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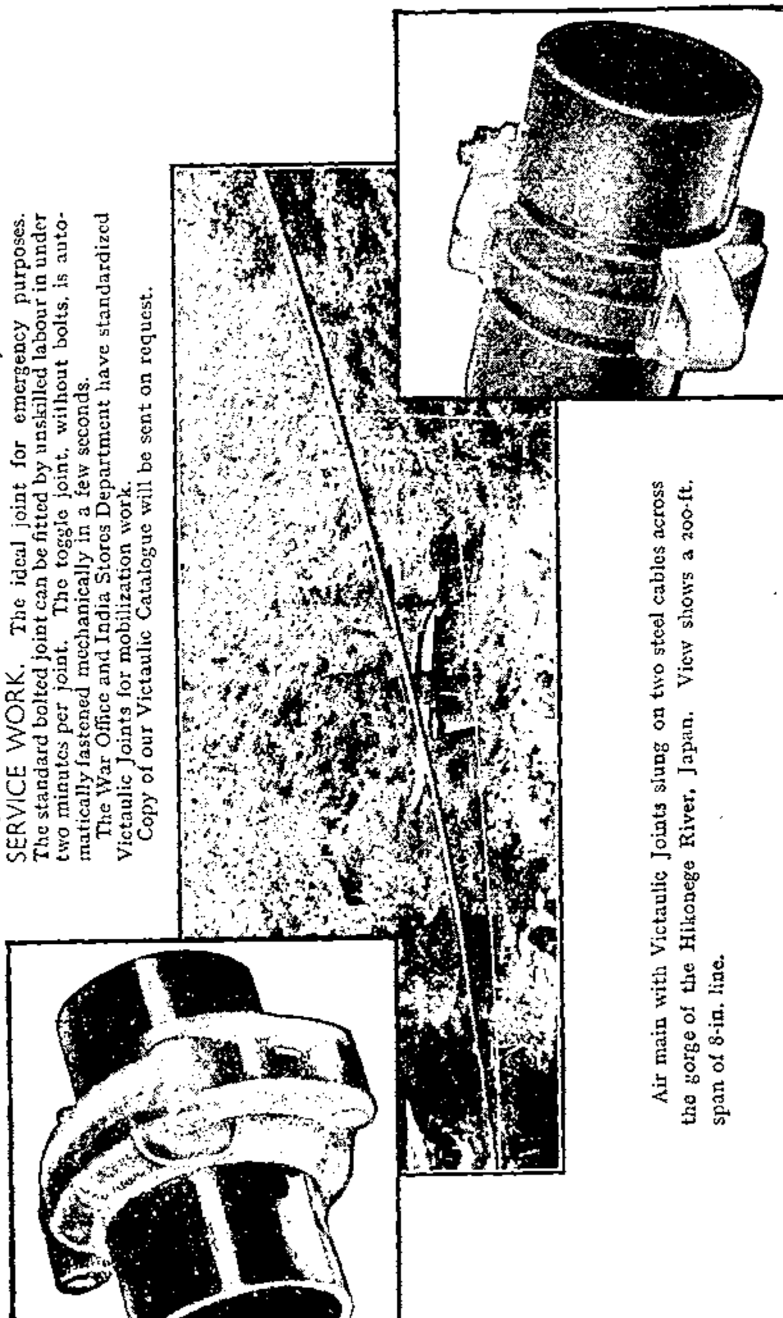

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Secretary: Colonel F. E. G. Skey ..... 14th September, 1939

2,375—1.12.39.

The grave of Major-General H. S. Palmer.

Yokohama waterworks 1 & 2

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MAJOR-GENERAL HENRY SPENCER PALMER AND THE YOKOHAMA WATERWORKS.

WE have to thank Mr. R. M. Austin, H.M.'s Consul-General at Yokohama, for the accompanying photographs (1) of the grave of Major-General Palmer and (2) of the Mayor of Yokohama, His Honour Mr. S. Aoki, bowing before a Memorial Stone which has recently been set up at the Municipal Waterworks to mark the fiftieth anniversary of the construction of the waterworks according to the plans of General Palmer.

In forwarding the photographs Major-General F. S. G. Piggott, C.B., D.S.O., Military Attaché, Tokio, writes :—

The attached translation of a brief history of General Palmer's career and accomplishments, drawn up by the City Office of Yokohama, gives further details.

In acknowledging the photographs and document I asked the Consul-General to convey my sincere thanks for the Mayor's courtesy, and added that I was certain that the honour paid to the memory of an officer in my Corps would be greatly appreciated by his brother officers.

This is an interesting example of the Japanese respect for history and tradition, and also of their sense of gratitude. These traits are sufficiently strong for a ceremony in honoured memory of an Englishman to be held by a public official, in spite of the anti-British demonstrations then taking place throughout Japan.

TRANSLATION.

DEDICATED TO THE FOUNDER OF OUR WATERWORKS.

A monument erected to the memory of the late Major-General H. S. Palmer, at the cradle of Yokohama's Waterworks.

To recall the eminent services of the Englishman, the late Major-General H. Spencer Palmer, founder of the Upper Water-Supply, in which the international port-city of Yokohama takes great pride, and which is the genesis of our modern civilization, and also to commemorate the 50th anniversary of its foundation in Yokohama,

the city has erected a monument. The work was started in August of last year at the source of the Upper Water-Supply, the first one in Japan, in Misawa-Mura, Tsukui, Kanagawa prefecture, at the junction of the Sagami and the Doshi rivers. On the monument, eight Japanese characters, written by Mr. Aoki, Mayor of Yokohama, which read "The Place Where The First Water Supply in our country was built" are engraved. The top of the monument is 7 shaku* 5 sun from the ground; the width of the tablet is 6 shaku; height 3 shaku 5 sun and the thickness 2 shaku; it is made of granite and the cost was 1,400 yen. Completed some time ago, the unveiling ceremony was held on the 12th June, 1939.

The late General Palmer was born in England in 1838, and came to Japan in February in 1883, as a Lt.-Colonel of the Royal Engineers in British Army. He was later promoted to the rank of Major-General. He died on the 10th February in 1893, in Tokio, at the age of 55.

Yokohama in those days urgently needed a water-supply system and so asked the General, who had constructed the waterworks in Canton and Hong-Kong, to investigate the matter, and subsequently employed him as consulting engineer. Thus the construction of the waterworks was started in April, 1885, under his supervision, and completed in September in 1887. It cost over 1,074,000 yen, and the amount of water supplied was 2 litres per person a day. This was the first up-to-date water-supply in this country.

Meantime, General Palmer made a report to Osaka City regarding a water-supply in that city and also took part in the construction of the Tokio Water-Supply Co., presided over by the late Mr. Eiichi Shibuzawa. It is particularly noteworthy also that he took part in the plans concerning Yokohama harbour-construction; these were started in September, 1889, and completed after seven years at a cost of 2,440,000 yen.

As mentioned above, General Palmer took the lead among foreign engineers in devoting himself to engineering work in our country, especially in connection with water-supply in Japan. Our manners and customs were quite different from those in his country but he always displayed rare ability; and we must offer our heartfelt thanks to his services towards the progress of the science of water-supply in this country.

* 1 Shaku (10 Sun) = 11·931 inches.

NOTE:—A Memoir describing the career of Major-General H. S. Palmer was published in *The R.E. Journal* of 1st. May, 1893.

THE HAIFA–BAGHDAD ROAD.

By LIEUT.-COLONEL R. BRIGGS, D.S.O., M.C., R.E.

INTRODUCTION

IT is regretted that it is not possible for the author to produce a technical paper on this work at this time. The work is not yet completed. The author gave up charge of the work at very short notice, and has only got such facts and figures that he has carried in his head. It is hoped, however, that the following description of the processes used, the difficulties to be overcome, and the description of the organization evolved, for a work of such magnitude, carried out by Military Engineers in the heart of the desert, may be of interest to all Engineers.

The author, having had no previous major road experience and no knowledge of the Middle East, received a telegram in June, 1937, asking if he would volunteer to undertake this work. This was a rather frightening proposition, but one which held out such interest and scope for individual effort that it was accepted readily, but not without much trepidation.

The author sailed for Palestine at the end of June, 1937, and was joined, as assistant, by Captain A. M. Hamilton, who had constructed the Rowanduz Road through Kurdistan, and was given the following terms of reference :—

To prepare an approximate estimate for that portion of the Haifa–Baghdad Road from Jisr-el-Majami on the River Jordan to the Transjordan–Iraq Frontier as an agency work for the Colonial Office. The road to be :—

(1) Passable throughout its length in good weather, and on which the minimum of delay will be caused in wet weather.
(2) Maximum axle loads 8 tons.
(3) The work to be carried out by direct labour.
(4) To be completed in two years.
(5) It is thought such a road can be built for £230,000, assuming that no work will be necessary on the firm portion of the desert.

HISTORICAL.

Since the Great War several railway surveys have been made over the route, but costs and government retrenchment have caused the abandonment of these schemes.

In 1923, the Australian brothers Nairn, two ex-Service men, made the crossing of this desert possible for travellers and freight by running a regular convoy service from Baghdad *via* Rutbah, thence through Syria to Damascus. It is not now liable to attack by tribesmen, but it is liable to stoppages of a week in wet weather, when the desert becomes a sea of mud and water, and the journey still remains somewhat of an adventure.

In 1932, the Iraq Petroleum Company laid a pipe to carry their oil from their wells at Kirkuk to Haifa, and laid a duplicate line to Tripoli in Syria. The Haifa pipe follows the most direct line through British Mandated Territory from Rutbah to Haifa, and proceeds straight across this, irrespective of grade or terrain. They cleared a track for their pipe and stores-carrying vehicles parallel to the pipe, which will be described later. Without this track and the tube wells sunk by this company along the route, this road could not have been surveyed in the time, nor could construction have proceeded at the pace it did, as only one road head could have been worked on owing to the impossibility of supply.

TOPOGRAPHICAL.

No accurate maps exist of Transjordan.

The distance from Haifa to Baghdad is approximately 600 miles or 960 kilometres.

Haifa–Nazareth–Tiberias–Jisr-el-Majami. A first-class asphalt macadam road exists.

Jisr-el-Majami–Irbid (38 kilometres). The Public Works Department were gradually improving this road to the limited extent of their financial resources. The road runs through inhabited country, and rises from 600 feet below sea level at the Jordan to 2,500 feet at Irbid ; had a 4-metre water-bound macadam surface on 20 cm. of soling on 24 kilometres of its length. The unsoled portions were often impassable in wet weather. The alignment was good, with maximum grades of about 1 in 14, but it had many hairpin bends and long side cuts in rock up the sides of precipitous wadis. The Transjordan P.W.D. agreed to complete this portion of the road as a charge to the Colonial Office, and the road is being widened with 5 metres surface of full grout of Colas on 20 cm. of hand-packed soling, on a 7-metre formation, and fully bridged and culverted throughout. This portion will not be further referred to in this paper.

Irbid–Lava Belt (66 kilometres). The pipe line runs along the

side of a range of hills for the first 30 kilometres, and crosses many valleys, wadis and small steep ridges of limestone. It then crosses a range of hills and is altogether a most unsuitable road location. After much cross-country travelling in rough going, a good location was found about 5 kilometres north of the pipe line. It passes over good agricultural land, consisting of cotton soil and red clay, for 10 kilometres; then it runs over loamy clay at the bottom of foot hills with numerous limestone outcrops; it then joins a wide valley at 15 kilometres. Desert is now reached, and the route crosses the range of limestone hills over a low pass. Instead of a multiplicity of small wadis, five large wadis had to be crossed, and the final grades will not exceed 1 in 20. The Hedjis Railway is crossed at kilometre 42 from Irbid at Mafraq, and the pipe line is again met. The Hedjis Railway is a single line of narrow gauge, connecting Damascus and Haifa with Transjordan. At Mafraq is the I.P.C. stores railhead, only a skeleton of what it was in the days of pipe construction, but a good tube well, an electric light plant, rail sidings and a small stores-forwarding staff remain. There is a most uncomfortable rest hut at the railway station but it serves good European meals. From 5 kilometres west of Mafraq to the Lava Belt, 14 kilometres east, is a flat, hard, desert, passable in all weathers for a limited number of vehicles. From Irbid to Rutbah, in Iraq, no water exists except for such wells as have been drilled by the I.P.C., and again no water until the River Euphrates is approached at Ramadi.

The Lava Belt stretches for 170 kilometres, and traverses one of the most desolate and forbidding areas on the surface of the earth. It is not flat, but broken up by gullies, undulations and extinct volcanoes. It is closely covered with black basalt rocks piled in confusion, single rocks up to several feet in diameter on the surface; these continue some five hundred feet down. The interstices between the rocks are filled with lava ash. The wadis run in flood after heavy rain, and the larger ones that flow from the Jebel Druse in Syria flow also when the snow melts. The I.P.C. cleared a track through this lava, and soled it over a width of 6 metres with lava stones, blinding the surface with clay and lava ash. The track is very rough, and is closed to traffic in wet weather. In constructing this road little attention was given to grades and it was just laid over the natural ground level, but it made communication and stores carriage possible. In the middle of the lava is H 5 Pumping Station of the I.P.C. No spare water is available here for road work, however, and no water is available until a further 25 kilometres, where a deep well is situated, 120 kilometres from Mafraq. A natural spring exists at Azraq, 45 kilometres south of the road, equipped with pumps and an old pipe line to H 5; this will be reconditioned to fill this gap. The highest point on the road is in the middle of the lava, and is 3,000 feet, approximately.

Lava Belt–Transjordan/Iraq Frontier (90 kilometres). This section runs over a slightly undulating desert of alluvial clay underlaid with limestone, and the surface covered with a layer of flints. One large deep wadi crosses the road, but at many places water crosses the desert in wide, flat and shallow flows, causing no erosion to the surface. During rain this desert becomes a sea of mud and water, and vehicles sink to their axles. The rainfall is, however, only about 5 inches per annum, and stoppages rarely exceed one week.

It will be noted that over the whole of this desert no sand exists, and clean gravel only exists in some of the wadi beds.

THE CLIMATE.

In summer the temperature rises to 105° F. during the day at H 4, and 100° F. at Mafraq; in winter 70° F. on a bright day, but can be very cold at times with 15° of frost at night. There is usually a difference of 40° between day and night temperatures in both summer and winter. Violent dust storms are common, and throughout the summer one's skin and respiratory organs are always full of fine clay dust. In winter the climate can be delightful on a sunny day, and in spring the desert is covered in grass and flowers.

Rainfall east of the Hedjis Railway averages about 5 inches per annum, and west of the railway about 12 inches. East of the railway 5 inches may fall in one place in one day, and another place may have little or no rain during the year.

THE ESTIMATE AND SPECIFICATIONS.

Space will not admit of details of the estimate, and the processes recommended will be described under the work later.

Considering the volume of traffic and the loads: The I.P.C. run cross-country vehicles of 60-ton load on multiple axles with axle loads of 9 tons, and tyre pressures of up to 80 lb. per square inch, from Iraq to Mafraq, and commercial lorries from Baghdad with similar axle loads run over the route to Haifa, and as it is not practical to limit speeds on such a desolate route, it was recommended that the surface and formation should be capable of carrying all loads on pneumatic tyres with pressures not exceeding 80 lb. per square inch, and be continuous over the whole route. Culverts to take the British standard train. Bridges to be Crown Agents for the Colonies standard steel-span heavy bridge, which could be strengthened later if required. Heavy I.P.C. vehicles to run over the old causeways and not use the bridges.

A considerable time was spent studying processes, costs and output of labour in Palestine, Egypt, Transjordan and Iraq, and detailed costs for the various processes recommended were worked out.

No detailed survey was attempted, as the time and staff given for the estimate did not allow of this. Costs of typical sections were, however, worked out in detail.

It was decided to recommend that the section from the Lava Belt to the Frontier should be done by contract, as a British firm of Murdoch and Brooks in Baghdad had the plant and trained operators for the type of construction recommended, and their prices appeared reasonable. No other firm in the Near East had the necessary plant. The remainder of the work to be done by direct labour.

A detailed plan for organizing and carrying out the work was submitted, together with detailed lists of staff, plant, tools, petrol, oil, lubricants, tentage, etc., required.

The abstract of the estimate, excluding agency charges to cover overheads, was as follows:—

1. Cost of road construction	£428,430
2. Cost of salaries of subordinate staff ..	41,210
3. Cost of accommodation	3,000
4. Cost of medical service	4,760
5. Cost of workshops, and transport for staff and its maintenance	10,000
6. Purchase of land	2,000
7. Cost of telephone	1,000
	490,400
Add 5% contingencies	24,500
Total	£514,900

Tools and Plant are depreciated two-thirds value on the work, and this value is included in Item (1). The remaining one-third will be recovered on disposal.

The estimate was completed by the middle of October, 1937, and the author returned to England.

The author spent from November, 1937, to May, 1938, awaiting a decision as to whether the work would receive sanction. During this time, specifications were drawn up by him for the plant required, and for a contract for raising and consolidating the earth formation, and mixing, laying and consolidating the surface on the 90-kilometre section of the road from the end of the Lava Belt to the Iraq frontier, the work to be done by machinery; and a contract for the hire of tractors, graders, scrapers and other American type road plant, for direct employment on other sections of the work.

Opportunity was taken to get in touch with various makers of the types of plant required. Tenders were called for, so that as soon as

financial sanction was given there should be no delay in placing the orders. Provisional sanction was given for a staff, and the personnel were selected.

Sanction was actually given early in May. Contracts for plant and work were signed and placed, and the advance party sailed on 14th May, arriving in Palestine on 24th May.

THE PLANT, MACHINERY, AND TRANSPORT.

The plant used is of particular interest to Military Engineers because of its variety, portability and its efficiency for this type of work. Owing to the difficulty of maintaining a large labour force in the desert, machinery was used in preference to hand labour where possible. In war, a large labour force on a road will be most vulnerable. These machine methods of road-making attracted considerable interest from engineers in the Near East, and it was the author's experience that in Transjordan, where the labourer costs 3s. for a ten-hour day, including the cost of his water and accommodation, a considerable economy resulted in the use of this machinery, savings in some cases being as much as 100 per cent.

A brief description of the plant is as follows :—

PLANT PURCHASED.

Nos.	*Description.*
4	Halman T.18.D. 180 cubic feet per minute. Compressors driven by 40 b.h.p. Dorman Diesel engines on a pneumatic-tyred carriage.
3	20 by 9 inches Goodwin Barsby cast-steel jaw-crushers driven by 30 b.h.p. Lister Diesel engines on steel-tyred carriage.
3	Goodwin Barsby 16-inch wide belt portable elevators driven by 3¾ Lister petrol engines.
4	24 by 9 inches Goodwin Barsby cast-steel jaw-crushers, on steel-tyred carriage driven through universal shaft by a D.4 Caterpillar 40 h.p. Tractor from a rear power take-off. Designed to author's specification. The clearance to allow the crusher to deposit a windrow of crushed stone sufficient for a surface 10 cm. thick over a road width of 5 metres.
8	Millar's paddle mixers with 10-cubic feet mixing box on a steel-tyred carriage. Side skip loading. A mechanical bitumen pump is incorporated, and the whole driven through a universal shaft from the rear power take-off of a D.2 20 h.p. Caterpillar Tractor.
8	Bristowe Bitumen Heaters of 320-gallon capacity, output 200 gallons per hour. Equipped with standby hand bitumen

Nos.	*Description.*
	pump. Heated by Rutherford non-power oil-burning equipment. Mounted on a pneumatic-tyred chassis.
	These heaters are towed behind the mixers by the tractors and the three machines are operated as one unit. The axle clearance allows the plant to deposit a windrow of mixed material sufficient for a surface 10 cm. thick over a road width of 5 metres. The heaters and mixers were specially designed to the author's specification for work in combination with the tractor-driven crushers. The windrow of bitumen macadam being spread by a blade grader reduced labour to a minimum for this process.
1	Littleford 1250 U.S. Gallon Model C Bitumen heater and distributor, on a 4-wheeled trailer chassis with dual low-pressure tyres.
12	Aveling DX8 single cylinder 8-ton Diesel Rollers.
6	Aveling DY10 single cylinder 12-ton Diesel Rollers.
2	Pneumatic drill sharpeners with pneumatic oil-fired furnaces.
6	D.4 Caterpillar Tractors. Three for general haulage of plant, and three for operating the crushers.
4	D.2 Caterpillar Tractors for operating the mixers.
4	Muirhill ½-yard loading shovels.

TRANSPORT PURCHASED.

Nos.	*Description.*
8	Thorneycroft 106 b.h.p. "Amazon" petrol-engined 3-axle cross-country chassis tractors, on low-pressure tyres, drawing :—
3	Carry-more Semi-Trailers with platform bodies on dual rear axles, to carry loads of 15 tons.
5	Carry-more Semi-Trailers on single rear axles, carrying 2,000-gallon Bitumen Tanks, insulated and with air pressure discharge.
1	Ford V-8 Utility car.
4	Chevrolet coupé "pick-up" cars.
1	Chevrolet 5-seater saloon car.
4	Chevrolet Utility cars.
6	Chevrolet 1-ton "pick-up" trucks.
6	Chevrolet 2½-yard tipping lorries.
9	Chevrolet 500-gallon water tank lorries.
18	Muirhill 2½-yard Dumpers.

HIRED PLANT.

Nos.	*Description.*
3	R D 8 Caterpillar Tractors.
1	R D 7 Caterpillar Tractor.
2	Le Tourneau Heavy Rooters.
2	Angle-Dozers.
1	Le Tourneau Model K 12-cubic yard Carry-all Scraper.
1	Caterpillar No. 66 Blade Grader.

CONTRACTORS' PLANT.

Nos.	*Description.*
2	R D 7 Caterpillar Tractors.
1	R D 8 Caterpillar Tractor.
2	Caterpillar No. 42 Elevating Graders with 22-foot Carriers.
1	Le Tourneau 12-cubic yard Carry-all Scraper.
1	Caterpillar No. 66 Blade Grader.
1	Caterpillar No. 12 Auto Patrol.
1	John Dere Spring Tooth Harrow.

NOTE.—All Caterpillar Tractors, Road Rollers and Bitumen Heaters ran successfully on crude oil from the I.P.C. pipe line.

THE WORK.

On arrival in Palestine on the 24th May, the immediate problems facing the party were :—

1. Set up a headquarters' office, stores purchase and forwarding department, in Haifa.
2. Construction of a base on railhead at Mafraq on the Hedjis Railway in Transjordan.
3. Start the contractor working on the construction of the formation between the Lava Belt and the Iraq frontier by the 25th June, the date on which he was ordered to assemble his plant and material.
4. Keep the contractor supplied with food and water, oils, lubricants, etc.

An office was hired in Haifa, in charge of the assistant to the C.R.E., an R.E. captain, who had under him a stores branch with a warrant officer in charge of stores, assisted by three locally engaged clerks and one typist. All stores were kept on ledgers in Haifa, and taken on tally cards when issued to the store at the base at Mafraq, and on inventories when issued to any section of the work. The A.C.R.E. had a clerical branch which dealt with :

a. Correspondence generally.
b. The construction account.
c. Recruiting of skilled trades from outside Transjordan.

1.—The desert near H_4 in wet weather.

2.—Heavy Rooter tearing up limestone preparatory to Scraper making a side cut.

3.—Angle-dozer cleaning a track in lava belt.

4.—12-Yard scraper making a cut and fill.

Haifa - Baghdad road 1 - 4

5.—Two elevating graders on last cut on earth formation desert sector and a blade grader finishing the top.

6.—Blade Grader ditching and casting up berm.

7.—A Soling gang.

8.—Engine driven Portable Crusher and loading elevator.

Haifa - Baghdad road 5 -8

This staff consisted of :—

Two engineer clerks, Royal Engineers.
One draughtsman and one typist, locally engaged.

In the same office was the paymaster, a major in the Royal Army Pay Corps, assisted by one serjeant R.A.P.C., and two locally engaged clerks. The paymaster paid all labour personally during the first week of each month, and prepared and checked all pay sheets, and on behalf of the C.R.E. carried out an audit of all expenditure, pay sheets, petrol, oil, and stores accounts, and paid all bills. He also acted as an adviser to the C.R.E. on all pay and financial matters. He had under him, attached to the staff of each of the two executive engineers on the road, a locally engaged pay clerk.

The Iraq Petroleum Company, Ltd., had a stores-forwarding depot at Mafraq on the Hedjis Railway, with two railway sidings, which was used during the construction of the pipe line, and was unused and dismantled except for a small store, their well and lighting plant. This company made a great contribution to the ease of starting up the work by placing half their compound and one siding, also 12,000 gallons of water and 6 kilowatts of electricity, at the disposal of the War Department. The C.R.E. was lucky to find that the workshop and living huts of the Army Ordnance workshops at Haifa were on his arrival up for disposal by tender, but, as the tenders had not been accepted, he was allowed to purchase these at the price of the highest tender and obtained for £100 :—

Four living and office huts of corrugated iron, lined with three-ply wood, each 30 ft. by 20 ft.
Two workshop sheds, each 80 ft. by 40 ft.

which were dismantled and sent by road and rail to Mafraq to form the Base Camp there. The dismantling and re-erection were carried out by the Arab contractor of the Royal Engineer Services at Haifa at his local running contract rate. From these an officer's mess and quarters, N.C.O.'s mess and quarters, native staff block, office block, stores blocks and workshop bays were made. Additional native quarters and stores were made of mud-brick and corrugated iron.

It was planned to divide the work into two sectors (see map).

The Mafraq sector was to stretch from Jisr-el-Majami to H 5, with headquarters at Mafraq, and the H 4 sector was to stretch from H 5 to the Iraq/Transjordan frontier, with headquarters at H 4, each under an Executive Engineer. Work was to be concentrated on the two ends first, where the present tracks were always liable to stoppage in rain. In the autumn, 1939, both sections were to work towards H 5 with headquarters at H 5, and to complete the road by the end of the summer of 1940.

The C.R.E., during the first and second weeks in June, took the

engineer officer, an R.E. captain, who was to take charge of the H 4 end of the road, which was to extend from H 5 to Iraq, a distance 183 kilometres and included the contract work between the Lava Belt and Iraq, showed him the country and instructed him on how the work was to be carried out.

On return to Haifa a road engineer, loaned by the Shell Company of Egypt, reported to take duty as engineer in charge of the Palestine end of the road, which was to extend from H 5 to Irbid, a distance of 137 kilometres. This engineer had spent some weeks with the C.R.E. on this location during the preparation of the estimates, and knew the C.R.E.'s plan and the methods of work proposed.

An Englishman, who had previously held various positions in Palestine and Transjordan, was engaged as officer in charge of the Base at Mafraq, and his duties were :—

a. Recruiting officer for local labour.
b. Stores, fuel and food supply, and its reception and distribution to the work.
c. Supervision and organization of transport.
d. In charge of plant erection, and of repair workshops for plant and transport.

On the 26th June, four one-ton trucks and four utility cars having arrived, were loaded with kit, tentage, etc. The following nucleus staff departed for Transjordan, and arrived in Mafraq the same day, and the H 4 party in H 4 the day after.

Mafraq :—Deputy Commander, Royal Engineers, Mafraq.
One Royal Engineer N.C.O., engineer clerk.
One Royal Engineer N.C.O., surveyor.
Officer in charge of the Base.
One ex-soldier, head storekeeper.

H 4 :— Deputy Commander, Royal Engineers, H 4.
Two Royal Engineers, N.C.O., surveyors.
One ex-soldier, head clerk.

For political reasons it was not possible to employ Jews in Transjordan, and the Transjordan Government were very averse to the employment of any except unobtainable trades from outside Transjordan, and in the course of four months, from this modest beginning, an organization, employing 2,000 directly employed labourers and utilizing and operating plant and transport to the value of roughly £80,000, was in full work. The great majority of the operators and labourers were new and unaccustomed to machinery and their work.

Messrs. Murdoch and Brooks, contractors of Baghdad, were prompt in assembling their plant. They brought two Elevating Graders, with 42-inch belts, and a 66 Blade Grader, towed by three R D 7

Caterpillar Tractors, across the desert 300 miles from Mosul, and started raising the earth formation 8 metres wide and half a metre above the desert surface on a straight run of 90 kilometres.

We will now turn back to the Base at Mafraq, where the organization for the employment of direct labour all along the road was evolved.

The Base Camp.

Living quarters for superior staff and artificers replaced tents in the Base, also workshops, stores and offices were soon erected, with water and electric light laid on. Contracts were placed locally for black hair Bedouin tents for labourers, twenty-five to a tent; capital cost £1 per head. A mobile workshop was purchased containing a generating set operating, among other tools, a 6-inch lathe, drilling machine, valve grinding machine, also a press and a very complete outfit of special tools for servicing, maintaining and testing motor vehicles, and Chevrolet cars in particular.

Police.

A native police force was supplied at a cost against the work by the Desert Legion, consisting of a motor patrol of one serjeant and four *jhundies*, to work at the Mafraq end, and four camelry to patrol the H 4 end. These proved invaluable in keeping the peace in the many strikes that occurred, and prevented any serious bloodshed. In addition each engineer enlisted his own force of armed watchmen, mostly Bedouin of good family and influence with the tribes. They each brought a rifle, and carried one or two revolvers and a few knives stuck round them, were girded with bandoliers of ammunition, and looked a very bloodthirsty crowd. Each labour camp had one or more of these, at the rate of about one to each seventy labourers. Any theft or crime in or against the camp was taken as a personal insult by the watchman, which might be the cause of a blood feud. These men also acted as the secret service to forestall strikes and trouble.

Medical.

A medical officer with a staff of medical dressers, one dresser to each large camp, was employed under medical supervision of the Transjordan Medical Service. Four-bedded wards were built at H 4 and Mafraq. Each labourer was medically examined, vaccinated and innoculated against typhoid and cholera, and, if lousy, his hair was cut off and his clothes deloused.

RECRUITING AND PAY.

To prevent crowds of labourers assembling at Mafraq on the chance of getting work, and waiting there with no means of subsistence, arrangements were made for headmen of tribes and villages to send men as required. This was unsatisfactory, as a body of Arabs from one village or tribe when enlisted together are always conspiring and striking, and will not work except under their own leader, who is more interested in seeing that a minimum of work is done by his party than he is in his employer's interest. Once we had obtained the bulk of our workers, we reverted to the old system of engaging individual applicants, and breaking up the gangs.

On engagement and after medical inspection each man was given a brass disc with a number on it in Arabic and English, and he was registered. His name and number and rate of pay were entered on his gang's monthly time-sheet and on the register. A timekeeper, usually a young Arab just left school, with a knowledge of English, was employed on each gang of between 25 and 50 men. On joining work in the morning a line was put in the space for the day opposite each man's name, and the line was made into a cross at the completion of work. At the end of the month the time-sheets were consolidated on to the wages check list.

The totals of pay were telephoned to Haifa, and the Paymaster flew with the cash to Mafraq by R.A.F. plane, and was escorted by the Police Patrol throughout the road. Pay took six days to complete. On receiving his pay the labourer handed in his disc as proof of payment, and he was handed a new disc of different shape for use in the next month. In the following month the original disc was again brought into use.

COMMUNICATIONS—TELEPHONE.

A private telephone system was laid throughout the road and to the Haifa office, and was operated by the road staff. At Haifa it connected to the military and civil exchanges. The wire ran on a spare arm of the I.P.C. telephone, but was constantly being melted when the I.P.C. pipe line was punctured and fired by Arab bands. The Mafraq office was also connected to the Transjordan telephone system as it was seldom possible to hear speech from Palestine, though the civil telephone service messages were relayed by R.A.F. wireless from Amman.

RAIL.

Trains ran three days a week from Haifa to Mafraq, but owing to shortage of rolling stock and the steep grades, our heavily loaded trucks were often left at the bottom of the grade, and took up to a week to arrive.

Feeding.

Enquiry was made from various contractors with a view to placing a contract for the supply and distribution of food to labourers, and the question of the scale of rations was taken up with the Transjordan authorities. The Transjordan Government, however, were expected to insist on a luxury scale that was far in excess of any that the labouring classes would normally provide themselves with, and they would not allow a non-Transjordian contractor to supply. No contractor existed in Transjordan who could be relied upon to carry out a contract of this magnitude.

It was therefore decided to exploit local initiative and give encouragement to smaller shopkeepers to open canteens in the labour camps. It was necessary to ensure however that, during the wet season, no shortage of staple food should occur in any isolated camp.

West of the Lava Belt, where communication with villages could be obtained by the labourers, there was an ample supply at reasonable cost and shopkeepers opened canteens in Mafraq and in the camps. Camels and donkeys could bring food and a gang would send a representative to do their shopping in some village.

In the Lava and east of it prices soared, and it was difficult to persuade a merchant to undertake the business. A big merchant of Amman was however persuaded, on the conditions that :—

1. The Government transported all his supplies free to his shops from Mafraq.
2. He sold his goods at prices ruling in the settled districts, his prices to be subject to approval of the C.R.E.
3. He would be given a monopoly of shops and canteens in the labour camps, but labourers would not be prevented from bringing in outside supplies.
4. He should keep 7 days' reserve of certain staple items in each camp, and 10 days' reserve in store at Mafraq.

The above arrangement worked well on the whole.

Workshops and Maintenance.

A young R.E. staff serjeant, military mechanist, was placed in charge of workshops at Mafraq. He had under him an Arab plant foreman, with Diesel experience for erection and repair of plant, and an Arab foreman for repair and maintenance of motor transport.

The transport was running ten hours a day on the work, and each vehicle was given a thorough weekly inspection of about half a day in shops, and was greased, oiled and looked over daily by the night shift. Each vehicle had a log book in which everything done was entered, and a record of oil, tyres, petrol and oil issues was kept ;

a 100 per cent check was made each month against petrol store issue books, and petrol consumption of each vehicle was worked out.

Spare parts were a big problem. Both General Motors, Ltd., and the Caterpillar Tractor Company supplied stocks of spares to our stores at Mafraq, and agreed to take back all unused spares on termination of the work at cost price. With British firms it was necessary to purchase stocks of the spares required, involving a large capital outlay. The probability was that many parts would be unused. When the unexpected failure occurred, a delay of three to four months was occasioned in getting the spares from England. In these instances, parts could usually be manufactured locally in Palestine or in our shops, but this was often more expensive and material or workmanship were inferior.

All transport and plant on the Mafraq sector of the road work were based on Mafraq Base for repair and maintenance.

At H 4 a similar arrangement was made for maintenance and minor repairs, and a workshop was built there with a Greek foreman mechanic. Major repairs were sent to the Base workshop at Mafraq. Each engineer also had a foreman mechanic to supervise the running maintenance of his plant and machinery on the work. These arrangements worked well.

TRANSPORT AND STORES DISTRIBUTION.

The three Thorneycroft 15-ton Flats did not arrive until late in 1938, and a local contract was made for the supply of 4-, 5- and 6-ton trucks. After the arrival of the Thorneycrofts they ran every three days to H 4 with fuel, stores, tools, plant, food, etc. The journey took eight to ten hours for the 203 kilometres. These vehicles were able to convey the heaviest machinery and plant employed on the work, with the exception of the R D 8 Tractors. Between trips to H 4 these vehicles did local journeys with supplies in the Mafraq sector.

The light trucks, cars and water tankers were distributed to sections of the work, as required, by the C.R.E. During peak periods, extra trucks were hired under contract.

BITUMEN SUPPLY.

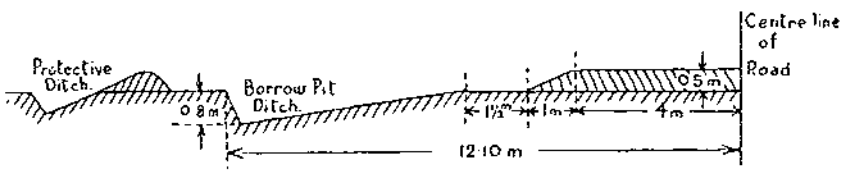
The Shell Company of Egypt, the contractors for the supply of bitumen, received their bitumen by rail in bulk at Mafraq, and transferred it to storage tanks at their siding. It was then re-heated and delivered to War Department in 2,000-gallon Thorneycroft road tankers or into drums as required, cut back to such specification as demanded.

Construction from East of Lava Belt to the Transjordan/Iraq Frontier.

The previous year the author visited the R.A.F. Cantonment at Habbaniya near Baghdad, where, with a similar soil and an even greater scarcity of stone, roads had been successfully constructed and had carried heavy traffic for four years without any noticeable trouble. Here the formation had been raised half a metre above water level, and a 4-inch gravel and bitumen premix surface had been laid direct on to the earth formation. Trouble had only occurred when the roadside drain had been too close to the edge of the formation, and water had penetrated under the road. It was therefore decided to construct this type of road on this section of the work.

The specification given to Messrs. Murdoch and Brooks under their contract on this section was :

1. *Formation.*—Raise and consolidate a formation half a metre high and eight metres wide on top over the whole 90-kilometre length as shown below and finish to shape and grade.



The formation to lie through one winter's rain to assist consolidation. Payment by the cubic metre of soil after consolidation.

2. *The Base Course.*—Crushed stone to be supplied by the War Department on the road. The contractor to spread a base course 3 cm. thick and spray this with bitumen supplied by the War Department and roll. This course was to provide a clean smooth bed on which the mix-in-place of the surface mat could be carried out.
3. *The Surface Mat.*—Further crushed stone to provide a carpet 8 cm. thick, making a total consolidated thickness of 10 cm., to be supplied on the road by the War Department. The contractor to spray this with bitumen and mix and spread with an Auto-Patrol and finally consolidate. A power sprayer and crude fuel oil from the I.P.C. pipe line being supplied by the War Department.

The elevating graders started work early in July, and had raised just over 100 kilometres of the formation by the 1st January, 1939 (including 10 kilometres in the Mafraq sector). The makers assess

the output of a 42-inch belt elevating grader from 225 m^3 in poor to 450 m^3 in good conditions per hour. In the six months during which these two machines were employed, they elevated approximately 450,000 m^3, an average of 1,250 m^3 per day or 625 m^3 per machine per day. The ground from all outward appearances seemed ideal for the operation, but over about 30 per cent of the distance a limestone stratum, varying from rotted stone to hard limestone, was struck by the plough. The surface of the desert was also covered with a thin layer of flints up to about 2-inch gauge on the limestone sections. A tractor-drawn rooter had to be employed to break up the rock before elevating it. The rock and flints caused a lot of wear and tear on the machines, especially the belts on the elevators. The machines had a rough passage across the desert from Iraq to site, causing wheels to collapse, and in consequence it was very seldom that both machines were in working order at the same time, and sometimes neither of them. These various troubles were not foreseen, and delays were caused in waiting for spares from Baghdad and the United States. The contractor when possible worked up to 20 hours per day, and must be congratulated on his perseverance under such difficulties of ground and climate. The author can think of no other machinery or other means of doing the work so speedily or at such an economic rate under the conditions.

Compaction of this bank was carried out by blading each layer of soil after it was cast on by the elevating grader and it was afterwards levelled to grade where necessary by a 12-cubic yard Carry-All Scraper, and finished with a slight crown by auto-patrol. Every 400/600 metres the borrow pit was filled to allow traffic to enter, leading on stone later and turning round during mixing operations. This fill was placed below a culvert on a down grade or on top of a rise.

Culverts were required on an average of two to three per kilometre, and consisted of 15-inch reinforced-concrete pipes, cast at the nearest water point, laid two or three pipes together with masonry headwalls. A number of concrete causeways, with rough masonry in cement drop walls and with slopes of one in forty, were constructed with a flat length to allow a maximum depth of one foot of water across the road during flood.

Only one major wadi existed in this sector, and it was crossed by six 30-foot spans of Crown Agents for the Colonies standard heavy bridge, single traffic, made of steel troughing. Piers and abutments were of concrete, faced with masonry.

Traffic was encouraged to use the formation to assist consolidation, and it was planned that the winter's rain would sufficiently consolidate the bank to allow surfacing to be started in the early summer of 1939. That winter the rainfall on this sector, however, did not exceed 2 inches, and this fell before the section east of H 4

had been completed, so it was decided to surface from the Lava to H 4 only in 1939.

A protective ditch and bank was made by one cut of a 66 blade trader on the uphill side of the borrow pit, and about 10 metres from it, to lead water to the culverts and causeways, and protect the borrow pit and edge of the formation from erosion that might be caused by any considerable flow of water in the borrow pit. The borrow pit thus only taking away such a rainfall as fell on the road surface.

The engineer at H 4 spent July sinking trial pits over the desert looking for stone. It was very difficult to know the quantity of stone that would be procurable, as an outcrop was caused by an upward bend in the strata, and a good stratum would often disappear in the earth again before any considerable quantity of stone was excavated. Many outcrops found were of poor quality or a thin layer only. New quarry sites had therefore to be continually sought for. A reasonably good quality limestone was found at a maximum carry of 10 kilometres from the road, and with an overburden not exceeding 1 metre. Quarrying started at once, and 60,000 m^3 of stone had been quarried ready for crushing by the 1st April, 1939; the output was $1\frac{1}{2}$ m^3 per man per day.

Two Goodwin Barsby 20 by 9 inch portable crushers, with portable belt elevators, crushed this stone $1\frac{1}{2}$ gauge down at the rate of 8 m^3 per hour fed by hand. The crushed stone was left in stacks at the quarries to be loaded into dumpers by loading shovels and led on to the road immediately before surfacing.

Surfacing.

Surfacing started early in April, 1939, and included the following processes:—

1. The Base Course.

Three centimetres of crushed stone was led on to the road and spread by auto-patrol on a width of $5\frac{1}{4}$ metres, and was rolled with an 8-ton roller.

A Littleford distributor, drawn by a D 4 tractor, sprayed this with bitumen at 2 kgs. per m^2 and this was again rolled.

2. The Surface Mat.

Crushed stone was led, in quantity to provide 8 cm. of stone over a width of 5 metres, and dumped in a windrow on one side of the road. This windrow was bladed across the road by auto-patrol, and it was found that a layer containing most of the crusher dust and fine chippings remained, while the new windrow contained most of the larger stones and chippings and a few fines.

The layer of fines was screened by hand to extract the chippings for the later seal coat.

The windrow was then flattened by auto-patrol into a bed 2½ metres wide, and mixing started over lengths of from 500 to 900 metres. Fifty-five kgs. of 80 per cent bitumen at 240° F., sprayed at 35 lb./square inch pressure per m^3 of aggregate, were found to be required, and the work was started early in the morning.

One quarter of the quantity of bitumen was applied, and, while the distributor was being refilled and heated, the bed of aggregate was cultivated with a spring tooth harrow.

Following a second equal application of bitumen it was cultivated twice, following which the auto-patrol turned the material over twice, and carried it across the road, leaving it again in a bed 8 ft. wide.

A further equal application was followed by two cultivations and the remaining quarter quantity of bitumen was added and cultivated once. The last application was usually made by 11 a.m. The auto-patrol then completed the mixing by blading the material from one side of the road to the other, four trips being required to transport the material, and mixing was completed by 3 p.m. The mixed material was spread by auto-patrol, and completed by 5 p.m.

At 5 a.m. each morning, one pass was made with an 8-ton roller travelling at 2 to 3 miles per hour, and the road was then opened for traffic, and was rolled again at 4 p.m. Care was taken not to use the roller when the material was soft enough to show waves in front of the wheels.

3. Seal Coat.

It is planned to apply the seal coat before the winter of 1939, but one section was sealed as an experiment about a week after mixing. A 5-metre spray bar distributed bitumen at 1½ kgs. per m^2, and the surface was blinded with chippings and rolled.

4. Berm.

Immediately before the first rolling, material from the berm is brought in by hand to make an even joint with the stone mixture. In rolling, the outside roller wheel is run partly on this material and partly on the stone mixture. After sealing, the auto-patrol will be used for trimming the berms to continue the camber.

It is reported that the resulting surface has extraordinarily good riding qualities at any speed, far surpassing those achieved by means of hand spreading. It was also observed that a concrete causeway with slopes of 1 in 40 could be crossed at 80 kilometres per hour with scarcely perceptible vertical movement of the car.

9.—Tractor driven crusher.

10.—Surfacing with Millar Paddle Mixer driven by power take-off from tractor.

11.—Thorneycroft Amazon carrying 8 ton roller.

12.—Applying Bitumen on the base course.

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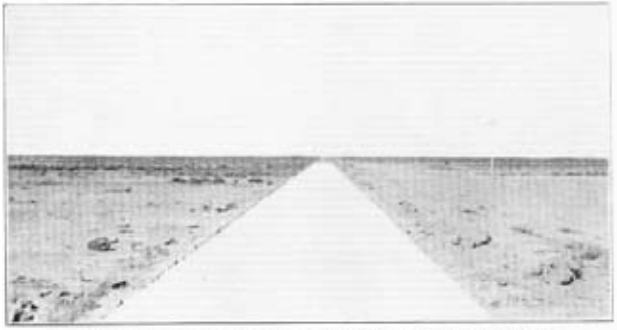
13.—Cultivation after first application of Bitumen.

14.—Autopatrol mixing and a "Chummy Three" culvert.



15.—Experimental section on lava road sealed and finished.

16.—After first rolling.

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Equipment Used.

Formation.

2 Caterpillar No. 42 Elevating Graders, with 22-foot carriers.
2 Caterpillar D 7 Tractors.
1 Caterpillar D 8 Tractor, with Le Tourneau Model K Carry-All Scraper.
1 Caterpillar No. 66 Blade Grader.
1 Le Tourneau Rooter.

Mixing.

1 Caterpillar No. 12 Auto-patrol with roller attachment (also used for final blading of Formation).
1 John Dere spring tooth Harrow.
1 Littleford Bros. Model C Bitumen Distributor, with 1,250 U.S. gallon tank on 4-wheel trailer chassis and dual low-pressure tyres.
1 Caterpillar D 4 Tractor for drawing Distributor and Harrow.

Bitumen Supply.

It was found that bitumen leaving Mafraq in the Thorneycroft tank wagons at 150° F. arrived at site at 125° after an eight-hour run. It was found that a tanker could be held for two days before unloading, and that 80 per cent bitumen could be unloaded at a temperature considerably below 100° F. Normally, less than ten minutes were required to fill the distributor from the tanker.

The tractor proved ideal for towing the distributor, owing to the even speed maintained by the governor of the tractor. It was found that, in discharging 1,000 to 1,200 U.S. gallons on a run of 700 metres, the total output could be gauged to within 25 gallons. The heater raised the temperature in the distributor 3 to 5° F. per minute, depending whether the tank was hot or cold in starting.

The Lava Area.

Formation.

Three major re-alignments of the I.P.C. road, totalling 15 kilometres, were made to avoid long steep grades, and to reduce the number of wadi crossings. In one case the I.P.C. road crossed the same large wadi in six places, and the re-alignment reduced these to two.

About 25 per cent of the I.P.C. road will have to be re-graded to eliminate acute vertical curves, improve bends by increasing the radius, adding super-elevation and raising the I.P.C. soling where it has subsided.

In all this work a heavy rooter was employed, drawn by an R D 8 Caterpillar tractor fitted with angle-dozer equipment. The rooter is first passed over the alignment, where it will upturn any boulder up to about one metre dimension, and the angle-dozer will push

it off the formation. Any rock that was larger had to be blasted, the bore holes for the charges being made by a Holman compressor. This work was continuous over almost the whole of the 100 miles of Lava country. When the required grade had been excavated, a thickness of about 1 foot of lava ash and soil was placed and consolidated above the rock as a bed on which 20 cm. of hand-packed soling was laid, so that uneven consolidation of the soling should not occur, as originally happened with the I.P.C. soling.

Culverts were mostly constructed of roughly cut slabs of lava rock, producing a series of openings 2 feet wide. The end and wing walls were of roughly cut masonry in cement.

Wadis were crossed by causeways. Where the grade down to the wadi was not too severe, the bottom of the causeway was made at wadi bottom level. In other cases, an over-and-under causeway was constructed, the openings and drop walls being faced with masonry in cement and a concrete roadway provided.

Road Metal.

Along the whole length of road, lava stones in sizes suitable for crushing were piled in continuous heaps in the quantity required for surfacing. The tractor-driven 24 by 10 inch Goodwin Barsby crushers moved between these heaps and the roadside. The tractor drove its crusher through the rear power take-off, and then moved about a metre and crushed again; by this means a continuous windrow of crushed metal was left at the roadside.

Surfacing.

Mixing started after the author had handed over the work. The procedure planned in this section was that surfacing should start at the two ends, one end under control of the engineer at H 4, and one under the engineer at Mafraq. A number of D 2 tractors, each towing a Millar mixer and a boiler, and operating the mixer through a rear power take-off, should pass along the soling. The mixers should be fed by crushed metal from the windrow beside the road, and, working in a similar way to the crushers, deposit a windrow of mixture on the road surface. The mixture to be laid in two courses for a thickness of 10 cm., and spread by hand or by blade grader; each course to be separately consolidated. Two courses appeared necessary to prevent minor inequalities in the old soling reproducing themselves in the finished surface. The final surface to be sealed with bitumen and blinded with chippings.

The following experiments have been made to reduce the cost on the better portions of the old surface, where some hand work would still have been necessary in order to rectify small inequalities in the soling.

The earth surface over the soling was scarified, bladed and sprayed with crude oil from the pipe line at 2 kgs. per m^2. Crushed stone was

added to an average depth of 5 cm., spread with auto-patrol and rolled thicker at the crown than at the edges to provide a camber. The centre half of the road was sprayed with bitumen at 1 kg. per m^2, and then the whole width was sprayed at 2 kg. per m^2. This was rolled next morning and 3½ cm. of stone added, and sprayed at midday with 2 kg. per m^2 and rolled next day. This was repeated with another 3½ cm. layer next day, and two days later the surface was sealed with 2 kg. per m^2, blinded with chippings, rolled and opened to traffic. The appearance was good, but the stones were not so well bound together as in the mixed sections.

Adjacent to the above experiment, a 500-metre length on a base similarly treated with crude oil, a depth of 10 cm. of crushed stone was added. This stone was mixed by auto-patrol with 60 kg. of bitumen per m^3, as was done in the H 4 area previously described, except that 20 kg. per m^3 of crude oil was added after the first application of bitumen. In mixing, the scarified material from the original road was incorporated in the mix, and the crude oil was of great assistance in handling this added quantity of fines. This treatment is said to show every promise of success, and it is now proposed that the whole length from the east of the Lava to H 5 should be blade mixed in this manner. This will greatly speed up the surfacing process, as owing to the necessity of postponing the surfacing between H 4 and the frontier until next season, the plant for this work can be employed, leaving all paddle mixers free for work on the Mafraq sector.

Irbid to the Lava Belt.

The Irbid end of this sector has a considerably higher rainfall than to the east of the Hedjis Railway. The winter rain coming from the west across Palestine is deposited on the ridges of hills, and the last of the rain is usually deposited on the Irbid escarpment and peters out on reaching the railway. Rainfall east of the railway usually comes from the south in the form of isolated storms. The area stretching about 10 kilometres east of Irbid is a rolling country of red clay and black cotton soil, which is good agricultural land, but impossible to work on for weeks at a time in winter. Passing eastward, the country then becomes more arid and hilly, until a barren, hard, desert plain is reached a few kilometres short of the railway, and this continues to the Lava Belt.

It was decided that formation work should continue as far as possible from the railway towards Irbid before the rain set in, and if possible to complete the formation to allow consolidation by rain before 1939. On the flat desert, formation and soling work would be possible throughout the winter. The whole length should be fully bridged, but as no statistics of rainfall and run off were available,

bridging should not be started until observations had been made during the winter.

The following plant was hired from Messrs. Murdoch and Brooks for formation work on this sector, but was not due for delivery until late August:—

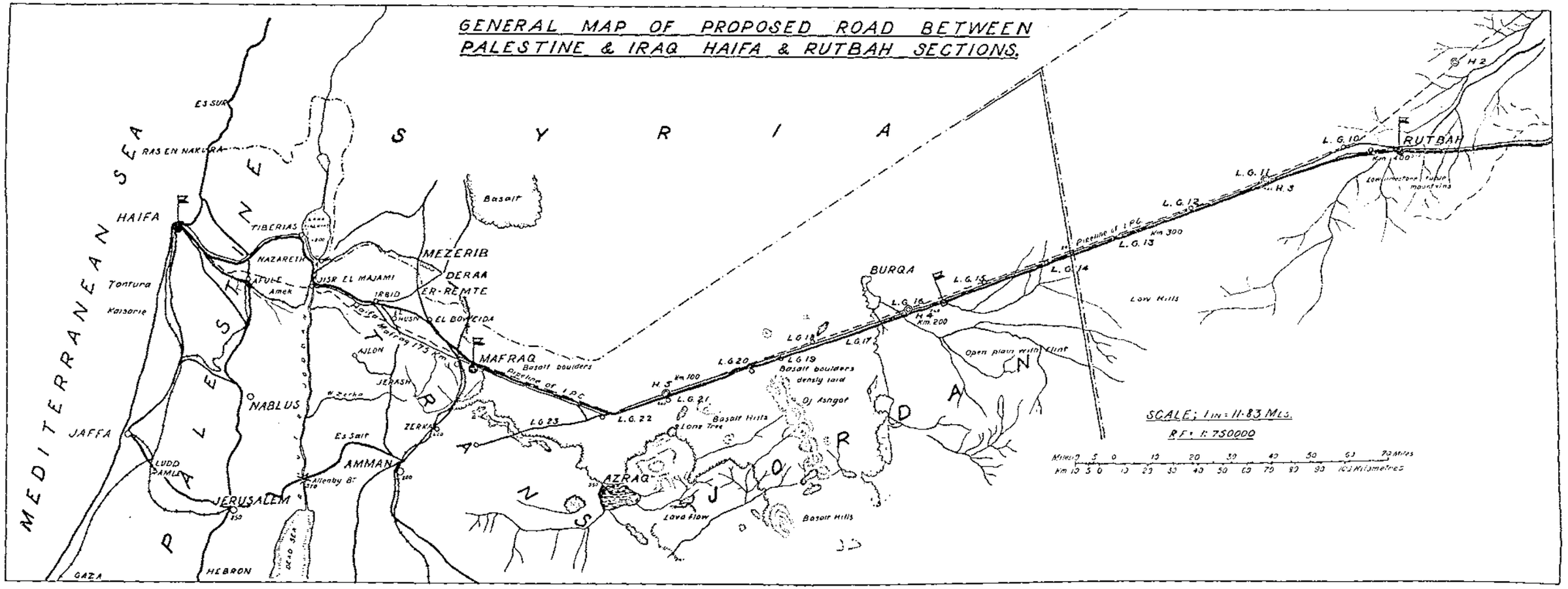
1 Caterpillar 66 Blade Grader.
1 R D 8 Tractor fitted with Angle-Dozer.
1 12-yard Le Tourneau Carry-all Scraper.
1 Heavy Rooter.
1 R D 7 Caterpillar Tractor.
1 R D 8 Caterpillar Tractor.

Pending delivery of plant, work was concentrated on quarrying and collecting stone for soling and surfacing. Although outcrops of limestone occurred all along the alignment, in most sections a sound stone was difficult to find without a carry of 10 kilometres. A quarry was operated by direct labour, and stone was supplied from this over a length of 10 kilometres of road. Having ascertained the cost of extraction, the road was divided into lengths of about 10 kilometres, and tenders for the quarrying and collection of stone for each length were put out to contract. All stone was on the roadside by the end of 1938.

In August, a blade grader was put to work ditching, crowning and shaping the formation on the flat well-drained section east and west of the Hedjis Railway, and the training of the soling gangs commenced. By September, two gangs each 100 strong were employed west of the railway, and they had worked up to an output of 10 square metres per man per day, stone being piled ready at the roadside. The output was therefore 400 metres of road per day. In the rains, first one gang and later the second gang, were transferred to the east of the railway.

One of the elevating graders from H 4 was transported to Irbid, and in one month raised a formation of the same specification as at H 4 on the 10-kilometre length of cotton soil east of Irbid. On this section, all cut and fill work was performed by a 12-yard carry-all scraper, assisted by a heavy rooter to break up the rock. Any hard rock formation was first shaken by explosive in bore holes. The angle-dozer was used on short lengths of cut and in filling-in culverts and bridge abutments. The carry-all scraper proved a most useful and economical machine for cut and fill work so long as continuous employment can be found for it. The angle-dozer cannot compare with it on this work except on very short cuts, or where large pieces of rock have to be moved. In all except a few minor cases, and laying charges in blasting, all formation work was carried out by machines, and by New Year, 1938–39, when rain stopped further work on the formation, only about 8 kilometres remained to be completed.

GENERAL MAP OF PROPOSED ROAD BETWEEN PALESTINE & IRAQ HAIFA & RUTBAH SECTIONS.



A particularly heavy early rainfall occurred in November over the whole sector from Palestine to the Lava. At Mafraq, the rainfall in 48 hours was 13 inches, an inch more than the whole average for a year. All the larger wadis between the railway and Irbid ran at a depth of about two metres. The maximum flood heights of all wadis were recorded. The local Arabs were unanimous that this was the highest flood they had ever experienced in this area. The flood heights observed were quite twice that estimated by the engineers from observation of erosion marks on the banks. Phenomenally heavy floods were occasioned by the same storm in Palestine. This was a very lucky happening for us, as many of the wadis never again ran more than a few inches deep last winter. Unfortunately, this rainstorm did not extend beyond the west edge of the Lava Belt.

After this rainfall it was decided to fully bridge the road from the Jordan to the Hedjis Railway, and work was started on bridges and culverts. Reinforced-concrete pipes of 36-inch diameter singly or in groups for the smaller openings, reinforced-concrete slabs up to 4-metre spans, and Crown Agents for the Colonies standard steel trough heavy bridge, singly and in multiple spans, using the 20-foot and 30-foot standard spans. All having masonry-faced abutments, piers and wing walls, etc., filled with rubble cement concrete. On an average, three water-ways per kilometre were required, and on the 42 kilometres from the railway to Irbid, six bridges, of one 90-foot, two 70-foot and three 20-foot spans respectively.

The latest information shows that the work is closely following the estimate of cost, and it is confidently expected that the work will be completed on time.

The author wishes to express his appreciation to the Shell Company of Egypt for placing Mr. J. Flemming, one of their road engineers, and several foremen experienced in bitumen application and the running of road plant, at his disposal, and for all the assistance they have given in placing their wide experience at his disposal. Also to the Near East representative of The Caterpillar Company for his advice and weeks of personally training operators, and putting his experience of American road work at our disposal.

*MINOR FRENCH FORTRESSES AND BARRIER FORTS IN AUGUST–SEPTEMBER, 1914.**

By BRIG.-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., D.LITT.

THE stories of the Belgian fortresses of Liége and Namur and of the French fortress of Maubeuge in the earlier days of the war in 1914 are fairly well known. Not so the fate of some of the minor French fortresses and barrier forts, such as Montmédy, Les Ayvelles, Charlemont, Hirson, Reims, Longwy, Manonviller, Troyon, and Camp des Romains. What happened to them is not without interest.

Their garrisons were too large for the purpose of blocking a route for a short time and too small for an active defence. No policy seems to have been laid down for the instruction of their commandants, and such orders as were issued to them generally arrived too late. The first seven fell in the original German advance in August, 1914.

Montmédy (near the Belgian frontier north of Verdun) was a fort held to ensure the destruction of a railway tunnel. It had a garrison of 2,500. The authority for the demolition did not arrive until the night of the 26th/27th, and the charge was fired at 5 a.m. The commandant then asked permission of the Grand Quartier Général to retire on Verdun after destroying all stores, as the Germans were close at hand. The authority did not arrive until 3 p.m.; so after waiting for dusk, at 8 p.m., the garrison tried to get away through the woods; at least 400 were killed, only 52 reached Verdun. Montmédy is now in the Maginot Line.

Les Ayvelles was a fort 2½ miles south of Mezières, covering a railway junction and bridges over the Meuse. It had a garrison of a thousand Territorials. The commandant was told that he would receive instructions, and that his fort should be considered as a *point d'appui* for the field troops operating on the left bank of the Meuse: "In case of ill-success the fort should be evacuated, like the field of battle." On the 25th August, on which day the Germans crossed the Meuse below Mezières and closed up to the river above the town, the commandant asked for instructions. Getting none, except that he was to use his guns, he prepared to evacuate the fort. At 6 p.m. an army commander gave him a formal order to remain, though the armies were retiring; but he left the

* Information extracted from the French and German Official Histories, *Places fortes et places faibles* by General Clément-Grandcourt and articles in the *Militär Wochenblatt*.

fort with his men and managed to rejoin the field troops. A corps commander sent some of them back under another officer. The fort was bombarded next day and then finally abandoned.

Charlemont, just above Givet on the Meuse, was a powerful fort commanding perfectly the railway viaduct and several bridges over the Meuse; but some of its guns had been removed and in 1914 it had only two 155-mm. howitzers, with a garrison of 50 officers and 3,000 men. During the Battle of the Frontiers it fired a few shots. Not until the 29th August did the Germans bombard it, hitting one casemate and burying in it 27 men. On the 30th it was summoned to surrender, with the threat that if it did not comply the open town of Givet would be destroyed. The summons was declined, and the bombardment was resumed at 5 a.m. on the 31st. The fort surrendered at 3 p.m., having had about a hundred casualties.

Hirson, a barrier fort with annex batteries, which blocked the junction of five railway lines, had been declassed in 1912. On the 12th August efforts were made to mobilize it with half a battalion of Territorials, a reserve battery and 15 field guns from Lille. It was abandoned in the general retreat.

The declassed position *Laon—La Fère* suffered the same fate.

Reims, with its seven forts—some of which were the pillars of the German defence for 4 years, others of the French, and the names of two of which, Brimont and La Pompelle, have been inscribed in the book of history—had also been declassed. An attempt was made in August to regarrison and rearm them; but, practically nothing resulted. The place was abandoned in the great retreat, mostly recovered in the advance after the Battle of the Marne, and then held until the end of the war.

Longwy, blocking the railways from the two Luxembourgs, was "declassed in principle." It had an old bastioned fort as a nucleus, with works outside constructed on mobilization and a line of advanced posts as much as 5 miles out. The garrison consisted of 61 officers and 3,500 men, with 50 guns of 90-mm. to 120-mm. calibre, with black powder ammunition; it had no wireless or underground telegraph line. After reconnoitring the place and (according to the German Official History) bringing up a siege corps under a general of engineers, a bombardment was opened at 5 a.m. on the 21st August. A regular attack was made on the defences from the north and north-west, which the commandant resisted by sorties. Longwy, in spite of the age of its defences, held out until 4 p.m. on the 26th; very few of the garrison escaped.

Manonviller was an isolated barrier fort in the midst of the forests of the Vosges, east of Lunéville, blocking the *route nationale* and the Strasbourg-Nancy-Paris railway, the main line through the Vosges. Constructed solidly of good concrete, it lacked protection against

gas. The armament was eight 155-mm. guns in steel *tourelles* and the garrison 19 officers and 745 men. When the German Sixth and Seventh Armies advanced, Manonviller remained in communication with the French Army until 11 p.m. on the 24th August. At 9 a.m. on the 25th it was shelled by 16-inch and 12-inch howitzers, besides small calibres. The garrison was kept inside the perimeter. "The moral effect of the giant shells on the nerves of a garrison not yet war-hardened was decisive." At 2 p.m. on the 27th the white flag was hoisted. The concrete was cracked but not smashed and only one arch had collapsed, crushing one man. One *tourelle* was cracked and another put out of action at 9 a.m. on the second day. "The fort though fairly invulnerable being isolated was impotent."

The story of *Forts Troyon* and *Camp des Romains* requires an introduction. The 30-mile gap between the fortresses of Toul and Verdun was blocked by six forts on the Hauts de Meuse on the east bank of the river, the fourth and fifth from the south being Camp des Romains, overlooking St. Mihiel, and Troyon 9 miles north of it. The long gap between them was filled by the Batterie des Paroches on the western bank of the river. During the Battle of the Marne, 6th-9th September, 1914, an attempt was made to capture Troyon. This fort was small and though built in 1879, had been very little strengthened since then. It had good concrete cover, a magazine cut in the natural rock, and a wide wire obstacle. Besides 12 flank defence guns, it was armed with four 120-mm. guns and twelve 90-mm. The shells had black powder bursting charges. The garrison was an active infantry company, half a fortress battery and some telegraphists. At 5 a.m. on the 8th September, the approaches to the fort being covered by a number of piquets and cyclist patrols, the enemy's approach was reported. A bombardment by 6-inch howitzers was begun at 8.45 a.m. at the rate of 60 shells per hour. At 7.15 p.m. four Austrian 12-inch joined in. Next day Troyon was summoned to surrender, and on refusal to do so a further 5-hour bombardment was fired. Instead of leaving the men to be battered in the fort, the commandant had made them dig shelter trenches on the glacis outside among the wire. When the Germans tried to assault they were shot down at 30-yard range and lost 600 men to the defenders' 10. The bombardment was resumed at 4 a.m. on the 10th. On the night of the 11th/12th a relieving force drew near and on the 13th the Germans withdrew, leaving their gun ammunition behind.

After the Battle of the Marne the whole Allied Line west of Verdun advanced, leaving the protection of the right flank in the Hauts de Meuse to the Toul-Verdun forts, one reserve division and a cavalry division. On the 18th September—bad weather preventing aeroplane reconnaissance—a German force of 6 divisions suddenly

advanced south-west from Metz (the centre of which lies only 33 miles east of the centre of Verdun) and attempted to break through the fortified line Fort des Romains—Troyon in order to cut off Verdun. Pushed out well to the front of the forts the French defended their line with vigour ; but the reserve division was thrust aside and, though reinforcements were hurried up, the 5th Bavarian Division reached St. Mihiel. The fort Camp des Romains, immediately south of St. Mihiel, was then surrounded. It was of the same age as Troyon. " Dominant, isolated, conspicuous, it was a shell trap, a magnet for shell under modern conditions." On the top of a hill, it had two straight sides of about 220 yards facing north and south, east side 140 yards and west about 100 yards. " Not a broken, bastioned or tenaille trace, not even on the gorge. No flankers in its trace." Built of rough limestone, the arches of the casemates were only about 12 feet thick ; but they had been covered with a mattress of sand 12 to 15 inches thick. The ditch was deep and defended by caponiers with 30 inches of earth over them, and on the glacis was a wide wire entanglement. Its artillery consisted of four 120-mm. and ten 90-mm. guns, with black powder charges, and one anti-aircraft gun with eight rounds ! A subterranean telephone wire connected the place to Verdun and forts nearby. The garrison was 1 officer and 204 men of the 166th Infantry Regiment, 3 officers and 210 artillerymen and about 40 sappers.

On the evening of the 22nd the Camp des Romains was fired on by field artillery and at 8 a.m. on the 23rd, siege artillery including 16-inch and 12-inch howitzers opened on it, on the fort to the south of it, on the Batterie de Paroches, and on Fort Troyon. At 5.29 a.m. on the 25th, that is after 45½ hours' shelling, the bombardment ceased and the 6th and 11th Bavarian Infantry Regiments, with engineer detachments, assaulted, in eight columns, three against each of the long sides, one against the eastern side, and one against the south-eastern corner. The fort was not " ripe for storm." Only the three columns on the northern side broke in, passing through a single gap in the wire. One of them, moving along the ditch, entered the eastern face. A German sketch map shows by dots German dead lying thick in the ditch of the three sides which were attacked.

A desperate hand-to-hand fight lasting three hours ensued inside the fort ; negotiations for surrender were opened about 8 a.m., and the white flag was formally waved at 8.50 a.m. Five officers and 503 men were taken prisoner according to German accounts, but the total garrison according to the French accounts had been only 441, of whom 40 were killed and 70 wounded. The Bavarians, who seemed to have suffered more than double the French casualties rendered the prisoners military honours with a band and by presenting arms as they marched out. Having run short of gun ammunition, the

Germans made no further progress in this quarter, but they had established the " hernia of St. Mihiel," which so crippled the defence of Verdun.

The general conclusions to be drawn confirm the old doctrine, that the defence should be pushed well outside the fortress or fort and be an active one, that during the bombardment the greater part of the garrison should be sent into trenches outside the perimeter, and that unless relieved an isolated fortress is bound to capitulate.

DIGEST ON RECENT DEVELOPMENTS IN I.C. ENGINE FUELS.

By MAJOR W. G. FRYER, R.E.

(NOTE.—In this summary, the word "Diesel" refers to any I.C. engine ignited solely by the heat of compression).

THE Institution of Mechanical Engineers organized some remarkably interesting discussions on I.C. engine fuels last summer. A survey of the present situation is given. It is changing rapidly. Solid and compressed fuels are gaining ground and displacing diesel oil, just as diesel oil, only a few years ago, displaced petrol for heavy transport work. The change at present occurs in transport work, as solid fuels bear no tax; whereas imported petrol and diesel oils carry a tax of 9d. per gallon.

The light car seems likely to remain on petrol for several years to come.

HOME AND ABROAD.

In December, 1938, there were 23 vehicles running on producer gas in Great Britain. Producer gas is generated on the vehicle, from anthracite and coke usually, with plant that requires little attention; and used in an I.C. engine.

In France, 10 per cent of commercial vehicles must be run on home-produced fuel—normally charcoal and anthracite mixture—and a grand total of 10,000 producer-gas vehicles probably exists there to-day. Many of these are in the army.

In Germany, a decree has been issued forcing all large omnibuses, fitted to run on petrol, to be converted to run on substitute fuel by 1st October, 1939. Twelve thousand buses were affected.

In Japan, new motors cannot now be registered unless they are equipped to run on charcoal or other substitute fuel.

In Italy, public transport is forbidden to use imported fuel. So there.

PLANT.

Four well-known types of portable producer gas plant are readily obtainable in Great Britain. They work on charcoal, anthracite, or coke. Low temperature coke is suitable.

1. The Koela up-draught type, with water injection.

2. The H.S.G. (High-Speed Gas) cross-draught type, with water injection.
3. The Gohin-Poulenc (British Gazogenes, Ltd.) cross-draught type, without water injection.
4. The Dupuy cross-draught type, without water injection.

The Koela plant was fitted to a lorry which travelled to India a few years ago. The Highland Transport Company, Inverness, ran a 31-seater bus for over a year on H.S.G. plant and gained startling economies. The Gohin and Dupuy are apparently very successful in France. The cross-draught types are less bulky than other types; and lack of water injection makes the plant simple without necessarily giving poor results.

ADVANTAGES OF PRODUCER GAS VEHICLES.

The advantages of using any cheap home-produced fuel are clear. Anthracite and low-temperature coke can be made available in any quantity. Figures produced by the Highland Transport Company show fuel economies obtained at pre-war prices.

Producer gas bus, 32,000 miles at 2·1 lb. per mile. Fuel cost 60s. per ton. (*Note*—Anthracite *can* be obtained at 13s. per ton.)	£90
Cost of petrol bus, 7½ miles per gallon. Petrol cost 1s. 2¼d. per gallon including tax	£253
Cost of diesel bus, 14 miles per gallon. Oil cost 1s. 2d. per gallon including tax	£136

The exhaust is on the whole cleaner than petrol and diesel exhausts. There is no knocking on load.

SNAGS.

1. A petrol engine adapted to producer gas loses about 30 per cent of its power. If the compression ratio can be increased to 8 : 1 (petrol engines are about 6 : 1) this loss is less serious. Supercharging reduces power loss to 5 per cent.
2. Lighting up takes five minutes.
3. Some producers give poor acceleration after idling.
4. Bad fuel gives trouble due to clinker, ash, low calorific value of gas, high rate of wear in engine. There is no standardized fuel at present.
5. The producer gas generator takes up space and weight—equal roughly to a very fat man.
6. Fire cleaning and refuelling present problems. One charge should last for over 100 miles.

Choice of Plant.

The cross-draught types have advantages in weight and adaptability. It is doubtful whether water injection is necessary with good fuel. The latest Gohin plant is said to give good acceleration after idling.

Doping of Solid Fuels.

Three per cent by weight of sodium bicarbonate, when well mixed with fuel, improves its activity and reduces clinker.

New Engine Cycle—The Erren.

Yet another cycle has been added to the honourable series of Carnot, Otto, and Diesel. It is named the Erren cycle, after the inventor; and applies to gaseous fuels, primarily of the compressed gas type. A full charge of air is drawn into the cylinder at each suction stroke, as in the diesel; but gas is introduced into the cylinder *during compression*. Some form of ignition is needed even if high (diesel) compressions are used. This may be an electric spark or an oil spray. Producer gas and town gas will not fire on compression heat, even in a diesel engine. The Erren engine seems likely to increase the use of gaseous fuels of all types, as it shows good thermal efficiencies compared with petrol or diesel engines.

The City of Birmingham Gas Department has developed a compressed town gas service which seems suitable for use with the Erren engine. The gas can be delivered to the vehicle compressed up to 3,000 lb. per square inch. Special lightweight bottles, carrying 330 cubic feet of free gas, weigh only 124 lb. empty, and will nevertheless stand an hydraulic pressure test of 4,500 lb/square inch.

Coal Dust Engine.

Coal dust engines in small numbers are working in Germany. The dust is blown direct into the cylinder. There are no British-made engines, and their future is obscured by cylinder wear and patent right entanglements. No early developments are expected.

Warning.

Anyone contemplating buying a producer-gas set should insist on seeing a set working with the fuel he proposes using. The results will often be disappointing, as some agents make unwarranted claims for the plant they offer. A producer-gas set, in nearly all cases, demands a special engine to work with it and special fuel. The ordinary petrol engine does *not* work happily on producer gas owing to the loss of power.

FUELS.

The best fuels are those which contain the least ash, clinker least, and are sufficiently active to remain alight on low draught. The reactivity of the fuel is conveniently assessed by C.A.B. (critical air blast) values. The critical air blast is the slowest air rate needed to keep a fuel burning—units, cubic feet per minute.

Anthracite has a C.A.B. value of about ·035. Any fuel with a C.A.B. value of over ·04 (*e.g.*, ordinary gas coke is ·06) has been found unsuitable in one producer-gas vehicle. Almost any gas works can provide coke with a C.A.B. value of ·025 to ·03 ; and these are very suitable for most vehicle producers, where the fire gets no attention.

Charcoal has a reactivity of about ·01, and is therefore often used with a fuel such as anthracite, which has a value rather on the high side.

C.A.B. value therefore jumps at once into engineering jargon. It seems to clarify the word " reactivity," which in these times is almost political.

MILITARY APPLICATIONS.

In view of the necessity for restricting the use of imported fuels in wartime, these new developments should be watched carefully. At present, they attract attention in civil life principally because they open up legitimate (temporary ?) ways of avoiding fuel tax and petrol control.

This is not an argument for employing solid and gaseous fuel in W.D. vehicles. Economies are, however, in certain cases so huge that tax-free petrol can be shown to be dearer. Solid fuels are safer to handle than petrol, even if more laborious.

Owing to the time taken to light up (five minutes), a simple producer-gas plant is unsuited for fixed A.A. searchlight work, or fortress engine rooms. A small tank of liquid fuel, or bottle of compressed gas, overcomes this objection, and makes the use of solid and compressed fuels feasible. Similarly, for power work in fixed stations, solid and compressed fuels are practicable. The decision then turns on fuel-handling advantages, and use of local fuels. There certainly seems every reason why charcoal producers should be used for power supply where oil supply is difficult and timber and labour cheap.

Unfortunately, solid fuels are inconvenient for mobile field armies, owing to the space and weight of the producer for small lorries, and the fuel-handling difficulties. But if petrol and fuel oil were severely restricted then the producer-gas 3 tonner, the producer-gas A.A. searchlight engine, the producer-gas pumping set, might be commonly met.

THE FORMATION AND TRAINING OF A "NEW ARMY" FIELD COMPANY R.E. (82nd) FOR THE 19th DIVISION, B.E.F., OCTOBER, 1914–JULY, 1915.

By COLONEL R. F. A. BUTTERWORTH, C.M.G., D.S.O. (LATE R.E.).

FOREWORD.

THE narrator was Staff Officer R.E. Malta on the outbreak of war—aged 38, and with no previous field company or war experience. He had, however, served for four years as Adjutant of a Territorial R.E. Unit, which gave him some insight in the method of teaching Field Works and Bridging, and experience in the handling of non-regular soldiers.

THE NARRATIVE.

I arrived at the S.M.E. in the afternoon of the 3rd October, 1914, reported to the Brigade Major (Major H. W. Weekes), and was posted to No. 2 Billeting Company. The Mess was crowded with Regular officers (many, like myself, from overseas), Special Reserve, Territorial and Temporary officers. I could get no accommodation in barracks, nor indeed in Brompton, and was found a room in a hotel in Chatham High Street. No. 2 Billeting Company was one of three "super" depot companies formed for the reception of the masses of recruits arriving for R.E. and Signal Units. The headquarters of No. 2 were in the Model School, Chatham Lines, and our men were billeted in New Brompton. The company was 1,200 strong when I joined, and was commanded by Major W. A. J. O'Meara (R. of O.). The only other officer was 2nd-Lieut. B. C. Dening. We had a regular Pay Corporal, and three Corporal instructors. With this small staff we could do little but see that our men were fed and paid, and keep them employed with squad drill, physical training, and a little elementary field work instruction. Meanwhile the S.M.E. and Depot Staff were working overtime in forming Field, Fortress and Signal Companies, preparing documents, and dispatching embryo units to their destinations.

The Formation of the Unit.

My Company, the 82nd Field Company R.E. was in orders on the 16th October and I was furnished with a nominal roll of 200 men, and instructed to have them ready to march to the station *en route*

for Bulford Camp, at 9 a.m. on the 18th. The men were warned on the afternoon parade of No. 2 Billeting Company, next day, and then sent to their billets to pack. No uniform or equipment of any sort had been issued, so the men only had to put together their small possessions, which were collected by lorry, and taken direct to the station. Two soldier-like men in civilian clothes were handed over to me on the marching-off parade ; both time-expired R.E. N.C.O's, one, ex-serjeant H. Deyermond, to be my C.S.M., and the other, ex-Serjeant A. Johnson, to be my C.Q.M.S. Both of these men proved pure gold, and both ended up with D.S.M.'s and Commissions. I had no officer on our departure, and was the only individual in uniform, but I marched off proudly at the head of this gallant, ill-clad, almost ragged, ten score of young men, who were to become, in due course and after many tribulations, a Field Company R.E., trained and equipped for the field. I only knew one of them, an ex-sapper called Collins, who had been cook's mate in the 21st Company with me a few years before. He had volunteered to come with me ; I accepted him, and made him company cook, my first appointment and, as it turned out, a very lucky one.

The Move to Bulford.

The steadiness and good behaviour of these oddly assorted two hundred men on the journey from Chatham to Bulford was remarkable. Although untrained, there was no difficulty in lining them up along the platform, and there was no noise whatever, or confusion when they entrained. I was a little anxious on arrival at Waterloo Junction, when I was told that we had to change into a train in the main station. I saw no possibility of marching the men across the footbridge and along that long narrow passage connecting the two stations, so I asked my C.S.M.'s advice. He said, " Tell them to follow you, and then march straight ahead." I did so, and the men followed, and entrained without any further advice or instructions. On arrival at Bulford we found that we were to be accommodated in tents, but we were allotted two barrack huts as dining-rooms, and I was given half a hut as my company office. The tents were standing, for which I was very thankful. My C.Q.M.S. was invaluable. He knew his job from the start, and had a wonderful way of getting hold of any stores or equipment available. It was not long before rations were drawn, and the first dinner cooked by Collins and two volunteer cook's mates. That same afternoon, the C.Q.M.S. and myself borrowed two mounts from a signal unit, and rode over to the Ordnance Depot at Tidworth to find out what was the situation as regards uniform and equipment. We were disappointed to find that no uniform whatever was available, but we got 50 rifles and belts, and some small kit in the way of clasp-knives, cutlery and cleaning gear. That was all.

Early Training Days.

As a start I had all the men on parade, and asked anyone to fall out, who had had any previous military training. Two responded, both smartish ex-R.E. Territorials. I then asked for any man who who had been a foreman in civil life. About four stood out. I picked the likeliest looking pair from the latter, and made these, and the two Territorials, acting Lance-Corporals, to be in temporary charge of sections. Their names were Awde, Barraclough, Carter and Hider. The next step was to organize the unit into sections, allotting so many by trades, the remainder of pioneers, to each. Practically all the men came from the North Country, and were either in the heavy industries or miners (N.B.—I lost all the latter on the formation of the mining companies). We had very few carpenters or bricklayers, which was a little unfortunate. Many of the pioneers had no trades at all, but had joined "t'Ingineers" to be with their "pals" from the shops. The drivers were all put in a mounted section for training purposes, and their instruction in the early stages was carried out by the C.Q.M.S. who, having been a mounted serjeant in a field company, was well up to the job. At an early opportunity I paraded all the men in a barrack room, and gave them a talk on the organization and duties of a field company, and an outline of the training they would be going through, to fit them for their special work in the field. Incidentally I found these talks very helpful and valuable, and in the first weeks I set apart half an hour each day for a talk to the company on training, progress of the war, and any matters requiring explanation or elucidation. Until we got some uniform and boots, especially the latter, it was difficult to do much outdoor drill or field training. We started with physical training and squad drill, and indoor instruction in elementary field works, *i.e.*, knots and lashings. For the latter we had the use of plenty of rope and spars, and enough barrels and superstructure to make a barrel-pier. We had to go easy with the physical drill, as the pathetically thin working clothes of the men would not stand much strain, and the sight of safety-pins holding together ripped garments was all too common. But the spirit of the men was splendid, and even the many small hardships and inconveniences of the early days never affected their keenness. Football was started, and one of our barrack huts was converted into a reading and recreation room. We soon had our first "Sing-Song." Luckily, I was early given an imprest account, and I was able to draw on this for an adequate supply of crockery, to supplement the partial issue of china bowls. The rations from the first were adequate and of good quality, and Collins with his two assistants turned out excellent meals three times daily. This kept people happy.

At the start we were rather hampered by want of transport, but my C.Q.M.S. always seemed to be able to borrow a mount for a

daily visit to the Ordnance, and he managed somehow to get hold of a G.S. wagon to fetch stores, as they became available. There was at this time no chance of giving any instruction in riding or mounted duties to the drivers, so these were trained in field works with the sections. As my only qualified instructors were the C.S.M. and C.Q.M.S. and the latter had to spend a lot of time at Ordnance, the drill was taken by the C.S.M. (who did it very well), and the field works by myself. I was assisted later by a very useful old soldier, Corporal Scholes, ex-R.E. who had been a Field Work Instructor, and was loaned to us by the S.M.E.

Arrival of Subaltern Officers.

Luckily, the situation was much improved by the arrival of two subalterns, who had just completed a short course at the S.M.E. They were two keen young fellows, temporary officers, who had had one or two years' experience with engineering firms, S. N. Barron and H. C. Bates. They knew their drill and were qualified to give preliminary instruction in field works and digging. Barron, who was a constructional engineer, undertook the training in field works and the use of the pick and shovel, while Bates, who had been building bridges for the Midland Railway, took over the instruction in bridging, light railways and demolitions. As regards technical equipment, we were able to draw 50 picks and shovels and a proportion of cutting tools, in addition to the bridging equipment already referred to.

Early Organization.

On the arrival of the first two subaltern officers I was able to develop further the sectional organization. Barron was posted to No. 2 Section, and Bates to No. 1. By this time, too, it was possible to estimate the qualifications of the four acting Lance-Corporals for permanent rank. I promoted the two outstanding ones to Serjeant, and the other two to Corporal and 2nd Corporal respectively. Four more sappers were promoted Lance-Corporals with a view to further advancement at an early date. At the same time I put G. C. Cowan, a bank-clerk from the Midland Bank, in the company office with the rank of Corporal, and his brother, on the recommendation of the C.Q.M.S. was promoted 2nd Corporal (mounted). Both of these brothers did exceedingly well, and the elder one became C.Q.M.S. two years later. We had enough N.C.O's now for company duties. An orderly corporal was instituted, and a guard mounted by day and night. The company began to take shape.

A month later two more subalterns arrived for duty—A. F. Hewett and J. Strachan—very young and very keen, having just finished their education at engineering schools. Strachan

survived to command the company for the last six months of the war. The posting of these officers to Nos. 3 and 4 Sections completed the company organization, except for the Captain second in command, who was not posted till some weeks later.

Meanwhile the 19th Division, to which the 82nd Field Company belonged, was being rapidly formed and trained. The 81st Field Company (Major C. A. Elliott) was with us at Bulford, and the 94th (Major F. G. Guggisberg) was in training at Basingstoke. The headquarters of the Division and the Divisional R.A. were located at Bulford, while the infantry brigades were being formed at Tidworth, Blackdown and Winchester. Luckily the 57th Brigade, to which the 82nd Company was affiliated, was at Tidworth, and it was possible to be in touch with the Brigadier and Staff from the first.

The Training of the Company (Dismounted).

It was now possible to draw up a programme of training for the Unit. My instructions were to have the Company ready to take the field in three months' time, *i.e.*, by New Year, 1915. I arranged a programme accordingly, allotting so many days or hours to each sub-head of technical training, while provision was made for tactical and physical training, and equitation. A complete copy of this programme was issued to section officers and serjeants, and on every Saturday morning the part of the programme (with any amendments) for the following week, was posted on the notice board. Each section was trained under its own officer and N.C.O's, and, to ensure uniformity of instruction, I instituted a lecture every evening (except Saturdays and Sundays) after tea, when I explained the work for the next day, and the method of carrying it out, to the officers and N.C.O's. We had weekly route marches, usually on Friday, and these were executed in conjunction with a tactical scheme, illustrating the role and work of a field company in attack or defence. In this period, too, we did a lot of night work, such as finding the way by compass bearing to some point, carrying and using tools noiselessly in the dark, tracing out a line, putting up wire, etc. The facilities for technical training at Bulford were very good. We had a variety of ground for the tactical siting and digging of defence lines, chalk strata for instruction in mining, and plantations for instruction in clearing the foreground, and the making of fascines, bivouac shelters, and rough huts.

The Training in Mounted Duties.

This was not so easy. It was not until a month had passed that we were able to procure eight horses and saddles for a start on riding and horse-management. We then began riding classes in an open-air *manège*. It was found that few of the enlisted drivers had ever

sat on a horse before, though several were carters or teamsters. Two of the worst were brought to my notice as never having had any horse experience. They explained to me that they were "engine drivers." I gave them the option of being remustered, but they preferred to stay with the horses. They did quite well. But we could not make a start at driving, as we had no vehicle or harness. My C.S.M. solved the difficulty by obtaining a G.S. wagon and harness from an Australian unit going overseas from Larkhill. He told me it cost him 2s. 6d.—a cheap buy. I was not so lucky. We found a derelict dog-cart in a ditch at Sling, with a smashed wheel and shaft. It looked ideal for a Mess cart, so I put on our wheelwright to repair it. He did this most efficiently and repainted it. The owner then turned up and claimed it. Riding instruction progressed rather slowly at first, as my only available instructor was the C.Q.M.S. who had very limited time to devote to it. With the arrival of Captain C. G. Lewis, R.E., a new era started. He proved a most able and keen instructor, and the standard of riding, driving, and horse-management rapidly improved. Soon after his arrival, more horses and saddlery became available, and we received one or two technical vehicles. The high standard, eventually attained, was a striking testimony to Lewis's work.

Company and Section Rolls.

From the very start I kept a company roll, for my own use, in a handy-pocket-book made by Gale and Polden. In this was entered up every officer and man, as he arrived, with the address of his next of kin; subsequently rate of pay, promotion and later, casualties, transfer, and evacuations. It was very little trouble to keep up, and I found it of the greatest value for my two years in command of the Company.

The section officers kept similar little books for their sections and the Captain for the headquarter section. Such a record assists an officer to know his men personally, and is a great help in selecting anyone for a special job or promotion.

Arrival of Reserve.

In March the Company received a reinforcement of one officer (J. Haw) and fifty other ranks. These were drafted to sections to complete the quota of trades as far as was possible. Eventually nearly all were absorbed into the establishment, including the first reinforcement to be left at the base. When we finally marched off there were only ten to leave behind.

Discipline.

From the very beginning I realized that there was going to be little crime. The men were all so keen and earnest, that they seldom

tried to rebel against authority or break the rules. Punctuality on parade was never any difficulty, and there was no drunkenness or bad behaviour in camp or quarters. Our only real trouble arose from periodical week-end leave. All the men of the unit were from the North of England, and a week-end from Friday night to Sunday night was largely spent in the train. There were nearly always absentees on Monday morning, and at times men did not return till Tuesday or later. Used as the men were to civil life when a man stays away and forfeits the day's pay, it was difficult to make them realize that this could not be allowed in the army. I explained all this in one or more of my "talks," but I found it difficult to eradicate completely this tendency. Practically all the men, youths as they were, were married, and I have no doubt that gentle pressure was brought to bear at home to keep them over time, and to risk my displeasure. Heavy fines and stoppage of leave were the only deterrent. I hated taking these measures. Inoculation was another stumbling-block. It was an innovation, and all the men disliked it, though the majority submitted after a little persuasion. A few steadfastly resisted, and it had to be a case of "no inoculation, no going overseas." In the end all, but three or four, came into line. Later on, the "inoculation" clause became part of the condition of enlistment.

Issue of Uniform and Equipment.

As already explained, we were somewhat handicapped at the start for want of uniform and boots. We were soon able, however, to get a partial issue of boots for those most in need, also some socks and underwear, and some flannel shirts.

After two months at Bulford we received our first issue of blue uniform. It was rather ugly and of inferior serge, consisting of jacket, plain blue trousers, and a fatigue cap. We were glad to get it, however, as many of the men were definitely in rags by this time, and it *was* uniform. It was February, 1915, before we began to get service dress, and the unit was completely equipped by the middle of March. By this time, too, we had exchanged our first issue of D.P. rifles, for service rifles with bayonets and web equipment.

As regards technical equipment, we got our first tool-cart and limber G.S. in December, and afterwards we were able to horse and equip one section complete. This was excellent for instructional purposes, and each section had the use of it in turn. More technical vehicles and sets of harness arrived after the New Year, and by the end of February we had everything, except our pontoon wagons and a few items required to fill the tool-carts. On the 22nd March, we were able to parade as a complete and fully equipped field company. This was a great day.

TRAINING NOTES.

Entrenching.

In November we worked, in conjunction with the 81st Field Company, in laying out and excavating a small complete trench system at Shipton Bellinger, for the use and instruction of the 57th Infantry Brigade. While we were doing it, we were inspected by Field-Marshal Lord Kitchener, then Secretary of State for War. This was exceedingly good instruction for both officers and men, as we camped near the site, and did a lot of the work at night. Incidentally we got out a very good drill for night-wiring, which we found invaluable in our early days in Flanders, when the sappers were being largely used for this work. During this exercise we also got some useful experience in designing and constructing dug-outs, m.g. emplacements, etc.

Wire Cutting.

As a sequel to the Shipton Bellinger training, we were told to practise wire-cutting and the destruction of wire entanglements, for the passage of infantry. For this we made and experimented with Bangalore torpedoes, constructed of iron pipe filled with gun-cotton primers. We also practised at night, using wire-cutters and strong hooks, like boat-hooks, made out of round iron bar. 2nd-Lieut. Bates invented a grapnel, with a flexible wire cable attached, to be fired out of a home-made mortar into the enemy entanglement. The cable was then hauled in from the front line trench. While practising with the latter near Sling Plantation, the charge of powder to carry out the grapnel and its cable was rather overdone, with the result that the grapnel parted from the cable, and soared over the plantation like a rocket, landing in some new huts on the other side. Bates went after it, and found a party of workmen staring at the half-embedded grapnel, and discussing the situation.

Trench Mortars.

The British troops in Flanders were badly up against the German trench mortars in the early days of trench warfare, as they were unprovided with such weapons. We were told to try to improvise something of this nature. Experiments were made with lengths of iron water pipe, using a jam tin, which exactly fitted the bore, as the bomb. Here again our keenness to get results led to overloading the gun. During an inspection by the Divisional Commander, a mortar made of 4-inch pipe completely disintegrated, the charge and bomb exploding together inside the bore. Luckily everyone was under cover. As a matter of fact we did evolve a 3-inch trench "how" with a jam tin bomb and time fuze, which we used later with some effect in the "Orchard" near Festubert. In addition we made

several kinds of bombs for throwing, such as stick-bombs, hair-brush bombs, and even a rifle grenade. All this experimental work was good instruction in handling explosive, connecting up fuze, etc., even if the results attained were a bit amateurish.

Pontooning.

We spent a very useful fortnight, during March, on the Thames at Pangbourne, carrying out instructions in pontoon bridging, light and heavy. There was plenty of equipment, easily sufficient to bridge the river, as well as three or four Weldon trestles. We kept a flying bridge going all the time, which was good instruction and useful for ferry work. The march to and from Bulford, with nights in billets at Marlborough and Newbury, gave us useful practice in march discipline and billeting. By this time, too, we had an efficient fife and drum band, organized by the C.S.M., which was a great asset on the march.

Other Bridging.

We had few facilities for heavy bridging at Bulford. We had the use of the weir pool at Amesbury, where we made single and double-lock bridges lashed and bound with wire, as well as a pier for transportation. The latter was partly on cribs, and then on piles. Bates designed a "Howe" girder bridge, which he and his section constructed out of hutting material, requisitioned from the contractor.

Another bridge, made by Barron, was a suspension foot-bridge constructed of telegraph wire and light planking.

Tactical Training.

Before we got our horses and equipment, we did weekly route marches, combined with a simple tactical idea and scheme. On these, "observation" was practised, *e.g.*, questions would be asked as to the nature of a bridge, or how many times we had crossed the railway, etc.

As soon as we had our full equipment we made a tactical march through the Savernake forest, sleeping in bivouacs, and doing day and night schemes. Subsequently, sections were sent out in turn for the night to carry out an engineer reconnaissance or a scheme, and the rest of the company would march out next day to complete the exercise; the whole unit returning to camp together. We also had some very instructive Field Days, working with the 81st Field Company under the C.R.E. (Lt.-Colonel P. G. Grant). During May we did some combined training with the 57th Brigade and then with the Division, ending with Divisional Manœuvres, 24th–26th May, when we bivouacked and worked as divisional engineers.

Final Touches.

The month of June was spent in section and company training, and in recapitulation of technical instruction, which had been somewhat hurried in the early days. During this final month we practised turning out on an alarm by day or night. A section officer would be given his orders, involving a march to some destination with a scheme to carry out when he got there. We did this occasionally as a company, and the captain or a subaltern would be put in command.

Casualties were practised, giving section serjeants the command of their sections. A big effort, too, was made in horse-management and stables discipline, with a view to getting the horses as fit as possible, and under the best possible control of their drivers, for the move overseas.

The company paraded at full strength, with the 19th Division, for inspection by H.M. The King on 23rd June.

We received orders to mobilize for overseas on the 10th July, and embarked in *S.S. Mount Temple* at Southampton on 18th July.

If the company that landed in France on the morning of the 19th July was not the best trained of the new field companies, it was certainly one of the happiest and keenest, and it worked hard and cheerfully through long months of war, and took part in many battles.

THE KOHAT PASS RIFLE FACTORY.

By LIEUT.-COLONEL E. E. READ, M.C., R.E.

FORTY miles from Peshawar and close to the frontier, lies Kohat, headquarters of one of the six frontier districts. Owing to a large re-entrant of tribal territory the road between them passes for some 14 miles through tribal territory, re-entering British India through the Kohat Pass, from where it descends sharply on a very steep hillside into Kohat.

This portion is inhabited by a sub-tribe of the Afridis, called the Adam Khel. These have in the past caused considerable trouble, but with the growth of wheeled traffic, Government has been compelled to take steps to ensure safe passage for all persons, which now includes marching troops. This is assured by a treaty backed by payment of a substantial subsidy, and by the enlistment of *khassadars* from the tribesmen. No police or frontier constabulary are allowed, nor do troops piquet or leave the road when passing through; no incidents have occurred for many years, and European ladies can now motor through, though the road is closed during darkness.

It is necessary clearly to understand the status of the tribes. Their territory is quite independent, except for foreign policy, and they are not subject to British or Indian Law. The King's writ does not run, murder is no crime, and they can, for crimes in their own territory, only be punished by tribal custom. For crimes committed in British territory however, they may be called to account collectively; they are also forbidden to issue counterfeit or to manufacture bombs. No such interdict lies on the manufacture of arms and hence the Kohat Pass Rifle Factory. Its history dates back to before the British came to this part of the world.

It is the ambition of every tribesman to own a rifle; the majority achieve this ambition early in life, and in fact those who don't have reduced chances of survival. The carrying of this sign of achievement is as much a polite custom as the wearing of pyjamas. The normal daily work of sitting and talking together, therefore, usually assumes the appearance of a prelude to battle, although the intentions are entirely pacific. The Adam Khel are a fine virile race and, with the Orakzais, enjoy the unique privilege of being the only Afridis who may be enlisted into our army.

There are several sources of supply for rifles for tribesmen.

Russian weapons traded in through Afghanistan, weapons stolen, or captured in battle, weapons looted from Afghanistan in the revolution of 1929–30, and weapons manufactured in tribal rifle factories. Of these tribal factories, the most important and efficient is the subject of this article. We thus have a factory, in an area specially protected by us, to some degree controlled by us (you cannot go there without political permission) which produces arms, many of which are sold into Waziristan for use against us. It is possible that our continental neighbours might find the situation illogical, but to most of us it seems strangely logical and reasonable.

The factory itself is no imposing affair such as is to be seen on that other main road in England. The industry is carried on in a series of adjacent mud huts, each the home of the workers, forming a small colony, which strangely enough is one of the few unfortified villages in the area.

The organization appears to be very loose and is largely in the form of a co-operative colony. There is an owner whose son acts as manager, but the workers are usually free to sell their products individually to private customers, after a suitable commission to the management. There are about eighty workers, a very mixed lot. They consist mostly of old outlaws from Northern India, some locals, Punjabi blacksmiths and various odd tribesmen. Oddly enough there are few, if any, skilled fitters or turners. There is little attempt at mass production and usually one man will go right through with the work of one weapon, making all the small parts in succession, except the barrel and the woodwork. The supply of steel is one of the major problems. No steel may be sold from British India for this purpose (ostensibly). But the Lord provides the M.E.S. and P.W.D. and consequently, as every frontier G.E. knows only too well, any small ironwork is always being pilfered. A road sign on a steel post soon disappears and an R.C. one soon gets broken up for the reinforcement. On small culverts, short girders which are portable have an unaccountable way of disappearing and getting mixed up with a load of firewood on a passing string of camels. Many of the few local trees are walnuts and the rifle stocks are good.

We were hospitably received by the local *malik* and were shown everything. There was no attempt at concealment, in fact they showed considerable, and rather justifiable, pride, in their achievement. The whole was very reminiscent of " the regular work of the Corps," " the making of bricks without straw." The available apparatus was so primitive or non-existent, as to give pain to a real E. and M. Officer. One could not help feeling that if a real rifle could be produced here, then with the resources of say a Field Park Company, there should be no difficulty in turning out a six-inch gun, or an A.A. predictor.

A detailed description of the apparatus is impossible, but the

1.—The Factory.

2.—Turning a barrel.

Kohat Pass rifle factory 1 - 3

4.—Hard Tools

5.—Boring a barrel.

6.—Finished products.

Kohat Pass rifle factory 4 - 6

boring of the rifles is interesting. The drill consisted of an old file which reamered its way through. A constant tension was supplied by the weight of a stone on a bit of string round a pulley. The chuck head was fixed to a bicycle wheel, which was turned by an old blind man who has turned the same wheel for 15 years. He is the only real mass-production expert—one man, one job. The locks, bodies, sights, etc., are all made very simply. The only tools are a vice and a file, with the rare occasional use of a hacksaw or bowstring drill. The predominant work is filing—and more filing. The master keeps a complete set of dies and stamps for reproducing all the marks of the principal British factories. The final products are stamped with "Lee Enfield," etc. The Royal Crown, dates, numbers, etc., according to the purchasers' taste. That some are upside down is immaterial and V.R. is marked with the year 1930.

The rifle ready for sale is really a very fine imitation and in appearance is indistinguishable from the real article except to the expert. In fact, the only catch is in the precision and the wear. Rather more than half the rifles are of the old lever Martini type. This is still popular as it is simple and less likely to jam. As the tribesman has seldom an unlimited supply of ammunition, really rapid fire is unimportant. The most desirable rifle is an exact replica of the modern service rifle, but this is difficult and laborious to achieve, as they cannot easily make a bolt that will not jam. It is interesting to note that if a service weapon is captured in action or stolen, it is seldom sold whole, but individual parts are used in tribal-made rifles, as it were to improve the local breed. The cost of an ordinary rifle is about Rs.30s. and for a best quality one, with all the marks on it, about Rs.60s. A Government rifle complete sells for about Rs.400s., whilst about four years ago it fetched up to Rs.1,000s.

We had some difficulty with our photographs as the older men were a little shy, but we were given an excellent tea party with true Pathan hospitality and parted the best of friends.

FIELD ENGINEERING (INDIA).

THE following extracts from *Training and Operation Reports*, 1937 *and* 1938, issued by the Engineer-in-Chief, India, are republished.

1. FORTIFIED POST FOR TOCHI SCOUTS.

Posts to accommodate 12 platoons of Tochi Scouts each were built at Biche Kashkai and Ghariom in 1937. They were both built to the following general specification :—

(i) A boulder perimeter wall 6 feet high, with a firestep.
(ii) Two corner towers in masonry in p.c. mortar.
(iii) Two belts of double apron wire fence.
(iv) A permanent water supply with reservoir 48,000 gallons.
(v) A magazine with stores for one Infantry Brigade for 3 days.
(vi) An approach motor-transport road.
(vii) Camp piquets as necessary.

The post at Biche Kashkai was begun on 11th November and completed on 8th December by two Field Companies and 1 Road Construction Battalion. That at Ghariom was begun on 1st November and finished on 4th December by two Field Companies and an average Infantry Working Party of 400 men.

Details of the post at Biche Kashkai are as follows :—

SITING OF THE POST.

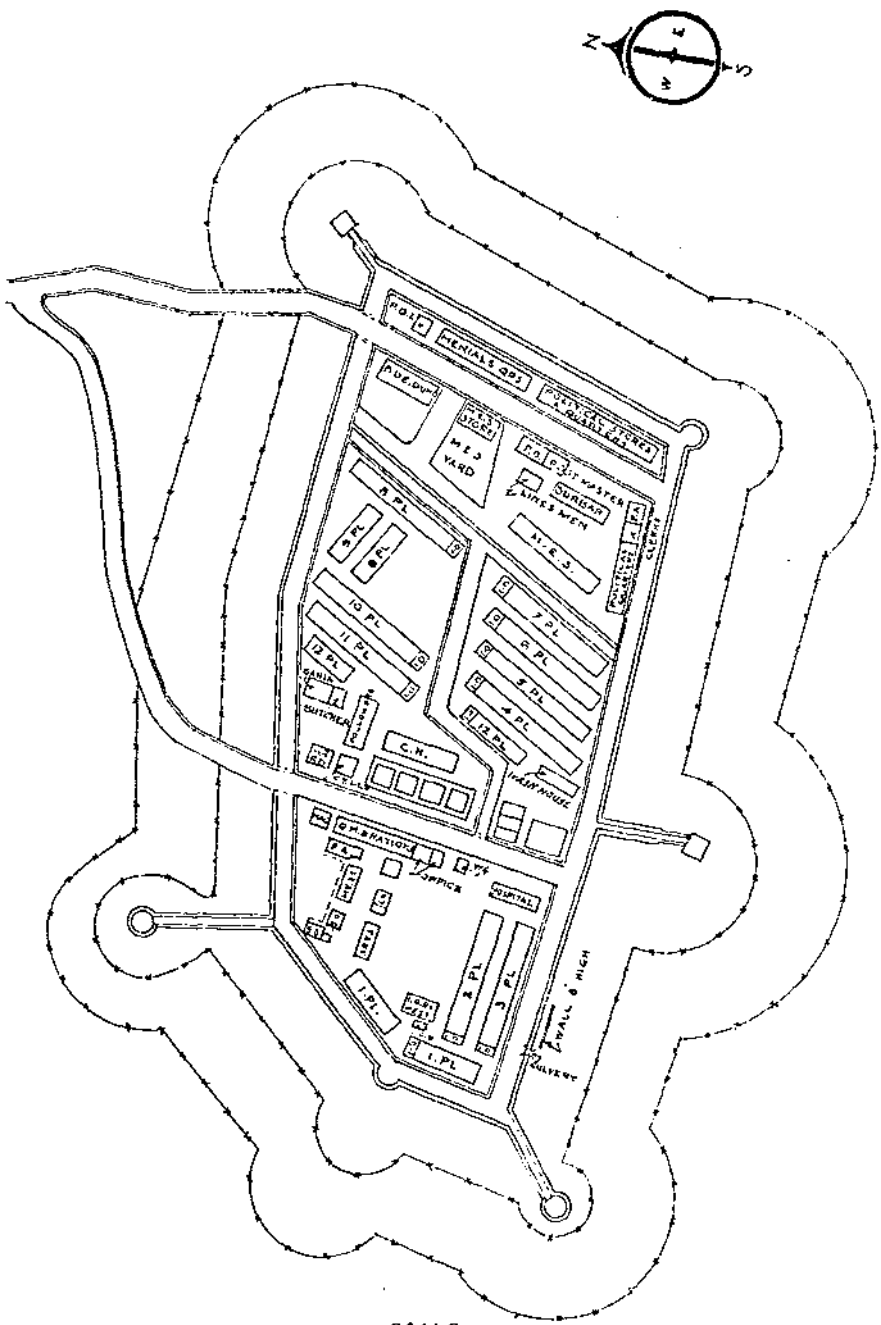
The Officer Commanding the Field Company, Sappers and Miners, was shown the approximate site of the post by the Deputy Chief Engineer. Thereafter a rough layout was designed and fitted to the ground in consultation with the Commandant Tochi Scouts, who was responsible for the tactical siting of the perimeter walls and detached posts. Space was left for additional buildings.

WORK CARRIED OUT.

Defensive Works.

(i) A boulder perimeter wall 6 feet high, 1,200 yards in length with a firestep. Corner posts were incorporated in the wall.

BICHE KASHKAI POST.



(ii) Two detached posts, connected to the perimeter by covered approaches of boulder walling, were constructed completely of faced stone in cement mortar. The posts were similar in design and each had a floor of 3 inches of p.c. concrete on rammed earth, raised 6 feet above ground level. They were roofed with earth on corrugated galvanized iron sheeting supported on bullies. Each post had a 6 feet perimeter wall with firestep, and also three loopholes for machine-guns, so sited that they were able to fire down the outer belt of barbed wire defence.

(iii) Two belts of double apron fence, approximately 20 and 50 yards away from the perimeter wall, were erected by the Tochi Scouts. The inner belt was visible from the perimeter all round; most of the outer belt was visible from the perimeter and where not visible was covered by the detached posts.

Accommodation of Garrison.

The following buildings were constructed:—

(i) British Officers quarters for 2 officers (bedroom and bathroom each).
(ii) Mess quarters (ante-room and dining-room) 17 feet by 39 feet.
(iii) Cookhouse for Mess.
(iv) Cookhouse for men.
(v) Hospital for 10 patients, and dispensary attached.
(vi) Guard Room—19½ feet by 30 feet.
(vii) Indian Officers' Mess 19½ feet by 42 feet.
(viii) Washhouse.
(ix) Brigade dump for reserve rations—60 feet by 20 feet.

Of these (i), (ii), (iii), (vi) and (vii) were roofed with corrugated galvanized iron covered with 3 inches of earth; the hospital was roofed with mud on *chatai*, and the Brigade dump and washhouse with corrugated galvanized iron sheeting only.

Except for the two last named, all buildings had walls, 18 inches thick, of faced stone in mud mortar, pointed in cement.

Water Supply.

(i) *Source.*—An irrigation cut about 500 yards south of the Post, which takes water from the Khaisora river at a point about 700 yards upstream.

(ii) *Pump and Rising Main.* The rising main was 4 inches Victaulic about 400–500 yards long. A diesel Lister pump set was installed.

The head was approximately 250 feet.

(iii) *Storage.*—48,000 gallons. Four 12,000 gallons reinforced-concrete tanks were constructed to give this capacity.

(iv) *Distribution.*—2-inch screw piping.

LABOUR.

Detail.	Dates.	Man days.
Field Company S. & M. (200 men)	11 Nov.—8 Dec.	6,880
Field Company S. & M. (160 men)	30 Nov.—7 Dec.	
Road Construction Bn. (420 men)	11 Nov.—22 Nov.	4,620
M.E.S. Masons (14)	11 Nov.—7 Dec.	378
Contractor's coolies (390)	Approx. 16 days in Nov. and Dec.	6,163
Contractor's masons (3)	21 Nov.—7 Dec.	51
	Total ..	18,092

TRANSPORT.

30-cwt. lorries—3 from Field Company, S. and M.
1 from Tochi Scouts occasionally.
4 from other arms for 7 days.

Civilian Bedford trucks—2.

Also occasional lorries borrowed from troops encamped near the post.

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2. DEMOLITION OF TRIBESMEN'S KOTS AND VILLAGES.

During the Waziristan operations, 1937, a common task was the demolition of a tribesman's "Kot" consisting of a fortified tower, with adjoining buildings enclosed in a courtyard. Very often the adjoining village was also destroyed. The following data is of interest :—

Demolition of Towers.

As a rough working rule for the normal tower 15 feet by 15 feet and 25 feet to 40 feet high :—

(i) If no solid masonry plinth, minimum charge 24 lb. gun cotton, either split into 4 charges of 6 lb. in each of the corners, or placed centrally in the ground floor in an excavation. Tamping is unnecessary.

(ii) If solid masonry plinth, normal charge 48 lb. gun cotton buried centrally in the centre of the plinth. Tamping is not a necessity, but improves results.

The normal working party is one sub-section S. and M. Time 1 to 2 hours.

Demolition of Houses.

Where the house consists of a main room, 35 feet to 40 feet long, with a verandah attached, two charges fired simultaneously and placed at either end of the main room, are recommended. If the roof is weak, a chase, 1 foot deep, should be dug in the four walls at the base.

Demolition of Villages.

The quickest way to pull down mud or rubble walls is as follows :—

(i) Cut into the wall near bottom to half its width with a pick along the length to be pulled over.
(ii) Fix a rope to the other side of the wall with a picket or crowbar driven into the wall; then pull over.
(iii) It is a help if corners of walls are blown out first with G.C.; 2 lb. will suffice.

The best sequence of demolishing a mud or rubble building by hand is :—

(i) Drop roof into centre.
(ii) Pull walls outwards.
(iii) Burn roof.

If time is short, the best thing is to burn the roof in site.

"C.I.E.S.S." (*late* "C.I.R.E.S.").

By MAJOR O. S. G. SHEPPARD, R.E.

(This article was written in July, 1939.)

IN the June, 1936, issue of this *Journal* appeared an article on "C.I.R.E.S.," in which Major (now Col.) Simpson, who now holds the appointment of Chief Inspector, explained the function and duties of the Royal Engineers Inspection Department. Few R.E. officers serve in this department during their careers, and it is consequently a closed book to many. The object of that article was to throw some light on what the "R.E. Stores," as it is familiarly called, does, and how it is done.

In 1936, the title of the Chief Inspector was changed from "C.I.R.E.S." to "C.I.E.S.S."—Chief Inspector, Engineer and Signals Stores—a more accurate and comprehensive title.

To recapitulate, very briefly, the functions and duties of the department, it is necessary, in the first place, to make it quite clear that "C.I.E.S.S." is not a storeholder. He is responsible for the inspection of all Vote IX Stores (*i.e.*, technical equipment used by the R.E. and R. Signals), and for a large variety of Vote X Stores (*i.e.*, building materials and electrical and mechanical plant purchased for the Director of Fortifications and Works). He is also responsible for the preparation of purchase specifications and drawings to guide the manufacture of Vote IX Stores, and for the preparation of the draft paragraphs to cover the introduction of new stores and modifications thereto into the *Vocabulary of Army Ordnance Stores*.

It is therefore evident that an officer's duties are by no means confined to inspection, but the object of this article is to deal as far as possible with that particular function only.

The rate of production during the re armament programme has made it necessary for the department to evolve an inspection technique different from that which was adequate to deal with the orders of the lean years. The writer has been fortunate in having witnessed this development, and the great growth of "C.I.E.S.S." during this period.

In 1935, the Chief Inspector was assisted by two Inspectors, one of whom was responsible for all R.E. Stores and the other for stores used by the R. Signals. The R.E. Inspector controlled three Assistant

Inspectors, and the R. Signals Inspector had one Assistant Inspector. Since then the establishment has largely increased, year by year.

As soon as a contract has been placed the responsibility for inspection devolves on an assistant inspector and his subordinate personnel—the Section, consisting of a Foreman Examiner, Assistant Foreman Examiners, and a number of Examiners who carry out the actual inspection and tests. These are enlisted from ex-Service men or from civilian life, some as lads and some as tradesmen, and they are graded and paid in accordance with their qualifications.

The main object of inspection is to ensure that the War Department is getting what it has paid for—that the equipment complies in all respects with the drawings and specifications as regards materials, dimensions, performance and finish.

Inspection technique varies considerably with the particular equipment ordered and with the size of the order. A contract for 500 Sound-locators obviously requires very different handling to a contract for 500 picks or 10,000 electric lamps, or to a small order for half a dozen gear wheels. Each case is considered on its merits and there is no hard and fast rule.

Prior to 1934, the manufacturer made the article and then dispatched it to Woolwich for inspection. If it was found to be defective it was returned to the works. But, as the size of the contracts rapidly increased, it became an economical proposition to carry out the inspection at the manufacturer's works, and now very little inspection is done at Woolwich, with the exception of samples, small orders for replacement parts and type tests on such stores as electric bulbs, searchlight carbons and batteries. The space available in the Royal Dockyard at Woolwich is also by no means adequate to cope with the present rate of influx. It may be claimed that the rate of the re-armament programme and inspection at works has enabled a more thorough and searching inspection to be carried out than was practicable before. Inspection of the finished article only enabled the performance to be checked, and the exterior finish and such dimensions as could be measured without considerable dismantling. Inspection at works enables a check to be imposed on the components to ensure interchangeability, and the workmanship and fitting can be inspected, through the stages of manufacture, up to the final assembly. It enables an unsatisfactory part to be spotted and rejected in the early stages of manufacture, thus obviating the delay consequent on the rejection of the finished article. It makes it easier to adopt changes in design to incorporate improvements or alterations to suit production methods. Last but not least, inspection at works results in close contact between the department and the firm, which makes for good co-operation.

In the case of the larger and more important contracts a staff of examiners, under a man specially selected for his technical

qualifications, organizing and administrative abilities, and tact, is made resident at the works. For the smaller contracts, an examiner may be sent once or twice a week to the works while manufacture and assembly are in progress, until such time as the final inspection and tests may perhaps warrant his whole time attendance. Strictly speaking, the duty of these examiners is to inspect exactly to the drawings and specifications, and to reject parts or assemblies which do not comply, or to point out to the manufacturer that the incorporation of such parts in the finished article may entail final rejection. Whether or not failure to comply with the drawings necessarily entails rejection is the responsibility of the assistant inspector, who has to use his technical judgment and knowledge of the use for which the article is required. In other words, the examiner's job is to determine questions of fact only, and he has, in theory, no powers of discretion. Actually a good and experienced examiner will use his discretion to a degree depending on his capacity to shoulder responsibility.

The contractor is required to furnish the resident examiners with suitable office accommodation, with labour for assisting them in carrying out the tests and with certain inspection tools and appliances. They are supplied with a copy of the contract, specifications and drawings, and with copies of any other documents and letters which affect inspection; also with any special gauges and sub-standard electrical measuring instruments.

We will now review what happens from the time when the contract is placed.

As soon as a copy of the contract is received from the Director of Army Contracts, the assistant inspector has to decide on the inspection action required. The main alternatives are :—

(1) Inspection at works, either by a staff of resident examiners or by periodical visits.
(2) Tell the contractor to submit a sample to Woolwich, after which inspection of the bulk supply would be carried out at Works.
(3) Type tests of samples at Woolwich in conjunction with inspection of the bulk supply at works, *e.g.*, secondary batteries, electric bulbs, searchlight carbons.
(4) Inspection after delivery at Woolwich.

The contractor is then advised what inspection action will be taken, and is sent a copy of the *General Inspection Instructions*. These outline the organization of the inspection department, differentiate between the functions of the various W.D. officials with whom the contractor will have to deal on the various contractual, financial, technical, and progress aspects of the contract, and point out the

powers of the subordinate examining staff. The normal inspection procedure with regard to raw materials, timber, machined parts, castings, forgings, welding, etc., and sub-orders is explained.

For a large contract, the "main contractor" will purchase all the materials he requires specially for the job, though he may use certain common materials from stock. He may also decide to get certain parts and sub-assemblies (*e.g.*, castings, forgings, pressings, motors, switches, wood boxes, etc.), made by "sub-contractors." These sub-contractors may again sub-contract portions of their work. For nearly all large contracts, the contractor is required to submit copies of all his "sub-orders," and the sub-contractor may be asked to submit copies of his sub-orders, and so on. Sometimes, on smaller contracts, the manufacturer is only asked to send in copies of his sub-orders for certain specified materials or parts. The object is to enable the department to inspect the material or parts in the early stages of production, to ensure that they are suitable and to obviate delays due to the rejection of the finished article owing to a faulty component or poor material. It also makes it possible to watch that one sub-contractor is not over-loaded with orders from several main contractors. The policy of the War Department is to develop a broad basis of supply for all the important articles of equipment, and it is obvious that this sound policy would be largely negatived if all the main contractors obtained their castings, for example, from one source. This can generally be arranged by representations to the contractors, but, in the last resort, the War Department has the right of veto on a sub-contractor.

The possession of sub-orders also enables the department to watch that the contractor is not going to be held up for lack of some particular material or component during production.

The first sign of production activity is a spate of these sub-orders, and the assistant inspector considers what inspection action should be taken on each one. His decision is guided by the material concerned (*e.g.*, whether it is a special high-tensile alloy steel or an ordinary mild steel), the purpose for which it is required, and the reputation of the sub-contractor. In the majority of sub-orders for such ordinary materials as mild steel plates, bars and sections, small brass castings, nuts, bolts and washers, etc., the assistant inspector would usually decide that they can be "waived and released"—*i.e.*, inspection at the sub-contractor's works is waived and the goods are released for dispatch to the main contractor, where inspection will be carried out as necessary. The alternatives open are to require the sub-contractor:

(1) Not to dispatch the goods until they have been inspected at his own works (*e.g.*, electric motors, fabricated structures, important machined parts).

(2) To submit a sample or a certificate of analysis and test for material (*e.g.*, castings, alloy steels, mild steel used in stressed parts.

(3) To submit a sample for approval before dispatching the bulk supply (*e.g.*, switches, cable, paint, mouldings and pressings, locks, hinges).

(4) To dispatch the material to Woolwich for inspection (*e.g.*, lenses, bexoid colour filters used in focuscopes).

So far as the department is concerned, an era of comparative quiet then intervenes, during which the manufacturer proceeds with the collection of material, manufacture of jigs and tools, and planning of his production programme. When this is well in hand is a suitable time for the assistant inspector to pay a personal visit to the firm. If the firm has not previously had a contract subject to inspection by C.I.E.S.S., such a visit will enable him to explain the department's methods and requirements, and to acquaint himself with the firm's organization and idiosyncrasies, to smooth over any difficulties or troubles which may have already appeared, and to make that valuable personal touch which helps so much the successful execution of a contract. Perhaps in no other sphere can that blessed word "co-operation" mean so much. At the same time the assistant inspector will acquaint himself with the production programme, inspect the space allocated for assembly and test, examine progress made with jigs and tools, and form his own opinion as to when production is likely to start. On their side, the firm will almost certainly take the opportunity of asking for various concessions to suit their own methods of production, and may have certain suggestions for improvements in design. Most of these points the assistant inspector will be able to settle on the spot, others he may consider should be submitted in writing.

The time at length arrives when, if the contract is a large one, the staff of resident examiners must be sent to the works. The first duty of the examiner in charge will be to make sure he is in possession of the contract, specification and drawings, and the necessary testing instruments; to settle into the office which has been provided by the firm; and to acquaint himself with the lay-out and organization of the firm, and the foremen in charge of the various shops.

The actual work of inspection may be considered under five heads:

(*a*) Materials.
(*b*) Processed parts.
(*c*) Machined parts.
(*d*) Sub-assemblies and final assembly.
(*e*) Final tests and inspection.

The policy of C.I.E.S.S. is to make the fullest possible use of the firm's own inspection organization, and it is impressed on the manufacturer that the department's inspection is additional to, and not in substitution of, the work's inspection. There is sometimes a tendency for a firm to try and put the whole onus of the inspection of parts and assemblies on to the department, and this has to be combated. The extent to which a firm can be induced to carry out inspection depends on the methods which they adopt for their own commercial products. A firm with up-to-date production ideas has an inspection staff which is independent of the manufacturing and production side, and which carries out a 100 per cent inspection between each machining operation. In other, usually the smaller or more old-fashioned firms, inspection is done, to a greater or less degree, by men responsible to the foreman of the shop, whose chief concern is to keep up his production. Throughout the various stages of inspection the department's examiners work in close touch with the firm's inspectors, the object being to make the W.D. inspection concurrent with, rather than additional to, the works inspection. Full use is also made of the firm's testing facilities.

We will now consider these various stages of inspection in greater detail.

(*a*) *Materials.*—The resident examiner satisfies himself, to a degree depending on the type of material and the use to which it is to be put, that all material ex-stock or material " waived and released " on a sub-order complies with the specification requirements. He may do this by inspecting certificates of test and analysis, by having a piece tested at the works or by some local testing authority, or by having a sample sent to Woolwich. He may also consider it advisable to have a piece tested from a consignment off a sub-order which has been released against a test certificate, to ensure that the correct material has actually been dispatched or that the quality is being maintained.

(*b*) *Processed Parts.*—This term covers castings, forgings and welded structures. For castings, the resident examiner satisfies himself that test bars are being cast and pulled for each pour ; he periodically examines the test certificates and occasionally witnesses a test bar being pulled.

The recognized method of ensuring sound welding is to permit the employment of only skilled welders and approved materials. To this end each welder is required to make sample welds, which are visually examined and tested to destruction ; and the electrodes used have to be approved. The resident examiner then checks that only approved welders are being employed, and visually inspects the welding.

(*c*) *Machined Parts.*—It is particularly on the dimensional inspection of machined parts that the department tries to rely as far as

possible on the firm's own inspection. We have already seen that a firm which uses modern production methods carries out a 100 per cent inspection after each operation, and the resident examiner can then confine himself to making sure that such inspection is actually in operation, and to carrying out occasional checks. If he inspects, say, 5 parts out of a batch of 100 and finds that one of these is not to drawing, it is evident that the firm's inspection staff are not carrying out their job properly, and he rejects the whole batch for re-inspection by the firm.

A good resident examiner imposes his check inspections judiciously, not haphazard, and looks for errors particularly in vital dimensions which, if wrong, would cause serious delays in assembly, or would produce a lack of interchangeability which might not be apparent during the later stages of inspection.

During this stage, deviations from the dimensions and tolerances shown on the drawings do not necessarily result in summary rejection unless they affect interchangeability, but the defect is pointed out to the firm, who can then proceed at their own risk. Complete interchangeability of every part manufactured by different firms is not expected, and indeed would be almost impossible to attain, but interchangeability of all major parts, complete units and sub-assemblies is most important.

Stages (*a*), (*b*) and (*c*) apply similarly to sub-ordered parts or sub-assemblies at a sub-contractor's works.

(*d*) *Sub-assemblies and final assembly.*—Experience has shown that good inspection and supervision at these stages is of vital importance, if the finished article is to continue to give good service after passing the final tests. This is work which must be carried out by a thoroughly skilled man, and depends more on the use of the eye and "feel" rather than on the employment of gauges and micrometers. The examiner must watch that trains of gears and bearings have the proper degree of freedom and absence of play, that nuts are adequately secure and locked, that dirt is excluded, that ball races are packed with grease, and that electrical connections are clean, secure and neatly arranged, etc., etc. The article might well pass its final tests with all these defects, but it is evident that trouble would develop sooner or later. This is one respect in which inspection at works produces a more thorough and searching inspection than the pre-re armament inspection of the finished article at Woolwich.

During the assembly inspection one of the firm's inspection staff should work alongside the department's examiner, in order that he can see for himself where the error lies and take steps to have it put right during the machining operations. To achieve a regular and rapid flow of production it is important that the parts should "fall together," without recourse to file or scraper, and it is rarely that this occurs during the early stages of production.

(*e*) *Final tests and inspection.*—This stage is evidently the responsibility chiefly of the department, but the firm are required to supply labour and personnel to assist in taking readings of instruments. The examiner enters up the results of the various tests in tabular form, carries out a general visual examination, and finally, just before dispatch, checks that the article is complete with any accessories and loose parts.

We will now consider what are the duties of the assistant inspector during this time. It must be remembered that he has already probably had a lot to do during the pre-contract stages, but here we are only concerned with his duties while the contract is actually in progress.

In the first place, he must see that the resident examiner has an adequate staff, and that this is utilized economically. Only a proportion of the examiners are skilled tradesmen, and these should not spend their time in carrying out simple routine tests and straightforward dimensional checks, which can be equally well done by semi-skilled men after a little training. The resident examiner in charge must not be tied down to one particular job, but must be free to supervise the work of his staff and to investigate troubles. The assistant inspector must see that the resident examiner has a really thorough knowledge of the equipment being inspected, and he can sometimes arrange for him to attend a short instructional course at Woolwich, or to visit another firm where production is already well advanced, and profit by their experience.

Concurrently with the inspection at the works of the main contractor, inspection of sub-order material has to be arranged for, and a considerable volume of correspondence requires to be dealt with.

" Progress " is a word which has been much to the fore during the rearmament programme. The Director of Mechanization has a group of staff officers particularly dealing with this aspect of production, but it is inevitable that C.I.E.S.S. should have considerable responsibilities in this direction. The assistant inspector must keep a look-out for technical difficulties which might delay production, and for dilatory sub-contractors. In some cases, where one sub-contractor is supplying several main contractors with an important component, experience has proved that it is necessary for the assistant inspector to allocate the sub-contractor's production month by month, to avoid one contractor building up a superabundant stock while another is held up for lack of the same article. This involves a good deal of work, particularly when the demand is outrunning the supply. He must be ready to give his opinion on the rate of production that can be reasonably expected in the future, which may differ widely from the contractor's forecasts and promises.

Much of the equipment being produced at present is of new design. It is therefore inevitable that improvements are thought

of after production has started, and defects may be found when the equipment goes into service. In many cases, therefore, the assistant inspector is inundated with a spate of amendments from the Royal Engineer and Signals Board and their experimental establishments; also with suggestions from his own examining staff and the manufacturers. Many of the suggestions from the latter are to facilitate ease and speed in production to suit their own particular methods: these can be allowed if the degree of interchangeability required is not destroyed. Once a firm is actually in production any amendment, however slight, will almost invariably cause a delay in production. The policy is not to "gild the lily." Evidently a vital alteration or addition must be incorporated, but less delay may result if it is embodied after the equipment has been made rather than during manufacture. It has to be decided during what stage of production less vital amendments can be introduced without delaying production.

A reference has already been made to the assistant inspector's first visit to a firm, while they are planning their production programme. Further visits will have to be made from time to time, to watch inspection and keep in touch with progress, and to deal with troubles and design alterations as they arise. A lot of paper-work can be saved by fairly frequent visits, but there are times when it is better to leave the firm alone to get on with the job. These visits, though often involving a lot of travelling and long hours, form a welcome change from the office chair, and are a very interesting part of the job. They enable an officer to see a very wide and varied cross-section of the engineering industry and to make pleasant and valuable personal contacts.

There has been no space in this article to explain in detail how the various types of equipment are inspected, and to what tests they are submitted, nor, perhaps, would this be of interest to the general reader. But it is to be hoped that some light has been thrown on dark places.

NOTE:—Since this article was drafted the Inspection Department Engineer and Signals Stores has been transferred from the War Office to the Ministry of Supply. The range of duties, the general policy, and methods of execution described in this article have not as yet been affected by this change.

MAP MAINTENANCE—POLICY AND TECHNIQUE.

By CAPTAIN M. O. COLLINS, R.E.

INTRODUCTION.

DURING the period that any officer is connected with survey it is more than probable that at least half, if not more, of his service will be spent upon map maintenance, as opposed to the making of maps *ab initio*. Yet despite this distribution of duties, which normally falls to an officer's lot in peace or war, it is curious to note that no text-books exist on the subject, no principles are laid down, and it never forms part of a survey course. However well grounded an officer may be in the science of surveying, it does not necessarily follow that this knowledge will be an adequate equipment for controlling a system of map maintenance. Though there is certain knowledge which is of use as a general grounding, it has to be developed considerably further before it becomes of any practical value.

Most organizations, however, which are concerned with map maintenance, civil or military, have been in existence for some considerable period, and, as a result, generally contain a nucleus of senior subordinates who have been doing something for many years. Owing to his previous training an officer tends to rely to a great extent on these subordinates, often deriving his actual knowledge from them. Circumstances such as these undoubtedly tend to produce an attitude of *laissez faire*, for, even if the energy and desire to reform exist, the knowledge necessary to carry such reforms through is not always adequate. For these reasons, the author proposes to examine briefly the existing conditions and circumstances which are generally present in any system of map maintenance, particularly with reference to policy. From this analysis it is hoped to make suggestions for improving the technique and, finally, to attempt to lay down the principles of map maintenance.

POLICY.

Owing probably to a conception based on consideration of initial surveys, most maps are revised under cyclic arrangements, that is to say, every five, ten, or fifteen years. This arrangement has on occasions been justified as economic and convenient. The former

is questionable, whilst the convenience of the arrangement is applicable only to the surveyor himself, in that it entails the minimum of thought on the part of both officers and subordinates. It is difficult to trace any precise evidence by which one can arrive at the justification for this policy and, in consequence, one has of necessity to fall back on assumption. It is probable that, when considering a revision system in the beginning, undue weight was given to the reproduction processes. In the case of an initial survey, the time occupied in field work must always be large in comparison with the office stages of drawing and printing. In view of this relationship there was little justification in reducing the time taken on reproduction, because the total gain was small, even where it was attainable. The natural tendency in such circumstances would be to accept the eight or nine months, necessary for reproduction under the old methods, as a necessary if unfortunate fact, and to legislate for this in the system. As a result, there would seem to be little harm in arranging for a reproduction of a new series every five years, and thus allow the office craftsmen to maintain their unhurried pace of past generations. Such an outlook would, it is true, be a reason for evolving a cyclic system ; it is in fact the only reason which, good or bad, seems any justification at all. The fallacy, of course, is obvious, but it has only become increasingly so under modern conditions. This fallacy is the basic assumption that the need for map revision is based on a constant rate of topographical change. This might be true if applied to the natural features of the earth alone, but in such a case the actual changes are so slow as to be unlikely to require a new map for several generations. In actual fact, the surveyor, once he has produced a map, is far more dependent on human effort for new material, bringing as it does political, social and economic changes in peace and a rapid construction and destruction in war, all of which are duly reflected topographically. Changes such as these are far from constant in rate, and are rarely predictable in incidence for many years ahead.

In such circumstances, therefore, a periodically revised map is unlikely to be of maximum value as an up-to-date picture, except in those few and fortunate cases where the change has become so slow as to be unaffected by the time spent on reproduction, and where revision has moreover coincided with finality in topographic amendments.

These cases to-day only occur in practice in uninhabited areas where the map requirements are, in view of the urgency elsewhere, practically negligible. Moreover, the fact that so few demands can be fulfilled by a cyclic policy is in itself sufficient condemnation of a system which is useless to the map user, however much the surveyor may pride himself, like Joseph, in the map with its coat of many colours, and its perfection of craftsmanship. It is the more remark-

able and also the more regrettable that the military surveyor is an even greater offender in this matter of colours than his civil counterpart. Whatever the reasons for his choice, he starts with an initial handicap which hampers his endeavours to provide up-to-date information of topographical changes.

Destructive criticism, valuable as it is, is not, however, complete without its constructive counterpart and in consequence it becomes necessary to suggest a new policy to replace the old. To do so, let us state the basic considerations which should govern such a policy.

They are :—

(*a*) That the map user should always be able to obtain on demand an up-to-date map when it is really required.

(*b*) That the time spent on production will represent an exact measure of the minimum " out of dateness " of a map and therefore, the shorter it is, the more likely is it that the first condition will be fulfilled.

(*c*) The surveyor cannot record changes until they have actually taken place, and their inclusion therefore must await the collection of the necessary data.

(*d*) The need for revised maps is most acute in those areas where changes are greatest.

Fulfilment of these conditions implies a constant amendment of existing maps as changes occur, in such a way that copies are easily and simply reproducible on demand by those who require them. Furthermore, it becomes an essential that the reproduction itself should be a matter of hours or days, rather than weeks or months. Such a policy has been called " continuous revision." Its successful employment requires a consistently high standard of technique and organization. Failure to maintain such a system at maximum efficiency will not only cause inconvenience but will expose the lack of efficiency immediately and mercilessly. However unpalatable such a prospect may be to the surveyor, it is no justification for retaining older methods behind which he could successfully barricade himself, provided always that there is a reasonable certainty that a workable system can be evolved. It now remains to enunciate the technical principles and organization to work a continuous revision policy. They would appear to be as follows.

(*a*) *That an adequate organization is developed to ensure that information of all alterations is collected as soon as possible.*

This is no more or less than a survey " intelligence service " and its aim should be, not merely to accept such information as is offered to it, but to develop all existing resources to such an extent that it is automatically informed of any alterations, small or large. The

development of such an organization presents no real difficulty but it is a sad truth that the less information that is collected, the easier will the subsequent stages become. It is therefore the keystone of the whole system and the better and more smoothly it works, the better service will the surveyor give to the map user.

(*b*) *That the transference of topographic information from the original source to the final reproductive form should be carried out in the minimum number of stages, which should preferably be mechanical rather than manual.*

The actual technical details required to fulfil this condition depend largely on the type and scale of the map under consideration, as well as on the form in which the information is presented. Of these three factors, the latter is probably the only one over which the surveyor has full control. Matters of type and scale are generally dependent on a particular or general need. Even so, it is possible to maintain this principle, provided the information is recorded in a suitable form. The decision as to what is the best form involves a precise technical knowledge of the methods employed in subsequent stages, as well as continual experiment in the elimination of such of these stages as are redundant.

(*c*) *That the "manuscripts" from which the lithographic production starts should be undistorting, everlasting, easily amended, and simple and quick to revise and reproduce.*

At present this ideal is not completely attainable. Materials, however, such as Astralon Nova-trace, enamelled zinc and Anodysed Aluminium, have recently been produced which go far towards fulfilling the conditions required. They are a considerable advance on paper, the principal medium employed in the past, which fulfils practically none of the conditions required. It should also be remembered that the fulfilment of even one condition is a gain and that, in consequence, there is a distinct advantage in using less imperfect material, however far it may be from the ultimate perfection required.

(*d*) *That the reproduction processes should be as simple and rapid as possible.*

Many of the processes of lithography have been in use for twenty or thirty years. They are excellent of their kind but, because the control of this particular trade has been the prerogative of the foreman printer, few, if any, advances have been made, comparable with other scientific trades. There is therefore a large field for research and improvement. Even so, however, the existing processes, when properly organized, can be made to serve the needs of continuous revision without serious inconvenience.

(*e*) *That the design of the map should be dependent on use and not on aesthetic principles.*

In all cases, the minimum number of colours consistent with clarity should be employed. The most rapidly amended and reproducible form is a single colour map. Any departure from a single colour not only complicates the revision but the printing as well. The adoption of many colours is therefore, within limits, a tacit assumption that the map requires no amendment, and should therefore only be employed for very small scales where the information provided is so generalized as to require little alteration.

In producing the above brief summary, the problem has to a great extent been generalized in order to give as broad a view as possible. R.E. officers, employed on survey, however, are vitally concerned in a particular aspect which is not mentioned in detail and that is map maintenance in war. Technically, the principles remain the same, but the whole "tempo" of the problem is accelerated, whilst at the same time a failure to "deliver the goods" will handicap operations seriously.

We may, it is true, have to undertake new surveys in war, depending on the theatre of operations, but we will always be concerned in questions of maintenance, whether it be of our own maps or those of others. We are, therefore, far from attaining military perfection, even as surveyors, if we concentrate on initial surveys to the neglect of map maintenance, which is at least as important, and at the same time a far more probable form of employment.

THE USE OF WEAK BRIDGES FOR HEAVY LOADS.

Translation of an article entitled "Ausnutzung schwacher Brücken fur schwere Lasten." By CAPTAIN BUJARD in the *Vierteljahreshefte für Pioniere* for May, 1939.

MOTORIZED units often find themselves in the position of having to use roads passing over bridges whose maximum carrying capacity is either unknown or else is laid down for public traffic at a lower weight than that of the heaviest load in the unit in question. Military necessity may require that such bridges should be overloaded without hesitation, provided that they are short, and that the possibility of their collapse will not completely hold up the advance of the column. If, however, the bridge is of considerable span and height, the limits permissible for the material and style of construction must be considered before taking the responsibility for overloading it.

It is a matter of great military importance to lay down these limits. Three methods of procedure can be adopted :—

1. Rules of thumb for the use of bridges of known carrying capacity, to be adopted by the commanders of all motorized units.
2. Simple calculations for engineer N.C.O's.
3. Accurate arithmetical calculation of the carrying capacity by engineer officers or other technically qualified persons.

A simple method of procedure is desirable, so that the commanders of all motorized units may be able to determine the limits in question, by rule of thumb. But rules of thumb are inaccurate, and, in some cases, they give too cautious results.

The same applies to simple formulæ, suitable for N.C.O's instructed in their use. Only a very accurate calculation on engineering lines, worked out by engineer officers or other qualified persons, can give the correct maximum load permissible for a bridge carrying military transport. But this does not mean that the rules of thumb and simple formulæ should be abandoned, for in many cases they are quite accurate enough, particularly in the case of loads that do not appreciably exceed 8 tons. In certain circumstances all three methods are necessary, and the next most accurate need only be adopted if a simpler method has not given the required result.

In the following paragraphs the two first mentioned simple methods will be described, in so far as they may be deduced from the German rules and regulations. The third method, here omitted, depends upon the application of a few simple formulæ, the knowledge of some principles of bridge construction, and the use of tables. Since these require further simplification, an explanation of the procedure is not given here. Its application is only slightly easier than the working out of a demolition scheme. So accurate a calculation is not important enough for many units. In armoured units and others possessing loads exceeding 8 tons it is essential for the engineer officer to have a basis for determining the amount of strengthening required for a bridge. Not only this, but he must know how much extra strain can be put on weak bridges in order to keep up the mobility and rapidity of such units. In certain circumstances this knowledge may be of extreme importance in achieving a military success.

I. THE USE OF BRIDGES OF KNOWN CARRYING CAPACITY FOR MILITARY TRAFFIC.

The carrying capacity of a bridge is based on the weight of a vehicle with two axles in the most unfavourable position on the bridge. Besides that, the distance apart of the axles, and the distribution of the load upon them, are assumed to be the most unfavourable that are likely to occur in practice. Now, if the bridge is required to carry a vehicle with three axles or with chain tracks, the distribution of axle loads is far more favourable, and the total weight of the vehicle may be higher than the maximum prescribed load, without exceeding the carrying capacity of the bridge.

Since many army vehicles, as well as numerous other mechanically propelled vehicles, have a more favourable distribution of axle loads than that for which the official maximum is laid down, it follows that the carrying capacity of a bridge does not necessarily coincide with the maximum weight of a vehicle that may cross it with safety. As a rule it will be less. For instance, a lorry weighing 8·5 tons laden will require a bridge of a carrying capacity of only 7 tons.

It is, of course, not possible to leave the determination of the available carrying capacity of a bridge to the unit itself. The limiting figure should be painted on every vehicle. This, in fact, was actually done in a certain corps area in 1938. By taking advantage of favourable conditions in the design of vehicles, bridges can be overloaded well beyond their official carrying capacity.

A further overloading of bridges is justified on the following grounds :—

(*a*) With army transport, building materials may be subjected to heavier stresses than is permissible with ordinary traffic.

(*b*) Allowances made for impact in calculating for public traffic, especially for uneven surfaces, *e.g.*, pot-holes, need not come into consideration with slow, smooth-running traffic.

The following rules of thumb are therefore applicable to the possible overloading of bridges by army transport. They apply equally to wood, steel, masonry, concrete and reinforced concrete.

For vehicles in column :—

On every bridge in sound structural condition the carrying capacity prescribed for public traffic may be multiplied by 1·3 *for army transport.*

Vehicles may travel in column at usual speeds.

Passage of single vehicles :—

On every bridge in sound structural condition, provided the road surface is even, and vehicles travel slowly and smoothly, the effect of impact to be considered is diminished, and the carrying capacity prescribed for public traffic may be multiplied by $1{\cdot}3\times\phi$ *for army transport.*

The factor ϕ will be taken from Table 1 (page 565).

In this case vehicles must proceed singly, that is, at intervals equal to the span of the bridge.

Example.—A column of motor lorries is required to cross a bridge whose carrying capacity for public traffic is limited to 5 tons.

Span between supports=25 metres.

Total weight of each laden lorry=8·5 tons.

Available capacity for motor lorries=7·0 tons.

ϕ for spans between 21 and 30 metres=1·36.

Available carrying capacity for army transport $5\times1{\cdot}3\times1{\cdot}36=7{\cdot}5$ tons.

The passage may not be carried out in column, but singly, with a minimum interval of 25 metres between vehicles. If the road surface is in good condition, the vehicles may travel at their usual speed. If not, the speed should be reduced.

The proposed marking of vehicles and the application of these rules of thumb will enable all arms to take full advantage of bridges of known carrying capacity.

All bridges on main roads, Class I and II and urban roads, not included in Class I (24 tons), and all bridges on all other roads

and lanes with a carrying capacity of less than 5 tons, must carry a board indicating their carrying capacity for public traffic. The rule has not, at the moment, been carried out all over the country. But military reasons will often justify the ignoring of the limiting loads laid down for public traffic. In many cases it will be possible to apply the rules of thumb to advantage.

II. A Simple Method of Calculating the Carrying Capacity of Wood and Steel Bridges.

Where the method of construction allows, the carrying capacity is calculated according to the Tables for Bridging Construction. For calculating the superstructure, Table 2 (page 565) is applicable.

If the Bridging Tables do not give the required result, calculations should be worked out for :—

Longitudinal road bearers,

Cross road bearers,

Roadway support (only if it consists of planking),

by the above method.

For all other parts of the structure (*e.g.*, main girders, piles, etc.) it may be assumed that they will at least carry the load corresponding to that the longitudinals are capable of carrying.

The calculation of the longitudinal and cross beams is worked out from the formula

$M_b = W \times s$ (equation of moments).

In this formula—

M_b is the bending moment, *i.e.*, a value expressing the stress to which the beam is subjected as the result of the span and the load ;

W is the moment of resistance, *i.e.*, a value expressing the strength of the beam from its height, shape, and dimensions.

s is the permissible stress for the material in question.

To ensure an accurate arithmetical result it is desirable that these values should be taken from the tables. A reference to the tables is recommended in the Engineer Regulations. In this case the rules of thumb mentioned in Part I of this article are fully applicable. Moreover, it will then be possible to teach senior N.C.O's, who have only been taught simple calculations, to improve their knowledge by going more deeply into technicalities and obtain more accurate results.

(Three paragraphs referring to pages in the German Engineer Regulations are here omitted.)

TABLE 1.

Impact Factor ϕ.

Span l in metres	5	10	20	30	40	50	60
ϕ	1·40	1·39	1·37	1·36	1·34	1·33	1·31
Span l in metres	70	80	90	100	110	120	130
ϕ	1·30	1·28	1·27	1·25	1·24	1·22	1·21
Span l in metres	140	150	160	170	180	190	200
ϕ	1·19	1·18	1·16	1·15	1·13	1·12	1·10

TABLE 2.

Thickness of Planking in Wooden Bridges.

The span c of the planking is the clear span between roadbearers increased by 10 cm., or, as a maximum, the distance, centre to centre, between roadbearers. The maximum span of the planking applies to planks at least 20 cm. wide, and simply supported, as given in the table. For narrower planks, the span $c_1 = \frac{c \times b}{20}$, where b is the actual width of the plank in cm.

Thickness of planking d (cm.)	Maximum span of planking c (cm.)	
	8-ton bridge	16-ton bridge
5	33	—
6	48	29
7	65	39
8	85	51
9	108	65
10	133	80
11	160	97
12	—	115

If there is more than one layer of planking, the thickness of each plank is :

with double planking .. 0·71,
with treble planking .. 0·58,
times the thickness of the single planking.

AN OVERLAND TRIP BY CAR IN AUSTRALIA.

By LIEUTENANT A. T. J. BELL, *Australian Staff Corps.*

INTRODUCTION.

ON the completion of two years' tropical service in Darwin, one naturally turned one's mind to the trip south. Despite the delights of the fortnight in a ship, one could not but be attracted by the trip overland, which no longer possesses the difficulties of the past, for the through trip from north to south is done by at least half a dozen cars every year. We three members who were to form the party, set out about making preparations for the trip.

The car at our disposal was a 1927 six-cylinder 27 h.p. American car which had already some 150,000 miles to its credit. Nevertheless, after performing such jobs as tightening up the big ends, renewing king-pins and bushes, overhauling the radiator, and replacing shackle bolts and bushes, etc., the car seemed blessed with a new lease of life. The springs were removed, stripped, and greased. This job was of infinite value to us, and it is recommended to all those contemplating similar trips, as it ensures that spring leaves can readily be changed. A 15-gallon extra petrol tank and 10-gallon water tank were fitted. When finally loaded with 32 gallons of petrol, 10 gallons of water, rations for 7 days, tools and spares, extra tyres, cordage and the like, including the three members of the party, the car weighed just under 3 tons.

The only other point to be settled was the route to be followed. There are two principal routes which can be followed from Darwin to Melbourne (our ultimate goal) :—

(1) Darwin—Alice Springs—Adelaide—Melbourne.

(2) Darwin—Cloncurry—Brisbane—Sydney—Melbourne.

Despite route (2) being some 1,000 miles longer than (1), for various reasons it was decided to follow this route.

Section DARWIN TO NEWCASTLE WATERS.

We left Darwin at 0920 hours, 27th July, 1938, loaded to the gunwale. The bitumen roads of Darwin finish 2 miles out of the town, and that was the last bitumen road we saw until we reached Mount Isa, 1,000 miles away. From Darwin to Birdum the track follows the railway line fairly closely. The first 50 miles of the track

from Darwin has been recently re-located and built by the Department of Interior. This road now passes below the " Manton Gap," the proposed site of the dam which will provide Darwin's water supply. While the road has only an earth formation, pipe culverts have been included, and this section of the road appears to be an all-weather route. Our first stop on this section was to let air out of our tyres, which had increased in pressure from 30 lb. to 45 lb. per sq. in. That night we made Pine Creek, a tiny town of about half a dozen houses, a hospital, police station, two hotels and two stores.

At Pine Creek and all the other towns down the line we saw a land and cattle sale solemnly advertised by a man known as " Old Man Brown." Several thousand head of cattle and horses and a hundred or so square miles of country were offered for sale. On making enquiries, one found that nobody knew the exact number of head of cattle or horses on it, as the cattle and horses had never been mustered. This incident is typical of the Northern Territory.

Next morning we had to slacken off our king-pins, as their tightness had made the car very tiring to steer. That night saw us at Katherine, of similar size to Pine Creek. Katherine has two notable features, firstly, that it is on the banks of the Katherine River, a pretty tree-lined shallow river with permanent water, and secondly, that it is the headquarters of the well-known flying doctor.

The country on this section varies from flat (near Darwin) to very undulating, with numerous rocky outcrops of diorite, quartz, and a form of soft ironstone. The country is fairly well timbered with gum trees, and a short straggly tree with a broad green leaf. Pandanus palms grow near water. The country abounds with termites, and small red anthills about 3 feet in height are nearly as numerous as trees. After leaving the re-located 50-mile section of track from Darwin, the road consists in general of two wheel tracks winding in and out of the trees, unmade or graded in any way. This holds, with a few exceptions, practically to within 200 miles of Brisbane, a distance from Darwin of approximately 2,000 miles. The track between Pine Creek and Katherine (63 miles) is the worst track that any of the party had ever been over. The track is crossed by innumerable creeks with steep sides and rocky bottoms. For one rocky section of about 15 miles the track dips into one creek, rises up a steep pitch, and then dips steeply to another creek practically continuously.

During the day we passed two lone cyclists. One felt that at least these people must be mad, cycling on such a trip. One cyclist was riding around the world, and the other was riding to Darwin to find the ideal wife. One wondered which one would achieve his object first.

Next morning we were up long before dawn to put an extra leaf in one back spring. On the bad roads of yesterday this spring had

caused us some anxiety. We had only gone some two miles out of Katherine, when we were overtaken by our publican of last night, who had jumped into a car and driven after us, merely to inform us that we were taking an old and very rough track to Birdum. This action is typical of people living in the Territory.

The track from Katherine to Mataranka had a good surface but wound so much that it was not possible to travel more than 15–20 m.p.h. From Mataranka on to Birdum the track improved greatly. The country from Katherine to Birdum is flat, sandy, and heavily timbered. From Mataranka a track leads off to the Elsey Station, made famous by Mrs. Aeneas Gunn in her book, *We of the Never Never*.

We were very pleased to sleep at the hotel at Birdum that night, as we knew we had some cold nights on the ground ahead of us.

Birdum is the terminus of the railway line from Darwin, (363 miles). It is a small place, consisting of the usual store, hotel, a couple of white-washed houses, some coal bunkers, and an engine shed.

From Birdum to Newcastle Waters the country is flat and heavily timbered with low trees and scrub. The track follows the overland telegraph line. Along this section, from Birdum right through to Queensland, the Commonwealth Government has put down a sub-artesian bore approximately every 20 miles. The bores enable cattle to be driven along these routes. The bores consist of the bore itself, tapping the sub-artesian belt from 200–600 feet below the surface, a large windmill pumping into a 500,000-gallon above-ground earth tank, and two 100-feet steel cattle troughs. This water is mineralized but is drinkable at most bores, except at those within a 40-mile radius of Anthony Lagoon.

We arrived at Newcastle Waters about 1600 hours next day. Here we filled with petrol (33 gallons), oil and water. Petrol at this place was 4s. 2d. a gallon. Our stock had to last us for 451 miles to Camooweal. Petrol can be obtained at the five stations on route to Camooweal, but only at a prohibitive price. Beer at these out-back places is about 3s. a bottle, but is cool, largely owing to the use of kerosene refrigerators. Until we were well into Queensland, we had considerable tyre trouble, mainly due to overloading. Despite the fact that we left Darwin with a practically new set of tyres, we averaged nearly one and a half punctures a day until we were within 200 miles of Brisbane.

We saw little or no game between Darwin and Newcastle Waters. Normally, one would expect to see large numbers of kangaroos and wallabies, at any rate as far as Katherine. No crocodiles were seen in any of the northern rivers or waterholes, nevertheless, one would not have risked swimming in them.

As an instance of the difficulty of obtaining tools and spare parts

Section of the track near Katherine.

The Katherine River.

Brunette Downs Cattle Station.

An overland trip by car in Australia 1- 3

The Edith River near Pine Creek.

No. 5 Bore Barkly Tablelands.

Typical Queensland Country Track.

An overland trip by car in Australia 4-6

on this section, we lost our screwdriver shortly after leaving Darwin, and could not buy another until we reached Camooweal, approximately 1,000 miles away.

The main industry of the Northern Territory is cattle raising. There are some very large herds in the Territory, on some very large stations. Victoria River Downs Station has an area of 25,000 square miles, while Alexandria Station has an area of 15,000 square miles. Some of the small towns in the north, such as Pine Creek, depend also on mining for their existence, mainly gold mining. All these mines are small and none of them could be described as flourishing. Rare minerals, such as Wolfram and Tantalite, are also found in very small quantities. It is claimed that there is gold in large quantities at Tennants Creek, a town in the central Territory, but little has been produced to substantiate these claims.

Section Newcastle Waters to Camooweal.

The section from Newcastle Waters to Camooweal is over the Barkly Tablelands, much advertised as a pastoral area. After travelling over this section and hardly seeing a blade of grass or a tree for 400 miles, one wondered rather what the cattle lived on. However, the country 100 miles or so north of the route followed by the overland track, is much better pastoral country.

The track across the Barkly Tablelands is fairly good and will stand a high speed (50–60 m.p.h.) in a modern car. For the most part the track is over " black soil " country, with the result that it only needs a shower of rain and a herd of cattle on the track, to make it a very unpleasant track to travel on afterwards. However, if one watches for dried-up creeks, one can make very good speed on this section.

The Barkly Tablelands have an altitude of about 1,000 feet, are practically flat for 400 miles, and appear the most desolate place one could wish to see. Extraordinary mirage effects are noticeable on them. One also had the impression that one was in the centre of a depression and was always going uphill on this very flat country. In places, the Tablelands are covered with short, tufty grass, but the greater part is quite devoid of all grass. A gravel known as " Ribbonstone," a form of jasper, occurs in parts; the reason for its occurrence is not clear.

We left Newcastle Waters hoping to make No. 8 Bore that night but were forced by a puncture to make camp earlier. It was bitterly cold, with the S.E. trade wind blowing continuously. There was no wood at all that would burn, and all cooking had to be done by primus stove, an essential when crossing these Tablelands. Next day saw us camping for the following night at a bore between Anthony Lagoon and Brunette Downs Station. One felt very glad

to have the 200-mile stretch between Newcastle Waters and Anthony Lagoon behind one ; it is a long way to walk if a major breakdown occurs.

Anthony Lagoon is on a slight rise, without a blade of grass or a tree. It consists of a homestead, police station and store. At our camp at the bore that night we were looked after by the caretaker of the pump engine (windmill not fast enough at this bore), who insisted on supplying us with curry, firewood and meat. The best return we could make for this was a stiff nip of rum. He also assured us that the dingoes would sniff our faces that night. They may have done so but we did not notice them. The caretaker was very disappointed because we were unable to give him the latest scores of the test match then in progress. Our figures were two days old.

Next day we passed through Brunette Downs, Alexandria, Rankine and Avon Downs, to reach Camooweal at 2000 hours that night. We were very pleased to reach our destination and sleep in a hotel out of the piercingly cold wind. We arrived at Camooweal with 2 gallons of petrol left. One felt that this was too small a margin.

Camooweal has about 150 buildings and houses; it is a distributing centre for stations around, in addition to being the border town of Queensland.

From Darwin to Camooweal, one might well say that the tracks are well defined and there is not a great likelihood of losing one's way. Nevertheless, there are a number of forks and alternative routes. The golden rule is to enquire at every station or homestead. People at such places can always give good directions to the next station, but can seldom give directions beyond that.

A great change has come over the life of people in the Northern Territory in the last 5–10 years. The development of the inland air services and flying doctor services has quite altered their conditions. Until just recently, all large stations possessed W/T pedal sets, mainly for summoning the flying doctor. These are now being replaced by two-way R/T. This fact alone is giving these people a different outlook.

One felt that one might be pardoned at feeling a little sad at leaving the Northern Territory, it is a comparatively unknown place, where one meets the most hospitable of people, and also some very fine rogues. People in the Territory do things daily which would be described as epics in the south.

Section CAMOOWEAL TO BRISBANE.

On arriving at Camooweal, one felt that one was nearing civilization. Nevertheless, we were still 1,400 miles from Brisbane and 1,300 miles from the first all-weather bitumen road. From Camooweal to

Brisbane took us 11 days, but, given favourable conditions and no rain, this should be a 7-day trip in comfortable stages.

The Country from Camooweal to Mount Isa and Mount Isa to Cloncurry is very hilly and rocky. The track is very rough and slow to travel on. From Camooweal to Mount Isa (125 miles) is a good day's run. Mount Isa is a thriving mining town, depending mainly on the large lead-zinc mines for its existence. The Mount Isa mining company mills and smelts its ore at Mount Isa, sending away nearly pure lead in bar form. The zinc refining and separation from the silver percentage is done overseas. Mount Isa is the terminus of the railway line from Townsville.

After leaving Cloncurry, the country is flat and one is on the "black soil" plains of Queensland. These plains are well grassed with "Mitchell" grass and carry large numbers of sheep. In addition, they abound with animal life; kangaroos and wallabies were seen by the hundred, while quite a number of plain turkey were passed. At Tambo the type of country changes to undulating, although there is still a considerable amount of black soil. This section of the country is heavily timbered in parts. Mixed grazing is carried out. Near Dalby the country continues to be very undulating but changes to farming country. Between Dalby and Toowoomba, the charm of these green valleys with their small farms and dairies is very real. A number of acres of this country are under wheat. At Toowoomba some very fine mountain views can be obtained. From there into Brisbane, after descending the ranges, the country is hilly and covered with dairy and berry farms, also a few orange groves.

Throughout Queensland by this route at intervals of 60–100 miles there are fine country towns such as Longreach, Winton, and Blackall. The population of these towns is about 3,000 or more, the towns are well and spaciously laid out. Most of them are well equipped with services such as water, electric light, etc. Nearly all these towns through Central Queensland depend on artesian bores for their water supply.

The Queensland rivers at this time of the year are all dry. These rivers have steep banks lined with gumtrees, and broad flat sandy bottoms. Mention must be made of the names of some Queensland towns, particularly the very small ones. On one section of the railway sidings run thus:—Dulbydilla, Mungalla, Ulandilla, Womalilla, etc. One felt after hearing these names that Bury St. Marys and Old Sarum had nothing on them.

The trip across Queensland was not without incident for us. We laid up the car at Mount Isa and went over her, doing a number of small repairs and a general tightening up. We were delayed a little by a faulty vacuum tank near Winton. On leaving Longreach, we were assured by a motorist, who had just come through, that the 68 miles to Barcaldine was better than it had ever been. We left

straight away for Barcaldine, and got half-way there when it started to rain. Very soon the car was cutting deep tracks in the road, and the going was very heavy. About dusk we went into a soft patch and got thoroughly bogged. By this time it was raining heavily and it was useless to try to get on any further. Next day the rain stopped at about 1000 hours and by means of 30 fathoms of 2-inch cordage, we rigged a spanish windlass to a tree and were out of the bog by 1300 hours. That day we did 10 miles, getting bogged five times on the way, despite careful scouting of the route wherever it looked soft. About every mile or so in this mud it is necessary to let a car cool and to clear the mud between the wheels and mudguards. This is a feature of black soil mud, that it sticks to everything, particularly when the mud is drying. Next day we made a slow and heavy trip to Barcaldine, where we stayed for a day, partly to repair a cracked timing casing and partly to allow the roads to dry before proceeding farther.

This incident is typical of the Queensland black soil roads, which are good roads while dry, but practically impassable after ½-inch of rain. In this case, 1 inch of rain fell and the road was impassable for 48 hours.

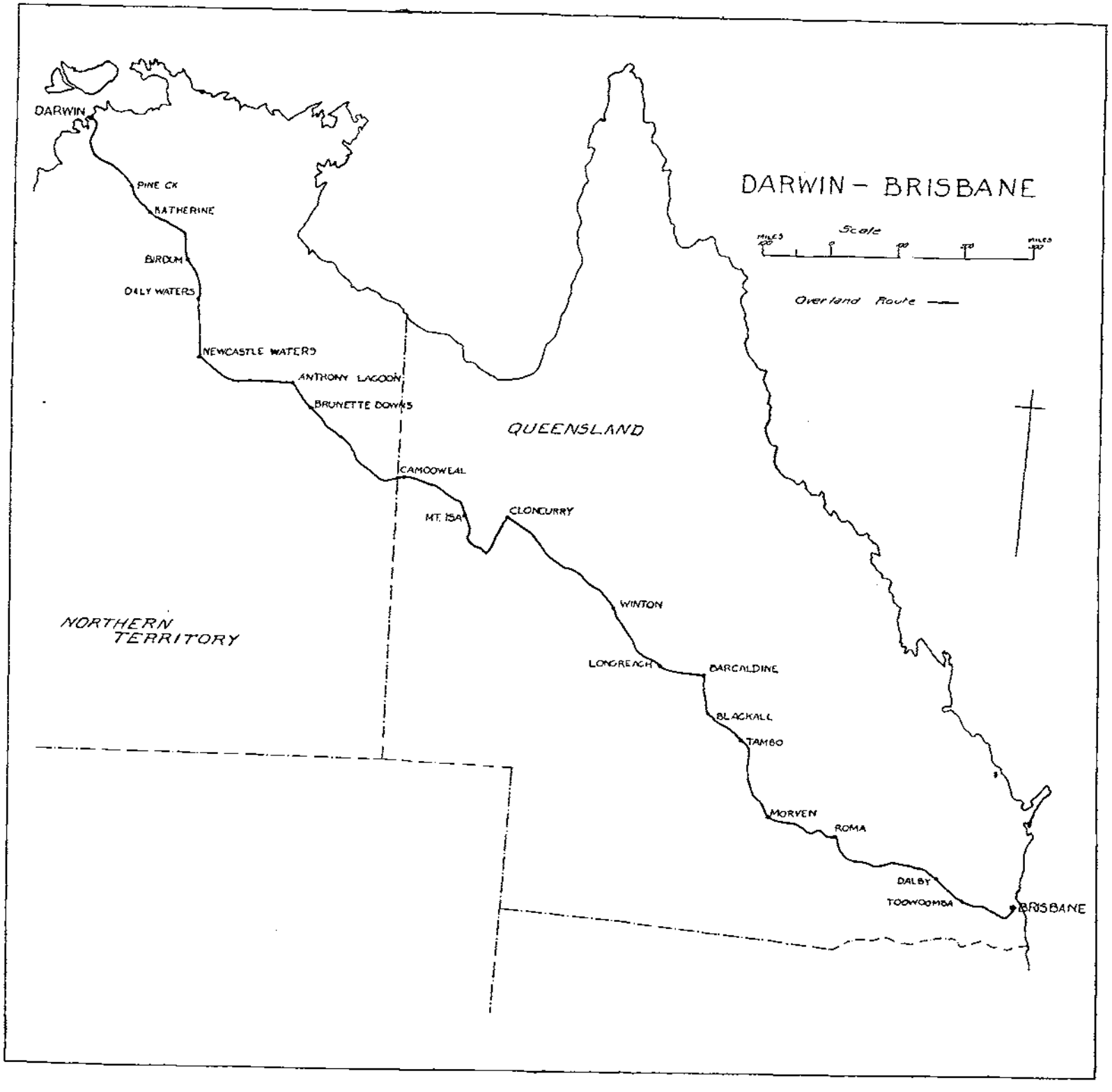
Apart from putting down bitumen roads, which are too costly for the distances to be covered in Queensland, attempts are being made to build all-weather roads by putting down well-drained clay. Such a road is the "Condamine" Highway, which will connect Roma and Dalby. The procedure is to form the road with a grader to about two to three feet above the surrounding country and then lay about one foot of red clay, well contained at the sides and roller consolidated. This procedure appears to be successful.

Section Brisbane to Melbourne.

This section was covered with only minor incidents by the Pacific Highway from Brisbane to Sydney, and the Hume Highway from Sydney to Melbourne. The roads are good all the way and the trip is too well known to warrant a description of it. It was completed in five days' running time.

General.

The trip from Darwin to Brisbane was accomplished in 17 days (16 days' running time) and from Brisbane to Melbourne in 9 days (5 days' running time), making a total of 26 days from Darwin to Melbourne, a distance of 3,642 miles. A table follows showing days run and running times, etc. Running time for each day includes


DARWIN – BRISBANE
Scale
Overland Route
DARWIN
PINE CK
KATHERINE
BIRDUM
DALY WATERS
NEWCASTLE WATERS
ANTHONY LAGOON
BRUNETTE DOWNS
QUEENSLAND
CAMOOWEAL
MT. ISA
CLONCURRY
WINTON
NORTHERN TERRITORY
LONGREACH
BARCALDINE
BLACKALL
TAMBO
MORVEN
ROMA
DALBY
TOOWOOMBA
BRISBANE

halts for meals, running repairs and punctures, etc. The table ends at Brisbane.

Day No.	Place — From and To	Distance (miles)	Running time (Hours)	Remarks
	Darwin			
1	Pine Creek	153	11½	
2	Katherine	63	4	
3	Birdum	147	8	
4	Beyond Newcastle Waters	150	11	Between Anthony Lagoon and Brunette Downs
5	No. 6 Bore	195	8½	
6	Camooweal	246	11½	
7	Mount Isa	125	8	
8	McKinlay	225	13	
9	Winton	146	7	
10	Beyond Longreach	160	11½	
11	Saltern	10	3½	
12	Barcaldine	22	3½	
13	Tambo	137	7	
14	Roma	270	14	
15	Dalby	180	13	
16	Brisbane	140	6	
		2,369	141	

Average daily mileage = 148 miles.
Average daily running time = 8·8 hours.
Average speed (including stops) = 16·8 m.p.h.

TALES OF A MALAYAN LABOUR FORCE.

By "MATA KACHA."

II.—A GRAVE UNDERTAKING.

THERE is a saying that in China one is never out of sight of a Chinese, dead or living. Certainly, one of the features which most impresses the traveller on his first visit to the "Middle Flowery Republic," or to places where Chinese have settled, is the magnificence of their tombs and the vast areas of land occupied by family and public cemeteries.

In Singapore, where three-quarters of the population are Chinese, not only do we find their graves sprawling over acres of most valuable building land almost in the heart of a town, but the face of every little hillock in the surrounding countryside is also pock-marked with the elaborate tombs of local Chinese families. So it was with the Military Acquisition; and one of the earliest of our problems (to be considered simultaneously with survey, the eviction of squatters, and anti-malarial measures) was that of the Chinese graves.

In my youth, Chinese graves and Egyptian sarcophagi seemed in the story books to vie with each other as origins of lifelong pursuits and persecutions. One began, I remembered, by tampering with a grave in the heights of Yun-nan and ended by narrowly avoiding a Chinese knife between the shoulders in a Thames-side villa at Kew. So the thought of an ordered tampering with several score of Chinese graves in Singapore appeared to offer an investment in experience which might in due course be repaid with ample interest.

The Chinese, of course, worship their ancestors and so they set much importance upon the care and ceremony with which their dead are interred. A Chinese funeral is an impressive affair, with its gaudy *décor* and subtle deceits. Before the gaily-coloured catafalque go sweepers and hornblowers who, by their brushings and blaring, should drive away malicious spirits from the procession's path. Occasionally the catafalque itself goes empty, the corpse travelling rapidly by another and circuitous route, in order to deceive the evil spirits who might follow it and trouble the dead in the afterworld.

The coffins here are immense, made of rough-barked slabs six and more inches thick, sawn four-square from the boles of great trees and spiked together. Various are the timbers employed in their construction, but a rich man will have none but the best *kledang*, a Javanese hardwood of increasing rarity and amazing lasting power. Coffins of this timber we found, after fifty years and more in the ground, showing no signs of rot, and apparently immune from the

attacks even of such a universal destroyer as the white ant. Empty and dry they are heavy enough, but laden and waterlogged after years in the ground, they may well weigh half a ton each.

Huge sums of money are customarily expended by the Chinese on their dead, as much as two thousand dollars (about £150) being commonly laid out on the grave alone. The coffin is generally buried shallow on the slope of a hill, head towards the summit, and the earth is mounded over and sometimes covered with a skin of cement. Occasionally we came across regular vault-like chambers constructed to receive the coffins. At the corpse's feet is erected a granite tablet bearing his name and epitaph. Around the grave itself is then built one or more low circular walls of masonry or concrete as defence against the onslaughts of evil spirits. These walls terminate at the lower end of the grave in wings, frequently heavily decorated in bas-relief, and almost invariably guarded by fierce granite lion-dogs, male and female. The dog, proud, carries his fore paw on the the globe, the mother fondling her pup sprawling underfoot. Before the grave are coloured tiled terraces, widening, and one, perhaps two, votary altars stand beside. The defensive walls unite again in front with, occasionally, outworks of brick for additional spiritual security. Planted in strict symmetry around this deathly fortress you will find tall palms or formal arrays of giant spiky aloes, while the grave of a rich or prominent man may still further be decorated with tall granite columns, on which are deeply incised in Chinese characters pæons of praise. One such pair, weighing a ton each, bore an epitaph of which the following is a free doggerel translation :—

> " In southern wilderness exiled,
> Upon his labours fortune smiled,
> By whose help flourished he, and died
> His name at that time honoured far and wide."

Nearly all the granite found in these graves is of a fine grained variety, admirable for sculpture, dark blue in colour, and especially imported from China. The best is said to be hewn in the quarries of Amoy, in the province of Fukien. From one grave we subsequently recovered over seven tons of this stone, mostly ornamented with carvings, besides ten tons of broken brick and concrete, all of which was in due course incorporated in our own works.

Once the burial is over and the masons have finished their labours, many of the dead receive no further attention beyond the periodic provision of paper " money "—gold and silver foil pasted to sheets of paper—and the regular burning of crimson joss-sticks on low green porcelain stands before the altars. Once annually, at the " Feast of the Sleepy Moon," the devout repair and clean up the tombs, but many lie for ever untended and quickly become overgrown and lost to sight under a closely-laced mantle of secondary jungle.

For this reason, our first duty was to discover and to make a register of the graves on our land, so that the necessary licences might be obtained for the exhumation. The completing of this register took months. Our prime requirement was a large-scale plan, showing the location of each tomb in relation to the lot boundaries. Then each grave received a number, and we set out, with bailiffs, interpreters, representatives of the Chinese Protectorate, and a gang of coolies, to make our list. Occasionally we found a tablet gone, when inspection of the mound behind would reveal a longitudinal depression in the turf, showing that some family had attained its lifelong ambition to carry its dead back to China. Indeed, this traffic assumes such proportions that, to deal with it, special shipping arrangements are regularly made. What with clearing undergrowth, cleaning, reading, and translating inscriptions, we were lucky if we got ten graves done in a day. Most of them contained two, some three, coffins. In this way we duly registered one hundred and thirty-six corpses. Then followed the tedious backstage work of tracing descendants and obtaining from them their formal approval to the proposed exhumation and reburial, not always an easy task. The general offer we were able to make was exhumation and proper re-burial, including the re-erection of the monument, in a plot to be provided at Government expense in the public cemetery. With true Chinese prevarication the negotiations dragged on for weeks. Some owners, usually of the least tended graves, demanded fantastic rates of compensation; others desired to be allowed to make their own arrangements for the removal; to others, again, this appeared to offer a golden opportunity to effect the return of their ancestors to China. At length a flat rate per corpse was arrived at, either to be expended by us on our scheme, or by the claimants as they saw fit, dependent only in the latter case on the utter removal from our land of the graves. If the method of disposal of those whose owners could not be traced presented the least difficulty, the provision of the licences to exhume these proved the most complicated of all. The most exhaustive searches had to be undertaken and shown abortive before Government would authorize an act which might bring unpleasant repercussions if a belated claimant should turn up subsequently. At length, however, all was settled and we duly received, in the following form, the authority to proceed:—

SPECIAL LICENCE TO EXHUME A CORPSE.

"In pursuance of the power conferred by Section 256(5) *of Ordinance No.* 135 (*Municipal*) *I do hereby grant permission to The Staff Officer R.E., Fort Canning, Singapore, to exhume the corpse of Chang Ah Moh, buried on the* 16*th October,* 1908, *in the burial ground at Alexandra Road for the purpose of reburial at*

Bukit Brown in accordance with the conditions stated on the back hereof."

Sd.

Colonial Secretary's Office, Singapore. — *For Colonial Secretary, Straits Settlements.*

In the meantime, news of our proposed mass exhumation had spread abroad and brought in a series of applications from undertakers and contractors, begging to be allowed to tender for the work. The most entertaining of these, perhaps, came from a gentleman named Dye Seng.

" SIR " (he wrote),

"BURIAL GROUND AT ONG GEE SAN TO ANTY PLACES."

We have the honour to submit herewith our application for contract of conveying buried man's bones (skeleton) to another place.

We beg to state that we have considerable and vast experiences of this and that we undertake to receive payment after completion of same.

We beg that you will kindly give us this kind of work for which act we shall be ever grateful.

We have the honour, etc."

This letter gave rise to an ephemeral correspondence in which, among other absurdities, the possibility of including in the local " Schedule of Prices " appropriate items to cover this class of work was discussed. Payment on a measurement basis was favoured "per *katty** per foot run, foot depth." This levity may seem to have been in doubtful taste, but it enabled us to approach what promised to be a most unsavoury task in a mood as nearly normal as possible ; for upon us now devolved the duty of ensuring that the corpses actually went and that the conditions of this remarkable contract were properly carried out.

The work was eventually begun by a wizened old Chinese and two younger men, who might have been his sons. I had anticipated some elaborate ceremonial, but the old undertaker had his living to make and little time or money to spend on frills. A couple of joss-sticks he lit each morning, and these lasted him until evening, when he lit two more to show that his day's work was over. We had imagined, too, that the coffins would be excavated and removed bodily to their new resting-places, but such was apparently not the custom. As each was uncovered, the spikes were drawn, the cover lifted off, and the contents carefully transferred to large earthenware jars (like those provided for Ali Baba's forty thieves). Each jar was then sealed

* (Local measure of weight = 1·33lb.

with an upturned plate bedded in putty and the number assigned to the corpse in the register painted on in red.

On the first day the old man dealt thus with six; all men, long buried in cheap coffins, whose sole remains consisted of a few dry, rotting bones, some clusters of hair, and a golden ring or two. When evening came, there they stood on the roadside, their tumbled coffin lids sprawling beside six gaping openings in the face of the hill behind. The old Chinese, expressionless, lighting his short clay, enumerated them to me. Then he and his sons loaded their prizes, one by one, on a ramshackle old Ford and clattered off into the gloaming.

For a day or two they occupied themselves removing the tablets and lion-dogs and the better pieces of carved granite from these six tombs, and then they started again. This time three of the six they opened were women, placidly lying there, pinky-yellow in flesh, exactly as they had been buried thirty-five years before. At first glance they might merely have been asleep. The old man declared simply that if left exposed to the sun's rays they would soon melt away and then be easier to handle. "We often have this trouble with the women," he added, and busied himself with the easier menfolk.

By midday, however, it was not the female corpses but the entire labour force which had melted away. Perfume hung heavy on the windless air and was now clearly to be detected at a range of half a mile. Together the six graves lay open to the sun, yellow sandy wounds in the hill's green side. White cloths and brightly-coloured *sarongs* from the coffins were strewn around, making discordant stabs of colour in a landscape of olive and sap. One saffron corpse hung face downwards, half in and half out of its grave. The whole scene reminded me irresistibly of some early Master's conception of the Last Day.

The situation clearly called for action, so we summoned the Sanitary Authority with its formaldehyde sprays, and the fiat went forth that henceforward one coffin only should be opened at a time and its contents entirely disposed of before another was attacked. Then the work went on.

Had it not been for the brilliant sunlight, the singing of the cicadas, and the powerful odours which rendered the scene so unmistakably real, the whole ghastly performance might have seemed but a nightmare. But it was nothing to that which was to follow. The sun's rays were found to work too slowly, and a long-bladed knife had to be brought into play before these female corpses were finally consigned to their several jars. That day's consumption of tobacco exceeded a normal week's supply.

On that day and those which followed we watched the process oft repeated and we grew callous with experience, bolstering our

waning curiosity with macabre talk. One told of common graves in plague-time, and another how he had fallen once through the earth into one of the immense jars in which the Dyaks of Borneo bury their dead upright, to find himself sharing this narrow accommodation with a recent corpse. We found ourselves laughing at such horrors, as men will to protect themselves from fear when horror is commonplace. From the graves we saw taken men, women, and children; gold and silver ornaments, silks, and porcelain figures. With one old Chinese man had been buried a bag containing two hundred English shillings—pathetic evidence of a respect for the Queen Empress which imagined her paramount even in the world to come.

Several families arranged their own removals, some of which turned out to be no more than mere business-like packings for shipment to China, and one came upon jars and headstones together, crated and labelled, on the roadside awaiting transport to the docks. In at least one case the entire coffin was actually raised laboriously and removed with much ceremony, approximating to that of the original funeral, while a few, more devout than the rest, preceded the transfer of their ancestral remains from coffin to jar by simple ceremonies beside the open grave.

When at length the corpses were all gone, the graves were filled in and the massive coffin timbers stacked and burnt—all, that is to say, but a few specially selected *kledang* slabs which it seemed a pity to destroy. From these in due course was constructed for the office a bookcase, in which the grain of this perfectly seasoned timber showed to great advantage.

Although the corpses removed to the public cemetery were there re-interred with all their granite magnificence above them, those for export left with only their name tablets. In this way there came into our possession some excellent examples of lion-dogs, columns, and other sculpture in fine Amoy stone, in addition to many tons of masonry blocks, broken brick and tiles, left at the sites of the other graves. At last the work was all finished and we could certify completion of this funereal contract. For a month we had gone about our daily labours in a formalin-scented atmosphere of death, amid broken coffins and reeling tombstones, cold, dark, empty graves, and laden jars. Now that it was over, we liked to comfort ourselves with the thought that this gruesome duty had, at any rate, furthered materially Imperial aims in the Far East.

In Parliament, about this date, a formal request for the return to Ireland of the body of Sir Roger Casement, now buried in the Tower of London, was met with an eminently Parliamentary reply, to the effect that it was not the policy of the British Government to interfere with graves. Whatever significance this may have had in Whitehall, it clearly had none in the Golden Chersonese.

LIEUTENANT-GENERAL SIR JOHN FOWLER, K.C.B., K.C.M.G., D.S.O.

COLONEL COMMANDANT, ROYAL CORPS OF SIGNALS (RETD.)

JOHN SHARMAN FOWLER, the second son of Mr. R. Fowler, of Rahinston, County Meath, was born on July 29th, 1864. He was educated at Cheltenham and Coopers Hill, and received a direct commission in the Royal Engineers in January, 1886. After two years at the S.M.E. he was posted to the Field Park Depot at Aldershot. Here he remained for four years, during which he obtained certificates from the Veterinary School and the Hythe School of Musketry. He went to India in 1892 and was posted to the 6th Company, Bengal Sappers and Miners, with which he took part in the Isazai Expedition in the Black Mountain region. In June, 1893, he joined the 4th Company at Roorkee, under Major Aylmer, V.C., and in September of that year was sent on Special Duty to Gilgit. He was still in Gilgit when, in the early days of 1895, troubles were breaking out in Chitral, and he was sent with a party of twenty Sappers and some engineering stores to join the small escort of the British Resident in that country, who were about to be besieged in Chitral Fort. Accompanied by Lieut. S. M. Edwardes, he passed through Mastuj on the 5th of March and at Buni joined hands with a Subadar and 40 men who were escorting a supply of ammunition for the garrison, but had been held up there by rumours of hostile gatherings ahead of them. On the 6th they reached the large straggling village of Reshan, and finding the rumours of hostilities confirmed, they left the stores and ammunition in a sungar, and advanced cautiously along the precipitous road bordering the Chitral river. Fowler had climbed a steep slope to examine some sungars on the far bank, when he was attacked and forced to retire on the road, during which he was wounded in the shoulder. The enemy were driven back by heavy fire, but Lieut. Edwardes decided that further advance was impossible and the party fell back to Reshan, which they reached after severe fighting. The sungar was now untenable, so a group of houses adjoining a polo ground was occupied and put in a state of defence, and all the stores transferred to the new enclosure. Here they held out until the 15th, in spite of constant firing from the neighbouring houses and the necessity of fighting their way to the river whenever it was necessary to replenish their water supply. On the 13th some Chitral princes opened communication with them under a white flag, an armistice was discussed and on the 14th some supplies were brought

Lt-Gen Sir John Sharman Fowler KCB KCMG DSO

in by the enemy. Deceived by these friendly relations, on the 15th, the two officers were induced to join the princes in watching a polo match, and in the dance which followed they were treacherously rushed and captured. Those who took part in the Relief Expedition will remember that the villain of the piece was Umra Khan, Chief of Jandul, and on the 24th, after many hardships, they were handed over to him. To everyone's surprise he treated them well, and after bringing them down to his own country of Jandul, he eventually, on the 14th and 16th April, released them without ransom to Sir Robert Low. For his services, Fowler received the new Frontier medal and the D.S.O., and in September of this year was promoted Captain. He did not return to Gilgit, but, after a short leave in England, rejoined the Bengal Sappers and served with the 5th Company against the Mohmands in 1897. For this he was again mentioned in Despatches and gained two more clasps to his Frontier medal. In January, 1898, he came home to join the Staff College, on a nomination, and on completing the course at the end of 1899, was sent at once to South Africa with 100 linesmen and telegraph operators to join the Telegraph Service in the field. There is little on record of the two strenuous years he spent in South Africa, but from June, 1900, until the conclusion of hostilities, he held the post of Director of Telegraphs in the Orange River Colony. He was mentioned in Despatches, by Lord Roberts and Lord Kitchener and received a brevet majority in June, 1902. He also received the Queen's medal with three clasps, and the King's medal with two clasps. He returned to Aldershot in October of that year, and in the following January took up the appointment of Staff Officer to the C.R.E. in Ireland, and S.O.R.E. to the III Army Corps. In December, 1903, he was promoted substantive Major, and in 1904 he married Mary Henrietta Olivia, daughter of Mr. John M. Brooke. He remained in Dublin until March, 1905, when he was transferred to Aldershot as D.A.A. and Q.M.G., 2nd Division, and served there for four years. On returning to duty with the Corps, he took up the command of the 2nd Air Line Company at Limerick and held this appointment until the end of 1910, when he received the brevet of Lieutenant-Colonel and was selected by Major-General (Field-Marshal Sir William) Robertson, the Commandant, to be an Instructor at the Staff College. He was promoted substantive Lieutenant-Colonel at the end of 1911. In April, 1913, he was transferred to be Commandant of the Army Signal Schools at Aldershot and Bulford, with the mobilization appointment of Director of Army Signals to the British Expeditionary Force. He was at G.H.Q. in that capacity throughout the Great War.

Aided by a most efficient staff and with the full co-operation of the officials of the General Post Office, who unstintedly furnished the material and personnel required for the great expansion of the Signal Service, Fowler was able to direct its development on pro-

gressive lines in organization, personnel and equipment. Some idea of the expansion can be gained by the increase in number of Signal units. The B.E.F. took the field with 10 Signal Companies, 1 Signal Squadron, 5 Air Line Sections, 10 Cable Sections and 1 Wireless Section; in November, 1918, the "Order of Battle" shows it had 4 Signal Squadrons, 9 Signal Troops, 1 Signal Battalion G.H.Q., 5 Army Signal Companies, 61 Divisional Signal Companies, 18 Corps Signal Companies, 62 Air Line Sections, 52 Cable Sections, 88 Brigade R.G.A. Signal Sub-sections, 49 Army Field Artillery Brigade Signal Sub-sections, 41 Area Signal Detachments, 2 Light Motor Set Wireless Sections (besides those in the Signal Companies), 6 Signal Construction Companies, 5 Light Railway Signal Companies, 4 Motor Mobile Pigeon Lofts, 127 Horse-drawn Mobile Pigeon Lofts, 8 Fixed Pigeon Lofts, 4 Messenger Dogs Sections.

From being a service which commanders at manœuvres hardly knew how to use, Signals grew to be an integral part of the machinery of command, and G.H.Q. could speak by telephone to at least Brigades. From top to bottom there was an *esprit de corps* which, in the most troubled times, seldom allowed communication to be interrupted for long.

Fowler's great services were, on the one hand, tactfully ascertaining from the General Staff what its requirements were and keeping them informed of new possibilities, and maintaining the best relations with the G.P.O. and commanders, and on the other hand, whilst looking ahead—and he was very far-seeing—leaving the execution of work and the examination of new ideas to experts. He was, in fact, an ideal Director, a charming personality, accessible, receptive, valued by those in authority senior to him, and able without pressure to get the best work out of his subordinates.

In 1915 he was created C.B., and in January, 1916, he received the brevet of Colonel, and was promoted Major-General a year later; he was made K.C.M.G. in 1918. His services were mentioned eight times in Despatches and he also received, besides the war medals, the American Distinguished Service Medal, the French Legion of Honour, 3rd Class, and the Order of St. Vladimir, 4th Class with swords.

After the war, when the Royal Corps of Signals was formed, it was fitting that he should become its first Colonel Commandant. The appointment was made in September, 1923, and Fowler vacated it on reaching the age limit at the end of 1934. In February, 1921, he became G.O.C. at Singapore, but was transferred to the China Command in the following June.

The China Command in 1922 included the garrison at Hong-Kong in the south, as well as the troops in Tientsin and the Legation Guard at Pekin. As G.O.C., Sir John Fowler made extended tours, acquainting himself at first hand with the many diverse problems that face a Military Commander in the Far East. He was peculiarly well

fitted to this appointment; his charming personality brought him into intimate touch with the many influential men who controlled British interests, and he never failed to turn his knowledge to the best account.

Both here and in Singapore he interested himself in the local volunteers, and in both Commands his interest greatly benefited the Units.

He was a most popular Commander. All who knew him or served under him at Hong-Kong will remember the smile with which he welcomed all comers, the delightful informal hospitality of Sir John and Lady Fowler, the keenness with which they both entered into every local social activity.

Fowler was a keen sportsman. Like most Irishmen, a horse had a large share in his outdoor activities, and at Hong-Kong he played polo. In his spare time he also played tennis. He played with a tennis racquet that must have had nearly as long a service as the General's; no one will forget the sobbing sound it gave when he struck a hard and low one over the net.

He returned home in March, 1925, and was promoted Lieutenant-General in February, 1926, the year in which he was made K.C.B. He retired from the Army in March, 1928, and died at Harrogate, on September 20th, 1939.

All Reviews of Books on military subjects are included in the provisions of K.R. 535c (*1935*).

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

THE AMERICAN WAR OF INDEPENDENCE.

By Lt.-General SIR GEORGE MACMUNN, K.C.B., D.S.O.

(Bell. Price, 15s.)

Those who wish to know the results of recent historical research on the other side of the Atlantic will find General Macmunn's volume of 360 pages (with good illustrations and sketch maps) a useful compendium; those who wish to begin the study of the War of Independence will find it a lucid introduction. Without making any claim to original research, he has put together an easily read story, the best piece of popular history he has yet written.

Recent events have shown us how the causes of war can be misrepresented, and as regards the events of 1775–1783, the false account set about by partisan historians in America and Opposition party hacks in England persisted for nearly a century. Our Gloomy Dean has said: "In my opinion no historical event has been so grotesquely and perversely distorted."

"The bulk of American historians now admit that the actual case for rebellion was small and that How and Clinton had brought resistance to an end [in 1786] had it not been for the French and Spain." The rebellion, like revolutions we know of, was brought about by a small party of discontents, in Boston, on a seed-bed of a disinclination of the Americans to pay their share of the expenses of the Seven Years' War, by which, owing to the defeat of the French and Indians, they had much benefited. One modern American historian has estimated that when terrorism and propaganda had done their work "35 per cent alone were in favour of rebellion, 25 per cent were timid and uncertain, and about 40 per cent were very definitely and determinedly against it"—it might have been Germany at the advent of Hitler.

The British Parliament and people took little interest until, at the end of 1774, rebel forces invaded Canada.

When the trouble began in Boston there were less than 10,000 British troops in America, of which the greater part were in Canada and only a few at New York. "Successive Ministries had elected to destroy the magnificent army of the Seven Years' War." All as usual had to be improvised, and to make matters worse the Secretary for War and the Colonies was Lord George Germain, who as Lord George Sackville had lost his command and commission for misconduct at the Battle of Minden. If any one man was responsible for the loss of the American Colonies it was he; but "the failings of our parliamentary system in times of national crisis" must not be overlooked. The Minister drew up ingenious plans of campaign in London, but omitted to ensure that all the forces in his combination were told their parts; he thus brought about Burgoyne's surrender at Saratoga.

How and Clinton had got the better of Washington, and his ever-decreasing army was dying of cold, neglect and hunger at Valley Forge. Then France, angry at the loss of Canada, seized the opportunity to deal a blow at Great Britain: she brought Spain in her train, and sea-power turned the scales; for the Navy had been as much neglected by Parliament as the Army. "How very little things have changed since the world began."

J.E.E

THE CAMOUFLEUR AND HIS CRAFT.

By R. Myerscough Walker.

Mr. Myerscough Walker's work appears in four parts in the issues of *The Builder* for September 15th, 22nd, 29th and October 6th.

Part 1—*Approach.* The author points out that not only is camouflage part of the defence mechanism for most forms of life but that for mankind it also involves the twin blessings of decentralization and harmonious building.

The painter, the architect and the naturalist have all got their part to contribute and are equally indispensable.

Part 2—*Methods.* After brief references to tactical and strategic camouflage, the author turns to concealment of civilian buildings by imitative and disruptive methods.

Part 3—*Technique.* This part contains a series of hints on disruptive colour schemes and describes an instance of imitative camouflage of a factory. The need for further research is stressed.

Part 4—*Paints and Conclusion.* The types of paint available and their suitability for application to various surfaces are discussed in this part.

All four parts are illustrated with annotated examples of camouflage schemes.

A.D.C.

SURVEY OF INDIA—GEODETIC REPORT, 1938.

Published under the orders of Brigadier C. G. Lewis, O.B.E., Surveyor-General of India.

(Price Rs. 3, or 5s. 0d.)

The triangulation carried out during the season under report consisted of the re-observation of a portion of the Assam Longitudinal Series, lying between Gauhati and Goalpara. This has special interest, as it traverses an area much disturbed by the great earthquake of 1897. The series was originally observed in 1859; since then, apart from the great earthquake, the region has been subject to many more or less severe shocks. In determining the amount of earth movements, the difficulty is to obtain some stable point of reference, with which comparisons of old and new values can be made. This becomes a matter of arbitrary selection, as it is generally impracticable to go far enough outside the area affected in search of undeniably undisturbed points. In this case two stations, about 150 miles apart, were assumed not to have been affected by the earthquake and comparisons of the points lying between were made relative to them. These relative movements have been shown on a chart, both as to amount and direction. The largest relative movement between two near stations is 5 feet in 12 miles. This conclusion can be accepted irrespective of the stability of the stations of reference. Very little movement in height was found. Observations were made with the Wild Precision Theodolite. The average triangular error was 0·64 seconds.

The results of the readjustment of the Indian Triangulation, by the Computing Office at Dehra Dun, leads to the conclusion that the length and breadth of India have been measured with a probable error of 1 in 500,000.

Observations of deviation of the vertical, both in the meridian and the prime vertical, were carried out at 49 stations in a line extending southward from Mandalay to Victoria Point, in the extreme south of Burma. The most striking result of these observations is "the confirmation of the great geoidal rise from north to south which, by chance, agrees closely in amount with that provisionally shown in previous Geodetic Reports. The extent of the anomaly is extraordinary but its existence is now placed beyond dispute." According to the chart, on which the results have

been plotted, the amount of the rise is about 45 feet at Mandalay and 155 feet at Victoria Point.

Observations for variation in latitude were originally carried out at Dehra Dun during the years 1930–33, but the variations were so large that it was thought they must be due to abnormal refraction conditions, prevailing on account of the proximity of that station to the neighbouring hills. For this reason it was decided to transfer the work to Agra, where it was thought refraction would be more stable or at least unaffected by hilly ground. They have now been in progress for two years, but they show just as large variations as were found at Dehra Dun.

Working in conjunction with Meteorological Department's Upper Air Observatory at Agra, attempts are being made to explain this quite unexpected result. It is mentioned incidentally that the Topographical Service in the Dutch East Indies for 1936 found very large variations of latitude at Batavia for the years 1932–35, with a maximum value about January. No doubt we shall hear more of this in future reports.

Longitude observations have been continued bi-weekly since the time of the international longitude programme in 1926, with the object of detecting possible periodic variations and also to establish a really reliable value for Dehra Dun which could be compared with a similar value at some distant date, possibly revealing the existence of continental drift. It has long been clear that apparent variations "have arisen only from instrumental and personal sources of error which are larger than the actual variation." It is thought, however, that the determination of a really good value for Dehra Dun has now been attained; observations have, therefore, been discontinued. The accepted value is 5 h. 12 m. 11·77 sec., which is the same as the value obtained in 1894–96 by telegraphic arcs, showing the latter must have been a remarkably good piece of work.

Of 58 earthquakes recorded on the seismograph at Dehra Dun, only five are stated to have been felt in India. The most distant one was in Mexico.

It is always gratifying when it is found possible to apply methods of purely scientific research to practical ends. The development of geophysical prospecting is a case in point. Here it is possible to use gravity measurements to ascertain variations of density beneath the earth's crust, thus conveying information of the utmost importance to searchers after oil.

The report states that an assistant of the Burma Oil Company has been working at Dehra Dun on the computations of anomalies in areas in which the Company are undertaking geographical prospecting in the field.

H.L.C.

MAGAZINES.

THE MILITARY ENGINEER.

(July–August, 1939.)—The International Political and Military Situation.

A paper read by Sir Willmott Lewis, Washington correspondent of the London *Times*, on the 9th May, 1939.

The writer describes the coming of democracy in the U.S.A. and France in the eighteenth century, the balance of power in Europe in the nineteenth and twentieth centuries, and, after the World War, the revolutionary movements in Germany, Italy and Russia. He next refers to the attitude of Britain and France towards the revolutionary movement, and the possibility of war. At the time the article was written the author did not think that the decision to go to war would be made for a long time.

Engineers in Foreign Armies. By Lieut. P. W. Thompson.

The writer describes the *Pionierkorps* of the German Army, and compares it with the American and British Corps of Engineers. The German *Pionier* subaltern never

expects to serve with anything other than a "combat" regiment. He does not specialize, and receives no training in civil engineering. The Germans have had to face a big problem in expanding their officer corps during the past five years, during which the number of Engineer battalions has increased more than tenfold. Special difficulty was encountered in filling the captain and major grades.

N.C.O's are selected from conscripts who have completed their two years' service and have volunteered to serve for another ten years. Privates are called up at about 18 years to serve for six months with the *Arbeitsdienst* and two years with a battalion.

The Engineer complement of the German Infantry Division is organized as a battalion. In the battalion are three companies; each company has three platoons, and each platoon, three sections.

Engineer units are extensively motorized, but not completely so. Two of the three companies are called "foot companies"; their tools are carried in horse-drawn vehicles. The third company, battalion headquarters and all trains are completely motorized. The motor trucks are of enormous size: as a rule they have three axles. Each company has nine machine-guns.

The training schedule is carried out at high pressure. A maximum time is given to watermanship and bridging, much is devoted to obstacles, little time is given to infantry drill, marksmanship and road building.

The Safety of the Panama Canal.

Major Colby discusses the question whether the Panama Canal is sufficiently well protected against possible air raids. The destruction, by bombs, of one of the locks might close the canal to shipping, and prevent the junction of the Atlantic and Pacific fleets in an emergency. Amongst other suggestions, the possibility of camouflaging the canal is considered.

The Upper Columbia and Snake Rivers. By Major Weaver.

The ordinary head of navigation on the Columbia River is at Priest Rapids, 73 miles above the confluence of the Snake and Columbia Rivers; the similar head of navigation on the Snake River being at Johnson Bar Landing, 232 miles above the mouth of the river.

The writer makes a proposal for rendering both rivers navigable for a considerable additional distance by the construction of a series of dams and locks.

Mapping Aeroplanes and their Future. By T. Abrams.

The writer explains the difficulties encountered in mapping large areas of country economically from aeroplanes. He describes a new type of plane, the Abrams explorer, which, with its engine and propeller in rear, and peculiar sweep back of the wings, offers advantages over the more conventional type.

A comparison is made between the American system of high-altitude mapping with high-velocity aeroplanes, and the European system of low-altitude mapping with slow aeroplanes. Different types of cameras are described.

Meet General A. By Captain Ehrgott.

A study of the characteristics required in a young officer who hopes to rise to the rank of divisional commander. Energy, physical and mental, is the prime requisite of a commander. A high degree of intelligence is of relatively small importance. A well-balanced and mature emotional nature is valuable, but not essential. The ability to win friends and influence people is essential.

Surveys and Mapping in the United States. (A joint letter of the Secretary of War, Secretary of Commerce, and Secretary of the Interior.)

A strong plea is made in this letter for accelerating progress in mapping the United States. Less than 25 per cent of the country is covered by accurate topographical maps. It has taken more than 40 years to accomplish this much. It is suggested that young engineering graduates should be employed in this work, and that the Corps of Engineers should supplement the results obtained by them.

The Work of the Bureau of Mines.

Mr. J. W. Finch describes the functions of the Bureau of Mines, its purpose and

organization, and the technologic phase of its work. Special studies are made of coal, petroleum and explosives—all essentials in industrial preparedness for national defence.

Improvising an End-Loading Railway Ramp. By Captain Asensio.

An account of a method of loading and unloading the motor vehicles of an anti-aircraft unit. A ramp was extemporized out of a long flat railway truck by removing the bogie from one end and lowering that end to the rails. This procedure brought the level of the floor at the lower end of the ramp to within about 18 inches from rail level. The slope was completed by means of short ramps and cross-overs of boiler plate.

Strategic Military Supplies in Foreign Countries. By Major Roush.

This article, which contains several tables, gives details of the metallic and non-metallic ores produced in the United States and the six countries (including Japan) which—it was expected—might become involved in hostilities. Colonies are not included. The tables are intended to show the relative ability of the various countries to meet the demand for strategic minerals.

(*September–October*, 1939.)—*Washington National Airport.* By Lieut. Tripp.

A description of the Washington National Airport, now in course of construction on the west shoreline of the Potomac River, overlooking southern Washington. The land for the airport, some 742 acres in extent, is being reclaimed from the Potomac River by dredging the bed of the river and pumping the excavated material through large pipes over the area to be covered. The spoil is kept in place by outer levees, which, being of pervious sand and gravel, aid in draining the area, and act as a retaining wall to resist the outward thrust of the semi-liquid material in suspension.

The Democracies Prepare for War.

Lieut.-Commander Harrison, who has visited a number of British and French factories employed in making war material of all kinds, dwells on the necessity for close collaboration between manufacturers and the naval and military authorities.

Concealment of Motor Vehicles.

Lieut. Arnold describes the general principles of camouflage and the methods of applying them. To conceal a vehicle, a covering is often thrown over it, called, for convenience, a "drape." Drapes, 36 feet square, are made of fish-netting or of "visinet," a commercial sacking woven of paper. A number of experiments were made, and the photos taken from aeroplanes often gave surprising results.

His Majesty's Foreign Legions. By Roger Shaw.

An account of the foreign legions employed by the British, *e.g.*, the Huguenot refugees serving under William of Orange, the Hessians in the American Revolution, the King's German Legion, and others.

An Experimental Bamboo Stringer Bridge. By 2nd-Lieut. Allen.

An experiment was made in the Philippines in the construction of a bridge consisting entirely of bamboo poles and lashings. Two types of bamboo were available: root stock (from the ground to a height of 12 feet), and ordinary market bamboo stock (above 12 feet). Root stock was found to be the only suitable type for road-bearers.

A road-bearer was made of short lengths (3 to 12 feet), having, throughout its length, four bamboos in cross-section. Not more than one joint occurred at any one place. With three road-bearers, and a span of 18 feet, the bridge was able to carry a load of 3,000 lb. with very little deflection.

Eighteen feet appeared to be a maximum span in practice. The road surface was unavoidably rough.

The Cost of Unpreparedness. By Captain Barth.

An account of the campaigns in which the U.S.A. have been involved, from the Revolution beginning in 1776 to the World War. Each campaign found the army unprepared, as a result of which the wastage in man-power and in money was enormous. To this must be added the cost of a phenomenal pensions list.

Safety Pays ! The Corps of Engineers Proves It.

Major Vaughan explains the value of proper precautions in engineering work, both for the conservation of life and health, and from the point of view of their economic value.

Strategic Mineral Supplies. Straws in the Wind. By Major Roush.

Lists of strategic minerals imported into Germany, Italy and Japan show a more or less steady increase during the past ten years. In the case of Italy and Japan, the dates of the Ethiopian campaign and the China war are clearly marked. It is a remarkable fact that commercial and political interests have been opposed to each other, *e.g.*, that both Germany and Italy have imported largely from British and French possessions, and that Japan has imported large quantities of iron, steel and petroleum products from the U.S.A.

The Seismic Method of Exploration Applied to Construction Projects. By E. R. Shephard.

An investigation into the speed of propagation of seismic waves in different sub-surface materials.

A.S.H.

REVUE MILITAIRE SUISSE.

(*July*, 1939.)—*Des qualités du chef subalterne.* By Major Couchepin. A reminder that, in this age of sport and bodily fitness, the old motto "*mens sana in corpore sano*" runs some risk of being misconstrued. The cult of physical powers must not exclude the development of intellectual powers. From the subalterns come the generals. A constant development of physical, psychical and moral qualities must be the aim of all who aspire to command.

Le problème des camions utilisables par l'Armée. By Capt. Tapernoux. A reply to an article, appearing in the *Revue* in January and February, which called for more regard to be paid to the utilization of railways. The author desires to show that motor transport to-day must remain the chief means of support to any modern army. But although the Swiss Federal authorities have a system of subsidies for motor vehicles fit for military use, the number of suitable vehicles is not great, and is not likely to furnish a sufficient supply for lengthy operations. A further development is required, and especially, a standardisation of type.

Landsturm et Armée de campagne. By Lieut. Bovet. The experiences of the author, during the last three years as a Territorial in the Swiss Army, convinces him that the Landsturm, numbering about 100,000 men, are fit troops to take their part in the field army.

(*August*, 1939.)—*Le Capitaine.* By Capt. Nicolas. In a militia army, like the Swiss, the short periods of service do not permit of a consecutive course of training during which an officer's qualifications and character can be observed, trained and developed. The exigencies of civil life interfere with military advancement. The selection and training of the Captains—matters of great moment in a militia force—become restricted. It is with the ideals of a captain's functions that this article is concerned.

The author gives him a high place in the military hierarchy. "The value of an army depends on the value of its captains."

Les relations du peuple et de l'infanterie. By Capt. Klunge. "The Queen of Battles" is still the infantry, says the author. As the people, so the infantry. With a conscript system, it is obvious that the infantry must reflect the characteristics of the people from whom it is drawn.

Barrages et défense anti-chars. By Capt. Schenk. An interesting article, in general terms, on tanks and anti-tank obstacles. The extra light tanks, as experienced in China and Spain, have shown their weakness in the insufficiency of their armour to

resist even ordinary machine-gun fire. The author bases his remarks upon a medium type of tank, 12 to 18 tons.

In approaching the problem of the defence against tanks, he poses three questions:—

(*a*) Where to make the obstacles.

(*b*) How and when they should be made.

(*c*) Who will make them.

With Switzerland for his background, he observes that his country is far from being impenetrable by tanks. In the Alps and the Jura Mountains, anti-tank defence would not be complicated, but on the plateau, conditions are far less favourable. Even on marshy ground, the tank is not incapable of movement. The author shows that the average infantryman, loaded in battle order, puts a pressure of 1 kilogramme per square centimetre on the ground, while an average tank puts .60 kilogramme per square centimetre. This argument is, perhaps, not altogether infallible; it is possible to imagine that both infantryman and tank might flounder. Those who remember tanks in the Ypres Salient in October, 1917, will appreciate the obstacle which water-logged ground can offer to these engines.

With regard to the second question, the author classifies his obstacles in three groups; those of first urgency, which the troops construct with their field equipment, and which are obviously only a temporary protection, such as minefields, steel cables, etc.; those improvised with materials found on the spot (*e.g.*, felled trees); and those of a permanent nature (*e.g.*, ditches, pits, steel rails, concrete blocks). Finally, he comes to the third question, who shall build the obstacles? There is no other conclusion possible than that the work falls to the Sappers.

(*September*, 1939.)—*Deux mots à nos lecteurs.* (Editorial.) A reminder that a large number of Swiss troops are now mobilized, and on watch on the frontiers. The *Revue* will continue to provide them with profitable reading.

L'Infanterie et les chars de combat. By Capt. Delay.

The author poses four questions:—(1) What will be the state of mind of the infantryman when first confronted with a tank in battle? (2) How can he, by suitable training, be guarded against a moral shock? (3) What should be the degree of knowledge throughout the different stages of command, of the tactics and capacities of the tanks? and (4) can the infantry defend itself against the tanks?

The first question is dismissed abruptly. Recent experience has so far not included fully-trained troops on both sides. The second question is answered by training; by making the soldier familiar with the performance of the tank, with the art of using ground, with the use of anti-tank weapons, and by making him aware of the amount of support he will get from behind.

For the third question, the author advises his readers to study Einmannsberger's *Der Kampfwagenkrieg* and Von Schell's *Kampf gegen Panzerwagen*. The first of these works gives a very complete summary of the great tank actions of the last war—Cambrai, Soissons, and Amiens. The second book deals with the tactical employment of tanks, and six phases of anti-tank defence are described: 1, in marching columns; 2, during the approach march; 3, in the defence; 4, in the attack; 5, during pursuit; and 6, during retreat.

The last question is partly answered by the previous reply. Infantry by itself cannot oppose tanks. It must be armed with anti-tank weapons; it must be closely supported.

Défense d'un village par une compagnie renforcée. By Capt. Verrey. An interesting article, illustrated with numerous sketches, on the defence of a village by a company, reinforced by an "infantry gun" and a section of machine-guns. The organization of the village defence is explained, and the employment of the different weapons is illustrated. Much reliance is placed upon the use of the automatic weapons; and obstacles, barricades, etc., are included. The author, an infantry instructor, credits the company commander with a comprehensive knowledge of the task before him. He does not refer in any way to the time required to construct the defences. Engineer assistance is not reckoned with.

Commentaires sur la guerre actuelle. Most of the forecasts, which were widely indulged in, have been proved wrong. The war has not opened with vast air offensives, pouring destruction upon capitals, industrial centres, lines of communication and concentration areas. In the west, mobilization has proceeded uninterruptedly.

The German doctrine of mechanical warfare, pursued at high speed and in great strength, has been followed with astonishing success in Poland. After a campaign of unprecedented brevity, aided by favourable weather, the Germans have destroyed the whole Polish Army. The Poles, whose fighting qualities under better conditions cannot be denied, had no chance against the superior German machine. The German tanks were employed like cavalry, but with greatly enlarged radius of action. They attacked the flanks and broke up the rear organizations. They went straight through and disorganized the chain of command.

On the west, the whole outlook is different. Here the French forces have had time to mobilize unmolested. There has been no onrush of invading German Armies sweeping away the covering troops. The French have carried the war into German territory, reconnoitring the Siegfried position, feeling its strength or weakness, destroying with long-range artillery many of the outlying works, and extracting the German land mines and traps. No wasteful onslaught has been made against impregnable positions; but slow, deliberate action has put the French in possession of valuable information, and a certain moral effect has been gained by doing all this on German soil.

No mention is made of the arrival of the British Army.

A monthly commentary is promised.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*July*, 1939.)—*Tactique allemande des chars de combat.* By Major Callens. There are two schools of thought regarding the tactical use of tanks: independent tank action, or close co-operation with infantry. In general, it may be said that the Germans favour independent action, while the French prefer the methods of co-operation.

The article deals with the action of tanks as part of a mixed force, and not the action of armoured divisions. It is well known that Germany was slow to recognize the use of tanks in the war of 1914–1918; at the end of it, she only possessed about fifty. Since the war, she has largely increased her mechanized forces, and in 1938 she had at least five armoured divisions. She probably has ten or fifteen to-day.

The German tanks are of three kinds: light, medium and heavy; all similar in build, differing chiefly in their armament. The light tank, of 6 to 7 tons, carries two light machine-guns; the medium tank, of 12 to 15 tons, carries in addition a 37 mm. gun; the heavy tank, of 20 to 25 tons, carries a 37 mm. and a 75 mm. gun, as well as two light machine-guns. Photographs of each type are given.

Massed attack is still the German ideal. Smashing through by sheer weight seems to be the Teuton's main object; the German training and characteristics do not confide much independence to the individual. Tanks in attack will be disposed in several waves, each with a definite objective. The first wave's objective will generally be the enemy's anti-tank guns and artillery. The second wave will break up the enemy's front line; the third will give close support to the attacking infantry.

Each unit will move on its objective by a series of short bounds. A few outriders will precede the leading wave in order to draw the fire of the enemy's anti-tank guns and force them to disclose their positions.

Three examples of German tank tactics are given in illustration, drawn from recent articles in the German review *Die Panzertruppe*.

In summing up, the author remarks that the German tank tactics are marked by audacity, rapidity, and flexibility.

Le guidage par T.S.F. des avions militaires. By Capt. de Callatay. A technical article on navigation by wireless for airmen.

Le blindage des avions. By Colonel Desmet. Very few, if any, aeroplanes are protected against bullets and shell splinters. It is a question of weight. The vulnerable parts might have partial protection, but only at the cost of speed, which in itself is the best form of protection. Petrol tanks might be made of some elastic material which would close up after the passage of a bullet. This was actually tried in 1916 and 1917, and is stated to have had some success.

Protection of the engines would interfere with their cooling.

Examining each vulnerable point in turn, the author comes to the protection of the pilot. Here again, there is not much that can be done, but attack from the rear being more dangerous than that from in front, this is the one direction in which some form of protection might be developed.

Origines et filiation de l'Armée Belge. By Colonel Verhaegen.

A descriptive account, to be continued, of the origins and historical connections of Belgian regiments.

(*August*, 1939.)—*Pages d'histoire de l'Armée Belge pendant la Guerre* 1914–18. By Capt. Corvilain. An account of a small raid on a post at Nieuport on the night of April 8th/9th, 1918, in which the little party of nineteen lost eight killed and ten wounded.

Le General Rennenkampf, jugé par ses compagnons d'armes. By J. Savant. The author has collected accounts of General Rennenkampf's career from various sources. The General was a soldier of tremendous energy in his younger days. After holding several important staff appointments, he became Colonel of the 36th Dragoons, and a General in 1900. He commanded a column of Russian troops in Manchuria in the campaign of 1900–01 against the Boxers, and distinguished himself by several forced marches.

The article is to be continued.

Origines et filiation de l'Armée Belge. By Colonel Verhaegen.

A further instalment of the historical origins of Belgian regiments.

Participation Militaire Belge à l'Exposition Internationale de l'Eau à Liége. By Major-General van Daele. The Water Exhibition held at Liége in 1938, included a surprising variety of exhibits; among them were several illustrating the uses and treatment of water by the army, from models of inundations to water-softening processes and shower baths used in the Great War. Such a homely element as water could scarcely have been expected to yield so interesting an exhibition.

The principal military exhibits are briefly described by the author, who was President of the Military Commission appointed to the Exhibition.

W.H.K.

RASSEGNA DI CULTURA MILITARE.

(*July*, 1939.)—*Le risorse economiche dei paesi mediterranei.*

General Deambrosis concludes his series of articles on the economic resources of Mediterranean countries. He dwells on the central position that Italy occupies, and her commercial relations with Germany.

La campagna di grande polizia nel territorio del governo Harrar. By Major Carraglia.

An account of the operations conducted in the Harrar province between June, 1936, and April, 1937, to suppress the risings amongst the tribes of Abyssinian Somaliland. The operations were carried out by General Nasi, Governor of Harrar, in accordance with the plan of operations of the Viceroy, Marshal Graziani.

Al nostro confine occidentale.

Captain Cuneo gives a description, with a map, of the boundary between Italy and France in the Maritime Alps. The boundary, as it approaches the sea, is by no means an ideal one for defence. It was fixed by Napoleon III in 1860.

The author quotes from two French writers of articles dated 1870 and 1894, who consider that the boundary should have been fixed further east, as far as the Col di Tenda, a conclusion with which he, as an Italian, naturally disagrees.

Albania.

The first instalment of an article describing the latest tract of country acquired by Italy in the Adriatic. Although naturally a poor country, of which parts are very malarious, it has great possibilities, and is only at the beginning of its industrial development.

Calcolo e confronto economico dei vari tipi di muri per le opere di difesa dei campi di tiro per armi portatili.

Captain Parisella discusses the theory of the stability of parabolic walls, walls of uniform thickness, and tapering walls.

Studio comparativo su alcuni saggi elettrochimichi proposti per la determinazione della stabilità delle polveri infumi (continued).

Drs. Tonegutti and Brandimarte describe a number of experiments made with samples of various smokeless powders.

(*August–September*, 1939.)—*La nostra grande guerra nei rapporti con gli ex alleati.*

General Corselli gives an account of the diplomatic relations between Italy and the Entente powers after the outbreak of the war in 1914. Austria completely ignored Italy—the third partner of the Triple Alliance—when she made war on Serbia. From the start of the war there was a strong feeling in Italy in favour of joining in on the side of the Entente. Russia opposed the acceptance of the Italian offer, on the grounds that it would complicate the peace settlement at the end of the war.

The writer quotes the articles of the Treaty of London (signed on the 26th April, 1915), laying down the conditions which Italy accepted in return for joining the Entente powers. He points out that the conditions were not all kept, and various diplomatic blunders were made.

The fact that Italy remained neutral during the first few months of the war, and then joined in on the side of the Entente, enabled the latter to retain control of the Mediterranean, and made a great difference to the final result of the war.

Le risorse economiche dei paesi mediterranei.

The fourth instalment of an article by General Deambrosis.

The writer compares the British and French colonial empires. He considers the organization of the British Empire, apart from its greater size, far superior to that of the French.

Taking the three great maritime powers with interests in the Mediterranean: Italy, France and Britain, the proportion of the tonnage of their commercial shipping is as 1 : 1 : 6, whereas the tonnage of their navies is as 1 : 1 : 3. This does not, however, correctly represent their relative strength in the Mediterranean, where Italy's central position gives her a considerable advantage.

Un confronto storico ed un insegnamento circa la guerra di rapido corso.

Colonel Fiocca makes a comparative study of two lightning campaigns: Napoleon's offensive blow at Carcare (east of Genoa) in 1796, and the Austro-German attack on the Italian position in the autumn of 1917—the twelfth battle of the Isonzo—the success of which surprised even the victors.

Concetti di tattica tedesca e raffronti con la concezione italiana e francese.

A study, by Major Mascia, of the tactical rules laid down for the German, Italian and French armies respectively. There are points of similarity between all three, but the dynamic character of the German and Italian tactics stands out in contrast with the measured and more methodical character of French tactics.

Albania.

A second article on this country. The population is mainly divided into Ghegs, to the north of the Shkumbi line, and Tosks, to the south. Each sub-division has its own dialect. A description is given of the chief towns, *i.e.*, Tirana (the

capital), Scutari, Valona, Durazzo and Alessio, as well as a history of the country from the earliest times until the intervention of Italy during the World War.

L'artiglieria italiana nella presa di Gorizia.

General Dallari describes the work done by the Italian artillery in the attack on the Gorizia bridgehead in August, 1916. This was the first occasion on which the Italian artillery had a numerical preponderance over that of the Austrians.

Strade militari.

Colonel Steiner discusses the main requirements of military roads. The gradients may be considerably steeper than those of ordinary roads, *i.e.*, 10 or 12 per cent. Even a 20 per cent gradient is permissible for mechanical transport, provided it is broken occasionally by flatter slopes. The width should be kept down to a minimum; curves may have a radius of 6 to 8 metres. It will often pay to construct a double road, one for outward and the other for returning traffic. Cover from view is desirable.

A few hours will usually be sufficient for working out a rough road project. An Abney reflecting level is the best instrument for laying out the trace of a road.

In the construction of a road, the carriage of spoil over any appreciable distance should be avoided. Mechanical means, *e.g.*, excavators, should be made use of as much as possible. Picks and shovels must be regarded as out of date, and even rock-drills must not be considered the only contrivances for speeding-up work. In the way of machinery, a good deal is required to bring the army up to date.

With regard to road surfacing material, what is nearest at hand should be used. In many cases, the American practice for the construction of earth roads might be followed with advantage, by mixing sand or grit with clay in the proportion of 4 parts to 5. Salt added to the mixture will absorb moisture and keep the surface firm.

Bridges should be constructed with local material, if any is available. A small crane for lifting timbers is very handy, and a pile-driver is often necessary. All tools in use on a civil job should be available: not necessarily of a large size.

Working parties should be detailed for each kind of work, and workshops should be provided in convenient places.

Jacomo Fusti Castriotti, architetto militare e inventore. (1501–1562). By Prof. Provasi.

This article records the life and work of a distinguished military architect. Castriotti's services were first placed at the disposal of the Holy See. As assistant to Michaelangelo he helped to fortify the castle of St. Angelo, and, later on, he fortified Sermoneta, Anagni, and Paliano to bar the Roman campagna from the kingdom of Naples.

About 1553 he went to France, and rendered valuable services to Henry II and his successors in the wars against England and Spain. (*To be continued.*)

A.S.H.

MILITÄRWISSENSCHAFTLICHE MITTEILUNGEN.

(*July*, 1939.)—*Militärbündnis gegen Einkreisung.*

In reviewing the military and political situation for the second quarter of 1939, Major-General Paschek describes the British encirclement policy against the Central Powers and the counterstrokes carried out by the latter. One of the counterstrokes was the occupation of Albania by Italy.

The writer's usually fair comment is marred by a strong anti-British bias.

Technik und Wehrmacht. A lecture delivered at Vienna by General von Eimannsberger, of the Artillery.

The writer points out how, in the past, the German Army had no very high opinion of technics, and regarded them as a matter for the workshop. The army has, on the whole, been slow to adapt itself to new conditions.

The Prussians did not think highly of the needle-gun when it was first introduced.

It was inaccurate, but it had three times the rapidity of fire of the Austrian muzzle loader. The result of the Austro-Prussian war proved its value.

The French introduced the Reffye mitrailleuse in 1867, but they did not employ it correctly in the Franco-German war, using it in batteries as artillery. Its failure threw back the development of the machine-gun until the World War.

Sind die U.S.A. wirklich bedroht?

Colonel Mlacker describes the geographical position of the United States, her natural products, industries and commerce, and asks against whom her recent enormous increase in armaments is directed? She is threatened by nobody, least of all by the Rome-Berlin axis. The writer suggests that the President's imperialistic policy is to divert attention from internal troubles, and to bring pressure to bear on Mexico and some of the South American States. Finally, American efforts may be directed against Japan.

Die Lehren aus dem spanischen Krieg.

Major-General von Lerch quotes from a book entitled *Les lecons de la guerre d'Espagne*, by General Duval. This book is of special value, because General Duval was present in person during the operations in Spain up to October, 1937. At that time he was able to foretell a final Nationalist victory. It is not possible to learn from a civil war the lessons that can be learned from a national war. In a civil war, both sides begin the struggle unprepared. The Republicans carried on the war with politicians; they had no experienced officers. They made the mistake of disarming the bodies of troops that offered them their services, and shot their officers. The Red sailors murdered their officers. On the other hand, the Nationalists had experienced officers, and the Moroccan troops were loyal and reliable.

Die Eisen—und Stahlerzeugung, eine Grundlage der Wehrmacht. By Captain Klein.

The military strength of a nation depends largely upon her production of iron and steel, which she must be able to maintain at full working capacity during a protracted war.

Britain, once the leading producer of iron and steel, had remained stationary for several decades. During that time Germany had rapidly overhauled her. From 1932 onwards Britain made a rapid spurt, but never succeeded in approaching Germany's production. In 1938 there was a set-back in Britain's output, and Germany forged ahead and even outstripped the United States.

Since then, with the occupation of Austria and Czechoslovakia, Greater Germany has largely increased her output of iron and steel, as well as her production of iron ore.

Zündvorrichtung für Fliegerabwehrgeschosse. By Dr. Staeger.

The problem of setting time-fuzes correctly in anti-aircraft shells will always be a difficult one. Dr. Staeger explains a device for getting over the difficulty.

The shell is fitted with a magnesium flare, which is ignited on discharge and arranged so as to throw a beam of light only at right angles to the shell's axis. When the shell is in the proximity of an aeroplane, the latter will reflect a portion of the light on to a photo-electric cell inserted in the shell. The latter will be exploded electrically by means of an amplifier.

(The idea seems rather far-fetched. *Reviewer.*)

(*August*, 1939.)—*Vor 130 Jahren.* By Colonel Ehnl.

The events that occurred in 1809 at Regensburg, Ebelsberg, Aspern and Wagram, and the Tyrolese rising are well known and have been thoroughly discussed.

It is, however, not so well known that, four years before the battle of Leipzig, a campaign was conducted by Austrian forces which, advancing from Bohemia to Leipzig and Bayreuth, freed the kingdom of Saxony and the margraviate of Bayreuth from the armies of Napoleon.

The campaign is described in this and subsequent articles.

Maritime Probleme im Ostseeraum.

This article, by Admiral Gladisch, was written in April, 1939. Subsequent events might have led to a change in some of his views.

During the World War, Germany retained command of the Baltic. The Baltic and the Black Sea were the only seas that Britain's overwhelming naval power was unable to dispute.

One of the main reasons of the value of the Baltic to Germany is the import of raw material and goods, particularly iron ore from Sweden. It is also of vital importance to seven lesser states, other than Germany and Russia. Russia is in a position of being self-supporting without her Baltic trade.

The writer contemplates the possibility of war between Germany and Russia, in which Russia's object would be to interfere, mainly by means of U-boats, with German communications. The convoy system, as a counter to U-boat warfare, will not be fully effective in a restricted sea like the Baltic. The effect of the air arm is also an unknown quantity. It will, to some extent, reduce the value of the Kiel canal.

Kolonien als militärische Stützpunkte. By A. W. Bode.

In making a claim for the return of the German colonies, the writer maintains that Germany could not use them as strategic points for military or naval purposes, but that they are a necessity for her for the supply of raw materials.

Kriegswirtschaft. By Major Oswald.

Organization for the production of war material is of quite modern origin. The combatants entered on the World War with practically no organization of any sort for carrying on protracted warfare. It had to be developed as time went on. Matters are very different now, when affairs are so regulated in peace-time that every man, woman and child can do his or her part to help the country when war breaks out.

Der Konflikt in Ostasien. By Major-General von Lerch.

The writer continues his series of articles on the Sino-Japanese conflict. In this eighth instalment he deals with the period from the 10th May to the 15th July.

The great offensive carried out in April by Chang-kai-shek against Hankow and Nanchang was unsuccessful and was countered in May by a Japanese attack north-west of Hankow, which led to a battle on the Han river. The 26 Chinese divisions engaged lost heavily, and the battle proved one of the most decisive of the war.

Subsequently the Japanese occupied a number of Chinese ports, *e.g.*, Swatow, Foochow, and Wenchow. These events were followed by the isolation of the British and French concessions in Tientsin, and encounters with the Russians on the Manchurian border.

A.S.H.

WEHRTECHNISCHE MONATSHEFTE.

(July, 1939.)—Ein deutscher Gasdruckladet.

A description of a light machine-gun manufactured by the Knorr-Bremse Company of Berlin.

Automatic machine-guns are classed either as gas-pressure loaders or recoil loaders. The former have been adopted by 80 per cent of national armies on account of their greater simplicity, both of construction and in working. Recoil loaders have a more complicated mechanism and require a higher standard of workmanship. They have hitherto been exclusively adopted in Germany.

A feature of the Knorr-Bremse gun is that the gas pressure is conducted from a point near the muzzle, through a tube parallel to the barrel, to the breech. The method of working the gun, changing the barrels, etc., is fully explained.

China als Aktivposten der japanischen Kriegswirtschaft. By Dr. Schöne.

The great expansion of the population of Japan during recent years has compelled her to fall back on China for her requirements of coal, iron ore and cotton, and as a market for her manufactured products.

In this article Dr. Schöne shows how China's trade with Japan is increasing year by year, to the detriment of her trade with European countries.

Auch eine Schlacht des Weltkrieges.

Major Mende explains how the mining industry during the World War was a battle in itself. In the first few days after the outbreak of war, 27 per cent of the workers in the mines were withdrawn for service with the colours.

The importance of maintaining work in the mines in full swing was only gradually realized. The difficulties in connection with the employment in mines of women, boys, men unfit for the army, and prisoners of war, are emphasized.

Die Nationalisierung der Weltwirtschaft.

Dr. von Minden compares the process of industrial expansion in former days with the nationalization of world industries in modern times. A consequence of the World War has been a change from industry managing its own affairs to a control of industry by the state. The writer concludes with a sketch of the four-year plan in Germany. (*To be concluded.*)

Die industrielle Mobilisierung im Ausland.

Captain Narath concludes his article in this number. The shadow system in Britain is quoted as a satisfactory method of doing away with the many delays to which the manufacture of munitions is liable.

The United States are in a particularly advantageous position, owing to their great natural resources, and to the fact that their armament factories are not likely to be interfered with to any appreciable extent in war-time.

Die Beziehungen zwischen Kriegsvorräten und Anlaufszeit der Kriegsindustrie.

General Ludwig discusses the connection between the accumulation of munitions in peace-time and the time necessary to get their manufacture into full swing when war breaks out. Too large an accumulation leads to extravagance and waste, whereas a scarcity of munitions might entail disaster.

(*August*, 1939.)—*Das Halbkettenfahrzeug als militärisches Zugmittel.* By Dipl. Ing. Student.

The writer traces the development of the half-track car, *i.e.*, a car with ordinary steering wheels in front and chain-tracks behind, for military purposes. The construction of this type of car has received a special impetus in America. One of the best known systems is the Kegresse. The steel links of the track are fitted with rubber pads to damp the noise. Other types mentioned are the Morris-Martel, the Linn, and the Vickers-Armstrong tractors.

Gewehrgranaten. By C. Waninger.

At the beginning of the World War the rifle grenade consisted of a long rod that fitted into the rifle barrel and carried a grenade at the forward end. Later on, the rod was dispensed with, and various improvements were made with a view to increasing the range. The original grenades were injurious to the rifle, and the writer explains how large a proportion of the energy of the charge was wasted. He describes improvements for eliminating these drawbacks.

Ein Beitrag zur Zahlungsmittelversorgung besetzter Gebiete im Weltkrieg. By Dr Holzhauer.

The provision of coinage in a country temporarily held by an army of occupation presents difficulties, and Germany and Austria adopted different methods in the countries that they occupied during the war. The Germans issued a special kind of paper money, while the Austrians adopted the currency of the occupied country, and, at the same time, stopped the flow of Austrian crowns into the country concerned.

The writer describes methods adopted by the Germans in northern France, in Belgium, Russia, Rumania and Italy.

Der Bündniskrieg—wehrwirtschaftlich gesehen!

Dr. Leonhardt reviews a book by General Wetzell: *Der Bündniskrieg.* Future wars will always be wars of alliances. In the World War, the Central Powers relied upon Germany very largely for their armaments. The two Balkan States lacked the necessary organization, but, in the writer's opinion, Austria failed to do her proper share in producing armaments, and an undue share of the task fell on Germany. The Entente powers were most successful in distributing their armament work, the

U.S.A. providing the raw materials and half fabricated stores. Germany made the mistake of underestimating—not the American soldier—but the capacity of the U.S.A. for providing raw materials and armaments.

Die Nationalisierung der Weltwirtschaft.

Dr. von Minden concludes his article on the nationalization of world industries.

Competition in armaments has its own political and industrial laws. The higher the cost of armaments rises, the greater will be the disturbance of trade and commerce. Once the cost surpasses a certain figure, governments will be compelled to take over other industries as well as armaments.

Die französische Kraftstoff—Eigenversorgung. By Hans Lehmann.

The writer maintains that the French have, in recent years, neglected the development of large and medium lorries, and that a very large proportion of the vehicles in use in the country are from 10 to 15 years old. On an average, German cars are of much more modern types than the French.

As regards motor spirit and lubricants, France has only recently commenced to accumulate reserve supplies, having no appreciable mineral oil supplies of her own. Her colonies furnish palm oil and earth-nut oil, both of which are useful for Diesel engines. Alcohol is produced from sugar beet, potatoes and wheat, and is mixed with petrol. The use of producer gas is encouraged.

A.S.H.

THE INDIAN FORESTER.

(*July*, 1939.)—The third instalment of *Forestry beyond the Indus* treats of the progress made in Swat. Many Sappers, some even of those still serving, will remember the time when Upper Swat, beyond Landakai, was a closed country. It is now a progressive State, admirably ruled by the Wali, whose administration is helped by a network of motor roads and telephones. The valuable deodar forests are being exploited on working plans compiled by Khan Sahib Allayar Khan, of the Indian Forest Service.

Of interest to officers serving in the Bombay Presidency are draft grazing rules, which, if passed by the Legislature and faithfully carried out by the Executive, should result in a great improvement of rural amenities, as well as bring about better breeds of cattle. The draft rules, however, do not touch on the impoverishment of the herbage, owing to its destruction by superannuated cattle, which Hinduism forbids the owners to destroy.

Afforestation for the control of malaria is a useful treatise. It comes as rather a surprise to learn that dangerous anopheles have no use for shade; presumably that of trees is referred to, for everyone knows the preference of mosquitoes of all kinds for the dark corners of bungalows by day—up chimneys, behind pictures, inside boots and below beds.

(*August*, 1939.)—*Forestry beyond the Indus* is continued in an account of the forests in the Gilgit area. The late political agent summed up what he called the "melancholy and almost incredible story" as "Forty-one years of consideration; the mysterious interlude of a Mr. Steane and finally a working plan by a ranger, sent to this agency without maps and for information, three years after it was completed." There are, it may be remarked, few trees in the area, owing to the scanty rainfall, but therefore all the greater reason to conserve what there are.

Shikaris will find the article on the *Protection of Wild Life* of great interest.

The Relative Stability of Vegetational Types, in spite of its heavy title, provides light reading. Given by Mr. Champion as the presidential address of the Indian Botanical Society, it deals with what are known as climax types of vegetation, *i.e.*, the kind of mixed or unmixed trees, shrubs or plants which nature will work up to, if not interfered with by man.

Lastly, *Wanted a Dictator?*—an extract from the *Allahabad Farmer*—underlines what *The Indian Forester* has been stressing for years, the imperative need of all concerned to stop erosion.

F.C.M.

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