distance by air would be unbalanced to a greater or lesser extent during the period of build-up. This unbalance was particularly noticeable in vehicles which for our sea-borne army had been provided in great profusion. One aircraft could lift say one hundred men, but to lift their organic vehicles on present scales might require another ten. This difficulty of air-transporting vehicles was of vital importance to the military engineer whose vehicles were often his tool as well as his carrier.

In referring to scales of vehicles and equipment the speaker suggested that many officers considered the present units' tables of equipment to be a lower limit for comfort and efficiency, to be supplemented by private enterprise whenever possible. He suggested that a unit's G1098 equipment should be likened to a set of golf clubs; the rules of the game placed a limit on the maximum number that could be carried, but, when no trolley or caddie were available, a player would invariably make do with a reduced selection. In this connexion were field units trained and able to leave part of their G1098 equipment behind; had they smaller sets for differing circumstances; was full value being made of multi-use equipments?

An air-transported unit would be complete in men long before it could hope to approach completeness in equipment whatever steps might be taken in simplification. It was, therefore, vitally important to know not only what to leave behind, but to know the order in which equipments should be taken. This was no new problem to the military engineer but were we organized to operate this kind of plan over a long distance and were communications good enough to permit of any change during an air-transported move?

It was also equally vital to get the most out of every available aircraft. In the case of weapons the aim was clearly to move the most and heaviest that could be manned and supplied. With vehicles and working machines the problem was slightly different; here effectiveness was related not only to size but also to the length of time available for work. As a simplified example, a Size 2 tractor would just fill a Beverley, but it would not be worth while taking the equipment unless it was possible to use it continuously at its destination and sufficient operators were available to ensure that it worked all the time. No machine should be taken which could do the work to be done in less than continuous shifting. As regards the aircraft operators themselves the speaker pointed out that a Beverley was normally only allowed eighty hours flying time a month. A civilian Airline Company might get sixteen hours a day out of a similar machine. Even allowing for the considerable differences in servicing and operating facilities, he wondered whether this availability time was good enough for our principal strategic vehicle.

In conclusion Colonel Cartwright-Taylor drew attention to the administrative and support units engaged in the theatre of operations and in the mounting area. The speed of build-up and the possibility of rapid resupply in the field by air would inevitably mean that forward held stocks and forward repair organizations would be reduced to a minimum with the consequent increase in the number of Urgency and "Red Star" types of demand. Up to now manpower shortages and organizational simplicity had led to a system of routine store resupply and repair operating in echelons with a full pipeline. What reorganizations and rearrangements would be necessary to meet the changing requirement; had we an adequate system of communications to operate it; could our Movement Control and forwarding organizations meet the demands that would be placed upon them?

Discussion

Colonel J. R. Blomfield, OBE, MC, in opening the discussion said that he would try to present a picture of the framework of a typical air-transported operation and point out the major tasks during its various phases. There was nothing very new about these tasks except that they had to be carried out faster than ever before, with fewer men and with fewer resources. The operation he was going to consider was one in an undeveloped country depending entirely in its initial stages on air-transport both to lift the force to its destination and to maintain it thereafter.

There were four types of aircraft available namely:—

The Strategic Transport Force, comprising the Britannias and Comets, which had a good capacity for carrying men and some capacity for small vehicles and easily packaged stores. These might be augmented by the Britannic but, until this heavy freighter was available, we had nothing that would air-lift heavy vehicles and plant strategic distances. All these aircraft had to operate from sophisticated airfields.

The Medium Range (up to 500 miles) Transport Force of intra-theatre aircraft which could operate from airstrips 4,000 feet long. These were the familiar Beverley and its successor the Argosy.

The Short Range Transport Force of fixed-wing aircraft, capable of a range of 150 to 160 miles, namely the Pioneer, the Twin Pioneer and their successors the Caribou and the Herald. They could operate from rough airstrips of under 2,000 feet in length.

The Helicopter Force which could operate up to a radius of 35 miles and required virtually no prepared landing grounds; their lift, however, was very limited.

In the typical operation under consideration a Force consisting basically of a Brigade Group might be transported from the United Kingdom by the Strategic Transport Force to some overseas base airfield; from there the Medium Range Transport Force could lift the Force to an advanced airfield within a range of 500 miles. With this advanced airfield as a base the Force, which would have a minimum of road transport, could operate up to a distance of some 35 miles and be maintained by helicopter. The radius of action could be increased by interposing a lift of between 150 to 160 miles by the Short Range Transport Force. He intended only to consider the engineer problems of such an operation before the arrival of the follow-up "sea-borne tail". There would of course be the normal combat engineer tasks in direct support of the Brigade Group's operations. The other principal tasks in support of the operation as a whole would be:—

The provision of air-landing facilities at the Medium Range and Short Range Transport airheads, and their maintenance.

Water supply, a particularly important task in an undeveloped country, the air-transport of jerricans of water being most wasteful.

The construction and maintenance of roads and tracks and forward communications.

The local acquisition of engineer stores, there being nothing more difficult to get put on an aeroplane than an item of engineer stores.

As the opening speaker had stressed, the inclusion in the airlift of every man, vehicle and piece of plant would have to be bid for and justified to a very critical staff if it was to arrive at the right place at the right time. The scale of the engineer support was another problem. Presumably the Force would include the Brigade Group Field Squadron—should that unit, in operations such as those described contain parachutists as an integral part of its establishment? It was possible that a Squadron of a Corps Engineer Regiment might also be included in the Order of Battle of the Force provided the Chief Engineer could persuade his Commander that it was vital; but who would the Force Commander be; from where would his staff be found and who would fill the appointment of Chief Engineer to the Force?

Captain R. D. Spary said that there were three types of air-transported operations namely the parachute assault; a combination of Short Range Transport for personnel and Medium Range Transport to parachute equipment, followed later by Air Landings when an airfield was available; and lastly a pure Air Landing Operation. The first of these types of operation required specially trained parachute engineers, but normal Field Squadrons would be called upon to take part in the other two types of air-transported operations.

All such operations were dependent upon aircraft availability and limited by weight restrictions. This latter limitation in fact effected the definition of the term "airportable", and no unit could be considered to be truly airportable unless its personnel, vehicles and equipment could be transported in a realistic allocation of aircraft. There must be a drastic reduction in the presently conceived transport and equipment scales, there was no room for luxuries, and the maximum use must be made of the few vehicles taken by ferrying and the employment of relief drivers.

When referring to parachutable equipment, which would now no longer be used solely by parachute engineers, Captain Spary referred to the Medium and Heavy Stressed Platforms (MSP and HSP) of five and eleven ton capacity respectively. The Beverley would carry two MSPs or one HSP; the Argosy could, with certain restrictions, carry two MSP, but not an HSP. Typical loads were:—

MSP	D4 Tractor, less blade and winch, or
	D4 Tractor blade and winch, or
	Wobbly wheel roller
HSP	BTD6 or BK10

As there would probably be very few HSPs available for engineer equipment, he considered that it would be best to standardise on the MSP, regarding the HSP merely as a bonus, and to design engineer equipment to fit that particular type of platform. For instance a D4 Tractor, complete with its blade and winch, could be carried on two MSP's in one Beverley, but a greater efficiency on the ground could be obtained from two light tractors, each of a capacity of say 65 per cent output of a D4 tractor, carried on two MSPs in a Beverley. With this light equipment it should be possible to prepare an airstrip on which heavy equipment could be landed later.

In all airtransported operations the initial procurement of engineer resources was the responsibility of the RE field units and it was essential to have in such units a gifted and imaginative officer capable of obtaining stores and materials expeditiously and who was not afraid to depart from conventional methods if necessary. In order to provide continuity, and to relieve the assault squadron commander, it was essential that some element of a higher engineer headquarters should arrive as soon as possible after the assault landings to take over expanding commitments. There must also be flexibility in planning and a "cushion factor" to absorb foreseen difficulties, and an allowance must be made for a certain amount of duplication of essential personnel, wireless sets and equipment to counter accidents and delays.

In all air-transported operations close liaison with the Royal Air Force was an essential and to obtain the best co-operation Liaison Officers must be knowledgeable, persuasive and experienced.

Finally, in any such operation there would inevitably be constant and continuing changes of plan which, unless stoically and cheerfully accepted at all levels, could seriously affect morale and increase confusion.

Lieut-Colonel W. F. Cooper said that he wished to stress the aspect of the relationship between the Sappers and the Commander and staff essential for success in air-transported operations. Five basic facts were involved:

1. In a large number of typical air-transported operations the tasks of the infantryman were basically similar and the arms and equipment needed were roughly the same. In the case of the Sappers this was by no means always the case.

2. Owing to the inevitable shortage of airlift, there would always be a fight for space on aircraft particularly for Sapper heavy equipments.
3. There was a requirement for a concentrated engineer intelligence establishment to be linked with operational intelligence at all planning levels.
4. Air-transported operations had often to be mounted in a great hurry, usually at a weekend or on a Bank Holiday. Essential planning data must, therefore, be in the possession of the force actually engaged in the operation. Reliance could not be placed on always obtaining data from Whitehall Ministries.
5. In the typical air-transported operations being discussed the size of the force involved was small.

In referring to these points in detail Lieut-Colonel Cooper went on to say that for security reasons the initial planning of operations, and the calculations for aircraft requirements, were often carried out at a high Joint Planning Staff level, or by the nominated Commander and a small nucleus staff. Sapper advice was often not taken at that stage, and in his view that was a serious weakness. It was only a Sapper who could fully appreciate the engineer tasks involved and who could estimate the minimum requirements to carry them out based on the state of equipment, training and experience in air-transported operations of the engineer troops available for a particular operation. Effective Sapper representation on planning was essential at all levels.

In the fight for aircraft space the Sappers were always at a disadvantage because their loads were bulky and awkward. On a recent exercise a piece of RE equipment had holed the floor of an aircraft and it was accidents such as this that increased the unpopularity of our loads. It was, therefore, most important that the Sappers should build up a situation in which they were trusted by their Commanders and the Air Staff and their demands accepted unquestionably as fair and reasonable. Here again engineer intelligence was important because no bid should be made for the air carriage of any item of engineer store which might be obtained locally at "the other end". If the Sapper bids were to be accepted it was essential that the Sapper Commander spoke with the confidence arising from experience, and that experience could only be achieved by constant training. What was needed was a greater number of purely Sapper airborne exercises since, because of limitations of time and other factors, all arm air-transported exercises were often inevitably unrealistic from a Sapper aspect. A world wide exchange of ideas was required; experience gained in all theatres should be pooled and exercises carried out to test new ideas and methods; these purely engineer exercises should be supported by Commanders and their superior skeleton staffs who in turn would come to appreciate what Sapper work, necessary to support air-transported operations, really implied.

Major R. J. N. de V. Wade explained that he had recently attended a Course at the AATDC. His Port Squadron was one of those which had been told to make itself air-transportable. A Port Squadron usually consisted of a Headquarters and a Port Maintenance, a Lighterage and a Stevedore Troop. The Lighterage Troop did not have to carry its craft around the world, the cargo handling gear of the Stevedore Troop was easily air-transportable, but the present heavy cranes of the Port Maintenance Troop, its heavy vehicles and its 23,000 lbs of stores presented a real problem. Lighter cranes and crane attachments would have to be used in operations where suitable equipment was not available locally at "the far end". An air-loading team had been detailed in each troop and the maximum number of officers and NCOs had been sent on Airportability Courses. In addition, a system had been devised whereby the Air Transport Liaison Officer at Lyneham called upon his Squadron for assistance in loading aircraft for exercises at every possible opportunity. Arrangements had also been made to assist an RAF unit to move from Yorkshire to Hampshire. The problem involved the movement of 600 tons of varied stores and his air loading teams had the opportunity of loading, lashing and unloading stores for the RAF in their own planes—an excellent experience in Air Movement. It was, perhaps, the first example of the Corps extending its responsibilities for stevedoring from the maritime to the aerial sphere. This development might have been envisaged when RE officers were chosen to fill Air Transport Liaison Officers' posts at certain strategic airfields in the United Kingdom.

Brigadier E. F. Parker, OBE said that, speaking from past experience, one of the main problems connected with any operation involving the rapid move of a unit was that of preparedness. What so often happened when a unit received an order to take part hurriedly in an air-transported operation was that you found that half your sergeants were due to be posted away; all your drivers were national servicemen with not enough time left to serve to make them eligible for the operation; nobody had been inoculated and all your vehicles were Class II. These were practical problems likely to confront any unit commander and, unless they could be avoided in future in all units likely to be affected, the necessary degree of readiness essential for the success of the kind of operations under discussion would never be achieved.

Major T. Harris, MBE, said that he was employed with the Air Ministry. In drawing attention to Colonel Cartwright Taylor's disparaging comparison between the available flying time of the Beverley and that of a comparable civilian Airline plane, he explained that the Beverley was designed in 1946 and had an archaic form of piston engine whereas the Viscount was equipped with a modern engine with an overhaul licence of some 3,500 hours between major overhauls. There was also a great difference between the maintenance facilities of the two organizations. The civilian Air Line Company operated between fixed airfields equipped with all facilities and experienced maintenance tradesmen; the RAF on the other hand, in the operations being discussed, would probably have very few facilities at one end of their haul anyway.

When referring to a new type of strategic aircraft being developed he said that it might have an all up weight of 100 tons; it would, therefore, be very restricted in the airfields it could use even though the weight might be distributed over 16 wheels.

The C130 was used by the American Military Air Transport Service. It was a very good aircraft and it was possible that we might be air-transported one day in those aircraft either strategically or tactically. The modern and projected Short Range Transport Force aircraft were the descendants of the wartime Dakota. They had not the short range and take-off performance possessed by the Dakota, but they carried considerably more weight.

He went on to mention the use of palletised loads and how the RAF intended to carry freight in their new aircraft. The aim was to use a pallet 8 feet by 7 feet, with a carrying capacity of 8,000 lbs. To load this weight on only 56 square feet would require careful and thoughtful packing and

Squadrons, who might have to move by air, should plan to load their equipment in boxes that would nest well together and be capable of being packed on pallets expeditiously. Pallet loads should be arranged in order of priority in case individual pallets had to be left behind. The loads on each pallet had to be constrained by cargo nets, etc and the drill of packing and securing must be well practised if speed in loading was to be achieved. For easy handling the centre of gravity of the load should coincide approximately with the centre of the pallet. A Transfer Loader was being developed to handle the 8,000 lbs pallet and transfer it between aircraft and road or rail vehicles. But until this equipment was available there would be many practical loading and unloading problems to be overcome. There was also a scheme to carry fuel tanks, of about 800 gallon capacity, on pallets. In his opinion, however, he would have thought that, rather than unload the pallet at the "far end", it would be better to pipe the fuel out of the tank into some ground installation and send the aeroplane back to refill the palleted tanks.

On the subject of reconnaissance he pointed out the possible use of the Beaver Aircraft, now in the hands of the Army Air Corps, which should be an ideal small aircraft for RE reconnaissance parties and their equipment.

In order to reduce the need to carry heavy water supply stores and boring rigs, he suggested that there was a requirement for a light, man-portable, modern type Norton tube well equipment. The widespread use of such equipments would allow a large number of water points to be established and saving could thereby be effected in the piping and storage tank requirement.

Brigadier D. W. Reid said that he hoped that the previous speaker had considered the problem of loading rolls of Summerfeld Track onto an 8 by 7 pallet. He could assure Brigadier Parker that the state of operational readiness of the Sappers of the Strategic Reserve was now greatly improved.

He wished to stress two points connected with air transported operations. Firstly, there was an attitude of mind that must be cultivated. Not only those in the Strategic Reserve, but every Sapper officer, must be prepared for the suddenness of such operations. As instances the Garrison Works Officer at Bulford had on a Friday evening last July been ordered, without warning, to fly immediately to Kuwait. The Commander of 38 Corps Engineer Regiment left Ripon recently for a quiet weekend in London where he was located and forthwith flown off to British Honduras. A resilience of mind and a calm acceptance of the unexpected were all important. You must never be surprised, nor put out, by anything that might happen. Secondly, there was the training aspect. Since the war, due to shortage of manpower, there had been great talk of reliance on machines to replace men. Now we were faced with the problem of fighting for space on aircraft for those very machines. We might indeed find ourselves engaged in operations without them. We must, therefore, to recultivate our inclined-to-be-forgotten basic field engineering skills, knots and lashings, the application of power and the use of the handspike. In that connexion he referred to two examples. The Luneburg Stone had to be moved some years ago from Luneburg Heath to the Royal Military Academy, Sandhurst. The stone weighed seven tons and it was proposed to lift it onto a 10 tonner with two cranes, but the slings could not be passed under the stone. An elderly retired Sapper officer, however, with six men from a German Artisan Works Company lifted the seven ton block with a few tackles and handspikes a foot off the ground without any cranes or other similar mechanical aids. The other example was a personal one; with one strong man to help him, he had successfully moved a large rhododendron bush, weighing with the ball of earth around its roots about half a ton, using two lengths of 2 inch piping and some planks and transported it some 200 yards with a garden roller and a ladder to a new site in his garden where it had taken root and flourished.

Captain R. Emery confirmed the need to have parachutists in each Field Squadron, trained by 9 Independent Parachute Squadron, who could be used as an advanced reconnaissance party.

Colonel M. L. Crosthwait referred to the article by Brigadier D. W. Reid, published in the June 1961 issue of the RE Journal, entitled: "Gems, Germs and Hovercraft" written to stimulate thought and excite imagination in the development and the future military use of hovercraft. He wondered why no mention had been made of that form of air transport during the discussion, and he wondered whether we were becoming too stereotype in our outlook. As regards the small light weight tractor with a capacity of only 65 per cent of a D4, mentioned by Captain Spary, he doubted its real worth although it would no doubt shift a rhododendron bush.

Lieut-Colonel P. W. E. Kidner also referred to the problem of the air-portable tractor. He said that there appeared to be three courses open. The first was to put into the Argosy aircraft, either on a platform or on its own, an angle dozer complete, equipped and ready to work as soon as it was unloaded from the aircraft. The second course was to select a bigger basic machine and strip it so that it took perhaps an hour to assemble and put to work on arrival—that was the line being worked upon at the moment. The third course was to accept the fact that the tractor must be carried on a heavy stressed platform and fly only in a Beverley, and use the biggest tractor that could be carried in that way.

If the first course was adopted we would be limited to a partially stripped BTD6 of about 40 hp which was considered too light to be really effective. The second course was to take a machine comparable to the D4 so far mentioned in the discussion—an obsolete machine not now manufactured and, therefore, unfortunately irreplaceable. The currently manufactured D4 Series C would not go into an Argosy, thus when the present D4 machines in service wasted out there would be no comparable crawler tractor. The machine now under investigation was the International Harvester BTD8, a considerably more powerful machine than the BTD6 and only marginally heavier.

The third course of accepting the heavy stressed platform and the Beverley aircraft meant that it would be possible to carry a D6 machine, partially stripped with the blade as a separate load. There was a need to learn whether this was the right answer from a user's point of view.

In referring to the air-transport of fuel he mentioned that 850 gallon collapsible containers were being designed to be loaded into aircraft. When not used for carrying fuel the collapsed container could be stowed at one end of the aircraft leaving at least two thirds of the cargo capacity space available for other loads.

Lieut-Colonel J. C. D. Montgomery also referred to the need for readiness, especially on the part of small specialist units which might be required to move suddenly by air, and for the need for a good system of engineer intelligence to be set up, backed by a sensible anticipation of possible commitments. Readiness ought also to extend to pre-arranged and officially pre-agreed methods for the local procurement of engineer stores.

He was glad that the question of the carriage of fuel had been mentioned. This could be a most serious problem if transport aircraft had to refuel at the "far end". Modern aircraft, particularly the vertical take-off kind, used vast quantities of fuel. It would be of little value saving engineer effort on airfield construction if fuel availability at the right place became the limiting factor in aircraft radius of action.

Captain R. D. Spary said that he wished to comment upon some points made in the discussion.

In the procurement of engineer stores the greatest flexibility must be allowed to the officer responsible for local purchase.

When referring to tractors he had mentioned a hypothetical machine with 65 per cent efficiency of a D4. That was a poor figure but he had used it to stress his point that, by adjusting platform loads, it was possible to get greater efficiency on the ground. Everyone, he was sure, wished to standardise on one type of platform, either the medium or the heavy, provided the most efficient machine could be loaded upon it.

Referring to Brigadier Reid's point that we might have to make do with a minimum of engineer equipment, he considered that there was a case for the employment of light parachutable tractors for the preparation of landing strips capable of taking planes carrying the heavier engineer equipment which need not be parachutable.

Regular Corporals were now being posted out of 9 Independent Parachute Squadron to other Field Squadrons. Due to the improvement in recruiting excellent material was being received from 1 Training Regiment RE but, unless Squadron Commanders were prepared to let good recruits go to 9 Parachute Squadron for training, it would be some time before there was a pool of parachutists in every Field Squadron.

Colonel A. G. Peart referred to the excellent engineer intelligence staffs that operated during the last war and their close liaison with the planning staffs at Headquarters. It appeared to him a very retrograde step when these engineer intelligence staffs were given up at the end of the war. They should be revived if we are to recover our acceptance into the early planning stages of operations and early consultation on the engineer problems involved which might be vital to success.

Captain A. T. Goodman said that several speakers had drawn attention to the availability of aircraft space for engineer equipments, or rather the lack of it; he wished to draw attention to the availability of engineer plant. Mention had been made of the Size 4 Catapillar Tractor, the BTD6, the BK10 grader and the light wheeled tractor the Michigan. Altough we held ample stocks of the D4 the equipments were over 15 years old and already obsolete. The BTD6 was an excellent machine but holdings were small. The BK10 was our only airportable grader and here again stocks were small. Supplies of the Michigan wheeled tractor were better, but in his view a wheeled tractor was only a fair weather machine and he suggested that a powerful crawler tractor, possibly the size of the BTD8 or the D6, ought to be developed constructed of light alloy to make it airportable.

Major-General D. C. T. Swan, in closing the Meeting, thanked those who had spoken from prepared notes and those who had made extemporary contributions; the early speakers had posed many questions, many of which had been answered, and in addition many points of extreme interest had been discussed.

The Opportunities for Civil Engineering Graduates in the Army

By COLONEL H. CARTWRIGHT-TAYLOR, BA, AMICE

This article is based upon a talk given by the author to the Engineering Society, Queen's University, Belfast. The talk was illustrated with twenty slides showing engineer activities and equipment and the chart reproduced with this article.

YOU have asked me to talk on the opportunities for civil engineering graduates in the Army.

Before I go any further I think I would like to make one thing absolutely clear. In the Army we require *military* engineers, and the success and scope that an individual achieves must depend in the end upon his skill and ability in that field, and upon the many other facets of personality that influence success in any sphere. By this I mean that you will not become Engineer-in-Chief if you are solely an expert, let us say, in soil mechanics or in the construction of elaborate shell concrete roofs. Nevertheless military engineering is a professional business and, therefore, one must start it with a professional education and it is our experience that the education normally given to either a civil or a mechanical engineer is well suited for the military engineer.

As you all know the great bulk of the officers of the Regular Army enter that profession through the Royal Military Academy at Sandhurst. We like in the Corps of Royal Engineers to have officers of degree standard, and at the present time some two-thirds of our share of the output from Sandhurst is of that standard. These officers go from Sandhurst either to Cambridge University where they read Mechanical Sciences or to the Royal Military College of Science at Shrivenham, where they take an external BSc London University Degree normally in civil engineering. We also gladly consider applications from men who have achieved a recognized degree at any university, and in the past many who have been commissioned in this way have risen to high ranks in the Corps.

I have said that military engineering is a professional business, let me quote what the Council of the Institution of Electrical Engineers say about a professional engineer, and then let us consider something of the professional scope of the military engineer today, so that you may judge for yourselves as individuals whether it is the sort of life and career in which you would find scope and fulfilment—I quote:—

"A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method of outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer. His work is predominantly intellectual and varied and not of a routine mental or physical character. It requires the exercise of original thought and judgment, and the ability to supervise the technical and administrative work of others.

"His education will have been such as to make him capable of closely and continuously following the progress of his branch of engineering science by consulting newly published work on a worldwide basis, assimilating such information and applying it independently. He is thus placed in a position to make a contribution to the development of engineering science or its application.

"His education and training will have been such that he will have acquired a broad general appreciation of the engineering sciences as well as a thorough insight into the special features of his own branch. In due time he will be able to give authoritive technical advice and to assume responsibility for the direction of important tasks in his branch."

Let us look then a little closer at the professional duties of a military engineer in the light of this definition, and let me requote certain phrases:—

"It requires the exercise of original thought and judgment and the ability to supervise the technical and administrative work of others."

In the Army we call this Leadership and Command, and in the profession of military engineering the man who can retain this ability under the stress and strain of battle is the man that is required.

Again to quote:—

"His education and training will have been such that he will have acquired a broad and general appreciation of the engineering sciences as well as a thorough insight into the special features of his own branch."

What are these special features of his own branch? The duty of the military engineer is to overcome the hazards and hindrances of nature so that the Army he supports can live, move and fight with the minimum of restriction. He will have to bridge rivers, cross swamps or deserts, prepare ground for aircraft to operate, arrange to unload ships where there is no port, demolish enemy works and facilities and provide for the men of his Army a degree of comfort and physical protection that will enable them not only to survive but to continue their own individual military functions with efficiency in any conditions of climate or terrain. Both the human body and military equipment are immensely adaptable and will continue to function under quite appalling conditions, but men must be watered and sheltered and even special machines have in the end only a limited ability. The cliffs may be too high for it to climb, the swamps too soft for it to cross, or the sea too rough for it to manoeuvre.

Those of you who read *Eagle* or similar "comics" will have observed that the fantastic machines of Colonel Dan Dare always seem to operate in perfect weather, and the devilish devices of his enemies all seem to limit themselves to short-term fair-weather activity. It is, however, in bad weather, and after days of continuing fighting, that the Army leans most heavily on its Sappers.

You will see that we battle against the natural hazards of this world and to that extent we are civil engineers. I believe, however, that in modern conditions our scope must be wider and our methods perhaps less sophisticated than those which are possible in civilian life though in the past wars, when time has been given, considerable and complex schemes such as the Mulberry Harbour have been possible. I said before, and I repeat it here, that the scope for a man whose interest is exclusively in reinforced concrete is small, but for the man who is prepared to build upon all the general engineering he has been taught, it is enormous.

It would not be possible for me to describe to you the career of a "typical Sapper officer" for clearly there can be no such person. One of the greatest strengths and attractions of the Corps of Royal Engineers is the wide variety of employment and posts that come the way of the individual; in a career of twenty-five to thirty years politicians can place a widely varying role upon the Army and upon the military engineers in it. What I can do, however, is to say something of what is happening now to Royal Engineer officers and also give examples of what they have achieved in the not so distant past.

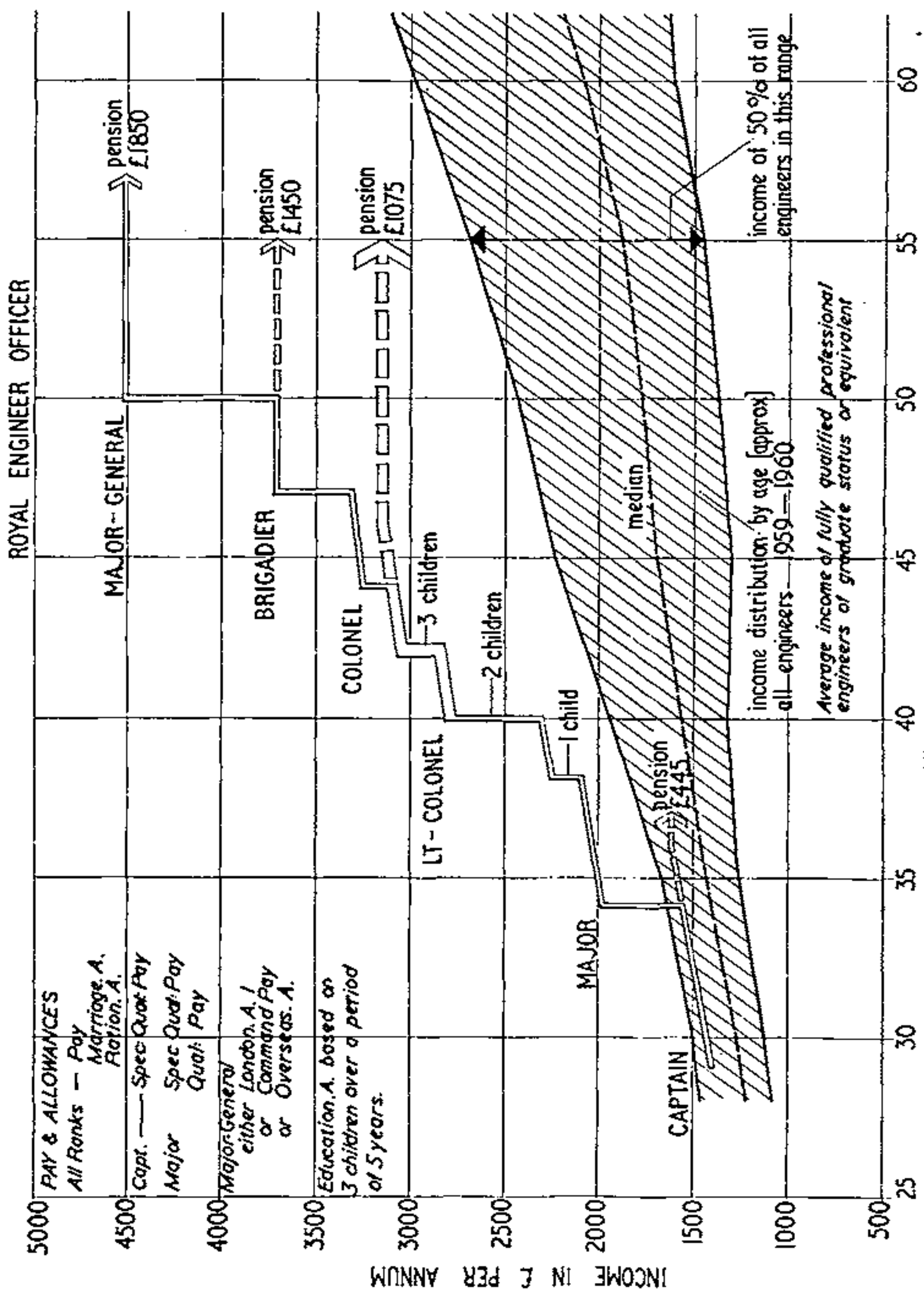
On first appointment the graduate engineer must master the basic skills of military engineering. This will involve a period of perhaps a year at the School of Military Engineering and other Schools learning about military engineer equipment and military engineer problems. He must also master the basic skills of soldiering and learn to live and think as a soldier. This is important for three principal reasons. Firstly, he will be practising his profession on the field of battle and unless he is trained to live under these conditions he will be a danger both to himself and to his comrades. Secondly, he must study engineering problems with the eye of a soldier; it has been said that the most difficult task of any engineer is to discover what his client really needs and the military engineer can only do this by studying closely and becoming thoroughly familiar with the business and problems of soldiering. Thirdly, he must start to teach himself the responsibilities and techniques of command.

The young RE officer will find himself in a Field Troop in command of perhaps forty or fifty men and in control of a good deal of expensive equipment and machinery. He will be responsible for the welfare, training and efficiency of this body of men and machines. He will be tested and judged not only on his personal technical and intellectual abilities but on the performance of his Troop as a whole in the tests allotted to it. In this position, if he is fortunate, opportunities may come his way of working on major projects or training exercises. I might quote as examples the recent construction of a considerable bridge across the River Ouse in York, the building of a road in the jungle of Malaya or the works of construction and maintenance of the test base at Christmas Island, descriptions of which you may have read in Brigadier Muir's Paper to the Joint Meeting of the Institution of Civil Engineers and the Institution of Royal Engineers last year.

After three years or so at this business the officer will be in a position to decide for himself in what direction he wishes his future to go. He will have seen a good deal of the work of the Army in general and of the Corps of Royal Engineers in particular and he should be able to assess in which particular field his likes and abilities are most probably to be fulfilled. He will see scope perhaps as a surveyor in the Survey Regiments mapping odd corners of the world or the military branch of the Ordnance Survey in UK, or perhaps as a railway and port manager with the transportation units. He may have been attracted to regimental and military life generally and will aspire to its highest posts through the Staff College at Camberley and employment on the General Staff, or he may feel that his strength is in the technical field seeking to improve and explore in the vast area of equipment techniques. In this last field there is much to seek and higher professional training is offered either through the technical staff or by long professional courses and attachments. These latter have taken RE officers with contractors, consultants and public authorities all over the world. We now at this moment have officers working for the Snowy Mountains Authorities in Australia besides officers working as executive engineers with Commonwealth Public Works Departments in Africa and Malaya and officers employed on many large engineering projects in this country. For those who, despite their early training as civil engineers have a mechanical bent, we have workshops to manage both in the field and in static installations and we give advanced professional training in a wide range of mechanical and electrical subjects. By the age of 30, in addition to military experience and advancement, an officer who so wishes should have had little difficulty in obtaining an Associate Membership of the Professional Institution of his choice.

You may know that up to a few years ago the Royal Engineers were responsible for the construction and maintenance of all military works and buildings; this responsibility has since been transferred in peace to a civilian organization, but the Royal Engineers must still be prepared to take it on again in war and emergency and we maintain a close liaison with the civilian Works Organization and have officers and technicians seconded to it at all times. We are at present supervising on their behalf the construction of large new barracks in Kenya and Malaya.

At about 33 years of age the officer is due for promotion to Major. To achieve this he must have passed an examination largely military in content and must have received proper recommendations in his annual reports based upon his personality and skill. As a Major the RE officer has open to him the full scope of his career. He may be in command of a Squadron of more than 200 men with machinery to match. He may be employed upon the General Staff or upon the Engineer Staff in any Headquarters with considerable responsibilities for both technical and administrative planning. He may find himself instructing at a School or working upon the development of engineer equipment at an Experimental Establishment, or he may find himself in an executive capacity in any of the various spheres of activity of the Corps. He will find that he changes his appointment every two or three years depending upon his scope and the needs of the service. After two or three such appointments he will have covered a very wide field and will be ready and eligible for promotion to Lieut-Colonel. Naturally as he becomes more senior the difficulties of promotion become greater, selection is more precise and qualifications and recommendations more difficult to obtain. However in the Corps of Royal Engineers the proportion of promotion has always been relatively high and we feel that this is at least in part due to the high educational attainments and abilities of our officers compared with the general average standards of the Army as a whole. I am not here to discuss the way to ensure high rank in the Army but I see no harm in telling you a few simple figures. There are at this moment some 1,350 officers serving who either are or have been Sappers. Of these thirteen are Generals, twenty-two are Brigadiers and fifty-two are Colonels, and again nine of the Generals, twenty-one of the Brigadiers and forty-three of the Colonels are University Graduates. Lastly to those of you who are interested in money, you may recollect that in 1959 the three principal professional Institutions conducted an inquiry into the salaries earned by their Members of various ages. The chart


ROYAL ENGINEER OFFICER
PAY & ALLOWANCES
All Ranks — Pay
Marriage. A.
Ration. A.
Capt. — Spec Qual Pay
Major Spec Qual Pay
Qual Pay
Major-General either London. A.
or Command Pay
or Overseas. A.
Education. A. based on 3 children over a period of 5 years.
MAJOR-GENERAL
BRIGADIER
COLONEL
LT-COLONEL
MAJOR
CAPTAIN
pension £1850
pension £1450
pension £1075
pension £445
3 children
2 children
1 child
median
income of 50% of all engineers in this range
income distribution by age (approx)
all engineers 1959—1960
Average income of fully qualified professional engineers of graduate status or equivalent
INCOME IN £ PER ANNUM
AGE IN YEARS
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
25
30
35
40
45
50
55
60

accompanying this article summarizes the results of that inquiry and I have superimposed upon the chart the corresponding figures for Army officers—a very favourable comparison.

Gentlemen you asked to hear about the opportunities for civil engineer graduates in the Army and I hope that I have made them clear. It might, however, be appropriate to point out to you that, despite what you may read in your papers, the Army and the Royal Engineers are still employed in very many places throughout the world. There are now in British Honduras ten RE officers assisting with engineer troops in the rehabilitation of that Colony after "Hurricane Hattie". There are RE officers serving with Commonwealth forces in India and Pakistan, in Ghana and Malaya. You will find them mapping in the remote, undeveloped areas, and working on the Rocket Range at Maralinga in Australia. Many voyages of exploration include in their parties RE officers and perhaps I might say we even have some in Belfast. Truly we are still ubiquitous.

The Coventry Cathedral Screen

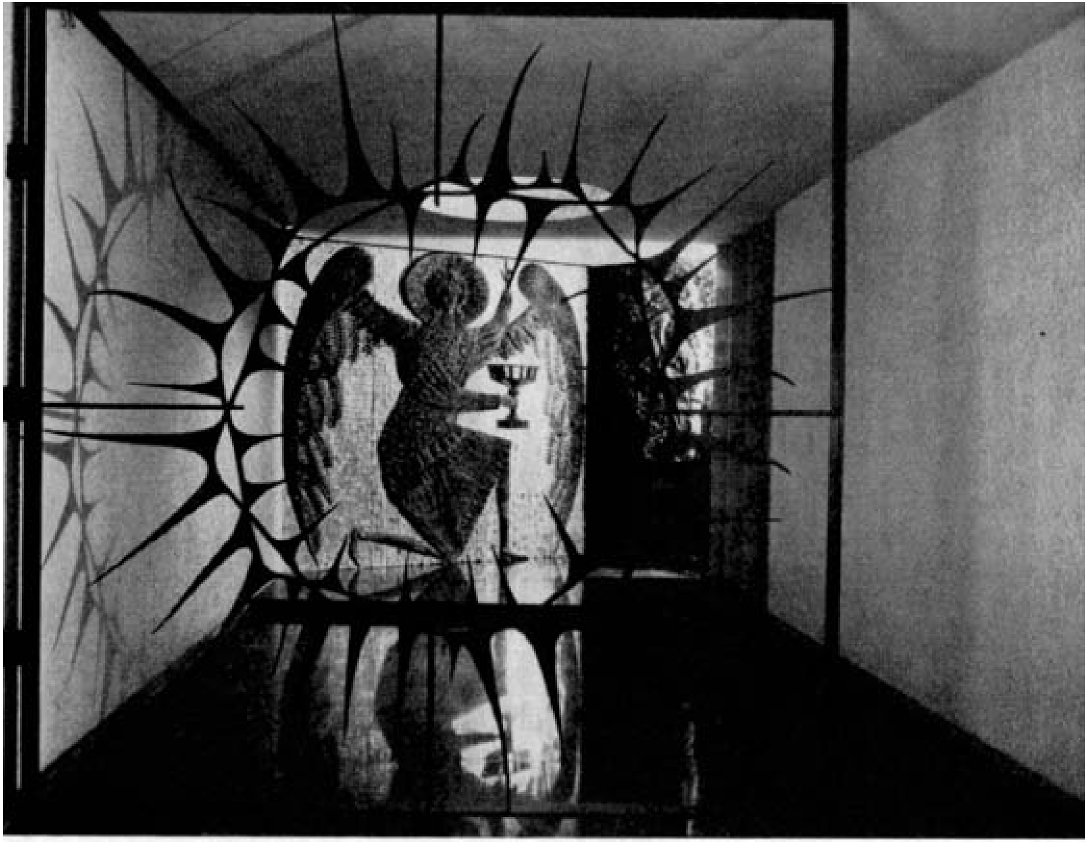
By Lieut-Colonel R. E. Young, DSO, DFC, RE and
Lieut-Colonel H. W. H. Webb-Bowen, RE

During his tour of duty as Commander No 1 ESD, Long Marston, Brigadier H. R. Greenwood, OBE decided that it would be appropriate for the Corps of Royal Engineers to make some contribution to the new Coventry Cathedral. In consultation with the Cathedral authorities and the architect it was decided that this might take the form of a wrought iron screen to be erected at the entrance to the Chapel of Gethsemane. This was duly approved by the Engineer-in-Chief and the Commandant SME was charged with the responsibility for its fabrication.

Sir Basil Spence, the architect of the Cathedral, designed the screen which took the form of a crown of thorns in a rectangular frame, the whole to be finished in egg-shell black. Quotations for materials were sought early in 1961, and as a result of these inquiries and in view of the finish required, it was agreed to use mild steel instead of wrought iron and to employ electric arc welding.

The materials were delivered at the beginning of April 1961 and work started in the Welding Shop in the RE Park, Chatham. This was carried out by sapper trade trainees under the direction of the civilian instructors, Messrs Tinkling and Ferrigan, who made good any errors in workmanship produced by these sappers.

Eventually after several months of painstaking work a faithful realization of Sir Basil Spence's beautiful design was completed. It is 10 ft square and weighs 6½ cwt. Nine mild steel mounting blocks were provided for fixing the screen to the floor, ceiling and left wall. These were machined in the Machine Shop and then galvanized to prevent any possibility of discolouration of the building materials with which they are in contact. One



The Coventry Cathedral Screen

of these blocks was engraved with a simplified design of the Corps cypher on the front and "1961" on the reverse. A anti-rust protection coating was applied to the screen for its journey by road to Long Marston.

The cost of the materials and the carriage of the screen to Long Marston was borne by Corps funds.

At the end of September 1961 the screen arrived at Long Marston and the task of preserving, installing and finishing the screen fell to No 1 ESD. There it was put through the full preservation process which involves immersion in ten different tanks to ensure absolute cleanliness followed by full protection of the metal. The overall size of the screen was too large for the tanks so it had to be dipped twice in each, treating one half at a time. A sealing coat of red oxide zinc chrome primer and the first paint coat were then applied by hand. These were air dried.

The Gethsemane Chapel has a reinforced concrete roof, a similar side wall with a pebble dash finish and a black marble slab floor above concrete in which is set the small bore copper pipes of the under floor heating. As this work had already been completed, the fixing of the rag bolts to hold the mounting blocks presented the contractor with some difficulty in avoiding the reinforcing bars. The floor proved all too difficult so the blocks there were merely recessed into the marble and not bolted down.

The problem of moving the screen to its final position in the Cathedral was aggravated by the only adjacent entrance being blocked by scaffolding for the installation of the organ. The screen, therefore, had to be manhandled the full length of the nave of the Cathedral, over the top of the high altar and thence, via the Lady Chapel, to its final site. Great care had to be taken to avoid damage to the marble floor. The screen was then rivetted to the mounting blocks and the final coats of paint were applied by hand.

On 7 December 1961 a ceremony was held in the Cathedral to receive the screen from the Corps. This was attended by representatives from Chatham and Long Marston who had been concerned in the fabrication and erection of the screen. The Chief Royal Engineer was represented by Brigadier E. F. Parker, OBE, Commandant, SME, and he formally handed over the screen to the Secretary and Treasurer of the Cathedral Reconstruction Committee. He in turn asked the Provost of Coventry Cathedral to receive this gift into his custody. The ceremony was followed by a short service conducted by the Provost.

A print of the original design of the screen with Sir Basil Spence's manuscript amendments and a sample "thorn" approved by him have been deposited in the RE Museum.

The accompanying photograph, reproduced by permission of Henk Snoek, shows the screen installed in Coventry Cathedral. It stands in a prominent position at the end of a vista and, in the course of time, it will be seen and admired by many worshippers and visitors.

NOTE. *A short description of this screen appeared in the March* 1962 *edition of the* RE Journal.

EDITOR.

Correspondence

3 Long E & M Course,
SME, Chatham.
11 March 1962.

The Editor,
RE Journal.

Dear Sir,

ELECTRICAL AND MECHANICAL ENGINEERING IN THE ROYAL ENGINEERS

One of the conclusions to my article on "Electrical and Mechanical Engineering in the Royal Engineers" in the December issue of the *Journal* is open to misinterpretation and I crave your indulgence to correct this.

I said "The training of officers for E & M appointments needs *improvement* not only so that there shall be an adequate number of officers to carry out the tasks which have been outlined above, but so that these officers shall have the opportunity to acquire civilian qualifications".

This could be taken to imply that the E & M technical instruction at the SME is at fault. Nothing was further from my mind. The instruction received by my course, both academic and practical, was excellent and invaluable.

The "improvement" I sought was in the matter of obtaining recognition by the Professional Institutions of Electrical and Mechanical Engineering of the Long E & M Course, as has been achieved for the Long Civil Course with the Institution of Civil Engineers.

Readers will know by now that the Institution of Mechanical Engineers has recognized No 4 Long E & M Course and I have no doubt that every effort will be made to secure the co-operation of the Electricals in due course.

Yours faithfully,
J. McDowell, Major, RE.

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3 Long E & M Course,
SME, Chatham.
14 March 1962.

The Editor,
RE Journal.

Dear Sir,

DEVELOPMENT OF ENGINEER EQUIPMENT FOR THE ARMY

Brigadier Jarrett-Kerr's reply to my letter advocating "simplicity" and "Repairability" in military engineering equipment does nothing to allay my fear that our designers are tending towards more, rather than fewer military specials.

I quoted the LAFB and Heavy Ferry pontoons as examples of elegant over design, with the very simple Uniflote of Thos. Storey as the other extreme and was dismayed to see that the Brigadier compared the LAFB to the Uniflote as a race-horse to a cart-horse.

To continue the equine metaphor, I cannot help feeling that MEXE is backing the wrong (type of) horse. A race-horse is finely bred for the limited field of the race course. It requires skilled handling and attention on and off the course; its working life is limited and quite inflexible and in the event of an accident is pretty well unrepairable.

I agree that the cart-horse is too slow and cumbersome an alternative but at least he is robust, powerful, flexible and requires far less cossetting than a race-horse. In fact I am certain that a proper compromise for military requirements is in terms of cobs or heavy hunters. I think I made this clear in recommending that the principles of the Uniflote be considered in a light alloy version.

I may add that in repairing LAFB at Liphook it was not any shortage of extrusions that worried me but their staggering variety in what is, after all, only an overgrown, load-carrying punt.

Nevertheless, it would be unfair to place all the blame for complex military specials on MEXE. I feel that the present system of developing a GS specification is largely responsible. A simple engineer requirement which might have been met, with slight modification perhaps, from current civilian production, becomes an engineer's nightmare by the time it has satisfied all the GS requirements. These can include such things as lorry and air portability, self propulsion at convoy speeds plus full cross country performance, insistance on the use of "Standard" WD engines which are often quite unsuitable for the machine, operable from Himalayan altitudes to sea level and from the tropics to arctic conditions as well as being soldier and waterproof.

These specifications must be scrutinized closely by experienced engineer campaigners before they are passed to the designers with a view to cutting out all but the absolute essentials.

Designers must then be given a free hand within the specification to try the latest materials and techniques. Early in the design stage, however, there must be a re-examination of the trend of the design to determine likely production and maintenance problems. Such an assessment would give an opportunity to confirm that the original design parameters have not been overtaken by other developments and to insure against over-designing. The views of industry must be sought in the matter of production, as the Army cannot hope to compete in this field, and of appropriate technical officers in the questions of maintenance and repair.

Indeed, for all I know, this may be the current policy of the authorities concerned and if so I apologise for stating what appears to me to be the correct approach to securing better and simpler equipment.

Finally, I would like to expand a little on the aspect of "repairability". I fully agree with Brigadier Jarrett-Kerr that there is not much opportunity for repair in the shooting and mobile phases of modern war but I have yet to serve in an operational theatre in which there were not pronounced lulls in the fighting. Examination of recent operations and the concept of "Limited War" shows the same pattern. Brigadier Jarrett-Kerr refers to repairs under peace-time conditions, but what is peace-time now if it is not merely a series of extended lulls between operations such as Korea, Suez, Kuwait, Belize and all stations to total war?

During these lulls, advantage must be taken everywhere to repair and maintain equipment, preferably in a manner which approximates as closely to conditions in the field of modern war as we can contrive.

If equipment is simple it is usually more easily repairable unless it can be made so cheaply and abundantly as to be expendable. I do not believe we can afford to contemplate the abandonment without any attempt at repair of equipment like the heavy ferry at, I understand, £80,000 per raft.

Yours faithfully,

J. McDowell, Major RE.

Major-General A. G. B. Buchanan, MICE,
4 Montacue Court,
Folkestone.
21 March 1962

The Editor,
RE Journal.

Dear Sir,

LOCATION OF RETIRED RE OFFICERS

I have often wondered where retired officers tend to settle. In earlier days one thought of them in large colonies at Bath and Cheltenham.

The keen NE wind has kept me indoors lately, so I took the *RE List* of November 1961, and waded through 1567 names, noting addresses by regions.

The whereabouts of 137 are unknown and 217 give Bank or Club addresses, so I have omitted all these, and this leaves 1,213.

These 1,213 are located in the Table which I enclose.

Perhaps you would consider publishing it, as others may be interested.

Yours faithfully,
A. G. B. Buchanan, Major-General.

London	86	
Metropolitan counties	301	Middlesex, Kent, Surrey, Bucks, Herts.
Southern counties	258	Sussex, Hants, Wilts, Dorset
SW and Western counties	122	
East Anglia	70	
Northern counties	63	
North Midlands	20	
South Midlands	87	
Wales	14	including Monmouth
Scotland	48	
Northern Ireland	9	
Channel Isles	5	
Isle of Man	1	
Commonwealth and Colonies	92	
Foreign countries	37	including Eire
	1,213	

Memoirs

MAJOR-GENERAL A. E. DAVIDSON, CB, DSO

Colonel Commandant RE (Rtd)

MAJOR-GENERAL ALEXANDER ELLIOTT DAVIDSON, CB, DSO, Colonel Commandant RE and one time President of the Institution of Mechanical Engineers died on 29 January 1962.

He was born on 15 August 1880, the son of Colonel John Davidson, CB of the Indian Army. After passing through the RMA Woolwich he was commissioned into the Corps on 22 November 1899. On the completion of his YO courses at the SME he was selected to attend a Mechanical Engineering Course at Chatham Dockyard. He saw service during the latter part of the Boer War with the 45th Steam Road Transport (Fortress) Company, equipped with "Steam Sappers", and with the London Electrical Engineers Mobile Searchlight Section at Pretoria. In May 1903 he was recalled to attend a course of training at Messrs Thornycrofts' Mechanical Transport Works at Chiswick.

His next appointment was with the Inspectorate of Iron Structures and Railways at the War Office. This was followed by a tour as an Assistant Instructor in Electricity at the SME. After a short time spent with 1st (Fortress) Company at Gibraltar on defence electric light duties he became, in December 1909, Secretary of the Mechanical Transport Committee working under the Directorate of Transport and Movements the War Office.

In June 1914 he was posted to 12th (Field) Company then in Ireland. His Company was in the 6th Division which joined the British Expeditionary Force in France in September 1914. Almost as soon as he had arrived in France, however, Davidson was appointed Deputy Assistant Director of Transport. When the transportation services were reorganized in 1916 he became an Assistant Director and he was employed as such until August 1919. He was promoted substantive major in 1916 and he was made a brevet Lieut-Colonel in 1918. He was awarded the DSO in 1916 and he was six times mentioned in despatches.

In 1920 he was appointed Chief Inspector of RE Stores at Woolwich and as such an Associate Member of the RE Board. He left Woolwich in 1924 to become a Deputy Director of Fortifications and Works at the War Office but the following year, on promotion, he became a Military Member of the Mechanical Transport Advisory Board, and later a Member of the Tank and Tracked Transport Technical Committee. In 1927 the Directorate of Mechanization was formed with Major-General A. Brough as the first Director and Davidson, then a Colonel, became Chairman of the Technical Committee, Mechanical Warfare Board, an outstation of the Directorate located at Woolwich. In 1931 he was appointed Assistant Director of Works (QMG9), the War Office dealing with the mechanical and electrical engineering side in which he had specialized. He was gazetted ADC to the King in February 1935 and in that year also he was elected President of the Institution of Mechanical Engineers, the first serving officer ever to receive that much coveted mark of honour and significant recognition of professional standing.

Major-General AE Davidson, CB DSO Colonel Commandant RE

In March 1936 he was promoted major-general and appointed Director of Mechanization, the War Office, which appointment he held until his retirement in August 1940.

He was made CB in 1938 and a Colonel Commandant RE on 3 June 1940.

He married Janie, daughter of Charles MacColl, in 1912. His wife predeceased him in June 1961.

As a YO at Chatham he was keen on dinghy sailing and whilst an Assistant Instructor at Chatham 1905–1909 he was an enthusiastic oarsman and rowed in the Sapper fours in many regattas. He was a member of the London Rowing Club. In 1961 he most generously donated a sum of money to the RE Sports' and Games' Fund which was used to purchase a silver trophy named the "Davidson Bowl" to be awarded annually to the best all-round RE unit competing in the Army Ski Championships in the Duchess of Kent's Cup competition. In his will he also made a most generous bequest to the RE Sports' and Games' Fund.

Major-General J. S. Crawford, CB, CBE wrote thus of Major-General Davidson in the Chartered Mechanical Engineer, the Journal of the Institution of Mechanical Engineers: "Major-General A. E. Davidson (Past-President) who died recently, became an Associate Member of the Institution in 1906, transferring to Member in 1911. To give a true and accurate picture of Alexander Davidson is not easy, because he was by nature shy and reserved and many people found this reserve difficult to break through, but once this was done one found a man of quiet wit and great sympathy. I, as his Deputy during his appointment as Director of Mechanization, got to know him well. I never heard him say an unkind word against a brother officer. He would do a good turn but would be embarrassed and almost rude if he were thanked. This shyness must to some extent have been a handicap, but did not prevent his steady promotion in the Army. It was sad that he should have arrived at the age of retirement in the early part of the last war.

He was, I think, the last of the early Pioneers of mechanical transport in the Army; he commanded one of the first sections of mechanical transport in Kimberley, South Africa, in 1902. In 1910 he was Secretary to the Mechanical Transport Commission and took his part in the preparation and the terrific expansion of mechanical transport in the 1914–18 War. I first met him when he was on the Staff of the Director of Supplies and Transport at St Omer in May 1915. He was then a major, and I a subaltern, but I remember being tremendously impressed by his knowledge and memory for figures. Even then I found him reserved and I never saw him lose his temper.

From 1927–1931 he was Chairman of the Mechanical Warfare Board—a period when design and development of tanks was of the greatest urgency. Unfortunately, Britain had only thoughts of disarmament and money for any project was cut to the bone, and design of a tank is a long term problem.

In 1936 he was appointed Director of Mechanization and I had the honour of serving under him as Assistant Director and later as his Deputy. It was a trying time leading finally to war. David John, as we called him, bore that strain with great credit. Finally, may I add that he had one great pleasure outside the Army; the Institution of Mechanical Engineers. As a Member of Council in 1921, Vice-President in 1932 and President in 1935, nothing gave him greater pleasure than attending Institution meetings. At the end I am sure he must have looked back on his career with a feeling of pride in achievement."

In addition to his membership of the Institution of Mechanical Engineers, he was a member of the Institution of Marine Engineers and of the Diesel Engine Users' Association, becoming President of that Association in 1950. His Presidential address, given on 19 October 1950 entitled: "A Golden Jubilee with Oil Engines—Akroyd Diesel and others" was a masterly review of the evolution of the oil engine and its developments for military requirements. There could have been no man more experienced, or qualified, to speak on that subject than "the General" as he was affectionately called.

His funeral service was held at Christ Church, Hampstead. Among those present were Major-General Sir Douglas Campbell, representing the Chief Royal Engineer, and Brigadier A. H. G. Dobson, representing the Engineer-in-Chief, and Mr K. H. Platt, Secretary of the Institution of Mechanical Engineers, representing the President and Member of Council of that Institution.

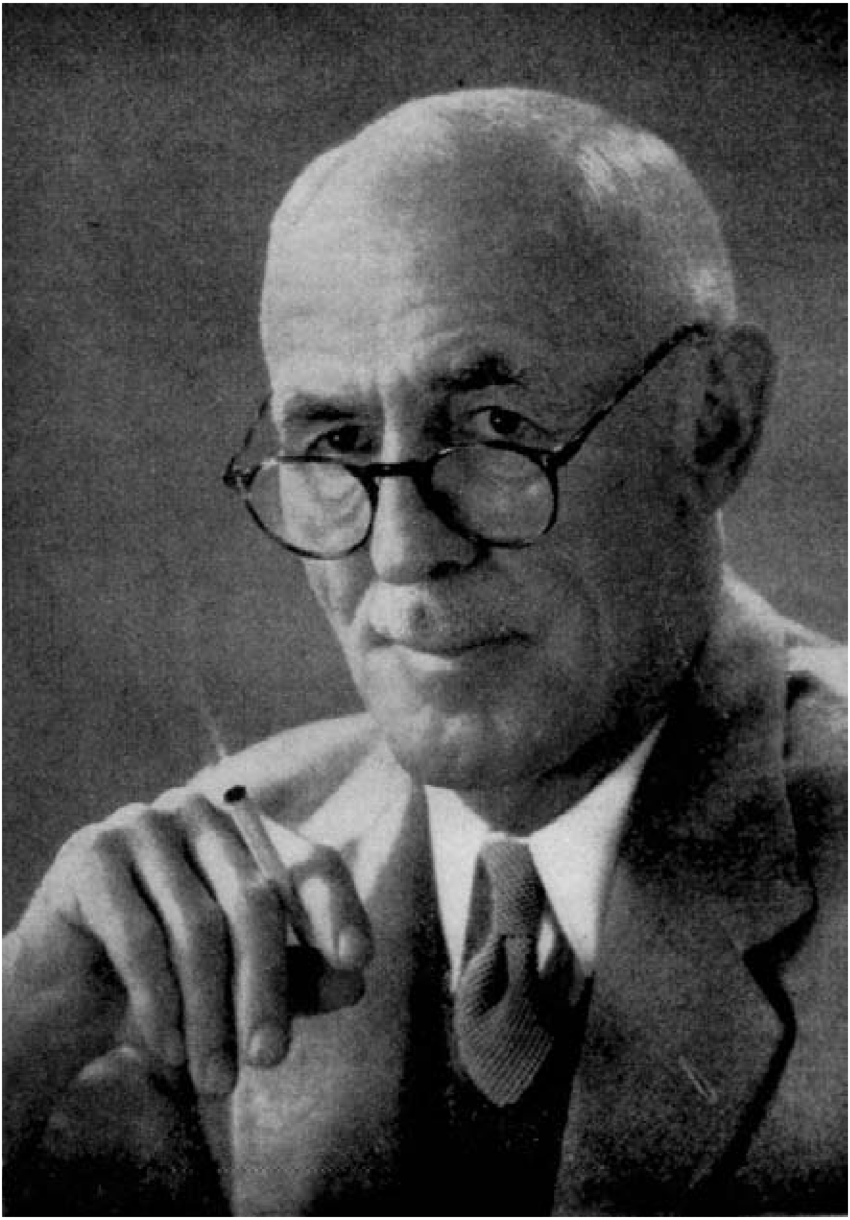
BRIGADIER SIR OLIVER WHEELER, KT, MC

Edward Oliver Wheeler was born in Ottawa on 18 April 1890, the son of Arthur Oliver Wheeler, Dominion Land Surveyor, and Clare daughter of Professor John Macoun. He was educated at Trinity School, Port Hope and the Royal Military College, Kingston where he was awarded both the Gold Medal and the Sword of Honour. Like many other Kingston Cadets, similarly honoured, he chose a career in the Royal Engineers and he was commissioned into the Corps in June 1910.

After the normal courses at Chatham Wheeler was posted to India in July 1912. His first appointment was that of Garrison Engineer Dehra Dun and he later moved to a similar appointment at Meerut. On the outbreak of war in August 1914 he was posted to 3 Field Company 1st (Bengal) Sappers and Miners, then a part of 7 (Meerut) Division, the first Indian troops to reach France in October 1914. For just over a year the Division was engaged continuously in bitter trench fighting on the Western Front. In December 1915 the Division was transferred to Mesopotamia. Wheeler remained with 3 Field Company until he was sent back to Roorkee towards the end of 1916 to raise 18 Field Company, a new unit. Having raised and trained the Company it was sent, with him in command, to join 18 (Indian) Division in Mesopotamia. In March 1919 he became Brigade Major 51 Brigade and took part in operations in Iraq and Kurdistan.

He was twice mentioned in dispatches for his services on the Western Front. In Mesopotamia he was awarded the Military Cross in 1916 and he was five times mentioned in dispatches. He was also awarded the Legion of Honour, and in January 1919 he was made a brevet major.

On returning to India in December 1919 Wheeler went once again to Dehra Dun where he was posted, on probation, as an Assistant Superintendent in the Trigonometical Survey Office. Thus started his long and distinguished connexion with Survey work in India which was to last unbroken until his retirement.



Brigadier Sir Oliver Wheeler KT MC

In 1921 he took part in a "reconnaissance" Everest expedition in preparation for the assault the following year. With Morehead he mapped the areas to the north, east and west of the peak as well as the Tibetian plateau; and with Mallory and Bullock he discovered the Chang da, or North Col, after months of high mountaineering in exposed conditions. Major Wheeler had been specially selected for this reconnaissance on account of his reputation as an expert in the Canadian system of photo survey. One of his tasks was to make a survey by photographic means of the area within a radius of ten miles of Mount Everest. He began his survey in the Khombee Pass and he spent most of the summer of 1921 in lonely camps 18,000 to 20,000 ft high. In the words of the Expedition leader: "He had the hardest and most trying time of us all, and deserves the greatest credit for his work."

Promotion came steadily on his return to military duty. In 1935 Wheeler became Director of Map Production; in 1938 he became Director of the Geodetic Branch and the following year he went to Calcutta as officiating Surveyor General of India. He was confirmed in the post in 1941 and he held that important appointment throughout the Second World War until his retirement in March 1947. He was knighted in 1943.

He married in 1921 Dorothea Sophie daughter of N. E. Danielsen Esq, of Edgbaston, Birmingham. They had one son.

After his retirement Sir Oliver Wheeler returned to live in Canada. From 1950 to 1954 he was President of the Alpine Club of Canada. Besides being a most experienced mountaineer he was keen on shooting and fishing. He published several technical articles and papers on survey and he was also a frequent contributor to the *Canadian Alpine Journal.*

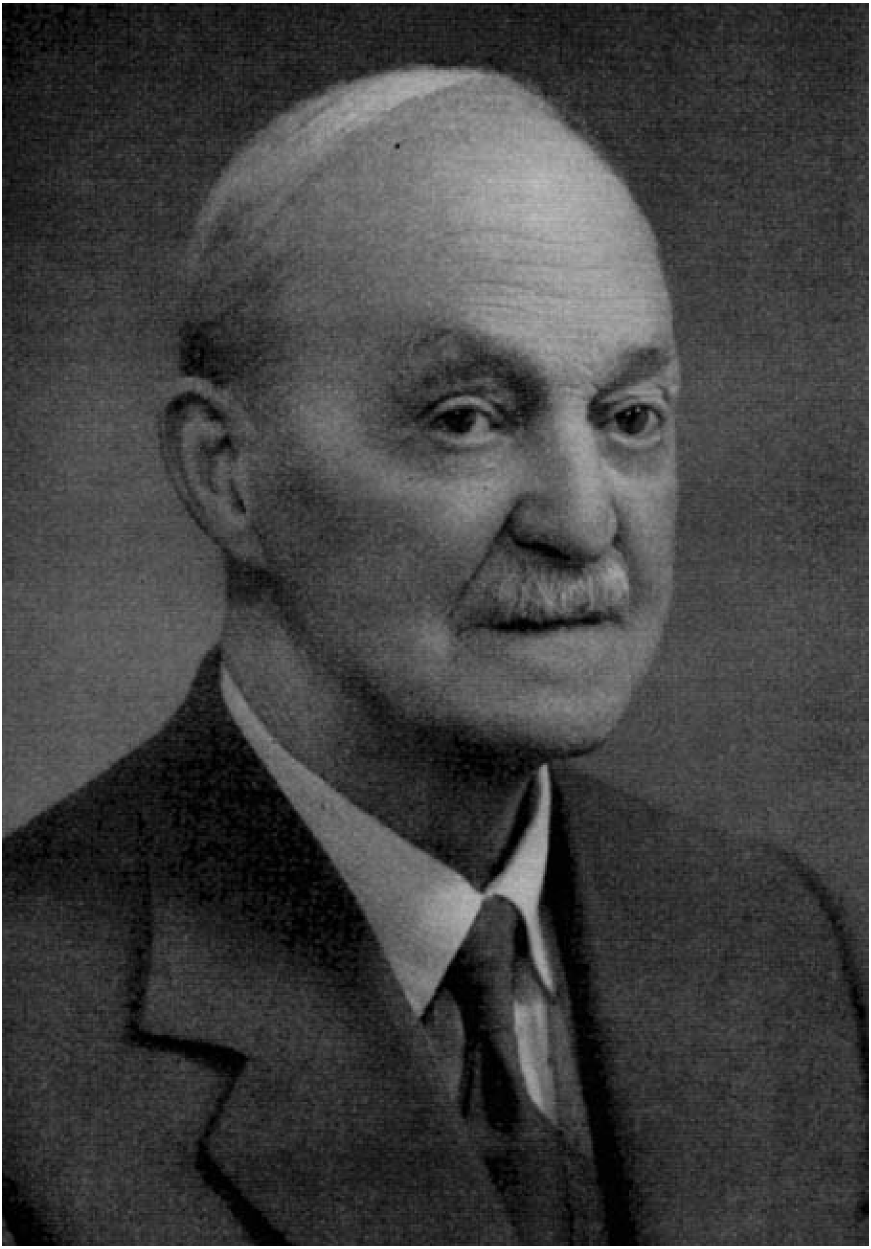
He died in hospital at Vernon, British Columbia on 19 March 1962 at the age of 71.

COLONEL A. J. G. BIRD, CIE, DSO

ARTHUR JAMES GLOVER BIRD was born on 4 February 1883, the son of C. P. Bird Esquire of Drybridge, Hereford. He was educated at Cheltenham, and at the RMA Woolwich where he won the Sword of Honour.

He was commissioned in the Royal Engineers on 21 December 1900 and, after completing his Chatham courses of instruction, he was posted to 24 Fortress Company at Malta, where he also acted as Sub-Divisional Officer Mtarfa and Gozo.

In January 1907 he joined the Bengal (then 1 PWO) Sappers and Miners at Roorkee where he spent nearly a year with 4 Company before being sent to Peshawar to join 6 Company just in time to take part in the operations against the Afridis in the Bazar Valley. After these successful operations 6 Company formed part of Major-General Sir James Willcock's Force which moved against the Mohmands beyond Shabkadar. After demolishing many Mohmand towers, and working on roads and water supply, often under snipers' fire, the Company, commanded at that time by Captain (later Lieut-General Sir Ronald) Charles, returned to Peshawar. Bird accompanied 6



Colonel A J G Bird CIE DSO

Company when it moved to Roorkee and was given command of the Company towards the end of 1908. In 1909 he assumed command of 4 Company at Rawalpindi, and stayed with the Company continuously until promoted CRE in September 1918. His Company went to Delhi for the Durbar in December 1911, and then back to Rawalpindi, and to Roorkee at the end of 1913.

"AJG" was on leave in the UK when the First World War broke out. He joined his Company, however, in Egypt whilst it was on its way from India to France with 7 (Meerut) Division. The Company arrived at Marseilles on 15 October 1914 and, by the end of the month, it formed part of the Indian Corps holding the line Fanquissart-Neuve Chapelle-Givenchy. After almost a year of bitter trench warfare the Division left France for Mesopotamia, where it arrived in December 1915. 4 Company bridged the Euphrates at Nasiriya, and then rejoined the Division in time for the final advance on Baghdad at the end of 1916. In November 1917 the Company operated with 21 Brigade when an advanced enemy detachment at Daur (below Tikrit) was surprised and destroyed. In January 1918 the Division left Basra for Egypt, and 4 Company was soon engaged on roads and water supply in Palestine. One of the larger and less pleasant tasks undertaken was the drainage of marshy and malarious lakes, one of which was in full view of the enemy. In March 1918 "AJG" became CRE 60 (London) Division of XII Corps then forming part of the Salonika Army. In September that year the Division moved to Palestine. Shortly after the Armistice, Bird became CRE "Taurus Tunnels" with the task of ensuring that the Constantinople–Baghdad Railway was kept in operation.

His wartime services gained for him a DSO in March 1915 and a Brevet Lieutenant-Colonelcy in January 1918. He was seven times mentioned in dispatches during the years 1915–1919, and was awarded the Order of the Nile 4th Class.

After a brief visit to India and leave in the UK he returned to the Bengal Sappers and Miners at Roorkee, and in 1922 he once more took command of 4 Company for a short time before being appointed successively Superintendent of Instruction and Superintendent of Park there. In March 1925 he went to Rawalpindi as SORE I, and in July 1926 he returned to Roorkee to take up the coveted appointment of Commandant of the Bengal Sappers. In April 1930 he was appointed Brigadier RE at Army Headquarters at Simla, and in March 1932 he became Assistant Commandant at the new Indian Military Academy, Dehra Dun, opened to accelerate the process of Indianization of the Army in India. There he remained until retirement three years later, when he was awarded the CIE.

In 1927 he married Eileen Julia, younger daughter of Sir Edward Cameron, KCMG, of Bath; there were three daughters of the marriage.

He died on 5 March 1962, aged 79 years.

"AJG" was a great sportsman, keen on all forms of athletics and good at all the games he took up; he continued to play hockey and polo while Commandant at Roorkee. He was extremely popular with his officers and other ranks, both British and Indian, and was an excellent choice as first Assistant Commandant of the Indian Military Academy at Dehra Dun, and a splendid Commandant of the King George V's Own Bengal Sappers and Miners.

COLONEL J. E. MARSH, DSO, OBE

John Evelyn Marsh died in Millbank Hospital after a short illness on 27 February last, aged 59 years, and with his passing the Corps has lost a most colourful personality.

He was commissioned into the Royal Engineers on 31 January 1923 and, on completing his YO Course at Chatham, he served two years with 26 Field Company at Bordon and 5 Field Company at Aldershot. He spent most of his spare time in the saddle and he developed a love of the horse that was never to desert him. After this short tour with Field Companies he was posted to Chatham. In those days Sapper officers at Aldershot and those at Chatham could be clearly distinguished by the kind of breeches they favoured, the colour of their strappings, the type of service dress cap worn and the width and brilliance of their chin straps. Their outlook and ideas were often inclined to be as contrary as their dress.

John Marsh hit Chatham like a "ball of fire" from Aldershot when he was posted to the Training Battalion in February 1928. In his ultra Aldershot-style uniform with his faithful spaniel Patch always at his heels, he was a unique and almost revolutionary figure on Brompton Square. But when occasion demanded he could be as "GS" in his clothing as any Chatham paragon. He was indeed selected to pose for the plates produced in Engineer Training Volume 2 (Drill) 1929 depicting an "Officer (Mounted) in Marching Order (near side)", and ditto (off side). The near side view is reproduced with this Memoir. He was, of course, also a splendid Party Officer in charge of recruits, and a great golfer.

In spite of considerable dissuasion and in the face of many obstacles John Marsh gathered together at Chatham a few couple of fox-hounds; this often necessitated long journeys in an old box-type Austin Seven to collect individual hounds and bring the car-sick acquisitions back to Chatham. By sheer charm and determination he obtained permission from farmers, in parts of the country where foxhounds had not been seen for decades, to allow drag-lines to be built and for mad soldiers to gallop and jump over their land. It was a purely one man effort with no financial, or other, assistance from the Corps. Nevertheless Mr Marsh's Hounds very soon made a name for themselves and proved that draghunting, based on Chatham, was a viable concern. Once this had been established official encouragement and assistance was soon forthcoming and the Royal Engineers Draghounds were formally established and went from strength to strength. Marsh remained as Master until being posted to India in the second half of the 1931 trooping season, and before he left the RE Draghounds had been recognized as an "authorized" pack of Hounds and figured in Baily's.

His time in India, after a short tour as Assistant Garrison Engineer Bangalore, was spent with the QVO Madras Sappers and Miners, and he served in 12 Field Company at Bangalore, 15 Field Company at Razmak and 33 Field Troop at Sialkot. On 5 June 1934, whilst on leave in the UK, he married Joan Allison elder daughter of the late Lieut-Colonel J. O. Little of Rungnut Tea Estate, Darjeeling.

In March 1936 he returned to the Training Battalion at Chatham as a Captain. Robin Gabbett, who was considerably his junior, was at that time Master of the RE Draghounds, but it was typical of John Marsh cheerfully to serve as a hunt official under him. He did, however, take over responsibility for the hounds and kennels and it was not long before he had instituted new lines in parts of the country not previously hunted. During that season, almost the last of the era of the horse in the British Army, there were twenty-eight Cavalry horses in the RE Stables at Chatham (each hired for hunting for the modest sum of 15*s* a month) besides six RE Chargers and a few private horses. Fields of over forty used to be out with the Drag, and fields of less than thirty mounted followers were rare. Gabbett left Chatham at the end of the 1936–37 hunting season and John Marsh automatically became Master, and he remained Master for the seasons 1937–38 and 1938–39. Due entirely to his drive the first RE Draghounds Point-to-Point Steeplechases were held at Goose Farm, Wrotham on 26 February 1938. The meeting was an immense success. In response to an invitation from John Marsh, Frank Goddard brought his "Tally-Ho" Coach and team of fine chestnuts and drove down the course in true Ascot style. The 1938–39 season opened badly, the Royals and the Greys, from whom "fifteen bobbers" were to be obtained for hunting, were ordered suddenly to Palestine. This was a sad blow but, thanks to support from the Royal Marines and the Regiment at Gravesend and from local hunting people, fields were as large and thrustful as in previous years. The Point-to-Point was again held at Goose Farm and the season ended in a blaze of glory. It was John Marsh's last season, and he could hardly have foreseen when he left Chatham, shortly after the Point-to-Point, that the hounds would soon have to be put down and that the RE Drag would not be resuscitated until 1950.

In April 1939 he embarked for Shanghai to become OC Shanghai Area and OC RE China (Shanghai, Tiensin, Peking) where he stayed until being posted in November 1940 as a Major to 4 Training Battalion RE. In September 1941 he was appointed Officer Commanding 23 Field Company, then in 1st Division. In March of the following year, with the rank of Lieut-Colonel, he became SORE Operations and Training at Headquarters Southern Command, but soon after he was sent on No 2 Senior Staff College

Course before becoming CRE 77 Division in December 1942. In March 1943 he became CRE VIII Corps Troops with whom he served in North West Europe until after the Rhine Crossing, and in March 1945 his Sappers had the distinction of building the first British bridge across the Rhine, a Class 9 Folding Boat Equipment Bridge at Wardt, 1,320 feet long with 1,000 yards of approach road. The bridge was appropriately called Draghunt Bridge and, like the hounds after which it was named, the early days of its history were fraught with difficulties. John Marsh called forward his first bridging vehicles at 0600 hours, but it was not until 1300 hours that they began to arrive on the bridge site owing to enemy fire. The bridge was open to traffic in ten hours, but during the following night a traffic jam at one end broke the bridge, twenty-two bays being half sunk and displaced down stream. Nothing daunted, however, Draghound Bridge was reopened for traffic in a remarkably short space of time.

Further promotion came in June 1945 when he was given command of 18 AGRE. He held that post until almost the end of hostilities when he was made Deputy Chief Engineer Hamburg. For his wartime services he was awarded the OBE in March 1945 and the DSO in July of the same year. He was mentioned in dispatches in August 1946.

After the war he held the appointments of Commander 25 AGRE (TA), President of No 10 War Office Selection Board and Officer i/c RE Records. He retired in May 1956.

John Marsh was a splendid Sapper officer in every way, charming, kind and gentle, but thrustful and determined when the need arose. He could have had no enemies and in any company he radiated good humour and unbounded enthusiasm.

R.E.D.

LIEUT-COLONEL J. A. A. PICKARD, CBE, DSO

Jocelyn Arthur Adair Pickard, who died on 18 April 1962, was born in 1885, the only son of the Rev H. Adair Pickard of Oxford. He was educated at Rugby and the Royal Military Academy, Woolwich, from where he was commissioned into the Royal Engineers on 21 December 1904.

After serving seven years in the Corps he resigned his commission on 20 December 1911, and transferred to the Special Reserve. From 1912 to 1914 he was employed in the London Traffic Branch at the Board of Trade. He was recalled for full time military service on 5 August 1914 and he served on the Western Front throughout the First World War, rising to the rank of Lieut-Colonel. He was awarded the DSO and four times mentioned in despatches.

On leaving the Army once again after the War Pickard was, in 1923, selected to carry out the task of building up on a national scale the pioneer work of the London Safety First Council and the British Industrial Safety First Association and from those beginnings sprang the Royal Society for the Prevention of Accidents. Pickard became its first Director-General; he retired in 1950 after 27 years connexion with the inauguration and development of the Society. Although the Society was by some looked upon as being primarily concerned with the prevention of road accidents, Pickard never ceased to stress its more far-reaching objectives, namely to prevent accidents of every kind. He was responsible for many of the ideas subsequently incorporated into the Highway Code, and he was the inaugurator of the "Kerb Drill" for children. The idea came to him when watching some children playing at soldiers. He realised that there was the answer to the natural instinct of the child to rush blindly across the road which had caused so many tragic accidents. The command "Halt" and the subsequent drill appealed to the children as a game at first and it later became an automatic precaution. The many lives so saved have become an intangible but a most fitting memorial to him.

He married Angela Mary, a daughter of A. Conyers Baker in 1920. They had a son and a daughter.

Major-General B. K. Young, CBE, MC, writes:—

"I joined the Royal Society for the Prevention of Accidents in January 1946 knowing nothing of its work and having never before met Pickard, the

Director-General; I could not have found a more worthwhile job nor a better chief. In 1948 I became his Deputy. He was a man full of ideas, an invaluable state of affairs since we were faced with the post-war rebuilding of accident prevention work in Industry, on the Roads and in the Home, and at the same time searching for accommodation and expanding the Staff in order to cope with the many and increasing calls being made on the Society.

Pickard was a most likeable, modest and retiring man; he relied on his Staff, whom he always backed up, to put his ideas into practice and he had no desire to take any credit. He was a delightful man to serve under; the office under his wise guidance had a happy, friendly feeling—none was more pleased than his Staff when Pickard was awarded the CBE in 1948 for his life's work in accident prevention.

He retired in 1950 and I had the good fortune to take over from him an organization which was known throughout the Country and which had a worldwide reputation. Firmly based on the foundations which Pickard had so well and truly laid, the Royal Society for the Prevention of Accidents has continued to expand and that expansion is still going on under Brigadier R. F. E. Stoney who took over from me when I retired in 1959.

Besides Safety in Industry, on the Roads and in our Homes much valuable accident prevention work is today being undertaken in such different fields as Agriculture, on the Water and lastly but by no means least, amongst the "under-fives", the most vulnerable age group of all, and in every way a most difficult problem to tackle.

No greater tribute can be paid to Pickard's unremitting life's work and wide knowledge than the fact that the ways and methods of accident prevention which he advocated, and many of which he himself originated, have stood the test of time and are being employed today not only nationally but internationally.

Book Reviews

MATRICES FOR STRUCTURAL ANALYSIS

By S. J. McMinn, MEng, PhD, AMICE, AMIStructE

(Published by E. & F. Spon Ltd. Price 57*s* 6*d*)

The Matrix method of analysis has for some time been used in the aircraft industry, and is becoming popular in solving more complicated civil engineering design problems, such as the design of shell roofs. It is a particularly powerful mathematical method for solving difficult design problems and one well adapted for use in digital computers.

This textbook is designed for the purpose of familiarizing structural engineers with matrices. Particular attention has been paid to the more elementary parts, and the book shows in detail how structural problems can be translated into the new form.

A well laid out and well explained book. It is emphasized, however, that for the reader to understand this book he must have a minimum standard of mathematics and of the theory of structures of Higher National Certificate in Civil Engineering.

M.G.H.

CONCRETE—PROPERTIES AND MANUFACTURE

By T. N. W. Akroyd, MSc(Tech), AMICE, AMIStructE

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

Many excellent reference books and papers have been produced on the subject of concrete technology, and it is difficult to find a new publication on this subject which has something new to offer the reader. This book, *Concrete—Properties and Manufacture*, by T. N. W. Akroyd, however, achieves distinction in three main respects. Firstly, it is well presented and easy to read; secondly, it is right up to date; and thirdly, it collates a wealth of useful information for the reader that could only otherwise be obtained by reference to a large number of other publications.

The book begins with a discussion of the properties of concrete (creep, elasticity, shrinkage, permeability, strength, etc), and it is of interest to note that the author includes the Vee Bee consistometer as a means of measuring workability. A chapter is then devoted to concrete materials, including mention of some of the more unusual special cements such as expanding cement, hydrophobic cement, etc. Additives are also covered comprehensively. The third chapter on mix design follows the well known RR Note No 4 method, and gives some useful examples to the student.

Further chapters on manufacture of cement, quality control of concrete, resistance to deterioration, and surface finishes, are adequate and comprehensive but require no special comment. The last chapter on special concrete, however, deserves mention since it includes some useful information on many types of concrete including gap-graded, lightweight, pre-packed concrete, and concrete used for atomic radiation shielding.

Perhaps special mention should also be made of the excellent referencing at the end of each chapter for any reader who may need to obtain more detailed information on a particular problem.

As the author intends, this book will be of interest to students, graduates, and site engineers alike, but there is no doubt that it would be a useful reference book for any engineer involved in concrete construction or design. J.R.J.

CONCRETE PRODUCTS AND CAST STONE

By H. L. Childe

(Published by Concrete Publications Ltd. Price 18*s*)

This book is one of the well-known "Concrete Series" of publications, and was last revised in 1949. Since its last edition of twelve years ago, however, the growth of technology in the pre-cast concrete industry has been so rapid that this new edition, incorporating information on many of the materials, processes, and types of machinery introduced to the industry in the last few years, is both welcome and necessary.

The first four chapters deal with the materials used in concrete, and the information given on lightweight, aerated, and fire-resisting concrete, the use of plasticizers and pigments, and the normal mix proportions for common pre-cast units such as flags, lintels, kerbs, firebricks, pipes, etc, is of particular interest.

The next seven chapters cover a variety of subjects including mixing, control, curing, storage, and surface finishes. Most of these have been covered in many publications and technical reports, but the author's comments on the mixing of foamed and air-entrained concrete, and the frequency and amplitude of vibration required for good compaction are worthy of note. The chapter on surface finishes that can now be achieved, including for instance, aggregate transfer methods, is particularly interesting.

A further five chapters are devoted to various moulds for pre-cast concrete work. Practically every conceivable type of mould is discussed and this section alone is sufficient to recommend the purchase of the book by any engineer who may be involved in the production of pre-cast units.

Lastly, the two final chapters are concerned with methods of manufacture and prestressed concrete, respectively. In the latter, the long-line system of production of pre-tensioned units is well covered, but post-tensioning methods are dealt with rather inadequately. Since the book is mainly concerned with the construction of small pre-cast (probably factory made) concrete units, however, this omission is perhaps understandable.

This has always been one of the few comprehensive books on precast concrete construction, and now that it has been revised to include all the modern materials and techniques, it once again becomes an invaluable member of the small group of books that form the essential library of every practicing engineer. J.R.J.

PARTISAN WARFARE

By Dr Otto Heilbrunn

(Published by George Allen & Unwin Ltd. Price 21*s*)

Dr Heilbrunn is no new writer on irregular warfare. *Communist Guerilla Warfare* (Allen & Unwin 1954), written by him in conjunction with Brigadier C. A. Dixon, was well thought of. His latest book, *Partisan Warfare*, is apparently an individual effort and is disappointing. It is a theoretical study of guerilla and anti-guerilla warfare during and since the Second World War.

Guerilla or partisan warfare, which is synonymous, is of course virtually as old as warfare itself. The Old Testament contains several references to it. The Boer War was prolonged some two years as a result of the brilliant guerilla tactics of de Wet and Botha. No military student needs to be reminded of the "side shows" of T. E. Lawrence in Arabia during the First World War; and as pointed out by Colonel the Hon C. M. Woodhouse, DSO, OBE, MP—Commander of the Allied Military Mission to the Greek resistance forces during the Second World War—in his generous foreword to this book, the Spanish resistance during the Napoleonic wars gave us the word *guerilla* to add to our language. Its literal translation is "little war".

In spite of "the nimbus of invincibility with which the numerous and wide-spread partisan forces tended to become invested during the Second World War", they have since then been defeated in Malaya, Kenya and Cyprus. Dr Heilbrunn studies the reasons for the failure of the Germans, and our more recent successes. He draws theoretical conclusions from his examination.

In his evaluation of resistance movements, however, he tends to overlook certain facts of importance. At the end of the Second World War, most British politicians would privately, if not publicly, have admitted that many of the resistance activities supported by the Allies ultimately became more of a post-war nuisance than they were a war-time asset. Moreover, although they were good morale raisers whilst the outcome of the war was still in doubt, as soon as it was virtually certain that the Allies would be victorious, some became an embarrassment to us and were more of a political thorn in the side than a military benefit, even before the war was over.

It was perhaps largely as a result of this outlook that after the war, the War Office did not take more active steps to encourage the study of partisan warfare. It was apparently thought that any allied resistance forces in the future should be strictly limited in scope, and given the primary task of obtaining intelligence rather than attacking the enemy.

Perhaps both political and military thinkers of those days were unable to foresee one major factor. This was that, whereas the resistance forces which caused us embarrassment during or immediately after the Second World War were invariably Communist inspired, in a Third World War the political aims of any resistance movement would be likely to be anti-Communist and, therefore, largely of our way of political thinking.

A further point which is inadequately dealt with by Dr Heilbrunn is, that whilst resistance forces are militarily weak and are being built up in strength, their activities must largely be clandestine. But as soon as their activities become of sufficient importance to have a direct bearing upon regular army operations, the responsibility for them must be transferred to the commander of the regular forces in the theatre concerned. During the Second World War the transfer of control was in most cases delayed too late and this resulted in considerable friction between the local regular forces and the clandestine organization, originally responsible for encouraging and assisting the development of these resistance forces. The timing of their transfer calls for very careful judgment if this is to be avoided in future.

Perhaps as a result of the general unpopularity of war-time resistance forces at the end of the Second World War, although certain analyses and evaluations of them were made by the Special Operations Executive, none was made readily available for study by Staff College students, leave alone by regimental officers. Dr Heilbrunn has attempted to meet the requirement for such a study in English. Unfortunately his English is poor. Much of his book is unbalanced in substance and his theoretical deductions are often over-simplified. A great deal of his terminology is inevitably unprofessional and his book as a whole, apart from a well written Appendix, gives the impression of being unedited. Nevertheless, he has made a bold attempt to meet a long-wanted need, and his bibliography alone should be both of interest to the military student and of value to the War Office authors who, it is understood, are at present reviewing our military pamphlets on both guerilla and anti-guerilla warfare.

As a nuclear stalemate becomes more likely, so does it become more important to study the recent fighting in Malaya, Vietnam, Cyprus, Cuba, Laos and Algeria, all wars of a type which Colonel Woodhouse aptly calls "sub-conventional", which in technique are largely a development of the resistance movements of the last war. *Partisan Warfare* is worth reading as a forerunner to up-to-date training pamphlets on this important type of warfare, which may well become the pattern of most future wars.

E.C.W.M.

THE BLINDING FLASH

By JOHN FRAYN TURNER

(Published by George G. Harrop and Co Ltd, London. Price 18*s*)

Here is the story of a man; a man blessed with a wife, whose courage and fortitude matches his own. The hero—for so he is, judged by any standards—was a young officer in Bomb Disposal. He was severely wounded and totally blinded in September 1943 while removing mines and booby traps, laid in the West Pier at Brighton as anti-invasion measures.

In his Foreword, General Horrocks outlines the salient incidents in the story, and what follows here is largely taken from that Foreword. Ken Revis was trained to be a structural engineer and had almost qualified when the last war broke out. At the age of 23 he joined the Corps and was commissioned into Bomb Disposal. In 1941 he married Jo, and during the next two years he dealt with many types of bomb, showing nerve, courage and organizing ability in the process. On 10 September 1943 while he was removing booby-traps in the West Pier, thirteen mines blew up in his face. His mangled body was rushed to East Grinstead Hospital. No less than twenty plastic operations were required to remake his shattered face; but not even the most highly skilled surgeon could replace his eyes. With single-minded courage Ken and Jo Revis determined to lead an independent, normal life again. They formed a valiant team to which an Alsatian guide dog was later added. Ken learned braille at St Dunstan's; he learnt to type; he took part in dances and even ran in the sports.

His first job—arranged by Lord Fraser, himself a blind man, wounded in the First World War—was to assist Sir Clutha Mackenzie, the head of St Dunstan's in India. After Indian independence, Ken and his wife returned home and he was appointed to the personnel department of the Nuffield group at Cowley. Even this was not enough, he felt he must have some professional qualification. He decided to become a solicitor. His firm gave him leave, and St Dunstan's helped with his studies; now, after five years' solid work, he is a qualified solicitor and assistant Press officer with the Nuffield group.

That is the work side of the picture; but besides that he has raised hundreds of pounds to help in training guide dogs; he has piloted a glider or sail plane; he has water-skied and ridden horses; he has sung on television and learned to play the guitar; and, with his wife at his side to guide him, he has even driven a motor car at 100 mph on an airfield runway. As General Horrocks says: "I am left with the conviction that the characters of these two young people have been strengthened by the struggle they have been through."

The author of this book has written several others, one of which your Reviewer has noted in the *Journal*. He has written the kind of book that might be described as good reporting: facts, dates, events and motives are faithfully given. He is particularly clear in technical descriptions, whether of bomb mechanisms or surgical operations; and he gives the reader an understanding of the problems of a blind man. There are many photographs; but somehow the letter-press does not seem to conjure up in the mind of the reader any very clear picture of the man and his wife; and but for the photographs one might not recognize them if you met them in real life. There are a number of rather slap-dash pieces of reporting and a few printer's errors. The most moving passages concern Jo's feelings and doings from the time she received the telephoned news of the accident until she reached her husband's bedside.

This is a book that is quickly and easily read; and, because of the example for life that Ken and Jo set all of us, it is a book that should be read. M.C.A.H.

Technical Notes

ENGINEERING JOURNAL OF CANADA

Notes from *The Engineering Journal of Canada*, December 1961

THE CHAMPLAIN BRIDGE: Unfortunately, this paper is not as interesting as its subject warrants, and the general description of the bridge is impaired by the lack of a site plan. There are, however, five very good photographs of different portions. The total length of the structure, including approaches, is over four miles, and it includes three prestressed concrete sections, and a high-level steel structure spanning the Seaway canal.

The design and construction of the prestressed concrete sections are given particular attention. They comprise twelve spans of 128 ft, forty-four spans of 176 ft 4 in and two of 168 ft 8 in, and four spans of 172 ft, giving a total length of about 2 miles, using 482 prestressed concrete girders. Two three-lane carriageways, 38 ft wide, are provided, and the bridge is designed for a load 25 per cent greater than that of two 20-ton trucks and 16-ton trailers per lane.

INTERCONNECTED POWER SYSTEMS: This is a comprehensive and somewhat academic exposition of the basic requirements of load-frequency control and turbine governors. Both specialist and student of power system engineering will find a lot of useful information in this paper, the author of which makes a number of recommendations for the improvement of regulation in power generation and distribution.

THE SASKATOON PRODUCTIVITY PROGRAM: It is widely recognized that increased productivity is essential for the well-being of this country. Saskatoon is faced with a very similar problem, the need to produce goods of internationally acceptable quality at a competitive cost. As the author of this paper says, this requires more than straight technology. His brief report of local efforts to examine the problem, and to teach management techniques, is of considerable general interest, and the pilot experiment which he describes provides a good basis for constructive thinking.

"TONNAGE" OXYGEN: Although unlikely to concern the military engineer, this is a most interesting example of the conversion of what was originally a waste product into a manufacturing agent.

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

DRB TOPSIDE SOUNDER SATELLITE: The ionosphere, which reflects high frequency radio waves, is of extreme importance to communications, but its reflective properties vary widely. It has been studied from the earth for many years, but very little is known about its upper side, beyond the height of maximum ionization. The topside sounder satellite experiment is designed to sound the ionosphere from above, and to provide data for the investigation of conditions above it. This is a very interesting description of the design and instrumentation of the satellite, and of the problems which have had to be solved.

STEAM POWER PLANTS: That the trend towards centralized control, performance monitoring, and automatic operation can apply to steam power plants is clearly shown by this paper, which is however primarily of value to specialists.

DOUGLAS FIR PLYWOOD MANUFACTURE: It is usually interesting, and often salutary, to learn what is involved in the production of a commonplace material. This particular industry manifestly calls for sound engineering layout and design, as well as for special skills.

RESISTANCE OF ALUMINUM TO CONCRETE, STUCCO, AND BRICK MORTAR: A comprehensive series of tests shows that aluminium is not seriously affected by being embedded in common alkaline building materials. Examinations carried out after periods of 8 days, 6 months, 18 months, and 10 years indicate that superficial etching may occur during the period when concrete, plaster, etc are setting, but that no appreciable corrosion takes place thereafter unless there is frequent exposure to alternate wet and dry conditions. The greatest effect occurs at the junction of concrete and air, and the extent of attack increases with the richness of the mix. The most effective protective treatment is a single coat of bituminous paint. The general conclusion is that aluminium alloys, other than in thin sections, can safely be used in conjunction with ordinary building materials in all normal conditions of exposure.

ENGINEERING EDUCATION: Although it is based on conditions in Canada, this paper raises many practical questions that must interest every modern engineer. The problem is not one for the universities alone: it challenges both industry and the engineering profession.

SASKATOON SEWAGE STABILIZATION PONDS: It is surprising to learn that a city with a population of some 95,000, roughly equivalent to Cambridge or Halifax, has no sewage treatment facilities. In this country, the design of sewage disposal plant is usually prejudiced by the need to adapt or extend existing installations. This discussion of the alternative methods of treatment, given a free hand, is interesting and instructive, but the suggested solution might not be altogether acceptable in these islands.

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

HYDRAULIC CAPACITY OF LARGE CORRUGATED METAL CULVERTS: The design of pipe culverts described in ME Volume V Part I and RESPB No 5A is based on Manning's formula, using a value of 0.021 for the coefficient n in the case of corrugated metal pipe. From recent experiments described in this paper, it appears that this figure should only be applied when the depth of corrugations is ½ in. Experimental results using corrugations 2 in deep and at 6-in pitch, with pipe diameters of 5 ft and 7 ft, and a length of 80 ft, indicate that the value of n in such cases should be approximately 0.035.

THE DESIGN OF A CANADIAN GANGSAW: This is an interesting discussion of large-scale sawmill practice, and of the factors involved in designing and selecting sawmill machinery.

REVISION OF THE CONCRETE SECTION OF THE NATIONAL BUILDING CODE: The 1960 revision of Canadian national specifications relating to concrete materials and design excluded a number of design considerations about which insufficient details were available for study. It is concerned mainly with shear strength, bond between concrete and reinforcement, and the control of cracking. This is a clearly written commentary on the changes introduced, with a frank statement of the aspects still to be reviewed.

RANDOM VARIABLES IN ENGINEERING DESIGN: This is a misleading title. The paper is concerned with unwanted signals in electrical control systems, and is written for specialists. R.P.A.D.L.

CIVIL ENGINEERING

Notes from *Civil Engineering and Public Works Review*, December 1961

THIXOTROPIC CLAY SUSPENSIONS. This is the first of a series of articles by Professor Billig on the properties, and the uses in civil engineering, of thixotropic clay suspensions. Thixotropy is the property of a suspension to change its state, from the fluid to the solid state, and vice-versa. These suspensions, the best known of which is Bentonite, are being used on an ever-increasing scale in this country. The most common use is for the stabilization and waterproofing of the soil around tunnels and caissons, particularly during construction. In other cases soil is stabilized to increase its bearing capacity. A low-friction layer of suspension around a caisson can be used to simplify sinking through difficult ground. In another field, small quantities of Bentonite, added to concrete, increase its permeability, plasticity and workability. The article describes the physical and chemical properties of suitable clays. For instance, Bentonite, which consists mainly of a leaf-structured silicate called Montmorillonite, has high expanding properties and a capacity for base exchange. It is able to absorb up to seven times its own weight of water in going into suspension. The article then discusses the rheological properties of the suspensions, which concern the movement of the particles within the suspension under different loadings.

THE HAMMERSMITH FLYOVER. Many articles have already been written on the design and construction of the Hammersmith Flyover. This one gives a good over-all picture of the reasons for building the flyover, the principles of the design, the composition of the structure, and some information on the construction methods. It does not give much information on the prestressing.

THE DEGREE OF REDUNDANCY OF STRUCTURES. One of the problems in analysing the forces in a large stiff-jointed structure is that of determining the degree of redundancy. This article, the first of two, explains a relatively simple method of solving this problem. Basically, the number of members for a structure to be simply determinate, if all joints are pinned, is twice the number of joints, excluding the base connections. In this method, each restraint at a joint is treated as being equivalent to an additional member in the structure, whilst any joint where there is only a roller type of support is equivalent to one less member. The degree of redundancy is then found by subtracting twice the number of joints from the adjusted number of members, taking account of the fixity and roller supports.

In considering symmetrically loaded multi-bay structures, only one half of the whole is considered, the other half being replaced by further pinned or rigid supports in the case of a frame with an even number of bays, or by roller supports where the number of bays is odd. These latter supports transmit resistance to rotation but transfer no shear load, since there is no shear in this position.

THE EFFECT OF MIX PROPORTION ON VACUUM CONCRETE. This is the second article describing some tests carried out at the Royal Military College of Science. Concrete test cubes were subjected to vacuum after placing, in order to draw off some of the excess water, and thus increase the strength. Different times of vibration and different types of aggregate were used to give a wider scope for the tests. The conclusions, given in this article show that the strength of the concrete was in fact increased. No applications of the method are suggested, but it might possibly be worthwhile in the large-scale production of small precast units. It was stated in the first article that the method has been used fairly extensively abroad, including the USA.

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

WENTBRIDGE VIADUCT & BY-PASS. The Wentbridge viaduct, 470 ft long and 100 ft high is the largest of its type in Europe; it consists of a prestressed concrete box girder, continuous over three spans, with two pairs of tapered raking leg supports. In all, some 90 miles of 2 in diameter and 30 miles of 3 in diameter tubular scaffolding were used in the centering for the structure.

THE DEGREE OF REDUNDANCY OF STRUCTURES. This is the final part of a previous article; in it the author goes on to develop his method to space frames.

This number contains several articles on different aspects of the use of timber in civil engineering. One of the most interesting is:—

TIMBER SHUTTERING TO GIVE TEXTURED CONCRETE. When it is required to use rough timber to give its characteristic texture to a concrete surface, the timber should be correctly selected and treated. The best timbers for the purpose are Larch, Douglas Fir and Scots Pine, all of which possess well developed and demarcated bands of summer wood. The timber should be flat sawn to give the best effect. It is preferable that the mould should be made up in a joinery shop rather than on site, and that the timber should be air dried before use; some swelling is bound to occur when the bands are moistened during concreting, but this is better than shrinkage and possible loss of grout if the boards are insufficiently seasoned. The final texture can either be obtained by subjecting the boards to weathering, so that the softer spring wood fibres are eroded, or by machining with slightly blunted cutters and slow feed speeds, which has the same effect.

THIXOTROPIC CLAY SUSPENSIONS. The second article in this series discusses the behaviour of thixotropic solutions, with particular reference to their concentration and temperature. It goes on to describe the results of investigations into the solidification and liquefaction times, the viscosity and the flow diagrams under different conditions of load, acceleration and velocity.

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

SPINNING OF THE MAIN FORTH ROAD BRIDGE SUSPENSION CABLES. The suspension cables of the new Forth bridge contain some 30,000 miles of 0.19 in diameter galvanized steel wire. This article describes the process of building up the cables from the wires, carried over eight at a time by a sheave fixed to an endless hauling rope. Before spinning could start, temporary footbridges had to be erected across the river, about 4 ft below the eventual level of the main cables. About sixty men were employed on each shift of the cable spinning work and, with the traveller moving at up to 700 ft per minute, more than 300 miles of wire could be placed in a day. Special safety precautions were necessary in view of the height of the catwalks above the water; the catwalks and safety railings on the towers were of an unusually strong standard for temporary works. Communications were maintained by means of a highly developed telephone installation and by RT equipment.

THIXOTROPIC CLAY SUSPENSIONS. The third article in this series considers the practical applications of Bentonite and other similar suspensions. In shaft or well sinking and certain forms of pile-driving, an annulus is formed around the casing being driven, which is then filled with Bentonite to provide a low friction layer, and decrease the resistance to driving. When it is required to improve a soil formation, either as regards strength or resistance to moisture penetration, various materials can be injected to achieve this purpose. Chemical solutions, usually producing silicates, should be used for fine-grained soils, whilst clay-gel injections and cement or cement-mortar injections should be used as the grain size becomes progressively larger. J.C.P.

THE MILITARY ENGINEER

JANUARY–FEBRUARY 1962

"MULTIPURPOSE WATER CONTROL ON THE MISSOURI RIVER", by Brigadier General W. R. Shuler, United States Army. This is a description, illustrated with a map and photographs, of the water control system on the Missouri which was initiated in 1930 by the construction of the first dam. The project is a multiple purpose one providing for irrigation, flood control, navigation, municipal water supply and hydro-electric power. The organization of the Reservoir Control Centre and Co-ordinating Committee by means of which the sometimes conflicting claims of the various interests are reconciled is given.

"PLACING PILES BY VIBRATIONS", by Anthony V. Iarrobino. "The principle that devices powered by sonic waves expand and contrast in relation to the frequency of vibration is employed by the sonic driver to large masses utilizing high power. The driver working at up to 140 impulses per second sets up vibration waves travelling at the speed of sound in the material the pile is composed of, the frequency being such as to place the pile in resonance frequency so that the energy is transferred with high efficiency from the driver to the base of the pile. This power coupled with the expansion and contraction of the pile, plus the dead weight resting on the driver forces the pile smoothly into the earth." This is the theory and the article describes the highly successful demonstration which was given by the inventor last year. In the opinion of the author the results achieved were most impressive. The sonic driver was shown to be an effective, practical, and economical method for placing piles in sands with a minimum of noise and shock. It also showed itself to be equally efficient for extraction. He makes reservations about its general application for all types of soils and says that more trials are needed before a final conclusion can be reached. The method has been patented in the US.

"CONSTRUCTION OF AEROSPACE MEDICAL CENTER", by Major-General Robert J. Fleming Jr., Army Corps of Engineers, Colonel Adolf Kroeber, United States Air Force and Lieutenant-Colonel George L. Hahn, United States Air Force. The Aerospace Medical Centre is the United States' principle school and research centre in the field of aerospace and aviation medicine. This article describes the design and construction of a new home for the centre at San Antonio, Texas.

Basically, the special requirements are buildings in which conditions existing in aerospace operations can be simulated and their effects on the physiology and reactions of men and animals can be studied. Two buildings are described in some detail. First the Bionucleonics Laboratory for the study of the effects of nuclear and cosmic radiation on living beings, and secondly the Bioastronautics-Biodynamics Laboratory. The latter will be the centre of research and evaluations of reactions of humans and other animals to varied problems of living under simulated space conditions including the surface of the moon.

The article gives many details of the difficult construction problems met with in providing the facilities required and is an impressive illustration of the immensity of the effort called for to put a man into space or to land on the moon, since although only a part of the whole effort, the centre is taking over six years to construct, occupies an area of 60 acres and contains a great deal of highly specialized design and construction work which must be very expensive.

"LARGE BLAST LOAD GENERATOR", by Captain Daniel I. Lycan, Corps of Engineers. This article describes in some detail a large scale testing device designed to simulate the effects of nuclear weapons in the kiloton and megaton ranges so as to obtain data for the design of underground structures. The Large Blast Load Generator (LBLG) gives a peak pressure of 20–500 psi in ½ millisecond with a 2-second duration of the pressure. The available surface area for dynamic loads is 446 sq ft and the depth for soil and test specimen is 10 ft so it will be seen that the installation is a formidable one and the details of design are interesting. The power behind the pressure is produced by the firing of primacord in perforated steel pipes. The article is well illustrated.

"AMPHIBIOUS ASSAULT BULK FUEL SYSTEM", by Colonel William W. Lewis, United States Marine Corps. The increase in the quantities of fuel required by amphibious forces which has taken place even since the last war has led the United States Marine Corps to develop more efficient methods of ship to shore delivery and inland distribution.

In principle the system does not differ from the methods used in 21 Army Group in Normandy but the equipment is improved. This consists of collapsible neoprene tanks, 10,000 and 900 gallon, rigid aluminium tanks, 800 gallon for use in landing vehicles, centrifugal self priming pumps, distribution hose and water separator filter units. The article is well illustrated and the organization of the Automatic Supply Distribution Battalion of the Force Service Regiment, responsible for the installation and operation of the system, is given. An unusual new development is the Rolling Fuel Transporter, of which a photograph is given. It looks like a trailer with two huge tyres on its wheels. The capacity is 1,000 gallons and it has a high cross country capacity.

"FIELD PROFILES MECHANICALLY PLOTTED TO SCALE", by Lieut-Colonel Walter C. Carey, Corps of Engineers. This is a description in some detail with illustrations of a method of surveying the under water cross sections of river crossings, etc. The system has developed gradually and now, as described, consists in a combination of echo depth sounder and distance wire with self recording mechanisms.

"RADIOPROTECTANT DRUGS", by Jack de Ment. The author of this short article is research consultant in biophysics and pharmacology at the University Medical Centre in Portland. He gives an outline of the research in hand and the theories underlying it but regrets that so far no radioprotectant for human beings has been found. The advantages of one extend far beyond the limits of protection in war. They could be extensive in the field of medical research and treatment of disease. J.S.L.S.

THE CONTRACT JOURNAL

Notes from *The Contract Journal* No 4306, 4 January 1962

INCREASING USE OF SEA WATER ENVISAGED. At the moment, excluding ships at sea, about 400,000 people throughout the world depend entirely or mainly on converted sea water. With the estimated growth of consumption during the next decades this number is likely to increase considerably. Already water rationing in summer is very familiar in many countries.

For communities like the State of Kuwait, where fuel costs are almost negligible and the pass out steam is used to produce electricity, cost can be kept low. The cost of using converted sea water for large scale industrial users would, however, be unacceptable in a country like Britain. The paper goes on to consider development work, specialized uses, freezing processes and solar distillation; and concludes that although improvements in conversion costs will undoubtedly occur, wide-spread application of conversion to solve large scale shortage is not imaginable. M.G.H.

Notes from *The Contract Journal*, 25 January 1962

BUILDING RESEARCH STATION DIGEST NO 18—DESIGN OF TIMBER FLOORS. This Digest supercedes that published as Digest No 1 in 1948. The article is mainly concerned in the design and construction of timber floors to prevent dry rot, and discusses the problems of material selection, ventilation, etc, required to prevent such conditions occurring. Several useful sketches are included illustrating methods of ventilating ground floors and fixing timber boarding to concrete bases.

Notes from *The Contract Journal*, 1 February 1962

JACKBLOCK METHOD OF CONSTRUCTION: This article describes an interesting method of construction shortly to be used in the erection of a seventeen-storey block of flats in Coventry. The roof is constructed at ground level and raised by hydraulic jacks to such a height as to allow the construction of the core supporting walls of the top storey. The next floor is then cast and the whole jacked up again. This sequence is continued until the whole building has been constructed and lifted into its final position. One of the main advantages of this method is that all construction is done at ground level in "workshop" conditions. Erection will be in the dry at equable working temperature, and there should be no loss of working time due to rain or frost.

Notes from *The Contract Journal*, 8 February 1962

PRECAST UNITS IN CROSS-WALL SYSTEM: This article describes a new system of multistorey construction being used in a building development scheme in Great Cumberland Place, London, W1.

The development is T shaped in plan in two main blocks, one of seven storeys and the other thirteen storeys. The superstructure is of normal reinforced concrete construction up to first and second floor of the blocks, respectively, but beyond this, load bearing, pre-cast reinforced concrete wall panels are used instead of the conventional beam and column construction.

After a floor has been shuttered and the reinforcement fixed, load-bearing wall panels are "hung" from special steel lattice portal frames. The portal frames support the panels whilst the surrounding floor is being poured, and also form the support for the next deck floor. More portal frames are erected and the next lift of panels supported whilst the second floor is poured. The lower portal frames are then struck for use on the next floor of the building.

The article also gives some details of the support of adjacent roads and buildings during excavation of the foundations. Chemical injection using the TDM process was used to form a hard, stable, waterproof curtain around the site.

Notes from *The Contract Journal*, 22 February 1962

FORMWORK USED IN CONCRETE CONSTRUCTION: A draft specification for formwork, recently published by the Technical Committee of the Reinforced Concrete Association in "Structural Concrete", is repeated in this article.

These specification clauses are intended for use in all forms of building and civil engineering construction, and are sufficiently comprehensive to be used without alteration or amendment.

Comments on this draft specification should be forwarded in writing to the secretary of the RCA, 94–98 Petty France, London, SW1. J.R.J.