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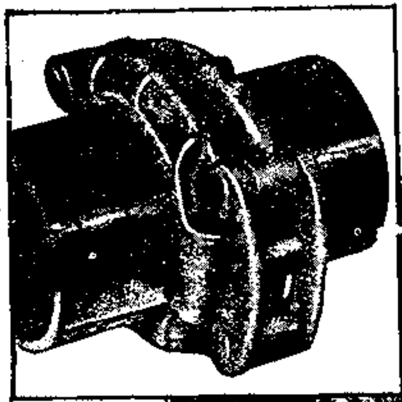

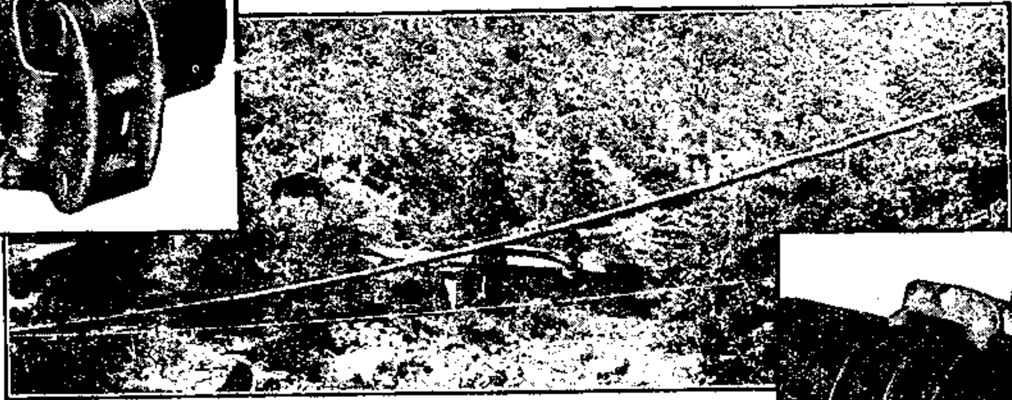

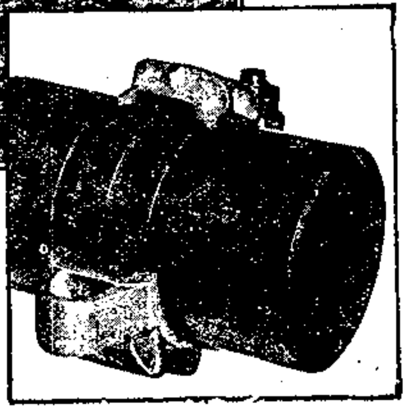

THE ROYAL ENGINEERS JOURNAL

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

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Photo 1.—Lieut.Colonel J. L. B. Templer, K.R.R.C.

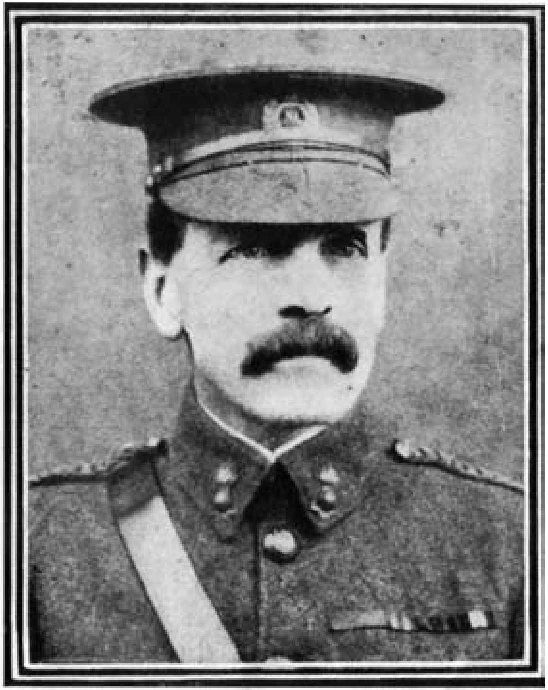

Photo 2.—Colonel (later Major-General Sir John) Capper, C.B., R.E.

The History Of Early British Military Aeronautics 1,2

THE HISTORY OF EARLY BRITISH MILITARY AERONAUTICS

By BRIGADIER P. W. L. BROKE-SMITH, C.I.E., D.S.O., O.B.E.

PREFACE

NOT long before the 1939–45 War the author was invited by the Institution of Royal Engineers to write, for publication in the *R.E. Journal*, an historical account of the air activities of the Corps when it was responsible for military aeronautics, prior to the formation of the Royal Flying Corps in 1912. A good deal of preparatory work had been undertaken when the task had to be relinquished owing to the full-time employment of the author during the war, and subsequent circumstances further delayed its completion.

In the compilation of the account valuable help has been received from many sources. These include Major-General Sir John Capper, Colonel Sir Charles Arden-Close, Colonel H. B. Jones, Brigadier-General R. B. D. Blakeney, Colonel A. H. Bell, Colonel A. D. Carden and Major H. R. P. Reynolds, who were in their time employed in the R.E. air branch. Acknowledgements are also especially due to Mr. C. F. Caunter for assistance freely given, and to Mr. G. A. Broomfield for information in regard to Mr. S. F. Cody's early flying efforts.

The author apologizes for the frequent appearance of his name, in the course of the narrative, amongst those of others of much greater achievement.

CHAPTER I

BALLOONING ESTABLISHMENT AT WOOLWICH AND CHATHAM 1878–91

Start of practical developments at Woolwich—Previous efforts to get ballooning taken up—Balloon Equipment Store—Free ballooning fatality—School of Ballooning at Chatham—Introduction of gas tubes—Goldbeater's skin balloons—Technical transport—Bechuanaland and Sudan expeditions—Ballooning camp at Lidsing—Experiments at Lydd—Aldershot manœuvres 1889.

THE practical development of ballooning in the British Army began in 1878, when authority was given for the experimental production of balloons and field equipment in Woolwich Arsenal. Captain H. P. Lee, R.E. and Captain J. L. B. Templer of the Middlesex Militia (subsequently K.R.R.C.(M)) were appointed to carry out the experiments, and an initial grant of £150 was given for the construction of a balloon.

Captain Lee, who at the time was in charge of railways in the Arsenal, had been experimenting in the manufacture of hydrogen on behalf of the Balloon Committee which is referred to later. Captain Templer was an intrepid aeronaut, possessing his own balloon, who had for several years taken an interest in the military uses of balloons and had many practical suggestions for the organization of a field ballooning equipment.

Prior to this, credit must be given to Lieutenant (subsequently Captain) G. E. Grover, R.E., and Captain F. Beaumont, R.E. (who had attached himself to the Federal Army balloonists in the American Civil War), for their persistent efforts between 1862 and 1873, in face of continued lack of belief in the military value of balloons, to get ballooning taken up in the British Army.

They were attached to the Ordnance Select Committee, and made experimental ascents for reconnaissance purposes at Aldershot and Woolwich in 1863 with a balloon and improvised equipment hired from Henry Coxwell, the well-known civilian aeronaut of the time; the balloon was inflated with coal gas at the local War Department gasworks. It was agreed by the Ordnance Select Committee, two members of which also made ascents, that balloon reconnaissances would provide useful information, and Mr. F. Abel, F.R.S., the Chemist to the War Department, made investigations to determine the most suitable balloon material and the best method of generating hydrogen; the cumbrous nature of the ballooning equipment hitherto in use and the lack of an efficient hydrogen-holding balloon material being serious stumbling-blocks. In his report Mr. Abel indicated that military ballooning equipment could not be extemporized, but in 1865 it was decided not to proceed in the matter "in times of profound peace."

Continuing his efforts, in 1868 Captain Grover drew the attention of the War Office to the successful employment of balloons in the war between Brazil and Paraguay the previous year and asked for sanction to construct a hydrogen apparatus suitable for use in the field, but it was considered that the expenditure of valuable time and money upon a further inquiry was not then justified.

The Franco-German War of 1870–1 brought the subject forward again, and it was referred to the R.E. Committee, which was reconstituted in 1870 to consider inventions and improvements in engineer equipment. The small balloon committee, composed of Captain Beaumont, Captain Grover, and Sir Frederick Abel, which had continued to deal with balloon questions at Woolwich, became a sub-committee of the R.E. Committee. At this time Captain Grover was succeeded by Major Scratchley, R.E., and in 1873 Lieutenant C. M. Watson, R.E. replaced Captain Beaumont.

In 1873 the War Office called upon the R.E. Committee to prepare details of a balloon equipment for the Ashanti expedition. Lieutenant Watson worked out proposals for a transportable gas generating apparatus, devised in 80 lb. loads, so as to be suitable for carriage by native porters as was necessary on the Gold Coast, and Mr. Coxwell offered to supply two silk balloons with car and net, etc., for £2,000. But the improvised outfit would have been costly besides being of doubtful efficiency, and could not have been completed in time for use on the expedition, so the idea of providing balloon observation for it was abandoned.

No important action was taken on the recommendations of the R.E. Committee until 1878, except to allow the construction in Woolwich Arsenal of apparatus for the generation of hydrogen by the two alternative methods of passing steam over red hot iron filings and the action of sulphuric acid on zinc. A proposal of the Committee, made in 1875, that the gas should be carried in the field, compressed in steel tubes, and generated at the base, was pigeon-holed.

Between 1872 and 1878, except during his absence on active service in the Sudan in 1874-5, Captain C. M. Watson,* who, as already mentioned, joined the balloon sub-committee in 1873, played an active part in the advocacy of military ballooning and in the quest for an efficient method of providing hydrogen in the field and for a reliable material for the envelope of a hydrogen war balloon, both of which were essential to further progress. He was associated with Captain Templer from 1875, taking part in free balloon runs with him, and was instrumental in getting him appointed to the experimental team in 1878.

Pending the production of military hydrogen balloons, and later to supplement them until a permanent hydrogen plant and a satisfactory field gas equipment could be provided, Captain Templer's large coal-gas balloon, the *Crusader*, was used for captive and free ascents. The successful construction of a balloon at a cost of £71 and promising ballooning experiments led to the constitution in 1879 of the "Balloon Equipment Store." The first balloon was the *Pioneer*, of 10,000 cu. ft. capacity, and made of specially treated and varnished cambric; the gores for the balloon were designed by Captain Watson. Captain H. Elsdale, R.E., now joined in the work, replacing Captain Lee, with whom he was to alternate as the officer in charge of ballooning during their respective tours of foreign service from the end of 1879 to 1881 and from 1882 to 1884.

Captains Elsdale and Templer took a balloon, Captain Templer's *Crusader*, to the Easter Volunteer review at Dover in 1879 and again

* Eventually Colonel Sir Charles M. Watson, K.C.M.G., C.B., M.A.

at Brighton in 1880. The balloon was filled with coal gas at the nearest gas works and towed to the scene of action, a smaller balloon being also filled and taken along to provide gas replenishments. It was recorded that observation of the field day operations at Brighton was prevented by fog and the dense clouds of smoke from the rifle firing, together with the burning fuses of the artillery, until the weather cleared and the smoke dispersed.

In 1880 military balloon training was initiated at Aldershot by Captains Elsdale and Templer with personnel and transport from the 24th Field Company R.E., and in this year for the first time a balloon detachment attended the Aldershot manœuvres. This was repeated in 1882, Captain Lee then being in command.

Free ballooning was much practised, and there were many adventurous incidents. The most dramatic of these, in December, 1881, nearly brought Captain Templer's career to a premature end. The ascent was made from Bath in a coal-gas balloon named the *Saladin*, with the object of carrying out meteorological observations. Captain Templer was accompanied by Mr. Walter Powell, M.P. for Malmesbury, who was a skilled aeronaut and had been financing the first attempts at making a goldbeater's skin balloon which will be described later, and Lieutenant Agg-Gardner of the South Wales Borderers Militia. The clouds became so thick that the ground below could not be seen, the wind was rising, and the night was fast setting in as it was near the shortest day, so Captain Templer decided to land. On descending he found that the balloon was fast approaching the sea near Bridport, the beating of the waves on the shore being audible. Discharging ballast, he cleared a village in the path of the balloon, and valving hard brought the balloon down on the other side, landing 150 yards short of the cliffs. Captain Templer had apparently decided that the grapnel would not hold, and calling to the others to follow him he rolled out of the basket as the balloon dragged along the ground in the strong wind, holding the valve line. Lieutenant Agg-Gardner jumped out, breaking a leg, but Mr. Powell, who was probably entangled in the rigging, did not jump out at once. Captain Templer, badly bruised, hung on to the valve line until his fingers were cut to the bone, but the balloon, relieved of the weight of the two men, rose at great speed and disappeared over the sea, carrying off Mr. Powell, who was never seen again. After this tragic episode Captain Templer made no more ascents, and he concentrated on his valuable equipment work.

Towards the end of 1882 the ballooning activities were transferred to Chatham, where the ballooning establishment, later called the School of Ballooning, formed part of the School of Military Engineering. Captain Templer was in charge of a small factory for the manufacture of balloons and hydrogen and the provision of balloon equipment, which he set up in some old huts in St. Mary's Barracks, whilst an R.E. officer was responsible for the actual ballooning. Captain Templer roofed over a derelict ball court for use as an erecting shop, and further to save expense used old beer barrels for the sulphuric acid and zinc hydrogen plant. Junior R.E. officers and men were attached for ballooning work from companies at Chatham. Major Lee, Major Elsdale, and Major Watson served in turn as Officer in Charge of Ballooning and in command of the military personnel up to 1889.

Officers and other ranks engaged on ballooning were closely associated with the factory; this association was to continue for many years.

In 1882 authority was given for experiments in the use of steel cylinders to carry hydrogen under compression, which had been recommended seven years before by the R.E. Committee on the advice of the Balloon Committee, and in 1884 the carriage of hydrogen in the field by this method was finally introduced. Lieutenant J. R. L. Macdonald, R.E. and Lieutenant F. C. Trollope, of the Grenadier Guards, who was also attached, co-operated with Captain Templer in the design of the tubes; the greatest difficulty was to devise a valve for the tubes, secure against the leakage of hydrogen. This superseded the cumbrous manufacture of gas for every inflation in the field, and in the introduction of this equipment the British service was several years ahead of all others. The hydrogen-making installation now included a gas compression plant.

Another notable achievement was the production by Captain Templer of balloons of goldbeater's skin, which was more impervious to hydrogen, very tenacious, and lighter, strength for strength, than any other balloon material. Goldbeater's skin, which was prepared from membranes from the lower intestine of the ox, was so called because it was used in the process of making gold leaf. An Alsatian family named Weinling had for some years, in the east end of London, been making small balloons of this material, which were used as toy balloons and for scientific purposes, the skins being imported from the Continent, where they were salted down and packed in barrels. In 1881–2, Captain Templer, having experienced great trouble in constructing balloons which were even partially impervious to hydrogen, employed this family to experiment in the manufacture of a large balloon. The building up of a large balloon of this material was not easy, but difficulties were eventually overcome; the Weinlings were taken into Government employ and brought to Chatham, where a 10,000 cu. ft. balloon, the *Heron*, was completed at the end of 1883. Meanwhile Captain Templer, assisted by Lieutenant J. E. Capper, R.E., who was then serving in the 11th Field Company at Chatham, had also made a smaller balloon of silk treated with linseed oil, in order to try that material; this was the *Sapper*, of 5,600 cu. ft. capacity. This was better than the varnished cambric balloons, but the goldbeater's skin balloon proved to be so superior in all respects that the type was adopted, and a diminishing band of members of the Weinling family remained on the task of constructing British military balloons for over thirty years.

The actual material was no secret, but their method of preparing and securely joining up the skins was known only to the Weinlings. The secret was jealously guarded by the family (numbering about seven), and when the amount of work required extra hands considerable obstruction had to be overcome. The completion of the first balloon was delayed as the principal balloon hand was imprisoned for three months for an assault on the police, and Captain Templer had great difficulty in getting the family to agree to the employment of two Sappers on the work.

Two standard sizes of balloon were made, of 10,000 and 7,000 cu. ft. capacity, the latter being intended to lift one light man in favourable conditions. To economize to the maximum in hydrogen and transport, a few smaller balloons were also constructed, of about 5,000 cu. ft. capacity, for use in countries with a low elevation above sea level, as in Egypt and the Sudan. As a result of experience the smallest sizes were soon discontinued, and later the 10,000 cu. ft. ballon became the standard pattern.

The secret of the construction of goldbeater's skin balloons of man-carrying size was preserved for many years, and the British service had the monopoly of them; ultimately, about 1912, the Germans used the material for the internal balloons of Zeppelin airships.

The evolution of the necessary technical field transport had begun at Woolwich with the extemporization, on a G.S. wagon frame, of a balloon wagon, which carried the cable and winch, an empty balloon prior to inflation, and accessories. For some time after the introduction of the gas tubes they had to be transported in G.S. wagons or in trucks drawn by a traction engine or "steam sapper."

In 1885 balloon detachments were employed under Major Elsdale with Lieutenant Trollope in the Bechuanaland expedition and under Major Templer with Lieutenant R. J. H. L. Mackenzie, R.E., in the Red Sea littoral operations in the eastern Sudan. The manning and equipment of these two detachments severely strained the small resources of the infant organization at Chatham. Ten balloonist N.C.Os. and sappers went to Bechuanaland, and only eight could be found for the Sudan expedition. These small parties had to be supplemented by untrained men borrowed from units in the field, and transport had to be similarly found. Camels were used in the Sudan to carry the gas tubes, which were a miscellaneous collection of various sizes, and contained only enough hydrogen for four small balloon fills. A gas plant was taken out and installed at the base at Suakin, but it was apparently found impossible to replenish the tubes, probably owing to deficiencies in personnel and transport. The best equipment had been supplied to the Bechuanaland detachment, which left England in the autumn of 1884 before it was decided to send balloons to the Sudan.

In the Sudan expedition the lack of transport and gas seriously hampered the ballooning operations and few positive results could be obtained in the few weeks during which ballooning was carried out, although it was reported that the presence of the balloons gave the troops confidence. Soon after the detachment arrived, a balloon was filled at Suakin, and on the following day, 25th March, 1885, Lieutenant Mackenzie observed from the balloon for seven hours during the 7-mile march of a convoy from Suakin to McNeill's zariba at Tofrik, three days after the disastrous action there. The balloon, of 7,000 cu. ft. capacity, was towed by a wagon inside the convoy square at a height of 400 feet ; movements of our troops, camels and small bodies of the enemy, up to a distance of 3 miles were reported, and our troops marching in a square out of the zariba were seen at a distance of 5 miles. The moral effect of the balloon on the Arabs was such that, although two previous convoys had met with considerable opposition, there was none on this occasion, and the Arabs were observed to be dispersing in all directions.

Another historic ascent was one made near Tambuk on 25th April by a 6-stone Arab named Ali Kerar, to a height of over 2,000 feet. He reported that he could see big guns firing at Suakin, 28 miles away. Major Templer verified this by heliograph, and it appeared that a *feu de joie*, in which the guns took part, had been fired in honour of the Khedive's birthday. The name-plate of the little 5,000 cu. ft. balloon, the *Fly*, was still to be seen, preserved with those of other war veterans, in the Balloon Factory at Aldershot in the early nineteen hundreds.

There was no fighting in Bechuanaland, but ascents were made in April, 1885, at Mafeking, and General Sir Charles Warren, the Force Commander, went up in a 10,000 cu. ft. balloon (the *Heron*), obtaining a good view of the surrounding country. Owing to the height of the ground above sea level the lift of the balloons was much diminished, and the smaller balloons would have been of little value for active operations.

In these campaigns the suitability of the newly introduced balloon material and gas tubes for active service conditions was proved, but the operation of balloons was severely hampered by the lack of properly constituted balloon units.

After the return of the balloonists from these expeditions activities were revived at Chatham, and in 1886 a summer training camp was established at Lidsing, 6 miles from Chatham, on land adjacent to a farm owned by Major Templer, which he acquired for this purpose. A quaint feature of the balloon field was a large pit excavated in the chalk which gave complete shelter to a 10,000 cu. ft. balloon. It was in the shape of an inverted cone and a spiral path led to the bottom where a stout anchorage was fixed. To provide shelter at other places portable balloon screens were used, consisting of canvas bays mounted on jointed tubular steel poles, which were supported by a complicated system of guys. Screens of similar pattern continued in use at training camps and ballooning grounds for many years.

Major Templer was no stickler for red tape, and throughout his career took any short cut he could to get what he wanted for the work to which he devoted himself. It is related that he managed to bring back from Suakin, during the evacuation of the expeditionary force, one or two traction engines and some other useful machinery which he found lying apparently derelict at the base, by chalking them with the address "School of Ballooning, Chatham." By some accident an E.P.* tent or marquee also found its way with the balloon equipment to Chatham, where it provided a mess tent of unauthorized luxury for the officers at the balloon training camp. Always a fervent advocate of mechanical road transport, Major Templer made good use of the traction engines to transport heavy stores and gas tubes.

In 1886 a balloon detachment under the command of Major Elsdale went to the siege artillery practice camp at Lydd, with promising results which led to the annual attendance of a balloon at this camp. Amongst many stories of the naïve remarks, made from time to time by people to whom a balloon was a strange novelty, one related by Sir Charles Arden-Close,† who as a R.E. subaltern was attached to balloons in 1887–8, may be quoted. When at Lydd he had the duty of showing a lady visitor the balloon, which was pegged down in its screen. After he had given her an exhaustive description of the balloon, and how it worked, she said that she thought she understood it all except one thing, and then asked, "How do you breathe inside?"

Other activities included experiments in aerial photography which were carried out by Major Elsdale, who sent up small balloons carrying an automatic camera; he had started this when he was at Halifax, Nova Scotia, in 1883, taking some successful photographs of the fort from the air.

* A large tent with double walls and roof, provided for British troops in Indian and known as the "European pattern" tent.

† Colonel Sir Charles F. Arden-Close, K.B.E., C.B., C.M.G., D.Sc., F.R.S.

Following upon the small results which the extemporized balloon detachments had been able to show in the Bechuanaland and Sudan campaigns, there was a renewal of the scepticism which had previously prevailed regarding the utility of balloons, and efforts which were made by Major Elsdale and Major Templer to get a permanent organization sanctioned were unsuccessful. The annual ballooning grant, which in 1886 was only £2,000, was reduced in 1888 to £1,600, and Major Templer was not even recompensed for the expenditure which he had incurred in providing the balloon exercise ground at Lidsing.

In 1888 Major Elsdale, who had done valuable pioneer work in the development of military ballooning and equipment, was succeeded by Major C. M. Watson. Major Watson continued to press for a permanent organization, recommending the immediate formation of a balloon unit with a proper establishment and with its own horses and drivers. The War Office decided that a balloon detachment should visit Aldershot during the manœuvre season of 1889, with a view to the matter being settled. The favourable report on the performances of the detachment by General Sir Evelyn Wood, the G.O.C. Aldershot Division, who was a strong believer in the possibilities of the balloon, led at last to the establishment of a balloon section on a regular basis in the following year.

Major Watson left towards the end of 1889 to take up an appointment at the War Office. He had done much previously to get military ballooning started, and, equally with his old friend Major Templer, had the satisfaction of seeing the formation of a regular unit and a permanent ballooning establishment in sight before his connexion with ballooning finally ceased.

In spite of the small means available the equipment had been improved, and the technical transport taken to Aldershot included three special wagons for the carriage of the gas tubes in the field. They were built up on G.S. wagon frames, as had been done previously to provide the balloon wagon. These tube wagons each carried forty-four tubes 8 in. long by $5\frac{1}{8}$ in. diameter, holding 100 cu. ft. of hydrogen under a pressure of 1,500 lb. per sq. in.; by increasing the pressure to 1,800 lb. per sq. in. the capacity could be increased to 120 cu. ft. for war use. The tubes could be turned on independently, and the gas was passed into metal chests at the rear of the wagons, from which it was conveyed to the balloon through goldbeater's skin hose and metal junction pieces.

Lieutenant B. R. Ward, R.E., who had just joined the balloons and taken over command of the detachment from Lieutenant H. B. Jones, R.E., took the personnel to Aldershot by train, whilst Lieutenant Jones proceeded with the wagons; these were towed by a "steam sapper" to Guildford, where they were met by teams of horses from Aldershot. Colonel H. B. Jones, C.B., relates that the journey to Guildford from Chatham took three days. The speed was limited to $3\frac{1}{2}$ miles per hour, a man with a red flag had to walk in front, and the train could be called on to halt to allow any horsed vehicle to pass. After the manœuvres the detachment was ordered to Lydd. The traction engine was unable to cope with the load of five heavy wagons and a water cart when tackling the steep hill in the middle of Guildford. The engine was uncoupled and taken to the top of the hill, and the wagons were wound up one by one by a wire rope, the date of whose last test was lost in antiquity. It was market day and the combination of a dense crowd, a doubtful wire rope, and wagons filled with compressed hydrogen caused the officer in charge an anxious half-hour. Further on a police superintendent stopped the train, which he said, could not travel by night as it was not carrying agricultural implements. The argument that the picks and shovels carried on the wagons as part of their equipment were agricultural implements was not accepted, but eventually the superintendent allowed the train to go on to the next stopping place for the night, and nothing further was heard on the subject.

One interesting point had to be settled on return to Chatham. Prior to going to Aldershot, Lieutenant Jones had enterprisingly bought a horse, as he had to be mounted for the field training ; it was highly probable that he would require it again the following spring, but he was not entitled to draw forage at Chatham. The O.C. Training Battalion, to which he was attached, pointed out the danger to a young officer of getting into bad company if frequently involved in the buying and selling of horses, and after much correspondence forage was allowed.

In those days marching order consisted of tunic, riding breeches, jack boots and spurs, helmet, belts, sword, and sabretache. On the first field day in which a balloon participated, when an ascent was about to be made it was with the greatest difficulty that a scandalized staff officer could be convinced that belts, sword, sabretache, spurs and helmet must be discarded by the observer, even though a visit from Princess Beatrice during the morning was a probability.

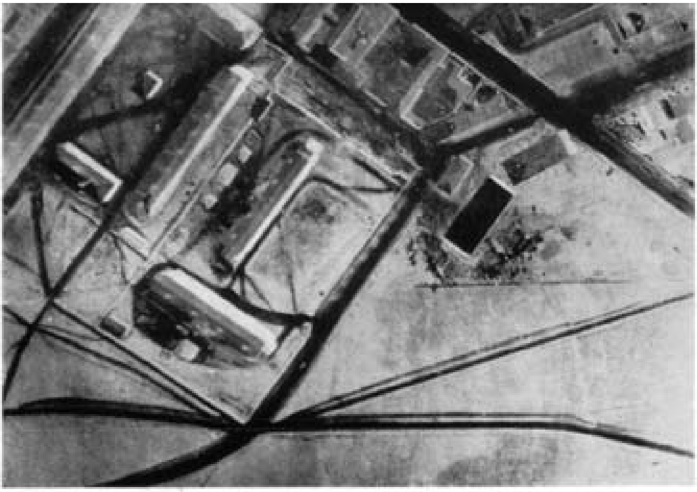

Photo 3.—Air photo of Citadel Barracks, Halifax, Nova Scotia, in 1883.

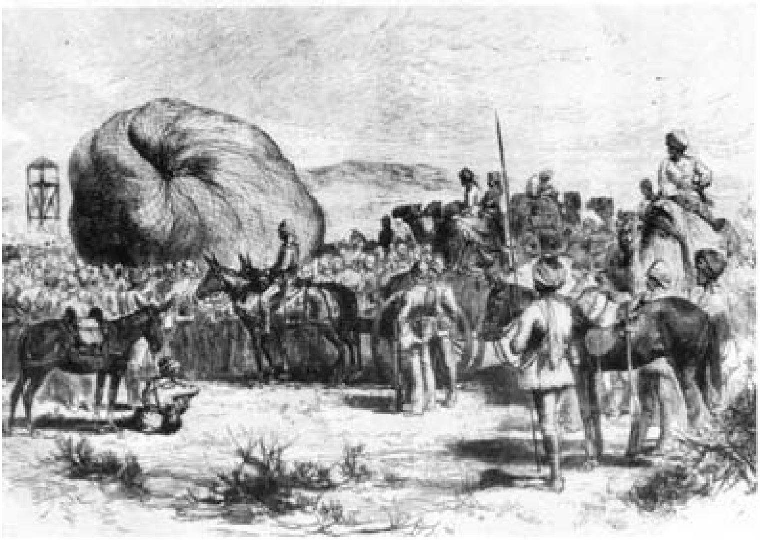

Photo 4.—Balloon being inflated near Tamai during the Sudan Expedition, 1885.
(By courtesy of Illustrated London News)

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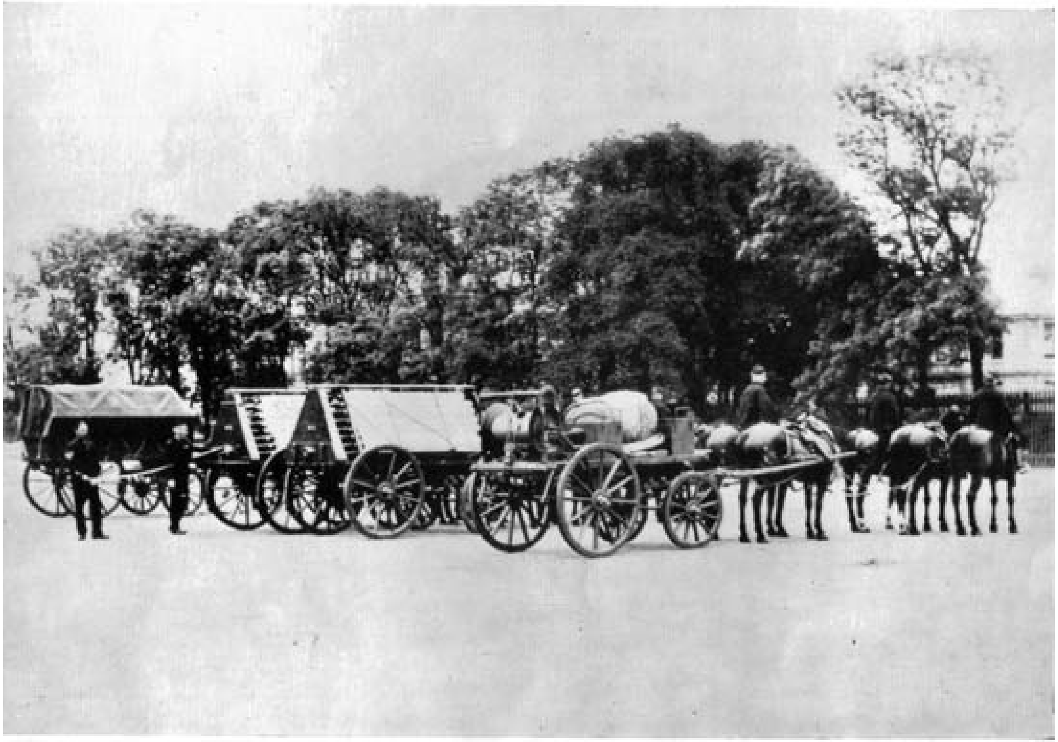

Photo 5.—Original Balloon Transport, 1889, showing Balloon wagon two of the three tube wagons and equipment wagon. Major C. M. Watson, R.E., in command.

Photo 6.—Captive Balloon, 1893. Lieut. H. B. Jones, R.E., in car.

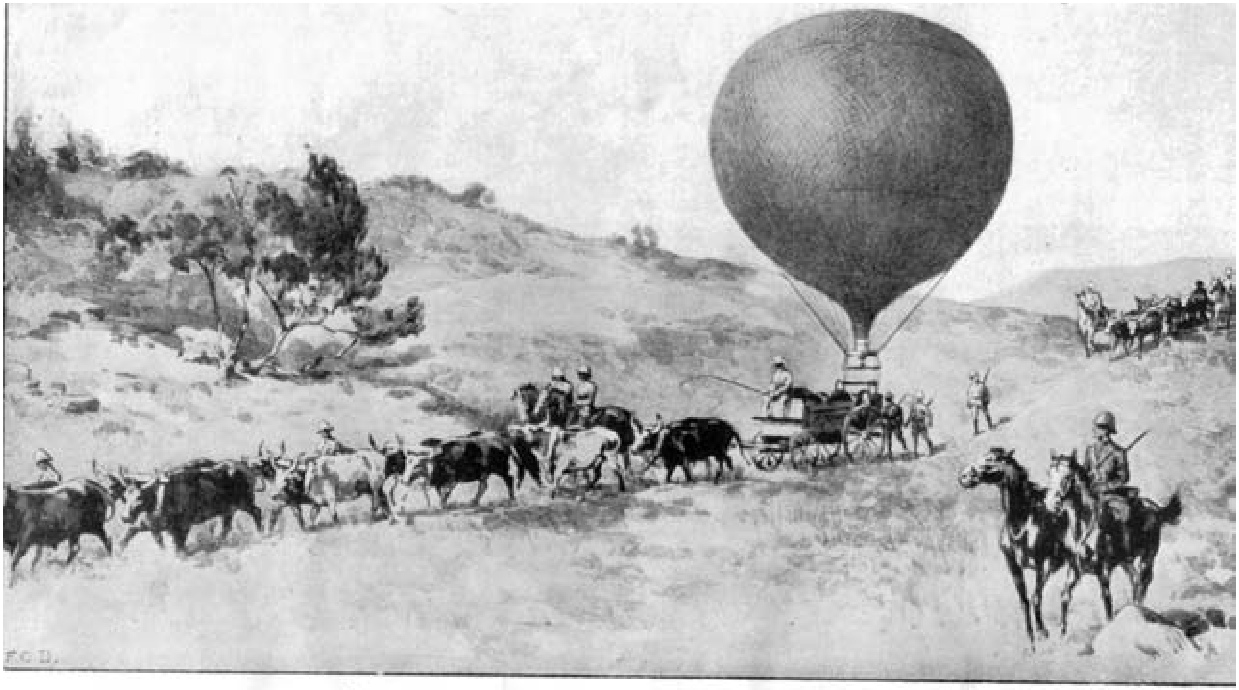

Photo 7.—1st Balloon Section near Kroonstad, South African War, 1900.

(By Courtesy of the Illustrated London News

CHAPTER II

BALLOON UNITS AND FACTORY AT ALDERSHOT TO END OF SOUTH AFRICAN WAR. 1891–1902

Formation of Balloon Section and Depot R.E.—Move of ballooning branch to Aldershot—Designation Balloon Factory officially adopted—Development of training and equipment—Free Runs—Engineer Training—Expansion during S. African War—Balloon Sections in S. African War—China Expeditionary Force—Indian Balloon Section—Balloon Factory during S. African War.

IN 1890 the Balloon Section and Depot was constituted under the command of Lieutenant H. B. Jones, R.E., an air unit being now for the first time included in British Army establishments, and it was decided to move the ballooning branch, including the balloon and gas-making establishment, to Aldershot. A site for the latter was found on the bank of the Basingstoke canal, adjacent to the R.E. (Stanhope) Lines. In 1891 the Balloon Section moved to Aldershot, and on completion of the new workshops and sheds the factory (which was still entitled the School of Ballooning) was established there under Major Templer in 1892. The establishment of the Balloon Section and Depot (which included the factory or School Superintending clerk and a few other N.C.Os. of the Depot employed in the factory) was three officers and thirty-three other ranks. No provision was made for mounted personnel and horses; these had to be borrowed from other units, an unsatisfactory and highly unpopular arrangement.

The new factory contained many facilities which had been lacking at Chatham. These included the corrugated iron Balloon Shed for the construction and overhaul of balloons, which stood up above the surrounding buildings and was large enough to contain several inflated balloons. The site was by no means an ideal one, but difficulties were surmounted, and it was a proud day for Major Templer when the balloon shed was completed, although in the opinion of the oldest inhabitants it ruined the amenities of Aldershot South Camp.

The old hut barracks at Aldershot were at that time being taken down and replaced by brick buildings. The components of these huts were in great demand and applicants were allotted huts on condition that they were cleared away. Major Templer secured a good allotment, and a small traction engine and truck, manned by all available hands from his civilian staff, including some of the women who made the balloons, and a few sappers, were turned out to collect the material. One hut was very like another, and frequently an angry commanding officer would find that a hut allotted to him, which was possibly rather well found, had totally vanished. Meanwhile small temporary buildings sprang up in the balloon yard, which supplemented the authorized accommodation with a number of useful additional shops and stores. Layers of felt from hut roofs provided a firm foundation for the balloon yard which was swampy, and by melting down gutters and flashings quantities of zinc, which was scarce and costly, were obtained to keep the hydrogen factory running.

In 1896 the facilities were further improved by the installation of a Siemens electrolysis plant for the manufacture of hydrogen.

The adoption of the electrolysis process had been considered as far back as 1880, and during the period when the ballooning establishment was at Chatham it was tried from time to time, experiments being made at the works of the Anglo-Brush Electrical Company in 1882 and subsequently in the Electrical School at Chatham ; but the gas produced contained some of the sulphuric acid with which the water to be electrolysed was acidulated. The preoccupations of the move of the Balloon Factory to Aldershot and its establishment in its new quarters prevented further attention from being given to the subject until 1892. Investigations which were made by Colonel Templer with a view to introducing a better hydrogen tube (the results of which will be described later), necessitated visits to factories where oxygen was generated and compressed. Observing the efficiency of the electrolysis process as then developed, Colonel Templer pressed for the installation of an electrolysis plant in the Balloon Factory, but this was not finally achieved until 1896.

This plant had the advantage of providing pure hydrogen, free from the acid fumes, detrimental to the balloon material, which could not be eliminated from the gas produced by the zinc and acid process, and at the same time the cost of hydrogen for ballooning was greatly reduced ; the saving was increased by the credits obtained from the disposal of the other product, oxygen. The new plant could supply 10,000 cu. ft. of hydrogen in twenty-four hours, and after its introduction the old-fashioned zinc and acid process was little used except for field gas factories.

In 1897 the designation Balloon Factory (which had been locally used since 1894) was officially recognized for Colonel Templer's establishment, and Colonel Templer henceforth held the appointment of Superintendent Balloon Factory. He had for some years previously been entitled Instructor in Ballooning, although this designation had for a long time been inappropriate.

The period between the move to Aldershot and the outbreak of the South African War was occupied in developing the training and equipment, and a comprehensive *Manual of Military Ballooning* was compiled by Captain B. R. Ward, R.E. This was largely based on notes on the technique of ballooning and the uses of balloons composed by Captain H. B. Jones, who served with balloons from 1887 to 1895 and commanded the Balloon Section from its formation in 1890 until he left in 1895; it also included elaborate tables to facilitate aerostatical calculations, by Major C. M. Watson, and chapters on free run reconnaissance and photography by Major Willoughby Verner, the topography expert, and Lieutenant A. H. W. Grubb, R.E.

The training included attendance at artillery practice camps, short courses in ballooning for officers of other arms, and practice in observation in co-operation with other arms, including participation in manœuvres, as opportunity offered.

An important innovation was the inclusion of a few Staff College graduates in the ballooning classes. In the selection of balloonists weight was a consideration, and it was rumoured that Staff College students whose wives were anxious that their husbands should remain on terra firma had the time of their lives in the matter of feeding.

The technical transport consisted of the balloon wagon, four tube wagons and an equipment wagon, all drawn by four horses. The balloon wagon carried the cable and hand-operated winch, a balloon in its basket when unfilled, instruments, sketching gear, telephone equipment for communication between the balloon and the ground, and other accessories. The 1888 pattern tube wagons had been modified to carry thirty-five tubes instead of forty-four, as the latter load was too heavy for four horses. The four wagons sufficed to inflate one balloon with a margin for replenishments, and three wagons were simultaneously used for a fill, a 10,000 cu. ft. balloon requiring about a hundred tubes, under normal conditions. The technical equipment G.S. wagon carried a spare balloon and cable and other stores. Under a balloon drill which was standardized, a well-trained detachment could fill a balloon and put it up in twenty minutes.

About 1898, after experiments and trials, which had been prolonged since 1892 owing to restrictions of funds and manufacturing difficulties, Colonel Templer finally succeeded in getting the 1883 pattern welded tubes replaced by tubes of spun steel made by the new Mannesman process, which gave greatly increased strength for considerably less weight and reduced the transport in proportion to the gas carried. The gas transport was increased to six tube wagons, each carrying nine tubes 9 ft. long by 8 in. in diameter, which held

500 cu. ft. of hydrogen at full pressure of 1,800 lb. per sq. in. These wagons were of simpler design than the earlier pattern, and better fitted for rough handling in the field ; the gas chest at the back was done away with and the nine tubes were connected by detachable rubber tubing to a portable metal " filler " and thence to the hose. The six wagons supplied enough gas to fill two balloons up to 13,000 cu. ft. capacity ; three wagons were used for a fill as before. This equipment was employed in the South African War.

As the balloons were small, the use of mechanical winding gear for hauling down was unnecessary, except for fortress or siege work in a restricted space, for which the balloon section was not equipped. The equipment and transport were designed for handiness and mobility, and the heavy steam winches used in foreign armies, which had much larger balloons, were not adopted. The balloon detachment could be carried on the wagons for short distances.

The normal method of hauling down the balloon was to bear down the cable by means of men walking or running with a pole slung on the cable by a snatch block ; alternatively a wagon to which the snatch block was attached could be used, or the balloon cable could be pulled in through a fixed snatch block, by moving the balloon wagon.

The balloons could be usefully operated in winds up to 20 m.p.h., and the usual working height for ascents was 1,000 ft. The 10,000 cu. ft. balloon, which remained the standard size, could lift two 140 lb. men with gear in a calm or in a mild wind. From 1894 larger balloons up to 13,000 cu. ft. were made ; these were at first intended primarily for free runs, but they were useful for giving a better lift for captive work, and were valuable in the South African War.

Reports could be made by sending down messages and sketch maps in weighted bags hung on the balloon cable, and by telephone between the balloon and the ground.

Free runs were regularly undertaken and their technique was developed ; they were usually made to exhaust the gas when it had deteriorated after a period of use in captive work, and when the balloon required overhaul, the cost of fills for free runs being only admissible on special occasions. They were included in the synopsis of balloon courses, and were, not unnaturally, the most popular item of these courses.

Free runs were necessary in order that the aeronauts might be able to control and land the balloon safely if it broke away. They were considered also to have direct military value, to provide aerial transport out of a besieged place (as exemplified during the siege of Paris in 1870, when sixty-six free balloons conveying passengers and dispatches ran the gauntlet of the investing German armies) ; or to make reconnaissances, or possibly bombing raids, across an enemy salient in a favourable wind. All balloonist officers had to qualify as free-run pilots.

On landing after a free run, the officer in charge reported by telegram to Aldershot, and the aeronauts returned to headquarters by train, the balloon, packed in its basket, travelling in the guard's van. Ordnance Survey maps were normally taken on free runs, but the Bradshaw railway map was valuable for plotting the general course or for determining the position on descending from the clouds, and was regularly used when a detailed map of the country underneath was not available.

Captive balloons being fair weather appliances, the ballooning personnel were trained annually in field-works, and employed on building works with the engineer services in the winter, like the personnel of field companies, so that they could be profitably employed when balloons were not in use. This system was of application in various degrees to all R.E. field units, to facilitate interchangeability of personnel. It had its advantages in the South African War, when the Balloon Sections were employed on engineering work after their balloons had ceased to be required. Later, the increase in the complexity and continuity of air work, due to the successive introduction of kites, airships, and aeroplanes, rendered it increasingly impracticable, as well as being unsuitable, to continue full engineer training. Between 1905 and 1910 engineer training, except for the purposes of trade tests, was progressively reduced, and it was ultimately abolished in 1911. At the same time, the personnel were increasingly recognized as specialists, and retained in the air branch.

Balloons, regarding the military value of which there had been continued scepticism, proved themselves in the South African War.

In September, 1899, there was still only one section and the depot, now with a strength of four officers and forty other ranks, but with no mounted establishment of its own. On the outbreak of war the branch was rapidly expanded. All available qualified officers and reservists were recalled for service with balloons. Between September, 1899, and March, 1900, three sections were sent out to South Africa. Balloon Depots (including field hydrogen factories) were established at Cape Town and Durban, and an additional balloon detachment was extemporized in the field.

To cover other possible requirements of the army, the authorized establishment was raised to six sections early in 1900. In August, 1900, a fourth section was dispatched to China; this will be referred to again later. To complete the establishment two nucleus sections with one officer each were formed at Aldershot. From these a balloon detachment under 2nd Lieutenant T. H. L. Spaight, R.E., was provided for the Australian Commonwealth inauguration celebrations in January, 1901.

In South Africa all the Sections acquitted themselves well, in reconnaissance and gun-spotting, until, after the break-up of the Boer armies, accompanied by the flight of President Kruger in August, 1900, the open or guerilla nature of the operations was considered unsuitable for the employment of balloons. The Boers, who had no balloons themselves, disliked the British balloons intensely, and often made special efforts to destroy them, in which they were unsuccessful. They perforated them occasionally, and wounded an aeronaut once.

At the high ground levels encountered on the South African plateau (up to 5,000 feet above sea level) the 10,000 cu. ft. balloons had insufficient lift and larger balloons of capacities up to 13,000 cu. ft. were used when necessary. The wagons were drawn by teams of oxen or mules, a slow and hampering process, particularly in the case of the oxen, which could only march in the early morning or late evening, or at night.

Particulars of the sections sent to South Africa and China and their performances are given below.

1st Balloon Section.—Commanded by Captain H. B. Jones, R.E., with Lieutenants A. H. W. Grubb, R.E., and R. G. Earle, R.E. This section joined Lord Methuen's force on the Modder River on 9th December, 1899, after establishing a gas factory and balloon depot at Fort Knokke, Cape Town.

At the battle of Magersfontein on 11th December, in the first, unsuccessful operations for the relief of Kimberley, useful observations were made of the enemy positions. From that date until the middle of February, 1900, frequent ascents were made, though severe dust storms and lack of shelter for the balloon caused great trouble. Balloon information enabled the British force to march on Paardeberg. During the investment of Paardeberg in February, 1900, the balloon observers made useful sketches of the Boer position, and directed the artillery, which had been firing on the wrong mark, on the bottom of the river bed where the Boers were concealed. The result was the capture of Cronje and his army. Balloons were hit several times during the operations, but were not seriously damaged.

The 12,000 cu. ft. balloon *Duchess of Connaught** was holed at Paardeberg and was leaking badly. The hydrogen was transferred in the field to another balloon, the 11,500 cu. ft. *Bristol*—a skilful operation, which saved gas. The *Bristol* (one of the first of its size, and coincidentally a forerunner in name of the first group of Army training aeroplanes), was used in the fighting at Poplar's Grove on

* This balloon had been named by the Duchess when it was completed at Aldershot in 1894, and went off on a free run, the customary method of entertaining visiting personages.

7th March (when the section was attached to the Cavalry Division in the advance on Bloemfontein), and deflated after three days. It was refilled at Vet River on 6th May, in the advance from Bloemfontein, and was kept filled for twenty-two days, marching 165 miles with the 11th Division. It took part in the engagements at Vet River and Zand River, and after being kept in a sheltered place near the river at Kroonstad for ten days, it was eventually emptied on 27th May after crossing into the Transvaal at Vereeniging. The above incidents speak well for the tenacity of the balloon material and the training of the section.

At Pretoria, balloon observation located the Boer position, and facilitated the capture of the enemy force on 5th June. Observations were carried out continuously for five days, although the balloon was perforated in several places, patch repairs being made, as was readily feasible with goldbeater's skin balloons.

On 19th July, 1900, the section marched from Pretoria and joined General Pole Carew's force for operations in the Eastern Transvaal; but on 2nd August, when it had reached Brugspruit, owing to severe losses of oxen in the heavy artillery unit and the Naval brigade, all of the section's oxen were transferred to them, and the section, rendered immobile, was returned to Pretoria by rail.

There was no more ballooning after this. The section was employed upon engineering work, and was eventually broken up, the personnel being drafted away to other duties.

For their services with the Balloon Section, Captain Jones was awarded a brevet majority, and Lieutenant Grubb the D.S.O.

2nd Balloon Section.—Commanded by Major G. M. Heath, R.E.,* with Captain W. A. Tilney, 17th Lancers, and 2nd Lieutenant C. Mellor, R.E. This section was in Ladysmith during the siege. Arriving on 27th October, 1899, one of the last units to reach Ladysmith before the place was invested, it filled and put up a balloon on 30th October for the battle of Lombards Kop. After twenty-seven days the stock of hydrogen with the section, which could not be replenished from the base at Durban, was exhausted, and ballooning had to cease. During this time constant observations were made, with excellent results. The Boer positions and movements were reported, useful sketch maps were made, the enemy's big guns were located, and artillery fire, including the fire of the successful Naval Long Toms, was directed.

The balloons drew the Boers' artillery fire, and several were brought down by it, including the two balloons which were put up on 31st October—but they were not materially damaged. The balloons were most vulnerable when near the ground, and the

* Eventually Major-General Sir Gerard M. Heath, K.C.M.G., C.B., D.S.O.

section was, therefore, especially practised in rapid manœuvring and in quickly hauling down and letting up balloons.

After the cessation of ballooning the section was employed on defence works. Later, after the relief of Ladysmith, it was converted into the 3rd Field Troop R.E.

Major Heath received the D.S.O. for his services with the Balloon Section.

3rd Balloon Section.—Commanded by Lieutenant (temporary Major) R. B. D. Blakeney, D.S.O., R.E., with Captain B. A. Warry, Essex Regt., and 2nd Lieutenant A. H. Bell, R.E.

The section arrived at Cape Town at the end of March, 1900, after a brief period of training at Aldershot. On 21st April it joined a force of artillery and infantry at Warrenton, just south of the Vaal River, part of General Sir Archibald Hunter's 10th Division, which was operating on the left flank of Lord Roberts's grand advance on Pretoria and in the first instance covering the relief of Mafeking.

From Warrenton, where the 10,000 cu. ft. balloon *Trumpet* was filled on 23rd April, the section materially assisted in forcing the Boers to evacuate Fourteen Streams and their positions on the right bank of the Vaal. The balloon observers located the Boer laager across the Vaal, the enemy trenches and movements were observed, and the fire of guns and howitzers, including a 6 in. gun, was effectively directed. Captain G. F. MacMunn, D.S.O., R.A.* frequently took part in observation from the balloon. The 6 in. gun was brought up from Kimberley on a railway mounting and, firing from a specially constructed siding, dealt under balloon direction with the laager, some 7,000 yards away, which was invisible from ground level.

After the engagement on 5th May at Rooidam, a few miles to the south-west, and the occupation of Fourteen Streams on 7th May, the Boers retreated from the line of the Vaal, leaving the field open for the advance of the 10th Division ; ten days later Mafeking was relieved.

The balloon was emptied on 9th May, after being in constant use for fifteen days. As the result of an order to join Lord Methuen's 1st Division, which was swiftly rescinded, the section then spent six weary days on a fruitless march from Kimberley to Boshof and back by night with ox transport, unescorted on the return trek. On 16th May the section, having thus been left behind, followed the advance of the 10th Division, arriving at Potchefstroom, via Vryberg, a month later.

There were now no opportunities for ballooning with the 10th Division, and on the suggestion of Major Blakeney, who as a former

* Eventually Lieut.-General Sir George F. MacMunn, K.C.B., K.C.S.I., D.S.O.

balloonist had been recalled from the Egyptian State railways for service with balloons, the section was for the next fortnight successfully employed in reopening and operating the railway from Klerksdorp. On the decision to evacuate Potchefstroom, the section was moved on by train to Johannesburg where it was finally broken up.

Extemporized Balloon Detachment.—As the 2nd Balloon Section was locked up in Ladysmith, a detachment was extemporized by Captain G. E. Phillips, R.E., for employment with General Sir Redvers Buller's Ladysmith relief force. It was equipped with some balloons and gas tubes from reserves of the 2nd Section. Although handicapped by its nature and limited equipment, as well as the usual cumbrous ox transport, the detachment did good work during the relief operations, but it was able to achieve no major results like those obtained by the regular sections.

4th Balloon Section.—Commanded by Captain A. H. B. Hume, R.E.,* with 2nd Lieutenant T. E. Martin-Leake, R.E. Captain Hume had been a subaltern in the original Balloon Section on its formation in 1890, and was detached from the Survey of India for ballooning duties. The 4th Section was sent to North China for service with the British contingent of the international force which occupied Peking to protect foreign interests menaced by the Boxer rebellion, but it arrived too late, after the fighting was over. Balloon ascents were made, however, and the equipment compared favourably with that of other nations.

Some of the equipment, including the field gas factory and six of the N.C.Os. and Sappers of the 4th Balloon Section were taken to India by Captain Hume in 1901, to start an experimental balloon section in the Bengal Sappers and Miners at Rawalpindi. Captain Hume trained Captain W. A. Stokes, R.E., who was the first commander of this new section, and was succeeded in command by Captain G. C. B. Loch, R.E., Lieutenant P. W. L. Broke-Smith, R.E., Captain T. H. L. Spaight, R.E., and Lieutenant C. E. Colbeck, R.E.

The transport was provided by converted Army Transport carts, drawn by four to six mules which were borrowed from the Supply and Transport Corps. Seven to eight carts (balloon cart, equipment cart, and five or six tube carts each carrying seven 6-ft. gas tubes), were needed to fill a balloon in the field. The mobility of the section was materially less than that of horsed transport R.E. balloon units, which could move more rapidly and

* Major and Brevet Lieut.-Colonel J. R. L. Macdonald, R.E., commanded the 4th Balloon Section in the first instance, but on arrival in China he handed over command to Captain Hume.

carry the personnel on the wagons on occasion, but considerable proficiency was reached in the handling of balloons. The section was moved to Roorkee in 1909, and in 1911 it was abolished.

The section was never fully equipped with a permanent gas plant, adequate facilities for overhauling balloons (which in the Indian climate deteriorated rapidly without regular treatment with glycerine), or its own transport animals and drivers, and the expense of properly equipping it was not thought worth while. Due partly to the disabilities of the section and partly to the general lack of interest in balloons, which was finally accentuated by the prospects of the supersession of balloons by aeroplanes, the section had little opportunity of employment in co-operation with other arms. It, however, developed a good technique, and successfully practised direction of artillery fire at Hutti artillery practice camp.

In November, 1899, Colonel Templer went to South Africa as Director of Steam Road Transport.* For many years he had been an exponent of mechanical road transport, and since the Chatham days the Balloon Factory had possessed traction engines and trucks, which fetched and carried stores, drew balloon vehicles when necessary, and provided gas trains for training camps and manœuvres. Later on this transport was similarly to serve the early airships.

This was a period of great activity in the Balloon Factory, turning out additional balloons and equipment for the Balloon sections. The normal output of balloons was doubled, and thirty balloons were sent to South Africa, besides meeting other requirements. During Colonel Templer's absence Lieut.-Colonel Macdonald acted as Superintendent of the Factory, and fathered the new sections, until August, 1900. After this, Major F. C. Trollope, late Grenadier Guards, was in charge until Colonel Templer returned in February, 1901. Lieut.-Colonel Macdonald and Major Trollope were both old hands of the earliest Chatham days ; Major Trollope (who became a Lieut.-Colonel in the Reserve of Officers) remained on as Assistant Superintendent until 1902.

* Unfortunately, the ship carrying the traction engines was wrecked on the way to South Africa and the outfit was almost entirely lost. On arriving at Cape Town with the 45th Company, R.E., which had a special establishment for this purpose, Colonel Templer was only able to organize an attenuated road transport service from local resources in traction engines, principally at the base. He returned to the U.K. at the beginning of 1901, to resume his previous duties. Further consignments of traction engines were eventually sent out, and the R.E. steam tractors were employed fairly extensively up to the end of the South African War, among their uses being the haulage of stores and bridging materials. Some further details are given in *The History of the Corps of Royal Engineers*, Vol. VII.

(To be continued)

CONTINENTAL VIEWS ON THE TRENDS OF WAR

By MAJOR-GENERAL B. T. WILSON, C.B., D.S.O.

THE air traveller from Northern Europe to Italy on a clear day cannot fail to be impressed with the view of the Alps as they loom up like a bastion far away on the southern horizon.

They are not only a great massif but also a refuge of freedom, for Switzerland has been free to settle her own affairs ever since 1499, when at the peace of Basle she finally shook herself free from the shackles of Austria.

This freedom has not been vouchsafed to the Swiss without continuous exertions. In the two World Wars of this century, they held themselves ready to fight any power or group of powers which might seek to infringe "the perpetual neutrality of Switzerland" proclaimed by the Congress of Vienna in 1815.

The military strength of the country lies in its girdle of mountains and in the spirit of its inhabitants, as manifested in a most efficient militia based on universal service.

From its central position in Europe, the Swiss Government, advised by its very competent General Staff, watches with great vigilance all the military developments of the day—Switzerland is particularly well suited for this kind of military watchfulness. With her German, French and Italian cantons and her immense tourist traffic, she is perhaps the most internationally minded country in Europe, or indeed, the world.

In this international clearing house of ideas, including those on war, the officers of the army produce a monthly periodical called the *Schweizerische Militär Zeitschrift*, which is a mine of up-to-date information collected from all over the world.

Most of the articles are in German—very occasionally some are in French. Prominent German soldiers contribute valuable papers on their varied experiences in World War II, especially those about Russia. Many articles from American military journals appear as translations. The British campaigns in Africa, Italy and North-West Europe are closely analysed. The lessons of the war in Korea as revealed by American soldiers are being actively discussed, so that where necessary the training of the Swiss Army may be brought up to date. The attitude of Swiss soldiers is modest but practical and determined. They say in so many words that their army has not had recent practical experience of war and must profit by that of those which have. Without any doubt it will. It is therefore not unfair to say that the *Schweizerische Militär Zeitschrift* provides an unrivalled continental view of the trends of war.

The writer endeavours here to set down a résumé of a great accumulation of military opinions culled from its pages. In doing so cordial acknowledgements are made to many contributors, in particular to General Gouard for his important article "War Experiences and Home Defence," to Colonel Max Waibel for his study of Korea and to General von Senger and Etterlin for his comments, from the German side, on Cassino and the fighting in Italy.

General Points

Modern weapon design is based generally on the belief that the heavy weapon silences the light one. The 105 mm. gun-howitzer, for instance, has ousted the 75 mm. as the standard field gun. Tanks tend to carry heavier armaments and to be more heavily armoured to resist it. Within the limits of the practicable, heavier and intenser fire power is the goal of the military inventor. Fire power is more intense to-day than it ever has been. A modern force of whatever size, must devote its chief attention to :—

(1) Fire Power
(2) Mobility
(3) Training.

Fire power and mobility are factors which obviously have to be reconciled with each other. Thus the new recoilless automatic rifle can be fired much faster than its predecessor, but has much lighter ammunition, so that the user can carry more of it.

Training is stressed as being all important. Two years is regarded as the minimum time in which the modern soldier can be made efficient. As total war and brutality unfortunately go hand in hand, training must be tough. Great demands must be made on the young soldier during his training to ensure that he really is tough and that he knows it.

Air Power

Although the pre-eminence of the air is constantly emphasized there are few articles on the exercise of air power as such. Anti-aircraft artillery is well covered, especially the control arrangements.

The German Army in Italy had to contend with heavy hostile air superiority. Inadequate German air reconnaissance made the German H.Q. half blind. Towards the end of the war the movement of formations to and from Italy was inordinately difficult owing to continuous damage from the air to the railways through the Alps.

Where sea and air superiority are certain, landings on open beaches are most effective operations of war. The threat of landings is a nightmare to the defence and compels the holding of extra large reserves which usually can ill be spared.

Infantry on the defensive, expecting an enemy assault, must, in the face of air bombing and low flying aircraft, lie close and wait for the appearance of the hostile infantry, just as they must do under creeping artillery barrages or when attacked by armour. As such air support is not as accurate as artillery fire, it will cease or pass over in ample time for the defenders to deal effectively with the advancing enemy infantry.

Air attack on road bridges behind the forward zones in Italy usually portended an imminent large-scale British attack.

Bombing by heavy bombers at 12,000 feet or over was less effective than that of light bombers at about 6,000 feet.

Armour

The main motif of the modern assault is "no infantry without tanks and no tanks without infantry." This motif will be dominant in all fairly close country, such as that of Western Europe. In the Russian steppes, in deserts and when an enemy is near complete collapse, armour may possibly be used like cavalry masses were sometimes used in the past, but not often.

The heavily armed and armoured tank is, therefore, the chief type required in modern war.

Bridges in Europe are often not strong enough to carry such tanks, so that military engineers will often be faced with the job of underpinning them quickly.

The importance of training all infantry units to work with tanks is heavily stressed. Infantry must, in particular, understand the limitations of tanks and not misapply them if they come under command.

Special reference is made to the flame-thrower tank, as being amongst the most formidable in-fighting weapons on the modern battlefield.

Infantry

The three-piece division and brigade or regiment continue to be the norm. The brigade group, or "combat command" in American parlance, with armour and anti-tank elements included in it, is mentioned as a handy formation for rapid counter-attack against a numerically superior enemy who relies on masses of men rather than on skilled battle technique.

There is a strong word of warning about the motorization of infantry, which inclines units to cling to their vehicles and the roads, thus losing the characteristic flexibility of infantry, including the capacity to carry a pack.

Artillery

The spectacular part played by armour and dive bombers in 1940 during the German conquest of France and the Low Countries caused the over-hasty thinker to conclude that artillery was going into a decline. The war in Russia, however, soon showed that far from going out of business, the artillery was more important than ever. At Alamein, Field-Marshal Montgomery deployed a mass of artillery which would have delighted Napoleon and used it much in the manner of 1914–18 for breaking through the Axis defences. Higher formations using guns of greatly increased range, with harder hitting shell fillings, can now cover far deeper areas with intense concentrations of artillery fire. Greatly improved air observation, radar devices and artillery survey have all added to the speed, accuracy and flexibility of fire control. A higher commander who knows how to use artillery can thus direct his battle in a very formidable manner especially in its opening stages.

With " atom " charges near becoming available for artillery shell and even quite conceivably for small arms as well, the fire power of the defence will tend to regain the advantage it had in 1914–18, always provided that the defenders are not overtopped in the air.

Infantry supported from the air and by the other arms on the ground is still the queen of the battlefield, but the artillery is the king-pin of the fire power structure.

When the drafts for their infantry ran short in Italy, the German commanders there resisted all efforts of the Wehrmacht H.Q. to turn their artillerymen into foot soldiers. It far preferred veteran gunners who knew their job on the battlefield to the doubtful gain of what would have been some bad infantry.

Reference is made to the larger amount of artillery ammunition which must be available close to the guns in any struggle between a highly trained, well-equipped army and an army of great masses. Various writers picture over-heated guns, no shells left and the last wave of the successive attacking echelons getting through to its objectives. It is believed that Korea has provided examples of such failure in the supply of artillery ammunition.

On the wide and loose fighting fronts which are inevitable in a war where one side disposes of great numerical superiority, the artillery itself will always require to secure its gun positions against unexpected thrusts of armour and infantry. It will not be able to rely on the cover of forward elements.

The quick-firing heavy mortar, ranging up to 4,000 yds., is now definitely an artillery close support weapon with " walkie-talkie " radio control of fire.

General reference is made to technical advances in artillery practice. They include conical bores (cf. the choke barrel of a shot gun), the hollow loading of projectiles for the production of increased effect on burst and " chained mortar bombs." The best weapon against tanks is universally agreed to be the gun, which itself must be mounted in a tank.

The enormous advance made by naval artillery in support of landings is generally recognized. Combined with air superiority it renders the plight of the defenders unenviable. The Gallipoli landings of 1915 would have been far less costly if the shore to ship fire control methods of to-day had been available.

ENGINEERS

The sapper, like the gunner, has an increased range of indispensability. Defences of all kinds, from permanent fortifications down to the slit trench, are vital. Permanent fortifications at Odessa, Sebastopol, Mareth and many other places took weeks and sometimes months to overcome and even then at great cost. Although not to be regarded as invincible, they economize force, take heavy toll of the enemy and gain time for offensive action. This was always the prime purpose of defences and still is.

The planning of demolitions is an art in itself. The element of surprise is important. Mention is made of an ingenious German practice in Italy of cratering half the width of a road in a defile for several hundred yards and of switching the cratering from one side of the road to the other every fifteen to twenty yards or so. This enabled the road to be used by the diminishing troops of a withdrawal without much difficulty. But when the vehicles of the advancing enemy came roaring along in pursuit, considerable traffic jams were caused, especially at night, which gave opportunity for artillery and air action.

Mines are important devices which receive special mention in an article called "Minenangst" or "Fear of Mines." The Russians made considerable and masterly use of mines even during their retreat in 1941, when barbed wire and other obstacles were seldom employed. They used them especially on the forward and rear edges of forests, in the rides and in clearings. 40,000 mines were quite commonly laid by the Russians in the various large forests which cover Leningrad. The Germans, in their turn, on a two-division front for the defence of Lemberg had a minefield of 200,000 mines extending to a depth of twenty-five kilometres. Minefields of such large compass constantly held up attacks by armour and infantry so completely that they had to be mounted again, after long delay, in a totally different sector.

"Minephobia" became so pronounced that on one occasion N.W. of Moscow, an unconfirmed report credited the Russians with the possession of dogs which were loaded with explosives and trained to brush up against tanks so as to touch off the charges. This rumour about Russian "mine dogs" so disturbed the *Panzer* crews that they gave vent to their feelings by opening up on any wretched village dog that hove in sight.

Although this story seems far too good to be true, the psychological effect of mines is undoubtedly very great. Like all other such fears, it can be kept under control by careful training. Units must be trained to cross minefields in peace exercises, just as they are trained to advance under the live fire of artillery, mortars and machine-guns. In war, rehearsals can sometimes be staged in back areas. The edges of the holes in which mines have been inserted are always most difficult to conceal, so that even the inexperienced can soon learn to spot suspicious places. They may have to do so, since sappers trained to mine warfare will always be in short supply.

A controller of mines is obviously an important figure. He must think big, use his imagination and work in the closest contact with the troops, otherwise their " minephobia " will be as bad as that of the enemy.

The use of smoke clouds in a big way is described in an American account of the crossing of the Roer, west of the Rhine, by the 30 U.S. Division in 1945. Smoke detachments using generators produced a smoke screen which was finally more effective than even the darkness of the night. Intended to last only twelve hours, it was continued at the request of the infantry for a total time of thirty-three hours, by which time the engineers had constructed a bridge for wheels and the attack became completely successful.

In war on the wide fronts of the continent, military engineers need to work on a big scale in the manner of the German constructor Todt. After his death in an aeroplane crash, the Germans never quite achieved the same results again. The Americans have the right outlook in this matter. We British are too apt at first to send a boy on a man's job, although our actual engineering equipment is probably second to none, cf. the Bailey bridge.

Mountain Warfare

The crests of mountains must be held and fought for. If a position on a crest is lost, it must be regained, otherwise the whole position goes. This will probably best be done from a flanking position on the same crest rather than from reserves held well behind the crest. Lateral communication is therefore most essential.

Schooling in mountain warfare pays big dividends. The success in Italy of the French African Corps is mentioned in this connexion.

The mule, carrying parties and the oil cooker come into their old prominence directly a formation gets pegged out in high mountains.

During a battle in mountains the acoustic effect of bursting shells and bombs is deafening and makes orders by radio most difficult to get through.

Air action is very alarming, but not very effective.

Korea

No really new weapons have been employed. It is a contest between masses and technique. So far the action of masses must have disappointed the U.S.S.R.

In the early stages the American divisions were sometimes so short of drafts that they used South Koreans to fill their ranks up to 50 per cent of their strength. This is a measure of the bitterness of the fighting.

Fire power and speed is the answer to an enemy relying on masses of men for victory—see "Combat Command" above. Long fronts were common, e.g., seventy-two kilometres for two U.S. divisions.

A loss of skill was manifest in air-army co-operation. Jet aircraft fly so fast that "pathfinder" machines were used with success to lead them on to ground targets.

The air transport of troops was a big feature of Korean operations.

Defence against Overwhelming Odds

An interesting German article gave an account of the defence of Pomerania against the U.S.S.R. right at the end of the war. A German corps of eight weak divisions with seventy tanks on a front of 250 kilometres is said to have been attacked by nine U.S.S.R. armoured corps and fifteen infantry corps with 1,600 tanks. The defence lasted from 22nd February to 10th March, 1945. It enabled masses of civilian refugees to escape into Western Germany.

Some Tactical Points

It is interesting to note that the reverse slope is in high favour for defensive positions, except of course in mountains where the crests must be held.

Infiltration by night is a new feature which requires study.

The Russian peasant is accustomed from his early youth to working in the dark without lights, which stands him in good stead on night operations. Being an excellent digger he also claws on to newly won ground very quickly, so that after a few hours he is most difficult to dislodge. If counter-attack is necessary, it will best go in quickly.

An interesting German opinion is that orders by radio are better than orders by telephone. If well delivered, they are short and incisive and cannot be interrupted by the recipient during reception. A telegraphic brevity is often necessary on the battlefield.

THE MECHANICAL HANDLING OF MILITARY STORES

By MAJOR J. E. L. CARTER, M.C., A.M.I.C.E., R.E.

"*Handling adds nothing to the value of a product, only to its cost*"
First principle of modern material handling practice

INTRODUCTION

IN this article an attempt is made to show how, by using new ideas and modern methods, there can be developed a general scheme for the mechanical handling of military stores.

This scheme can be applied to the building of bridges, the placing of concrete, the erection of huts, the distribution of mines in forward areas, the movement of stores over beaches, the clearance of dropping zones, the loading and unloading of lorries, railway trucks, ships and aircraft, to workshops and depots, and to almost any service activity where handling adds to the manpower cost of the military product, but not to its value.

The scheme as a whole makes a vast province, in which, to quote a military directive of Winston Churchill's, " there is an opportunity for brilliant administrative exertion, which might produce results in the war economy equal to those gained by a considerable victory in the field."

This article deals primarily with general principles, and secondarily, and in outline only, with their applications to certain problems of particular interest to the Corps. It suggests that handling, apart from the enemy, is one of the greatest drags on service effort ; that too little practical attention is paid to methods of reducing this drag ; that it is possible to introduce modern handling methods without disorganizing the Services ; and that the introduction of such methods will go far towards restoring the balance between Service manpower resources and commitments.

MANPOWER

Manpower balance is not a question of paper establishments, in which allotted manpower and transport are shared out between units to produce Services which balance on paper. Rather it is a question of certain simple, hard and unavoidable facts. Bigger tanks and bigger guns mean bigger bridges, bigger mines, bigger petrol consumption and bigger ammunition tonnages. Jet aircraft add to the trend. Development means increased demand. General considerations of scale on a number of major types of store indicate that at least 50 to 75 per cent extra tonnages would have to be handled during operations comparable with those of the last war.

At the same time, for a number of weighty reasons, manpower availability has decreased. Therefore, apart from the economy to be gained by mechanical handling, there is a considerable measure of doubt as to whether the Services would be able to operate under the stress of war, in the manner at present proposed, without a revolution in the methods of handling and moving stores.

If it is accepted that such a revolution is essential or even desirable, and no one who has looked with insight into recent establishment figures can doubt it, questions then arise as to how in principle and in practice it should be achieved.

The Service Environment

Military stores are moved from factories or other productive installations to their destinations all over the world. Normally they are handled far more than civilian stores, for in war-time the economics of stores production and movement have to give place to the necessities of war. In peace-time, stores normally move along well-grooved channels. In war-time, these channels are disrupted. Ports are obliterated, beaches are made into ports ; tracks become highways ; fields become depots ; jungles, airfields ; bush, dropping zones. Through all these pour men, vehicles and stores ; stores by the millions of tons, handled and re-handled, until the product of handling and tonnage runs into quantities of effort and cost sufficient to make even an astronomer quail.

In modern war there is no orderly deterioration of conditions from rear to front. A blasted port, a bombed depot, a shingly beach, or a muddy field may intervene anywhere in the long chain from the factory to the front. These conditions produce weak links in the chain. If, therefore, mechanical handling is to be applied to the movement of service stores, it must be applicable in the bad conditions as well as the good. In fact, although the latter must be exploited to the full, the former must be the basis on which any general scheme is planned.

The Approach to the Problem

How should such a scheme be developed ? What are the starting points ? In what direction must development move ? These questions arise. Here are some answers to them ; not dogmatic answers, not final answers, but answers which are good enough to stand up to practical trial, and to point the way to better ones.

A materials handling scheme for a modern factory is extremely specialized and refined. It is worked out in immense detail, and installed at considerable cost. It does one job supremely well. Such schemes are possible in highly developed service installations, such as underground ordnance depots, but are obviously inappropriate for general service purposes. The Services must treat mechanical handling problems like tactical ones. No two are alike, and there are often a number of good solutions to each. In the same way that for tactical purposes the soldier has weapons and methods, and applies them to the best of his ability to the tactical problem in front of him, so for stores handling he must have definite machines and methods and apply these to the handling problems in front of him.

Machines must be common user items just as are the rifle, the bayonet or the 3-ton G.S. lorry. The methods of using them must be varied to the problem, not to the arm or service.

Co-ordination and co-operation between the Services and within each Service are the first steps. If plans are made for the problems as a whole, economy and flexibility will follow, and these it must be remembered are basic principles in mechanical handling, just as in any other aspect of administration.

General methods will clearly not have the same local efficiency for any problem as methods which have been specially evolved for it. Thus it must be accepted that the most efficient system possible for the Services as a whole may not give more than a 75 per cent efficient solution to the general run of problems, whereas in a modern factory practically 100 per cent efficiency might be achieved by an entirely special materials handling scheme.

So methods must be developed which can be worked by machines reasonably efficiently in bad conditions, and more efficiently in good ones. It is no use to develop methods which are supremely efficient in good conditions and break down in bad.

The first condition for which to be prepared in any service mechanical handling scheme is that in which owing to the b—— staff, the b—— designers, the b—— politicians, or your own b—— stupidity there are no machines. This should not happen often, but every aspect of a general scheme must be examined against this case.

Service Stores, Stores Carriers and Stores Handlers

In the next stage the problem becomes a study in the interaction of three groups of factors within the Service environment.

1. *The Stores*

Service stores cover an immense range, but for the purposes of handling the majority, apart from bulk materials, fall within one or other of the following categories :—

(*a*) Man-handlable packs of regular dimensions such as boxed rations, ammunition, jerricans, mines and rolls of barbed wire.

(*b*) Structural components often irregular in shape, but generally intended for handling or capable of being handled in an emergency by a reasonable number of men, e.g., bridging parts, hutting sections and track stores.

(*c*) Single lift stores such as crated generators, M.T., "A" vehicles ranging up to fifty or sixty tons in weight and never intended for manhandling.

The last category has long existed and has required a basic provision of cranes. The main tonnages, however, lie in the first two, though there is a tendency with the general increase in scale of service requirements to transfer items from the category of stores which can be lifted by hand to those for which cranes must be used. As a result, even without a general adoption of mechanical handling there must be an extended provision of cranes and other mechanical aids for the Services. The adoption of a general scheme would involve firstly the fuller use of equipment which must be provided in any case, and secondly additional provision of equipment. This additional amount would, however, be less than the *pro rata* tonnages of stores to be handled would suggest.

2. *The Stores Carriers*

Service stores carriers, like service stores, cover an immense range, and include civil and military road transport, railway trucks, shipping and aircraft.

For the purpose of developing a general service mechanical handling scheme these stores carriers have the following characteristics in common :—

(*a*) Their variety.

(*b*) The immense capital cost invested in them.

(*c*) Scarcity.

(*d*) The lack of attention generally paid to mechanical handling requirements in their design.

(*e*) The difficulty of loading them to capacity by dead weight tonnage, owing to lack of floor space or cubic capacity in relation to tonnage capacity. Thus it is almost impossible to load a ship down to the Plimsoll line with mixed military stores and it is very difficult to get 10 tons into a 10-ton lorry or railway truck.

(*f*) The interaction of turn-round time, speed of carriage and distance on the amount of transport required on any route.

Great advantages could be gained for mechanical handling by the rebuilding of the Allied Merchant Shipping pool, by the replacement of rolling stock and by the re-design of G.S. road transport. This may happen in due course, but any mechanical handling scheme to be adopted now must—

(*a*) take the stores carriers as they are, and

(*b*) aim at taking advantage of the improvements which can, and will, be effected in them.

Another interesting point might be stated at this stage. One of the first principles of handling as taught at present is the avoidance of double handling. Thus, in discussing the movement of large tonnages of mines, it is said that, in order to avoid waste of labour, the lorries carrying the mines must, if possible, go direct to, and be unloaded at the point where the mines are to be laid. In fact, putting this principle into practice means more often than not the gross abuse of transport. Transport is used to hold stores, and not merely to move them ; reserves are kept on wheels, and lorries are kept waiting interminably until the tactical situation, the weather, or the vagaries of the labour force allow the stores to be unloaded exactly where and when they are required.

Thus the early release of transport by the acceptance of double handling should be one of the aims of a general mechanical handling scheme. This, of course, is in addition to the conservation of transport which follows from the increased speeds in loading and unloading when mechanical handling methods are used.

In fact the development of mechanical handling may relieve "Q" of the almost intolerable Hamletian dilemma :—"To dump or not to dump, that is the question."

3. *The Stores Handlers*

Here too there is a great range from which to choose. Anyone who has visited the Mechanical Handling Exhibitions at Olympia or studied the pages of *Mechanical Handling* or other trade publications will have a general idea of the large numbers of main and auxiliary handling equipments now on the civilian market.

The following points must be considered in relation to any selected for a general scheme :—

(*a*) Reliability in action in the service conditions in which it will be required to operate. Thus it is quite consistent with a general scheme that there should be a range of equipments of any particular type (e.g., cranes), some required to operate in depots at home and some in the bad conditions on which stress was laid at the beginning of this article.

(*b*) Availability in the civilian market. The Services have to dislocate civilian production enough by the special designs of their tanks, guns and aircraft. This should be avoided for mechanical handling equipment.

(*c*) Mobility in the appropriate conditions, i.e., in depots at home or moving and operating with an army in the field.

The essence of handling is lifting a store and depositing it in a required place. The primary mechanical handling appliances are undoubtedly cranes and forklift trucks, or machines combining the functions of both.

Forms of Load and Handling Levels

Now comes the first process of integration into the proposed general service mechanical handling scheme. This is the development of the conceptions of Forms of Load and Handling Levels.

First, think of three pictures, an assistant at a department store tying up parcels with string, a housewife with a shopping basket, a waiter with a tray. These three conceptions, string, basket and tray, are applied to simple handling problems in countless different ways by millions of people every day. The same principles can be applied to mechanical handling, and are as flexible there as they are in everyday life, but, of course, a machine and not a man carries the parcel and handles the basket or tray.

With the introduction of machines for handling stores a new conception must be accepted and clarified ; that is of handling level. Thus a one-man handling level might be designated roughly by a 50-lb. unit load, a two-man level by 100 lb. and so on. Machines are not limited in size and power in the same way as men and accordingly can handle very varying sizes of unit load. For economy in mechanical handling, however, it is desirable to group unit loads into levels appropriate to groups of machines. Naturally such levels cannot be hard and fast, but they represent a convenient idea in considering the general problem.

Handling Levels

Convenient handling levels are as follows :—

1. *The Manual Level*

(*a*) *Maximum lift* (for one man), 50–80 lb.

(*b*) *Characteristics* :—

(i) Has manual increments in the form of one-, two-, three-, four-, etc., man loads.

(ii) Is the emergency level when mechanical methods break down.

(iii) Some mechanical aids work in this level, e.g., conveyor belts or roller runway for one- or two-man loads.

(*c*) *Uses*—where mechanical methods are uneconomic or unavailable.

2. *The First (Assault) Mechanical Level*

(*a*) *Maximum Lift*, 1,000 lb.

(*b*) *Characteristics :—*

(i) Loads light enough to be manhandled in emergency.

(ii) Loads light enough to be skidded behind jeep and moved readily by comparatively light mechanical handling equipment in difficult conditions.

(iii) Units convenient for rapid handling in ships' holds and landing craft and in forward areas.

(*c*) *Uses*

Assault landings, airborne operations, the attack, supply of ammunition and other stores to forward troops.

3. *The Second Mechanical Level*

(*a*) *Maximum Lift*, 3,500 lb.

(*b*) *Characteristics :—*

(i) Loads can be handled readily by commercial 2-ton fork-lift trucks and by medium cranes.

(ii) Two or three loads in this level conveniently fill a 3-ton lorry.

(*c*) *Uses*

Loading of bridging equipment and general engineering stores, particularly for maritime shipment.

4. *The Third Mechanical Level*

(*a*) *Maximum Lift*, 7,000 lb.

(*b*) *Characteristics :—*

(i) Loads can be handled readily by 4-ton commercial-type forklift trucks and at reasonable radius by a 7-ton crane.

(*c*) *Uses*

For single lift transfers from one stores carrier to another when handling stores by 3-ton G.S. lorry, 3-ton light railway, or 3-ton trailer or sledge.

5. *The Fourth Mechanical Level*

(*a*) *Maximum Lift*, 25,000 lb.

(*b*) *Characteristics :—*

(i) Loads handled readily by 12-ton commercial-type fork-lift trucks and at reasonable radius by 20-ton cranes.

Also handlable by 12-ton gantries.

(*c*) *Uses*

For single lift transfers when handling stores by 10-ton G.S. lorries, 10-ton railway wagons or 10-ton sledges.

6. *The Fifth Mechanical Level*

In this must be included all lifts over 25,000 lb. in weight. It is, certainly for the moment, beyond the economic level for mechanically handling service stores and must be confined merely to special single lift items. No more will be said about it in this article.

The equivalent man-power factors of the various levels may be regarded as 1 : 20 : 70 : 140 : 500 : over 500.

Forms of Load

In the everyday analogy, three conceptions were mentioned, parcel, shopping basket, tray. It is proposed now to discuss these under the headings of parcelling and palletization.

1. *Parcelling*

(*a*) *General*

Parcelling, as the name implies, is a process of making a number of items of stores into a convenient unit load with something equivalent to string, in this case, steel tape. It is a deliberate and somewhat skilled operation. To obtain successful parcels, which stand up to handling and movement, experience and experiment are required. The making of parcels absorbs labour. It is in fact a careful and considered capital investment of labour to gain subsequent advantages.

(*b*) *Tools and Equipment Used*

A suitable general service tape for use in the first and second mechanical levels is 1 in. × .035 in. hot rolled tape with a breaking load of about 1.3 tons. This is the strongest tape standardized for service use, but heavier tapes are available commercially. The components in the system used (Messrs. Signodes') are :—

(i) The tape, supplied in man-handlable reels, rather like cinema film.

(ii) Simple stands in which the reels can be supported while the tape is run off.

(iii) Metal sleeve type seals which can be slipped over two thicknesses of tape and crimped to form a 100 per cent effective seal.

(iv) Hand tools for tensioning the tape.

(v) Hand tools for crimping the seals.

(vi) Shears for cutting the tape. This can also be done by service wire-cutters or tinsmiths shears.

(vii) Certain auxiliary components such as angle brackets for protecting wooden corners from the biting in of the tape when tensioned and staples for preventing the tape slipping.

Fig. 1 shows a group of these components for a light tape $\frac{3}{4} \times .020$ in. and also for $1\frac{1}{8} \times .035$ in. (which is very similar to the $1 \times .035$ in.). Further details may be obtained from Military Film Strip, 7025.

The ordinary commercial tape rusts, and therefore has a life which is too limited for general service purposes. It does, however, retain an adequate strength for about eighteen months in the open in England. To obtain a longer life galvanizing could be used, although this is rather expensive. Cheaper methods are under investigation.

The tools are comparatively cheap and provided they are kept busy the main cost of parcelling lies in the tape itself (about £40 a ton) and in labour costs.

(*c*) *The Making-up of Parcels*

(i) The first step is to decide on the composition of the parcel. Factors which will affect this are :—

(a) Whether the stores are to be moved administratively or tactically. Thus "shipping parcels" from U.K. might consist of a definite number of items all of one kind, but "tactical" parcels might have a complicated tactical composition.

(b) The relationship between "tactical" and shipping requirements. If, for example, a tactical parcel has to consist of six Bailey panels with four bracing frames added, it would be convenient to ship the Bailey panels in sixes and the bracing frames in twelves, breaking the bracing frame parcels at railhead to add the bracing frames to the main panel parcels.

(ii) The next step is to arrange the stores in a convenient grouping which is as compact as possible. This is to ensure that rearrangement under vibration will not slacken off the tapes.

(iii) Then comes the application of the tapes around the parcel in suitable places. Generally speaking the parcel should be designed to hold together with one tape in three broken. Every type parcel should be thoroughly tested under movement and handling.

From the above it is clear that methods of parcelling must be laid down in detail, and not adopted according to the individual views of different depots. Various types of parcels are shown in Figs. 2, 3, 4 and 5. The last is a parcel of Dannert and ordinary barbed wire, fifteen coils of the latter inside thirteen of the former, and gives a bulk reduction of 40 per cent. Two of these parcels, plus the appropriate pickets, make a convenient tactical 3-ton wiring lorry load. These barbed wire parcels can be loaded into any 3-ton lorry with a forklift truck at about five man-minutes per ton.

(*d*) *The Cost of Parcelling*

Based on the fair amount of experience now available it can be said for planning purposes that the parcelling of various types of bridging and general engineering stores takes :—

(i) 0.2 per cent by weight of the stores in tape.

(ii) About two man-hours per ton.

Thus for 1,000 tons of stores parcelled, 2 tons of tape would be used at a cost of £80 and 2,000 man-hours of labour costing £300 (at 3s. an hour).

Allowing for costs of seals and depreciation on tools, parcelling costs about £400 for 1,000 tons, of which £100 represents materials and £300 labour.

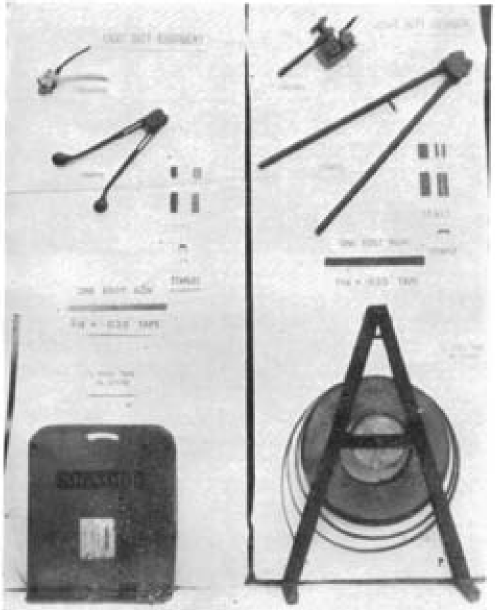

Fig. 1.—Light and heavy duty steel tape and tools and equipment for applying it.

Fig. 2.—1,000 lb. skid parcel being towed by jeep.

Mechanical Handling Of Military Stores 1,2

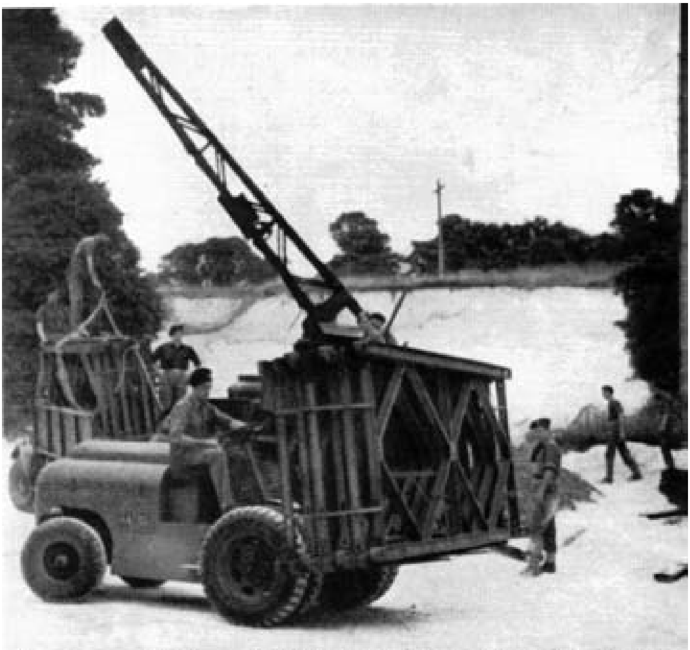

Fig. 3.—3-ton Coles Crane and "Matbro" forklift truck working together on the unloading and delivery of parcelled bridging stores to a bridging site.

Fig. 4.—7-ton Bridging Crane handling panel parcels in C.M.A. for Exercise "Surprise Packet." Note length of jib and general handling capacity of this crane.

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Fig. 5.—" Matbro " cross-country forklift truck handling parcelled barbed wire in C.M.A. for Exercise " Surprise Packet." The truck has been fitted with its jib arm in place of the forks.

Fig. 6.—6 × 4 ft. box pallets being used for local palletization in Messrs. Fisher and Ludlows' works.

Mechanical Handling Of Military Stores 5,6

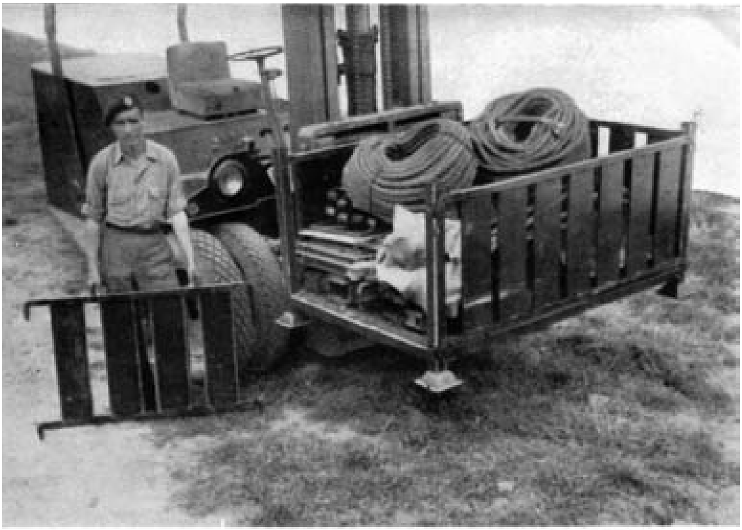

Fig. 7.—6 × 4 ft. box pallet with bridging accessories.

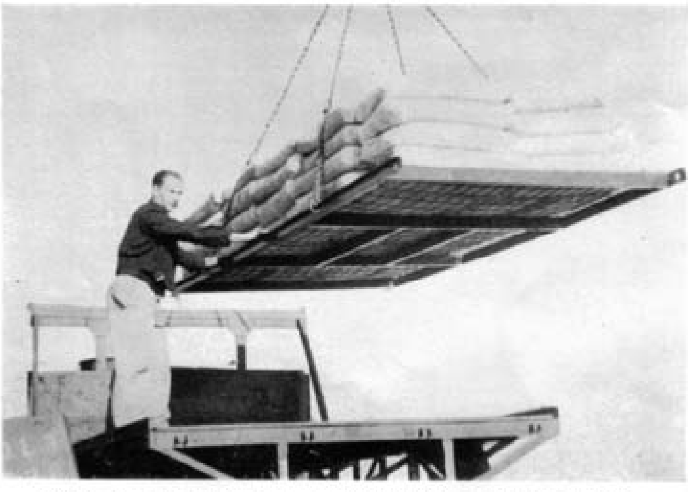

Fig. 8.—12 × 6 ft. pallet/cargo board loaded with 3 tons of hydro lime.

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Labour costs of loading unparcelled stores may be based on one man-hour per ton, and about 75 per cent may be regarded as saved on loading parcelled stores. Thus the man-power saving is in the order of three-quarters of a man-hour per ton per handling against the consumption of about two man-hours a ton for parcelling. It is clear that parcelling does not pay in man-power saving for a move from A to B, involving only two handlings, loading at A and unloading at B; but shows a profit for a move from A to B via C (four handlings). There are many factors which complicate the financial, as opposed to man-power, economics, but the points to remember are that :—

(i) The average military store has to be handled twenty or thirty times between the factory and the front.

(ii) The value of labour savings in frontal areas is greater than in rearward areas.

(iii) Parcelling is a protection against pilfering.

(iv) Parcel loading saves turn-round time for transport.

2. *Palletization*

(*a*) *General.*—A pallet is, in essence, a rectangular tray on which can be arranged a number of loads to form a convenient larger handling unit. A pallet with sides is a box pallet, and with corner posts a post pallet. An essential feature is the provision by one means or another of a clearance under the load-carrying surface, so that the forks of a forklift truck can be inserted to lift the pallet. This contrasts with a cargo board, which is a similar device fitted for slinging by crane. Pallets are made in a large number of sizes and of a variety of materials. They can be expendable or non-expendable. Their real cost is a function of their initial cost, their durability and the number of handlings for which they are used before being expended. Thus the economics of pallets are more complicated than that of steel tape, which is a straightforward expendable store.

In general, pallets are relatively expensive, and add substantially to the weight and bulk of a load.

In a two-way entry pallet the forks can be inserted from two opposite sides, in a four-way entry one from all four sides and in an eight-way entry pallet diagonally as well.

There are two basic methods of stacking palletized stores :—

(i) With flat based pallets carrying reasonably flat topped loads, one palletized load is stacked on top of the other, so that the bottom of the top pallet rests on the top of the stores on the lower pallet. Thus all the weight is transmitted through the stores as well as the pallets.

(ii) With box and post pallets which normally have a foot at each corner instead of flat bases, the feet of the top pallets rest on the corner posts of the bottom pallets. The weight therefore is carried by the pallet structure and not by the loads in the pallets (see Figs. 6 and 7).

(*b*) *Through Palletization*

One of the commonest conceptions of mechanical stores handling is that of through palletization, whereby stores are handled on pallets throughout their journey.

The conception is simple, but, in practice, owing to the wide range of stores carriers involved, even in the civil field, is extremely difficult to apply economically. The problem is essentially one of finding a small range of pallet sizes suited to the loads to be carried, and to the space and entrance dimensions of the stores carriers. With considerable trouble, reasonable compromises have been worked out for the general run of British road and rail transport, but it is questionable whether these can ever be economically extended to cover through movement along a complex L. of C. in time of war.

The advantage of through palletization is the possibility of complete mechanical handling at every transfer point, the disadvantages are the wastage of space, often the critical consideration, owing to dimensional inconsistencies and pallet thicknesses, the cost of the large number of pallets required, and the difficulties often encountered in loading palletized stores into unsuitable stores carriers. Undoubtedly as more attention is paid to the design of suitable stores carriers and the development of cheap expendable pallets, the economics of through palletization for service purposes will improve. At the moment, however, it must be regarded as a fruitful long-term line of research, suitable for immediate application only in certain limited conditions, e.g., between depots or other installations in U.K. or in circumstances where freight space is not of overriding importance.

(*c*) *Local Palletization*

In this case, as the name implies, the pallets are kept within a certain locality, e.g., a depot or other installation (see Fig. 6), or possibly are used locally between two neighbouring installations, such as a quay and a base depot where the transport link is short. Local palletization can be complete or incomplete. In the former case all the stores coming in are palletized on receipt and are kept palletized until dispatched. In the latter, palletization is only partial, pallets being used for the movement of stores, but not for storage. Obviously complete palletization is a greater labour saver than partial palletization, but, none the less, partial palletization may often be a more practical solution to a particular problem. It will in any case give substantial savings over manual handling.

At present, in a certain large depot, P.O.L. products in jerricans are handled manually. Complete palletization would lead to a tremendous loss of covered storage in the small curved C.G.I. shelters in which the jerricans are stored. In addition the cost of complete palletization would be high, and owing to the slow turnover in the depot, the pallets would not be really economically employed. Space does not allow a detailed examination of the problems of this depot here, but such an examination indicates that a capital investment of £6,500 on three forklift trucks, 300–6 × 4 ft. box pallets and certain auxiliary aids should result in saving the labour of about thirty men. Allowing for depreciation, maintenance and operation of the equipment, and without taking any credit for savings in transport turn-round time, this capital investment should yield an annual profit of about £4,000 !

This figure gives some idea of the savings which might be effected by quite limited investments in mechanical handling equipments and methods at isolated points without any necessity for introducing mechanical handling all along a complex movement channel.

3. *The Pallet/Cargo Boards*

Having considered parcelling and palletization, both of which involve the idea of reducing a large number of loads to a small number of lifts, it is important to study the question of load forms which will allow the loading and unloading of various kinds of transport in one mechanical operation.

Apart from the use of 3-ton parcels this can be done by the development of large light-weight pallet/cargo boards in two ranges :—

(*a*) Nominal 12 × 6 ft. of 3-ton capacity for use with 3-ton lorries.

(*b*) Nominal 15 × 7 ft. of 10-ton capacity for use with 10-ton lorries and open railway trucks.

It is essential that such equipment should be designed basically for crane handling as well as forklift truck. Such a pallet/cargo board carrying 3 tons of hydro lime is shown being loaded on to a 3-ton lorry by crane at Fig. 8. This pallet designed in 3 × 1½ in. M.S. channel weighs 400 lb. and can be readily mass produced anywhere. A similar 10-ton pallet would weigh about 700 lb.

The introduction of this type of equipment with suitable cranes (which are available) would allow the unloading of a fifty-wagon train and transfer to 10-ton lorries by one crane and four men in about five hours, or the dumping of 100 tons of ammunition or mines off 3-ton lorries by one 7-ton crane and four men in three hours. What is more important still, perhaps, is that the ammunition or mines could be picked up and reloaded by the same party in the same time. It will be appreciated that if the crane breaks down the pallet can be disregarded and the stores moved by hand.

The introduction of such pallets would open up a recovery and return problem, but when it was realized by units that the alternative to taking a little trouble to recover and return pallets was to handle the stores loose the recovery problem would disappear. Against this has been argued the tremendous wastage of so-called returnable jerricans in war. The answer to this is that there would be far fewer pallets than jerricans, and that they would end up at major terminals rather than at individual vehicles in the force.

An interesting end use of cargo/pallet boards is to support overhead cover for command posts, etc.

4. *Summary of Main Forms of Load*

The main forms of load in the scheme may be summarized as :—

(*a*) The ordinary parcel tied up with steel tape.
(*b*) The skid parcel.
(*c*) Palletization of orthodox civilian type for "through" use.
(*d*) Palletization using box pallets for "local" use.
(*e*) 3-ton pallet/cargo boards.
(*f*) 10-ton pallet/cargo boards.

In addition there are possible combinations of the above, e.g., the handling of skid parcels on 3-ton pallet/cargo boards until the last stage of their journey to the front.

Main Handling Equipment

The factors affecting the types of handling equipment to be used may be grouped under the following head :—

1. *Prime Factors*

(*a*) *Capacity and Capabilities*

Obviously the first consideration is the capacity to lift the loads and place them in the required positions. In some cases the lifting is best done from underneath by forks, in others from above by slings. The positioning may be by swinging a jib or by moving the machine.

(*b*) *Deployment*

The following must be considered :—

(i) The getting of the equipment to the site, e.g., the maintenance of convoy speed for machines which have to move with field units.

(ii) The ability to move on the site, particularly if ground conditions are bad.

(iii) Speed on the site, affecting the time to get from one job to another within a depot or on a site of work.

The consideration of these prime factors in relation to the handling levels and forms of loads suggests a general classification of equipment as follows :—

Cranes

Handling Level		Crane Rating and Type: Tractor Mounted	Lorry Mounted	Wheeled	Crawler	Railway
1st	½ T	1 ton	—	—	—	—
2nd	1½ T	2 ton	3 ton	3 ton	3 ton	—
3rd	3 T	—	7 ton	7 ton	7 ton	7 ton
4th	10 T	—	12½ } 20 } ton	12½ } 20 } ton	12½ } 20 } ton	12½ } 20 } ton
Uses		Beaches and Bad Ground	Mobile Ops.	Depots	Depots & rearward bad ground	Railway

Fork lift Trucks

Handling Level		Truck Rating and Type: Tractor Mounted	Mobile	Depot
1st	½ T	—	—	1 T
2nd	1½ T	2 T	2 T	2 T
3rd	3 T	—	4 T	4 T
4th	10 T	—	—	12 T
Uses		Beaches and bad ground	Undeveloped Depots, Mobile Ops. and forward areas	Depots

The following categories require discussion :—

(*a*) *Tractor-mounted Cranes and Forklift Trucks*

These would be needed in limited numbers for beach and other bad conditions. Light cranes mounted on tractors were used in the last war and are no problem as regards development. Simple fork-lift fittings can readily be developed for mounting as an alternative to the blade on cable operated dozers with P.C.Us. It should be possible to develop a proper tracked forklift truck fairly easily from the fully-tracked version of the Fordson Major tractor.

(*b*) *Lorry-Mounted Cranes*

The well-known 3-ton lorry-mounted Coles Crane is a second level crane. The new 7-ton Coles Bridging Crane is a third level crane. 12½- and 20-ton lorry-mounted Coles Cranes are available for fourth level use. For general field engineering purposes the second level (3-ton) crane should be in the Field Squadron, the third level (7-ton) crane held as plant in the Field Park Squadron and the fourth level (12½- and 20-ton) cranes held as heavy plant for operating 10-ton transfer points and for other special purposes.

(*c*) *Mobile Forklift Trucks*

The " Matbro Pneustac " 2-ton cross-country forklift truck, based on the Fordson Major agricultural tractor has recently appeared on the British market. This machine was designed to be " cross country " in the civilian rather than military sense of the term, but none the less is acceptable as a service mobile forklift truck for field use. It has a road speed of about 12 m.p.h. and a reasonable performance on poor ground. It weighs just over three tons and could be carried in a 3-ton lorry or towed at convoy speed in a light low-loading trailer. It could also tow its own trailer as an auxiliary aid. It is shown in use in Figs. 3 and 5.

(*d*) *Other Type of Equipment Referred to in the Tables*

These are generally available and in general use in depots and many other installations.

2. *Secondary Factors*

(*a*) Economy. The economy of the system is very much affected by the weight and complexity of the handling equipment compared with the weight of the product handled.

Thus a forklift truck of 3 tons weight will readily handle a 2-ton load, but a lorry-mounted crane to do this may weigh 10 or 12 tons.

The following table gives an idea of the relative economics of three main equipments and indicates the importance of having the right equipment for the job and of keeping a correct balance in provision and establishments :—

	Load Handled Freely	Maximum load handled	Weight of Equipt.	Approx. Cost of Equipt.
				£
Forklift truck	1½ T	2 T	3½ T	1,000
3-ton lorry-mounted crane	1½ T	3 T	9½ T	3,000
7-ton lorry-mounted crane	3 T	7 T	22 T	7,000

(*b*) *Provision*

Suitable types of equipment are available now. The amounts required for the introduction of even a high degree of mechanical handling could be readily produced in a short time compared with other types of military equipment.

(*c*) *Maintenance*

It is often argued against the development of a general mechanical handling scheme that it would impose an undue load on R.E.M.E. maintenance services. In fact the savings of transport consequent on improved turn-round times, and the reduction of stores needing to be held on wheels would cancel out the extra mechanical handling equipment provided. There would thus be little or no extra load on R.E.M.E.

Auxiliary Handling Equipment

Once the main forms of load were settled, and also the general nature of the mechanical handling scheme, it would be possible to introduce many types of cheap, simple and labour-saving auxiliary equipments and aids. In this category would come the hand-pallet trucks used for manœuvring palletized loads into railway trucks ; gantries for taking 3-ton cargo pallet boards off 3-ton lorries and ramps for skidding skid parcels to the ground.

Transport

1. *Design*

The features required in ideal body design for mechanical loading and unloading are, clear approaches, smooth surfaces and co-ordinated dimensions.

In practice this means, canopies off, sides down, no wheel boxes, and standardization of measurements within and between different types of transport.

For crane-loading the canopy must come off. For forklift truck loading the sides of a lorry must come down or off (and this does not mean leaving a 3-in. ledge each side to cancel out the 3-in. clearance in a pallet), although it may be possible to load from the rear of a lorry and skid the load forward.

Wheel boxes are a nuisance, but parcel loads and pallet/cargo boards can be supported in such lorries by a few pieces of 9 × 6 in. timber packing. The new civilian type vehicles now coming generally into service in this country have ideal bodies for mechanical loading and unloading.

Trials have shown that one man with a forklift truck can collect panel parcels from fifty yards away and load them into this type of lorry in under two minutes each. The fastest recorded time was 3 mins. 15 secs. for two parcels.

This allows one to think in terms of under five man/minutes for loading or unloading a lorry, which is comparable to the figures obtained with pallet/cargo boards.

2. *Operation*

To save driver man-power it is necessary to increase tonnage carried per power unit. This can be done by increasing the capacity of lorries, e.g., by using 10-tonners instead of 3-tonners. But this immediately introduces the question of bulk, in that it is almost impossible to load 10 tons of any military store, except ammunition, on a 10-tonner.

Two alternative systems require careful consideration :—

(*a*) *The " Mechanical Horse "*

In this system, well-known in the civilian world, a special tractor is used with a group of trailers, usually on local running such as delivery from a railway station. The tractor is designed to pick up trailers easily, and great economy is achieved in driver and mechanical equipment time by the " Mechanical Horse " delivering with one trailer while another one is being loaded.

(*b*) *The " Trailer Train "*

In this system, exemplified by the trailer trains of a circus on tour, a very powerful prime mover with one driver is used to tow a number of large trailers on long runs. Characteristics required for efficient mechanical handling are that the trailer dimensions should be related to lorry dimensions, i.e., there should be 3-ton trailers of the same body size as 3-ton lorries and 10-ton trailers of the same body size as 10-ton lorries. On suitable routes a 3-ton lorry might tow a 3-ton trailer. Alternatively special heavy tractors which do not carry loads themselves might be used for the work. Thus it might be made the practice for 900 tons of stores to be moved at a time by a R.A.S.C. platoon consisting of thirty heavy tractors each towing three 10-ton trailers. Such trains might require special traffic arrangements, but no more so than a convoy of heavy tanks. In forward areas normal transport would be used, pallet/cargo boards being used for transfer purposes.

Applications and Savings

Space allows the consideration of only one example ; the Field Engineer Regiment.

1. The main applications, using the forms of load described in this article, would be :—

(*a*) *Bridging.*—Unloading and carrying forward all types of parcel loaded and other stores. The mechanical erection of bridges. Excavation of home bank seats with grab.

(*b*) *Roads, tracks, bridge approaches.*—Unloading and carrying forward of stores. Use of grab for excavations, and for loading rubble, etc., into tippers.

(*c*) *Minelaying.*—Unloading and carrying forward of mines.

(*d*) *Defences.*—Mechanical handling of aggregates, cement, concrete, prefabricated shuttering and reinforcement, barbed wire, pickets, timber, filled sand-bags, turf for camouflage, etc.

(*e*) *Hutting.*—Unloading and movement of stores. Erection of huts.

(*f*) *Demolitions.*—Handling of explosives, raising of men and explosives to top booms of bridge trusses.

2. The main savings would be :—

(*a*) *Manpower.*—The machines employed on tasks listed above would be equivalent to about 300 tireless men or almost 100 per cent increase in the affective working strength of the regiment.

(*b*) *Time.*—There would be substantial savings in time, due partly to the speed of the machines and partly to the reduction in fatigue among the men consequent on the machines doing all the heavy work.

(*c*) *Casualties.*—These would be reduced, owing to stores being unloaded behind the danger areas and carried forward mechanically as required, thus reducing the number of men and vehicles under fire.

(*d*) *Transport.*—Considerable savings would result from decreased turn-round time, owing to the speed of unloading and the policy of immediate dumping of stores once they were within mechanical carrying distance of the site of operations.

3. *Establishment.* Its establishment of mechanical handling equipment might be :—

Equipment	Unit Cost £	Field Squadron: Fd. Tp.	Field Squadron: Sqn. H.Q.	Field Squadron: Total Sqn.	Field Park Squadron: Stores Tp.	Field Park Squadron: Br. Tp.	Field Park Squadron: Wksp Tp.	Field Park Squadron: Plant Tp.	Field Park Squadron: Fd. Pk. Sqn.	Total for Fd. Engr. Regt.	Cost £
2-ton Cross-country F.L. Truck	1,000	1	2	5	1	1	1	1	4	19	19,000
Trailer for F.L. Truck	300	1	2	5	1	1	1	1	4	19	5,700
3-ton Lorry-mounted Crane with Grab as Auxiliary Equipment	3,000	—	2	2	1	1	—	—	2	8	24,000
7-ton Crane	7,000	—	—	—	—	—	—	4	4	4	28,000
										Total Cost	£76,700

Summary

The conclusions in this article may be summarized as follows :—

1. Service man-power is out of balance owing to the growing weight of service stores and the diminishing availability of men.

2. Mechanical handling properly applied is a means of rectifying the balance of man-power, economizing transport and speeding up the delivery of stores.

3. The essential factor for successful application is the ability to handle stores mechanically in bad conditions.

4. The problem is one of developing a suitable group of equipments and methods, leaving detailed applications to the man on the spot.

5. The keys to development are parcelling and palletization, using the principles of string, shopping baskets and trays handled by mechanical housewifes and waiters in suitable levels.

6. The flexibility of local palletization may make it in many ways a more efficient method for service purposes than through palletization.

7. The one-lift loading and unloading of 3- and 10-ton units by means of pallet/cargo boards is a feature of the scheme.

8. The main handling equipments are cranes and forklift trucks in definite ranges of capacity and types.

9. Many simple, cheap but valuable auxiliary aids can be introduced once the main outline of the system is clear.

10 Further economics can be effected by a fresh approach to the transport problem.

Conclusion

In this article is recorded briefly the results of a line of thought pursued through several years. It is confined mainly to basic principles and the development of equipments and techniques. Although one or two examples are discussed in detail, space does not allow fuller consideration of the influence of mechanical handling methods on design, military establishments and operational methods. The questions that are left to the reader at this stage are whether an acceptable case has been made out for the development of a general scheme for the mechanical handling of service stores, and if it should follow the lines proposed in this article ?

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EXPEDITION TO NORTH-EAST LAND, 1949

By Captain W. Scott-Moncrieff, R.E.

(Published by kind permission of Mr. J. M. Hartog, M.A., leader of the expedition. This is NOT an Official account.)

Introduction

IN the summer of 1949, I was fortunate enough to be attached to the Oxford University Expedition to North-East Land; an island in the Spitzbergen archipelago, lying, as its name implies, north-east of the main island, West Spitzbergen. This island is about the size of Wales, and its centre is approximately 80° N., 23° E.; it is largely covered by a permanent ice-cap, with coastal fringes of rock and shingle on the north and west sides; on the south and east coasts the ice-cap runs down to the sea, and breaks off in sheer cliffs thirty to fifty feet high. Just before the war, for some unknown cause, on the south coast there was a sudden irruption of the ice-cap into the sea, forming a great semi-circular tongue of ice some seven miles long and fifteen miles wide at the base.

This tongue of ice was christened the Bråswell Glacier, and a main object of the expedition was to investigate its origin and present state. There was in addition a large scientific programme of glaciology, geomorphology, biology, survey, marine survey and meteorology.

To carry out this programme a party of five was taken; a larger number was desirable, but could not be taken due to the limitations of accommodation on the seal-hunting ship which was due to land us and take us off. The party consisted of John Hartog as leader, Lykke Olsen as deputy leader and glaciologist, Chris Harley as marine surveyor, Hugh Thompson as geographer, and myself as surveyor.

We took with us from the U.K. all our scientific equipment, clothing, rations, tentage, cooking gear etc., and proposed to supply ourselves with fuel, marine equipment and reserve rations in Norway. We also borrowed a whaler from the Admiralty to carry out the marine survey programme, and to provide an emergency means of returning to civilization should our sealer fail to pick us up.

THE JOURNEY NORTH

After a week of blazing heat packing up and seeing to final details in Oxford, Lykke and Hugh sailed with the equipment from Newcastle on 30th June. The rest of us sailed on 2nd July, arriving at Bergen on 3rd July. On 4th July we transferred on to the coastal mail ship *Ragnvald Jarl*, on which we were to go to Tromsø.

The ship would stop every few hours at the coastal towns and villages, and afford an opportunity to stretch our legs and have a cup of coffee. After passing the black, jagged mountains of the Lofoten Islands on the evening of 7th July, we passed through a country of low, rolling hills covered with birch-scrub, very desolate and barren, with a few crofts huddling along the shore, and reached Tromsø on the evening of 8th July, where we were met by Lykke and Hugh. We expected to sail the next day on a collier, the *Kaprino*, returning to Spitzbergen in ballast, and our gear was put aboard in the morning; but the master said that he knew nothing about us and would not take us. So John telephoned to Bergen and arranged for us to sail on another collier from Hammerfest. So on the evening of 10th July, we embarked on the *Polarlys*, another mail ship, which decanted us on the quay at Hammerfest, breakfastless, at half-past six in the morning, in icy, driving rain. We had a cheerless morning; Hammerfest had been burnt to the ground by the Germans in 1945, and consists of a cluster of nondescript wooden huts and ugly reinforced concrete buildings, huddled between low, rocky hills and the harbour. We had a miserable breakfast, and a shocking lunch and went aboard the collier *Nerva* in the afternoon. There we were expected and made welcome by the master, Captain Larsen. We were put into two spare cabins, with three bunks and two settees, and we fed with the master, who was full of apologies for the shortcomings of the food and accommodation; but in fact the food was excellent and plentiful, and we were better off than we had been at any time since we left the U.K. The only snag was that the ship, being in ballast, rolled badly.

We left Hammerfest on the evening of the 11th in a high wind, which fortunately moderated by morning. We left Bear Island to starboard on the 12th, and sighted the South Cape of Spitzbergen on the 13th. We sailed north along the coast all that day, in bright sunshine; there was a belt of pack ice lying between us and the coast, and the sea was alive with birds. At three o'clock the next morning we turned east into Isfjord and sailed on through thickening pack-ice until we reached Longyear City and moored to the coal quay.

John was unable to do anything until he had discussed the situation with the Norwegian governor, Herr Balstad, who was away on an official visit to the Russian consul, so we had an idle day. By the next morning the north-east wind had driven a lot of ice into Advent Bay, and we were unable to do much until the afternoon, when we got our gear on to a motor-boat and transferred ourselves regretfully from the *Nerva* to the sealer *Skandfer*, aboard which we were to make the next leg of the journey ; our heavy gear, which had preceded us in the *Kaprino*, had been loaded into the *Skandfer*, and we were put into the stern cabin—cramped quarters, with two bunks, into each of which two could squeeze, and the floor for the fifth man.

We were invited to dinner in the mining engineers' mess that evening, and were able to have a look at the town, which had been razed to the ground in the war. The houses were all wooden, with double windows, and much more building had still to be done. The mines looked odd, for they were high up on the mountainside, and had no pithead gear.

On the 16th we had our long-awaited discussion with the Governor. He was naturally a little doubtful of some of our plans as none of us had been in the Arctic before. However, he gave us a free hand, and lent us the *Skandfer*, which was on charter to him, to take us round to North-East Land. On 17th July we were ready to sail, with the whaler in tow.

The *Skandfer* is a stout, sturdy ship, about sixty feet long, of 35 tons burden. Like all sealers, it has a very strong hull, with ribs only a few inches apart, sheathed in stout oak planks, with an iron ram for breaking through pack ice. It is driven by a slow-running diesel engine, with sails to provide auxiliary power. And it stinks of seal oil. At this time it carried a crew of five, commanded by Captain Sebak. Also the Governor had sent his son Olaf, a boy of twelve or thirteen, to represent the interests of the Norwegian Government.

As soon as we left Advent Bay, we ran into a short, choppy head sea, which gave the sealer a most surprising motion, and worried us all a lot. We had to mount a watch on the whaler which was no great hardship among five of us, and meant that no one had to sleep on the floor ; but the whaler had to be baled every three or four hours, which was no fun. By the evening of 18th July the sea had calmed down, and we were rounding the north-west cape of Spitzbergen in an apparently dead world ; steep, barren rocks rising out of a cold, mirror-like, steely-grey sea ; here and there fields of drifting pack-ice ; and a low, grey sky. The only sign of life in this desolate place was provided by the sea-birds, guillemots, auks, puffins, gulls and fulmars swimming or flying, singly or in flocks, everywhere. By the 19th we had passed the north-east point of West Spitzbergen, and turned south-easterly down the Hinlopen Strait, which separates it from North-East Land (see map at end of article).

When we had passed through the Hinlopen, we made for Wilhelm Island, where we proposed to establish a food dump. This was a safety precaution, in case the *Skandfer* was unable to take us off because of the ice. If that should happen, we would have to wait until the sea froze, and walk back to Longyear City, and we would then have these reserve rations half-way between us and civilization. Unfortunately sea ice was lying off the island and the *Skandfer* could not get within two miles of the shore. So we loaded the stores on to a sledge, and pulled them to shore, a most unpleasant experience, for the ice was very hummocky, and contained many pools of open water which had to be avoided. The sledge was difficult to steer, we sank to our knees in drift snow, and to add to our troubles fog came down, and we could not see where we were going. However, after two hours of tortuous going, we eventually reached land, and established our dump in a cleft in a great rock, walling it up with stones to keep the bears from getting at the food.

We got back to the ship at six o'clock, and had breakfast and then went on to Vibe Bay, where the western edge of the Bråswell Glacier meets the land, and where we hoped to establish our base.

We reached Vibe Bay at midday, and here a great disappointment awaited us, for the bay was choked with rotten sea ice and we could not get near the shore. It was tantalizing to see great ice cliffs of the Bråswell Glacier glittering in the sun only a mile or two away, and to know that it would not be possible to land near them. So, after spending some time in vain regrets and impracticable suggestions, we went westwards to find an ice-free stretch of coast to land on. The nearest suitable place proved to be Cape Torell, the south-western cape of North-East Land, which we reached in the evening.

We found a suitable place to land, near a long-abandoned trappers' hut, and spent the whole night from ten o'clock till seven in the morning getting our gear ashore. It was back-breaking work ; we had to get the gear out of the hold, including a lot of heavy, awkward cases ; load it into the whaler ; row the whaler ashore ; carry the gear about a hundred yards over fine, yielding shingle, and then go back for more. There were between two and three tons of equipment, and by the time we had landed and stacked it all, our bodies were very weary and our tempers very short.

We left Chris and Hugh with the equipment, and John, Lykke and I re-embarked on the *Skandfer*, to sail round to Isis Point.

Isis Point

Isis Point was discovered some twenty-five years ago and has since been visited once more, but has never been thoroughly investigated.

All that was known of it is that it is a small exposure of land on the east coast of North-East Land breaking the line of ice cliffs which otherwise run continuously from Vibe Bay to Cape Leigh Smith, a distance of about a hundred miles. The intention was to land there, and fix its position by theodolite observations of the sun ; to map the land exposure ; to make collections of geological and botanical specimens. It was hoped that this could be accomplished in two or three days, and we would then start walking back to the base camp at Cape Torell, pulling our belongings behind us on a sledge.

So the three of us had our breakfast and went to bed, and slept for most of the day. The skipper made little progress for the fog shut down, and we spent most of the day moored to a floe. That night the fog lifted, and we saw the hummocky mass of the Bråswell Glacier looming greyly through the murk some miles to the north of us. We pressed on towards the east through thick pack ice to Cape Mohn, the south-east point of North-East Land, and then turned north ; when we passed it, about a quarter of a mile of the Cape had broken off and was engaged in floating out to sea. One of the charms of navigating in this area is that the coastline, where it consists of ice cliffs, is continually altering. After we had turned north the sea-ice opened out a lot, and at 5 a.m. we ran out of the fog into brilliant sunshine.

We sailed north in sunshine, with magnificent ice cliffs on the port beam ; these cliffs looked much higher than the cliffs of the Bråswell Glacier, with here and there waterfalls dropping straight into the sea. But after a while, despite the beauty of the scene, we began to get worried, for we seemed to have come a long way, and had seen no signs of Isis Point, and we feared that we might have passed it, or that it might not exist. Lykke suggested to the skipper that he check his position by sextant, but was informed that he had not got it, as he had lent it to a friend who had gone to Greenland for the summer ; however eventually he climbed to the crow's nest with his telescope, and after a while announced that he could see land, so we put in to shore, and landed with all our gear on the afternoon of 22nd July. As soon as we were ashore, the *Skandfer* put about and made off as fast as she could, in case the ice closed in again.

So there we were ; we had our sledge, skis, a small tent, three weeks' rations, li-los, sleeping bags, theodolite and plane table, a battery of aneroid barometers, thermometers, and many smaller items necessary for our comfort and our work. The first thing to do was to set up the theodolite and take solar observations while the sun was out, so Lykke and I got on with that while John started to pitch camp. Then we went up to the highest point and had a look at our kingdom. We found that Isis Point was much larger than we had been led to believe ; it consisted of a series of rocky spits and skerries, with a number of shingle beaches and brackish lagoons ; inland rose a continuous line of moraine heaps, ugly tumbled masses of clay and boulders, and behind that the ice cap rose to the limit of view ; the whole extent of the land was not more than a mile and a half long from north to south, and a mile wide east to west ; the ice cliffs ran away to north and south, and there was a continual rumble and splash as lumps of ice, loosened by the heat of the sun, fell into the sea. The land swarmed with birds ; everywhere eider duck were nesting ; and there were several colonies of Arctic terns, lovely to watch, but so vicious and aggressive that we found it necessary to wear hats to protects our heads from their beaks ; there were also Arctic skuas, glaucous and ivory gulls, and one day a pair of grey phalaropes.

It was now apparent that the work could not be done in two or three days, and John decided to spend up to a week at Isis Point, as it was not an easy place to get to, and we wanted to bring back as much information as we could about its topography, geology, botany and zoology ; all these are of considerable scientific interest as Isis Point is an isolated area of land only recently exposed by the receding ice cap. The latitude and longitude were also required as a check-point on the Norwegian aerial survey.

By the 26th we had completed the survey and geological work, despite some difficulty due to high wind and fog.

The morning of the 27th was spent in final preparations. We carried all our gear to the edge of the snow, and spent a long time fiddling about to find the best method of loading it on the sledge ; this was not easy, as the sledge was designed to carry a 250-lb. load, and we had over 400 lb. of gear. We waxed our skis, and here we discovered an omission in our equipment ; ski waxes appear to be intended to be applied in nice warm huts, not in cold, windy, open spaces, and we should have brought a small iron. This work all fell upon Lykke, as he was the only one who knew anything about skis, for John and I had never used them before ; however, we soon became fairly proficient.

At last, at 2.30 p.m. we set off.

Crossing the Ice Cap

As the crow flies, we were about eighty miles from the base camp, but we had certain things to do, and needed to cover about 120 miles to do them, and we had fifteen days' rations. We wanted to go over the top of the ice cap, taking aneroid readings every few miles, in order to discover its general shape. We wanted to try and find Nordenskiold's ice canals ; these were curious formations in the ice, first found by Baron Nordenskiold, a Swedish explorer in the 1880's, and only briefly glimpsed once since then. And we wished to investigate the source area of the Bråswell Glacier. It seemed easy ; idle along at 10 miles a day, lots of spare time to carry out our investigations.

So we set off at 2.30 p.m. on 27th July to climb up on to the slopes of the ice cap from Isis Point, steering a compass course due west to take us over the top of the ice cap. The weather was clear, and things were going nicely, until we struck an area of hummocky ice, in which the sledge overturned repeatedly. Then we got clear of this, and ran into an area of snow morasses ; these consisted of a slush of snow and water, up to eighteen inches deep, with a thin crust of ice on the top. Into these we went, skis and all, and we were soon soaked to the thighs ; fortunately, the sledge almost floated through, with its boat-shaped hull and high canvas sides, and our equipment remained dry. This had a serious effect subsequently, for we were never able to get our boots dry again, and they became very hard and unyielding and did a lot of damage to our feet.

We were through the morasses in an hour, and we never encountered them again, for which we were profoundly thankful, for it was most unpleasant floundering about in icy slush trying to drag a heavy sledge at the same time.

We stopped that evening at 7 p.m., and pitched camp. We were disturbed to find that our cyclometer showed we had travelled less than three miles, for we thought we had come at least five. But we were too tired to worry overlong, so we cooked and ate our vile pemmican broth—or " hoosh," as it is more fashionably called—and got inside our sleeping bags.

For the next two days we climbed steadily to the top of the ice cap. It was hard work hauling up the slope with a strong north-west wind blowing, and the skies grey and overcast. On the second day we checked the cyclometer, which was driven by a bicycle wheel attached to the back of the sledge, by counting paces for an hour and estimating distances, and we arrived at the depressing conclusion that it was right. The going continually improved, as the strong wind packed and crusted the snow. We found our man-hauling harnesses unsatisfactory, as the braces kept slipping off our shoulders and allowing the belt to fall down and trip us up ; however, the braces were improved by individual modifications.

For the next four days we crossed the top of the ice cap, covering a distance of 37 miles. Most of the time visibility was nil, due to drift snow when the wind was blowing, and mist when it was not. In drift snow we usually made reasonable progress, for Lykke, a dinghy sailor, could steer by the feel of the wind on his cheek. But on windless, misty days the only way to steer a course was by frequent compass checks and that meant endless delay, for the strength of the earth's horizontal magnetic field is small in those latitudes, and compasses take a long time to settle down. And, in that featureless desert of ice, it was easy to go wildly off course in a very short period. We had hoped that two would be able to pull while the third steered by a compass fixed to the sledge, but it was not possible. On 30th July we marched through a strong northerly wind, in thick drift snow, which caked and froze on our clothes until we were sheathed in a skin of ice. The 31st was our best day ; we were on the highest part of the ice cap, on hard crusted snow, and the wind and drift stopped. It was an extraordinary sight to see the drift swirling across the plain knee-high, like a river of smoke. When it stopped, we could at last see what the ice cap looked like. It was flat and featureless, with a level horizon in all directions ; it was for all the world like being in the middle of a calm, white, still sea. On the 31st we marched 12 miles, but on 1st August, we were hindered by mist and snow ; the new snow balled up on our skis, and caused a lot of trouble. On the 2nd we started to go down hill in the direction of some land we spotted in the morning, but the mist shut down and later in the day we ran into a system of large crevasses.

By this time we had crossed the ice cap, and had crossed the area in which Nordenskiold's ice canals were said to lie, without seeing any signs of them. We had also worked out a fairly efficient daily routine, which would have been very good had we adhered to it.

The man whose turn it was to cook slept in the middle of the tent and at 7 a.m. he got up—he usually overslept—and cooked breakfast, which the other two ate lying in their sleeping bags. After the natural disinclination to leave warm sleeping bags for the cold, hard world had been overcome, the other two got up, dressed—a simple operation ; we slept in most of our clothes—and went through the agonizing performance of inserting raw, tender feet into damp socks and iron-hard boots. Then the gear was packed up, the tent struck, everything loaded on to the sledge and we marched at ten—in theory, but we were usually away by eleven, except when we had to wax skis ; this operation took hours, heating a knife, smearing on as much wax as possible before the knife got cold, and then repeating the process endlessly. We marched till two, with a ten-minute halt every hour, which we needed. Then we halted for an hour to brew up cocoa ; we put the sledge broadside to the wind, dug a little hole in the snow for the primus, and squatted on our ski, sheltered from the biting wind by the inadequate lee of the sledge ; I count those hours among the most miserable I have ever spent. We marched on from three till seven, when we halted and pitched camp ; we usually managed to make some specious excuse for halting before seven. One thing we learned to do fast and

Photo 1.—Looking over the Hinlopen Strait to West Spitzbergen.

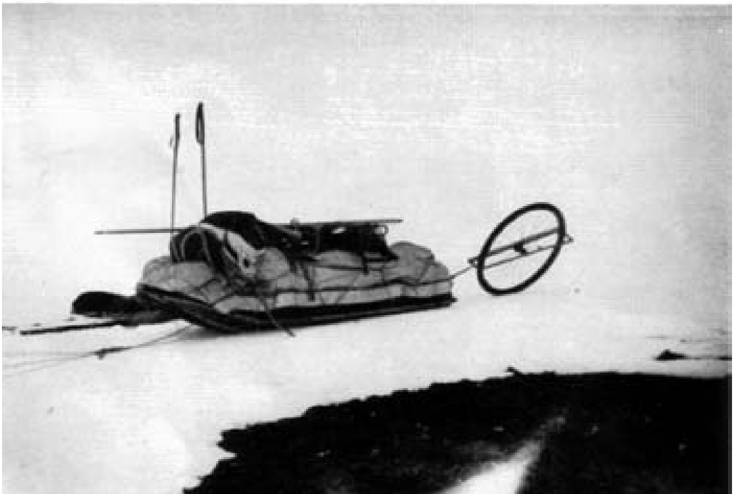

Photo 2.—The sledge.

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Photo 3.—An Ice Cap camp.

Photo 4.—Drifting floes.

Expedition To North East Land, 1949 3,4

efficiently was to pitch camp ; the tent was up, li-los inflated, food cooked, equipment stowed for the night within an hour. Then we could eat our revolting meal and get straight into our sleeping bags and harmony would prevail, except for John's cough—Lykke and I both smoked rank Norwegian tobacco, which affected John's throat adversely ; diaries would be written up, and we would sleep.

From this description of the day's routine we appear to have been an idle trio, but we were very tired and very hungry. The food was horrible, with nothing worth eating except two bars of chocolate. For breakfast we had a mush made of plasmon oats, sugar, raisins and margarine—it cannot be called porridge ; for lunch, chunks of cold pemmican, biscuits and margarine, and cocoa ; for supper pemmican broth, thickened with flour, and biscuits and margarine ; and we had to eat vitamin pills. To start with we could not eat our ration, but after a few days sledge-hauling we wolfed it ravenously.

I know of no occupation as monotonous and exhausting as sledge-hauling. One plods wearily on, hour after hour, with the trace everlastingly dragging at one's hips. There is nothing to distract the eye, no visible object to aim for, because most of the time one cannot see further than fifty yards due to mist or drift snow. All there is to see are the tips of one's skis eternally passing one another, or, even more depressing, the weary, bowed back of the leader in front. Seven or eight hours a day of this soon deadened our minds, and we found it a great effort to do anything outside the normal routine of keeping alive.

To return to the journey. On 2nd August we passed through a belt of wide, deep crevasses and camped on the other side of them. The next day it was snowing and blowing hard and so it continued all day long. We soon got into a maze of crevasses and ridges of pressure ice, forced up and twisted into extraordinary shapes. The crevasses were up to eight feet wide, great cracks in the ice, greenish blue in colour, with fantastic clusters of icicles clinging to their sides ; all day we threaded a tortuous course through these, sometimes having to retrace our steps, but by evening we emerged on to firm snow, though we could not see what lay beyond due to the mist. In the morning it was clear, and we saw that land lay half a mile ahead. So we went up to it to see what it was, and found that we were at the head of Wahlenberg Bay, and had spent the previous day crossing the Eton Glacier. Though the land was merely an outcrop of frost-shattered rock, it was a pleasure to be on something solid again. We looked around, and John collected some rocks, and we found an ivory gull's nest ; she had made a cup-shaped nest of fine shingle, and was sitting on three eggs.

We now knew where we were, and we had eight days' rations left.

John decided to see if we could get to the Bråswell Glacier before returning to the base camp. Accordingly we set off south-eastwards, and had a steep climb back on to the ice cap that afternoon. The weather was favourable the next morning, but during our lunch-time halt a blizzard hit us from the north-east. We abandoned all hopes of cocoa, and pressed on into the teeth of the gale. At 4.30 p.m. some knolls of rock projecting through the snow appeared on our right through the whirling snow, and we made for them, hoping to find some shelter to camp. We had a lot of trouble floundering about in deep drifts with the sledge, but we eventually dug out a flat place in a drift, pitched the tent, anchoring it by driving skis into the snow to windward, and settled down. By this time we were soaking wet with drift snow, and so was the tent, so things were even more miserable than usual. We got off early on the morning of 6th August, at 9.30, in fairly good conditions, for the wind had dropped, the clouds had lifted and the snow was hard and firm ; we could see all the coast of North-East Land from the Bråswell Glacier to the Black Mountains, and the snow mountains of West Spitzbergen beyond. But the weather looked very threatening, with inky-black clouds racing across the sky, and the distant mountains appearing a livid yellow, and, sure enough, at eleven o'clock the wind, accompanied by snow and tremendous low drift, hit us hard from the north. The surface by now was mixed, partially hard ice, on which we slipped and skated helplessly, despite the steel edges on our skis, and partially soft drifts, which gave us hard pulling. We went on till 3 p.m., and then there seemed no point in going further under such conditions, for we were exhausted by the alternations between drift and crust, and the sledge frequently overturned. So we camped, and John decided that as we were still a day's march from the Bråswell Glacier, and only had five days' rations left, we should turn back to the base.

The gale was still blowing hard in the morning, and the drift was rattling on the tent like small-shot so we delayed our departure till midday, when it moderated a bit ; this also gave us time to thaw out our boots, which were frozen solid. We set off westerly, trying to contour along the side of the ice cap ; but the slippery going and the strong north wind gradually forced us downhill to the edge of a steep slope some six or seven hundred feet high, and much as we hated losing height, we had to go down to find relief from the wind. We were now in an area of undulating hummocks of shingle, about ten miles inland, criss crossed with lanes of snow, along which we made our way till six o'clock when we camped. The change in weather was remarkable ; we sat outside the tent in the sun, in a gentle breeze, smoking our pipes and watching the cocoa boil. We went on the next day through the same sort of going, but we came across some melt-water streams and snow morasses, so we determined to return to the lower slopes of the ice cap. But there was a formidable obstacle on the way; a melt stream flowing in a gulley in the snow ten feet deep and about four feet wide at the top. After a good deal of discussion we threw our skis and ourselves across, and with our hearts in our mouths we gave a great heave on the sledge, and over she came. Then a long hard uphill pull to the Black Mountains that day, followed by two days' very hard work on a side slope in thawing snow, skirting the Black Mountains and the Rosenthal Glacier and on the evening of 10th August we reached the top of Torell Hill. We searched the coast for a long time with binoculars before we spotted the base camp, and fired a couple of shots to let Hugh and Chris know we had arrived. They fired an answering shot, and then we careered down to the bottom of the snow with our sledge, and pitched camp. There was a mile of rough ground between us and the base camp, and we were too tired to carry our gear over it till the morning. We were thankful to have got back. It had taken us fifteen days to make the journey, and we had covered a distance of 106 miles in that time, an average of only seven miles a day; it does not seem much, but it was weary work.

At the Base

The base camp, when we reached it after staggering down through a mile of bogs and boulders carrying our gear, looked very smart. It was sited on a bank of shingle about twenty yards from the sea, just beside the old trappers' hut, which was used as a store. There were three tents up, the little double-walled pyramid where Hugh and Chris lived, and two octagonal tents one of which was destined for us, the other being full of stores. The wireless aerial carried on poles added a touch of distinction to the scene.

We spent the next few days idly. We were ravenously hungry, and ate what we could whenever there was a chance. We compared notes with Hugh and Chris, and found out what they had been doing for the past three weeks; Hugh had been engaged in making glaciological and geomorphological investigations, and Chris had been fixing up the camp, rigging the whaler, and doing the thousand-and-one odd jobs that crop up. A little mild work was done. Hugh and Chris had to practise using skis. Lykke had spent a lot of time in Oxford making instruments for drilling holes in ice, and for measuring temperatures in the holes, and went off to the ice cap to try them out. I managed to shoot some eider duck, which made what seemed a most delicious stew; really, I suppose, it was very tough and fishy meat, but it was a wonderful change to have something to chew after living on slops for weeks. One day was still and brilliant, the first we had had since we landed at Isis Point, and

Hugh and I took the theodolite round to fix the key points in his geomorphological survey.

However, time was running short, and there was much to be done. The whole marine survey programme had to be abandoned, as the sea ice was too thick to allow us to get out from the coast. The Hinlopen Strait was usually clear, but at our front door was an endless steam of floes being carried one way or the other by the winds, tides and currents. But we had not been near the Bråswell Glacier, and something had to be done about that. So John decided that Lykke, Chris and himself would go out for a fortnight to see what they could discover, and Hugh and I would spend ten days going out to the Black Mountains, some twelve miles away, to survey and geologize.

Further Journeys

As the way to the Bråswell Glacier ran past the Black Mountains, Hugh and I were to take some of the other party's spare gear, and make a dump of it. Chris came with us to help with the hauling.

We got off on the 17th, in thick still mist, which soaked our clothes, and made accurate steering impossible. We had two days of this exhausting work, and reached the Northern tip of the Black Mountains, where we established the dump, and pushed on to set up a camp on a spur of the Black Mountains. Chris stayed with us till the 20th, when John and Lykke were due to reach the dump, and then departed into the mist to join them.

The Black Mountains have a more impressive name than either their height—they are under 1,000 feet—or their appearance warrants. The ice cap sweeps down till it is checked by a 5-mile long L-shaped ridge, which falls steeply to the low ground ; half a mile away, across a valley of glutinous clay, rises a steep tooth of rock, and three miles to the south-west is a long low ridge, which drops in steep cliffs on the seaward side, the haunt of black guillemots. These are all outcrops of black, dolerite rock—and everywhere lie huge weathered blocks of the same stuff, brought down by the action of frost and water.

This, then, had to be mapped. But for four days there was wind, rain, fog and snow, so all survey work was out of the question. I spent my time lying in the tent in my sleeping bag, reading. But Hugh had to go out and face the elements, taking his hammer and note-book with him, and would return soaked and miserable. I admired his persistence but was devoutly thankful that I could rest in my sleeping bag with a clear conscience.

At last, at midnight on the 24th, the clouds lifted, and I set out for the sharp tooth of rock to the south, with the plane table. I had a weary time slogging across the stiff, gluey clay and so to the top.

As soon as I got there the mist shut down but it was calm and still and fairly warm, so I waited an hour to see if it would lift. It did not, but the tedium was enlivened by a group of ivory gulls, some fifteen in all, which flew round and round screaming ; these beautiful birds, pure white in plumage with black beaks and legs, seem to typify the very spirit of the Arctic as they glide over the ice-floes at sea, silent, watchful and menacing.

I got back at about 2 a.m. and when I woke again at nine o'clock, the sun had come through and the weather looked promising, except for some banks of fog lying along the coast, so I started out again just before 10 a.m. I worked round the area till 7.30 p.m., when I returned to camp. The banks of sea-fog had come rolling inland at intervals all day long, and had been a serious hindrance, blinding me with clammy moisture for long periods, and obscuring points I wished to use for intersections and resections. However, I had a more or less accurate representation of three-quarters of the Black Mountains on the plane table, and another few hours of clear weather would give the rest.

I woke at 2 a.m. on the 25th, and found the sun shining brightly, and the air as clear as a diamond, so I set off immediately on skis, as there was snow near most places I wanted to visit. It had frozen hard, and there was a chilly breeze blowing, so the work was cold on the fingers. As conditions were ideal for sledging, it seemed best to move camp as soon as I returned ; but Hugh still had things to do, and was not ready till one, by which time the usual mist and rain had started again, so we postponed our departure till the next day. There was still mist, the going was very soft, but we had to get off, so we skirted the Black Mountain, crossed the Erica Valley, and climbed up on to the Vega Ice. It was very stiff pulling uphill on soft going, but by 5 p.m. we emerged above the mist and could see where we were, which cheered us greatly, dreary though the view was. A cold north-east breeze was blowing ; and the sun was hidden by racing black clouds ; banks of mist were forming on the South Ice, and rolling down over the Black Mountains to the coast, where they fumed up in ragged brown clouds. We went on till 8 p.m. when we made camp. Unfortunately the guy in the middle of the windward wall tore out, and the wall bellied inwards and filled the tent ; but the theodolite tripod proved an excellent prop. The next day it took us four hours maddening hauling on a side-slope to get to the bottom of the snow, above the base camp ; my artificial seal-skins were almost worn out, and finally broke an hour before we finished hauling, and I could get no grip without them, so Hugh had to pull almost single-handed. We lashed loads on to our pack-carriers, and stumbled back to camp over the rocks and marshes.

The camp was in good order when we arrived, except that one tent had been slightly damaged in a gale. We soon put that right, and settled into the octagonal tent and had a good meal. We had four days before the others were expected, on 2nd September, and plenty to keep us occupied. Hugh had a lot of ice-drilling to do, while there were any number of jobs to be done in the camp. On the 28th we tried to row the dinghy out to Karl Alexander Island, a small island some three miles off shore; the object was to try and shoot a seal, to investigate the formation of the island, which had never been visited, and to have a look at the bird life. But wind and tide were too strong for us, and we were forced to turn back.

The next two days Hugh spent at his drilling, while I busied myself in camp. The weather was variable, sometimes fine and sunny, sometimes cold and bleak, and it was beginning to get dark at nights. On the afternoon of the 31st, in the middle of a snow storm, the other three suddenly appeared, plastered with snow, but pleased to be back two days early, with their investigation of the Bråswell Glacier finished.

The 1st and 2nd September were lovely days, cold but clear. We tried unsuccessfully to shoot eider duck on the 1st, but while we were out in the dinghy a shoal of white whales passed by within a hundred yards of us, rolling their backs out of the water at intervals.

Waiting for the Boat

We were expecting *Skandfer* back to pick us up between the 3rd and 8th September, and we had arranged for Sebak to call us up at certain stated times to let us know how he was getting on. Lykke, who spoke Norwegian, listened in on the fishery wave-length, but heard nothing of Sebak, though he heard a number of interesting conversations between Hull and Grimsby trawler skippers off Bear Island, discussing the prospects of English league football.

Meanwhile, the 3rd and 4th were lovely days, so I mapped the area between Cape Torell and the Rosenthal Glacier, to link up with the Black Mountain map. Survey work was a real pleasure in those conditions. The bogs and streams had frozen hard, and made easy walking. There was no wind, and I could work comfortably without gloves. And I have never seen such a lovely view; the sky was pale blue, and the sea a bright, vivid blue, where it was not covered with white, shining floes and black, rocky islands—and in the background rose the remote snow mountains of West Spitzbergen. Days such as these fully compensated for the usual miserable conditions of wind, mist, and drift.

By the 5th we were getting pretty worried. The sea ice was lying thick off shore, much too much of it for *Skandfer*, and we had heard nothing from Sebak. We had discussed various means of getting back to Longyear City before, but now that there appeared to be a definite possibility of putting one or other of them into practice, we liked the prospect less and less. If the ice cleared, we could sail the whaler across to Wilhelm Island, and perhaps further down the coast, and then get back overland. If it did not clear, we must wait till the sea froze over, and then cross to West Spitzbergen on the ice ; if we did that, we must drag the dinghy with us, for if a storm broke up the ice, we had not a hope unless we had a boat with us.

However, our gloomy forebodings were set at naught, for on the morning of the 7th we saw a mast near Cape Torell, about three miles away. We set off hot-foot, and met our old friends Thorlief and Otto with the *Skandfer's* motor-boat. They could not get nearer to our camp than two miles, because of the ice, so we arranged to meet them a few hours later with what we could carry, and leave the rest, which we proposed to pack into the hut in the hope that it could be picked up next year. But by great good fortune, a strong west wind sprang up, and blew the ice eastward. So during the morning *Skandfer* moved along and moored opposite our camp. We hurriedly got everything together and sent load after load out in the motor boat. When everything had been loaded, the whaler was towed out and made fast, and finally we were taken aboard at about 6 p.m. The wind was blowing hard from the north, and the ship was moving uneasily at her moorings, but we were all so delighted to be aboard, that little things like that did not worry us.

The Journey South

We sailed at 8 a.m. on the 8th. Sebak wanted to go straight south, avoiding the confined waters and fierce tide rips of the east coast of Spitzbergen. We started off steaming east towards the Bråswell Glacier, to try to find a hole in the ice, which the wind had blown off shore on the 7th. We turned south at midday and made good progress, though it began to snow. But the mist closed down soon after, and we found ourselves among heavy belts of pack-ice with poor leads. Several times the ship had to break through, but that evening we came to a belt with no lead, so Sebak tied up to a floe to wait for wind and tide to open out the pack ; but while the crew were having their supper, the ice closed in, and we had to back out quickly to avoid getting trapped. The next day was much the same, a misty, rainy morning, with the dismal coast of Barent's Island in sight. All day we battered our way south through pack-ice, with several long pauses to let leads open out. By 5 p.m. we reached open water and steamed south along the west shore of Edge Island, in a considerable swell. In the morning we anchored in Tjuvfjord, off the south coast of Edge Island, in the lee of some skerries ; the current ran fiercely, and every now and then we had to up anchor to dodge a wandering ice floe. Here was our rendezvous with another sealer, the *Arild*, which was due to replenish our fuel supply, but did not turn up till evening. Meantime a third sealer, the *Østeris*, moored near us. We sailed in company with the *Arild* on 11th September.

We had been rather irked by these delays coming south, for our cabin was cramped, uncomfortable and smelly, and the food, though plentiful, was plain and monotonous to a degree. But the crew, though very tough, needed the rest, for the skipper and one engineer formed one watch, and the mate and the other engineer the other ; they worked six-hour watches, watch and watch, which is not, I think, a process which can be kept up indefinitely. However, we were all, for various reasons, in a hurry to get home, so we were pleased when at last *Skandfer* and *Arild* started to steam south, and we caught our last glimpse of Spitzbergen.

That afternoon we ran into a moderate south-westerly gale, which induced a horrible cork-screw motion ; of course we had to close down our cabin, and the atmosphere soon became vile, particularly as the seal-oil in the bilges got shaken up and added its characteristic effluvia to the already sufficiently vitiated air. The watch on the whaler was particularly unpleasant, as it was quite a feat to remain standing, but it was a consolation to see the Pole star high in the sky, and astern. The gale continued all next day and we were all pretty well knocked up. In the afternoon we had to cut the whaler adrift. It was sad to lose her when she had been towed all round Spitzbergen, and only had a few hundred miles to go. On the morning of the 13th we reached Bear Island, and moored in a cove out of the wind, in company with a number of fishing vessels.

We stayed there till the storm was over and sailed on the morning of the 15th. We saw no signs of the *Arild*, but heard that she had been blown to the east of Bear Island, and had gone on for the coast of Norway, which she reached somewhere near Russia, and had then coasted along to Tromsø. We sailed on in fair weather till we sighted the coast of Norway at midday on the 16th, and reached Tromsø in the small hours next morning. It was a great relief to have returned to civilization.

So we journeyed on south, with plenty of good food to erase the memory of the revolting rations we had been eating. The expedition had been a great experience, well worth the incidental hardships and tribulations. Also, although the unusual density of the pack-ice had prevented the completion of our programme, none the less a considerable volume of notes and collections had been compiled, which, from preliminary inspection, appear to be of some scientific value.

THE HOHNE PROJECT

By Lieut.-Colonel E. S. Barkham, R.E.

IN the area of Lüneburg Heath, before the war, Hitler built a summer training camp to hold a Panzer Brigade. The only reason for the camp being classed as "summer" seems to be that there was no central heating; for otherwise it consisted of first-class double-storey barrack blocks of latest design, with swimming pools, an officers' club of dimensions that would make even the "Wallahs of Poona" gasp, running tracks and other amenities. It swallowed up a little hamlet called Belsen.

At the end of the war, the British discovered the horror camp, a hutted area about a mile down a rough road past the barracks. Most of those from the camp who survived were put into the barracks as their first lodging on their way back to life. The huts of the horror camp were later burned by the British, and all that now remain are a few memorials and many large mass graves, each grave being a grassy mound with a plain wooden notice saying simply "4,800 buried here," or whatever the number may be.

In 1945 Hohne barracks thus became a huge camp for Jewish D.P's. It remained so until 1950, except for about one-third of the area which was wired off and occupied by British troops during 1947. In 1949 the British Forces of Occupation found that they needed all the barracks, and the slow process began of getting the D.P's. to move to suitable accommodation elsewhere. At the same time, detailed reconnaissances of the barracks were carried out.

A plan of the camp is at the end of this article. It will be seen that the main area is over a mile long, and about 500 yards deep. Generally speaking, each rectangle represents a double-storey barrack block capable of holding about 120 men at normal peacetime scales. In addition, there are cookhouse blocks, with kitchen, two dining halls, stores, wash-up rooms, etc., each capable of feeding 500 men at a sitting. In the married quarters area, each rectangle again represents a double-storey building, about the same size as the main barrack blocks. By any standard the camp is enormous.

Detailed reconnaissance showed that since 1945 damage and pillaging had been ruthless. All the stable blocks had been looted, dismantled, and the materials sold. The remains looked as if heavy bombing of the area had occurred. Workshops and all single-storey buildings had been stripped down to the bare shell, normally including window frames and any tiling on the walls, and usually the roof had also disappeared. The double-storey buildings were not always so bad, as the D.P's. had used them for living accommodation. Most of the roofs remained on, and some of the windows stayed in. But holes were knocked in walls, chickens were kept in almost every block, and the smell and filth surpassed imagination. In the cleaning out of each double-storey block, about twelve tons of rubble and filth had to be got outside and burnt on the spot. Anti-T.B. and disinfestation action had to be taken throughout. In spite of the German pine forests all around, firewood had obviously been in demand. There is plenty of timber in Germany, and the heavy roof construction of these barrack blocks show that Hitler did not economize in his use of it. The D.P's. made havoc of the roof members to keep themselves warm. The theorists would be surprised at the amount of timber you can filch from a heavy roof without immediate collapse. But they would have wagged their heads in self-satisfied glee when the first heavy snow falls came ; we found that some of the roofs were on, and yet they weren't. It is a fair generalization to say that the buildings in the best condition were like derelict blocks that hadn't been used for years, and the worst were shells only, with no roofs, windows or frames. (See Photo 1.)

The Engineer task was to accommodate an armoured unit, elements of the German Civil Labour Organization, with some other minor units, in the barracks, giving them normal peace-time scales of accommodation, with married quarters and full games facilities. It might be thought that such a task would resolve itself into a straightforward rehabilitation programme. Although much of the work was straightforward, a lot of conversion work was required, and also new work (see Photos 2 and 3). Whatever the German units were that originally occupied the barracks, their war establishments and way of life were different from ours. Leaving out details, we had to produce :—

	1950	*1951*
Officers' messes	3	1
Sergeants' messes	3	1
Cookhouses and dining halls for O.Rs.	3	4
Double-story barrack blocks for men's accommodation	19	24
Office blocks	4	11
Canteen blocks (N.A.A.F.I., etc.) ...	2	2
Garages	134 bays	176 bays
Asphalt hockey pitches	3	—
Grass football pitches	6	—
Grass cricket grounds	2	—

Running tracks	2	—
Swimming pools and changing rooms	2	—
Tennis courts	6	7
Tank road	2 miles	—
L.A.Ds.	2	—
Officers' married quarters	—	20
O.R's. married quarters	60	120
Children's school	1	—
Children's playground fully equipped	2	1
Cinema, holding 1,100 people ...	—	1
Churches and chapels	1	2

No plans of the buildings existed, so all blocks had to be measured up and plans made.

In January, 1950, the task was :—

Phase I	£500,000	To be planned, get all necessary approvals, put out to contract, and complete by 30th September, 1950.
Phase II	£170,000	To be planned, get all necessary approvals, put out to contract, and complete by December, 1950.
Phase III	£580,000	To be planned, get all necessary approvals, put out to contract, and complete by 30th September, 1951.

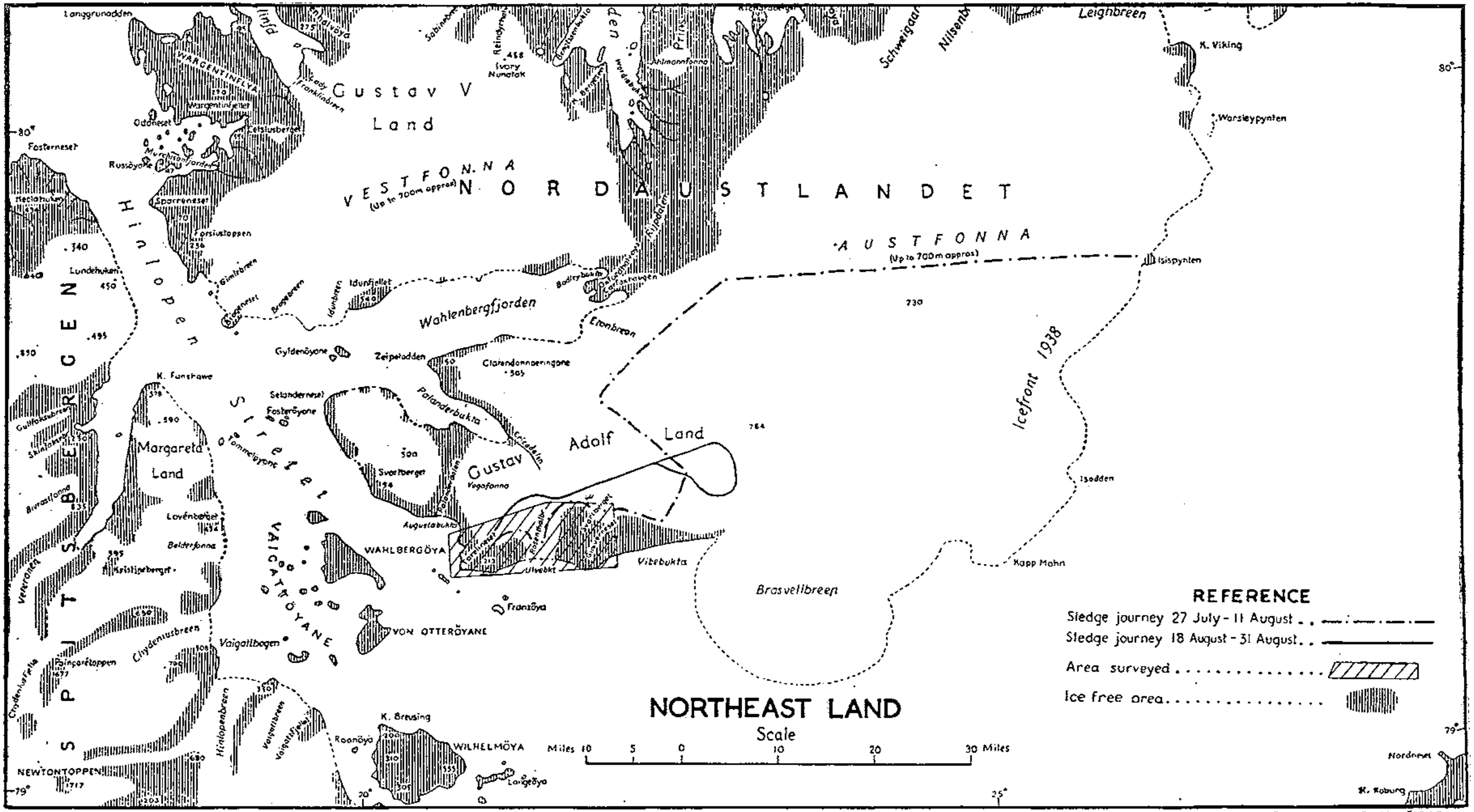
The German winter would intervene between Phases II and III.

In addition to this specific task, a C.R.E's. staff had to be formed to do the planning and to take over all Works Services in an area 75 miles by 100 miles, fairly well filled with troops. This staff consisted of British personnel, none of whom had been on a C.R.E's. headquarters before, and of German personnel (such as draughtsmen, typists, finance clerks) to be drawn from a one-eyed little German country town in the middle of hundreds of square miles of pine forest. Other works, spread out over the new C.R.E's. area, to be carried out in 1950, extra to Phases I and II of the Hohne affair, amounted to £1,600,000. Two D.C.R.Es. already existed, covering the whole area involved. The C.R.E. was given a second A.C.R.E. for planning, and it was decided that the D.C.R.E. concerned with Hohne would not deal with the project until work was let to contract, when he would have normal supervisory and accounting responsibility. By the end of January, 1950, when the C.R.E. arrived, the Chief Engineer had put draughtsmen on to measuring up the Phase I buildings, and had prepared some of the line drawings for them showing what conversion work was required.

In B.A.O.R., economy in British Engineer staffs had been effected by using the German Government building department (for those interested, the *Staatshochbauamt*, or S.H.B.). This organization exists throughout the British Zone, and as far as possible carries out all our detailed planning, contract work, and the supervision of building, being paid on a percentage of the cost of the work carried out. The use of such an organization means that the output of work per D.C.R.E. is greatly increased. When the D.C.R.E. requires any work done, he fills in the inevitable form or two, and passes descriptions of the work required, with outline drawings if necessary, to the S.H.B. The latter then prepare detailed estimates (or 1428's) for the D.C.R.E. who gets approval in the ordinary way. Then the S.H.B. prepare all the contract documents, call for tenders, and recommend the winning tender to the D.C.R.E. for acceptance. The D.C.R.E., or higher British authority, approves the tender and the S.H.B. accepts it.

In this way the British R.E. staffs are saved the tremendous labour of detailed estimating and of contract procedure, and the expenditure rate is greatly increased. It has been found that a D.C.R.E. with two British G.E's. and German assistants can spend annually £650,000 efficiently. The difficulty arises, though, with the C.R.E. The assistance of the S.H.B. is to the D.C.R.E., but not at a higher level ; and it has been found that if a C.R.E. has three D.C.R.E's. all working to this big capacity, he must allow a great many of the minor new services, £10,000 or less in value, to go through uninspected by him. In theory such a scheme would suggest that British D.C.R.E's. and G.E's. would be able to lead a life of ease, feet on the table, orders instantly obeyed. Somehow such dreams don't come true, and in this case the reasons are clear. There is either a shortage of trained German personnel, or they are not available where they are wanted ; also British building standards, and the requirements of the British Army, are different from those of the Germans. The money spent on our building work counts against reparations, and so the keeping of bills at as high a level as possible not only keeps German contractors on their feet, but also puts more money in the pockets of the German Authority, at the same time reducing the reparations debt. Close supervision by British Engineer personnel is therefore most necessary.

During the first two weeks of February, 1950, the German Authority collected their complete staff for the Hohne project, surveyors, clerks, draughtsmen, and works supervisors, only fifteen in all. The next 2½ months, at least as far as the C.R.E. was concerned, were a blurr of drawings, descriptions of work, Jews, Germans and "ginger." Put briefly, in that short space of time, detailed planning, detailed estimates (not very clever ones), contract documents, tendering, and the necessary approvals from higher authority, for £500,000 worth of work were pushed through.



Drawn by J.I.B. Nov 1949

Photo 1.—An example of efficient looting.

Photo 2.—Men's block nearly restored.

The Hohne Project 1,2

Photo 3.—O.Rs.' married quarters completed—each block holds five or six flats.

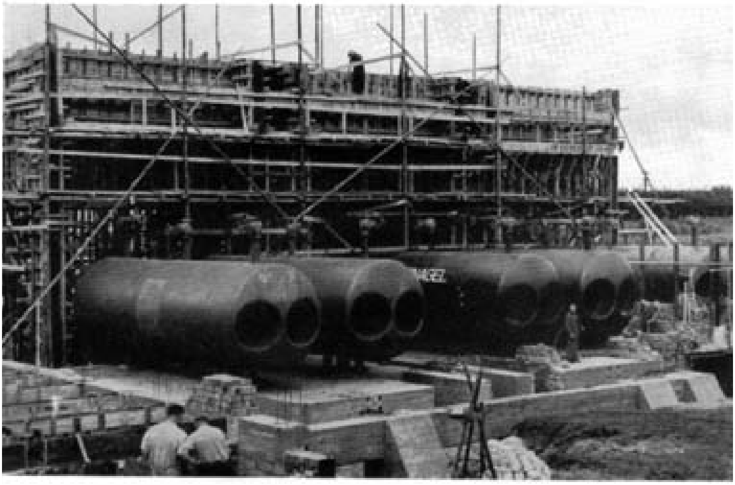


Photo 4.—The boiler house—The first five of twelve high-pressure boilers for the district heating project are bedded down. The coal hoppers are being constructed in the background.

The Hohne Project 3,4

Orders to commence work were issued on the 2nd May. This part of the project was completed by 30th September, 1950.

Normally, on a project of such magnitude, planning would be done one year for work on the ground in the next year. The hurry in this case has at times created the feeling of sitting on a bomb. No frightful scandals have so far come to light, though one or two interesting difficulties have arisen. For example the whole camp area is supplied with electricity, but clearly much of the underground cable work would need overhaul and repair. It was found that no accurate figure could possibly be given when getting out the estimates or when putting such work out to contract, as the extent of the damage and decay were unknown. At the estimating stage a cockshy figure was given. Contracts had then to be let for testing all the cables. When these were completed, further contracts had to be let to do the actual repair work.

As another example, all the considerable filtration and pumping plant that supplied the two large swimming pools had been looted. New machinery seemed to be available, but as the contract got under way awful fears arose about the underground piping, whether it was broken or blocked. The baths were wanted for use during the summer, and blocked or broken pipes deep underground would have meant delay and disappointment to the bathing belles of B.A.O.R. We were lucky though, and to date all has been well. But one engineer contingency arose ; the concrete bottom at the deep end of the baths failed to hold water and had to be drilled out, re-waterproofed and re-laid. The best guess as to the reason is that a greater concentration of chlorine originally used to occur at the deep end, and this in some way softened the concrete by chemical action.

Central Heating (see Photo 4)

The heating project for the camp is of interest to all engineers, not only to E. & M. Officers. There is no doubt that where large numbers of troops are to be concentrated in one area, as in this case, district heating is the long-term economical answer. At Hohne, no reasonable heating system previously existed, and so district heating throughout, from one, two, or even four main boiler houses was decided upon. It is hoped that a separate article on this project will be forthcoming later.

Tank Road

Adjoining Hohne camp is an area some twelve miles by nine miles where tanks carry out field firing. The ranges are in use six days a week almost throughout the year, and consequently a tank road, capable of continuous wear by our heaviest tanks was necessary along the whole of the east side of the camp, from A to B on the plan at the end of this article, thence out into the country. The total length required was two miles

To carry heavy tanks continuously a concrete road was clearly necessary, width to be 30 ft. The interesting problem proved to be what specification to adopt. It was expected that, given the maximum tank load, an accepted specification would be in existence in these days when design in concrete is so advanced. There was no time for protracted investigations or much letter writing to laboratories in the U.K., and consequently the best opinions within B.A.O.R. were taken. But even so, diverse ideas from people of experience were forthcoming, including the Germans, who, after all, built the *Autobahnen.* The subsoil in the area was sand, and when the surface was removed, a hard bottom for the road was exposed. The following seemed to be the main alternatives for a specification :—

(i) 10 in. concrete, unreinforced. This would have sufficed if it were guaranteed that the sand foundation would not "flow." Such a guarantee could not be given as deep side drains existed from the poor quality road that had been there previously.

(ii) Rubble or stone bottoming, say 5 in., below 8 in. concrete unreinforced. Whenever bottoming is put in, there is likely to be settlement in varying degrees, and so again no reinforcement was ruled out.

(iii) As for (ii), but reinforced top and bottom of the slab. This seemed to be over-insuring the road against cracking.

(iv) As for (ii), but reinforcement in the bottom of the slab only. Alternative (iv) was adopted, the actual specification being :—

(a) Pavement consisting of 8 in. concrete laid over a sub-base 6 in. in thickness. The sub-base to be a well-compacted layer of gravel or clinker.

(b) The concrete slab to be laid in two courses, the top course to be laid within half an hour of laying the bottom course.

(c) One layer of reinforcement 7–10 lb. to square yard to be laid 2 in. from bottom of lower slab.

(d) The bottom course proportions to be 1 : 2 : 4 by weight. Not more than 5 gallons of water to be used to each 1 cwt. of cement. Thickness of this course to be 6 in.

(e) Wearing course to be 2 in. in thickness, having proportions by weight of 1 : 1½ : 3. Not more than 4 gallons water to be used to each 1 cwt. of cement.

Some will say the decision was an over-insurance, but others will say there should have been reinforcement near the top as well. Top reinforcement in tank roads can be a menace. If you have normal expansion joints filled with bitumen, the filling gives way to tank tracks and the latter start to eat away the top edge of the concrete at the joint. Later on the joint gets worn away until it is a hole running the width of the road, about three inches across. Then a piece of reinforcement is exposed, a tank track gets hold of it and rips out the top reinforcement from the whole of the slab.

To lay the expansion joint diagonally across the road does not entirely overcome this trouble. Thought is being given to trying out a road in which the normal expansion joint is put in for the lower 5½ in. of concrete, but the richer mix of 2½ in. on the surface is put in with no actual gap, merely a hair crack made by using paper.

The writer lays no claim to being an expert in concrete roads; but it does seem that there is room for research both in the specification required for a concrete road to carry heavy tanks continuously, with various conditions of subsoil, and also in the sphere of expansion joints. The Hohne tank road would have provided a good opportunity to construct an experimental road in which the various likely specifications could have been put in over reasonable lengths, steadily reducing until part of the road was so weak as to break up after a lot of wear. But an object had to be achieved in a hurry, and such an experiment was not considered.

Stand-by Generating Plant

An interesting problem was also studied concerning whether or not a need exists for reserve generating plant in case of prolonged failure of the German civilian supply.

The camp is rather out in the blue, but it draws its electricity supply direct from the main German grid. A second connexion is now being made to another part of the German grid which will be independent of any failures in supply via the first connexion, unless they are of great magnitude. It may therefore be said that the camp has two more or less independent civilian sources of power.

Stand-by plant already exists for the camp water supply only. The central heating plant, however, which will use up to 500 kw., will not only provide heat for the whole community during the severe German winters, but cooking throughout the camp will also be from this source; and if the heating system fails during a prolonged frost, about twelve miles of quadruple underground heating pipes might freeze up. Not an easy problem when the cost of the stand-by plant is of the order of £50,000.

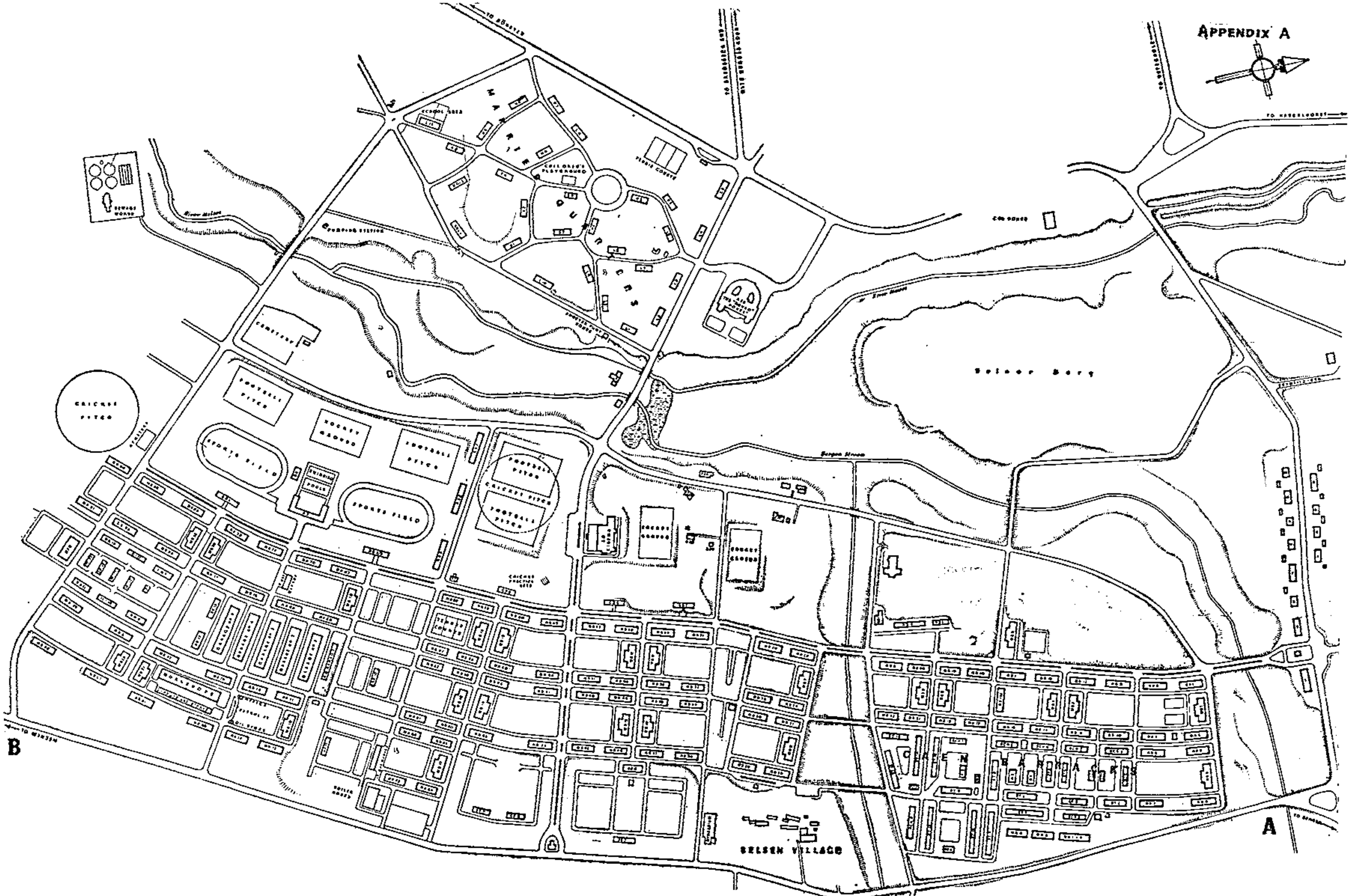
Position at the Time of Writing (August, 1950)

In an accommodation area of such magnitude, and with the political situation influencing the whole military outlook, there have inevitably been changes in the "Q" plan for Hohne, which have meant changes and increases in R.E. planning and expenditure. Even so, the main programme is so far on time.

Continuity, both in planning and execution of work has proved of great importance. In Phase I the peak in man-power was about 1,350, spread over many contractors. Hohne is rather isolated, and having drawn civilian labour to the site it is obviously economical to produce work for them until the project is complete. Likewise the planning staffs, both British and German, should be kept working as far as possible at a steady tempo. From the "Q" aspect, however, it is essential to lay down the work by phases; Phase I for the first unit or units to move in by a certain date, Phase II for the next units, and so on. Unfortunately this phasing tended to lead to a violent rush of planning for Phase I; then all brains and hands turned to the actual execution of Phase I. Then the same brains and hands will turn to the planning of Phase II. An "anti-phase" war is therefore being waged, and the planning rate is being steadied by simply listing all the work that has to be planned for the project, and peeling off the work block by block. Then the work is put out to contract in smaller amounts at more frequent intervals. A more even rate of getting approvals and letting contracts is certainly now being achieved. We are also studying carefully to see that workmen are kept on the site as far as possible even in the winter, by keeping up the planning rate on indoor work.

Since writing the above, your scribe was given a moderate ration of leave in September, 1950. It was then that the radio announced that another armoured division was to be sent to Germany. As far as Hohne is concerned that has meant, instead of the elements of German civil labour going in on the completion of Phase I (which was completed on time during September), that a major British unit is to occupy the accommodation. And so we have to get down to the replanning of garages and the converting of blocks to take an officers' mess, officers' quarters, and the like, all to be completed by the end of February, 1951, the extra money to be spent by then being about £200,000. Such changes of course keep up the slightly hectic atmosphere, but we still hope to complete the whole project by the original date of September, 1951. The over-all cost will be increased to £1,800,000.

APPENDIX A



HOHNE SITE PLAN

SCALE *of Metres*

THE MACKINNON ROAD DEPOT

By Brigadier W. D. M. Christie
(late Chief Engineer East Africa Command)

Introduction

FROM September, 1947, for a period of about three years very many officers and other ranks of the Corps worked at an out-of-the-way little station in the African bush called Mackinnon Road. The station is little more than a halt, 60 miles from Mombasa, on the Kenya–Uganda railway. The work was the building from scratch of a large store-holding organization and it is thought that a description of the problems met with, particularly in the initial phase, will be of interest and value to readers of the *Journal*. The article is of a general nature and it is hoped that it may be followed by one of a more detailed nature dealing with the construction of the 75-mile water pipe-line from Tsavo. A detailed article on Stores, entitled "The Leader Project—Engineer Resources" by Lieut.-Colonel J. C. R. Fitzgerald-Lombard, O.B.E., R.E., has already been published in the June, 1951, *Journal*.

The above will indicate to the reader that what is going to be described is the building of some form of base and he may well feel that there is nothing particularly new in this and that there is enough literature on the subject already. What this article hopes to do is to tell the story of a large engineer task carried out under most peculiar conditions.

Organization

Base is not a true term and the official title of the project is the Store-holding Organization, Mackinnon Road. This, when complete, was to consist of the following :—

First a large number of sheds, hard-standings, etc., to house nearly 200,000 tons of warlike stores coming from overseas ; next a comparatively small amount of accommodation for housing the military force who had to look after these ; thirdly, a considerable amount of permanent accommodation for civilians working at Mackinnon Road ; and finally permanent accommodation and permanent depots to replace those dotted about East Africa Command. The vital and interesting part of the project was the first, i.e., the store sheds and workshops for the main stores. This installation, initially only to house stores, had to be laid out so that in the event of war it could be in a few months converted to a proper Base, road and rail served in the normal way. It, therefore, had to be built as a Base from the start, even though rail communications were not actually laid in all cases.

Perhaps we are running ahead a little too fast, so it is now necessary to describe the inception of the project. At the end of the war there was a very large accumulation of extremely valuable Engineer and Ordnance stores located mainly in the Middle East, but also in other parts of the world. Most of this had to be moved from where it lay to some convenient place, and a high level decision was taken to concentrate it in the East African Territories. This was the genesis of the problem and, for reasons which will be discussed later, Mackinnon Road was selected. Having collected the stores there, it was a natural corollary to leave space near the various depots for the East African Command Depots to be sited there.

Site

In selecting the site, three localities were considered. The first, Mariakani, is on the railway 25 miles from Mombasa and, in consequence, had the advantage of being nearest to the port. Against it, however, was the fact that water was even further away than it was from Mackinnon Road, the rainfall twice as heavy and the climate less healthy and more detrimental to stores. The main objection, however, was that the site was on a Native Reserve which would have had to be moved, producing political difficulties and delaying the start of the project. A second site, Naivashsa, in the Highlands, had an excellent climate, but its distance, 400 miles from Mombasa, and at the top of a haul of 6,000 ft. ruled it out.

Mackinnon Road, though not perfect, and to the outside eye it appeared the last place on earth, had numerous advantages. First, being on Crown land there was no difficulty of entering into possession and there were unlimited possibilities for expansion. The site was level and the rainfall small. It had the nucleus of a few war-time buildings, which enabled the advance party of the construction staff to be accommodated. Though there was no water within seventy-three miles, this was closer than at Mariakani.

Scope of Project

The decision as to what the project was to comprise, where it was to go, what was available to build it, how it was to be built and other problems of a similar nature occupied the attention both of the War Office and General Headquarters Middle East through the summer and autumn of 1947. This article takes up the problem as it faced those of us who came out that autumn to commence planning and execution. In these last three words lay the key to our difficulties, because planning and execution had to proceed very largely together. The reason for this was an exacting time limit, which was that the first sheds had to be ready to receive stores from the non-treaty zones of Egypt by September, 1948, i.e., only one year ahead. True, fairly soon afterwards the date of September was moved to the 1st of January, 1949, and the whole storage portion of the project to be complete a year from then. Nevertheless when one considers that one was starting from almost absolute scratch, the problems of clearing bush, erecting a temporary construction camp for a labour force of many thousands, the bringing of water from over seventy miles, the planning and erection of over sixty enormous sheds and workshops, all within a matter of about two years, seemed scarcely a possibility. Added to this was the fact that there was no form of map or plan of the area and the type of shed to be erected was a completely unknown quantity—it was, in fact, the South-West Pacific Hangar (see Photos 3 to 6). It was quite vital therefore to start building the first shed not later than April, 1948, so as to learn how to build them and to have a few ready by the 1st September, 1948, when stores were expected.

Our first appreciation, therefore, aimed at producing a work table which would get all our preliminaries through by April, so that from then on labour would be available for concentration on the building of the sheds.

Planning

Perhaps the simplest way of explaining things is to give a brief description of certain activities during the early part of the work, and the first covers the period up to the end of 1947. In the Chief Engineer's office at Command Headquarters planning and estimating were going on at full blast, notwithstanding the fact that there was no detailed map on which to plan and extremely scanty information in the way of detail as to what was required and, finally, even scantier information as to rates of different types of work. It should be mentioned at this stage that this very out-in-the-blue project, done under war-time conditions, nevertheless, was required to conform to peace-time accounting procedure. This meant going through the process of "approval in principle", with rough estimates, and administrative approval with approximate estimates before, theoretically, any work could start. It is fair to say that the War Office permitted us to go ahead on vital services before allotments of funds, nevertheless we had to work out approximate estimates, not quite knowing what we were going to do and having little idea of rates. The reason for not knowing about rates was that it had been decided that the first phase of this work could only be done by direct labour, as no contractor could possibly install himself in a reasonable time. The skilled labour in the early stages was to be military, but as this ran out under the release scheme Italian artisans were to be enrolled and sent out. Semi-skilled labour was to be found from the Mauritian and Seychellois Pioneer Corps and unskilled labout from Africans straight off the bush. Our knowledge of how this mixed assembly would work and at what rate was sketchy in the extreme.

So much for Command Headquarters, and now let us turn to what was happening at Mackinnon Road, 240 miles away. About the 1st October, 1947, the first men from 717 Artisan Works Squadron arrived, followed by 57 C.R.E. Works, and their job included clearing bush, both for survey purposes and the beginning of the roads, constructing accommodation for themselves and the African construction force, rigging up a hospital and getting a temporary water distribution scheme going, as well as some light and power. Meanwhile down at Mombasa arrangements had to be made for the reception of construction stores and plant coming from overseas. Next, and most important, the 34 Army Regiment were also in process of arrival and theirs was the key task of getting a 73-mile water pipe-line through to Mackinnon Road as early as possible.

So much for the initial phase, little more than breaking ground on the project. The next phase, which was to cover the period January–April, aimed at producing more water storage, adequate accommodation for the construction force and, in fact, having as much as possible ready so that work on the bones of the project could be started as near April as possible. The problems were now beginning to clarify themselves and each one will be described in a few words.

Stores

The first major problem was " Stores " and as this has been fully dealt with in Lieut.-Colonel Fitzgerald-Lombard's article already mentioned, only sufficient will be said here to preserve the continuity of this narrative.

In brief our principal problems were :—

(*a*) The reception in the very early days of 100,000 tons of construction stores from overseas.

(*b*) Owing to bad communications up country the finding of storage space in Mombasa for about 40,000 tons of these stores.

(*c*) The problem of getting stores up to Mackinnon Road.

(*d*) The difficulties of receiving, handling and accounting without proper stores units.

(*e*) Arrangements for obtaining stores of local origin, particularly stone, of which several hundred thousand tons were needed.

By and large we solved our problems, as Lieut.-Colonel Fitzgerald-Lombard's article shows.

Plant

The handling of engineer plant was also an important problem. A great deal of this was required for the project and the number of pieces that came in from Middle East in the first year was over 700, including 4,000 tons of spares. In Mombasa we had much the same problem as we had over stores, but with one exception and that was a Plant Squadron arrived in the very early days. This was established at Chamgamwe camp, just outside Mombasa, and they were able to obtain a few good sheds which they used for workshops and spare parts near the docks. Again we had the inefficiency of a split unit. In theory, plant should have arrived in reasonable running condition but, in fact, this was far from being the case. What with standing in the desert, rough handling and pilfering between the Plant depot and Suez, the hazards of the journey made worse by bad loading, much of what finally arrived at Mombasa was in a sorry state indeed. Instead of just being able to give the plant a wash and brush up and send it up the road, a great deal of work on it had to be done. However, a steady stream, five vehicles a week, went forward and again there was no serious hold-up in work due to shortage of plant.

Labour

We can now turn back to what was happening at Mackinnon Road while all these outside activities were going on. It has been mentioned that the first troops arrived about October, 1947, and from then on a steady build-up occurred, not only of Sappers but other arms, and most important of all, the African Construction Force. By December, 1947, there were approximately 1,000 British and 3,000 Africans on this virgin site and it was in this month that the Chief Engineer Mackinnon Road reported to take over. It would have been ideal had he been able to concentrate immediately on planning the project, but this was found to be quite out of the question. The reason for this was that no provision had been made to have any non-Sapper Base Commander, and the Chief Engineer found himself O.C. Troops with no one to help him except a Garrison Adjutant.

It is useless to pretend that conditions at Mackinnon Road were pleasant and that troops were full of burning zeal to get on with the project. The great majority were shortly due for release and many were thoroughly " release happy " ; others with longer to serve felt that they had been "led up the garden path" when they were told they were coming to a land of milk and honey. There was a whole host of teething troubles, hygiene, welfare, shortage of water, arrangements with the civil authorities over the Africans, and so on. All these took precedence over pure engineering and it was essential to get them satisfactory. It was therefore decided that one of the two existing Cs.R.E. should become an Administrative Commandant for the time being whilst a non-R.E. was found and appointed. Unfortunately the administrative work was so heavy that the Chief Engineer was also tied down to it for a considerable time.

Meanwhile certain work was being speeded up, mainly the completion of the survey of the site and getting on with camp accommodation in its widest aspects. During the next two months reasonably satisfactory progress was made and there was a slow build-up in African labour. Meanwhile, though on the one hand a build-up in units was taking place, there was a corresponding run-down in actual numbers due to an accelerated release scheme. During March an Administrative Commandant arrived and he proved to be a tower of strength indeed, chiefly due to his knowledge of Africans and their language. All along, the East African Construction force had been a worry due to the hasty way they were collected together and difficulty of providing officers in sufficient quantity and of good quality. Though this was no part of the Administrative Commandant's duties, he did help tremendously in getting them to work. As a result of his arrival we were able to organize on a two C.R.E. basis, the division of work broadly being that one concentrated on Depots and Workshops and the other on Camps and Accommodation generally. What, however, was clear by now, was that the actual output of work was far short of what it should be and this was due to a number of reasons. The first and main one was the quite fantastically small output of the African labour; we decided that this must, at least, be trebled. Other reasons were that stores though arriving in reasonable quantities did not always conform to what was wanted; there had been no time to organize a stock pile to cover the inevitable variation between stores demanded, stores forgotten and stores actually required. A third reason was the run-down in staff, particularly in key personnel and, in addition, the great inexperience of a vast majority of Officers and N.C.Os. in this type of work. It can now be said that the end of March represented the lowest ebb of the project, but the numerous steps taken to improve things produced quite surprising results by the end of April.

To begin with the output of African labour did make a tremendous jump. The numerous welfare measures taken in hand during the previous few months began to show results and this had a marked affect on the morale of the troops, who felt that something was really being done for them. Another event, which gave the project quite a boost, was that we were able to start on the real bones of it, which was the erection of the S.W.P. Hangars, which we felt we had to start in April to get some finished by September. In fact when the project was visited on the last day of the month by His Excellency the Governor of Kenya one felt one was seeing an

Photo 1.—Typical Mackinnon Road " bush."

Photo 2.—First signs of civilization. Temporary married quarters of Neo-frango construction for Construction force. Each house had running water, water-borne drainage and a refrigerator.

The Mackinnon Road Depot 1,2

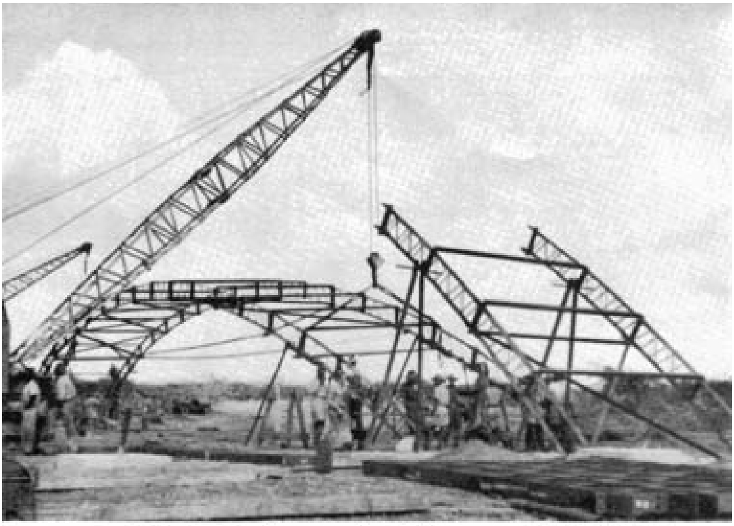


Photo 3.—South-West Pacific Hangar, colloquially known as "Igloo." Raising centr segments (72 deg.) of arch rings, using R.B.19s.

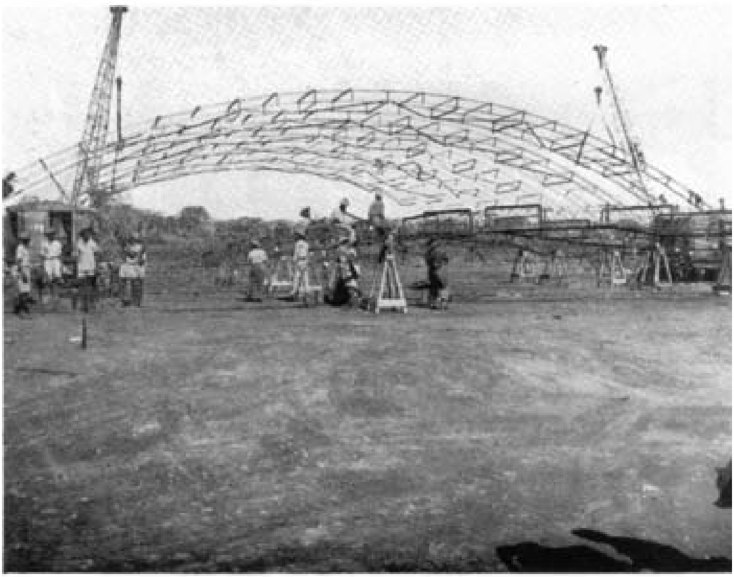


Photo 4.—"Igloo" partially erected, showing R.B.19s.

The Mackinnon Road Depot 3,4

Photo 5.—" Igloo " partially clad.

Photo 6.—" Igloo " abutments.

The Mackinnon Road Depot 5,6

Photo 7.—Part of Ordnance Depot showing dense bush.

Photo 8.—R.E.M.E. Workshops.

The Mackinnon Road Depot 7,8

impressive work moving well. Briefly speaking, in the preliminary phase we had accomplished, amongst other things, the following :—

(a) A Survey on a scale 1:2500, contoured at 5-ft. vertical interval.

(b) A camp for 2,000 Europeans, with a considerable amount of electric light and water storage for 140,000 gallons.

(c) 1,600 acres of bush cleared.

(d) 9 miles of road cleared, graded and consolidated.

(e) Accommodation for 7,000 natives.

(f) Construction of 2,700 yds. of rail sidings.

(g) 150-bed tented hospital complete and a 300 bedded one almost complete.

Other works were being started.

Altogether the future looked bright but there was one point, so far scarcely mentioned, but which had been our principal worry from the start and was to remain a worry for a long time to come and that was water, which deserves a section to itself.

Water Supply

It was mentioned earlier in this article that the nearest source of supply of water was 73 miles away from Mackinnon Road at Tsavo. This statement is not absolutely accurate, because there was a railway pipe supply at Mackinnon Road station which it was agreed might supply us with a maximum of 24,000 gallons a day during the early stages. This, of course, would not go far and had to be supplemented at considerable cost by tanker wagons coming up from Mombasa, and these tanker wagons counted against our allotments of trucks for hauling up stores. The average we got from these two sources was 35,000 gallons a day, so with a population of 10,000 and allowing for the waste on distribution, etc., the fresh-water ration per head worked out at something between two and three gallons per man per diem, a very meagre amount for a spot on the equator. There was in addition a bore hole which produced 12,000 gallons a day initially, later rising to 18,000 gallons a day, of saline water most of which was used for washing but which in time did give rise to skin diseases. In an attempt to step up this source of water we had a geo-physical survey of the area carried out by the P.W.D., but two experimental boreholes put down on the recommended sites produced nothing down to 400 ft., and the attempt was abandoned. This acute shortage of water, combined with its unreliable supply, had a most worrying affect upon everyone and was probably the biggest single difficulty to be overcome in trying to improve morale. It was quite useless to expect men to turn up clean and tidy when they had no means of washing their clothes. All along from the start, therefore, the problem of getting our own supply through from Tsavo was perhaps the main thing that occupied our attention.

The story of the work done by 34 Army Engineer Regiment will be told, it is hoped, by their own Commander in his own article, but briefly it was this: The Regiment arrived during November but short of accommodation stores and transport; however, they moved up to four locations on the pipe-line where they commenced building their camps. Pipe was gradually sent up and, as men became available, a 50-ft. lane was cleared through the bush for a detailed reconnaissance route. The plan, briefly, was to have a pumping station at Tsavo discharging, to begin with, through one 6-in. and one 8-in. line, later to be increased by two 6-in. lines to a reservoir at Mackinnon Road. The configuration of the ground required two boosting stations. A start was made on one 6-in. pipe-line alone. In the four months January–April the Regiment worked magnificently without any sort of let up. Every form of difficulty was met with and overcome, stores arrived in the wrong order and without the requisite tools, the unit suffering from release groups and last, but not least, the hazards of wild animals in the jungle. However, on the 30th April the first water, admittedly test water, did in fact arrive at Mackinnon Road, just as His Excellency was sitting down to dinner. Though much remained to be done, to those who had waited wearily for six months or more at Mackinnon Road came the knowledge that the Tsavo water was there and in a short time the supply was bound to improve.

To sum up, the achievements of the 34 Regiment can reasonably be described in this way: in some four months they had installed a water pipe-line equivalent to one from Portsmouth to London, over a ridge considerably higher than the Hog's Back, and through primeval jungle similar to what one would have found in pre-historic ancient Britain with animals equally wild and dangerous.

Second Phase of Work

So much for the first phase of the project, the most difficult and the most interesting one. The second phase, broadly speaking, covered up to the end of the year and was a continuation and consolidation of what had gone before. For example, treated water became available in May at the rate of 20,000 gallons a day and this immediately allowed us to increased our intake of African labour, which by the end of the year was approaching 10,000, of which we had 6,500 actually on the work. All through the year, however, though the delivery of water finally rose to nearly 200,000 gallons per day, things did not go too well. True, the second main, an 8-in. one, came into use, but meanwhile a lot of work had to be done on replacing faulty pipes and joints on the first line. Next a 500,000 gallon storage reservoir was completed by contract, very slowly and by no means efficiently. Thirdly, permanent filters and purifying plant were being erected by the East African Railways Administration and though their work was good their progress was very slow. The most unpleasant feature was, however, the fact that the pumps originally supplied were extremely temperamental, American pattern and without spares. New ones gradually made their appearance, and had to be tested and slowly put in. With all this going on no one could feel that the water situation at the business end was in any way secure and there was, in fact, one breakdown causing emergency measures to be taken at Mackinnon Road. To crown everything the November rains were quite abnormal and floods, higher than they ever had been before, washed away part of the intake and stand-by filter plant. Notwithstanding this the year ended with hope of a substantial improvement which was, in fact, justified.

The next difficulty was the run-down of British supervision but the effect of this was not so great as was expected, as classes were formed to teach promising N.C.Os. and Sappers how to supervise different types of jobs on which Africans were employed and physical output on unskilled work was reasonable. On the other hand highly skilled work and good financial control were impossible to achieve, due to lack of skilled staff.

Another unsatisfactory feature was the behaviour and output of the Italian craftsmen, of which we employed some 560. These men were specially enlisted in Italy to replace skilled British Sappers as they were released. Generally speaking, unless one had the Italians under one's eye, as in the workshops, they did the minimum work possible. Dotted about over an area of 10 sq. miles and with inadequate supervision they proved a very expensive source of labour and were the cause of many of our costs being high.

Revision of Scope of Scheme

At the end of 1948 certain decisions were taken in regard to the project which, briefly expressed, resulted in three of the Ordnance Depots which had not been started, being cut out. An impression got abroad that because of this the project was being heavily slashed and losing its importance. In fact, the cutting out of a number of stores sheds reduced the original project by only about 15 per cent and the whole project, which included putting the Command Depots at Mackinnon Road, by under 5 per cent. On the other hand the urgency of the project was less and, in view of the shortage of manpower elsewhere, a complete C.R.E's. staff was removed early in 1949.

A general review of the situation is perhaps a suitable way to end up this article except for a last section on lessons learned.

During the spring and summer of 1949 both the Command H.Q. Office and Mackinnon Road were heavily engaged on planning the balance of the project and complete, but very rough and ready, preliminary estimates were got out for this. These indicated that the total bill would be in the neighbourhood of 8 million pounds, of which we had completed only the first 1½ million. Had we had the original staff considered necessary, i.e., the equivalent of four C.R.Es., we could have gone ahead at the rate of 2½ million pounds a year and finished the job somewhere about 1951. In fact, we never had the equivalent of more than three and were faced with finishing it off with rather under two. This was extremely uneconomical as it was clear that it would take some six years or so to finish off, meanwhile much money had to be spent on maintaining the temporary camps and producing amenities for them. The extremely acute shortage of engineer man-power did, in fact, lower our numbers at Mackinnon Road to an absolute danger point and those numbers included quite a considerable element of civilians, few of whom took kindly to the rigours of the place.

The shortage of British man-power necessitated in turn a considerable run down in African labour and many Italians were also going home. Nevertheless the labour force that remained steadily went on with work although at a much slower tempo, By the middle of the year all the large S.W.P. Hangers were either complete or well on the way, the bulk of a 110,000 sq. ft. R.E.M.E. workshop was complete as was also a 600-bed hospital. The original road network was being surfaced and most important of all, a steady water supply, sometimes over 400,000 gallons a day, was coming into the camp.

It was reckoned that the existing labour force would complete all work in hand and the future work, almost entirely permanent accommodation, would be done by contract. The fact that many contractors were now willing to work at Mackinnon Road is an indication of what was achieved there in under two years.

Lessons Learnt

So much for the record of events and this article will end with lessons and a mention of certain special features.

One would think that a project of this nature would bristle with lessons but, in fact, there were not many new ones, only a lot of old ones relearned; relearned is perhaps not correct because the mistakes made were inevitable, due in many cases to circumstances outside our control. Perhaps it is best to say that this project rubbed in certain lessons good and hard and some of these are now mentioned.

An early and important problem was to obtain a correct solution to the problem of Command. The original organization only allowed for a Garrison Adjutant and this proved quite unworkable, some one of far greater calibre being required. Apart from this, however, was the problem of whether there should not have been a Station Commander of high rank who should have been responsible for the project from the start, the Chief Engineer being a member of his staff. This organization was, in fact, inaugurated in December, 1948, and it is thought that it was correct not to have brought it in any earlier. In the early days it was essentially a Sapper project and there is much to be said for the Chief Engineer being "King of the Island." It is considered, however, he should have had under him, from the very start, an administrative staff under a first-class Lieut.-Colonel. Next, in addition to this, there should have been a "Q" planning officer also from the start. At Command H.Q. the Chief Engineer's office was employed 90 per cent on the project and again they should have been relieved of much of their work by a special "Q" planning staff. It is of interest to note that the Chief Engineer worked entirely on directives from the Engineer-in-Chief M.E.L.F. for the first four months of the project, the first "Q" directive only appearing in December, 1947.

The lessons learned on the stores and the plant sides have been described in another article. There is no need to stress the fact that an inexorable time limit forced work to start without proper planning, a proper map and inadequate water, and these chickens repeatedly came home to roost. A point worth recording is, however, the handling of labour. This was the duty of the P. & L. directorate, and they had very mixed and difficult men to handle, Italians, Mauritians, Seychellois and over 10,000 Africans. A party such as this needs extremely capable handling at all levels and the P. & L. directorate were not strong enough to cope with it entirely satisfactorily.

Little has been said about transport but, by and large, the main roadlift from Mombasa was excellent. Transport in the Mackinnon Road area was not so satisfactory, not on account of lack of organization, but simply the Kenya roads were too much for the army lorry, backed by an inadequate maintenance set-up and shortage of spare parts. Right throughout the project we required at Mackinnon Road roughly a hundred tippers and eighty 3-tonners and we were always short of tippers.

A problem always under consideration was to what extent contract work should be used instead of direct labour. In the very earliest inception days of the project it was considered at the War Office that it should be carried out by one or more big contractors, contracts being let in London. The Engineer-in-Chief, W.O., who visited East Africa in the late summer of 1947, immediately formed the opinion that no contractor could tackle the job in the early stages and would require great help from the War Office to get going. We would, in fact, do the difficult part of his work for him and he would merely draw the profits. Events proved how right this decision was. The local contractors, as has been mentioned, fell down badly over the supply of stone contracts. Even a big European firm never really kept up to the mark on the major stone contract, though they did not have to start work till May, 1948. One of the first works' contracts was for the comparatively simple job of designing and erecting a 500,000-gallon reservoir. Only three firms tendered for this and of them only one was a possible ; even their design was for a reservoir of the wrong size and a considerable amount of the structural calculations had to be altered. They finally produced a reasonable job which, however, needed the maximum supervision from us. The main road contractor took months to get going and this might have proved a very serious matter. Luckily our temporary roads stood up well.

We were more fortunate in a contract covering concrete products, e.g., fence poles, electric light standards, pipes for concrete culverts, etc. Though again there was no rush to tender, finally two firms each took on about £50,000 worth of work and did quite well.

The whole of the first phase of the project had as its ultimate aim the production of storage sheds and a word on these should be said. The colloquial name for them was the "Igloo" ; a more inappropriate title cannot be imagined. In fact, they were vast sheds some 200 ft. long by 150 ft. wide, each, therefore, about half the size of a football field. They were of arch design rising to a height of 30 ft. They came from India and the Far East and we discovered afterwards their correct name was the South-West Pacific Hangar. We could get no information through normal channels of any details of erection, but fortunately a reply to a letter sent direct to the E.-in-C. India gave us a good deal of information rather late in the day. However, we guessed that we ought to start building these in April and, therefore, had some time to work out a scheme for erection. A most complete and admirable booklet was produced by one of the A.Cs.R.E., entitled "For ever Igloo," in which the complete erection from beginning to end was tabulated. The African is just about the most idle and stupid labourer in the world, but he has one quality, which is, having been shown a simple thing he can go on repeating it for ever. The result was most gratifying and the rate "Igloos" sprang up was most impressive. This was about the one case in which we had time to plan and results spoke for themselves ; our only hold-up was due to lack of adequate cranes for lifting the centre spans.

In no engineering project can finance and accounting procedure be neglected but, nevertheless, the insistence by the powers that be that we should adopt and be bound by the peace-time accounting procedure caused us endless worry. When all was said and done the opening phase, say, the first 2 million pounds' worth of work of this project was akin to an L. of C. project in war except that it was a good deal more difficult to carry out. In a high priority project of this nature in war, one's staff would probably have been well maintained with few changes; further there would probably have been a good proportion of experienced staff. Mackinnon Road did not have these conditions. Where the Mackinnon Road project was similar to a war-time one was that we were extremely doubtful of exactly what we had to do, and the usual impossibly short time in which to do it. Nevertheless the Chief Engineer's office at Command H.Q. for the first eight months concentrated on producing well over a hundred "Approximate estimates" which were very, very approximate indeed. Not only was the scope of the jobs not fully known, but more important, there was no data as to labour costs. Again, even a straightforward job like erecting a Nissen hut might well be dependent on whether it was erected by an Italian, a Mauritian, a Seychellois, an African or various permutations or combinations of these.

We, therefore, regarded these estimates as really only a method to get allotments of funds, but correspondence over them did cause a great deal of work. In addition, the very inexperienced and constantly changing staff on the ground had great difficulty in controlling expenditure when allotments did arrive. There were, certainly, breaches in procedure usually due to a change in scope of a service, causing an excess nevertheless on the first phase; the net excess was under 15 per cent of our preliminary guesses. Control of expenditure was, however, a very serious headache and if any officer is faced with doing a similar project under peace-time conditions he should endeavour to get some simpler system than the standard peace-time accounting agreed to beforehand.

Military and Civilian Background

A peculiar feature of the project and quite an important one was the background in which it was carried out. First there was the military one; Headquarters East Africa Command in 1947 was comparatively very small, in fact, akin to a small District at home; the grafting of our big engineer organization on to this produced complications somewhat similar to putting new wine into old bottles, and by that is meant there was inadequate "Q" staff in quality or quantity in the early days to absorb the large engineer one.

If the Military background was not satisfactory, the civilian one was even worse. It may be news to people, who have never served in

East Africa, to realize that it is a most undeveloped country. Lack of maps and bad roads have already been mentioned, but more important still, engineer intelligence on resources was either lacking or inaccurate. This let us into considerable trouble over stone and certainly hindered us in our designs for the water supply headworks on the Tsavo River. All this would not have mattered so much had we had ample time to plan the project, but as has already been stressed, this we never had. Those who have attempted engineering work in Africa will realize how difficult it is to achieve things in the face of what is perhaps the main curse of the colony the "*bado kidogo*" outlook, or put in another way, "procrastinate as much as you can." Again Africa itself seems to resent interference with its primeval state. Against these two imponderables, a mixed and changing bag of Royal Engineers succeeded, in under two years, in producing something which many people, who knew Africa well, deemed to be impossible, carving something permanent out of the virgin African bush. Perhaps the best way of ending this paper is to quote verbatim the Editorial to the July, 1949, number of the *Mackinnon Road Magazine,* dealing with a definite stage of the project, the arrival of the first married families for whom some forty Neo-frango type bungalows (see Photo 2) were being built.

"In an earlier issue of this Magazine a contributor who was about to go home drew attention to the vast improvements he had seen taking place over the previous year. Now, half a year later, he would certainly see greater progress, and would probably view with the greatest satisfaction those things which our new 'settlers' regard as the bare necessities of life. Electric light instead of hurricane lamps, water from taps in our own compounds instead of a precious ration delivered by train; houses, tarmac roads, and even a Broadcasting Station; these are some of the things that the earlier pioneers dreamed of, and won through sheer hard work in a relatively short space of time. And these, and more, are the benefits we now enjoy through our joint efforts. The realization that these things have sprung from the virgin bush in so short a space of time—that where in September, 1947, the only landmarks were the railway station, the old hangar, and two hills there is now a vast military township, this should show us, if we need showing, that something has been achieved."

A REGIMENTAL BRIDGING GALLOP

By " CROSSED KEYS "

INTRODUCTION

THANKS to the excellent facilities existing in B.A.O.R. in bridging equipment, transport and exercise areas the field engineer regiments there are able to stage ambitious projects in order to put into practice in the field what they have learnt at the static bridging training establishments.

Each year since the summer of 1949 " Y " Field Engineer Regiment has carried out its annual bridging training in two parts running consecutively. The first part, of four weeks' duration, has been spent in the Hameln bridging training establishment where, under ideal conditions, basic training could be carried out in watermanship, rafting and all forms of bridging. The second part, of two weeks, has been devoted to full scale exercises.

In 1951 the regiment was able to round off its preliminary training with its most ambitious bridging gallop to date, in the course of which five bridges (two Class 9, two Class 50 and one Class 80) were built across gaps of approximately 300 feet at water's edge in just over four days. This included dismantling one Class 9 and one Class 50 and carrying them 50 miles to new sites. This " gallop " was covered by two exercises known as " Fiddlestyx III " and " Chopstyx III."

That each year the scope of training has increased is evident when one considers that in 1949 these exercises (" Fiddlestyx I " and " Chopstyx I ") consisted of :—

One 80-ft. dry Class 50 bridge,
Two Class 50/60 rafts,
Two Close Support rafts,
One 300-ft. Class 40 Bailey Pontoon bridge,

for which more time was required. It was during the making of one of the above rafts that one unfortunate squadron commander launched a Class 50/60 pontoon complete with trailer and prime mover into the Weser. The whole was completely submerged, only the spare wheel of the " Mack " appearing above water and acting as a marker buoy. It is on record that this is the only time on that or any other exercise that the present C.R.E. ever laughed ! The divisional commander spent most of his visit watching the efforts of half the R.E.M.E. in B.A.O.R. trying to recover the equipment, which they eventually did. The cost of the damage amounted to only £4.

The 1950 exercises were rather more ambitious, in that Class 50 floating Bailey equipment was available and the " tempo " generally was speeded up. In 1951 the "gallop" was really put into these operations as will be seen below.

The aim of this paper is to explain the form of this gallop under the following headings :—

(*a*) Exercise setting.
(*b*) Troops taking part.
(*c*) Engineer work involved.
(*d*) General comments.

Exercise Setting

Naturally the Engineer problems were the guiding factor in setting the exercises.

Briefly, "Fabia" (own troops), a small country whose southern boundary ran east and west through Hanover, was at war with "Gotland," a similar size of country, immediately to the south of Fabia.

Fabia had advanced into Gotland with the object of capturing its capital, Göttingen.

Both armies were similar in equipment and general characteristics, that of Fabia being the larger ; the Gotland air force was the stronger, the Fabian air force only being able to guarantee local air superiority for specific tasks.

Exercise "Fiddlestyx III"

(*a*) On the 7th May "X" Infantry Division as part of a Fabian Corps had advanced up to the line of the Weser and the G.O.C. "X" Infantry Division decided to stage an assault crossing that night with a view to capturing the high ground to the south.

(*b*) The R.E. plan, in order to assist the crossing, was to construct two Class 50/60 rafts, two Close Support rafts, one Class 50/60 Assault bridge and one F.B.E. bridge.

A non-tactical pause was allowed on the 8th May in order to enable the regiment to load up the equipment used for the crossing the previous night.

Exercise "Chopstyx III"

(*a*) The crossing was made over the Weser as planned and, on the 8th May, "X" Infantry Division pushed at speed some fifty miles south-east. By early afternoon on the 9th May our forward troops were on the line of the Weser.

(*b*) The division carried out an assault crossing that night, the R.E. plan being similar to that for the 7th/8th May with the addition of a Class 80 floating bridge over the Weser required by 1200 hrs. on 12th May.

Troops Taking Part

The C.R.E. had dual rôles of C.R.E. " X " Infantry Division and Commander " Y " Field Engineer Regiment.

Imaginary troops and equipment under command were a field squadron from Corps Troops and necessary rafting equipment to provide two Class 50/60 rafts and two Close Support rafts at each crossing. The Corps Field Squadron was given the task of the construction and operation of these rafts and now fades quietly out of the picture. Some amusement was caused at " O " groups by the C.R.E. addressing the imaginary field squadron leader (for whom an empty place at these conferences was always allowed), and indeed after one such conference an officer who shall be nameless, was observed carrying out a search of the barn in which the conference was held, presumably to trace the missing squadron commander.

In addition to the Field Engineer Regiment, troops from the Divisional Column R.A.S.C. and a detachment from a Plant Troop R.E. took part in the Exercise.

For convenience the R.A.S.C. transport was formed into two Bridge Companies R.A.S.C.

Engineer Work Involved

The engineer work fell into three distinct phases as shown below, and it is proposed to deal with these each in turn :—

(*a*) Exercise " Fiddlestyx III."

(*b*) The approach march for Exercise " Chopstyx III."

(*c*) Exercise " Chopstyx III."

" Fiddlestyx III "

(*a*) This entailed the construction of a Class 9 F.B.E. and a Class 50/60 Assault bridge across a 320-ft. wet gap.

(*b*) The F.B.E. was built across the existing ferry site. The approaches were good and apart from general maintenance once the bridge was completed they required no attention.

The site was very restricted and made it necessary for the floating bays to be built one hundred yards downstream of the general bridge site. On the home bank two trestles were erected, whilst on the enemy bank one trestle was sufficient. The advance party was on the site at 2000 hrs., 7th May, and at 2100 hrs. unloading commenced. The floating bays were constructed very quickly, but delay was caused in the construction of the trestles due to badly maintained equipment. The bridge was finally completed at 0700 hrs., 8th May.

(*c*) The Class 50/60 Assault bridge requires a word of introduction. It was first constructed by this regiment in August, 1950, and again during the B.A.O.R. exercise "Broadside." It is a simple bridge made up by connecting Class 50/60 pontoons together, so that they form a continuous bridge across a wet gap (see Photo 1).
There were no existing approaches to this bridge and some fifty yards of rubble had to be laid on each bank before it was fit to take vehicles. Work commenced at 2100 hrs. on 7th May and was completed by 0600 hrs., 8th May. There were no difficulties in the construction.

(*d*) Commencing at 1000 hrs. on 8th May, all transport crossed the bridges.

THE APPROACH MARCH

The regiment commenced the march across 55 miles of difficult country at 0600 hrs., 9th May, and was in harbours by tea-time on that day.

The normal battle drill of recce parties, etc., on each route was carried out.

"CHOPSTYX III"

(*a*) This entailed the construction of a Class 9 F.B.E. bridge and a Class 50/60 Assault bridge across a 280-ft. gap on the night of the 9th May, and the construction of a Class 80 S.W.B.P.B. on the night of 10th May.

(*b*) Work on the F.B.E. bridge and the Class 50/60 Assault bridge commenced at 2000 hrs. and 2359 hrs. respectively on the 9th May, and was completed by 0300 and 1100 hrs. respectively on the 10th May.
Delay in starting on the Class 50/60 Assault bridge was on account of a German civilian driver during the approach march, breaking the convoy on seeing a unit location sign, with three-quarters of the bridging column following him. On being questioned afterwards his explanation was :—" Ich war nur aus für eine Tasse Tee " (I only went for a cup of tea) !

(*c*) At 2000 hrs. on 10th May work started on the 280-ft. Class 80 S.W.B.P.B. The bridge was made up of two 100-ft. landing bays, two end-floating bays and one floating bay. The end-floating bays and the floating bay were built about one mile up-stream whilst at the same time work commenced on the landing bays, which were built over the site of an existing ferry. Work continued throughout the 11th May and at 0300 hrs., 12th May, the bridge was finally completed (see Photo 2).

Photo 1.—Class 50/60 assault bridge "Fiddlestyx".

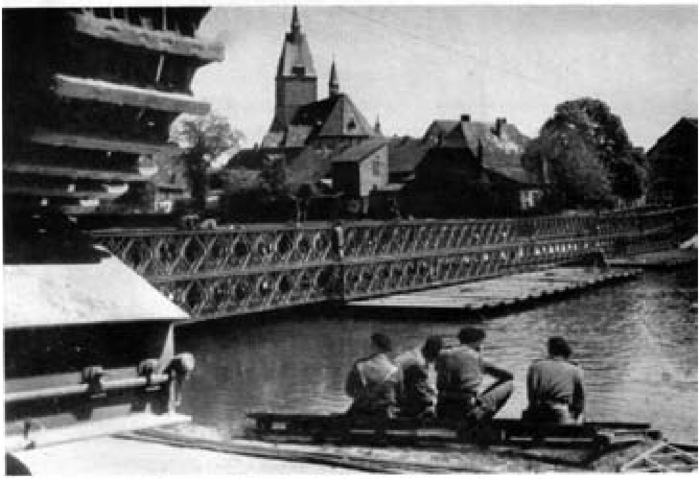
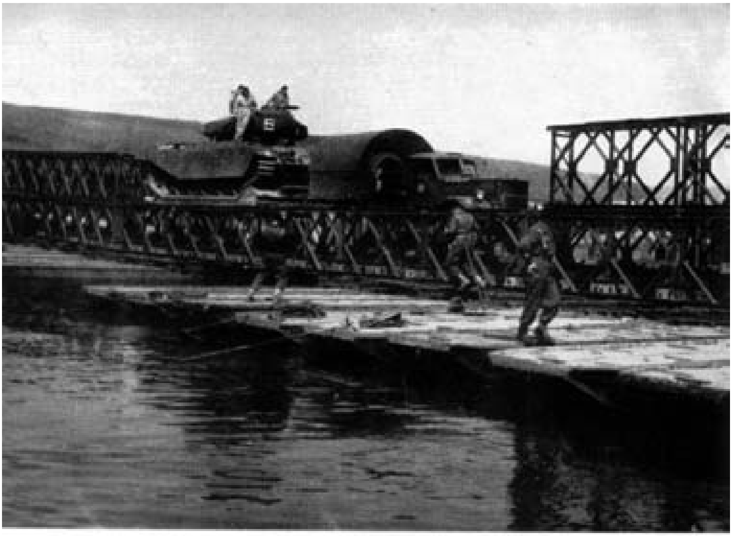


Photo 2.—Completed Class 80 B.P.B. "Chopstyx".

A Regimental Bridging Gallop 1,2



Photos 3 and 4.—Class 80 B P.B. with Tank and transporter crossing it.

A Regimental Bridging Gallop 3,4

(*d*) At 0900 hrs., 12th May, the transport commenced to cross the bridge (see Photos 3 and 4).

The building of "Chopstyx" Bridge completed the "gallop" and, after all transport had crossed it, dismantling and loading up commenced.

Fortunately the weather was fine and the regiment made short work of all this with the result that everyone was home, 80 miles away, by early morning of the 13th May.

General Comments

The standard of work was good, the junior N.C.Os. in particular doing well and taking far more charge than is usually the case.

Stress had been laid in previous exercises on the use of tape, gapping lamps and small name-boards when laying out stores, and little fault could be found on this occasion.

No attempt was made to do so-called record times in any particular task although the C.R.E. had planned on having the Class 80 pontoon bridge completed within twenty-four hours. One of the squadrons on this bridge did not in fact start work until 0600 hrs. on the 11th May, and faulty organization on the near-side landing bay further delayed the work. Nevertheless for the regiment to have built, dismantled and loaded up five bridges, each over a 300-ft. wet gap, in five days was in itself no mean feat and the effect on the general spirit and morale of the men was noticeable.

Preparation of Equipment

It is proved time and time again that equipment must be well checked and greased before use. This lesson was again driven home when the first F.B.E. bridge was constructed. Considerable delay was caused by the fact that the sliding portion of the trestle legs had rusted into the legs themselves and took several hours to free. This equipment was drawn from an Engineer Stores Depot but these particular items were not checked over by the Field Park Squadron when it collected the equipment.

Use of Plant

Lighting of the jibs of cranes proved useful in the off-loading of the pontoons and equipment for the Class 80 bridge.

It is now a standard battle drill in the regiment that for launching and de-launching 50/60 pontoons, Class II bulldozers are used and this was invaluable in the 50/60 Assault bridge. All that operators required was a little practice and after an hour or two they could operate perfectly well in reasonable weather without lights by night, on a dark night.

Organization of Work

Squadron commanders and troop leaders had to produce for the C.R.E. works tables for each particular task. The tasks involved six to eight hours' work at a stretch and a man was then given a rest and food. Rest was controlled and all personnel off duty had to lie down and relax even if they could not sleep.

Control of Bridging Equipment

Sound organization is essential if things are to go well. The O. i/c bridge control point must of course be on the command wireless net and he in turn must have a simple, well thought out plan for calling forward vehicles as required by the bridge commander. The order of the calling forward had previously been decided upon and is an essential part of battle drill. All concerned must have a copy of the loading tables showing the serial numbers of the vehicles and these serial numbers should be fixed on the windscreens of all vehicles.

Special care must also be taken in the selection of a traffic circuit for bridging equipment. This must be well signed and policed.

Communications

The ordinary regimental net was used and the fact of the regimental command set being a No. 52 set helped a great deal. The standard of driver-operators had improved on previous years because the majority of their work had been of a practical nature on regimental wireless courses, run continuously throughout the year. In addition it was found that netting drill for three periods of half an hour weekly for everybody concerned with wireless was also of considerable value.

The old familiar war cries of " Hear short tuning and netting call," " Net now;" " William Dog Able " repeated *ad nauseam* and the like, which normally disrupt the C.R.E's. " gin " net, were conspicuous by their absence, and it was pleasant to note that no use was made of " Slidex," all necessary information required being given in " Unicode " or, when on the march, by reference to report lines and nicknames.

Quality of the Men

The standard of work, spirit and endurance was of the highest order. Sappers worked extremely hard, and it was felt that unlike some of the other exercises on which the regiment had been, provided a man is kept in the picture at all times, knows what he has to do and is given organized rest with plenty of warm food and drink, then there is no limit to the work he can do. Some 160 lorries were driven by National Servicemen in the bridge company and the bulk of the regiment's own drivers were also National Servicemen.

Very few breakdowns occurred and drivers, both R.A.S.C. and R.E., were to be seen giving a hand voluntarily at any job of dismantling on which they happened to be.

Conclusion

The bridging gallop, thanks to the really excellent facilities in all respects provided by B.A.O.R. coupled with decent weather, proved a great success. It provided excellent training for all ranks and showed that, although for most of the year men are in very comfortable billets and therefore, one might think, apt to get soft, when it comes to hard work and living rough they can take it easily, provided they are looked after, know what they have to do and, above all, see the result of their labours.

RANDOM REFLECTIONS OF A REGIMENTAL OFFICER ON THE PROMOTION OF NON-COMMISSIONED OFFICERS

By Lieut.-Colonel J. M. Lambert, O.B.E., R.E.

"I AM afraid, Sir," said the Adjutant, in his best bedside manner, " that this is going to be rather a shock "—and he laid a piece of paper on the C.O's. table. The Commanding Officer looked at it warily ; it was a list of names and appeared harmless enough.

" It seems," went on the Adjutant, " that about half the N.C.Os. of the regiment are being posted during the next three or four months—including Sergeant Mallard—which really *is* a blow." Sergeant Mallard was a very useful spin bowler and a passable bat ; but apart from that his loss could scarcely be regarded as a disaster. But the others !—a Squadron Sergeant-Major—the Provost Sergeant—three Sergeants (one of them first rate)—seven or eight of the best Corporals and some really promising youngsters—the C.O. read through the list of names and his heart sank.

" Well," he said heavily and without conviction, " I suppose we'll get *some* replacements *some time*."

" I've already been on to Records about that, Sir, and they say there's not a hope of any replacements. They say we must fill vacancies by promotions ; and by the way, Sir, it seems that it is now quite in order to make National Servicemen sergeants."

The C.O. looked out of the window and there was a long silence —so long in fact that, eventually, the Adjutant blew his nose as loudly as he could in case " the old man " had gone to sleep.

" If I remember rightly," said the Colonel at last, " practically all the N.C.Os. in this regiment were recommended for promotion in their last confidential reports ; so there shouldn't really be any difficulty." The Adjutant looked slightly uncomfortable for a moment, but he rallied quickly.

"Yes, Sir, but those recommendations were for shadow promotion ; you may remember that most of the sergeants were recommended for promotion to sergeant. And then there was S.S.M. Pintail whom you found you could only recommend for promotion to corporal—though you did give him an S.R., I believe. And of course," he continued, "National Service N.C.Os. don't have confidential reports."

There was another long silence and the C.O's. frown deepened. "I must think about this," he said slowly—though it was by no means the first occasion on which he had had to think about it—"and I'd better get something down on paper to get my thoughts clear."

And these were some of his thoughts.

* * * * *

What we are asked to do in fact is—either run the regiment on an insufficient number of N.C.Os. or make N.C.Os. of men who seem patently unfitted to hold the rank. The first alternative isn't really feasible. It isn't fair on a Troop Commander not to give him a Troop Sergeant ; and anyway is it fair to make a Corporal try to do a Troop Sergeant's job and not pay him for it ? As for Lance-Corporals you've got to have *somebody* in charge of a barrack room ; this business of the "Senior Sapper" just doesn't work. So let's face it, these chaps have *got* to be promoted—no matter what their age, experience or quality.

Starting at the bottom :—the appointment of young Lance-Corporals shouldn't be difficult. Every time I see a squadron on parade I think what a number of decent, clean, intelligent-looking lads there are among them ; true they are probably only 18 or 19, but after all, a boy at a public school is often a prefect at 17 ; and the Lance-Corporal's job in peace-time is not much different.

I'm sure the raw material is there and that it can be shaped into the article we want. The trouble is that the shaping takes a great deal longer than people think ; it is a slow and gradual process if one is to avoid producing Sappers-with-stripes-up.

My Squadron Commanders are always complaining that these boys can't take responsibility—or don't want to ; and that they'll put up an awful black, and that I shall then say, "Who the blazes ever made that chap a Lance-Corporal ?" Or that if they're put in charge of stores they'll lose them ; and the Court of Inquiry will say that it wasn't fair to put such an inexperienced young N.C.O.

in charge, and recommend that the Squadron Commander should pay. Which is all true enough, I expect.

So often the young soldier nowadays thinks he can get promotion by being a good tradesman—and what's more he often does. He likes to spend his day wielding a nimble pencil, or chisel, or blow-lamp, or what have you ; and directly after work he leaves camp and goes into the town, or to civilian friends, or to the N.A.A.F.I. Club if there is one. The life of such a man is nearer that of a civilian than that of a soldier—or what that of a soldier used to be before the war.

Perhaps that's an extreme case ; but it's a tendency undoubtedly—a tendency which militates against a man becoming soldierly ; and a non-commissioned officer, whatever else he ought or ought not to be, *must* be soldierly. And that's not so easy to instil. Field-Marshal Montgomery once said, "We are by nature a martial but not a military race"—and he should know.

Of course there's the easy way ; when there's a vacancy just put the most suitable (or the least unsuitable) man into it, and apply the "make or break" principle. But breaking is so much less easy than making—and sooner or later, in another unit, the old cry will go up :—"Who on earth ever made this man a Corporal?" And besides it's not fair on the N.C.O. himself. I well remember that corporal who, a day or two after he arrived in the unit, was detailed as N.C.O. i/c escort to two prisoners being taken up to the "Glass-house." They both escaped and it was a court martial for the Corporal—who was broken. He told me he'd never had any instruction about that sort of thing—in fact he'd had no training as an N.C.O. at all. When I asked him why he'd been made an N.C.O. he said, "Because there was a vacancy in the establishment." A pity—he seemed a decent sort and might have made a good N.C.O.

What were those old clichés? "There are no bad N.C.Os.—only bad Officers" and "The N.C.Os. are the backbone of the Army." True enough no doubt but they don't help solve the problem ; in fact they seem to make it worse. If I'm going to promote some of the chaps I'm pretty sure I shall *have* to promote, the backbone is going to be a bit wobbly ; and I shall certainly qualify as one of the Bad Officers.

This sort of problem just didn't arise before the war—in fact the boot was on the other foot ; dozens of good chaps "sweating on the line" and no promotion for them. There used to be a Junior N.C.Os'. Cadre Class that ran the whole winter, and when a man came off that he was a ready-made N.C.O. You could go along and choose one off the peg so to speak.

My Squadron Commanders always belly-ache at sending N.C.Os. away on a Cadre Course—and I can't altogether blame them.

They have to send a goodish N.C.O. whom they can ill afford to be without. They lose him for about six months and when the course is over they may well lose him altogether—promoted into another squadron, or posted abroad or something. Anyway you can't send large numbers away on a Cadre Course—nor any National Servicemen.

No—we've got to make our own N.C.Os. and we've got to train them within the regiment and probably within the squadrons. All that we need is sufficient good and experienced N.C.Os. to help in the training. There's S.Q.M.S. Pochard for instance ; I remember him as a first-rate Troop Sergeant five years ago ; and Teal, the Sergeants' Mess Caterer. I'll dig them out to do a bit of N.C.O. training. I shall be told that the administration of the regiment will go haywire—but worse things can happen than administration breaking down ; though I may find it difficult to persuade District about that.

But how is this training to be done ?

Training in skills is one thing, but training in qualities is another. And it is qualities that one wants. You hear a lot about " Officer Qualities " these days ;—what about " Non-commissioned Officer Qualities " ? What are they and how do you train men in them.

How do you train a man to welcome responsibility ?—to have self-confidence ?—to be a bit aloof and a bit bossy ? How do you instil into him a sense of duty, a sense of loyalty and pride of unit ? And how can he be made to appreciate the meaning and value of discipline ? And how can it all be built up quickly—on a foundation of fourteen weeks' recruit training instead of the pre-war ten months ?

Take this question of responsibility for instance. How can you teach responsibility without giving it ? And how can you afford to give it to a man who is not fitted to take it ? How for that matter did I myself first learn to take it ?

I think it was at my prep. school. I suppose I was nine or ten years old and I was made O.C. Inkpots. We had a Form Master who was a very good disciplinarian ; he made each boy responsible for something. There was an O.C. Blackboard, an O.C. Chalks, an O.C. Floor, an O.C. Windows ; best of all (except O.C. Fire in winter) was O.C. Inkpots.

Each morning I had to fill up all the inkpots—one on each boy's desk with Steven's Blue Black, and three on the Master's desk—one black, one red, and one green. And then, with the aid of blotting-paper and spit I cleaned the white china tops of the ink-wells. Meanwhile other small boys were cleaning blackboards and windows, setting out chalks or sweeping the floor. How bossy and self-important we all became ! And by the time the Master arrived all was clean and ship-shape, and he was faced by a row of smug little boys beaming with pride and self-satisfaction. But it taught us the elements of taking responsibility—and a habit of mind which was of undoubted value later.

Is not this system the right one for the barrack room—or hut—or tent? Isn't the answer that any man before he's made an N.C.O. must have had, for as long a period as possible, some such small daily responsibility; and shown that he is able, eventually, to take it?

The N.C.O. i/c of the barrack room, etc., will then be in charge of men who themselves have responsibilities and he may come to learn that "the man in charge of the job ought to be able to stand around with his hands in his pockets."

When the system is expanded to include barrack-room competitions (preferably with no material rewards) it provides, in miniature, a grounding in almost all the non-commissioned officer qualities—a sense of responsibility, a sense of duty, a personal and community pride, and loyalty to one's fellows, and a realization (by results) of the value of discipline.

Then what about self-confidence?

How can one quickly instil self-confidence into a lad who, until a short time ago, had probably never spent a night away from his home and family, and was then suddenly thrown into a new, strange and seemingly hostile world—a bleak hut and a bleaker barrack square? For quick results there is only one way—Drill.

Once a man has learned to use his voice and to command a small squad on the parade ground he is over the first hurdle. He may take the bit between his teeth and become a bully—but he will gain self-confidence more quickly than by any other means. After that, a spell of duty with the Regimental Police will often work wonders; he will probably find himself marching one prisoner three times a day from the cells to the cookhouse and back again; and then standing over the man while he cleans his cell and lays out his kit. But it's all good N.C.O. training and if the Provost Sergeant is the right type it will be invaluable.

The answer then seems to lie not so much in special courses or Cadre Classes, but in introducing N.C.O. training into the daily routine of the unit. The places where this training is carried out are the barrack room and the barrack square; and the time for the training is—*all* the time.

Every man with a potential N.C.O. training recommendation ought to be getting some training as such—mainly by being given small responsibilities—from the day he ceased to be a recruit.

There will have to be some class-room lectures of course—on elementary military law, powers of arrest, guard duties and the like. This is where S.Q.M.S. Pochard, and Sgt. Teal, the Mess

Caterer, will come in. They can give these occasional lectures perfectly well after mugging it up a bit, and a chat with the Regimental Sergeant-Major. And it will do them a power of good—take their minds off battledress and beer-barrels for a bit.

Nevertheless, the essential training of the young non-commissioned officer is done, not in a class-room, but in the barrack room and on the parade ground.

For various reasons soldiers, nowadays, don't spend as much time in the barrack room and on the square as they used to do ; but if they are to be trained as N.C.Os. they must be brought back to them and made to function. There is no new discovery in all this ; it is as old as the British Army—certainly since the days of Sir John Moore.

But perhaps it needs rediscovering—at any rate by Officers, Warrant Officers and N.C.Os. who were not serving before the war.

There are other things besides training to be considered. There is this business of incentive. The status of a non-commissioned officer does not seem as potent an incentive as it used to be. There are always quite a number of men who are keen to get their "first tape"—but not as many as one would wish ; and oddly enough, they are not always the sort one wants. Of course the fact is that the status of N.C.Os. is not as high as it was pre-war—when "many were called but few chosen," and to that extent it is a vicious circle.

We ought to improve the status of non-commissioned rank. Dress, for instance. Why shouldn't N.C.Os. have more distinctive dress and accoutrements? Is this anonymity in army dress really necessary? The Navy makes a great distinction in dress between Petty Officers and Seamen. I have always remembered part of a speech made in the House of Lords a few years ago ; it was I think the maiden speech of Lord de l'Isle and Dudley, V.C.—"I don't know what the term 'democratization of the Army' means—but if it means breaking down the barriers and distinctions between Officers and N.C.Os. and between N.C.Os. and Private soldiers, then it will be the end of the British Army as we knew it"—or words to that effect.

In this matter of improving N.C.Os.' status, any distinctions, however small, will help ; and they needn't always cost public money.

For instance, if N.C.Os. were allowed to carry canes when walking out they would buy them quick enough. And if Sergeants were allowed canes with silver knobs I dare say most of them would pay for the privilege. And why should not Regiments and Corps decide their own distinctions of this nature? Standardization always tends to kill sentiment ; and sentiment, laced with discipline, is the cement which binds together soldiers ; units ; armies.

Why shouldn't more Lance-Corporals be paid as such?

Nowadays, the only paid Lance-Corporals are those having definite appointments in the unit establishment (and these are not handed out with any marked generosity by the makers of establishments). But it is necessary to have more Lance-Corporals than this in order to cushion the effect of postings, discharges, leave, sickness, etc.

There used to be an excellent system which allowed of a "float" of Lance-Corporals. It appeared, I remember, as a note at the bottom of each printed unit establishment; and was to the effect that, in addition to those shown, one Paid Lance-Corporal could be appointed for every so many private soldiers in the establishment. This not only provided the essential cushion, but greatly facilitated the training of the young N.C.O. It also added to the incentive of the first stripe—which otherwise so often means "all kicks and (literally) no ha'pence."

Then what about Corporals—and the very important step in promotion from Corporal to Sergeant?

The rank of Corporal seems nowadays to be rather in the doldrums, and I hear more complaints of bad Corporals than any other rank. Why is this?—it used not to be so. After all, by the time a man becomes a Corporal he should have shown that he has some N.C.O. qualities and therefore ready for more training and eventual higher rank. But so often it doesn't seem to work that way; a keen and go-ahead young Lance-Corporal puts up a second stripe and then seems to "call it a day"—or even go backwards.

Is it because he knows it is so difficult to break him? I doubt it; and in any case that was always so.

I believe one reason is the abolition of Lance-Sergeants. That was a tremendous incentive and kept every Corporal on his toes; he never knew when he might be told to put another stripe up and, having done so, be able to walk into the Sergeants' Mess. And it kept all the Lance-Sergeants on their toes too—for the same reason in reverse.

It wasn't only an incentive; it also helped with the training of the Corporals and Lance-Corporals; for the Lance-Sergeants could temporarily do the Sergeants' routine jobs, thus freeing the latter for training the Junior N.C.Os. The allowance was, if I remember aright, one Lance-Sergeant in every six Corporals—a very great asset indeed.

And now, having got as far as Sergeants—is one really going to consider making National Servicemen Sergeants?

From the unit's point of view it won't be much good promoting to Sergeant a National Serviceman who has less than six months to serve; which means he must rise from recruit to Sergeant in little more than a year.

However excellent a man is in character and ability, is it fair on *him* to expect him, with such little experience, to carry the prestige and responsibilities of a Sergeant R.E.? (If it is operational experience in war, which carries its own prestige, that is a different matter.) True we have National Service Officers (and first-class many of them are); but they are *Junior* officers and do not have to command other officers. Which is a very different thing from being Senior N.C.Os.

Unless N.C.Os. are fitted for their rank and unless we *require* them to be fitted for it, the rank itself is bound to lose status and prestige. Herein lies the danger of all promotion made from necessity rather than from fitness. The necessity may be overriding, but the corollary is inescapable.

Most of the foregoing are incentives requiring the proverbial "Act of Parliament" to put into force. Are there no practical ones that one could get on with straight away and not cost too much money? There's the Junior N.C.Os'. Club for instance. That is certainly an incentive—if it's a decent one which it often isn't. Too often it's just a bit of the Canteen—the back premises or the old wet canteen of former days converted. If it's in any way practicable it should be made a Junior N.C.Os'. Mess, in which they should have their meals. And their food ought to be just a bit better than the men's. The rebate should easily allow of a messing grant which might provide, say, one really good supper each Thursday. It might become a sort of guest night. It would at any rate get them all into Mess together and do something to revive that comradeship, the lack of which (so the Old Sweats always say) is a marked contrast with the pre-war Army.

Then there are the rather indefinable but most potent incentives provided by the attitude of Officers and Warrant Officers towards N.C.Os. The things that make an N.C.O. *feel* he has a status that is valued. For example: "That battledress of yours, Corporal Sheldrake, might be just good enough for a Sapper but it is NOT good enough for an N.C.O."—that sort of thing gets round very quickly and also ensures that N.C.Os. *do* get priority at the Quartermaster's clothing store.

There are other such devices to enhance prestige, but none of them can obviate the necessity to train N.C.Os. to *be* N.C.Os. This produces a prestige in itself; for a worth-while job surely must be worth training for. You don't get a carpenter by putting an untrained man into a carpenter's vacancy—nor an N.C.O. by the same token.

Without training, privilege is useless. The N.C.O. must first be fitted to accept privilege—he must learn (to misquote Oliver Cromwell) to "know what he serves for and love what he knows."

BOOK REVIEWS

MARINE AVIATION IN THE PHILIPPINES

(Published by the Historical Section U.S. Marine Corps)

The U.S. Marine Corps is a *corps d'élite* peculiar to the fighting Services of the United States. No other country possesses formations which can land on a hostile shore and operate almost independently of the Air Force and the Army—the Marine Corps has its own supporting arms, and above all, its own air force. This beautifully produced monograph is the history of the 1st Marine Aircraft Wing during the recapture of the Philippine Islands between September, 1944, and July, 1945. The Wing consisted of four groups, each of four to five squadrons, so that several hundred machines of different kinds are concerned, viz., Fighter, Medium Bomber, Dive Bomber and Transport aircraft. All these squadrons operated from hastily made air strips. Two other Marine Fighter Squadrons were carrier based. The whole Wing was commanded by a Major-General of the Marine Corps. Corps histories are notoriously difficult to follow unless the reader himself has taken part in the adventures described. This one is firmly based on the reports and war diaries of units, but other authorities are also drawn on, since the bibliography runs into over three pages. But even to the inexpert in the details of air warfare, one very big point does emerge. Until Marine aviators took a hand in the game of recapturing the Philippines "no ostensible effort had been made to use air-ground facilities to direct and control air strikes close to ground troops." The Marine aviators found themselves covering Army units who did not know the benefit of really close support. They had to sell the idea of this to doubtful divisional commanders. By putting their own "fly-boys" right into the front line on the ground, they convinced the troops themselves, that close support within a few hundred yards could be devastatingly effective. Then the generals came, saw and were conquered. After that the Marine aviators did a roaring business. In the recapture of Seoul in Korea last year, the Marine Corps airmen showed that they had not lost their skilful technique in close air support, which foreign observers reported to be astonishingly accurate and effective.

Given fighter cover and local air superiority, close support is immensely important in the modern assault. Its technique in peace-time is easily lost for it depends on the skill of experienced pilots, who soon get promoted and pass on. Air forces, too, have other more essential tasks than close support, the technique of which is easily forgotten and may have to be painfully relearnt on the battlefield. The Marine Corps with its magnificent infantry and its own aviators will no doubt help the Allies to keep close air support right up to date.

B.T.W.

THE SEIZURE OF TINIAN

By Major Carl W. Hoffman, U.S.M.C.

(Published by Historical Division—H.Q. U.S. Marine Corps)

Tinian is a small island in the Marianas, between Saipan to its north and Guam to its south. In 1944 it was held by only a mixed Naval and Army force of 9,000 Japanese. The American intention was to construct B.29 airfields in the Marianas for the bombardment of Tokyo, 1,250 odd nautical miles to the north-west. Tinian's capture was important, not only because it contained potential airfields to supplement those already being constructed in previously captured Saipan, but also because, if left unattacked, the Japanese could observe activity on near-by Saipan.

The enemy were long aware of an impending American attack, once Saipan was occupied, but he was tactically surprised when his prepared defences were avoided, and a landing was made by two divisions on two small beaches totalling only 220 yards in width. All his efforts to push the more numerous and heavily equipped Americans into the sea completely failed, and he gradually expended his strength in suicidal *banzai* attacks. The island was formally occupied in nine days, although one Marine battalion was employed in mopping up operations in the southern tip of the island for five months.

Hoffman's book records the meticulous planning, and faultless execution of this operation, but the battle for Tinian cannot in any way be compared to the Normandy landings, which preceded it by six weeks, on the other side of the world. It was quite a different operation from those carried out in Europe. There was no lack of landing craft or amphibious vehicles ; there was no real menace from enemy armour and the air, requiring large numbers of tanks, anti-tank guns and anti-aircraft guns to be landed with the assaulting troops. The beach, though narrow, required no complicated beach organization, or artificial harbour, though Seabees did construct a pontoon causeway, which was destroyed by a storm after three days. Adequate air lift from Saipan was, however, quickly made available.

The book is of value to students of amphibious warfare, since it is written in sufficient detail to give the pattern of a set-piece attack on a well defended island. It brings out the importance of careful planning, and the intimate co-operation of the Navy in putting the Marines ashore, and supporting them to their objectives. It brings out fully the toughness and bravery of the American marine and the Japanese soldier. It also shows how a skilfully thought out and executed deception plan misled the enemy into defending the wrong beaches.

D.G.B.B.

MEMOIRS OF A JUNIOR OFFICER

By LIEUT.-COLONEL M. C. A. HENNIKER, D.S.O., O.B.E., M.C., R.E.

(Published by W. Blackwood & Sons Ltd. Price 12s. 6d.)

Few men bother much about writing memoirs when they are young, nor usually have they time in which to do it. But where writing is in question, Lieut.-Colonel Henniker is a fast worker and with the help of some passages which had been published before, put the whole book together during a fortnight's leave. When really pressed he can do better even than this, for he tells us how he wrote a story of at least 800 words for the *Uganda Herald* in ten minutes whilst waiting for a bus. This would make even a Fleet Street journalist gasp with admiration.

Although such speed of composition is uncommon, it hardly lends itself to more than a galloping narrative of the author's adventures from the time of his childhood in India on to the day when he was promoted to field rank. As he then ceased to be a junior officer, the lively chronicle comes abruptly to an end, just as Hitler began to show the world that he had not "missed the bus" after all. This is rather irritating to the reader, who would like to have seen how Lieut.-Colonel Henniker's obviously original mind reacted to total war.

The book, written in a light vein, is eminently readable. Good stories follow each other in quick succession. We read how at Marlborough, already living at a vivacious tempo, the writer learned how to pull the communication cords of railway trains without paying five pounds. This expert knowledge stood him in good stead in later life.

A sympathetic passage describes how two Roorkee elephants used to salute, with uplifted trunks, officers in mufti, who took off their hats in reply. But they were out of date in a mechanical age. A drawing illustrates their departure.

It is all very good fun, but at times rather flippant and facetious. The tribesmen of the North-West Frontier have a dignity which is not successfully pictured in the book, nor are their attractive forms of welcome and farewell—" Inshallah " not " Imshallah " is the generally accepted transliteration of the Arabic " May God grant." The term " sepoy general " is sometimes displeasing on the printed page. It was used originally by jealous detractors of the Duke of Wellington, amongst them Napoleon. Would that we still had " sepoy generals " training their magnificent troops in India !

Sensitive sketches by Lieut.-Colonel C. G. Borrowman, R.S.W., add much to the attraction of the book. Young officers who aspire to get the best out of soldiering should read these memoirs. They will realize as they do so that a great deal of uncommonly hard work is required for success in the gentle art of combining business with pleasure.

B.T.W.

PRESTRESSED CONCRETE

By Professor Gustav Magnel

(Published by Concrete Publications Ltd., London.)

This second edition incorporates the latest developments in prestressing, with particular reference to statically indeterminate frames. The rewriting of the chapter on continuous beams has the advantage of being able to give examples and make reference to structures actually built.

Professor Magnel, however, has not been content to merely put his theory into practice. Considerable laboratory work has been done, since the publication of the first book, on the creep of steel under stress and a description of the results of the first tests made on a continuous beam are fully explained. The picture which the book presents is of a very able student never ceasing in his efforts to simplify the theory of prestressing for the use of the practical engineer.

It is, therefore, interesting to note the reference to the use by the Canadian Royal Engineers of prestressed beams in rebuilding a bridge to carry a pipe over the Terneusen Canal. The beams were made up from a series of hollow concrete blocks, which were then post-tensioned. This idea of stringing together a number of precast blocks, like beads on a string, to form bridge girders is an attractive idea to the Army Engineer and it is a pity, therefore, that this book does not go more into the practical aspects of construction, for precasting does not necessarily simplify the whole task, it merely alters the sequence of events.

One can be certain, however, that this is not the last word that Professor Magnel has to say on prestressed concrete and the results of his further work on this subject will be eagerly awaited.

H.J.C.

CONSTRUCTION WITH MOVING FORMS

By L. E. Hunter, M.Sc., A.M.I.C.E., M.I.Struct.E.

(Published by Concrete Publications Ltd. Price 7s. 6d.)

The present enormous rise in the cost of building anything is a matter of universal knowledge, and universal regret. There is very little to be done about it, but engineers will turn with interest to any means of achieving speed and economy by improved techniques. Into this category clearly falls the method of " moving forms " expounded by Mr. Hunter.

The use of moving forms is an economical method of constructing a tall, reinforced concrete structure which has more or less the same shape in plan throughout its height. A belt of forms is constructed on the ground, the depth of the belt being about four feet, and includes shutters for every face of the concrete, inside and out. As the work proceeds, this belt is lifted by jacks, exposing the completed concrete and providing formwork for a further lift. The belt starts to rise as soon as work begins, and must not be allowed to stop until the whole job is finished.

Progress by this method is, in general, about four times as fast as by the use of conventional shutters, and there is a considerable economy in materials, a high proportion being salved. These savings easily offset the extra cost of night work, and the small amount of special equipment required. The completed structure will also be free of construction joints, and therefore sounder and of a better appearance. It is not all easy money for the designer, however, because the detail must be modified to suit the method, and under certain circumstances more concrete and heavier bars will be needed.

The drawbacks of the method are connected with the rather terrifying thought, that if these forms ever stop moving for long enough for the concrete to harden the job is faced with disaster. This involves the careful planning of night work and overtime, delivery of all materials, and even meal breaks. The engineer, knowing what hard knocks the best laid plans of mice and men have had to take of late, may well distrust circumstances, to say nothing of his subcontractors. If, however, he decides to chance his arm, he will be greatly comforted by a copy of Mr. Hunter's little book in his office.

All the peculiarities of this form of construction are simply described, with a generous number of photographs and sketches. There is also an alphabetical list of snags and remedies, reminiscent of the invaluable hints which are to be found at the end of motor manuals, on how to restart a defunct car.

In fifty-six pages, readers cannot expect much in the way of design theory, or protracted treatment of jobs of the author's experience, but to an engineer who wishes to know just what is involved in " Moving Forms," I highly recommend Mr. Hunter's book.

D.A.S.

TECHNICAL NOTES

TUNNELLING

(*The Engineering Journal*, dated September, 1951.)

A paper, written by Brian Colquhoun on aspects of modern tunnelling, and presented before the 65th Annual General and Professional Meeting of the Engineering Institute of Canada, is reproduced in full. The author is a British consulting engineer with a wide knowledge of modern technique.

The paper is, therefore, mainly concerned with descriptions of British tunnelling methods, but he does include American projects. He also covers pioneer work on the Simplon and other tunnels through the Alps.

The paper starts with the early history of tunnels in Egyptian, Aztec and Roman times. He then gives a description of the three main types of tunnel, in rock, dry ground, and water bearing soils. The last is perhaps the most interesting, since it is the most dangerous and difficult.

He tells of the various types of shields used in water-bearing soils. Methods used for tunnels with mixed faces of earth and rock are discussed, and the hazards from "blows" and fires are pointed out. In conclusion experience with tunnels in the London Underground is related, and the similarity of underground conditions in London and Montreal is noted.

Anyone who reads this paper carefully will find much to interest him on future travels underground in London.

HIGH TENSILE ALLOY STEEL BARS FOR PRESTRESSED CONCRETE

(*Civil Engineering*, dated September, 1951.)

For prestressing concrete the use of bars instead of many times their number of wires should save labour in placing and tensioning. Various factors had discouraged the use of bars in the past, but with the production of greater quantities of high tensile steel and the development of stronger end anchorages, the steel bar is becoming a worth-while method of prestressing.

By having a positive screwed anchorage, instead of the normal friction grip, the bars can be easily restressed to eliminate losses due to creep and shrinkage. The screwed anchorage also eliminates slip, a factor which may considerably affect the percentage loss of prestress, particularly over short lengths where a slight slip in the end anchorage causes a big loss of tension. The figures given below are extracted from a table of comparison of the efficiency of the two types of prestressing.

	Steel Bars	Hard Drawn Wire (dia. 0.2 in.)		
	Any length	10 ft. length	30 ft. length	50 ft. length
(*a*) Initial Tension	95,000	126,000	126,000	126,000
(*b*) Total losses	15,000	33,500	24,500	22,700
(*c*) Residual Tension	80,000	92,500	101,500	103,300
(*d*) Efficiency $= \frac{(c)}{(a)}$	84%	74%	81%	82%

The figures show that the bars are much more efficient than the wires for the shortest spans, but against this, the initial tension (and consequently the residual tension) is less, so that more steel is needed to produce the same total prestress.

Steel bars are, of course, awkward to handle and their length has therefore to be limited to about sixty feet. Longer bars are made up by joining short lengths with threaded couplers. Details are given of a 160-ft. span railway bridge, now under construction, in which the bars are joined by couplers at two points.

BRITISH PLANT FOR ROAD CONSTRUCTION

(*Civil Engineering*, dated October, 1951.)

It is interesting to note the British manufacturers are keeping abreast of other nations in the development of road construction plant. During the last war, our dependence on plant supplied from the U.S.A. has caused a certain amount of worry that requirements in Britain would not be fully satisfied without the expenditure of dollar currency. It is therefore, reassuring to note the items of plant which we do now manufacture. This article which is continued in next month's edition provides a survey of British plant and gives numerous photographs.

Included also in this edition is a short and very practical paper by Karl Terzaghi on the soil studies connected with the construction of foundations.

BUILDING EXPEDIENTS

(*Civil Engineering*, dated November, 1951.)

A fear which has always worried the average builder, when considering whether to use prestressed concrete on his work, has been its reaction to fire. In this edition a start has been made to answer that question with reference to tests carried out at the Joint Fire Research Organization.

A short article on the construction of stabilized soil building blocks for use in East Africa suggests a possible solution to a military engineering problem in undeveloped countries. Stabilization with 2½ per cent cement was used. Details of this method of construction were also given in the December, 1951, *R. E. Journal*.

A description is also to be found in this edition of the Roxburgh Hydro-Electric Project in New Zealand which is the first of a possible chain of stations on the River Clutha and is to produce 320,000 kva. Some interesting experiments in the use of explosives are mentioned.

THE HANDLING OF CEMENT IN BULK

(*Civil Engineering*, dated December, 1951.)

Another chapter deals with the bulk supply of cement. With the cost of paper bags for cement representing 30 per cent of the cost, contractors are beginning to take more interest in the method of supply. Construction works needing a large supply of cement have often used bulk supply, but now the smaller sites must be catered for and the day may come when cement in paper bags will never be available. Developments on these lines are of great interest to the army engineer, as all will agree who have seen the wastage that takes place in overseas theatres due to damaged paper bags and damp penetrating the bags.

A LARGE NEW WALKING DRAGLINE

(*Civil Engineering*, dated December, 1951.)

An interesting article describes the new walking dragline made by Ransomes & Rapier Ltd. for the Corby iron ore quarries. This machine, reputedly the largest in the world, has a gross weight exceeding 1,600 tons, with a 20 cu. yd. capacity at a 260-ft. radius. A number of novel features are incorporated, amongst which the air filter and fan equipment for cooling purposes and pressurizing the cab to exclude dust is mentioned.