VOL. LXVII. No. 3 SEPTEMBER, 1953

THE ROYAL ENGINEERS JOURNAL

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AGEN HAM

THE ROYAL ENGINEERS JOURNAL—SEPTEMBER, 1953 VOL. LXVII. No. 3

18 YEARS' SERVICE

CONFIRMS

1934

TESTS

The illustration above shows shops in the Haymarket at Newcastle-on-Tyne where Cementone No. 7 Primer and Flat Finish was used for decoration of new cement rendering in 1934. This photograph was taken some 18 years later when the surface was inspected and found to be in sound condition after 18 years exposure. In 1934, tests were carried out by the "Decorator" Journal on all types of surface, including new plaster, new cement and asbestos sheeting. These tests proved the claims made that Cementone No. 7 was suitable for application to almost any type of building surface, eliminating the need for specifying special paints for different surfaces. Our claim, first made in 1934, that the "overall" decorative material had arrived, has been confirmed by thousands of contracts in all parts of the world and tests carried out by independent bodies. You would be well advised to use Cementone No. 7 Flat or Gloss Finish with Universal Primer on your next contract. A Handbook giving specifications and costs per yard will be forwarded on request.

Cementone No. 7

Report on Exposure Tests

rly in March we received from Messrs
man, Sons and Co., Ltd., of "Cementone"
ples of their latest material, "Cementone No
ne is a synthetic paint, made in both glossy and
ishes, with a special primer and undercoat,
pplicable either by brush or spray. It was claimed
that new Portland cement, asbestos sheeting, gree
laster, and similar materials which notoriously gi
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same job.

will be remembered that, in our April issue,
rs of tests which we had carried
e No. 7," and that we undertook
the results. It may be
fly the conditions

Correction

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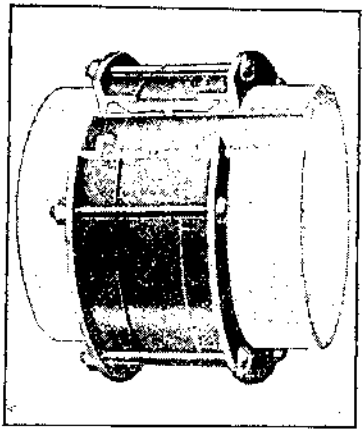
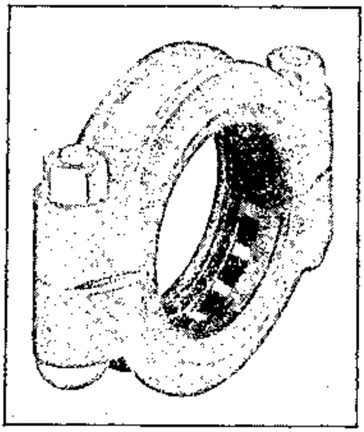
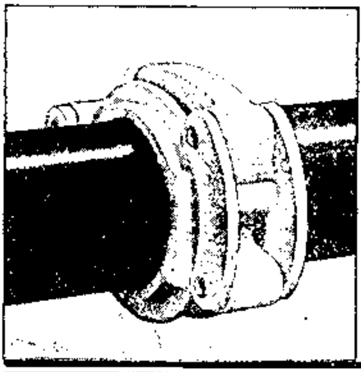
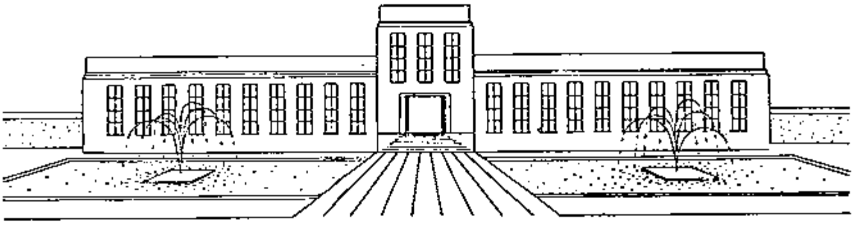
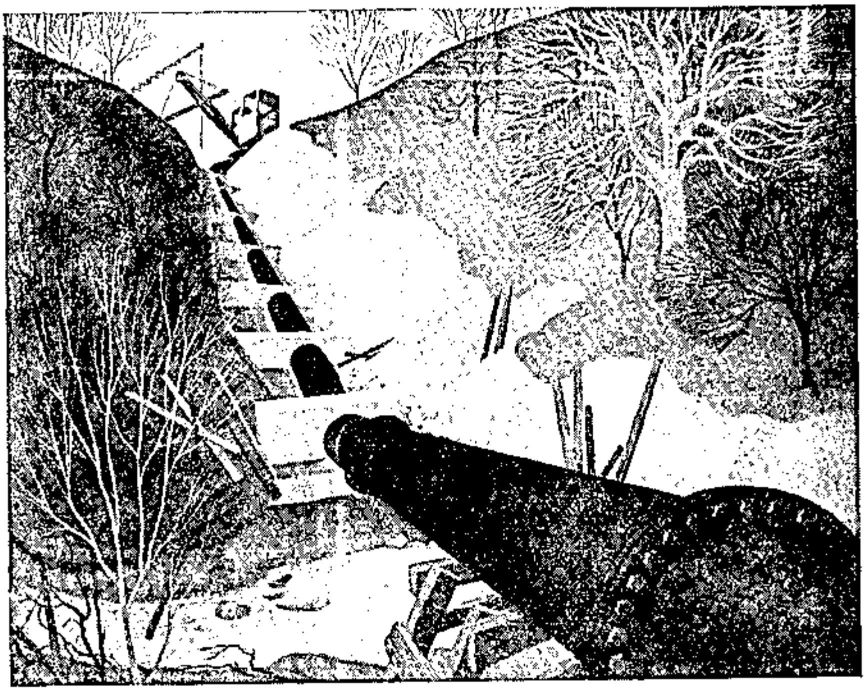
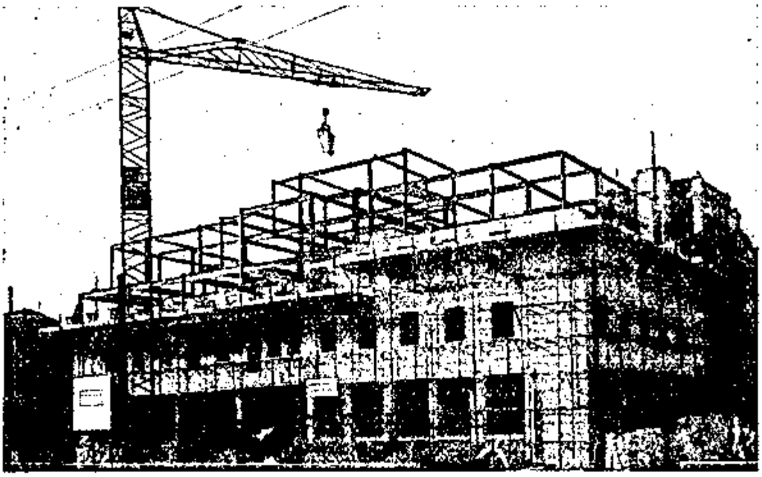




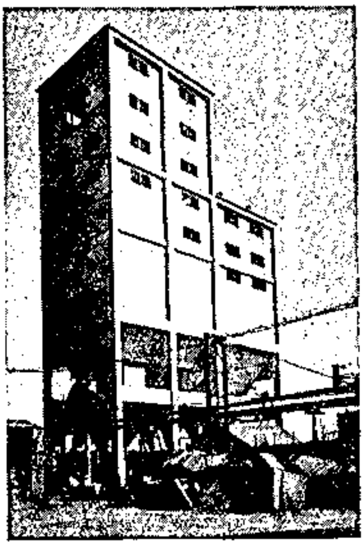




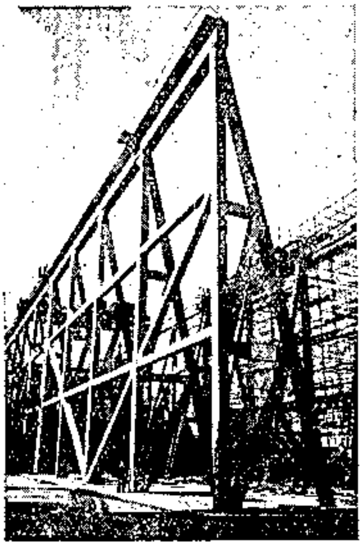




Queen Victoria Seamen's Rest—London, E.14



Reinforced Concrete Bunker, 105 ft. high, for South-Eastern Gas Board, Wandsworth Works



Reinforced Concrete Gantry, 71 ft. high, for South-Eastern Gas Board, Wandsworth Works

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SEPTEMBER, 1953

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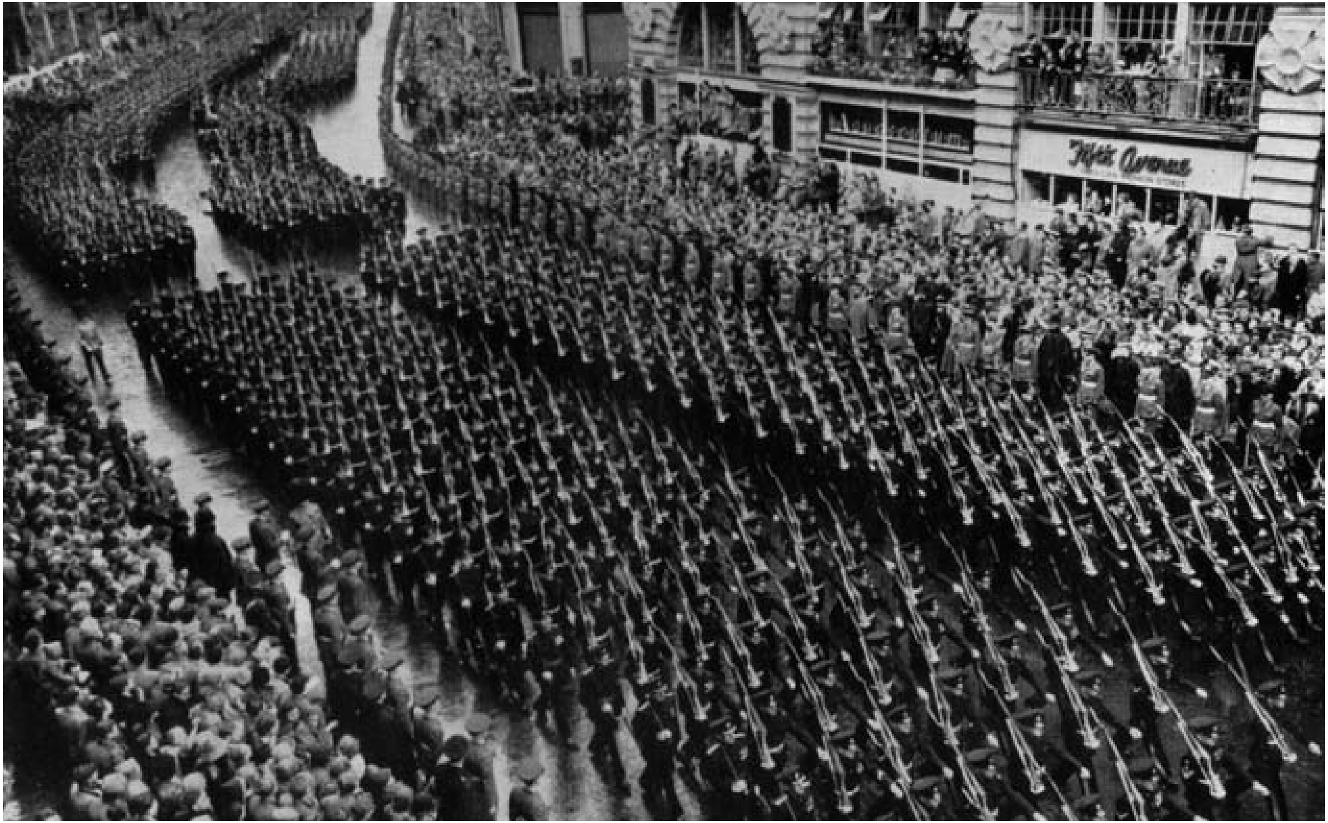


Coronation Day, 2nd June 1953

R.E. IN THE MONTEBELLO TRIAL, 1952

By LIEUTENANT-COLONEL A. P. SMITH, O.B.E., R.E.

INTRODUCTION

THE Corps was represented in the 1952 trial of the British atomic weapon in the Montebello Islands, N.W. Australia, by 180 Engineer Regiment. This article gives a general account of their activities. Security limits the information which may be published on the scale of the trial and the engineer effort involved. On the nature of atomic weapons, the general reader must be content with the pamphlet *Protection against Atomic Weapons 1952*.

The trial was organized as a naval operation under the command of a Flag Officer. A strong team of Ministry of Supply scientists under a technical director ran the technical side. R.E. were responsible for designing, planning, provisioning and carrying out the whole of the civil engineering works. We had some small but important assistance from a detachment of 5 Airfield Construction Squadron, R.A.A.F. The trial fell into the following periods: Preparation in the U.K. from June, 1951, to January, 1952; Phase I—the voyage to the islands of 180 Engineer Regiment, and the construction work; Phase II—the scientific preparations on site in August and September, ending with the explosion on 3rd October, 1952; Phase III—the recovery of records and salvage. In this article space does not allow description of the work of R.N., R.M. and R.A.N. in our support or of the very close and friendly relations which we had with them and with the scientists.

O.C. 180 Engineer Regiment was C.R.E. to the Flag Officer, Special Squadron for twenty months and the regiment was under naval command for a year. This may be the first occasion, since Major de Grey surveyed the coast of N.W. Australia in 1830, that an army unit has been under direct naval command for so long and it was the first time that R.E. had operated in West Australia since the early colonial days.

PREPARING THE EXPEDITION

The following principal works were required to provide the facilities needed by the scientists :—

A main base building of 1,800 f.s.

A number of R.C. pillboxes to house cameras, recording and telemetry apparatus.

Many concrete instrument foundations.

A group of R.C. pillboxes for Ministry of Works.

Several towers for cameras and aerials; many wireless masts.

Several light personnel piers for launches to come alongside.

Several miles of cable laying ashore.

Many instrument and marker stakes.

Fifteen miles of light roadway.

Hards on beaches, and stores dispersal areas of P.S.P.

Nissen huts for stores, generator houses, workshops, messes and canteens.

Three tented camps of about troop size to T.A. summer scales.

Some football and hockey grounds.

Three bathing enclosures, safe from shark and sting ray.

The requirements of the main works were clear when the C.R.E. was posted in May, 1951, but the R.E. project underwent continual growth even up to the date of sailing in February, 1952. About one half of the final engineer effort was spent on works which were only sketchily foreseen in May, when the firm plans for naval and R.E. organization were made. H.Q. R.E. was located in the same compound as the technical director and the principal scientific teams. This paid handsome dividends in liaison, since the first technical duty for the R.E. was to specify and then to design the works. The limitations of time, supply, tonnage lift, transport, plant and manpower had to be kept firmly in mind. Specifications, designs, and scales of accommodation had to be worked out from first principles. Estimates had to be prepared in terms of man-hours, plant-hours, and tons of stores, very early in the project. Planning time was very short, particularly in relation to the difficulties of supply of stores.

Many technical problems had to be solved. Preliminary study of the U.S. book *Effects of Atomic Weapons* indicated that, except in the blast wave of a nominal atomic bomb, it would be difficult to get precise estimates. Even blast wave pressure, however, is not easy to relate to a simple " EUDDL " ; the pressure wave at a point has a short but definite duration, variable with range, and it is only at its peak value for a few milli- or micro-seconds. At normal incidence the wave pressure is increased by reflection from twice to eight times, depending on range. It also varies considerably if incidence is oblique ; 50–70 deg. is the most unfavourable angle. A pitched roof, therefore, may be a grave danger. The shock wave pressure rises to its peak value almost instantaneously and forms an impulsive load. Structures should have a period of oscillation substantially different from that of peak pressure to peak suction. There were few reliable data on ground accelerations and displacements, and we had ugly visions of towers subjected to a horizontal acceleration at the base, as the blast wave hit a cabin at the top. Wind drag adds important loads at short ranges. Thermal effects have to be remembered and shielding provided against radiation. Much theoretical and empirical work remains to be done so that scientific data can be reduced to engineering codes of practice. As a result of this a technical decision can then be made of the distance within which protection would involve prohibitive effort.

In May a decision was reached on the main types of construction to be used. Tubular steel (not aluminium) scaffolding was chosen for towers, light piers, instrument stakes, and general purposes because of its flexibility in use and design, its likely availability and its small bulk compared with prefabricated steelwork. Towers and masts were designed to be liberally guyed. A check was made of shear strength across the legs, but their real strength lay in the fact that the shock wave would flow round the tubes. There were to be no closed cabins on the towers and rigidity for photographic purposes would be ensured by ample diagonal bracing. Prefabricated, precast concrete structures were ruled out because of shipping weight, bulk, and the likelihood of damage in transit. Structural steel frameworks, with cladding of heavy gauge C.G.I. or light steel troughing, were considered economical in weight, for incident pressures up to 1 lb./sq. in. Above that it seemed that the purlins and framework would become too heavy and complicated. Construction would be quick. This type of construction was, therefore, selected for the main base, although American reports of experience at Nagasaki were not encouraging and it was realized that design and supply would be difficult in the time. This left " cast *in situ* concrete " for the nearer solid structures. R.C. would be economical in shipping tons, and its disadvantages of slow construction and difficulties in production of aggregate and in training of men were accepted. P.B.S. and S.M.T. were available as track-making expedients. R.A.A.F. later produced P.S.P. for hards on beaches and stores dispersal areas. Nissen huts were selected for all temporary buildings, such as stores, generator houses and canteens, not required to be blast proof. Living accommodation on shore would be tents. Anderson shelters on a concrete base were used to house instruments at one minor and distant site ; they were quite satisfactory except for the difficulty of dust proofing. Sandbagging of light structures is an expedient, strongly advocated by the non-engineer, but rejected by H.Q. R.E. for this trial as quite incalculable, although its use is worthy of further investigation for Civil Defence purposes. A type of foundation, used in default of concrete for which our capacity was limited, was a structural steel box dug down and filled with sand. Several of these were designed and built, and were successful. All the main instrument foundations were of normal mass concrete ; some of the closer instruments were fixed on piled foundations (using scaffold tubes and Drivall) with a heavy concrete cap, in order to carry the high overturning moment of wind drag and shock wave.

D.F.W's. branch undertook the detailed design of the main base in structural steel and of the reinforced concrete pill-boxes. In both cases, the shock wave loadings (increased by the reflection factor where applicable) were doubled to allow for the impulsive nature of the load. The members and reinforcing steel were then designed to be stressed to the yield point ; this was considered legitimate because of the short duration of peak and total pressure. Draughtsmen were lent to D.F.W. by H.Q. R.E. for the detailing of these designs. The design officer and draughtsmen of H.Q. R.E. were kept very busy with preliminary and minor designs. Many maps and plans were handled and the number of prints taken was high. The draughtsmen took off all the quantities from their own designs.

A full schedule of R.E. works was included in Flag Officer Special Squadron's (F.O.S.S.) Trial Orders. These were amplified by C.R.E's. Works Instructions, Programme and Progress Chart, and by the drawings. Stores lists showed the planned end use of the stores ordered. Planning time and staff in H.Q. R.E. were short and the task estimates on which the programme was based, were not prepared sufficiently early or in enough detail to be of great help to regimental officers. An extra officer and a Clerk of Works (Construction) would have been an advantage in H.Q. R.E. The programme showed that there would be little margin in Phase I of the R.E. project. The only safety factors were the possibility of help from R.N., and the fact that some works scheduled for Phase I could be completed in Phase II, whilst the rest were being fitted with instruments, thus causing little over-all delay in scientific preparation.

Two recces of the islands were made. The first was done by a senior scientist and a naval hydrographer to decide the general suitability of the Montebello Islands for the trial. The report and outline scheme based on this was a masterpiece of judgement ; it needed no important alteration and indicated correctly all the engineering difficulties. The C.R.E. visited the islands with a scientist and D.D. Works and Buildings R.A.A.F. for three weeks, during a detailed hydrographic survey by R.A.N. After this it was possible to plan in detail the minor scientific works, the temporary works for R.E. and staff purposes, and assistance by R.A.A.F. on tracks, hards on beaches, and dispersal areas. The latter were completed before Phase I reached the islands and gave us a flying start which was vital to the success of our task. Much engineer planning and design had to be done before the C.R.E. came back with his report and the accuracy on engineer matters of the first scientific report was a great help. A 1/10,000 map of the islands had been made from air photos with no ground control and was remarkably accurate, in spite of some distortion and scale error. Good vertical, oblique and ground photographs of the islands were available.

The general organization of the trial was fixed by April, 1951, with minor changes after the C.R.E. joined in May. Phase I was to consist of two L.S.T. which were to carry the regiment and our stores (see Photo 2). Royal Marines were to form part of the crews and were to operate L.C.Ms. and L.C.As. for moving personnel and stores about the lagoon and islands. The L.S.T. were to be used as floating hotels for the troops, except that there was to be a detached camp for the troops working on the main base, which was somewhat isolated from the anchorage. Fifteen weeks were allowed for the working period of Phase I, and this was to include a fortnight when ships in turn went to Freemantle to refuel and grant leave. Any excess of engineer stores over the capacity of Phase I ships was to be shipped to Freemantle in advance and brought up to the islands under local arrangements. H.M.S. *Campania* and another L.S.T. were to bring out the scientists for Phase II.

180 Engineer Regiment was raised in August, 1951 ; the establishment was tailor-made to fit the tasks foreseen in June, and the accommodation in the ships. A feature of the establishment was the high number of warrant officers and staff sergeants. These experienced men proved invaluable and two Clerks of Works (Construction) should also have been asked for to help in planning, in training the men and, on site, in supervising or controlling isolated works. We were always short of officers. Two had to be employed, in turn, during planning, for detailed work in H.Q. R.E. to the detriment of training. No subalterns were allowed in troops ; they would have been a great help on the work and would have got good experience. Most officers had to undertake a dual rôle—for instance the Plant Troop Commander was also C.R.E's. E. and M. Officer.

The legal position of the troops was curious. Acts and Regulations do not seem to cover the command and administration at unit level and for a long time, of army by navy. During passages, the troops came under the Naval Discipline Act. The captain of a ship had summary powers up to forty-two days' detention or imprisonment ; minor punishments could be given by the O.C. Troops on board. Whilst the expedition was at anchor in the Montebellos, the army was reverted to the Army Act and the Regimental Commander had the normal powers of a C.O. The regiment was placed under G.H.Q. FARELF for disciplinary purposes, should a court-martial case arise. There are no detention barracks in West Australia and complications would have arisen had there been a court-martial case or a case meriting a long summary sentence. Fortunately, the standard of discipline was very high.

The regiment was raised at Crickhowell and moved to Longmoor in October, 1951, to train and to assemble the project stores. For this an unused sub-depot of the E.S.D. was borrowed. R.E. Records did us well. Tradesmen were found to cover the establishment, except in concretors, steel benders, and quarrymen, of which the Corps seemed very short. We got one concretor—unfortunately also an expert batman, one very experienced steel bender, and two miners with knowledge of quarry work. There was only one good welder. Carpenters were poor. They had little real knowledge of shuttering and did not reach the same high standard as the concrete gang whom we taught from scratch. Other trades were good. The signallers fully kept up their end of a combined service net with R.N. and R.M. R.E.M.E. craftsmen of the attached R.E.M.E. Workshops were excellent. The average age of the whole regiment was 23. Nine out of ten O.R.s were regulars, because N.S. men who joined in August, 1951, would not have had enough service in hand to see the whole expedition through. No one in the squadron had much experience of works by troop labour. An ambitious training programme was organized to correct this and to cover the types of work expected. This did a great deal of good, but less was achieved than had been hoped. Shortage of officers, the wettest November on record, and the continual need for fatigue parties in the stores depot were obstacles to training. Concrete training in particular, produced chiefly a good crop of lessons in what not to do, because of inexperience of N.C.Os. The stores fatigues gave good training in handling stores with plant, and many N.C.Os. and men became familiar with our stores and their marking. The morale of the troops was very high from beginning to end and was the biggest single factor in the success of the regiment.

The engineer project had to be planned on the basis that the regiment would take with it from the U.K. its full requirement for a year of every commodity except food, welding gases and P.O.L. These were to be supplied by R.N. Accurate estimates for the latter had to be put in. There was to be no logistic support to R.E. from Australia, but a rear link was arranged to Chief Engineer FARELF for supply of stores. In the event, the aim was nearly achieved and only very small quantities of stores were obtained in Freemantle by local purchase, through naval stores or from Singapore. This condition that the engineer project was to be based on the U.K. gave rise to much anxious and surprisingly accurate forecasting of consumption. Few consumable stores were left unused by the end of Phase II. The difficulty and uncertainty of shipping up to the islands any stores which could not be carried in Phase I ships made us prune our estimates very close and in general we had too few reserves of stores available at call.

180 Engineer Regiment was in the nature of a private army. A War Office " acquaint " (to use a naval term) issued by D.S.D., on the object of the expedition and asking addressees to help us,

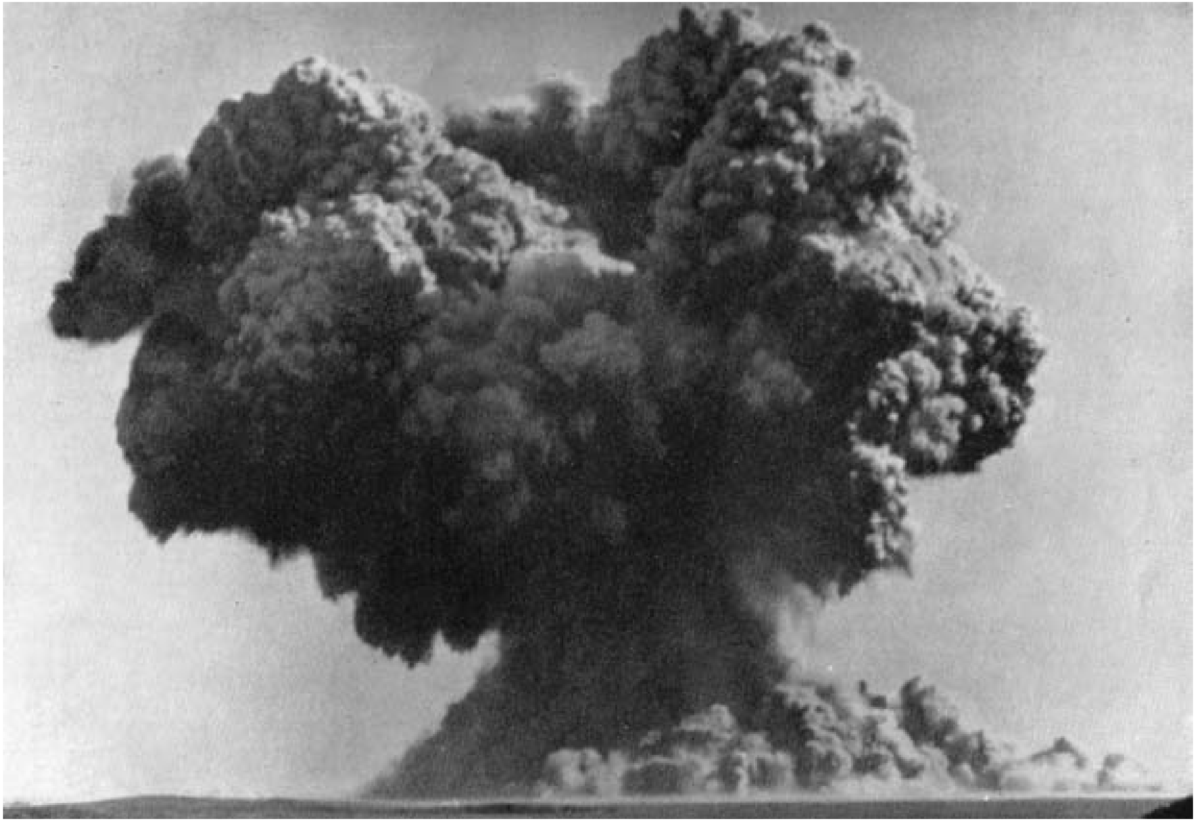
provided a magic key to priorities within the War Office. Equipment tables were approved in August, and supply began in September. The main demand for engineer stores was placed in September, with three later subsidiary bids—chiefly for stores of Ordnance origin. Supply was substantially complete by early December, although some items were delivered by the makers up to the day before sailing in February, and several hundredweight of spares for machinery and plant were shipped to Freemantle between March and May. The process of specification and design went on until December, concurrently with the ordering of stores. Indents had often to be based on approximate quantities off partially complete drawings, whilst later designs had to take careful note of what had been ordered. R.E.V.S. proved comprehensive, accurate, and easy to use. The inclusion in it of engineer stores of Ordnance origin was invaluable. Other scales and vocabularies proved hard to obtain. F.E.I. had to do much direct personal liaison to find out what was available, to earmark it and to determine a scale of spares or maintenance stocks. This involved many dealings with various War Office directorates, branches and depots and with supply branches or officers of Admiralty, Air Ministry, Ministry of Supply and with civilian manufacturers. Much of this was entirely " Q " staff work, but no other method would have obtained the stores in time. When indenting, we used a form of our own devising, with extra columns to record the end use of each item and the weight and shipping dimensions of the case containing it. The service depots did us well in supplying all stores packed for long sea voyage.

Shipping plans, consisting of a detailed manifest, drawings of the holds divided into thirty cargo blocks, and priority lists for tactical loading were prepared in October and November. They worked very smoothly. Hold cargo was loaded at 8 tons/hour and deck cargo at 10 tons/hour. The ships were discharged using L.C.M. and L.C.A. as lighters at 6 tons/hour. 17 Port Regiment gave us much valuable and skilled assistance at Marchwood, where the L.S.T. were loaded. In the whole expedition we learnt much about the handling of stores and cargo.

PHASE I, THE R.E. PROJECT

We sailed on 19th February and reached the Montebellos in the last week of April. This gave us fifteen weeks to complete the R.E. works project before H.M.S. *Campania* was to arrive in early August bringing the scientists for Phase II. During Phase I, L.S.T. were to steam in turn to refuel at Freemantle and be away a fortnight. If possible, the Sappers were to go with their ships for a spell in civilization.

The Montebellos are a group of desert islands about sixty miles off the N.W. coast of Australia and just in the tropics. There is no natural fresh water and the expedition relied on ships' distillers. The islands consist of more or less stabilized sand dunes on outcrops of limestone. Both stone and sand appear to have been formed in conjunction with coral ; the lower strata of rock are hard and give a fair quality of rather flaky and angular aggregate ; the sand is fine, particularly in the dunes. The ground is covered—except on shifting sand dunes—with grass or low scrub. The rocky outcrops carry much spinifex, a spiky cactus-like grass, which grows in great clumps up to waist height ; it is somewhat oily and burns fiercely. There are no trees except for some small patches of snake wood and, on some beaches, of rather stunted mangrove. A scanty rainfall occurs chiefly in the cyclone season in January and February. We had one day's rain in May and two in July. The climate and working conditions were pleasant. The nights were cool and the maximum shade temperature by day about ninety ; there was usually a cool dry southerly wind, often quite strong. All the islands had frequent and most attractive beaches of white coral sand ; the cliffs and rock outcrops were pinkish ; the vegetation a dull green. One group of islands is the home of a Japanese black rat and another of a most elusive tribe of cats ; both are survivors from shipwrecks in the past and have exterminated the wallabies. The sea is full of game fish, sharks and sting rays ; bathing was forbidden except in netted enclosures provided by us. In the spring, whales visit the islands and turtles breed freely. Flies were troublesome and needed strict sanitary control. There are no mosquitoes, sand flies or snakes, but lizards abound. The island has only been inhabited by pearlers as a cyclone anchorage. The lagoon outside the L.S.T. anchorage was somewhat obstructed by coral heads, but by working the tide, L.C.M. and L.C.A. found no difficulty in reaching any island where it was necessary to land men or stores. The going on land was better than we had expected. Land-rovers with 7.50 tyres could travel almost anywhere and make a good 10 m.p.h. Graded tracks were passable to four-wheel drive 3-tonners and only needed surfacing with P.B.S. or S.M.T. for half their length. A 25 m.p.h. speed limit had to be imposed. We had designed and provided 3- and 5-ton sledges to be towed by bulldozers, for hauling aggregate and the larger pieces of plant and equipment (see Photo 7). These were vital to success unless a much more ambitious programme of road construction had been carried out. The mail service was very good. A twice-weekly cinema was the chief recreation. The Sappers could not make much use of the canteens or hockey and football grounds ashore because of long hours and week-end work, but these were popular with R.N. whose duties kept them afloat. The Montebellos were no earthly paradise, but there are many worse places and



RE in the montebello trial, 1952 1

Photo 2.—Deck cargo on L.S.T.

Photo 3.—Personnel pier and landing craft.

RE in the montebello trial, 1952 2,3

Photo 4.—Camps under construction.

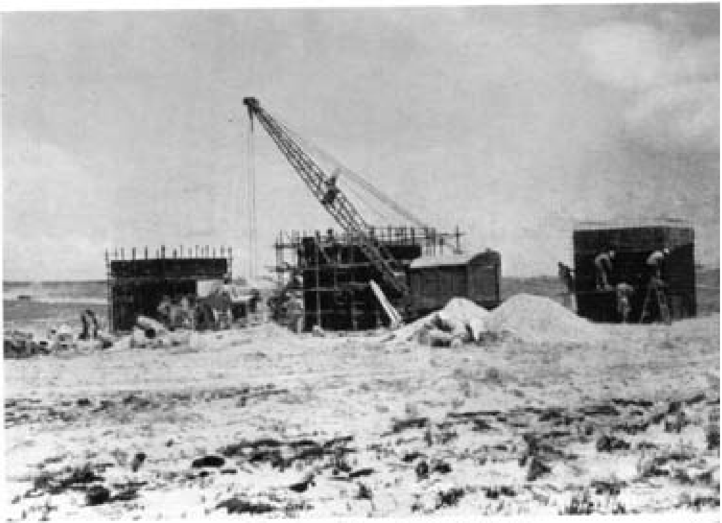


Photo 5.—Concrete construction.

RE in the montebello trial, 1952 4,5

Photo 6.—Rock crushing plant.

Photo 7.—19 R.B. crane showing repairs to jib in light colour. This photo also shows a bulldozer and sledge and some Nissen huts in course of construction.

RE in the montebello trial, 1952 6 , 7

stations. In spite of good meals and washing facilities, L.S.T. are crowded and uncomfortable as one's home. Hard work and the interest of a pioneer job kept discipline and morale at a high level, but we were heartily glad to see civilization in November. The sailors' chorus from *South Pacific* should have been our regimental march.

On arrival in the islands, the testing time of our planning, training and organization began. We knew from the start that we were to be tight for men, stores and time. The programme and progress chart was a hard taskmaster. We had arrived three days late because of bad weather and cargo handling in Freemantle. Unloading the ships went very well, with great keenness and long hours. Quarrying, rock crushing and foundations of the main buildings were slow in getting started. A six-day week was regularly worked and a Sunday shift was often necessary for parties that were behind. The lag on programme was seven days at the end of the fifth week and still the same at the end of the twelfth. But, by the end of the sixth, N.C.O's. had so much improved in knowledge and in organizing power, that this lag seemed certain to be recoverable and that the C.R.E. could let the Sappers go with their ships to refuel between the eighth and twelfth weeks. After leave came a big spurt, with valuable extra working parties from the Navy, Marines and R.A.A.F. The project was substantially finished when Phase II arrived a few days ahead of programme.

Over-all policy in Phase I was announced at a weekly conference held by the naval commander. R.E. policy was decided at C.R.E's. " O " Group. In general it was found that no important alteration to the allocation of men, transport, plant and craft could be made at less than forty-eight hours' notice ; sixty hours' was better. Details of the employment of landing craft were decided by R.M.O. and F.E.I. or an officer detailed by him.

A small R.E.M.E. Workshop, under a very experienced O.C. and W.O.II, answered directly to H.Q. R.E. It worked in very close conjunction with the Plant Troop and held the spares for all machinery and plant.

Among their triumphs were a considerable repair to the jib of 19 R.B. crane (see Photo 7) ; a welded half-shaft for a Chaseside crane ; a phosphor-bronze thrust race for a D4 clutch to replace a damaged ball-race ; and a number of naval repairs. At slack periods, they often carried out field engineering. This small unit was a great success and a very valuable part of 180 Engineer Regiment. The small R.A.A.F. detachment, with some construction plant, were with us for most of Phases I and II, after having given us a flying start. They were a most useful reinforcement.

The working area was very scattered over many islands and particularly in terms of travel time. Two hours north to south, and one hour east to west, by rover and landing craft, was the measure of the area. A helicopter would have been a great help to supervision. Craft run by Royal Marines gave us excellent service, but there were not quite enough of them and we needed unit boats in the same way as unit transport supplements M.T. from R.A.S.C. Stormboats with extra buoyancy tanks would have been suitable. The time consumed in getting to and fro between ships a few cables apart in an anchorage is considerable.

It had been decided in planning that only one troop should camp ashore, because this would save the stores and time needed for other camps. In retrospect, this decision was a mistake. Sappers are land animals and more comfortable ashore. From a camp it is easier to work overtime and to make evening recces or hold discussions on the site. Games and visits to the canteen can be more easily fitted in, for it is against human nature to play a game immediately after a long day's work or to go back on shore after once returning to a base ship. A tedious evening trip home by water bus, calling at several islands, all in sight of the base ship, would have been avoided.

In the planning stage, considerable doubts had been cast on the possibility of producing good concrete in the Montebellos ; the rock was poor and the sand was not sand at all but carbonates of calcium and magnesium. There was no good shingle. The C.R.E. flew half a ton of samples back to Melbourne from his recce and got a laboratory report confirming his opinion that field grade concrete would be possible. His twenty little sacks of " mineral samples " should have aided the cover plans of the recce, if they did not start an actual gold rush. The programme of concrete construction was about one-third of our total effort. We had to quarry and crush our own stone (see Photo 6), design our mixes and train field engineers to do the work. Sea water and rapid hardening cement were used. A cube testing machine was taken and crushing strengths up to British Standard were obtained from an unsuitable aggregate. Getting sufficient output from a quarry and crushing set-up was a big difficulty and we learnt a lot about the economical arrangement of plant. The crusher-run aggregate was flaky, angular and rather ill-graded, but just within the standard grading curves. It gave a very harsh mix, difficult to compact even with vibrators, if the dangers of segregation or of excessive cement content were to be avoided. The handling of aggregate and of mixed concrete was mechanized by the use of 19 R.B. cranes with grabs and skips. By the end of Phase I, officers, N.C.Os. and men had lost their fear of the difficulty of high-grade concrete work and output had greatly increased. The work had much in common with a programme of pillbox construction for defence. In rock crushing, output began at 18 man-hours per cu. yd. and reached 7.7 in our third set-up.

Concrete output varied from 30 to 43 man-hours per cu. yd.; these figures include transport of sand and aggregate from the quarries but not the crushing and quarrying; the lowest figure was obtained on a concentrated site reasonably near the quarries and towards the end of the job, when the gangs were fully trained.

No difficulty was found by the Tn. trained steel erecters and riggers in putting up the steel structures or in finishing the main base building. Tubular scaffolding was very successful in the towers and personnel piers. The latter were designed for launches and L.C.A., and stood up to their work remarkably well, but many had to be sited across the run of tide or sea; these were difficult to approach in single screw launches and were themselves liable to damage if L.C.M. were brought alongside in a rough sea. The guyed towers gave very stable camera platforms. P.S.P. was an effective expedient for hards on beaches and was in good condition after six months' heavy use. There are a few points in its use for this purpose. The hard should be reasonably wide; 100 ft. was adequate. The edge planks should be bent down and dug in. It is useless to grade the beach to an even slope as it will soon resume its natural contour, burying the hard. On fine sand, L.C.M., unbeaching by going astern at full throttle, tend to scour large holes under the planking. These do not refill on the next high tide and there is danger of the planking breaking up and holing craft. A P.S.P. hard on sand should, therefore, only be extended so far down the beach that it is accessible in each tide for maintenance.

Nissen huts were very quick to erect and very suitable. For many we laid a floor of P.B.S., instead of concrete. Double fly 160-lb. tents were good for living accommodation, but British marquees are single fly and are hot for messes or canteens. Australian Forces seem never to move a man without refrigeration at 1 cu. ft. per man in forward areas and 4 cu. ft. in base areas. This simplifies supply of fresh rations and is a valuable amenity in the tropics or in any conditions where daily supply is liable to interruption.

Our scale of plant and transport worked out about right. In the time available in 1951, we had to take what we could get and there was too much diversity of type. All vehicles should have been four-wheel drive and all 3-ton tippers. Land Rovers stood up to their work well. A crane boom attachment would have been an advantage on all bulldozers. 19 R.B. and Chaseside cranes did well; the latter had not quite good enough performance on soft tracks. The 1-ton Coles crane was very useful, but lacked cross-country performance, reach and lift. A Le Tourneau crane did valuable work. Our rock crushers were too small and heavier plant could, in fact, have been moved and installed without undue difficulty, although it was convenient that all our equipment could be lifted by 19 R.B. We took cranes, draglines, back actors and skimmers for all our 19 R.B. and never used the three latter; we needed more grabs than we took and could have used a shovel to advantage. Our simple sledges—a curved sheet of $\frac{3}{16}$ in. M.S. plate, with edge stiffening angles and side and tail boards—were most successful. More beehives should have been used for levelling and digging foundations in rock. The rule that borehole charges shall be fired by cordtex, not by detonators, is expensive in cordtex for quarry work. Our cement was rapid hardening in barrel. It set well with sea water and very little was spoiled, although barrels were roughly handled. Some ordinary cement in bags went off in the humid conditions in the hold of L.S.T. Our reinforcing steel was bent by the suppliers. Several hundred man-hours were needed to sort and rebend it after the inevitable damage in shipment. Even so this paid. To cut and bend this much steel from rod would have taken longer and we were short of steel benders. 14 S.W.G. binding wire was supplied in U.K. in lieu of 16 gauge demanded; it was far too stiff and had to be replaced by local purchase.

Weekly "sitreps" were made to "FOSS," assessing progress in terms of percentage completion of the items of the schedule in trial orders and of days' lag on the C.R.E's. programme. These had given a pessimistic impression in H.M.S. *Campania* and all in Phase II were pleasantly surprised at the state of completion on their arrival, at the quantity of work done and at the appearance and quality of the actual structures which had been hard to visualize from schedules and drawings. Even more warming to all of us in Phase I was the keenness, energy and remarkable speed with which the scientists got their equipment into action. This was the best possible reward to our men for their efforts in the long grind of the R.E. project.

PHASES II AND III—ASSISTING THE SCIENTISTS

180 Engineer Regiment had to reorganize and re-deploy for Phase II. Only R.A.A.F. and two sections of R.E. remained under full R.E. control. The remaining troops were turned over to providing services or working parties for the scientists. The officers had to take on a new attitude of mind. From having been engineering consultants and contractors for a distant client and responsible only for finished results, we became a firm of jobbing builders; labour contractors; power and light suppliers; and bus and transport operators. Troop Commanders changed military status from O.I.C. Work to O.C. Working Party. Work was still arduous. We had to juggle our resources to keep pace with the scientists and produce the help they needed. The concrete gangs were busy for the whole of Phase II on more instrument foundations and on the programme of R.C. pillboxes for the Ministry of Works. The men quickly learnt

to be useful laboratory or field assistants. Much simple field engineering was done. Two camps had to be put up on an emergency basis for scientists to live ashore. An important pier was knocked over and had hastily to be repaired. By the end of Phase II, all R.E. transport was working exclusively for scientific teams. Much bulky and delicate equipment was moved to site by lorry and sledge.

There was a big commitment for installing and running generating sets and for battery charging. About half the plant had been brought out, installed, and serviced in Phase I. The rest came in Phase II. In all there were a large number of generators of eight different makes, excluding regimental equipment. The bulk of these were service types and it was difficult to obtain from many of them the degree of reliability and voltage regulation necessary for scientific purposes which was greater than that acceptable in service specifications for field use. Fortunately, not all these sets had to run during the trial itself, and they worked satisfactorily, with only one minor failure which had no very adverse result.

In the latter part of Phase II, backloading of unwanted R.E. and scientific equipment and re-deploying of R.E. plant and transport for " D " day and Phase III produced awkward problems of transport and organization. Clearing the decks for " D " day involved much effort. Fire breaks had to be cut where they had not been made during the construction of roads, cable runs and buildings. There was the danger of missiles arising from rubbish and from structures, not in themselves blast proof, damaging those that were.

In Phase III, R.E. were for the first time, not at full stretch. The recovery of records was done by the scientists. We were only concerned with the salvage and backloading of equipment, transport and plant. A damage survey of R.E. structures was made.

Photo 1 shows the " mushroom "—the culmination of a year or eighteen months' hard work for us, but of many years' effort for the scientists. It was a great privilege to have taken part in so unusual an operation and very satisfying to have done what was asked of us. Throughout demands on effort and on the mental robustness of individuals were continuous and at war tempo.

The project was first-class experience for all ranks and achieved an efficiency of employment of men and plant, comparable with civilian practice in the U.K. The whole expedition, not least 180 Engineer Regiment, had astonishing luck but we felt that it had been deserved.

RECONSTRUCTION OF CHADBURY LOCK

By 2ND LIEUTENANT B. O. BAILEY, B.SC., R.E.

COMPLAINT has been made on several occasions in recent years, that in the United Kingdom the Royal Engineers have few worth-while opportunities to carry out engineering projects of real value in the course of training. Comparisons have been made, showing how much better are the opportunities in the U.S.A. for the Corps of Engineers to carry out useful projects of a kind that give really valuable experience to the officers and soldiers engaged. This article gives an outline of one project carried out in the United Kingdom, which not only gave most valuable training to a number of R.E. officers and men (including some parties of A.E.R.) but also made an important contribution to the programme of the Lower Avon Navigation Trust, which is designed to restore Shakespeare's Avon to its rightful place as a navigable river.

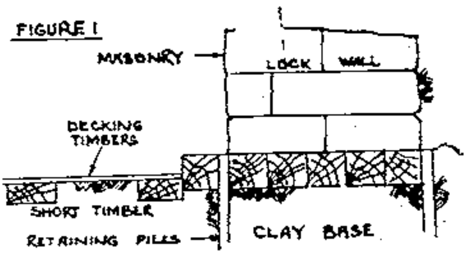
Early in 1952 an approach was made by the Lower Avon Navigation Trust to ascertain whether it would be possible to obtain R.E. assistance for their project to repair Chadbury Lock. The lock was originally constructed about 1750 and was repaired about 1850. By 1952, however, in common with other locks on the River Avon, it had fallen into a serious state of disrepair, and it was clear that extensive repair or complete reconstruction would be necessary to make the lock usuable once more. The lock, about two miles downstream from Evesham, together with a small island, and a weir extending the full width of the river, held back a head of some six feet of water. The lock was in danger of complete failure owing to the state of disintegration that the gates and structure had fallen into after many years of lying idle. The level of the river in the town of Evesham would have dropped about five feet if this had happened, and left a very small muddy stream trickling through picturesque Evesham, whose beauty is its river.

After a thorough reconnaissance the Trust was informed that the R.E. were prepared to dam off and de-water the lock, with a view to ascertaining what repairs and/or reconstruction might be necessary. This offer was gratefully accepted by the Trust, because its funds were strictly limited, and it had many other commitments besides Chadbury Lock. From the Sapper point of view this part of the project (which was all that it was originally intended to carry out) offered good facilities for the use of plant, including driving of sheet piling, and for the use of Bailey bridging for A.E.R. units.

It was on 22nd May, 1952, that work started on the construction of the two dams, consisting of No. 3 Larssen sheet piles between island and meadow, at the two ends of the lock. To form the whole length of the dams it was necessary to drive the farthermost piles from the meadow with the 19 R.B. standing on the island. For this purpose a 40-ft. single-single Bailey bridge was put across the downstream end of the lock to carry the 19 R.B. and piling equipment on to the island. The piles were first driven on the upstream end of the lock and then downstream. (The exact location of the pile dams can be seen on the General Site Plan.) Difficulty was experienced in driving the central piles, for the distance from the banks to these was so great that a vertical blow could not be obtained with the drop hammer. It was thought that to drive these piles with the 19 R.B. standing on the deck of the bridge would overcome this last problem, but it would have required the 19 R.B. to be jacked up by 2 ft. 9 in. to allow the telescopic leaders to clear the girder panels. It was considered that the navvy would not be sufficiently stable when placed so high on the bridge, and the piles were therefore driven entirely from the banks. The result was that the top of the central piles were damaged a little, but the job was very satisfactory—two sound, watertight dams. Then followed three days' work pumping out the lock, made very tedious by large numbers of waterlogged twigs which continually clogged the pumps.

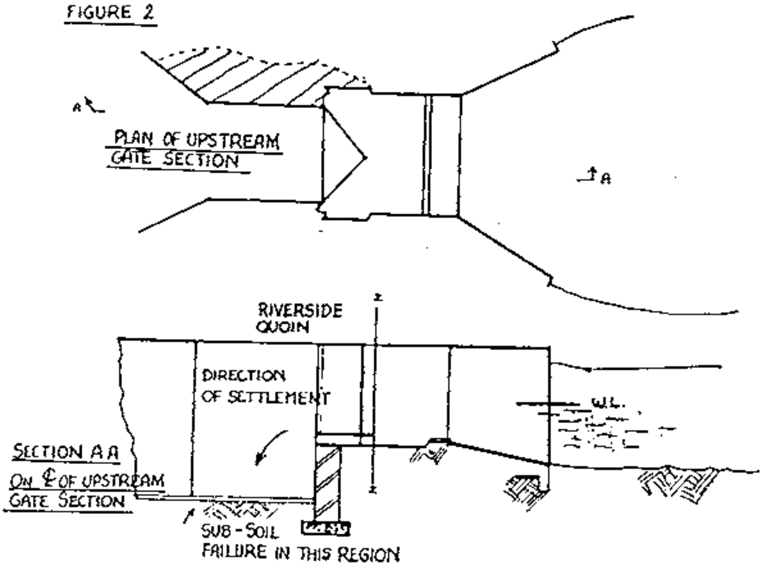
As soon as the lock had been pumped dry, a very careful examination of the structure was made in consultation with the engineers of the Trust. It was immediately obvious that repairs of a major nature were essential. The walls were badly cracked and bulging owing to the fact that tree and shrub roots had penetrated and, as they had grown, had swollen and cracked the brickwork and masonry. This, however, was not the most serious of the defects.

FIGURE I



The original structure seemed to have been built on a system of timber and timber pile foundations, as in Fig. 1. The timber in places had rotted and caused the settlement of the stonework. This had obviously occurred some time ago and the water had penetrated below the original timber flooring. Gradually the cretaceous clay base had been washed out and in its place was left a very unstable river sludge. In parts of the bottom of the old lock the timber base was virtually non-existent and the sludge had penetrated to depths of up to eight or nine feet. This state was fairly general over the whole of the base, the majority of the wall foundation timbers and the timber decking floor having failed, allowing this water penetration. It was of particular interest to see how some timbers, mostly those of greenwood, remained in very good condition, whereas the greater number of the rest was completely rotten.

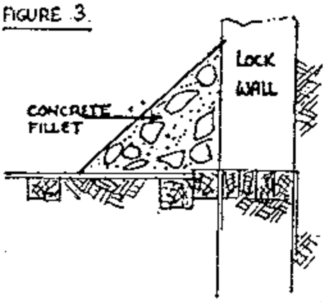
FIGURE 2



The upstream river side quoin showed a most remarkable subsidence. The sub-base had failed due to water penetration and the whole quoin block had sunk. Down the section ZZ Fig. 2, excavation revealed a vertical crack in the ground for the whole depth of the quoin, which had been filled in with earthy material. This had been hidden behind the masonry facing which is assumed to have been part of the repairs carried out around 1850. This crack, the result of the settlement of the quoin block, had been patched up, but the initial cause of the failure had not been remedied.

The failure of the foundation of the walls had necessitated the temporary repair of a fillet placed against the base of the walls in the lock. This fillet consisted of bagged concrete as in Fig. 3. Needless to say the repair was not very successful in stabilizing the walls.

FIGURE 3.



Against the downstream sill, bagged concrete had been placed in very large quantities. The idea of this had been, presumably, to seal a leak which appeared to be coming through behind the gates and quoin. Corrugated sheeting had been placed against the front of the sill and then bagged concrete put in front of the sheets, to try to seal the leak. This had not been successful for a reason that became obvious at a later stage in the demolition.

The downstream land side quoin block was being demolished and the jack hammer sounded hollow as it broke out the masonry. On further investigation, a chamber was found behind the masonry, about four feet in diameter. This chamber started half-way along the lock and ran down behind the walls, to make its exit at several points behind the gate sills and quoin. This was the leak which the corrugated sheeting and bagged concrete had failed to seal. The walls consisted of a 16-in. dressed stone facing, with a thickness of up to two or three feet behind, of mortar stabilized rubble and brick. Much of the mortar, both in the facing and in the rubble mass had become completely porous and no longer effective as a bonding material, in fact, the only force holding the stonework in position was gravity. The demolition of the masonry had to be more extensive than it was at first thought necessary, owing to this defect.

In the end it was found necessary to demolish all four quoin blocks, and the majority of the walls, owing either to failure of the foundations, or to disintegration of the mortar in the masonry.

It was this general state of dilapidation that led the Trusts' engineers to the opinion that the repair of Chadbury Lock would be a lengthy and expensive process. For financial reasons they favoured patching up and repairing the old stonework wherever possible. If the Sappers were prepared to leave the dams and pumps in position for eighteen months or two years, the Trust hoped to carry out repairs using volunteer labour and small contracts ; at the same time they realized that if there were sufficient funds to finance a complete reconstruction, a much more satisfactory and permanent job would result.

The Sapper view was as follows :—

(*a*) It was extremely risky to leave the dams and pumps in position unattended by Sappers for two flood seasons.

(*b*) Complete reconstruction was obviously the right answer and would give excellent experience to all engaged in the work.

(*c*) The project was rather larger than was visualized when we took it on, but if authority from War Office could be obtained quickly, there was a chance of finishing the job before the worst of the winter weather set in.

Accordingly War Office permission was sought for the work to be completed as a training project, and authority was granted on 28th September, 1952.

After the inspection of the old lock, the plans shown in Plates 1, 2 and 3 were produced. The following points of interest on the plans are worth noting.

(i) The old lock was diamond in shape whereas it was decided to build the new one with parallel walls for economy of expense.

(ii) The new structure was to be of monolithic construction with the walls and floor one solid unit. To have made the wall foundations independent would have necessitated greater excavation to the rear of the walls and this was not possible on the island side, where the space between the lock and the river was very limited.

(iii) The method of overcoming the problem of bonding in the new work to the old, is shown in the "Typical Section through Reconstructed Wall." See Plate 3. To do this, 3-in. diameter scaffold tubing was to be driven into the original ground behind the wall, the masonry drilled and bonding bars grouted into the old work. Then both bars and scaffold tube piles were to be cast in concrete to form the foundation for the new wall on top. A very simple and effective method.

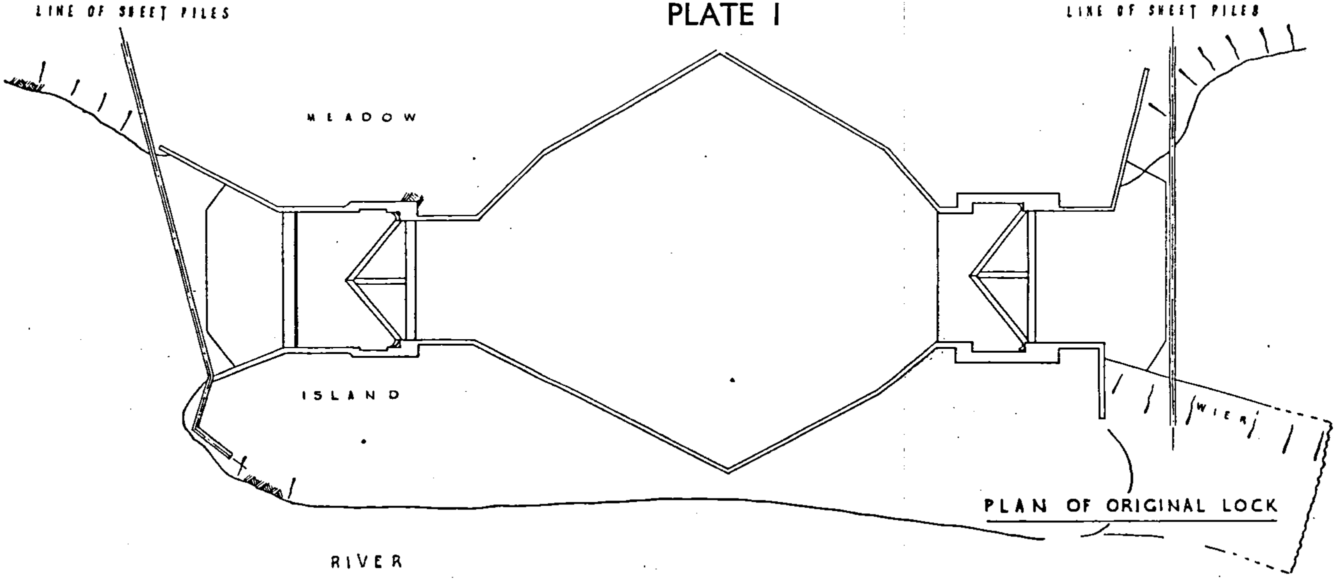
(iv) The walking racks for opening and closing the gates.

(v) The landing stage and steps on the downstream section.

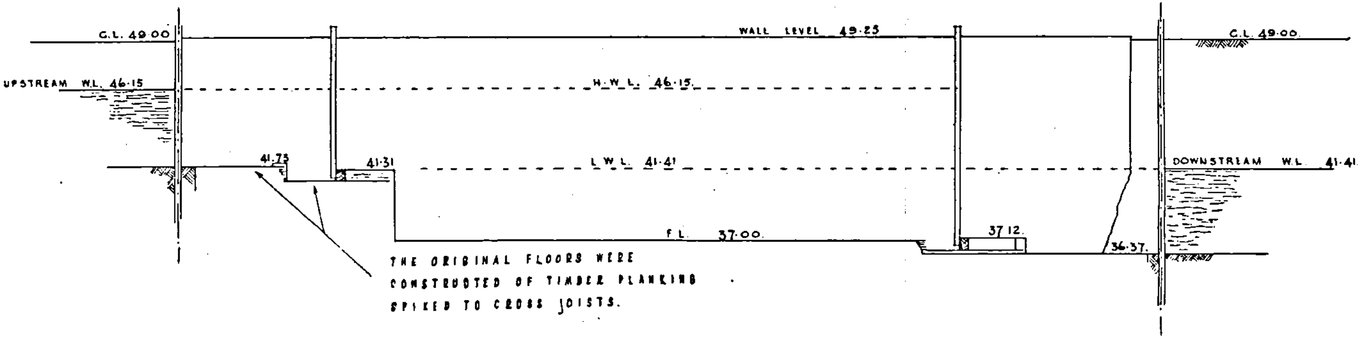
(vi) The provision of deep cut off walls under the floor to prevent water penetration under the lock. This was decided in view of the extremely porous nature of the limestone hardcore used to replace the original sludge in the lock bed.

As soon as the plans were approved by the Trust and authority from War Office was granted, work commenced on stabilizing the bottom of the old lock, and demolishing the unsound masonry. As front-end grab equipment was not available for the 19 R.B. at the time, sludge removal was attempted by means of a drag line where the walls were so badly damaged already that further damage was of no importance. Elsewhere, however, other methods had to be

PLATE I



PLAN OF ORIGINAL LOCK



THE ORIGINAL FLOORS WERE CONSTRUCTED OF TIMBER PLANKING SPIKED TO CROSS JOISTS.

DIAGRAMMATIC ℄ SECTION [ORIGINAL]

PLATE 2

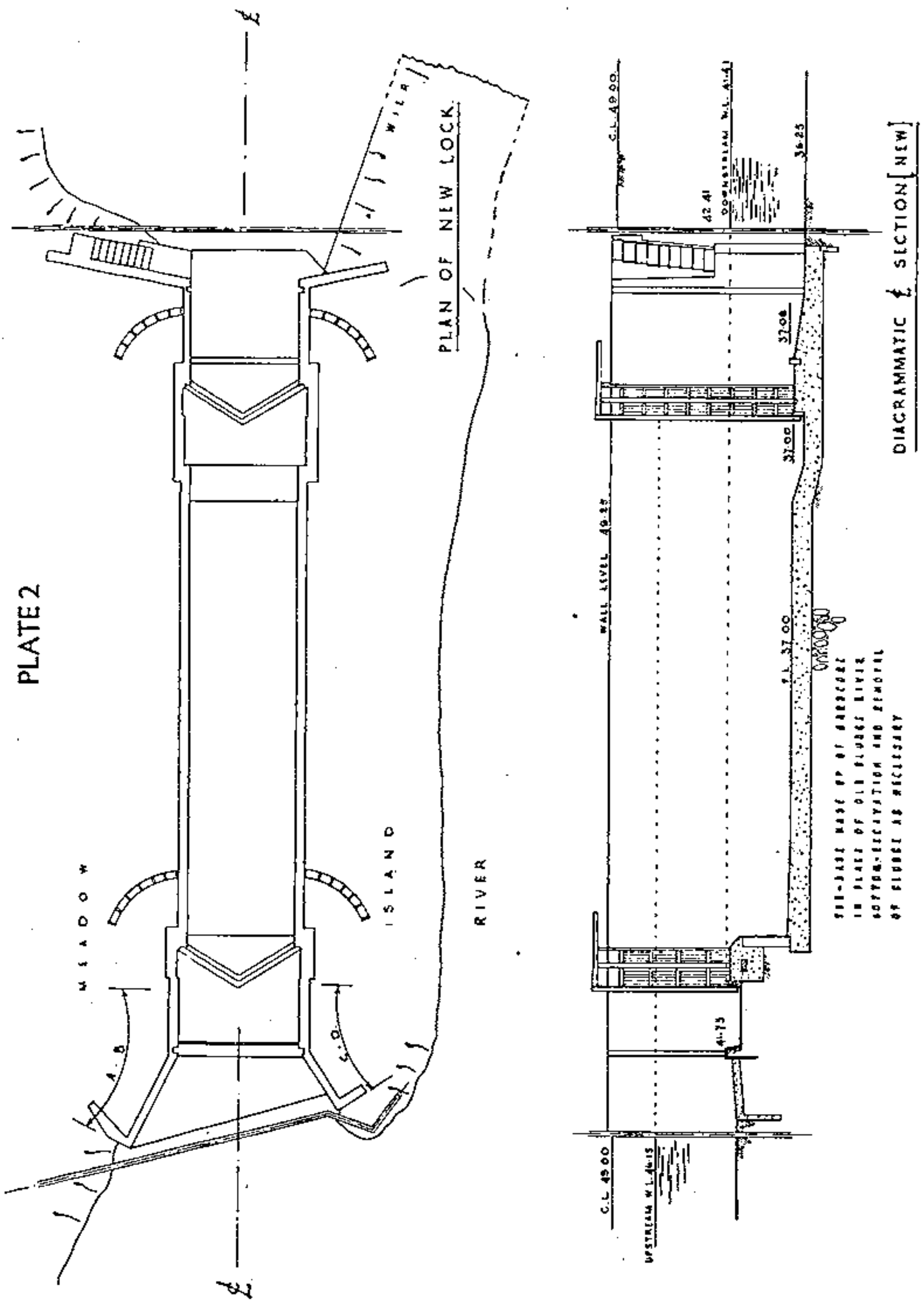
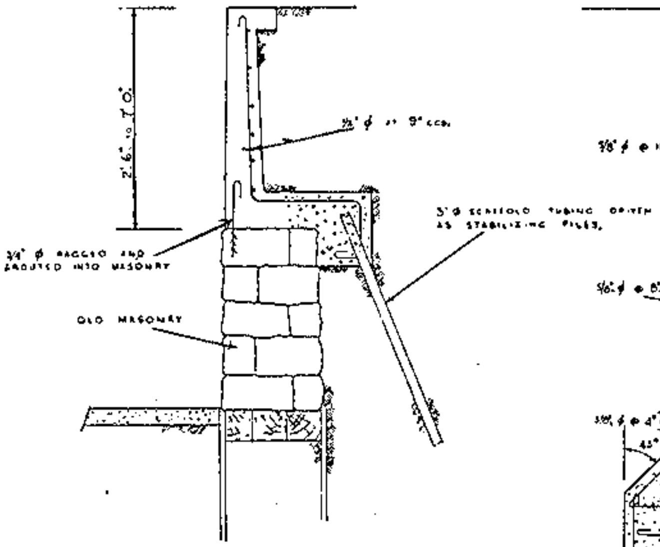
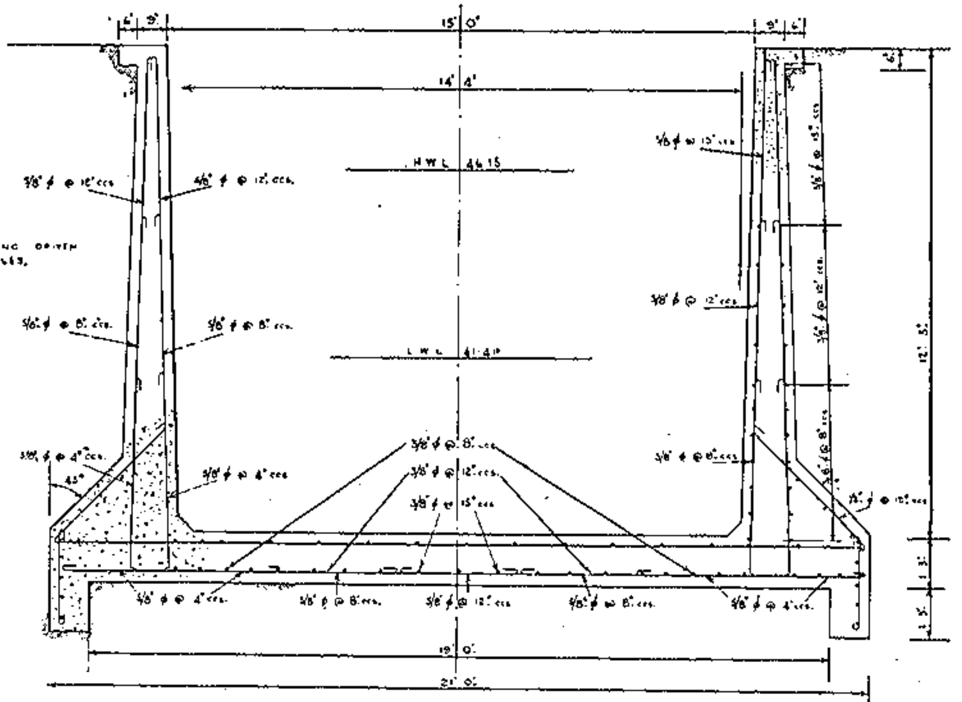

PLAN OF NEW LOCK
MEADOW
ISLAND
RIVER
WIER
A.B
C.D
℄
DIAGRAMMATIC ℄ SECTION [NEW]
C.L 49.00
DOWNSTREAM W.L. 41.41
42.41
36.25
32.08
32.00
WALL LEVEL 49.25
F.L 37.00
SUB-BASE MADE UP OF HARDCORE
IN PLACE OF OLD SLUDGE RIVER
BOTTOM-EXCAVATION AND REMOVAL
OF SLUDGE AS NECESSARY
41.75
C.L 49.00
UPSTREAM W.L. 46.15

PLATE 3



TYPICAL SECTION THROUGH RECONSTRUCTED WALL

CARRIED OUT ON LIMITS A-B & C-D [PLAN OF NEW LOCK]



TYPICAL SECTION THROUGH NEW LOCK

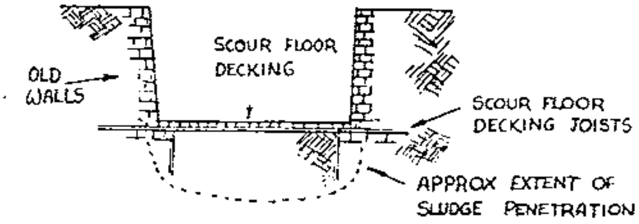
utilized. A trial was made to remove the sludge by washing it out to a large central sump and then pumping it out from there. This was not satisfactory as the waterlogged twigs previously mentioned, blocked the pump.

Hardcore was dumped in the sludge in an attempt to displace it and then to wash and pump it out, the twigs being trapped by the hardcore. This was not satisfactory either. The majority of it was eventually dug by hand, loaded into a skip and taken out with a crane. It was a slow business but finally it was possible to drain the surface and roll it with a small 2½-ton Barford roller. The estimated final bearing capacity of the lock bottom was in the region of 2 tons per sq. ft., which was very good considering the very soft condition that it was in to start with.

Most of the sludge removed was put in the river against the narrowest part of the island, in an attempt to strengthen it. The width of the island at this point was only 6 ft. and as the bottom of the workings were almost 15 ft. below upstream water-level, there were times of considerable anxiety when cracks appeared in the narrow section of the island. It was to allay these fears, that a Bailey bridge was placed across the centre of the old lock and the excavated sludge carried over it in dumpers. The sludge was then tipped off the end of the bridge into the river, against the narrow neck of the island. The last 20 ft. of the bridge was cantilevered out from the bearing and given a small uphill grade by means of launching links, enabling the tipping to be carried out at the exact required position.

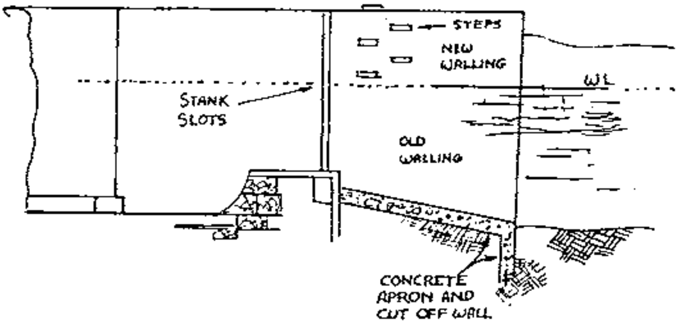
Under the old quoin and the old scour decking downstream of the gates, large timber joists protruded well under the walls beyond the limit of penetration of the sludge. See Fig. 4. The removal of these, also necessitated further demolition of the walls.

FIGURE 4.



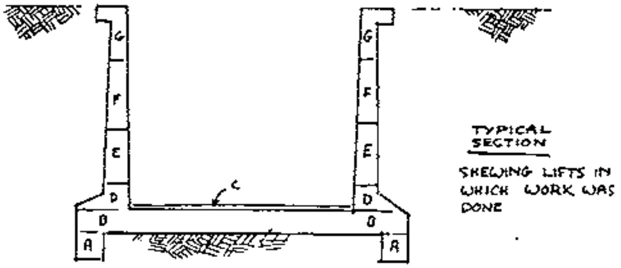
However the work of demolition and cleaning up was completed in due course and a start made on reconstruction. The first part tackled was the upstream walling above the quoins, where the old foundations were sound to rebuild upon. These walls were rebuilt in reinforced concrete and the chief difficulty was to obtain a satisfactory bond from the new concrete work into the old masonry. The method used has already been described and the details can be found in Plate No. 3. This section was rebuilt to include stank slots and steps, and a concrete apron was provided in front of the stank timber seating. The general arrangement was as in Fig. 5.

FIGURE 5



The main body of the lock was started more or less at the same time as work on the top section was in progress.

FIGURE 6



For this, the greatest part of the lock, the system of lifts and construction joints in the concrete was as in Fig. 6.

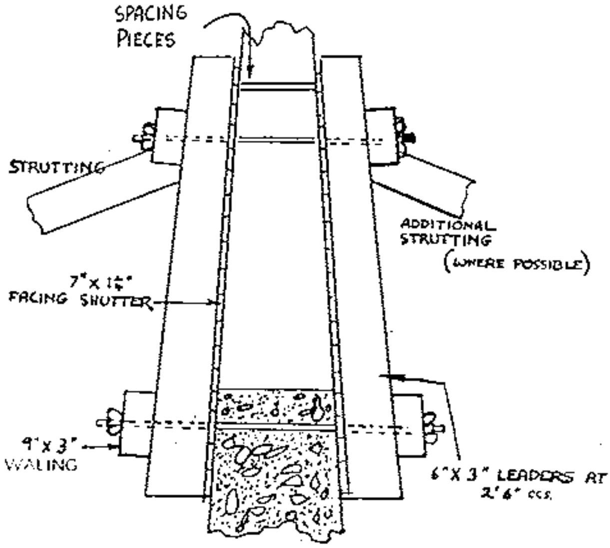
The parallel cut off walls were dug out first with a drainage channel on the outside of them, carrying away all the water to a sump at the lower end of the work. These were then cast, lift " A."

Then followed the main part of the floor containing the reinforcement for the slab and wall starter bars, lift " B." A final 3-in. trowel finished surface brought the bottom of the lock to invert level, lift " C."

After this the lift " D " was poured, bringing the wall 6 in. vertically higher than the top of the rear fillet. Into this, the lift " D," bolts were cast upon which to mount the shuttering. A further three lifts, " E," " F " and " G," brought the walls right up to the top including the capping, and in the centre of each wall, midway between gate seatings, a counterfort buttress was incorporated.

The general principle of the shuttering used was as in Fig. 7. (Sketch.)

FIGURE 7



The lower bolts were cast into the first lift. Bolts were used rather than wires as the steel supplied for the job was not in specified lengths and had all to be cut and bent on site. This produced many odd ends which had only to be threaded to make these bolts. The shuttering was then lifted on to the bolts in the top of the first lift in prefabricated panels together with leaders and walings. The nuts were then tightened up and the bottom of the shutter became fixed. Following this, the line on the front shutter was established and its position fixed by strutting against the opposite wall.

The upper bolts were then tightened against spacing pieces making the whole of the shuttering rigid. Where it was possible an additional strut from the rear face was used, but this was not practicable along the whole length of the lock.

The lift was then poured to the underside of the spacing pieces, leaving the upper bolts some 6 in. from the top of the lift. After allowing the concrete to set and to gain a little strength, the shuttering was simply lifted on to the upper bolts and the sequence repeated. This was the principle upon which the shuttering was based for the majority of the work, the simple straightforward walling.

The quoin formers were built up of a series of timber blocks cut to shape and fixed on to two 9 × 3 in. timbers. The blocks were then faced with zinc to produce a first-class smooth gate seating shutter. It was accurately located in position by means of a steel peg, one end of which was fitted at the centre of radius of the former and the other placed in a wooden block, set in the concrete, acting as a box ready to take the gate pivot. The wooden block was removed after the quoin had been poured and the actual gate pivot set in position.

The work had proceeded very well, the upstream end having been completed except for the gate quoins and the downstream except for the last 15 ft. (the section including the downstream stank slots and wing walls), when after five days of more or less continual rain, the river caused flooding of the work. On the downriver end of the lock, the flood waters rose considerably more than on the upstream end, owing to shallows a mile or two lower down the river. The water backed up and when within a foot of the highest point of the sides of the pile dam, a blow-through underneath the piles occurred. It was decided that the safest thing to do was to flood the lock. This neutralized the water pressure on the piles and the blow-through could be dealt with. More clay and sludge was placed against the outside of the piles and well trampled into position by men walking it in.

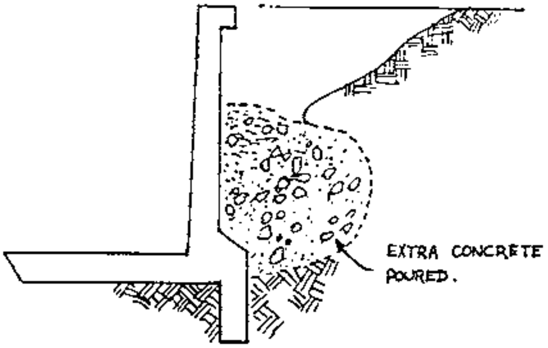
When the river went down five days later a start was made to pump out the lock again. This completed, it was discovered that the blow-through had been almost completely sealed.

The volume of water still being made, was such that it could be handled easily by the 4-in. Pheonix Chard Lister diaphragm pump. The rate of the blow-through afterwards increased and decreased with river level, but when it became too great for the pump, it fortunately always responded to the remedial treatment of trampling in clay in front of the piles.

Ten days after work had resumed following the first flood, the river rose again at a very rapid rate owing to a sudden thaw of an early snowfall and once more flooded the lock. Both these floods occurred from the downstream end, the river rising 4 ft. 6 in. above normal in the first flood and 6 ft. in the second one. The first caused a halt of about eight days from the time of flooding to the time that the lock was pumped out again and work could be recommenced. The second which was rather more serious, caused a delay of nineteen days, but it did not prevent work being carried out on the precast fencing units which were made on site for the boundary fence and other subsidiary site works.

During the interval between the first and second floods the majority of the work on the downstream gate section was completed. This presented few serious difficulties although a certain amount of extra concrete had to be poured behind the downstream meadow side gate quoin owing to an overhang on the original masonry, which had been left by the demolition of the chamber already referred to. To support this overhang, concrete was floated underneath it and the original masonry utilized as a back shutter. See Fig. 8 on next page.

FIGURE 8.



The concreting of the final end section of the floor presented a little difficulty, as the sump into which the whole of the lock bottom had been drained, lay very close to the piles and the end of the floor. The sump had to be moved right up against the back of the downstream piles, to get the floor concrete in and it was at this crucial period that the second flood of the river occurred and caused the blow-through to open up seriously.

In early January, after the floods, the downstream wing walls were placed. The meadow-side wall which incorporated a landing stage and steps, also had to allow for an existing land drain which carried a considerable continual flow. This was led through a 15-in. pipe, which subsequently was left in position, carrying the drain through the wing wall. The steps were cantilevered from the wall leading down to the landing stage, the level of which was about a foot above normal summer river level.

Both upstream and downstream sill timbers were fitted without great difficulty. They were bolted into the concrete so that renewal will be a simple matter in later years should this be necessary. Then the upstream gates were placed in position and fitted extremely well. Unfortunately in jacking up the gates to take up the adjusting straps, the pivot on the river side was disturbed. Although in correct position, it was decided to correct the cant on the pivot. In doing this, it was slightly displaced in the line of the sill and this necessitated repositioning it again. It was finally fixed in position with the gates shut up against the sill and the gates then formed a very satisfactory watertight seal under test. To carry out this test, the pond between the upstream piles and the gates was flooded. The downstream gate posts were fixed as part of the R.E. work, but the gates were fitted later in the spring of 1953.

The 19 R.B. was then fitted up as a dragline and the river, upstream of the lock was dragged, providing a 6-ft. approach channel to the lock. The strutting and timber catwalk were removed from the sheet piling and the piles in the island were cut off at ground level. It was thought that to draw these piles, would only disturb the island and from the point of view of water penetration behind the wall of the lock, it was definitely desirable to leave them in position.

The extraction gear available was very limited. A No. 7 McKiernan Terry Double-Acting Hammer was available, but to have tried to use this with a 19 R.B., would not have been very satisfactory. It would have taken the 19 R.B. all its time to lift the hammer alone, without trying to extract the piles as well. However, by dragging from in front of the piles and using a direct pull from the 19 R.B., they were dislodged, after a great struggle. Very skilful operation of the 19 R.B. managed to jerk them out inch by inch, overcoming the joint friction and the suction on the piles. The nearest of them, where the jib of the 19 R.B. could be raised to its maximum angle, came out without too great an effort. The furthermost piles, however, were far from easy to draw, and there were times when it was thought some of them would have to be cut off under water.

Upstream the piles had been driven into a solid blue lias clay and this together with the fact that they had been driven to a good depth below the inside working, made the piles quite difficult to extract. Downstream the piles had been driven through a shelly gravel bed of some 2 ft. thickness into the same clay bed. These piles had not been driven to the same depth below the inside working limit, but in spite of this they were very difficult to extract. It was later discovered that the shelly gravel through which the piles had been driven, had penetrated into the joints and thus when extraction was attempted, had set up extremely high joint friction in the piles. This work of extraction was tedious and slow without proper extraction gear, but was a great credit to the operator of the 19 R.B.

The piles extracted, little remained to be done except tidying up the site and dragging the small amount of sludge which had lain just in front of the piles. The removal of equipment from the site was quite a major task owing to the extremely bad state of the ground which resulted from heavy rain during the previous weeks. However, it was accomplished using a D4 tractor and a series of trailers.

Organization of the Work

Except on the occasions when it was necessary to launch or delaunch the Bailey bridge between the bank and the island, the total of men at work never exceeded twenty-five. The party lived on the job in tents until the middle of October and then in elephant shelters until the job was completed. A very experienced W.O.I. was in charge of the work on site and remained throughout, though the turn over of the remaining numbers of the party due to release, discharge and other causes was about 300 per cent. The working of the plant was directed by an experienced plant training officer, while the author was fortunate enough to be engineer in charge, although he found it no easy task to supervise the project from his base, 17 miles distant, when no relaxation of his normal duties was permitted.

Electric light was installed to allow night work and to improve living conditions at the camp. This led to the destruction of one tent due to an electrical fault.

The Lighter Side

Fishing in the river was a popular off-duty recreation. In this connexion one incident illustrating the lighter side of the project is perhaps worth relating. During the de-watering stage of the project, when only about 18 in. of water was left to be pumped out, a very large old pike was seen to be occupying a dark corner. As it was getting late it was decided to stop work for that evening and make an early start in the morning, with a view to catching the pike and cooking him for the midday meal next day. Unfortunately the security arrangements failed, someone must have talked and no one kept watch overnight. Whoever ate that pike for dinner next day, it was not the Sapper working party.

Conclusions

All the best articles are supposed to end with a series of conclusions, or lessons learnt. These are the majority of those learnt at Chadbury Lock.

(*a*) A project of this kind is extremely popular with the troops. They feel they are really engaged on useful work, and have more scope than on normal Sapper tasks or training.

(*b*) Trade skills and N.C.O. quality show up much more quickly and clearly on this type of work, than in normal peace-time soldiering.

(*c*) Discipline presented no problems. Even the threat of R.T.U. was enough to quell incipient troubles of that kind.

(*d*) Our civilian colleagues can teach us a thing or two about ensuring that a job does not get held up for stores.

(*e*) It is high time that we had proper pile driving and pile extraction equipment easily available as an article of store. This is a lesson that should have been learnt between 1939–45, but it seems to have been ignored.

(*f*) Even in a "Resources" unit a qualified National Service R.E. Officer may be lucky enough to find a real job of engineering to do!

Photo 1.—Dewatering completed showing original state of lock bottom and badly cracked, bulging walls.

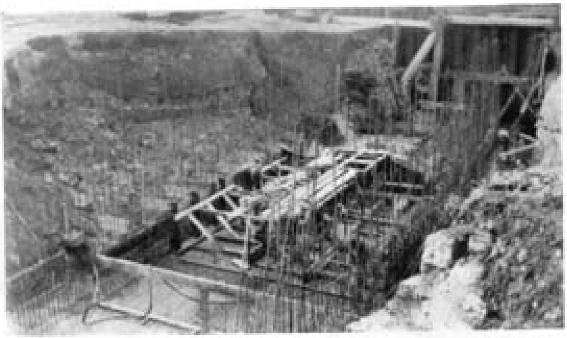


Photo 2.—Reconstruction in progress, showing part of the floor cast and the main reinforcement for the walls in position.

Photo 3.—The Sapper task nearing completion. Concreting work finished, the piles extracted and all that remains to be done, is the removal of the debris which was in front of the downstream piles. This can be seen in the foreground of the photo.

Reconstruction Of Chadbury Lock 1,2,3

Op Humane 1, 2

"OP HUMANE"

By Brigadier P. F. Foley, C.B.E.

Introduction

"OP HUMANE" is the title of a works project, totalling some £12 million carried out in the British Zone of Germany in 1951/52, in order to provide accommodation for an Armoured Division and certain other units. The project comprised the construction of new barracks for twelve major and eight minor units, and the adaptation of existing barracks to varying degrees. This account covers only the construction of the new barracks.

Background

(*a*) *Works Procedure in B.A.O.R.*

Works in B.A.O.R. are carried out through the agency of the Public Works Department of each "Land" (Province). The Engineer Works Service place demands on the German Authorities, in the form of sketch designs, layouts, and outline specifications, scrutinize and approve the acceptance of tenders, and supervise the work, the German Authorities being responsible for detailed planning, inviting and accepting tenders, and detailed site supervision.

Under normal conditions this procedure works through the usual Works Executive chain.

(*b*) *Situation in 1950*

In the late summer of 1950 the works programme appeared to have achieved stability, with a large project connected with the re-deployment of 2 Infantry Division and 7 Armoured Division well under way, and much work on administrative installations proceeding.

In late August, 1950, however, came the sudden introduction of a fresh re-deployment project, designed to provide accommodation for a second Armoured Division (the 11th), and involving a large number of unit moves, and the conversion and adaptation of many existing barracks, formerly owned by the German Army or Air Force. A part of this project is described by Major H. W. Pressland, R.E., in his article "The Tank Park" in the *R. E. Journal* of June, 1953.

This project not only absorbed most of the barracks available in the British Zone, but also stretched the Works Service to the limit of its capacity, and over.

At the same time reconstruction in Western Germany, after the chaos following the end of the war and the subsequent stabilization brought about by the monetary reforms in 1948, was increasing rapidly and absorbing vast quantities of the more important building materials, resulting in a shortage particularly of steel and timber.

THE "SHADOW PLAN"

No sooner was the project for accommodating 11 Armoured Division started, than a warning was received that yet another Armoured Division (the 6th) might be sent to Germany late in 1951, and preliminary planning for its accommodation was ordered. This planning was governed by the following main factors :—

(*a*) Very few more existing German barracks could be taken over ; therefore new construction would be necessary on a large scale.

(*b*) Economy in cost, timber and steel, and rapid construction would be vital. Very thorough standardization, the maximum use of concrete in various forms, and simplicity of design would be necessary.

(*c*) No more load could be placed on the already over-burdened Works Executive without risk of a breakdown ; therefore planning and control of the new construction must be centralized in the staff of the Chief Engineer, B.A.O.R., and the German Authorities must take a much greater share of responsibility than they had been given in the past.

ENGINEER PLANNING

Preliminary planning for new barracks began in November, 1950, with the object of producing sketch designs for every type of building likely to be required, a general specification, and type layouts, ready for issue to the Germans as soon as orders were received to launch the project.

In the pursuit of standardization, former German Army practice, as shown in the construction of barrack blocks and of their standard wooden hut, suggested a roof span of 12.5 metres, while bays of lengths of 2.5 metres were adopted because this is the normal panel length of German steel shuttering. Some trial work on the drawing board showed that the majority of such new D.F.W. standard designs as existed could readily be adapted to these ruling dimensions, but that for some buildings a smaller roof span, 10.5 metres, would be more economical. It was accordingly decided that :—

(*a*) Only two roof spans would be used,
(*b*) the unit bay would be 2.5 metres,
(*c*) all buildings would be plain rectangles, with no hips, no valleys and no excrescences in the form of lean-tos,
(*d*) 1948 Synopsis scales would be used.

Flat pitched roofs were adopted as being well suited to prefabrication in reinforced or pre-stressed concrete.

The general specification laid down limiting heat transmission coefficients for carcassing but left the choice of materials to tenderers on a " type-v-type " competitive basis ; it also covered finishings and external services, while district heating was specified, but the choice of methods and plant was left to tenderers.

The task of the drawing office was :—

(*a*) Adaptation of War Office designs, where such existed, to the ruling, metric, dimensions ;
(*b*) original designs for the remainder of the buildings ;
(*c*) production of type layouts.

Exact requirements not being known at this stage, and with a view to flexibility, it was decided that, initially, the basis of planning should be for a standard major unit, the Infantry Battalion, and minor unit, the G.T. Coy., R.A.S.C. Later a certain number of special designs and layouts were produced as time allowed and requirements became known more accurately.

Tank and vehicle garages presented no new problem because a standard universal garage had been worked out and adopted some time previously, but much thought was given to the layout of P.O.L. points and washdowns.

In all, some seventy sketch designs and twenty type layouts were produced in five months of planning.

Another task was the production of schedules of accommodation for each type of camp, and a schedule of fittings for each building, with dimensioned drawings where necessary.

Some technical notes are given in Appendix " A " on page 236.

INITIATION OF THE PROJECT

In March, 1951, it was announced that 6 Armoured Division would move to B.A.O.R. during the winter of 1951/52, the move to be completed by 1st April, 1952, and orders were issued for the project to be launched. Now for the first time the German Authorities were brought in, the scope of the project, as far as it was known at that time, was explained to them, and they were given the following tasks :—

(*a*) Reconnaissance for sites, which were to be approved by H.Q., B.A.O.R. and, subsequently, the acquisition of land.
(*b*) Site surveys, and the adaptation of type layouts to each site, subject to the approval of R.E. branch.
(*c*) Preparation of approximate estimates.
(*d*) Placing contracts, all tenders being submitted to R.E. branch for approval.

(*e*) Site supervision.

(*f*) Ensuring the availability of materials.

Even at this stage, the full scope of the project had not been settled. This was not done until August, the final demand being for barracks for twelve major and eight minor units, on ten sites, one of which was an existing camp where buildings had to be rehabilitated, and an Officers Mess, two Other Ranks Messes, and Garages added.

PROGRESS

Sites were selected, often after considerable argument over local objections, progressively between April and August, and work was started on each site as soon as sufficient detailed planning had been done. Six months was set as the target for the completion of each barracks, and once the first contracts had been approved work proceeded at a startling pace, the principal reasons being :—

(*a*) The labour available was almost unlimited, particularly since the construction methods adopted allowed a high proportion of unskilled or semi-skilled men to be employed. Further, the productivity of building labour in Germany is high, there being few restrictive practices and men being willing to work long hours for better pay.

(*b*) Materials were plentiful, with the exception of steel and timber ; the terms of tendering, allowing a choice of materials, were an important factor.

(*c*) Site organization by contractors, and co-operation between them, were excellent. It should be explained that in Germany contracts are usually placed for each individual trade ; this results in a large number of contractors working on the same site, but a measure of control is generally given, by agreement, to one of them.

(*d*) Although there was no site supervision by the Works Service, frequent inspections were made by the Quantity Surveying staff, and careful records of progress were kept so that claims for interim payments were passed quickly and contractors were consequently never short of cash.

In the late autumn it became clear that delays in steel deliveries, particularly for heating and water supply services, might jeopardize the whole project, and strenuous efforts had to be made to drive the German Authorities, at all levels, to ensure deliveries. The steel shortage and very wet weather, held up work badly on some sites and aroused great anxiety—it was a common sight to see two senior members of the C.E's. staff wandering forlornly round a site, rather like the Walrus and the Carpenter—only it was mud and not sand over which they wept.

Photo 3.—A Major Unit Barracks.

Photo 4.—Barrack blocks.

Photo 5.—Interior of garage.

Op Humane 3 ,4 ,5

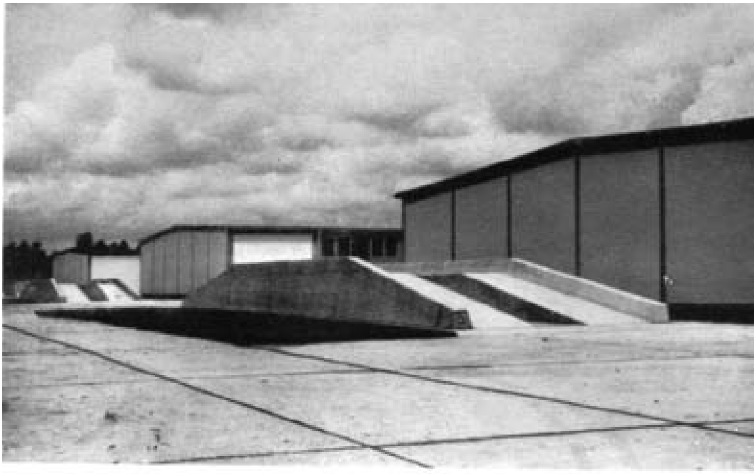


Photo 6.—Garages and tank maintenance ramps.

Photo 7.—Fuel pumps and wash-downs.

Op Humane 6 , 7

The moves of units from U.K. had originally been planned on a very tight programme, which proved to be too optimistic, several of these moves unfortunately having to be postponed.

COMPLETION

Nevertheless the last unit of 6 Armoured Division arrived in Germany before 1st April, 1952, and thus the main object of the project was achieved within ten months of the start of work, the actual time taken to complete barracks to a condition fit for occupation varying between six and nine months with the majority of building construction having to be done in the winter.

In an ideal world, each barracks would have been fully completed and tidy before the unit arrived, but time was too short ; consequently first impressions were often unfavourable. As work was completed, however, with young trees and shrubs established and newly-sown grass springing up, the improvement was rapid, and by the end of the summer of 1952 the new barracks presented a very fair appearance, especially those which were sited in forest areas. The feature which gained the most appreciative comments was, perhaps, the equipment of Messes and Junior Ranks Clubs, all of which were provided with the German equivalent of the most modern British fittings.

At Appendix " B " on page 238 is a list of the barracks with dates of starting work and completion fit for occupation, with some particulars of costs and other data. The total cost, incidentally, worked out at considerably less than the approximate estimate—an unusual feature in a works project.

LESSONS

Apart from the Tidworth reconstruction project, the " Op Humane " barracks were the first to be built by the Army in accordance with the post-war Synopsis scales, and so provided valuable information regarding the suitability of these scales for field units.

Much experience was gained by the Engineer Works Service in Germany, in the production of a large number of standard type plans and much detailed information, and in the adoption of a type of construction which is both quick and economical ; while on the German side, the Public Works staffs concerned, and a large number of contractors, became accustomed to planning and executing large new barrack construction projects for the Army. All this experience has been of the greatest value in connexion with later projects, in particular the provision of barracks for a Canadian Brigade Group, and a new Headquarters for the three Services in Germany. In fact it is fair to say that but for " Op Humane " the latter scheme could not have been planned and begun within the very narrow time limit imposed by financial considerations.

APPENDIX " A "

TECHNICAL NOTES

1. BUILDING CONSTRUCTION

(a) Buildings other than Garages

Following competitive tendering on a " type-v-type " basis, various forms of construction were used for roofs and walls, i.e.,

(i) *Roofs.*—Pre-stressed concrete beams carrying light-weight concrete slabs.

Pre-stressed concrete slabs.

Various types of patent roofs, mainly consisting of pressed steel beams at 60 cm. centres, filled in with hollow light-weight concrete blocks.

All roofs were covered with roofing felt, either black and sanded, or coloured green or red.

(ii) *Walls.*—Light-weight pumice concrete hollow blocks.

Foamed or cellular concrete blocks.

Poured " No-Fines " concrete, using rubble from bombed buildings crushed to a suitable size.

All walls were rendered, internal finishing being in distemper, except for dados in ablution rooms, kitchens, etc., which were of porcelain enamel paint, which has proved a very effective cheap substitute for glazed tiles.

(b) Garages

(i) *Framework.*—Either cast *in situ* reinforced concrete throughout or pre-cast r.c. stanchions with pre-cast beams pre-stressed by the Freysinnet method.

(ii) *Cladding.*—Wall panels of light hollow concrete blocks ; roof slabs of light reinforced or pre-stressed concrete with roofing felt covering.

2. ROADS

The following specifications were laid down :—

(a) Roads to Garage Areas

(i) For heavy " A " vehicles. On made up or soft ground—concrete 20 cm. thick with high tensile steel mesh reinforcement at top and bottom ; on firm sub-soil—unreinforced concrete 25 cm. thick.

(ii) For " B " vehicles. On made up or soft ground—concrete 15 cm. thick with one layer of steel mesh reinforcement ; on firm sub-soil—20 cm. concrete unreinforced.

The specified compressive strength for all concrete was 370 kg. per cm. (5,263 lb./sq. in.).

Specifications for garage floors were similar.

(b) Internal Camp Roads

23 cm. hard core and 8 cm. tarmac.

3. Hardstandings for "B" Vehicles

25 cm. broken brick, broken stone or blast furnace slag, covered with 5 cm. of fine ash.

4. Sewage Disposal

Wherever possible, foul drains were connected to existing public sewers. In the case of three camps, new sewage disposal works were provided. These were of normal design comprising settling tanks, filter beds, humus tanks and sludge beds, the effluent being run into a ditch or stream.

5. Electricity Supply was from the German grid and presented no problems.

6. Water Supply

In only one case was water not available from existing mains. Here a small water works was constructed, containing filtration, chlorination and softening plant and two reinforced concrete storage tanks each of 88,000 gallons capacity, water being pumped to the works from two deep wells.

7. Heating, Cooking and Domestic Hot Water

District heating is commonly used in Germany. The more modern plants use high pressure hot water, and this system has been installed successfully on a large scale in the Hohne reconstruction project, described in an earlier number of the *R.E. Journal*. It was therefore decided to adopt this method for all the barracks.

Tenders were invited on a performance specification basis ; consequently the systems employed showed considerable variations, which are summarized below.

(*a*) *Distribution*

In all cases save one, a 3-pipe distribution system for cooking and space heating was used, the flow pipe for cooking being at a constant 175° C., and that for space heating at a temperature varying with the outside temperature (175° C. and − 15° C.). Domestic hot water was provided by a separate ring main, controlled from the boiler house.

In one case the 2-pipe system was used, one flow pipe for cooking and heating working at a constant 175° C. Here again, D.H.W. was supplied by a separate ring main.

Working pressures vary with the size of the installation, that in the two largest barracks being 10 atm. (150 lb./sq. in.).

In this project, conditions favoured the 3-pipe system, the cooking loads being fairly concentrated and comparatively high in relation to the heating loads, and the raw water being generally hard. Under such conditions, the advantages claimed for the 3-pipe system are :—

(i) Smaller pipe sizes, partly offset by a greater total tonnage of piping.

(ii) Better heat control, and fuel economy.

(iii) Saving in accessories (heat exchangers and water softening plant).

(b) Heat Exchange

The following different methods of heat exchange for cooking and space heating were used :—

(i) A calorifier in each building.

(ii) A number of calorifier sub-stations, each serving a group of buildings.

(iii) One calorifier station, in the boiler house, this method being the most economical in material.

(c) Boilers

In all cases but one, " Economic " dry-back boilers were installed, the exception being " Lancashire " type boilers with economizers, which were accepted because they happened to be available.

For reasons of economy, and of availability of materials, the stoking system adopted consisted of overhead cranes with dump buckets, feeding sprinkler stokers, but undoubtedly automatic overhead feed to chain grate stokers would have been more satisfactory.

Figure 1 shows in diagrammatic form the boiler house and district heating layout in a major unit barracks, illustrating the 3-pipe distribution system with a calorifier station in the boiler house.

APPENDIX " B "

MISCELLANEOUS DATA

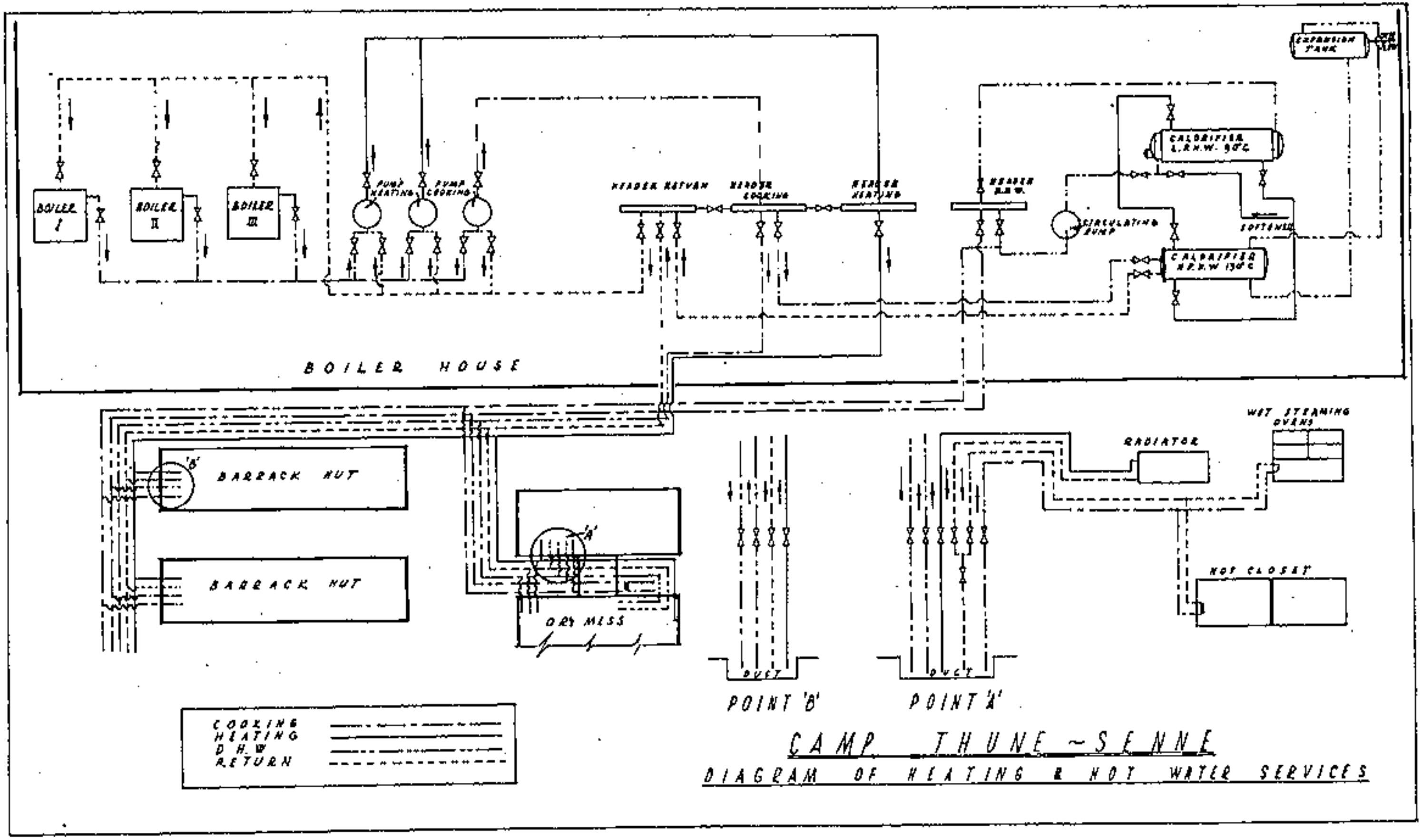
1. LIST OF BARRACKS AND CONSTRUCTION TIMES

Site	Units	Starting date	Date fit for occupation	Remarks
Osnabruck (Eversburg)	1 Major 1 Minor	5 July '51	15 Dec. '51	Existing barracks ; some new buildings added.
Osnabruck (Dodesheide)	2 Major 1 Minor	1 June '51	Feb-Mar. '52	The minor unit is an Armd. Bde. Wksp., R.E.M.E.
Minden	1 Major 1 Minor	1 June '51	20 Jan. '52	
Lippstadt	1 Major	21 June '51	31 Dec. '51	
Munster	2 Major 3 Minor	15 Jan. '51	Feb-Mar. '52	
Herford	1 Major 1 Minor	7 July '51	1 May '52	
Bunde	Div. H.Q. 1 Major	7 July '51	1 May '52	
Hubbelrath	1 Major	16 Aug. '51	15 May '52	
Sennelager	1 Major	15 Aug. '51	1 June '52	These barracks were for units not in 6 Armd. Div.
Delmenhorst	1 Major	17 Sept. '51	15 June '52	

2. COSTS

The *per capita* costs of barracks for various types of units are given below. These costs are for level sites and include district heating,

FIGURE 1.


EXPANSION TANK
CALORIFIER L.P.H.W. 90°C
CALORIFIER H.P.H.W 130°C
SOFTENER
CIRCULATING PUMP
HEADER D.H.W.
HEADER RETURN
HEADER COOKING
HEADER HEATING
PUMP HEATING
PUMP COOKING
BOILER I
BOILER II
BOILER III
BOILER HOUSE
'B'
BARRACK HUT
BARRACK HUT
'A'
DRY MESS
DUCT
POINT 'B'
DUCT
POINT 'A'
RADIATOR
WET STEAMING OVENS
HOT CLOSET
COOKING
HEATING
D.H.W
RETURN
CAMP THUNE ~ SENNE
DIAGRAM OF HEATING & HOT WATER SERVICES

but exclude external services and agency charges. They include garages which were provided for 100 per cent of " A " vehicles, and 50 per cent of " B " vehicles.

It should be noted that these costs have been calculated at the official exchange rate of 11.76 Deutschmarks to the £, whereas the true exchange rate at the time was assessed as approximately 18 DM. to the £.

Type of Unit	*Per Capita Cost in £ at 11.76 DM. to the £*
Infantry Bn.	448
Armoured Regt.	734
Field Regt. R.A. (S.P.)	449
Lt. A.A. Regt. R.A.	509
Field Engr. Regt.	449
Corps Signals Regt.	507
G.T. Coy. R.A.S.C., less Wksps. Pln.	562

The over-all inclusive cost per head of the project for twelve major and eight minor unit barracks, worked out at £814.

3. Quantities of Materials Used

(*a*) *Steel*

(i)	Reinforcement, angles and T sections	5,106 tons
(ii)	Sheet, for boilers, calorifiers and cooking equipment	1,497 tons
(iii)	Piping	3,720 tons
(iv)	Radiators	1,440 tons
		11,763 tons

(*b*) *Concrete Building Blocks*

Approx. 5 million (the equivalent of 65 million common bricks).

4. External Services Within Barrack Boundaries

(*a*)	Electric supply cable	67½ miles
(*b*)	Chain link fencing 6 ft. 6 in. high	26 miles
(*c*)	Heating ducts	23 miles
(*d*)	Concrete roads (average 20 ft. wide)	11 miles
(*e*)	Tarmac roads (average 13 ft. 3 in. wide)	20½ miles
(*f*)	Paths (average 4 ft. wide)	29 miles
(*g*)	Foul drainage, glazed stoneware pipes av. 8 in. dia.	25 miles
(*h*)	Storm water drainage, concrete pipes av. 16 in. dia.	34 miles
(*j*)	Water supply piping	26 miles

5. Labour

The average number of men employed daily in each barracks was 450.

"PRODUCE OR DIE"

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

"PRODUCE or Starve" is the slogan for post-war Britain. For British forces in a future war, particularly in a remote theatre, it may well be "Produce or Die."

. Systematic local production, either from local resources, or from special components and material shipped from the home base, can make a substantial, and possibly vital, contribution to the saving of shipping. An outstanding example in the last war was the making of jerricans from sheet steel, with machinery specially sent out to certain overseas theatres. Amongst other articles which have been, or well may be, produced locally are the following :—mines, hutting sections, doors, windows, camp structures, concrete products of all kinds including pre-cast components for pre-stressed concrete work, welded steel bridge components, timber girders, duck boards, "A" frames, bricks, pontoons, boats, office furniture and steel cupboards. Parcels of bridging equipment, and other unit loads for mechanical handling may also be regarded as assemblies to be produced in the field.

Local production, however, cannot be carried out without some use of local resources. Owing to the maintenance demands of modern military equipment and the need for dispersing base installations under the threat of the atom bomb, skilled labour will be in particularly short supply. The aim of this paper is to show how, in circumstances likely to be prevailing in a future war, certain current developments in British industry can be used for the improvement and extension of military production methods in the field, and to suggest that the study of such methods cannot fail to be of interest and value to any engineer officer, whatever his appointment or rank. To many readers, particularly those with experience of production in the last war, much in this paper will not be new. It is hoped, however, that they will be encouraged to publish, if they have not already done so, their experiences in this fascinating, though little studied, branch of military activity.

PRODUCTIVE AND NON-PRODUCTIVE PROCESSES

In the golden age, long gone, when life was simple, the symbol of production was the craftsman in his cell. Whether he were tinker, tailor, carpenter or smith, his tools and materials were ready to hand. Either by himself, or with the minimum of help from an apprentice or two, he made in his little workroom the products of his trade. His processes were all productive, but his rate of production was abyssmally low.

With the industrial revolution the picture changed. Through machines, power was applied to production. Material was moved from machine to machine. Products, flowing in profusion, were distributed throughout the world.

With the taking over of production by machines the tonnages of stores to be handled increased. The effort of handling materials from the sources of supply to the factories, into and out of storage, between machines and processes, and from the factory to the consumer began to absorb an inordinate amount of the total effort of production. Thus with the increase of productivity following from mechanization there came an increase in the non-productive proportion of effort. Another important factor contributed to this process. In an attempt to reduce the demands for skilled labour, productive operations tended to be broken up into smaller and smaller pieces, until it was possible for a complicated product to emerge from a series of processes in which each operator did little more than drill a hole, press a button, or tighten a nut. This could be achieved only by an increase in handling, and was made an economic possibility by the development of mechanical methods of moving stores along the production lines.

Non-productive effort adds nothing to the value of a product, only to its cost. In industry considerable importance is attached to the study of material handling methods as a means of reducing non-productive cost. Production planning is regarded as having two intimately and inextricably mixed aspects, the planning of material processing, and that of material handling. This is particularly the case in the United States. The productivity teams sent over to that country in 1948 under the auspices of the Anglo-American Council on Productivity were so impressed by the American methods of handling materials that in 1949 and 1950 special teams were sent to study this subject alone. Their reports on " Material Handling in Industry " and " Freight Handling " were subsequently published, and warrant careful study by anyone interested in production.

In these reports it was stated that from 15 to 85 per cent of the cost of production of an article lies in the cost of handling. It was clearly established that the greater average efficiency of American industry as compared with British lies largely in its attitude to material handling. In the U.S.A. every effort is made to eliminate non-productive processes. Those which cannot be cut out are reduced to a minimum. This is achieved as a result of consistent production planning, in which material handling methods are completely integrated with methods of production. It should be a prime aim of military production planning to attain this ideal.

THE PHASES OF PRODUCTION

Production can be considered as falling into a number of phases. These will be treated briefly here, and in greater detail later on in the article. The term factory will be used to cover any form of productive organization.

1. *Incoming Material.*—A factory depends for its continuous working on the receipt of raw materials or of components which have been produced elsewhere. The ordering of such material, progressing of orders, checking of quantity and quality, and handling of documents relating to incoming material may be regarded as the first phase of production.

2. *Stores Holding.*—This covers the holding of incoming material, of that produced within the factory, and of that awaiting dispatch. It includes the holding of proper stocks to ensure that there is no breakdown of production through shortage of material, the maintaining of material in good condition, and the ability to find and deliver material as required.

3. *Component Production.*—A final product consists of a number of individual components, some of which may have been grouped as sub-assemblies. The production of components is a clear-cut subdivision of work in the factory.

4. *Sub-Assembly.*—For convenience, and to facilitate final assembly, many components are grouped into sub-assemblies. Thus a ball race may be a sub-assembly for an engine, and an engine a sub-assembly for a car.

5. *Main Assembly.*—In this phase the final product takes form, as sub-assemblies and components are brought together.

6. *Outgoing Material.*—This covers the dispatch of material, including inspection, packing, handling and documentation.

A typical factory layout is shown at Fig. 1 on page 247.

Apart from the six phases described above, there are three aspects of production which are continually cropping up, the internal movement of material into and out of store, and between machines and processes, the checking of quantities at various stages, and quality inspection to ensure an adequate standard of workmanship. Defects in planning in relation to any of these can lead to serious wastages of production effort.

There are also many important aspects of production which can be covered by the term "man management"; but this article is not concerned with these, apart from any points which may arise in relationship to the processing and handling of material.

MASS, BATCH AND FLOW PRODUCTION

Mass production is a general term relating to the methods on which work is organized for the production of comparatively large quantities of an item by repetitive processes. The term is comparative in the sense that it might relate to the production of millions of rounds of small arms ammunition, or of a few hundred railway coaches. The term is not very precise, but conveys a general picture of the setting up of elaborate production machinery to give economic results over a long period.

Batch production and flow production merge into each other as types of mass production. The former involves the idea of organizing production in limited batches, one batch following another rather like the editions of a book. The latter, however, must be related to the idea of a river. Components and sub-assemblies converge in a controlled flow on a main assembly channel, and the finished product flows out unchecked into a sea of consumers. Perfect flow is the ideal of the modern production engineer. It should also be the aim of his military counterpart.

FLOW PRODUCTION—THE CIVILIAN PICTURE

Flow production starts with the idea of a time cycle on a main assembly line. Thus if a factory is required to turn out a motor car every five minutes, the main assembly line must be timed to a five-minute cycle and the processes of assembly must be broken into five minute operations. Provision must be made for moving the product from stand to stand within the time cycle, and work must be organized and the necessary machines and men provided to complete each operation in the planned time.

Sub-assembly lines must be kept in time with the main cycle. Storage must be available between the ends of sub-assembly processes and the assembly line as a reservoir to cope with minor variations in flow. Such storage is often provided by the capacity of the sub-assembly line conveyors, or by the containers in which components are being handled.

Assembly lines frequently spring from a stores marshalling yard. This is one of the main nerve centres of a factory. The stores controller responsible for marshalling material is in a key position. He will normally hold stores sufficient for keeping the assembly lines going for a predetermined period. He is able to see if any part of the factory supporting the assembly lines is falling out of cycle.

Behind the stores marshalling yard lie the component production lines. Here, too, flow conditions prevail. Machines, instead of being grouped in shops of different types, are lined up, regardless of type, so that components pass in a straight line from machine to machine, according to the requirements of production. In the more highly organized civilian factories this process is reaching a logical conclusion in the use of automatic transfer machines. Here components flow automatically from one machining operation to another so that, for example, a rough casting entering at one end emerges without any human attention, as a fully machined cylinder block at the other.

The picture of flow production conjured up so far, with its elaborate composition of automatic transfer machines, stores marshalling yards, conveyors and assembly lines, turning out complex products to an inexorable time cycle as a result, often, of years of planning, and millions of pounds of capital expense, seems indeed a far cry from any military requirement in a theatre of war.

Yet in these principles and practices lie tremendous possibilities for the military production engineer, even if he is only a subaltern in a field park squadron making duckboards.

The Military Problem

Military production problems are likely to differ from civilian ones as follows :—

1. Products, on the whole, will be very much simpler than those made in civilian factories, and will not need to be made to such small margins of error.

2. There will be neither time nor resources for setting up elaborate conveyor systems or machining lines.

3. Premises will tend to be scattered, and quite unrelated in design to the requirements of production.

4. There will be rapid changes in demands for products.

5. Many installations will be devoted merely to the assembly of components, which will have been produced either in the home base or at least farther back in the communication zone.

6. Labour will tend to be unskilled, and little time will be available for training it.

In general, this will mean that military production methods must be simple and flexible in operation. They must be capable of being rapidly established, and equally rapidly switched, from the production of one article to that of another. Owing to the simplicity of the products the material flow will tend to be high in relation to machining and other productive effort. There will thus be a tendency for non-productive handling effort to be high in comparison with productive effort. To take rather extreme examples, it is quite clear that handling must play a very much bigger part in the production of duckboards or cast concrete products than in that of typewriters or wristwatches.

ASSEMBLY LINES FOR MILITARY PRODUCTION

Owing to the comparative simplicity of military products assembly lines will be short. In many cases, in order to obtain the required output, it may be necessary to have a number of identical assembly lines working in parallel. On the other hand it is also possible, and is common commercial practice, to make a number of different, though related, products on the same assembly line. For military purposes there are a number of simple methods for the movement of products along assembly lines. These include :—

1. *Ordinary Gravity Roller Runway.*—The product may be moved either directly on the runway or on some sort of temporary flat base. In one factory, producing washing machines, final assembly is carried out on a roller runway. The first component of the assembly is the base of the dispatch packing case. This base, with the machine gradually being assembled on it, is pushed along the roller runway, until in the last operation the rest of the packing case is added, and the product is ready for dispatch. (See Fig. 2.)

2. *Trolleys.*—These can be of various simple designs, running on decauville track, either of normal gauge, or specially laid to wider gauge. (See Fig. 3.) Rubber-tyred trolleys running on concrete might also be used.

3. *Semi-live Skids.*—See Fig. 4.

4. *Skids, Pallets or Stillages.*—These can be moved along the assembly lines by forklift trucks, pallet trucks, or elevating platform trucks.

5. Direct transfer by mobile or overhead cranes, or by forklift trucks.

The methods to be used must depend on the availability of equipment, the nature of the product and the time cycle on the assembly line. The time cycle might vary from practically zero up to many hours. A short time cycle is not an essential of flow production. An interesting example of a long time cycle can be seen in the flow production of welded steel coaches in the railway workshops at Eastleigh.

Given a reasonable choice from modern commercial stores handling equipment there is no reason why a military production engineer should not be able to establish an adequate assembly line very quickly for any normal military product.

THE SUPPLY OF COMPONENTS AND SUB-ASSEMBLIES TO ASSEMBLY LINES

The elaborate methods by which assembly lines are supplied with components and sub-assemblies in the more highly developed civilian factories are obviously out of place in military practice. The most important development in this field in recent years has

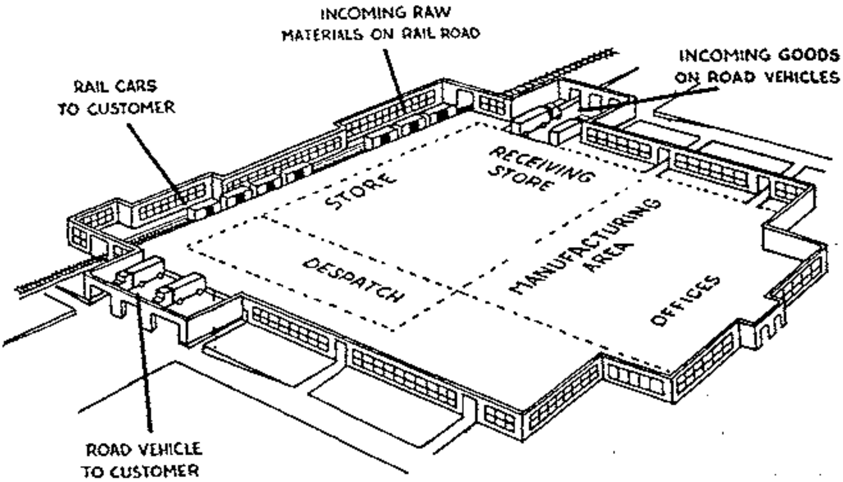


FIG. 1. Typical American Factory layout, showing the relationship of stores receiving and dispatching areas to the manufacturing area.
By courtesy British Productivity Council.

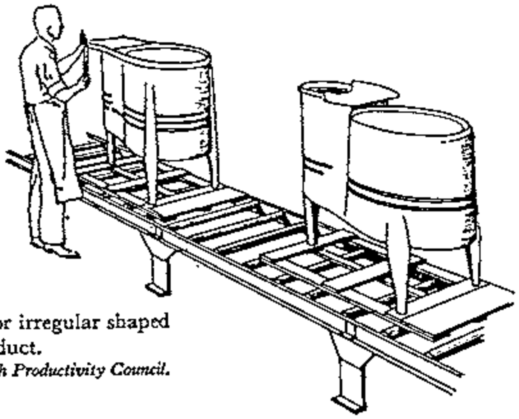


FIG. 2. Platform for irregular shaped product.
By courtesy British Productivity Council.

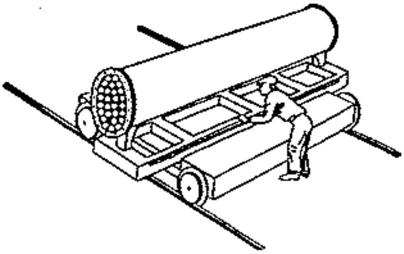


FIG. 3. Heavy mobile assembly assembly platform.
By courtesy British Productivity Council.

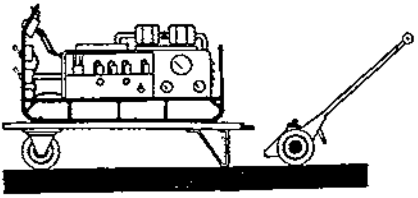


FIG. 4. Semi-skid used as a mobile platform.
By courtesy British Productivity Council.

been the forklift truck/pallet system of stores handling. This system has been put to many uses, one of which is the handling of stores in production. The factories in which this system is used instead of conveyors have problems similar to those likely to be met in the military field, particularly as regards the maintenance of flexibility in production. There is little doubt that the development of the forklift truck/pallet system of stores handling is the biggest single factor in making practicable the application of modern flow production methods to military production in the field.

The Forklift Truck/Pallet System of Stores Handling in a Factory

An ordinary pallet is simply a tray on which stores can be stacked. It is designed to be lifted on the forks of a forklift truck. Palletized loads can be stacked on top of one another, provided the stores on the pallets are of suitably regular dimensions, and of sufficient strength. Box and post pallets, as the names imply, are ordinary pallets with sides or with corner posts. They are designed to be stacked on one another regardless of their contents. Many pallets are designed for lifting by cranes as well as by forklift trucks (see Photo 1). Any boxes can be made into box pallets by the fastening on of suitable feet such as the "Flowstack" palleting foot (also seen in Photo 1). Ordinary flat pallets can readily be made up from rough timber for field purposes if necessary.

Where the forklift truck/pallet system is in force, all materials coming into the factory are palletized on receipt. In many cases, to save effort, arrangements are made with the factory's suppliers for material to be supplied already loaded in the factory's pallets. With the general introduction of mechanical handling methods throughout the Services, there is no reason why this should not be military practice as well. The palletized material is then moved into store to await use. The methods of storage will be discussed later in this article. Material required for use is withdrawn from store in complete pallet loads. These are carried either by fork-lift truck, or moved by trailer train (see Photo 3), to wherever they are required. The palletized loads are stacked at the input ends of machines or along assembly lines. Similar pallets are used at the output ends of machines to receive products which have to be moved farther on in the production sequence (see Photo 4). Short links, e.g., between adjoining machines, in such a system can be made by chutes or by short lengths of roller runway. Roller runways can be made to deliver straight into box pallets if convenient.

The great advantages of the system are that the flow of material is not tied to the track of a fixed conveyor, but can go from machine to machine, and shop to shop as required ; and that the whole

Photo 1.—Box pallets being unloaded by crane.

Photo 2.—Tote boxes being handled on ordinary flat pallets by "Stacatruc" forklift truck. Note how the pallets are wider than the forklift truck so that the machine can work right through a block.

By courtesy Lockheed Hydraulic Brake Co. Ltd. Reproduced from Material Handling in Works Stores, *by L. J. Hoefkens, published by Iliffe & Sons Ltd.*

Produce or Die 1 , 2

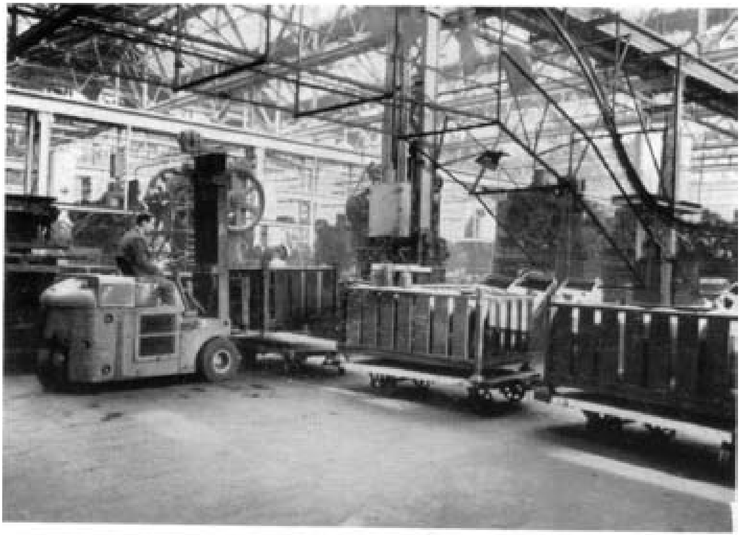


Photo 3.—Box pallets being handled in press shop by Coventry Climax forklift truck and tractor/trailer train.

Photo 4.—Box pallets being used in a flow sequence for material going through a press shop. Note space saving in the background where box pallets have been stacked three high.

Photos by courtesy Mechanical Handling *and Messrs. Fisher & Ludlow Ltd.*

Produce or Die , 3 , 4

system can be brought into operation in a matter of hours rather than months.

TOTE BOXES

Tote boxes, or work boxes, may be regarded as miniature box pallets and are used, often in conjunction with ordinary pallets, for the handling of small parts. Common sizes are 12 × 12 × 6 in. and 24 × 12 × 6 in. They have nesting corners to allow stacking, handles each end for lifting, and cardholders for details of their contents. They are very suitable for use with gravity roller runway. When full they rarely exceed 56 lb. in weight, and are thus convenient for frequent manhandling. If specially made tote boxes are not available they can be readily improvized from old ammunition boxes by removing the lids and welding on simple nesting brackets. Tote boxes can be stored in special racks, stacked on the ground or handled on ordinary flat pallets (see Photo 2).

MACHINING AND OTHER PRODUCTIVE PROCESSES

In flow production, work passes steadily from machine to machine and process to process in accordance with the time cycle on the assembly line. To achieve this in practice much skill in planning is required. Longer operations may have to flow in parallel through a number of similar machines. Some machines may have to work overtime to keep up with the cycle. There must always be small stocks between machines and processes to allow for minor variations in flow. Major variations must be investigated at once. One of the great advantages of flow production is that, by its very nature, it makes immediately apparent any drop in productivity in any part of the factory.

JIGS

Jigs are frames designed for holding work in exactly the right position for cutting, welding or drilling, and thus reducing the need for complicated setting out. The use of jigs speeds production, largely eliminates the chances of human error, and reduces the skill required from the operator. Thus skill and effort put into the design and construction of jigs can go far towards overcoming difficulties caused by the shortage of skilled labour.

In industry, jigs are often highly complex structures, and there are firms which specialize in their production. Jigs for military products, however, need not be complicated. The military production engineer will have little difficulty in making his own.

POWER-DRIVEN HAND TOOLS

There have been many developments in recent years in hand tools driven by compressed air or electricity. A number of such tools are in service in the Army, and others will become increasingly available. The use of such tools increases output and decreases operator fatigue. In typical examples the introduction of power screwdrivers, impact wrenches and hammers gave savings of time ranging from 45 to 65 per cent on manual methods, and at the same time practically eliminated operator fatigue.

Power tools must be made properly accessible to operators. It is often best to suspend such tools conveniently over the correct point in the assembly line, or to provide holsters in convenient places. Constant attention to apparently minor detail is one of the main means of speeding up production.

Storage, Air-Rights and Stores Documentation

Space devoted to storage is space lost to production. Storage is not a question of floor space. It is a three-dimensional problem. The stores superintendent must aim at reducing his demands on premises and hard standings by the use of his air-rights, which indoors go to the ceiling, and outdoors to the sky. Pallets and forklift trucks are designed to facilitate high stacking, and the savings in non-productive space which can follow from their use may, apart from any other advantages, well repay their cost.

The established tendency in storage is to have special places for each type of store. This is convenient for stocktaking, but tends to lead to much waste storage space, owing to the need for keeping vacant spaces to cope with fluctuating stocks of different components. Furthermore, when storage space is short, such stores tend to get into a muddle as sheer necessity leads to the stacking of numbers of the same components in different places. There is also a tendency for components which are last in to be first out, thus leading to an accumulation of old and deteriorating stocks in the backs of bins.

The modern practice in a palletized works store is to have a definite pallet stacking pattern and to fill the store by putting pallets into whatever spaces are vacant in the pattern. Reliance is placed on some simple system of pallet and stores documentation to keep a check on the location of components. Pallets and tote boxes each contain only one type of component. Record cards are stacked in the order of receipt, so that containers are passed out of store in the same order in which they come in.

Pallets are normally stacked so that each pallet is immediately accessible to forklift trucks. Solid block stacking, however, is also possible, and a commercial system known as the Flowblock Pallet Storage System has been evolved by Messrs. Fisher and Ludlow of Birmingham. In this system considerable economies of space are made, but pallets have to be located by a simple index, and extracted from the stack by a process akin to shuffling. This system, which is well worth military study, is the subject of a film, made by the firm, and can be seen in operation in the firm's own works.

CHECKING AND INSPECTION

Checking and inspection are operations which crop up again and again in any productive process. They are inherent in the maintenance of quantity and quality. They are required for incoming material, at intermediate stages, and for outgoing products. They involve counting, scrutiny and measurement and they often involve moving material. If unintelligently executed they can lead to serious losses of efficiency.

It is important to eliminate unnecessary checks and inspections. This can be done to the suppliers' and receivers' mutual advantage by having receivers' representatives with the supplying firm. It is better for all concerned that material, if it has to be rejected, should be rejected at the supplier's end rather than at the receiver's. Similarly, within a factory, it is important that inspection should, as far as possible, be integrated with production, so that the minimum of extra movement is involved, and rejection takes place as soon as possible after a slip has been made. Inspectors should be tactful as well as highly skilled. It should be clearly recognized throughout the organization that the object of inspection is to maintain the flow of proper quality production, and not to impede it. The inspector's aim should be not so much to reject unsuitable work, as to put the trouble right at its source. The provision of suitable, though often simple, appliances and gauges of the " go " and " not go " type is essential to speed up the processes of inspection. Gauges, to the inspector, are as important as jigs to the producer.

DESIGN FOR PRODUCTION

Details of design have an immense bearing on the problems of production. A good designer will have a good idea of how his design might be produced. A good production engineer, however, will almost certainly be able to make important improvements to the design from the point of view of production. The most intimate collaboration between designers and production engineers is necessary in order to obtain real productive efficiency. This is particularly important in the military field, where scarcity of materials and machines may dislocate the production plans for even the most carefully thought-out design. Designs must be kept under careful review, and changed intelligently if the needs of production are seen to require it.

PRODUCTION PLANNING

Provided the planning officer has a proper knowledge of the factors involved, production planning is little different from any other type of engineer planning. The planning officer must be told the quantities of the various items he is to produce by definite dates, and the resources which are available, or can be made available for this purpose. Such resources include men, machines, material, transport, power and premises.

To allow an outline plan to be made three main questions must be settled ; the proportion of time to be allotted to setting up ; the question of shift as opposed to day working ; and the establishment of the time cycle on the assembly line.

There is always a danger of undue pressure from above to start work prematurely without proper planning and setting up. This may lead to serious production losses in the long run. There is, of course, also, the danger of going to the other extreme. The planner must strike a happy balance in the use of the time at his disposal.

In considering shift working it must be remembered that men work better by day, but that machines are most productive if driven day and night. The greater the degree of mechanization in the factory the more likely is shift working to be profitable. A compromise may eventually be reached by making certain key machines work shifts, with the rest of the factory working only by day.

The assembly time cycle is dependent only on the required daily output, the hours to be worked per day, and the number of assembly lines to be worked in parallel, with appropriate allowances to cover the possibilities of breakdowns or delays.

The assembly line must now be planned. The assembly processes must be established, and also the method of movement along the assembly line. This must be related to the premises available. Planning must cover the provision of assembly jigs and fixtures, and of power tools, and the delivery of components and sub-assemblies to the correct points. Inspection, checking, packing and dispatch must be carefully related to the operation of the assembly line.

Thought and planning must then spread back along the flow lines of components and sub-assemblies. These reach back through the finished part store to the component production lines. Decisions will have to be taken on machine layout and the flow rate through machines. Each operation must be tailored to fit the time cycle, or some multiple or sub-multiple of it.

Finally, planning will be concerned with the receipt of incoming stores, storage problems, documentation, methods of stores issue and control, and liaison with the suppliers of stores.

In brief, remembering the analogy of a river, production planning must start at the mouth and work its way backwards, through the main stream and tributaries, to every source at which production starts to flow.

THE PLANNING OF DETAIL

This article has dealt in main with general principles. The understanding of principle is the first step towards effectiveness in planning of any kind. Production planning, however, is not only a question of understanding principle. It requires the most profound and systematic attention to detail. Flow production in modern industry has been defined as "super-planning." "Super-planning" means sound principles and super-attention to detail. It is attention to detail which gives punch to production.

Detail is studied in many different ways. Space here will allow the consideration of only one example. This is a work simplification chart reproduced from the Anglo-American Council on Productivity Report on Materials Handling in Industry (see page 255). In this a small portion of a production sequence is critically analysed. The material flow is recorded under the heads "operation," "transport," "inspection," "quantity check," "delay" and "store." Items are linked together in a sequence of events, but each one is clearly isolated so that it can be the subject of critical study. Other examples of similar charts can be seen in this and other publications mentioned in the bibliography at the end of this article.

ATTITUDE

In the modern approach to production planning attitude is regarded as all important. Nothing is truer than the old adage that "where there's a will there's a way." On this the following quotations will suffice.

"The problem of how to increase productivity is not created by engineering difficulties or lack of 'know how.' The problem lies in the attitude of mind of managers, engineers, supervisors, operators, in fact the attitude of all who are erroneously convinced that they are already using the best possible methods, the best possible equipment, the best possible design. The difficulty is to convince such people that 'there is always a better method.'"

John Bright in "You Can Speed Supplies," *Mech. Handling*, Sept., 1952.

"The attitude of top management is reflected throughout an organization. No results can be derived from a negative management which somewhat critically awaits the upward submission of ideas. Therein lies frustration."

C. G. Chantril.

SUMMARY

1. The development of productive capacity in overseas theatres is one of the most important aspects of major war.

2. Shortages of manpower, and in particular skilled manpower, demand the utmost efficiency in production methods.

3. Similar problems are met in the civilian field, and are being overcome by the application of flow production methods based on modern material handling equipment and ideas.

4. An important development since the last war is the extended use of forklift trucks and pallets in the flow lines and storage areas of factories.

5. The use for production purposes of forklift trucks and pallets, with their speed of deployment and flexibility in operation, warrants careful study in military circles.

6. Productivity is obtained not merely by the lavish use of expensive equipment, but by the systematic planning of production based on the detailed analysis of productive and non-productive processes.

7. Attitude is all important.

CONCLUSION

Production is the prime function of industry and a prime factor of war. This article is an attempt to relate some current thoughts on the planning of production to the problems of military production in overseas theatres of war. Little can be learnt from an article of this nature, except perhaps, how to look with seeing eyes into the vast fields of production which fill the modern world. Much can be learnt from such study. This article will more than fulfil its purpose if it serves in some way as an introduction and a guide.

SOME RECENT BOOKS AND PAPERS ON THIS SUBJECT

Productivity Report—*Materials Handling in Industry.*

Productivity Report—*Freight Handling*

Materials Handling in Industry, G. Landon-Goodman.

Materials Handling in Works Stores, L. J. Hoefkens.

" The Basic Principles of Mass and Flow Production," F. G. Woollard in *Mechanical Handling*, April, 1952, *et. seq.*

" Materials Handling in the Factory," C. G. Chantrill in *Mechanical Handling*, July, 1952, *et seq.*

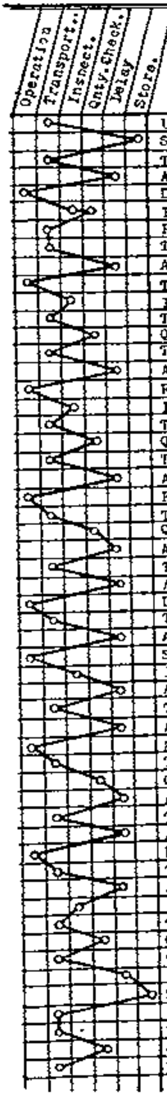
" You Can Speed Supplies," John Bright in *Mechanical Handling*, September, 1952.

WORK SIMPLIFICATION CHART

Part No: 60908	Part Name: SMALL DIECASTING
Point at which chart begins:	FOUNDRY RECEIVING
Point at which chart ends:	ASSEMBLY SHOP
Materials Information:	ALUMINIUM ALLOY INGOTS RECEIVED
LOOSE EVERY DAY	
No. components/unit Costed:	ONE
No. of Units per week:	200
Charted by: D.C.H.	Date: 7.8.49.

SUMMARY.

Event.	No.Off
Operations	8
Transportations.	20
Inspections	5
Quantity Checks.	7
Delays	13
Storages.	2
Distance travelled	2030 feet



Description of Event.	Dist. Moved In: Feet	Remarks:
Unload Ingots	20	Needs considerable improvement
Store		
Transport to Diecasting Machine	200	
Await Melting		
Diecast		
Inspect & count		
Place in Box Truck		
Transport to Press Shop	200	
Await Trimming		Some of these items can be eliminated by combining quality & quantity check with trimming
Trim		
Inspect		
Transport to Checking Bay	90	
Quantity Check		
Transport to Fettling	45	
Await Fettling		
Fettle		
Inspect		
Transport to Clearance Bay	45	
Quantity Check		
Transport to Capstan	140	
Await Capstan		
Form, Bore & Ream		
Transport to Checking	110	
Quantity Check		
Await Transport		
Transport to Degreaser	170.	Investigate possibility of deletion.
Await Degreasing		
Degrease		
Transport to Spotfacer	40	
Await Spotfacing		
Spotface		These four items now eliminated by re-designing the spotfacing cutter to deburr at the same time.
Inspect		
Await Transport		
Transport to Burring	10	
Await Burring		
Remove Burr		
Transport to Checking Bay	160	
Quantity Check		
Await Transport		
Transport to Degreaser	170	
Await Degreasing		
Degrease		
Transport to Inspection Bay	170	
Await Inspection		
Inspect		
Transport to Sub Store	180	Paper work & handling operations eliminated by transporting direct to assembly bay, eliminating entry to Sub-Stores (Production Control have approved this arrangement).
Quantity Check		
Transport to Bin	50	
Make Out Record Card		
Store		
Load to Truck		
Transport to Scales	50	
Quantity Check		
Transport to Assembly Bay	285	

This chart shows the work involved in the progress of a small casting.

Of the fifty-four events which occur, only eight operations shown in the first column had been pre-planned and time studied. These are the only operations which would be directly shown in a normal costing system.

A mere glance at the chart showed that several of the forty-six non-productive operations, could be completely eliminated.

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THIN GREEN LINES

By MAJOR J. I. PURSER, R.E.

NOTE.—It is emphasized that certain views expressed in this article do not reflect current War Office policy.

THE duty officer in his C.V. near Hamm (*R.E. Journal*, March, 1953, page 52) had some thought-provoking ideas about minefields. As a result I would also like to set down a few thoughts on the same subject, and in doing so will try to consider the problem from first principles. I believe that we still do not take full advantage of the mine as a potential obstacle because, despite the new laying drills, we have not yet wholly rid ourselves of the idea of a minefield being laid to a pattern, usually of a number of more or less parallel rows. It is this rigidity, this fixed idea of a pattern of continuous rows, which to my mind greatly reduces the possible effectiveness of a minefield.

The minefield has four characteristics which we want to get clear in our minds if we are to make the best use of it.

It is first of all a double-edged weapon. Whilst this to some extent is true of any obstacle, in that it cramps the style of both attacker and defender, the minefield can be a particular menace. Even though the defender knows where it is—or thinks he does from his map—it is not visible like a river and mistakes can, and do, happen. This fact may seem patently obvious but it is easily forgotten, particularly in the early stages of preparing the defensive position when the cry on all sides is often for mines and more mines. Once laid they cannot easily be picked up, so I think we want to be very careful before we start laying mines *within* the defensive position. However well we plan our counter attack and counter penetration tasks, it will be a bold man who will prophesy just how the battle will go ; and that cunningly-laid minefield on the flank or rear of a position designed to prevent its capture from that direction may well turn out to be the main obstacle in the way of any counter attack put in should that position be overrun.

The second characteristic is that the minefield can be laid practically anywhere and it can, and must, therefore be made to fit the defence. To talk about having positions to cover the minefields is completely the wrong approach. It is well known that one of the difficulties in defending a river line is that, in order to cover the river obstacle, the defenders are often forced to take up positions that are tactically quite unsuitable. The same must not be allowed to happen with the minefield. The greater part of the minefields must, of course, be covered by fire, but this we can do, not by positioning the F.D.Ls., but by positioning the minefields to suit the F.D.Ls. When we come on to the desirability of having mines in depth, however, we may find that we shall want to have some positions forward in the minefields, but these must be provided by our screens and not be our main defensive positions.

The third characteristic of the minefield is the ability to conceal it. I feel we have rather lost sight of this characteristic recently by going in for mines in quantity. I believe that any attempt to lay enormous minefield barriers is quite futile, because of the fact that they cannot be concealed. A large part of the value of a minefield is lost once its extent and disposition is known. Surprise is lost and the attacker can either take steps to avoid it or, more probably, assuming the mines have been laid in the most advantageous place, make a plan to breach it. Furthermore the layout of the minefields may also reveal the layout of the defensive localities.

It will be argued that the air photo will always reveal the minefield. I think this is only so if the mines are laid in any sort of pattern because an airphoto always reveals anything unnatural ; and there is nothing very natural about a regular pattern of mines, even if the pattern is confined to straight rows of mines at even spacing between mines. It is this regular pattern of little dots on the photo that shows up ; irregular marks will probably not be noticed because there are invariably innumerable little scars and irregularities in any piece of ground, and these in addition to fences and hedgerows want to be made full use of. Another disadvantage of the regular pattern is that, even if the minefield has not been spotted from the air, it will be very much easier to locate once the first vehicle has set one off. It is only a matter of casting around and finding one or two for the whole row to be located.

It is the inability to locate and define the limits of a minefield that make it so difficult for the attacker to deal with. Suppose some tanks have been halted by mines. They may well be a hundred yards apart. All the attacker can say at this stage with any certainty is that there were mines where the vehicles were stopped. Does he know the forward edge? Tanks may well have passed through the first rows unscathed. So to start with he has either got to allow a fair margin of safety on his side of the damaged vehicles, behind which he must start clearing or else take the risk of losing some tanks right at the start of his apparently cleared lane. Then how far do the mines extend? It may be obvious to say that it is difficult to make a plan when you don't know what exactly it is you have to do, but that is just about what the attacker is up against with a well concealed minefield.

The last characteristic of the minefield is its actual value as an obstacle. We can say of a river, for example, that it is a complete obstacle : the only way to cross it is by building rafts or bridges. This is not so with the minefield. Although we can draw on our maps little green lines to represent the rows of mines (or more correctly little green spots in rectangles to represent mine belts), these rows are not complete obstacles. The fact is that a minefield, even a thick one, acts only as a filter, and a very haphazard one at that. If we take a strip or row of mines with one mine every 3 yds. the mathematical effectiveness of the strip is about 30 per cent, i.e., it will, on the average, stop about one in three vehicles. But of course it is essentially a matter of chance and any one particular strip may not stop any. Nevertheless it is a deterrent to have a third of one's tanks immobilized during an attack, and this by only one strip of mines. If we remember then that the minefield is only a filter, we may avoid the snare of ringing round our defensive positions with little green spots inside rectangles and imagining that these will stop tanks.

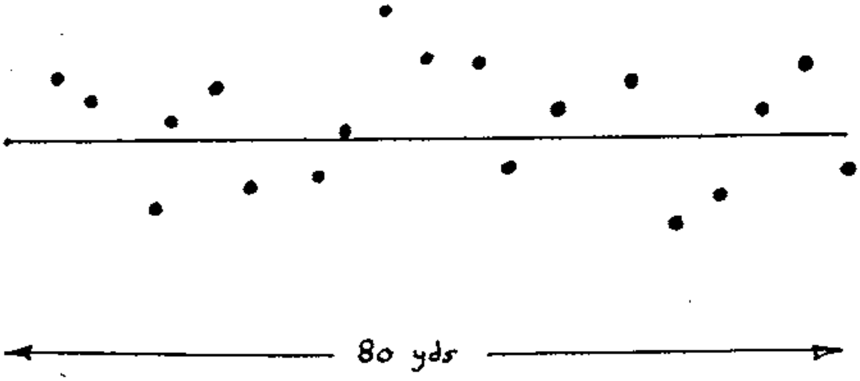
Herein, of course, lies the weakness of the mine. It can only be overcome by laying enormous numbers, but this will rarely be possible because of limitations in time and labour. And as I have said to lay large numbers without any attempt at concealment is a waste of effort, as it removes the mine's great asset of surprise.

Remembering, therefore, that the minefield is a two-edged weapon and that it is only a filter, the problem is how to dispose them on the ground so that (*a*) they fit the defensive positions and (*b*) cannot easily be located by the attacker.

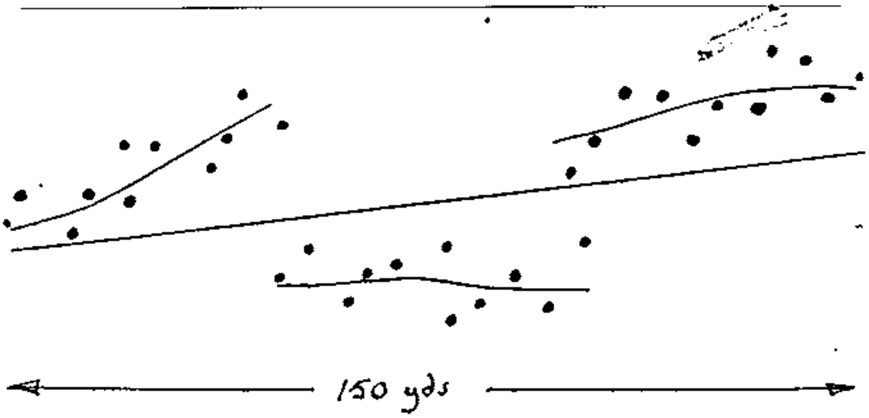
I will take the second of these first. It is obvious that we have got to make a start somewhere by having some sort of basic pattern and laying drill. To try and scatter a number of mines in a given area will be as difficult to do as it will be to form any idea of their possible effectiveness as an obstacle. It seems to me that the basis to work on will be an irregular strip containing on the average one mine every 4 yds. This gives it, by itself, a reasonable obstacle value of about 25 per cent. It would be attractive to close up the mines to one every 3 or even 2 yds., thereby making it 50 per cent effective. But there are snags to this : we may not have sufficient mines to give the field depth ; they will be easier to find ; and there is the danger of sympathetic detonation. However, we need not always be bound by this idea of laying them at a fixed average spacing, and if circumstances demand we can increase or decrease the spacing.

The actual strip might look something like Sketch 1.

This strip would be laid to conform to hedgerows, changes of cultivation, broken ground, irregular marks or patches in a field, and so on. It will, of course, be as stupid to lay them invariably along hedgerows as to lay them in straight, soldierly lines across fields regardless of natural features, as the enemy will soon tumble to this. The great thing is to have variety.



Sketch 1



Sketch 2

Strips may not be more than fifty or a hundred yards long, sometimes less, nor need they be straight, as once again there is the danger of there being a discernible pattern. So we will make breaks here and there as shown in Sketch 2. But it is still virtually a strip and there are no real gaps. (The continuous line down the middle represents the line that might appear on a 1/25,000 map to denote its position.)

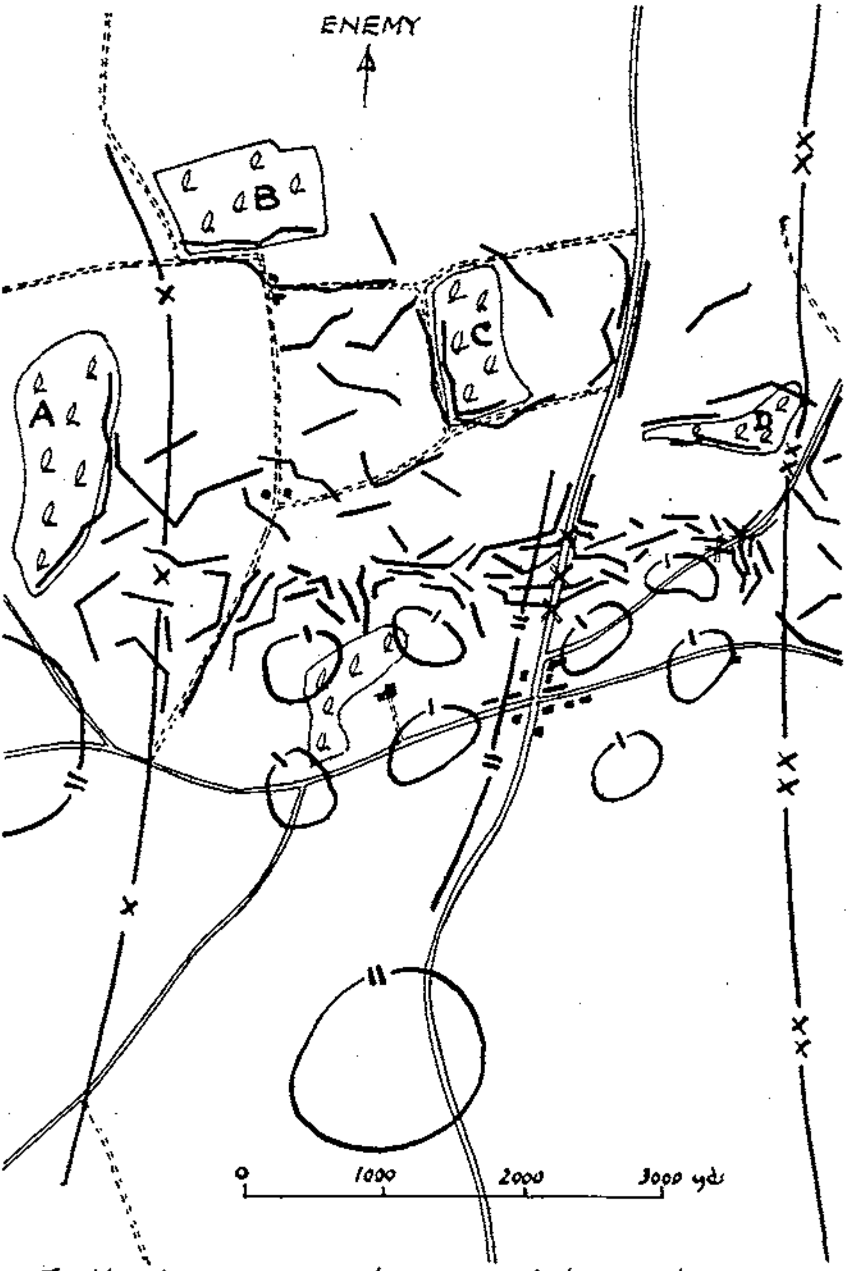
Our minefield will be built up of a number of these strips laid in varying directions and of varying lengths. In this manner we can economize in mines, because, instead of having to lay a field (or belt) consisting of a fixed number of rows all one behind the other and of the same length, we are now free to curtail a strip or leave small gaps in those places where the mines might not be very effective (for instance, in places where it is apparent that tanks are most unlikely to go). Nor must we be afraid to leave what look like gaps in our strips. When all is said and done, a minefield can never be a solid obstacle ; it will always consist of more space than mines. It is quite logical therefore to have strips of mines covering off gaps in the strips in front, just as in the old rigid patterned minefield we had mines covering off the spaces in the rows in front.

I can see two possible objections to this method. One is the difficulty of laying. I don't think this will be quite so great, though true enough, we may not be able to lay them quite so fast this way as if we adopted a more straightforward pattern. But as I have tried to show, I believe that a number of mines well hidden will be far more effective than a slightly larger number unconcealed. Also, I think we tend to make too much fuss about laying drills, when really all we need to do, basically, is to give each man two mines and tell him to bury and arm them ; 'and when he's done that to do the same with two more.

The second is the question of recording. Once again I think we tend to make heavy weather of this and the need to be able to recover our own mines. I know it is rather important on training to recover the ten-shilling lumps of concrete that we lay when we know we're going to have to pay for those we don't. But in operations I wonder how easy it is going to be to recover our mines, should we have to, even supposing them to be laid in a simple pattern. Landmarks and datum points are quickly obliterated and I doubt if the record of a minefield made by one officer will be of much use to someone else months later. On the other hand, it is still possible to make a reasonable record—I have found that a sketch to a scale of 1/10,000 is a most effective means of doing this and can easily be made by enlarging up a 1/25,000 map—and with this the officer laying should be able to recover the mines in a given area a few nights later if it is required to do so. Longer than this time I think he would be unwise to trust to his own sketch, as with the ebb and flow of the battle the enemy may well have superimposed his own mines on the original field.

We have now got our basic pattern (which is really a misnomer as its aim is to appear as little like a pattern as possible), and we can take a look to see how best to fit these strips into the defensive layout. There are clearly hundreds of solutions, and I am only going to indicate a line of thought that might be used.

Sketch 3 shows a brigade defensive sector, with the enemy at the top of the page. Localities are shown down to companies. To avoid confusion only the major roads, tracks and woods are shown,



The black lines — represent a series of strips as shewn in sketch 2, at an average spacing of one mine every four yards

Sketch 3

but we must imagine that the country is gently undulating with variations in height up to about fifty feet or so in places, and that the whole is fairly well hedged and fenced. Where suitable, full use will be made of these to hide our mines and wire. Fields of fire vary from a hundred yards to nearly two thousand in some places. The main road running north and south lies in a slight valley, with on the left (as we look at the sketch) a ridge, which is the main likely tank approach, running through the left forward battalion position and on to the reserve battalion. The right forward battalion is also on a slight rise, but not such a prominent one as the others. From some points in the reserve position good shoots can be had up the slight depression on the left of wood " A ".

We must first ensure that the enemy following up our withdrawing covering force cannot readily bounce the position via the main road, so we will lay a fairly compact minefield astride it and in good view of our forward localities. As the road will have to be well cratered we cannot expect to achieve much surprise here except possibly in the first encounter. Some of these strips link up with those close to the battalion positions ; others it will be noted run parallel to the road and towards the enemy in order to catch any of his vehicles that try to get off the road into the fields to gain cover. The other minor road will be similarly treated.

The enemy's intelligence will very likely have indicated the general area of our defensive position, so he will quickly start probing in on either side of the main road. He will doubtless try to get up into the woods " C " and " D " as a start, so we will lay a few mines in these areas to deter him. We must not forget that these mines may well be missed by the first vehicles moving in the area and their effect not be felt till later. Also, even if these mines are not covered by fire every tank temporarily immobilized is one up to us, as it has got to be re-tracked and made mobile again. This is apart from the moral effect of knowing that there are mines about.

The forward battalion positions must have mines within range of their own small arms and anti-tank weapons to deal with those tanks that will inevitably get round or through any outer belts of mines that are laid, and they ought to be sited thickest where we think the enemy is most likely to come or where we would least like him to. They will not necessarily ring the positions in a continuous belt. The rear edge of these strips should not be too close. If we keep it about 300 or 400 yards away we shall, in addition to having room for our wire, be able to thicken up with more mines on our side later on during the course of the battle when opportunity and more mines permit. In this connexion we do not want to regard the minefield as something static which, once laid, is finished with. It can be added to night after night. A small party of ten can go out and lay twenty or forty mines in a night (quite possibly more but it will depend entirely on who dominates no-man's-land)—i.e., a strip 80 to 160 yards long. But the farther out in no-man's-land they have to lay them, the more difficult it will be, and we will have to keep this in mind when deciding on our priorities ; it may be desirable to lay those nearest the positions first, but if we do this we may never get the opportunity to lay others farther out.

The main tank approach is the next thing to be considered, the ridge running south from between the woods " B " and " C ". In passing, woods are not necessarily tank obstacles—in fact few are. They will often form excellent forming-up places from which to debouch. On this piece of ground we want to make the enemy mine-conscious early on. To do this we will lay the mines in great depth, but not necessarily at great density. The same number of mines laid in a narrow or deep belt will take the same eventual toll, the only difference being that the effect will be more gradual. This is not necessarily a disadvantage. If tanks run into a narrow dense belt a number of them will be immobilized more or less at the same time, and if the effect is great enough will cause the attack to be halted, the tanks that are still runners withdrawn and a new plan made. If, on the other hand, the effect is a gradual whittling down it will be very difficult to decide whether to call it off or not, and the decision may be taken to go on until the time comes when it is clear that there are not enough tanks to press home the attack effectively. By this time it may be very difficult for the attackers to extricate themselves before our own anti-tank weapons have taken a good toll of them. The enemy will probably try to turn his immobilized tanks into pillboxes and reinforce them with infantry. For this reason we want to adopt an aggressive policy of sending out tank hunting parties at night (with engineers) to destroy these non-runners, or at least prevent the enemy recovering or repairing them. The more isolated the tanks are on the battlefield the easier this will be.

Lastly we must consider the flanks. We know that the enemy will try to locate and attack along the boundaries between positions. The mines here will obviously have to be laid in conjunction with flanking formations, and they should be both dense and deep.

We have now laid about 10,000 mines in the area shown on the sketch ; some of these are outside the brigade sector, but in the sector there are about 7,000 or 8,000. Within the small size of sketch it is impossible to show the mine strips in detail. Each line represents a continuous line like the one running through the strip illustrated in Sketch 2, with mines on an average every 4 yds. From the enemy point of view the minefield is virtually 2,000 yards deep across the whole front. The only marking that will appear will be along the rear edge. Gaps will be recorded rather than mined areas, and to the defenders the whole area will be regarded as a minefield with certain recognized routes for patrols or outposts.

How are we going to prevent the enemy from lifting those mines that have been laid well forward? This is not easy, but we must remember that he cannot see our mines like we can as little green lines on the map. To him the whole area is a potential minefield, and a big undertaking to clear. If he only clears lanes or sticks to those tracks which by experience he has found to be devoid of mines he will deny himself freedom of manœuvre. Nevertheless we cannot rely on such a passive policy, and we must have our screens forward in the minefield, armed possibly with some M.M.Gs., but at any rate with L.M.Gs. and rocket launchers, and with communications to enable them to call for artillery fire. This I think is the only case where we want to site positions to cover the mines, and depart from our main principle of siting the mines to conform to the defensive positions. These screens will be very hard to maintain, and they will probably have to do without transport. This may, in fact, be a good thing as, unhampered by the difficulty of hiding vehicles well forward and of moving them through the minefields, they will be more mobile and can shift their positions or extricate themselves more easily. Their tasks will be to make the enemy deploy early, report on his movements and harass his attempts to clear the mines at night or under cover of smoke. They must be prepared to fight all the way back through the minefield, delaying the enemy as long as possible.

The question of having a few tanks or heavy anti-tank weapons well forward as well is a difficult one. Clearly we would like to have some hard hitting guns well up, but the difficulty may be to extricate them through our own minefields, especially without giving away routes through them. On the other hand, it may be to our advantage to risk losing a few tanks if by so doing they can account for more of the enemy's and delay his main attack.

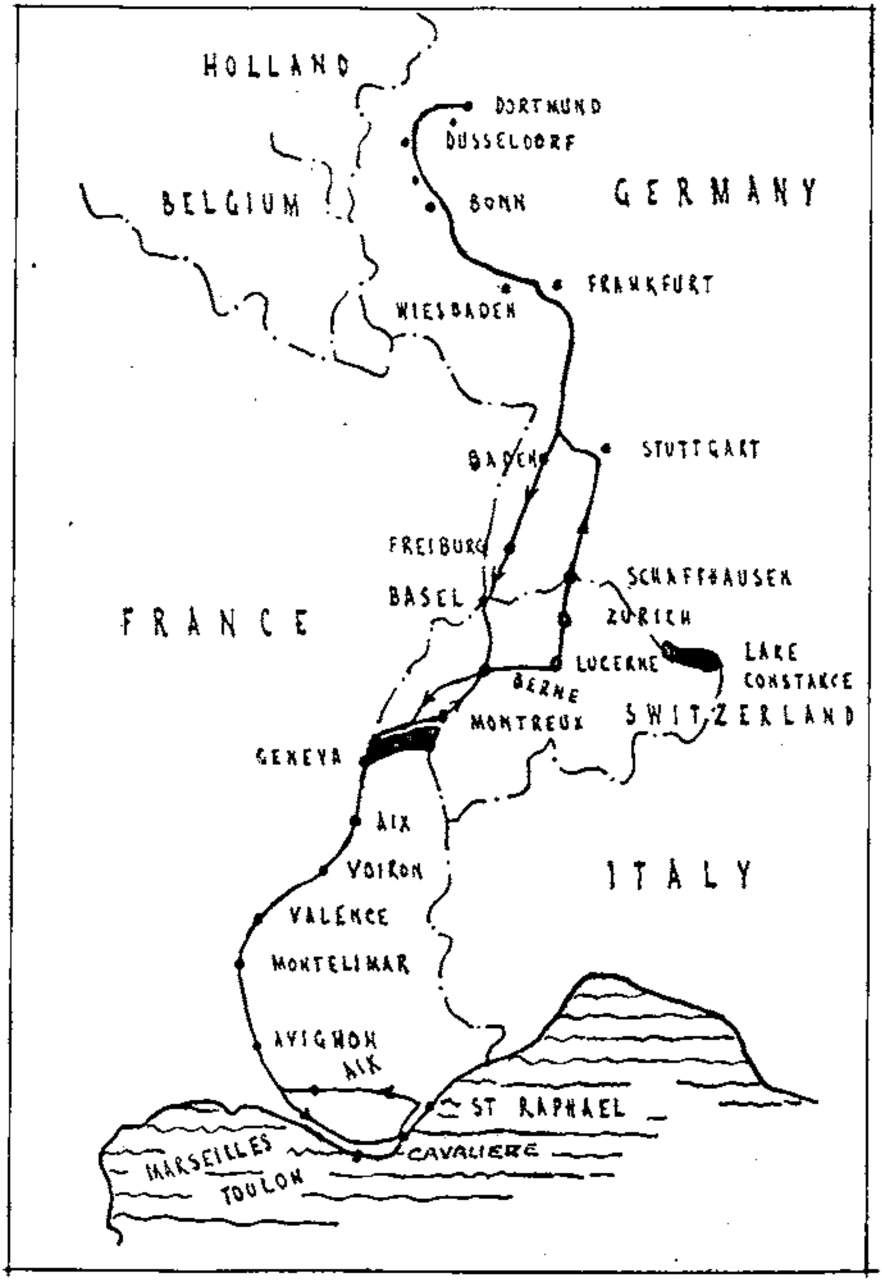
There must also be close liaison between the gunners and the engineers in the matter of bringing down D.F. It is not sufficient to indicate a minebelt as being an area for D.F. The actual strip can be recorded as the D.F. task (or at least its position known to the gunners), as this is where vehicles will be halted and where the enemy may either be engaged in looking for mines, recovering the vehicle, or forming a strong point round an immobilized tank as I have already suggested they might do. If medium guns can be used for this so much the better.

Anti-personnel mines can help to make the enemy's task of clearing the anti-tank mines more difficult. But however well recorded their positions may be these will never be known sufficiently accurately to stop them being a menace to our patrols, and, as I've indicated, we want to be free to patrol aggressively in our own minefields. They must, therefore, be laid only around the forward edges of the minefields or in (to us) easily recognizable areas. In mass their stopping effect is insignificant. They are largely a moral weapon. They will, however, hinder the attacker's mine clearance teams, though for this purpose I think a simple anti-handling device (on the lines of the " mouse-trap " mechanism) might pay better dividends.

I have made no mention of wire. I think this is primarily a close-in obstacle well covered by rifle and M.G. fire, and possibly close D.F., though there may be occasions when it can be laid well out in certain areas where M.M.Gs. can get good shoots. I do not think it can be effectively used to hinder clearance of the forward strips of mines, and as, of course, it is well nigh impossible to conceal, its use might destroy the advantages gained by hiding the mines.

Finally, how is this minefield plan actually going to be made and the necessary orders for its execution given out? I think the point to make here is that the commander, not below brigade level, will say what areas he wants mined and what routes or gaps left open, and in addition indicate to what extent he wants the mines to be in depth or in narrow belts, whether he wants them primarily to stop tanks altogether (if possible) or simply to hinder them, and to what extent he is prepared to allow anti-personnel mines to be used. The engineer will have to be with the commander during this planning because, apart from advising him on the resources available and the capability of utilizing them, he must be thoroughly conversant with the commander's ideas on how he wants to fight the coming battle, which areas he considers most important, how he proposes to use his screens, whether he wants tanks forward in the early stages, and so on. Once this general plan has been made and the engineer is quite clear as to what the commander has in mind, he can, I think, be left to get on with the detail, using every possible means of laying the mines to the best advantage. On certain points of detail he will obviously have to be in very close touch with the forward battalions, the divisional regiment R.A.C. and the gunners.

In summing up, to make the most of the mine we must be quite clear about the minefield's characteristics which are: its potential source of embarrassment to the defender as much as to the attacker, its ability to be laid practically anywhere and to be well hidden, and its effectiveness on the lines of a filter rather than a solid obstacle. As to its employment, as I see it very briefly, the whole thing depends, if it is to be of any value, on the use of every ounce of imagination, subtlety and low cunning. If we don't do this—if we rely purely on brute force and b—— ignorance—its effectiveness will be largely lost.



ROUTE TAKEN ON CARAVAN HOLIDAY

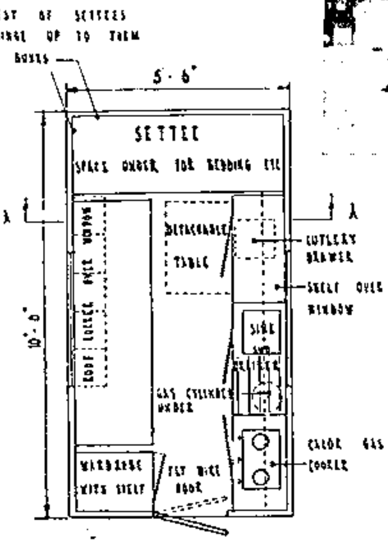
A CARAVAN HOLIDAY TO THE RIVIERA

By MAJOR H. G. W. HAMILTON, M.B.E., R.E.

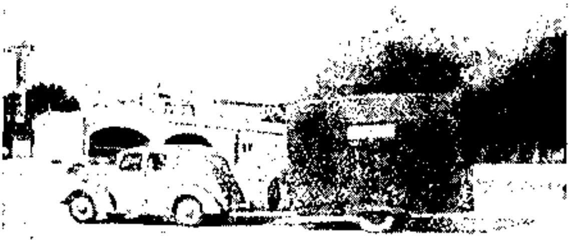
IT all started soon after we had taken delivery of our car at Dortmund where we are stationed in Germany. The car is a Ford Prefect, a bit smaller than we would have liked, but the delays in getting the necessary bank permits, coupled with the inevitability of having to pay purchase tax on return to England, precluded a larger and more expensive one. " We must go on a touring holiday this summer," said my wife, " France and Switzerland perhaps." But we had already used all but £40 of our combined foreign exchange for the year, and hotels are expensive for a family of four. So we decided to camp and take a tent, but this meant primus stoves, and my wife had had enough of them nursing in Africa and Italy. " Perhaps we could borrow an Army jeep trailer and put a calor gas cooker in it, and it would also take the tent," she suggested, " or, if that isn't possible, you could make one." Having decided to make the thing, our ideas grew until finally we decided to build a caravan, a light one, but one that would sleep the four of us ; we have 7-year-old twin daughters. Many evenings were spent with paper and pencil roughing out a design and the final outcome is shown on the diagram. The bodywork wouldn't be difficult, I could do that with wood and hardboard and in point of fact did, but metalwork and the equipment involved in making the chassis and undercarriage is not in my line. After many fruitless attempts to buy a chassis complete (one German firm wanted £60 without wheels or tyres), we found an old axle with wheels and tyres complete for 100 DM, some old pieces of angle iron and some old springs, and had these made up into a chassis.

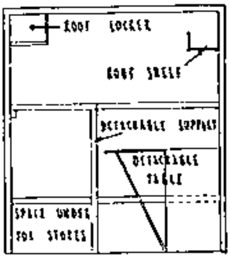
The chassis and bodywork were connected up and by 5th July we were ready to go, having had things like a ball hitch, gas stove and finally a light perspex sink sent out from England. The latter arrived the night before we left and was fitted a couple of hours before we departed. By the time we'd packed everything, the springs didn't look happy and there was little clearance between the axle and the chassis, but it was too late then to do anything and we decided to chance it.

It was mid-morning by the time we were ready and our first lap was along the magnificent *Autobahn*, an excellent way of starting,



PLAN





SECTION A-A WHEN TOP BUNKS ARE RAISED & TABLE IS IN POSITION

CARAVAN

as the grades were never big and the surface, except for the part through the Ruhr towns, usually excellent. However, after ten miles we had our first puncture. We hadn't a spare, so we jacked up and I was left to get lunch while my wife went off to get the tyre mended. (We'd heard tales of hold-ups on the *Autobahn* by D.Ps., and anyway a woman in distress can usually get a garage to do repairs more quickly than a man.) That night we spent in the yard of an inn near Bonn, where everyone was very friendly and interested. It was a mistake, however, as they locked the gate unknown to us and we couldn't get away to an early start. Lunch at Frankfurt and more *Autobahn* gave us a good mileage the next day and we ended up in the lovely hills above Baden-Baden. We found we could cruise comfortably at 35 m.p.h. on the *Autobahn*, but once we were off it, we couldn't do much more than thirty.

As it was hot we decided to start early each morning and drive for a couple of hours before breakfast and this always proved a good investment. The Germans, and French for that matter, in the country districts rise early and we found we could do our marketing for eggs and milk in the village markets often at 6 a.m. That morning we stopped for breakfast in a little village near Freiburg and were entertained by the sale of some squealing piglets outside our van door, much to the delight of the twins. A few miles from Basle, a violent thunderstorm caused us to shelter for fear of the van being blown over, and soon after we had our second puncture. These mishaps cut down our mileage for that day, but we had no difficulties at the Customs and were through in a matter of minutes.

Basle is an interesting town and we had a look at the Münster and had hot (and very expensive) chocolate in a café overlooking the Rhine, before continuing to Berne. There the children were fascinated by the clock, which provides a variety of entertainment at the hour, and also by the antics of the bears in the bear pit. The grades between Basle and Berne are all easy and " Susie," as the Prefect is called, had no difficuty in towing " Susannah," though she did get a bit warm on some of the steeper hills. We found a lovely site for that night on the lake of Geneva, just west of Lausanne, but we were glad of the fly wire netting we had over the windows and door, as the mosquitoes were out in force. Our usual early start took us past the next Customs outside Geneva before we had breakfast, but on approaching the little village of Albi near Aix Les Bains, an awful noise from behind announced our third puncture. Luckily we weren't far from the village, and it was soon put right, though we had lost an inner tube. However, a very peculiar noise had developed in the bearings and we limped into Albi to be told that the axle had cracked. Still, our luck was in, as although Albi hadn't a population of many more than 200, it had the usual magnificent French village garage, the proprietor in carpet slippers and his two sons with a week's stubble on their chins. They said they'd fix it and reset the springs, and by the time we'd gone into Aix for a much-needed bathe and even more needed money, they had " Susannah' in good trim and apologetically asked for Frs. 1,800, or about £1 18s. for their five hours' labour !

As the repairs were so cheap we decided to spend that night in a near-by hotel and have a good wash and a meal, but we regretted it afterwards, as our bill came to over £4 and we hardly had anything to eat. It seemed that breakdowns were cheaper than sleeping and eating. A 5 a.m. start took us through sleeping Aix Les Bains and over the pass to a fascinating place called Les Eschelles, where you drive through a tunnel and come out on a cliff face with miles of country spread out before you. After breakfasting near Voiron we were soon following the Rhone valley south from Valence along a grilling hot road through Montelimar, where every shop sells nougat. There wasn't much traffic and it seemed a case of " Mad dogs and Englishmen go out in the midday sun," and we had difficulty in finding some shade for lunch. Just before Avignon we had our fourth and final puncture, but again we were lucky as it occurred in a village. This time we had to buy a new inner tube and cover, which seriously cut into our financial reserves, but it stopped any further trouble. We pulled up for supper in one of the squares in Avignon inside the old walls. Avignon is a fascinating place with narrow (and rather smelly) streets and very old houses, but we couldn't go on without seeing the *Pont* even though it was dark by then.

As we were by now well behind our schedule, particularly as we had worked out from an atlas that the total distance was 850 miles to the coast when it was actually over 1,000, we decided to push on. We wrapped the children in blankets in the back of the car and set off towards Marseilles.

My dip light was not very good and also I hadn't the yellow filter that all French cars have, and I received many curses as people passed, some even driving straight at me and then swerving away, so I gave up after a couple of hours and pulled off the road at a petrol station. We'd done about 230 or more miles that day which was not bad as we'd had the puncture and a longish halt in Avignon, but the lure of a refreshing bathe in the Med got me going again early next morning and off we went with the twins still sleeping in the back of the car. Marseilles is a scruffy place and the main route takes you through the docks. Toulon is a little better, but the road surface on the cobbles is atrocious. However, by lunch we'd reached our objective—Cavaliere—and we lost no time in getting into the sea.

We had to look round for a site to camp for the three days which were all we could allow ourselves before starting back. Along that steep coast there are no possible casual sites which provide both shade and a degree of accessibility, and we eventually decided to camp in the organized site at Cavaliere. Here, for 250 Frs. per day (about 5s.), we were assured water and sanitation and the services of a shop which, had we had the money, could have provided all our meals. Most of our fellow campers were in tents, as there were few caravans, and our immediate neighbours were extremely friendly. On one side we had a Swiss family and on the other a French family with four girls and two boys, who adopted the twins and helped them to learn to swim.

By now we were starting to feel the financial effects of our breakdowns and the hotel at Aix les Bains. We had arrived on the Saturday and missed the bank to cash our remaining £10 travellers' cheque, and Monday was 14th July, Bastille Day, when the banks were shut again. However, the attractive girl in the camp office came to the rescue by waiving the rule for paying camp fees in advance and in addition lent me 1,000 Frs. to enable us to buy our milk and bread and fruit. These were the only items we had to purchase as we'd come with everything else in the caravan.

On Tuesday we packed up again and after visiting the bank, started a glorious drive along the coast towards Cannes, intending to take the Route Napoleon, north direct to Grenoble. Inquiries at St. Raphael, however, convinced us that the route was too steep and difficult for Susie and Susannah, and although on the map the distance looked much shorter, we worked out that the route back via Avignon and Valence was only twenty miles longer, due to the many hairpin bends on the Alpine route.

A final bathe at Frejus near St. Raphael and we sorrowfully left the Côte d'Azure and started off for home. We hadn't gone far when we came across an unfortunate honeymoon couple from England, who had had an argument with a large bus driven by a Spaniard to the detriment of their Minx. There was little we could do to help except to fortify them with coffee and whisky, as help was already on the way. That night we spent near Aix en Provence just off the road, and I don't think that we were very far from where Sir Jack Drummond and family were murdered a week or so later.

An early start the next day took us to Avignon where we went over the Pope's Palace and gardens and had a better daylight view of the *Pont*. We were interested to learn that the bridge was originally built in about A.D. 1100 and that only four of its original twenty-two arches were standing. It had not been used since the sixteenth century.

Our route back took us through Orange, the place from which the Dutch (and British) House of Orange took its name. After tea at Valence, we finished that day up in the pass with towering cliffs on either side, near Les Eschelles, a lonely spot, but rather magnificent.

We breakfasted next morning at Aix les Bains alongside the lake, and after doing some shopping, had another lovely bathe whilst the twins tried to catch minnows with an improvised net made out of surplus fly wire netting. We kept our fingers crossed whilst we passed Albi again, but Susannah was now behaving perfectly and was giving no trouble.

Our financial condition was now rapdily becoming desperate and we decided to see whether my grey suit, which my wife has always disliked, would fetch anything. In Geneva we diffidently walked into the local tourist agency—" Do you know where we could sell a suit as we are short of funds ? " we asked the clerk. " Certainly, sir," came the instant reply, and he even gave us a map and marked the shop and the route, as if impecunious Englishmen came in asking the same question every day ! However, £2 was all they offered, which was, of course, an insult !

After a most interesting tour of the League of Nations buildings, the guide saying his piece in three languages at each stopping place, we continued on to Vevey, just short of Montreux, where we made friends with the park keeper who allowed us to stay the night in his park on the water's edge.

We made inquiries of two or three locals regarding the suitability of the route south of Montreux over to Interlaken via Aigle and were assured that the grades were not too difficult, so off we set. However, within a few hundred yards of Aigle the road went straight up the mountains in a series of sharp hairpin bends. My wife and I took one look at each and said " No." How to turn on a hairpin corner was the next problem, but after unhitching the van and turning the car we managed, with the help of the occupants of a waiting car. This false information cost us thirty-four valuable miles, every one of which was eating into our slender financial reserves. We now took the route from Vevey to Berne and on to Lucerne and decided to give Interlaken a miss. Although there were many 10 per cent grades on this road, we had no difficulty, though we boiled coming up the first stretch from Vevey, and had to stop half-way up to cool off. We had lunch at the old university town of Fribourg, half-way between Vevey and Berne, and arrived at Lucerne that evening.

The lake looked lovely, but we drove on to Küssnacht, past the memorial chapel to Queen Astrid of Belgium, marking the spot where she was killed in a motor accident. We couldn't find a suitable spot here for the night and so we pushed on to the Zugsee and found a good site on the lake side between Cham and Zug.

For a change we started later the next morning after a pre-breakfast bathe in the lake, and came into Zürich, where my wife did a lot of window shopping around the magnificent shops there are in that city. Perhaps it was just as well that we had no money !

We were now down to our last few francs and I started to work out how much petrol I would require to get us into Germany where my B.A.O.R. petrol coupons would be valid again. Near Schaffhausen, I reckoned, I required a further three litres and had just sufficient money for that, but the girl misunderstood and put in five. After some rapid calculations we found that a tin of Nescafé was exactly the cost of five litres, and so on we went to see the magnificent Rhine Falls at Schaffhausen with the few francs and centimes we'd saved.

The frontier post is about ten miles north of Schaffhausen, and again we passed through the Swiss Customs with no delay. The German post was some distance on and between the two is a very steep hill which Susie refused to attempt after going up a third of the way. There was nothing for it but to back down and turn and go back into Switzerland. But we had no money and the needle was registering no petrol, so the route to Basle was out of the question. We were told to our relief that there was a small customs post on a side road and that there were no steep hills that way. We drove slowly and carefully, coasting down every incline and eventually passed through the post, but there was no sign of a German petrol pump. Another mile and we stopped, and there we were. There is one great thing about caravanning, delays over punctures, petrol difficulties and the like never really matter, as you only have to open up the van and one of you can use the time to get a meal going. It was supper time now, so my wife set to, whilst I stood in the road, jerrican in hand, ready to " flag " the first car. It wasn't a car, but one of those little motor scooters so popular now on the continent, and they have a very well sprung and comfortable pillion seat on which I was soon sitting. We had to go nearly six miles before we found a pump and then I had to hitch-hike back again. This time I found a commercial traveller with a *Volkswagen*. After a good and welcome supper we put the twins to bed in the car and pushed on, as it was now Saturday evening and I had to be back by Monday morning and we were still near the Swiss border. By 11 p.m. I'd had enough and we pulled in off the road about twenty miles south of Stuttgart.

The rest of our journey, mostly along the *Autobahn*, was uneventful, except that Susie indulged in her one and only misdemeanour and broke her fan belt near Frankfurt. With the van on behind, I couldn't risk going on without one, so leaving the van on the roadside, whilst my wife made some tea, I set off in search of a fan belt on this hot Sunday afternoon. I eventually found one at Wiesbaden that fitted after a considerable struggle.

We eventually reached barracks again soon after midnight, having done 364 miles that day which was not bad if the fan belt mishap, which cost us two hours, is taken into account.

We had done 2,210 miles in a fortnight, of which all but about sixty had been with the caravan behind. The Ford Prefect had certainly proved a reliable and tough little car, and the caravan had, except for the punctures, stood up very well.

The interior design of the caravan proved to be just what we wanted and I will not have to make any alterations, except to put in another window in the front for our holiday next year.

Next year, I think, we won't aim quite so high ; with a small car and children, 150 miles is quite enough for one day. But we thoroughly enjoyed our holiday and certainly felt that we had achieved something.

CROSSING THE CHANNEL IN A WHALER

By Captain I. T. C. Wilson, M.C., R.E.

IN 1772 Admiral Lord Nelson started his naval career in H.M.S. *Triumph*, guard ship in the Medway. As she was not a sea-going ship, the future Admiral spent most of his time in open ships' boats exploring the creeks in the area as part of his early training. In his own words " I became a good pilot . . . down to the Swin and the North Foreland." As a result of this the Nore Branch of the Royal Naval Sailing Association award a trophy, the Triumph Trophy, each year to the crew of a cutter, whaler or 14-ft. dinghy carrying out the best cruise over a weekend. A week-end being deemed to be from 1600 hrs. Friday until 0800 hrs. the following Monday.

It was decided that it was time the Sappers had a shot at winning the Triumph Trophy, so four of us, Captain E. N. Ross-Magenty, Captain G. L. Cooper, Captain A. A. Julius and myself got together to see what we could do about it. We decided at the start that the best possible chance would be a cross-channel trip. First of all we thought of doing the trip in two 14-ft. dinghies, keeping each other company, but when we looked at the map it became obvious that to sail from Chatham to Calais and return was a bit far to manage over a week-end. Sailing in dinghies presented problems about sleeping and eating too, and eventually discretion overcame valour and we decided that dinghys were not very suitable.

The S.M.E. had one whaler, on loan from the Navy, which was used primarily for teaching sailing, so we chose this for our week-end trip. We also decided that we would not try to start our journey from Chatham with a long sail down the Medway to start with, but that we would start from Sheerness and make the most of the tides to help us along. We chose the week-end 21st–22nd June for our attempt, partially because it was midsummer and therefore we would have a minimum of night sailing, but mainly because it was the only week-end which we could all really spare.

On Friday, 20th June, the whaler was towed down to Sheerness where it was given mooring space on the Gunwharf by 18 Water Transport Company, R.A.S.C. We had collected various items of kit which we thought we needed : oilskins, blankets, food, compass, torches, repair kit and life-jackets (to sleep on). This we loaded into cars and drove over to Sheerness, leaving Gordon Barracks in the evening. At Sheerness we unloaded our cars and prepared the whaler for sea. High tide was at 2347 hrs. and we wanted to go out on the ebb, so having got everything ready we went into the town for a last good meal. The meal was not exceptional, but the ties worn by some Italian Merchant Navy sailors in the same café were. Having had two thermos flasks filled with hot coffee, we returned to the Gunwharf and parked our cars.

The day had been lovely, sunshine with a fair breeze. At dusk the wind had dropped and we were a bit despondent, but with night a moderate to fresh westerly wind sprang up and we felt better. We climbed into the whaler, sorted ourselves out and prepared to go.

At 2345 hrs. we cast off our moorings and rowed clear of the Gunwharf. The wind now seemed to be quite fresh so we set the jib and mizzen sail and started off at that. Being a westerly wind it was almost dead astern as we sailed out into the estuary and round Garrison Point. Cooper and I took the first watch and the other two settled down to sleep in the bottom of the boat. We had baled out well before we started but there was still a little water in the bottom, so the life jackets helped to keep the sleepers dry. The hours of darkness passed quite quickly and uneventfully, except for one stage where we passed very near to some large uncharted buoys. We were making a good 3 knots under jib and mizzen, so for the sake of visibility we decided to postpone hoisting a mainsail until there was a bit more light. We managed to navigate quite easily, steering on a course set on a prismatic compass, and we picked up the various lights and buoys easily. We had no patent log, so we estimated our speed by dropping pieces of paper over the bows and timing them along the length of the boat.

Towards dawn the wind slackened a little and we hoisted the trysail and shortly afterwards changed that for the mainsail. As we did that, the whaler started to heel slightly and an agonised cry came from Ross-Magenty, who was sleeping on the leeward side and was getting wet, as the water in the whaler all went over to that side. At first light, about 0330 hrs., we were able to pick up landmarks on shore to confirm our position and found we were nearly off Birchington, about a mile off shore. The day was cloudy and promised to be dull but the wind freshened slightly and swung round to the south a little.

The watch changed at 0500 hrs. when we were just off Margate. We were making about 4 knots, and were still being helped by the tide. Here we had our hot coffee and a few biscuits and promised ourselves a proper breakfast when we changed watch again at

0900 hrs. Good progress continued, with Julius doing the navigating, and we began to be really hopeful of succeeding in our crossing. The wind was now south-westerly, moderate to fresh, but the sea was fairly calm and the sun made one or two brief appearances. At 0550 hrs. we rounded the North Foreland and changed course. At 0630 hrs. we passed Ramsgate and sailed on along the east coast until at 0750 hrs. we were off the Deal Bank and sighted the South Goodwin lightship. Here we changed course to south-east by east, which would take us close by the South Goodwin lightship and straight on to Calais. At 0830 hrs. we passed the lightship and waved our greetings to those on board. At this time we noticed that the wind seemed to be freshening and, as we started to hit the sea which was running in the Channel, we began to ship a little water, so we took in two reefs in the mainsail and that eased things somewhat.

At 0900 hrs. the watch changed once again, but it was now much too rough to attempt to cook a meal on our petrol cooker, so we fell back on the invaluable hardtack biscuits. As we went further into the Channel it became very rough (for a whaler) and some of the waves we met were at least ten feet. At this point we had a brief consultation on the advisability of turning back ; not that we were worried about the present sea, but we did not know how much more a whaler would take. We were, however, riding very nicely and we were all so keen to go on that we decided to chance it. A big factor in the decision was that at about this point we saw the coast of France. About ten miles out of Dover the sea seemed to be a bit calmer (or maybe we were getting used to it) and the sun came out, and apart from the occasional shower of spray we were very comfortable. Two of us unfortunately lost our breakfasts over the side.

At 1030 hrs. we sighted the clock tower at Calais and with this heartening sight came the discovery that the whaler was leaking, not badly, but owing to the leak and the spray we were taking, one of us was baling continuously from now on. The sea was absolutely empty and we seemed to be the only people trying to go to Calais that morning. We put out a fishing line with a spinner in the hope of catching something for a late breakfast. As we approached Calais the sea and wind both rose slightly and we began to ship a little water. The wind here began to veer round to the south a little and it soon became obvious that in spite of sailing as close to the wind as possible, we were getting carried by the tide past the entrance to Calais Harbour. We were told later that the water speed across the harbour mouth was four to five knots. We sailed in to within about 200 yards of the shore, missing the harbour entrance by about 400 yards. We then went about to try to retrieve the lost ground.

On this tack we made two unpleasant discoveries. One was that in the journey over, a plank had sprung, and on the port tack a small fountain was seen playing in the whaler ; the other was that we were making no way against the tide, but were simply going out to sea again. The tide had only just turned and we would have to wait about five hours for slack water. Under these circumstances we decided to run for the shore and beach the whaler on the sands to the east of Calais Harbour. This we did, landing at 1145 hrs., exactly twelve hours after we started off from Sheerness, an average of five miles per hour.

We had landed in surf on a very shallow sloping beach, about a mile from the mole guarding the harbour and the tide was ebbing. The wind was blowing hard now, and rather than allow the whaler to be left high and dry on a draughty beach we decided to pull her along by hand to the mole and into the harbour. So we got out. The sea was quite warm, which was just as well as we were often waist deep as we pulled the boat along. The waves were a nuisance as they would push the whaler and us to one side and the whaler being broadside on to them took a certain amount of water. However, we made steady progress and the water depth in the whaler never gave any cause for worry (I think it was all absorbed by our clothes and blankets in spite of trying to cover them).

When we were nearly on the mole we saw the Calais Lifeboat, the *Marechal Foch*, coming towards us. They had been called out for a yacht in difficulties further to the east at Gravelines, and when they saw us they wondered if we needed help. However, after a certain amount of crosstalk in several languages they got the idea that we were all right and did not need help, and they moved on to their other call. We struggled on until by about 1500 hrs. we were in deep water alongside the mole. We then tried to take the whaler round the end of the mole into the harbour, disturbing various French fishermen on our way. At the end of the mole the wind and the tide were against us and the waves threatened to smash the whaler on some under-water projections, so we dropped back to the outside of the mole (disturbing the fishermen again) made fast, and settled down to wait for slack water. The time was now about 1545 hrs. and we were all wet and not a little tired, nor had we had any lunch. We had a large tot of rum and were feeling a bit better and had started sorting gear in the whaler when the Calais Lifeboat appeared again. She had missed the yacht at Gravelines and, determined not to return empty handed, offered us a tow which we accepted and we moored in Calais Harbour at 1610 hrs.

On arrival at the quayside we found a bevy of reporters waiting for us, who demanded our story which we told as best as we were able in French. They could not speak English and were not satisfied with us, so got a further story off the crew of the *Marechal Foch*. The lifeboat had not been out since 1940 (according to some papers) so they made the best of their story and we were surprised to see the following notice in a French newspaper the next day :—

CROSSING OF CHANNEL MOTION

The adventures of four English officers who, in danger, just off Calais, refused the aid of the lifeboat.

The adventures which happened yesterday to four citizens from Great Britain, come from the white cliffs opposite, must make think all those who venture on the " large blue " in general, and on the Channel in particular without possessing for that, some knowledge and the practical necessities for that type of sport.

The tragi-comic adventure (more comic than tragic very happily) began on the other coast of the Channel in the hours of darkness and when the day came at the great Straights . . .

WE ARE FOUR CAPTAINS

Saturday . . . 2 o'clock in the morning . . . At the port of Sheerness (County of Kent), four men prepared themselves to embark on a " nutshell " or rather a simple skiff, six meters long, little more than one meter wide, with a little sail and no motor, the wind was not fit for dogs.

Our four men are from Chatham, a town situated between London and Sheerness . . . They are Captains in the Army of Her Majesty, in the engineers for precision . . . They are named : Wilson, 27 years old ; Ross-Magenty, same age ; Cooper (like Gary), 26 years old and Julius (like Caesar), 25 years old.

A few provisions and . . . now our " hardy navigators " are at sea . . . "

They were off to spend a happy week-end, first of all on the water then on French soil . . . And then the hard labour.

The Channel is capricious and in the course of our story we tell how our four soldiers came to fall on a beach (of sand), which set in motion the maritime services and others . . .

It was about 14 hours yesterday afternoon when the lookout post of the Port of Calais was alerted by something which had found itself on the coast of the " Beach of Paupers " . . . There had been a collision (neither more nor less) of a boat just off the " Moulin Rouge " towards Waldan and as a sequel to that, two yachts were thrown on the coast . . .

The port office told these things to the gallant firemen. These, thanks to their vehicle " Dodge " went off to look with a celerity which did them honour, for the members of the crew of the lifeboat

" Marechal Foch " who as everyone knows, live at the four corners of the town.

Now the Marechal Foch, having on board Doctor Drujon and commanded by the master Leon Avron, left their shelter and circled the end of the mole.

Refusal of Assistance

The lifeboat did not have to go far, only about 300 metres to the east of the mole when a curious spectacle was presented to them . . .

A light craft, a whaler more exactly, had fallen on hard times, in this case a bank of sand (well under water, it is understood). This frail skiff was being pushed by four men up to their shoulders in water, four men who were so disorganized that they had not even given a name to their yacht. As soon as possible the Marechal Foch shot three times a life line from her line gun . . . Trouble lost, for our four lascars entirely refused the assistance which was offered them.

The Marechal Foch, which was not able to come very near because of her water draught, continued her journey towards Waldan and reached the mole at Gravelines, looking for the waifs of the sea or even the second boat in the self-styled collision.

Trouble lost . . . Nothing on the sea, nothing on the beach, nothing on the horizon. The " sinister sea " was empty save for the skiff and its occupants in a naughty posture.

In the meantime, in Calais, the Calais Police had had wind of this thing and two of their worthy representatives went to examine the coast like we ourselves.

A telephone call was even made to the Hospital Saint-Pierre " Prepare yourselves to receive the wounded of a sinister wreck ! "

Returning to the Marechal Foch : these had returned to the Cape of Calais and found our four " shipwreckeds "—who, not far from the mole were mooring up. Dripping like soup they were brought into port and their " youyou " was moored by the Paul Devot alongside the Riddens.

It was 17 hours when the Marechal Foch regained her shelter.

The Current Was Too Strong

The shipwrecked, one found, were our four Britishers who had left Sheerness that morning . . .

They explained to us, entirely happy to have been towed at such a good cost (they did not have to pay for their help) how, arriving towards midday at Calais, they had been unable to enter into the mouth of the harbour, the current pushing them towards Waldan and that they had been thrown on the beach.

Useless to say that without the help of the Marechal Foch this adventure would have turned to the tragic for the amateur sailor (oh how !).

These latter, have the intention of returning to their country in the morning by the same means . . .

As for us . . . we wish them well.

We must have been rather rude to that reporter. The British newspapers were less verbose but more inaccurate :—

WRECKED—BUT NOT DISMAYED

CALAIS, Saturday.—Four British Army Officers who had rowed the Channel were rescued by a French lifeboat 400 yards from Calais harbour tonight after heavy waves had overturned their boat.

The lifeboat found the men, all officers of the Royal Engineers clinging to their boat, struggling to turn it over. They plan to row back to Britain tomorrow if the wind dies down.

However our arrival caused several comments from other craft in Calais and our story brought us several free drinks.

The next day the wind was blowing almost at gale force and we decided to spend the day in Calais, which spoiled our week-end cruise, but we also determined that by some means we must return to England on Monday night. On Monday, 23rd June, the wind had died a bit but had swung round to the north-west. We had repaired the whaler as well as we could with caulking cotton and white lead, but with that wind, a cross-channel journey would take at least eight hours, probably longer, and remembering that we had to return that night we made arrangements to ship the whaler back on a cargo boat.

On arrival back at Chatham, I received the following postcard :—

" State salary required (per week) for WILSON, ROSS-MAGENTY, COOPER and JULIUS to repeat sensational act twice nightly at Phœnix Empire. Bottomless boat supplied. Presume you have own tights and merman tails."

Signed.—p.p. Hammersmith and Kinglestein.

SOME CONSIDERATIONS AFFECTING THE MILITARY USE OF THE HELICOPTER, PARTICULARLY BY THE ROYAL ENGINEERS

by 2ND LIEUTENANT M. SMITH, R.E.

Note.—It is stressed that the views expressed in this article, as in other articles published in the *R.E. Journal*, are those of the author and do not necessarily reflect War Office policy.

INTRODUCTION

THE practical helicopter being a comparatively recent introduction, many of its potentialities have yet to be tested. A study of the history of its development does give a satisfactory basis for consideration of these potential uses, however. This essay will therefore commence with such a study, followed by a consideration of the characteristics of the present-day machine and its likely uses. The directions in which improvements must be made for satisfactory operation will follow from these factors.

HISTORY—EARLY MACHINES

Rotating wing flying machines were envisaged as far back as the fifteenth century by Leonardo da Vinci, and engaged considerable attention right up to the time of the first aeroplanes early in the present century. The success of the latter, together with the enormous improvement resulting from the first World War, tended to leave little interest in research on the alternative method of flight. However, by the middle of the nineteen twenties various types of gyroplane, autogiro and heliocopter had been flown in France, Spain and the United States. The most successful machines of the period were the " autogiros " of de Cierva, a Spaniard.

These machines depended on the forward impetus of a normal tractor airscrew to induce rotation, with resultant lift, in a backward-tilted rotor ; in this respect differing from the helicopter principle, where the rotor is powered and may be tilted to give forward motion, no other power being necessary.

Advances were slow up till the second World War, although successful machines were built on the helicopter principle by Focke Wulf in Germany, Breguet in France and Sikorsky in the United States. There were many problems to be solved in these early types, however, in particular the engine, transmission and rotor designs presenting difficulties.

The Effect of the Last War

Great strides were made during the war by Sikorsky in America, but little work was carried out in Britain until 1944, when a series of three experimental machines was ordered by the Ministry of Supply. The position to-day, therefore, is that in America designers are more experienced, and production is greatly in excess of that of any other country. France has produced a number of experimental machines of interest, while three British firms are engaged in design and one more builds Sikorsky machines under licence.

Factors—Characteristics

The helicopter to-day consists of one or more rotors of aerofoil section. These are normally driven by a reciprocating engine, although some aircraft, e.g., the Fairey Gyrodyne, have induced lift on the autogyro principle, and some experiments have been made with jet propulsion. Forward motion is given by the inclination of the rotors forward, occasionally supplemented by a standard aircraft airscrew or by a jet engine. With single rotor aircraft some form of counteraction of torque is necessary and this has taken the form of a minor airscrew on the end of a boom, or the ulilization of exhaust gases.

For consideration of everyday performance, some twenty-four aircraft have been classified into four groups, and an outline of the performance of each group follows :—

(a) *Group I.—Light, 1 to 3 seat Helicopters*

Most of these aircraft utilize a light-medium aircraft engine of 200–500 h.p. driving a single rotor. The payload varies from 200–800 lb., the range from 80 to 150 miles at 50–90 m.p.h. cruising speed. Two jet-engined types compare favourably with the orthodox machines in performance. Several machines dispense with the torque-correcting airscrew by various means.

(b) *Group II.—Medium, 4 to 8 seat Helicopters*

Normally on similar lines to the above group, those machines analysed have notably better performance figures in lift/horsepower, with engines of about 500 h.p. lifting about 1,000–1,500 lb. up to 150 miles at cruising speeds of 80–100 m.p.h. This improved performance is reflected by the fact that of the five aircraft in this group, three are in production and the other two are small-scale experimental models of larger machines. The " Gyrodyne " is interesting as being an attempt to obtain improved performance by a compromise between orthodox aircraft design and a gyroplane, and has been successful enough to justify the design of a much larger version incorporating the same features.

(c) *Group III.—Medium-Heavy, 9 to 15 seat Helicopters*

While the single rotor and tail-torque airscrew layout is still seen, most of these machines incorporate tandem rotors or intermeshing dual rotors. Those aircraft still having an engine of 600 h.p. improve in range over the first group, but are slightly slower, while the more powerfully-engined Bristol 173 has a range of 600 miles and a cruising speed of 105 m.p.h.—a great improvement on previous figures.

(d) *Group IV.—Heavy Helicopters*

All machines in this class are experimental, and have yet, therefore, to prove their worth. The most promising machines are the Kellet-Hughes, which is reported to have a lift of 40,000 lb. or 17 tons—twice its own weight—the 30-seater Piasecki and a Bristol project of the same size.

General Characteristics

These machines vary little from each other in the load borne by each unit of power—roughly a lift of 1,000 lb. per 100 h.p. of a reciprocating engine. The load per rotor only exceeds 7,000 lb. in the case of the Hughes, and rotors are about 50 ft. diameter with the same exception.

It may well be that these figures are not capable of any radical improvement with present engines, and it has been formulated that some new specialized power unit is required instead of the adapted aero-engine in current use. The rotor limitations are the tip speed —which may not exceed the sonic barrier without serious and, as yet, unsolved difficulties—and strength, for a long blade tends to become disproportionately heavy.

Other major characteristics of the helicopter are its manœuvrability with the vertical ascent and descent and consequent small landing area, and the ability to hover for indefinite periods.

Limitations

The disadvantages lie in the excessive fuel consumption, very high maintenance costs and high initial cost. The last two may well fall considerably with greater production. These machines at present are very tiring to fly and much remains to be done in simplifying the pilot's work.

Existing Uses

Uses to which the helicopter has already been put include a number of interest as having R.E. applications. These are considered below.

Observation aircraft may be used for most sapper reconnaissance tasks. These will be dealt with more particularly later, but the general considerations apply to any reconnaissance use. They are as follows :—

The observer must be experienced in the interpretation of the aerial view. Just as an aerial photograph differs in its quality of information from a ground physical survey, so does direct observation from above differ from either—and if it is to be a worth-while supplement or eventual substitute for other types of reconnaissance, it must be at least as accurate and prove itself more speedy and economical. This may well be so in the future.

The helicopter will, however, make it possible to supplement the air observation by direct ground survey of any point requiring information, as most terrain offers suitable landing points, and any that does not would probably be difficult of access in any case.

Limitations lie in thickly vegetated areas where important points may be missed, and in cases where secrecy is desired—for such a survey is very conspicuous. The question of vulnerability may well be important, and is dealt with later.

The most desirable type of helicopter would normally be a very light machine, but would certainly require to be a considerable improvement on the machines in this category already existing. The features most requiring attention would be the range, or rather the endurance, and the maintenance—for the machine, being a flying equivalent of a jeep, must be expected to be as easily serviced as a jeep.

The helicopter has been found to be a most useful machine for supervision and maintenance of power cables and similar services, especially in difficult country. This has an obvious application in such sapper tasks as water pipeline maintenance, the checking of minefield fencing and other protective works, and the speedy transport of parties for minor tasks spread over a wide area, thus enabling a relatively small number of men to manage an area where less satisfactory communications would demand a large number.

The machines required would be :—

For supervision and checking, the smaller types.

For maintenance parties, a medium machine capable of carrying half a dozen men and a reasonable amount of stores. In the case of unwieldy units, for example, barbed wire, pickets or lengths of pipes, it should be an easy matter to sling parcels outside the aircraft as it is neither fast nor does it require to be kept aerodynamically clean.

As a rescue aircraft and ambulance it has already proved its use, and the only specialized sapper utilization of similar qualities is for the rapid transportation of emergency stores.

Similarly as a communications aircraft its utility is being thoroughly tested, with good results, by the Americans, and while not a specific R.E. use it should prove as beneficial to the sappers as to other arms. For both these last uses a medium helicopter is suitable.

POTENTIAL USES

Potential uses for which the helicopter may prove suitable will now be considered. In some cases there has been some experimental work on similar lines to those mentioned ; in most, however, the ability of the machine remains to be proved.

Reconnaissance

Three fresh reconnaissance uses for which a suitably improved machine may be utilized are as follows :—

Minefield and defences reconnaissance, where personal observation will normally be better than any amount of descriptive or photographic material, however efficiently the latter is interpreted, by virtue of its being first hand, direct in time and capable of being supplemented by the means already in use.

For road and airfield reconnaissance it offers a very speedy and comprehensive means of survey—any areas requiring physical check may be more readily reached by this means than by any other. In the case of a bridge reconnaissance all alternative sites may be readily observed and compared in a short time.

Where a topographical survey is required isolated stations may be readily reached and served, saving much time and consequently saving skilled labour.

For all these uses either the small or medium helicopter is suitable.

Minelaying

The scattering of anti-personnel mines in the path of advancing infantry may prove possible, although the prevention of impact detonation is a problem.

Decontamination

The decontamination of an area infected by chemical or biological attack should be possible by spraying a suitable counter, where such a counter can be found and carried. By means of the helicopter alone it is possible to reach the centre of affected areas and measure their extent, density and the nature of the attack ; this being feasible with some form of grab or other sampling arrangement suspended beneath the machine.

Supply

Of the transport advantages that seem possible with the helicopter, the two most outstanding , so far as the supply of stores is concerned, are the great increase in speed of transit possible, with its corollary saving in the manpower at present used on such transit, and the possibility of one lift from ship to front, cutting out the expensive and dangerous intermediate lifts and depots. Engineer stores are relatively heavy and bulky and a much more efficient machine in the heavy class than at present exists will have to be designed before we can envisage any general use by the R.E.

Probably the best way to ensure economical use of helicopters will be by having all stores made up into pre-packed parcels of a standard bulk or weight for a standard aircraft.

Assault Uses

For the assault the helicopter would appear to be too vulnerable as yet to enemy fire. Korea has been quoted by some as proof to the contrary, but the Korean War is probably singular in the overwhelming air superiority which the U.N. forces have over all their own area and the forward lines of the enemy, and the relatively inefficient weapons the enemy has as his equipment. It seems probable that with more evenly matched forces the helicopter as a day assault vehicle would be a very expensive risk. The potential uses envisaged here in the assault are :—

(*a*) For night assaults on enemy areas as an improvement on the paratroop technique. At present the expense of training paratroops is high and the wastage in assaults is also high—it may well prove far better to organize bodies of men in 30–40 seat helicopters and land them together already organized as platoons.

(*b*) The sapper version of the last may be the landing of small parties of men as demolition squads behind the enemy's lines.

(*c*) Another assault use may be as a ferry, being much speedier than its water-borne equivalent. Whether it is not more economical still to use the helicopter for the whole lift instead of using it merely for the water crossings is debatable. Probably the answer lies in balancing the factors of number of helicopters available ; length of time before bridges can be built ; and how far forward the helicopter can be used before it becomes too vulnerable.

Bridging

For bridge building work the helicopter may be used in the reconnaissance, in bringing up supplies and men for the task, and even for laying small assault type bridges. As it can keep no more still than the air it is in, it seems doubtful whether it can be of any great use in actually erecting larger bridges in any but ideal conditions, and if it were used as an aid to launching, it would be a sitting target for artillery or air attacks, and its loss might result in the wrecking of the bridge.

NECESSARY IMPROVEMENTS

Some care has been taken in the survey of possible uses to give an idea of the size of machine required. It is felt that if any large-scale use of helicopters is to be made, they must be made economically competitive with the existing means of operation—and that will demand simple servicing and maintenance. If this is to be achieved the Army must have as few different types of machine as possible, and each type must be capable of performing the greatest number of tasks.

The machines needed to cover the above sapper tasks are :—

(*a*) A light aircraft for reconnaissance, inspection and communications.

(*b*) A medium aircraft for maintenance parties, ambulance and communications.

(*c*) A medium-large machine for raiding parties, and serving isolated units. This will require to be much faster than any at present in use.

(*d*) Two heavy machines—one 30–40 seater for troop transport, and one for use as a ferry, a crane, or for stores transport.

The first two of these should be within the capacity of the aircraft industry, but much research will need to be carried out before the last three are achieved, as a very great improvement on any present type is required.

CONCLUSIONS

The helicopter is still a relatively untried machine. Great strides are being made in design and performance, and it may well be that in three or four years' time, machines in production will be economically capable of most of the work given above. Whether they are suitable for army use will largely depend on how the three major faults of the type at present can be overcome ; the excessive cost, both initially and in running and in maintenance ; the performance ; and the vulnerability.

When these are either overcome or do not matter the assets of the helicopter will be of considerable use : its manœuvrability and the absence of permanent works required for its use—no roads, bridges or runways, and little space being required.

In order to provide a true justification on the grounds of economy the helicopter must supersede the existing services for the work and not merely supplement them—for that merely entails extra expense.

RECOMMENDATIONS

It is felt that the wisest policy for the army is to test such machines as are at present being manufactured, both in order to encourage further experimental machines and to give the groundwork of operational experience which is essential before they are brought into wide service.

If, also, specifications setting out the requirements for service machines of various sizes are issued, the manufacturers will then be able to have a target for their designs. This had best be agreed with all services and civilian potential users as :—

The wider the scope of the aircraft the more buyers and the less expensive the production ; and

Civilian machines can be adapted for use in time of war, and the production machine can then easily be modified.

When any machine proves itself to be up to the army standard and, therefore, capable of doing the work for which it is required as well as, or better than, any existing method, then let it be produced in the quantity necessary for true benefit to be derived from it, and let the existing organization be reduced by an equivalent amount.

If this proves possible to any great extent, then to the sappers, as much as to the rest of the services, it may prove possible to economize on the non-fighting or supporting manpower to a most helpful degree.

REGULAR W.O.S.B.

By "DAN"

OF the officers who joined the Corps before the War, I wonder whether many have any idea how the War Office Selection Board System functioned in the Far East in the light-hearted post "V.J." days ? Perhaps my own experiences were not entirely typical, but they may explain why some of us are now regular sapper officers.

I went to my regular W.O.S.B. in March, 1946. There were eight other candidates to be examined at the same time as myself. We came from all over the Far East to Singapore. Here we assembled in a comfortable bungalow for the last sitting of our particular board.

All of us had received emergency commissions during the war, so we had seen the W.O.S.B. system before. The main requirements then, as I remember them, were agility, a sense of balance and avoiding an interview with the psychiatrist. I had nightmare memories of the individual obstacle race. A railway sleeper had been tied to the ground at each end, leaving it loose. Victims were expected to lift the sleeper until the wires prevented it going farther, then crawl underneath. Simple if you are built that way. I was kindly rescued when the other competitors had finished their obstacles.

At least this regular board carried no psychiatrist, but this probably meant an additional requirement of agility and I was no thinner.

Many people considered it a disadvantage to know of the goings-on at these W.O.S.Bs. before visiting them. I was not sure. You may call it cheating, but when I met someone who had done this board before, I could not resist the offer of a trump card. Evidently we would be led to a very steep and slippery slope, perhaps thirty feet long, in the grounds of the W.O.S.B. bungalow. We would be required to manœuvre an empty petrol drum up this slope without it touching the ground.

My friend told me that the only solution was for each man to lie on his back up the slope, his feet on the shoulders of the man below him. The drum could then be manhandled up over the bodies without it touching the ground. With this one piece of knowledge the terrors of the board seemed greatly diminished.

Our board of examiners comprised one Major-General and three Lieut.-Colonels, all most pleasant gentlemen. It seemed a pity to have to meet them under circumstances which, to me anyway, were definitely strained.

The nine of us were divided into two syndicates, one of four and one of five. It was fortunate, the General said, that two of us were sappers. We would be able to help with so many of the problems. One of us went to each syndicate.

The General made every effort in his opening address to put us at our ease. So did the Colonel in charge of our syndicate who beseeched us not to make too many blobs as it would be so nice to have a good last course. The disquieting thoughts left with me came from my fellow candidates. They seemed full of self-assurance, and to prove it, cared not whether they passed or failed. I very much wanted to pass. I imagined my whole attitude must be wrong and that it surely would be noticed.

The first afternoon was spent doing some written tests. These were a popular series which one runs across in the army quite frequently. It is definitely impossible to remember the right answer, or reason it out, and I am sure I do worse each time I try them. The type of question is: " If Monday is Thursday, will Wednesday be next week? " if you see what I mean.

We never saw nor heard of those papers again. I believe they were a test of patience. We were probably closely observed under the strain. I cannot believe the Directing Staff could possibly have corrected them anyway.

The next morning at 7 a.m. we began the practical tests. Again it was to be my horror of surmounting obstacles, alone and unaided.

There was a coconut tree, part of it growing almost parallel to the ground, along which one had to balance. Some people have a sense of balance, some are padded against a fall. I am the latter; it must be awful to be neither.

There were tyres hanging from ropes and one was meant to clamber through them. I prefer the railway sleeper—at least one is not left dangling in mid air.

The final test was the worst. A water tank, perhaps thirty feet long, stood very full of dirty water. About half way along its length it was spanned by a gantry of iron pipe. A lashing lay coiled on the near bank, awaiting my arrival. All that was needed, so the Colonel who was supervising said, was to throw the lashing over the gantry, catch the free end and jump across the water. Especially simple for a sapper, practised in the art of throwing a lashing. I threw and threw, but the free end had no intention whatever of returning to me. The man who was following me around the course had arrived and was waiting his turn. The Colonel became fidgety. Beside the gantry was a ladder. Even to contemplate its use surely meant failure, but there was nothing else to do. I nipped up it and returned to earth holding both ends of the lashing, now safely draped over the gantry. I jumped and very nearly made it. In fact it was surprising what a height I was from the water when I fell. What had I done wrong? I had not lifted my knees enough. " Try again," said the Colonel. Every ounce of my effort went into that splash. " Third and last time " was just as bad, but I proved I could swim.

I was certain that all hopes of my regular commission had gone. Several years later I was sent by my Adjutant to London to sit the inter-B.Sc. exam, being told to return when it was all over. On the second day I wrote " No bid " on a mechanical drawing paper and left the examination hall for ever. The exam continued for ten days and this did not count against my leave. The temptation to take a couple of spare days in Singapore now was very great, but somehow I felt I ought to stay.

During the morning we each had to give a five-minute lecturette. The subject was " The most frightening experience of my life." We heard of dacoits in Burma, shellfire in Italy, and, from an older member, of a prison camp escape.

I had led a more sheltered life. The story I told was something like this. Beside our kitchen garden in Devonshire there is a potting shed. One day I entered with Smith our gardener. Our spaniel and retriever were routing about among the pots in a most damaging manner. Smith assured me there were no rats and he is seldom wrong. Just to placate the dogs, though, he did rearrange the pots. One rat broke for the door and escaped the very round spaniel. There was a very quick scrabble and I was certain, from the attention the retriever was giving me, that I was the proud possessor of the other rat. It was trying hard to escape from the waist line of my trousers at the back. This I was quite unable to tell Smith as I jumped up and down to the roof, yelling. The retriever was also jumping, which was no help. Smith was worried. He assured me the rat had gone through the door. "Was I all right? Should he fetch my father?"

After an age the rat could bounce no longer and made his exit by the other trouser leg. The retriever took him most satisfactorily. If you see me wearing breeches and stockings, when no horse is near, please do not call it affectation. On Sundays I wear trousers, tucked into my socks.

I sat down. The atmosphere seemed awkward. The General thanked me, saying it was an original story.

The lecturettes were followed by a further obstacle race, this time by all of us together against the clock. We had to carry a heavy roll of tentage representing a gun barrel over the queerest places. In a fine exhibition of daring and initiative I fell off a wall, taking the tent with, or rather on top of, me.

We broke off for lunch. I was approached by a gunner, who himself was not doing too well. A friend of his owned a pleasant restaurant. Would I care to join him as a waiter? The prospects seemed good, especially if I could be the wine waiter. A wonderful opportunity. My heart was lighter. The future was not entirely blank.

The afternoon started with another written paper, a type of essay. After I had handed mine in I noticed the words "Turn over" on the instruction sheet. There were several more rules, all of which I had successfully broken.

A bridge-building competition between the syndicates followed. We were given many pieces of stick and string, a wooden chair and a bicycle wheel with no tyre. We had to cross from point A to B, a dry gap, without touching the ground. The syndicate looked to me, the sapper. I looked knowledgeable. Somehow they were doubtful and impetuous. Without waiting for my priceless advice, they built a frightful contraption by themselves. Duly and deservedly it collapsed.

Things did not seem well. I needed a booster. I began to long for the petrol drum act, the one thing I knew I could do.

The General had us each in for an interview that evening. All very friendly, but the great piece of fortune which had been mine at a previous interview was not to recur. I had not been to school with the General's son; in fact he did not even say if he had one.

"Why do you wish to be a Regular officer?" was a question for which I was prepared. "Why do you want to be a sapper?" was much worse. My documents probably showed that, as a recruit, I had failed my mechanically minded tests: things like assembling a bicycle pump, an adjustable spanner or an electric bulb holder. Had I not spent an expensive six months on a short course at Cambridge I would have been removed from the Corps without further ado. The General knew of my efforts with the lashing at the water jump. I said I was interested in explosives.

Finally I was asked, " What will you do if you do not get a regular commission ? " Now was the time for a very rich man to try bribery. A hypnotist might have had a chance. A strong man would have said, " I shall be a waiter and will look forward to seeing you at the 'Butterside Down.' I would advise you a most passable wine."

I simply replied, " I have always been going into the army. I can't think of anyone else who would employ me." The General seemed to see my point of view.

And so we came to the last day. In the very early morning both the gunner and I fell into a " crocodile infested " pool while carrying a box of " vital medical supplies." We were rather hurt when our box proved to be a plant, the remainder of the competitors having hidden the real one until the pair of us were out of sight. They had then all crossed the " swamp " without incident.

At last we came to the slippery slope. We were given a very short length of rope and three unequal lengths of wood. All nine of us were together. Never have I looked more innocent. There were lots and lots of ideas, none of which (I was thankful) worked. After about ten minutes I produced my brain-wave, " Couldn't we lie on our backs and roll the drum up over us ? " Indeed we could. Everyone was prepared to try it. To show myself willing I lay on my back on the slope with my feet on the level ground. A man put his feet on my shoulders. He seemed remarkably heavy, but then it was a steep slope. No. 3 got into position—so did No. 4. I suppose his head must have been twenty feet from the level ground when I telescoped. No one was very badly hurt—just shaken. Eventually my method did work, but by popular vote I was not included in the human chain—I was passed rather roughly up the slope, in the same manner as the drum.

That completed the entertainments. We had the afternoon free, returning in the evening to collect the little slips of paper which showed our grading. Everyone under the age of 23, including the gunner and myself, had passed.

I am still interested in wine. One day I will have to retire. I must keep the future open.

MEMOIRS

MAJOR-GENERAL SIR RICHARD P. LEE, K.C.B., C.M.G.

"DICKIE" LEE, a divisional commander in 1917–18, Colonel Commandant 1931–5, who died 24th March at the age of 87 at his home, Woodlands House, near Southampton, had a most interesting and distinguished career. Good all round at games and an excellent horseman, he possessed practical military talents: his Army Commander, General Sir Hubert Gough, writes of him: "A very sound and sensible fellow, with a calm temperament and plenty of resolution." The *History of the 18th Division in the Great War* classes him as "a great general," and continues, "as a divisional commander he displayed infinite knowledge, quick grip and decision. His opinion was a considered one, and not easily changed, as indeed it rarely had need to be. He had a great gift of map-reading, and consequently never failed in his battle dispositions to make full use of ground. As a study of the history of the division shows, he had a settled distaste for frontal attacks; the large hauls of prisoners and corresponding small casualties can be traced to his determination to manœuvre." He might have attained higher rank in the service had he not been handicapped at the start by the slow promotion in the Corps: it took him twenty-five years to reach the lieut-colonels' list, whilst Gough (cavalry) required only eighteen—and Haig only fifteen.

Born 4th September, 1865, the son of the Rev. T. J. Lee, he was educated at Clifton, where he was in the South Town House with the late Field-Marshal Lord Birdwood (cavalry) as a contemporary, and had some success as a bowler. He went to the R.M.A. Woolwich in 1883, and was commissioned in the Corps, in a batch of which the late Major-General Sir Hugh Bruce Williams, who similarly commanded a division in the first World War, was the head. After leaving the S.M.E. he served, 1887–92, in the 20th Company at Halifax, Nova Scotia, and at Gibraltar. On his return home, promoted Captain in 1894, he served in the 1st Division Telegraph Battalion, in the Ordnance Survey, Dublin, and in command of the 19th (Survey) Company at Southampton.

Sent in 1898 for special Survey (boundary) duties at Wei-Hai-Wei, then occupied as a naval station, in 1900, in the Boxer troubles, in command of part of the 40th Company, he accompanied the Peiho River Column in the advance on Tientsin and Peking, clearing the river of mines and blowing up a huge dump of explosives. For his services he was Mentioned in Despatches and received a brevet majority—two years before he attained the substantive rank. For the next four years he was employed in the Geographical Section of the Intelligence Division, War Office; and then for another four years at Aldershot, where in 1908 and 1909 he won the R.E. Heavy-weight Point-to-Point. In 1910, on promotion to Lieut-Colonel, he returned to Gibraltar as C.R.E. and O.C. Companies, and for three successive years captained the R.E. Polo team which won the inter-regimental Polo Tournament.

Early in 1915 he was appointed C.R.E. of the 7th Division, to command which Sir Hubert Gough was transferred from the 2nd Cavalry Division. Gough very soon formed a high opinion of him " as a soldier, apart from his qualifications as an engineer." Between them they laid out what soon became known as the " Village [back] Line," a model of the combination of fire positions and good shelters.

When Gough was promoted to command the I Corps, he took Lee, now a C.B., with him ; and when further promoted to command the Fifth Army, he managed to have Lee promoted to be Chief Engineer of that Army and Major-General. In this capacity he served throughout the Battles of the Somme, being wounded in August. So highly did Gough think of his military talents that in January, 1917, on a vacancy occurring, he obtained for him the command of the 18th Division, which he held until the termination of hostilities.

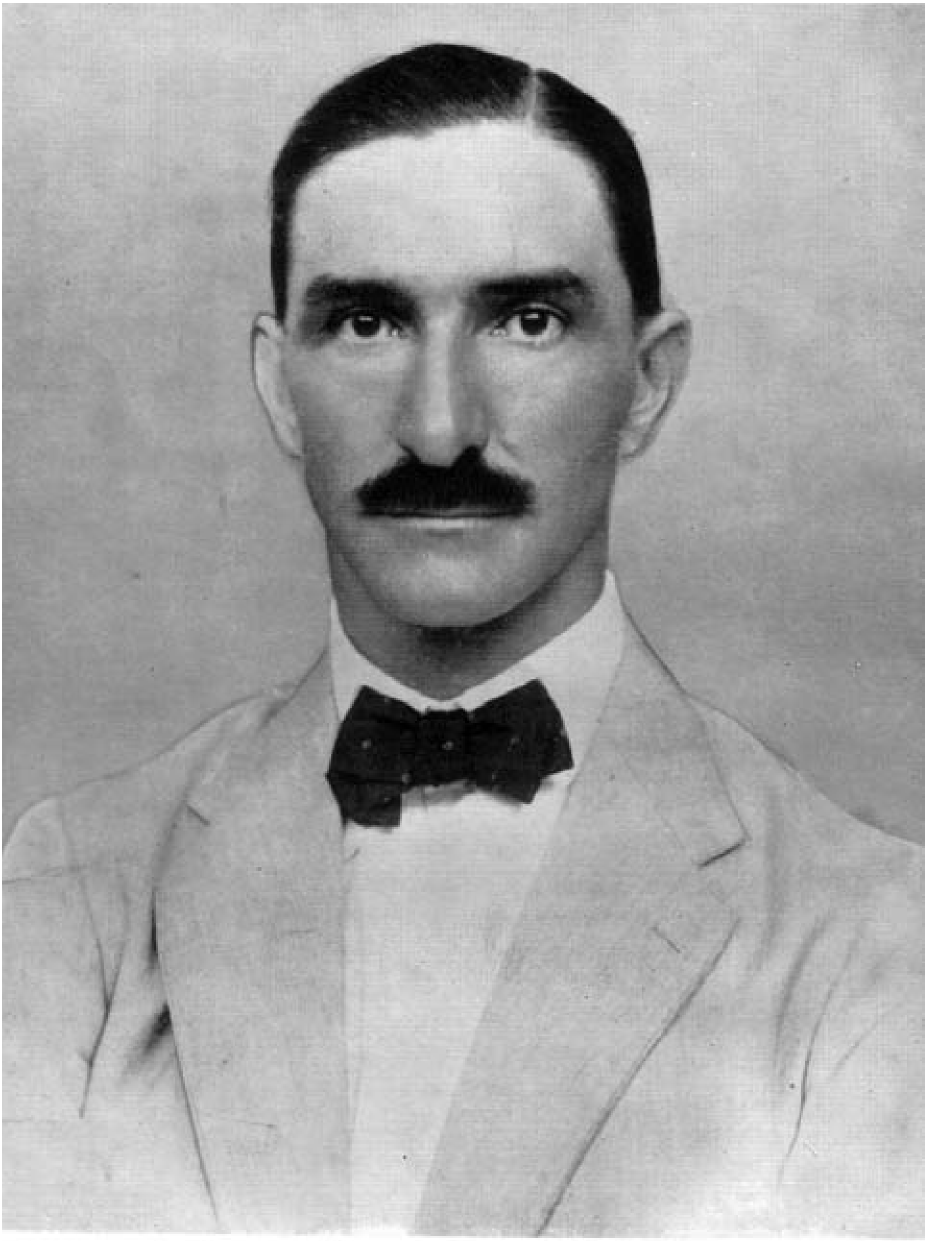
The 18th Division was engaged in most of the battles of 1917–18 : at Arras and Cérisy under Allenby and then Gough ; in the Passchendaele operations until 12th October under Plumer and then under Gough. In March 1918 it was still in Gough's Army and held its front all day on the 21st ; but the enemy managed to push back the divisions on its flanks, and Lee skilfully drew it out of the trap before it closed behind his men. In the advance to victory in August the division was still in the Fifth Army, renamed the Fourth, under Rawlinson, and Lee conducted a series of entirely successful engagements, capturing fifty times as many live Germans as the total of his own death casualties.

In January, 1919, Lee, promoted to K.C.B. in the final honours list, was recalled from France to take command at Tunbridge Wells, where trouble had arisen owing to changes in the demobilization programme, and received the C.M.G. for his services. He was later offered commands in India and in Mesopotamia ; but declined them for family reasons. He retired in 1923 and settled down at his home near Southampton, becoming a D.L. and during 1923–35 being Chairman of the Hampshire Territorial Association. In 1940 he raised and commanded the local Home Guard.

In 1898 he had married Julia Winifred, the only daughter of Mr. T. M. Lord of Claremont, Southampton, who died in 1950. Their only son, Major R. T. Lee, Grenadier Guards, was killed in 1941, but a married daughter survives.

J.E.E.

Major-General Sir RIchard Lee KCB CMG



Colonel GAP Maxwell CMG DSO MVO MC

COLONEL G. A. P. MAXWELL, C.M.G., D.S.O., M.V.O., M.C.

GODFREY ARCHIBALD PRENTICE MAXWELL was born on 29th November, 1885, the son of Captain W. F. Maxwell, R.N. He was educated at Cheltenham and was commissioned in the Royal Engineers from the "Shop" in 1904.

After the usual course at the S.M.E. he did a special Railway course, partly with the L. and S.W. Railway and partly with the 8th Railway Company, R.E. at Longmoor. In 1908 he was employed on the construction of the Baro-Kano railway in Nigeria. Three years later he returned to command the 53rd Railway Company at Longmoor. In 1912 he attended a special survey course at the S.M.E. and the following year was posted to the East African Survey Department under the Colonial Office and shortly afterwards was made Asst. Director of Surveys.

In 1914 the Colonial Office appointed him to the Nigerian Railways, and on the outbreak of war in August, 1914, he was in the U.K. collecting personnel to take out to Nigeria. Instead he was at once sent to France as D.A.D.R.T., becoming Asst. Director-General of Transportation in 1916. For his services in France he was awarded the M.V.O. in 1915, the M.C. in 1916 and the D.S.O. in 1917 and was Mentioned six times in Despatches. He was promoted brevet Major and received the following foreign decorations: Order of Leopold, Officer of the Legion of Honour and both the French and Belgian Croix de Guerre.

In 1918 he married Agnes Duncan, daughter of Mr. S. P. Rulhoen of Johannesburg.

After the war he was Deputy Chairman, Communications Section, Supreme Economic Council in Paris from 1919 to 1920 when he was appointed General Manager of the Tanganyika Railway, which post he held till 1935 when he retired, but in 1939 he was appointed Chairman of the Rhodesian Railway Commission. During the 1939–45 war he was employed as an Assistant Director of Transportation and was Mentioned in Despatches twice.

G.D.R. writes of him as follows :—

"On Saturday 25th April, 1953, Geoffrey Maxwell died at his adopted home town of Nanyuki in Kenya.

"The previous week, he had come to Nairobi for an examination, and had then learned that he had a malignant growth, which numbered his days. The time might be short, or the time might be a little longer. The only thing certain was, that it would be inevitable. It turned out to be short, one week only. I had seen him twice on his visit to Nairobi, and had recently written to him, offering him help in any way, but he did not live to receive that letter. Geoffrey accepted the verdict as bravely as he accepted the knocks of life. His one anxiety was for his wife, who had recently broken her leg in a fall.

"I have known Geoffrey and his wife intimately since 1921, when he was General Manager of the neighbouring Tanganyika Railway. They have often stayed in our house, and we have stayed in theirs. I have always regarded him with affection and admiration. He had tremendous qualities and ideals of service to his country and to his fellows, and as his record shows, he lived for his country, his Corps, and his fellow men. Few in modern times have travelled Africa so extensively, or knew it so intimately, or loved it so ardently. His knowledge of its history, its fauna and flora, and its culture was extensive.

"His hobbies were numerous, collecting shells, stamps, samples of trees, shrubs, butterflies, to list a few. He was a naturalist of no mean order, and a skilled photographer. With all this, he was also human and loved the company of his fellow men, music, singing, dancing, especially folk dancing, games, particularly tennis. A good talker and linguist, he was always welcome in all society.

"As a leader, he looked after his men and their families in a way they always remember, and speak of, with affection. In short a model man, a credit to his Corps, his Scottish ancestry, and his British race.

"He and his wife were devoted to one another, and went everywhere together, on almost every safari and every journey where circumstances allowed it. We, who knew him well, have lost a staunch friend.

"Our deepest sympathy goes first to his wife, and then to his sister, and other relatives."

LIEUT.-COLONEL B. L. A. COLLINS, O.B.E., M.C., R.E.

IF at 32 years of age you were a Brigadier—having fought at Dunkirk, won your M.C. in the minefields of Alamein, your O.B.E. at the Sicily invasion, and been G.S.O. I to three successive Chief Engineers of the triumphant Eighth Army—it would hardly be surprising that you were earmarked for a Course at the I.D.C.

All this had come to Abdy Collins in a short and brilliant army career. It was the result of a very fine brain, tremendous capacity for work, and loyalty beyond all.

But, if at the same time, you were a first-rate Master of Hounds—then truly you might claim to be " above the average."

Brian Leslie Lynch Abdy Collins, only son of Mrs. Abdy Collins and the late Bernard Abdy Collins, C.I.E., died on the 22nd December, 1952, after a tragically sudden illness, aged 39—not three weeks after the birth of his second son.

His childhood interests centred upon dogs, ponies and meccano. At Harrow in 1929 he soon became the despair of Masters, light-hearted, devil-may-care, but disarmingly " straight "—it was aggravating that he should persistently scrape through his exams with a minimum of preparation.

In 1931 he passed into the R.M.A. Life was now a real adventure, and for the first time he applied himself in earnest. He won the Science Prize and passed out fifth to become a 2nd Lieutenant, R.E., on 2nd February, 1933.

At Trinity College, Cambridge, he found an admirable balance between serious study, sport and undergraduate gaiety, to secure a comfortable Mechanical Science Tripos.

After distinguishing himself on his Mounted Duties Course he was posted to Singapore in January, 1936. As a Garrison Engineer he had plenty to do, but apart from his normal diversions of golf, tennis and cricket—it was the polo game which fired the enthusiasm of this lean, hard-riding subaltern.

In 1939 he was second in command of a field company in the B.E.F. A few months later at Dunkirk, the destroyer which picked them up was sunk by torpedo—and Abdy was one of the forty-two survivors of the 600 who crowded its decks. They were landed at Margate from a minesweeper at dawn next day—his 27th birthday.

In September, 1941, he was given command of No. 6 (Rocket) Field Squadron of 24 Armoured Brigade. This was a "plum " indeed —for the squadron was to develop a special technique and its training would be a stimulating responsibility.

The progress and efficiency of this squadron was the very core of Abdy's eager soul, and on 23rd October, 1942, its worth was proven on the desert before Alamein. Their casualties were heavy, and in writing afterwards of the action, his Brigade Commander declared that " no M.C. awarded was more deserving, and his squadron had enabled our tanks to crush the advance of 15 Panzer Div."

Soon afterwards Abdy experienced the peculiar elation of being blown up by a mine in his armoured scout car—and stepping out unscathed.

Then in November, 1942, he was packed off to Haifa for a Staff Course. But, because of outstanding ability, he was snapped up by H.Q. Eighth Army a month before it was over.

Early in 1943, he became G.S.O. 1 to the Chief Engineer, Eighth Army. So—the North African campaign : Mareth, Tripoli, Tunis, Bizerta. Next Sicily : his O.B.E., and the acquisition of a caravan he described as " indecently comfortable, complete with china wash-basin—taps which work—armchair—fan—lean-to shower—and all parked in a vineyard ! " Then Italy : Naples, the Sangro, Cassino, Rome and beyond.

After a fortnight's home leave in October, 1944, he was transferred to headquarters "ALFSEA"—which then meant Calcutta and the Japanese war for a change. In a short burst of promotion Abdy touched lightly on the rank of full colonel before settling down to the responsibility of Deputy Chief Engineer, as a Brigadier.

He made light of his work at this time—" now that the real fighting is over " etc. ! After Rangoon and the Japanese collapse he wrote blithely of his return to Singapore. But so did his E. in C. : " —few could have a greater loyalty and strength of character . . . he also loved a party . . . a great sense of humour." And Lieut.-General Sir Oliver Leese had written of " the immense amount of work done towards Engineer success by my D.C.E."

Then with demobilization came his reversion to Lieut.-Colonel and two years as G.S.O. I (Training) in the E.-in-C's. branch in Whitehall. But it was not until December, 1948, when posted to the S.M.E. at Chatham that he was able to satisfy that other childhood ambition. It was he who reformed the R.E. Drag, and in carrying the horn, his gay charm of manner, intolerance of foolishness and vibrant enthusiasm earned affection and respect alike.

Abdy Collins had married in October, 1945, Helen, only daughter of the Hon. Charles Douglas, of Malmesbury, Wilts., and Kirknewton, Midlothian—who, with two small sons, survives him.

Certainly he would have gone far if he had continued in the army. But Abdy was essentially a countryman and home-lover—so he had decided to become a farmer. Indeed he had already taken a farm in Fifeshire, planned the enterprise from A to Z—and, had he lived, would have been out of the army and launched on his new career within three weeks.

His sons have much to be proud of.

J.J.D.G.

Lieut-Colonel BLLA Collins OBE MC RE

Major-General HL Prichard CB CMG DSO

MAJOR-GENERAL H. L. PRITCHARD, C.B., C.M.G., D.S.O.

HARRY LIONEL PRITCHARD was born at Madras on the 16th November, 1871, the son of Colonel H. G. Pritchard, C.S.I., Indian Staff Corps. Educated at Charterhouse, he passed into the "Shop" in 1889, and was commissioned on the 13th February, 1891. Then began a career which was almost unique in its variety of service, nearly all of which was within the Corps.

After his course at the S.M.E. he was posted to a field company at Aldershot, and in November, 1895, was selected as a Special Service officer with the Ashanti Expedition, and employed chiefly on bridging, water-supply and hutting. He gained the Ashanti Star and a mention in despatches. The campaign was quickly over and on his return to England in March, 1896, he was lucky enough to be selected for employment on railway construction in the Sudan. For two and a half years he was employed on the survey and construction of the military railway from Wady Halfa to Kerma and then from Wady Halfa to the Atbara, a total of 585 miles. He took part in the advance on Dongola in 1896 and in the battle of Omdurman on 2nd September, 1898. At the end of the campaign he was awarded the D.S.O., three mentions in despatches, the Queen's Medal, the Khedive's Medal with two clasps, and the 4th Class of the Medjidieh—a series of awards which had hitherto rarely been achieved by an officer of subaltern rank.

He was next employed in Cyprus for five months under the Colonial Office, surveying a proposed railway route from Famagusta to Nicosia. Upon completion of this survey he was posted to Cork as Division Officer.

On the outbreak of the war in South Africa in October, 1899, he was ordered to the Cape for employment on railways under his former chief, Lieut.-Colonel Girouard, and for the next two and a half years gained a variety of railway experience, mostly on the works side. He was promoted Captain in February, 1902, and at the end of the war he had gained another mention in despatches, the Queen's Medal with four clasps and the King's Medal with two. After leave in England, he returned to South Africa as Assistant to the Chief Engineer, Central South African Railways, and in July, 1903, became Secretary to the International Railway Council (Transvaal and Orange River Colony), a post which he held until November, 1904.

All this experience of railway work under active service conditions led to his appointment as a D.A.Q.M.G. at the War Office, with the task of establishing an entirely new branch, Q.M.G.3, under Brigadier-General H. M. Lawson, the Deputy Quartermaster-General. Pritchard's branch was responsible for the general organization of the Railway Services for War, including the technical training of the three regular R.E. Railway Companies and the compilation of the necessary training manuals. One of the results of this organization was the establishment of the R.E. Railway Training Centre at Longmoor.

In March, 1907, while still a captain, Pritchard was posted to a similar appointment—D.A.Q.M.G. for Mobilization—at Army Headquarters, India. But here he met with his first disappointment. He disagreed with his Director as to the scope and organization of the branch, and paid the penalty by being transferred to Military Works as Garrison Engineer at Abbottabad. For the next five years he served chiefly at frontier garrison posts. While at Bannu, in February, 1910, he met with an accident which deprived him of his right eye. He made light of this handicap, and never allowed it to interfere with his aims or ambitions.

Returning to England as a major in 1912, he was appointed to command the 26th Field Company in the 1st Division at Bordon, which he took to France in August, 1914. He took part in all the 1st Division's operations from the battle of Mons to the First Battle of Ypres and the subsequent winter warfare in the trenches, gaining a mention in one of Sir John French's earliest despatches. In January, 1915, he was very severely wounded in the trenches near Givenchy, and was invalided home for nine months, receiving a brevet Lieut.-Colonelcy. After three months at Newark as Assistant Commandant of the new R.E. Training Centre, he was posted to Egypt as C.R.E. of a sector of the Suez Canal defences, and then as Chief Engineer of of the XVIth Corps in the British Salonika Force. He served with the Salonika Force to the end of hostilities, employed at first on the defences of Salonika, then on operations in the Struma Valley, and finally on the advance from Macedonia through Bulgaria to Adrianople. For these services he received a brevet Colonelcy, the C.M.G., three more mentions in despatches, the Greek Order of the Redeemer, and the Greek Medal for Military Merit.

On his return home, he was appointed C.R.E. Isle of Wight, but after a year, he was transferred to the South Aldershot District. Promoted substantive Colonel in November, 1921, he was appointed Chief Engineer, Northern Command, and in the New Year Honours of 1923 he was awarded the C.B. Next, he spent two years as A.D.F.W. at the War Office, and then three years as Chief Engineer, Eastern Command (1925–8).

In 1926, Field-Marshal Lord Milne, as C.I.G.S., appointed a committee to report upon the employment of the Royal Engineers, and Brigadier Pritchard was asked to submit his suggestions. This he did with the thoroughness for which he had now gained a wide reputation. Among the proposals he put forward was one that all R.E. units should be mechanized with the least possible delay, a change which was shelved at the time, but was carried out when Pritchard became Inspector of R.E. This was, he considered, his greatest work for the Corps.

He was appointed A.D.C. to the King, 1926–9, Colonel Commandant R.E. 1932–41, and Representative Colonel Commandant, 1937–9. In February, 1929, he was appointed G.O.C. Malaya, and in January, 1931, he returned to England and was appointed Commandant S.M.E., coupled as it then was, with the office of Inspector of R.E. and G.O.C. Chatham Area. After two years at Chatham, he retired in February, 1933, in his 62nd year.

Soon after his retirement, he became a member of the Home Office A.R.P. Committee, with the prospect of becoming Air Raid Commandant of London in the event of war ; but the strong views he held on the preparations which should be made were not accepted, and he resigned from the committee in 1935.

In 1937, he accepted the post of Editor-in-Chief of the proposed new volumes of the History of the Corps, from 1914 to 1939, and collected a large number of volunteers to assist in the work. The outbreak of war in 1939 naturally interrupted the flow of contributions, and many of the contributors fell out. Pritchard himself joined the Home Guard as a private and took part in organizing local war work. In 1942 he resumed his work on the Corps History and for four more years he devoted himself to it. Even at the end of 1946, when his eyesight failed altogether, he continued his editorship with the aid of a secretary. It can be truly said of him that he gave all his mental and physical energy to the completion of the new Corps History, bearing his afflictions during his last years with the greatest courage.

In his closing years there were two events which brightened the darkness for him—the success of his grandson, P. C. Harvey, as top of his term at Sandhurst and of his batch in the Corps, with the Queen's Gold Medal and the Silver Medal of the Institution of Royal Engineers, and the award to himself of the Institution's Silver Medal.

Pritchard was a keen Sapper, in every sense, throughout his career ; and he made friends wherever he went. He held practically every appointment that it was possible to hold in the Corps. He had a quiet manner, which inspired confidence but encouraged no incompetence in those who served under him.

In 1902 he married Elizabeth Gilbert, the daughter of E. Furze, Esq., of Alphington, Surrey, who, with two daughters, both married, survive him.

He died on the 14th May, 1953, at Speldhurst, Kent, in his 82nd year.

C.G.F.
W.H.K.

BOOK REVIEWS

THE CHRONICLE OF PRIVATE HENRY METCALFE

H.M. 32nd Regiment of Foot

Edited by Lieut.-General Sir Francis Tuker, K.C.I.E., C.B., D.S.O., O.B.E.

(Published by Cassell & Co. Ltd. Price 10s. 6d.)

Private soldiers of most nationalities have always been devoted to dogs. One of the most pleasing pictures in the Wallace Collection is a French picture by Verner called "The Wounded Regimental Dog." Sergeant Bourgogne in his story of the retreat from Moscow tells of an infantry soldier staggering along with the regimental dog on his back. Its paws were frozen and he could not bear to leave it behind.

Private Metcalfe, the hero of this little book, interposed to save the life of a white terrier early in the siege of Lucknow. He then shared existence and his scanty rations with "Bustle" through the worst days of the fighting. It was the story of the dog, which convinced Lieut.-General Tuker, that Metcalfe's chronicle was accurate, because "Bustle" was also mentioned in the diary of his real owner, the wife of a chaplain.

Like Private Wheeler, whose Peninsular-Waterloo letters have also been recently published, Metcalfe wrote in the legible copperplate style, which modern education affects to despise, yet teaches nothing half as good.

General Tuker describes his hero as a "cracking little chap" and the pattern of a good soldier. He hopes that his slender volume will find its way into many a private soldier's kitbag, to cheer and to inspire on bad days. To the ordinary reader, the chronicle gives a sidelight on the Indian Mutiny which is full of lively detail, fair comment and even romance. It deserves to be widely read.

B.T.W.

A SYMPOSIUM ON PRESTRESSED CONCRETE STATICALLY INDETERMINATE STRUCTURES

The symposium is a collection of seven papers by engineers well known in the field of prestressed concrete and published by the Cement and Concrete Association (price 25s.). The book includes the discussions arising from the papers which are lively and of great value.

This is a book for the design engineer. So few statically indeterminate structures have been built in the U.K. in prestressed concrete that it can hardly be said to contain much in the way of practical advice in construction. There is so much still to be learnt. The book covers structures as varied as bridges, frameworks, columns, circular tanks, shell roofs and cathedrals.

From the point of view of design it is interesting to compare the methods used by different engineers in providing continuity for beams over their supports. Prestressed concrete in these statically indeterminate problems suffers from the disadvantage that in so few cases have they been tested to destruction so that we might learn which method of obtaining continuity will produce the best results. It is, however, comforting to note that no structure in this medium has as yet failed.

For those who fear the sudden disintegration of prestressed concrete structures there is the example of the Gare Maritime at Le Havre, which was underpinned by continuous prestressed beams to stop it moving into the harbour. Even after the destruction of the station three times by bombing, by deliberate demolition, and the explosion of an ammunition train, all but one of the beams were used again in its reconstruction.

At the moment there would appear to be little possibility of complicated indeterminate structures in prestressed concrete being designed and erected by the army in time of war. Nevertheless those who are contemplating the construction of simple structures in this medium would do well to read the papers in which many points common to prestressed concrete structures are discussed.

H.J.C.

WELDING TECHNOLOGY

By F. Koenigsberger

(Second Edition published by Cleaver-Hume Press Ltd., London. Price 25s.)

The first edition of this book was reviewed in considerable detail in the *R. E. Journal* of December, 1949. In this second edition a thorough revision has been made of each chapter to ensure that it is absolutely up-to-date.

Details of edge preparation and butt and filet weld procedure, as specified in B.S. 1856 and 499, Section 7, both of 1952, are among other tables substituted for those previously included. Twenty pages of symbols for welding, also specified in the new B.S. 499, Section 7, make a handy addition to the chapter on design and drawing office procedure.

New illustrations have been included in many places and reference is made to the new cold pressure welding process and to ultrasonic flaw detection. Finally, an entirely new chapter on the welding of thermoplastics has been added.

This book is clearly written in simple language and gives a well-balanced description of all methods of welding. It is a good text-book and its excellent tables and footnotes also make it useful for reference purposes.

R.B.-S.

THE EARTH AND ITS MYSTERIES

By G. W. Tyrrell

(Published by G. Bell & Sons Ltd. Price 16s.)

Dr. Tyrrell has spent the whole of his life teaching geology and carrying out geological research. This book is written with a background of much experience and forms an introduction to the subject along traditional lines. It is all the better for that, since the development and history of our planet cannot be properly understood without a knowledge of the way the forces of denudation—the work of rain, flowing water, ice and the sea—act on the rocks forming the visible crust of the Earth. Following this line of approach Dr. Tyrrell leads us to study the way in which the once flat-lying sediments have been bent and broken by folds and faults to give the complex structures now found at the surface.

From the point of view of the Engineer, who deals with the rocks of the crust of the Earth as the source from which he obtains his raw material for constructional work from quarries or other excavations, a proper understanding of the origin and subsequent history of the rocks is not only a help in the proper planning of his work, but even an elementary knowledge adds much of interest to what he sees.

When, however, the Engineer comes to deal with problems which depend upon the geological structure at some depth below the surface, as in water-supply, tunnels or deep foundations a proper reading of the geological evidence is of prime importance.

A book like Dr. Tyrrell's clearly forms a sound foundation upon which further study can be placed.

The later chapters give a brief account of the different ages through which the Earth has passed in its long geological history. A study of this subject lends much interest to the proper understanding of the way the Earth has developed.

The last chapters touch on some of the more controversial matters of geology such as continental drift and the origin of mountain ranges. Matters which, though of much interest, are outside the field of practical use to Engineers.

The book can be recommended to anyone who wishes to know the elements of the basic facts of geology and the changes which have taken place in the crust of the Earth and are taking place at the present day. To know these elements of geology should indicate to Engineers directions where further knowledge would be of value to them in their own work, and in any case anything which enables one to appreciate a country-side more fully is to be encouraged. Dr. Tyrrell's book certainly does this.

W.B.R.K.

THE SKY AND ITS MYSTERIES

By E. A. Beet, B.Sc., F.R.A.S.

(Published by G. Ball and Sons, Ltd. Price 15s.)

This is a book on Astronomy which anyone can read and follow. Essentially it is for beginners in the sense that no previous knowledge is necessary in order to understand it, but at the same time it covers a wide field and contains a great deal that will interest those who already claim some slight acquaintance with astronomy.

The first chapter is called "The Mysteries Presented" and describes various celestial phenomena which are observable by all who have eyes to see with, and which naturally lead the more inquisitive and thoughtful observers on to fresh fields of discovery. This chapter strikes a keynote which is preserved throughout the book—namely, a practical approach to the subject—and the reader is continually urged to go and see for himself, preferably with the aid of a pair of binoculars.

There is no mathematics in this book, and the reader requires no knowledge of it. Those who wish to pursue the subject more deeply, however, are liberally provided with references to other works. These references are in the form of numerical annotations in the text and the corresponding references are listed at the end of each chapter. Some readers may find this annotation a little tedious as it tends to break the train of thought.

The text is illustrated by fourteen photographic plates, which are well reproduced and interesting. There are also fifty-six figures and diagrams of various sorts, and a skeleton star chart to help the observer to find the more important heavenly bodies.

One distinct merit of this book is the fact that reference is made to the most modern equipments and techniques, as well as to the latest speculations upon the past and future of the universe. For example, the author mentions the grotesque-looking radio telescope at Jodrell Bank in Cheshire and describes some of the work done with it. He concludes with a chapter which touches on such fascinating problems as the apparent expansion of the universe and the theory of continuous creation—without, however, coming to any definite conclusions. These he leaves to his more imaginative readers!

B.St.G.I.

TECHNICAL NOTES

STABILIZATION OF CLAY-GRAVEL ROAD SURFACES WITH RESINOUS MATERIALS

(*The Engineering Journal of Canada*, dated March, 1953)

Soil stabilization is of the greatest importance in road and airfield construction. As a result of research in America, Scandinavia and the United Kingdom, various chemical treatments have been evolved to diminish the water absorption of soils.

This paper sets out very clearly the results of both laboratory and practical tests carried out by the Swedish State Road Institute, and is well illustrated.

Briefly, the conclusions reached are :—

(i) Resin-stabilized clay-gravel has given very promising results, some surfacings having shown high stability, in unfavourable weather conditions, over periods of up to five years.

(ii) The composition of the clay-gravel is of great importance as regards both grading and the character of the clay-content.

(iii) A coarse-grained surface has the best wearing properties : areas with some deficiency of coarse material form weak spots.

(iv) Laying must be carefully done. Laying in wet weather diminishes the stabilizing effect and reduces the wearing quality of the surface.

DIESEL ENGINES IN PIPELINE PUMPING SERVICE

(*The Engineering Journal of Canada*, dated March, 1953)

The design and construction of a 700-mile oil pipeline were described in *The Engineering Journal of Canada* dated September, 1952 (see *R.E. Journal* for March, 1953). The basic operation and power requirements of oil pipelines are now further discussed in a straightforward and interesting paper, which gives details of the prime movers, pumping machinery and layout of the twelve stations on the 1,130 mile Interprovincial Pipe Line.

A major economic factor is the reduction of the pumping power required. In the case discussed, although there is a static head of 2,000 ft. assisting the oil-flow, approximately 27,000 h.p. is needed to overcome the friction losses at maximum throughput. Clearly, the diameter of the line should be the maximum that can be kept operating efficiently : this will also allow for future expansion.

The flow and pressure characteristics of the pumps must be flexible, and exact co-ordination of control at all stations is needed to maintain line-pressure and avoid surges. Single-stage centrifugal pumps are used in the installation described, three units in series normally being run at each station.

The diesel engine is the ideal prime-mover as it operates efficiently over a wide range of speeds and loads, responds immediately to control signals, and uses crude oil from the line both as fuel and as coolant. It can also use cheap natural gas fuel where available.

The special safety-devices and control system employed have several unusual and interesting features.

ELECTRICAL ENGINEERING AND OPERATING ASPECTS OF ALCAN'S B.C. PROJECT

(*The Engineering Journal of Canada*, dated April, 1953)

The September, 1952, issue of *The Engineering Journal* included a general outline of the new hydro-electric installation in British Columbia to serve the aluminium plant at Kitimat. Detailed information is now given about the electrical equipment being installed, and is of interest not only because of the vast scale of the project, but also because of the special requirements governing a bulk supply to electro-chemical reduction lines. There is no light load period : the steady load is virtually peak load and is literally continuous. The smallest load block to be either picked up or dropped is 130,000 h.p. and switching must be instantaneous.

The power station has an ultimate capacity of very nearly 2¼ million h.p. in sixteen units. The main power transmission lines, at 300,000 volts, traverse 49 miles, using the biggest conductors ever made.

Layout and the main components are well described and the essential data clearly set out.

AERIAL TOPOGRAPHIC MAPPING

(*The Engineering Journal of Canada*, dated May, 1953)

The importance of air survey in war is apparent. Modern equipment, by improving both accuracy and speed, has made this method of mapping a most valuable aid in constructional development, and one which can be applied in many ingenious ways.

Aerial photography can provide any required detail that is not physically obscured ; contours can be plotted at an interval of between 1/750th and 1/1,250th of the flying height of the aircraft. In peace conditions, therefore, sufficiently accurate data may be obtained for initial estimating, and the method has even been used for computing stockpiles of timber and coal.

This paper describes, very simply and clearly, the problems involved and the methods and equipment used, and provides an excellent introduction to the subject. The development of technique is interesting and examples of commercial application illuminating.

FOAMED SLAG AS A LIGHTWEIGHT AGGREGATE

(*The Engineering Journal of Canada*, dated May, 1953.)

Foamed slag was extensively used in the British rehousing programme immediately after World War II, for the rapid and economical production of monolithic concrete buildings. This paper describes tests of its physical and mechanical properties, and gives useful data for lightweight concrete made from it.

Foamed slag is produced by bringing into contact with blast furnace slag controlled quantities of water, so that the steam generated converts the mass into a light cellular solid, weighing 50–55 lb. per cu. ft. in the air-dry condition. This lightweight aggregate provides concrete weighing from 25 to 45 per cent less than gravel-aggregate concrete, and which is readily cut, channelled or plastered. Timber framing can be attached by ordinary wire-nails or cut nails, and thermal insulation and sound absorption are both good. The aggregate is very stable in the presence of water, but strong winds will drive rain into a porous, unprotected wall. Penetration can be completely prevented with stucco or cement-water paints.

Compressive strength is low as compared with gravel-aggregate concrete of the same mix ratio, but rich vibrated foamed-slag concrete mixes of plastic consistency will provide compressive strengths as high as 5,000 lb./sq. in. at 28 days, for use in precast work.

The widest application of this material is likely to be in the manufacture of precast building units, such as joists, floor-slabs, roof-slabs, blocks and bricks. Bridge decking can be built in the same way as flat slab floors and shows a considerable saving in weight.

THE MILITARY ENGINEER

(*Journal of the Society of American Military Engineers*)

January–February, 1953

" News and Comment "

" New Army Aluminium Bridge." After five years' work by the Engineer Research and Development Laboratories at Fort Belvoir it is reported that tests on the experimental T.6 bridge have justified proceeding to production. It is claimed that the T.6 can be erected faster than any other heavy tactical bridge. It is reputed to be wider than, and to take 50 per cent greater loads, than comparable divisional bridges of the last war. A 75-ft. length of the new bridge can be manually erected in approximately one-third the time required for the same length of the old Bailey bridge. A span of 180 ft. will carry divisional loads. The new aluminium panel weighs approximately half that of the same section in steel. Designed essentially for mechanical erection, it has been shown that hand erection of short spans is quicker.

By changing the transoms and decking the T.6, for divisional loads, is readily adaptable for Army loads when it is referred to as the T.7.

While designed for transport to site normally by truck, it is held to be conceivable that these aluminium sections could be dropped by air.

" Engineer Atomic Energy Study "

It is interesting to note that recent approval has been given to a study programme of the Corps of Engineers of the use of atomic energy for certain military requirements for electric power. The Chief of Engineers has appointed Colonel James B. Lampert as the officer in charge. No other details are given.

March–April, 1953

" Advances in E.R.D.L. Research," by Colonel H. Milwit.

The author has been the Commanding Officer of the Engineer Research and Development Laboratories, Fort Belvoir, since 1st July, 1952, and in an interesting and well illustrated article deals with some recent developments.

Under " assault, reconnaissance and bridge erection," considerable study has gone into the development of a new assault boat of lightweight materials. The T.2 is now being fabricated of moulded plastic, at a weight of 300 lb., to carry fifteen men. Provision has been made for use of a 25 h.p. outboard motor.

For use with Construction Equipment operating in Arctic areas ($-65°$) a new device, the gasifier, is being tested to facilitate starting gasoline engines in low temperatures. It is essentually a fuel pre-combustion chamber with a conventional spark plug. A quantity of the incoming fuel is burned under controlled conditions to heat and vaporize the main portion.

The author deals also with a new mobile 3,000 gallons an hour water purifier provided with a contact conditioner, called an erdlator, connected in series with diatomite filters ; recent developments in field survey equipment ; mobile laboratories and workshops ; and finally stresses the growing importance of plastics for their intrinsic properties rather than as a substitute for other materials. Recent plastic research and development include a dustproof, waterproof membrane for use under landing mats ; plastic coated fabrics and films for camouflage ; plastic sheeting as a glazing material ; and various resinous films for protective coatings.

The engineers at the E.R.D.L. continue to work in the closest co-operation with industry and other military services.

NOTE ON BRIDGING

In October, 1920, an article appeared in the *Royal Engineers Journal* showing a proposal that had been made by Professor Inglis (then Major Inglis) for bridging in the field. He proposed that a light continuous girder should be used which would be laid on the top of pontoons as shown in the sketch and girder ramps leading on to the bridge at each end. As loads passed over the bridge the girders would deflect and distribute the load over several pontoons. In this way a saving of 50 per cent in pontoons would be effected when building a heavy bridge and a comparatively rigid roadway would be provided instead of the switch back effect of ordinary pontoon bridges.

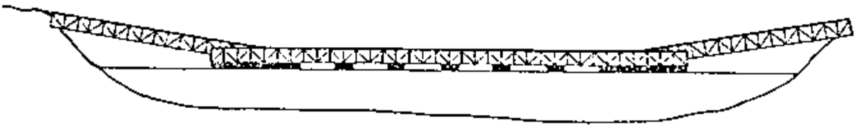


FIG. 1

At that time I was at Christchurch and was evolving the box girder bridge. A little later this was redesigned in a lighter form and used in the service for a considerable time. I was hoping that the girders in this light form would be suitable for use as a continuous girder over pontoons as Professor Inglis had suggested. I do not know why this proposal was not tried out.

The next step was the Bailey bridge in which the panels were pinned together in just the same way as in the box girder bridge and with the same advantages. For use with pontoons the Bailey girders were used to make a number of pontoons into rafts. In this case the Bailey girders were pinned at the bottom and butted against each other at the top when taking the load and so acted as a modified form of continuous girder. Quite recently, however, this idea has been revived in the form of continuous special girders resting on pontoons, and we may now see the idea of Professor Inglis in 1920 taking shape in our bridges of 1953.

G. Le Q. Martel, Lieut.-General.

USE OF PLANT IN U.S.S.R.

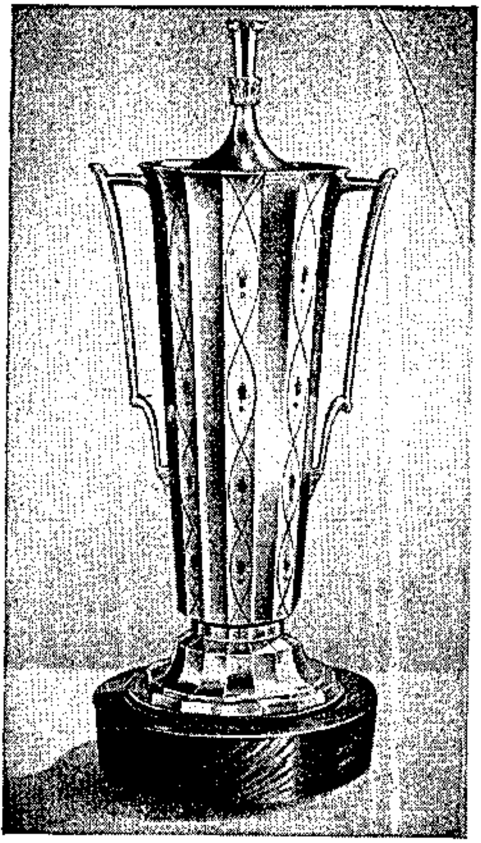
Civil Engineering & Public Works Review (May, 1953)

The second part of the article on Russian constructional methods on the Volga–Don Canal is described in this edition which is devoted largely to describing the plant.

It is particularly interesting to note the variety of plant used which includes 18 cu. yd. walking draglines, ⅝ to 1¼ cu. yd. grabs and shovels and multibucket excavators, not to mention 500 tractors with scrapers. One is left with the impression that there is no shortage of excavating plant in the U.S.S.R., though no mention is made of where this plant was made or what percentage was in use at one time.

It will be noted that the 5-ton wheeled tipper and a 15-ton tracked vehicle were the main means of transporting "muck", but that every endeavour was made to avoid using transport by using the walking draglines or scrapers. The amount of material moved was in the region of 126 million cu. yds. A further 34 million cu. yds. was moved by pumping the material as a slurry to form the fill to earth dams.

Also included is an interesting article describing flood damage to railways on the east coat of the U.K. caused by the gale and unprecedented high tides in January of this year.



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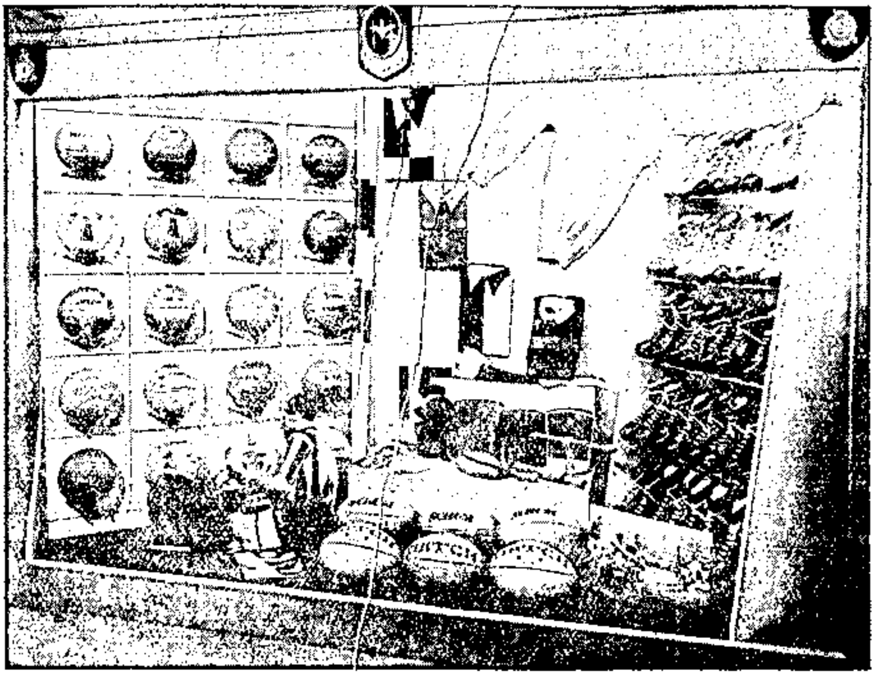

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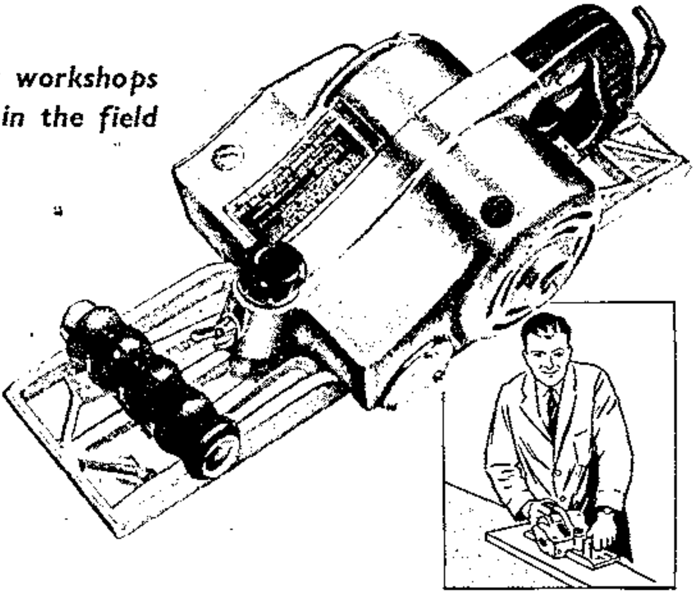

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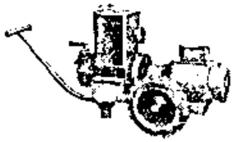

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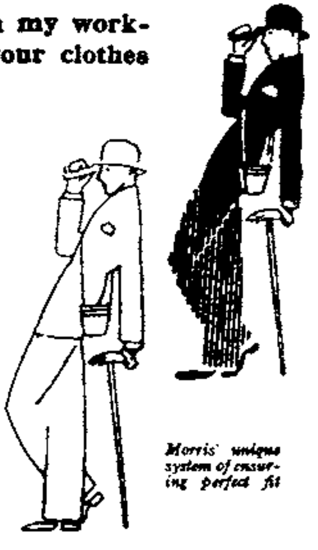

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