THE ROYAL ENGINEERS JOURNAL.—MARCH, 1936. Pages 1—162.

The Royal Engineers Journal.

VOL. L. MARCH, 1936.

CHATHAM:

The Institution of Royal Engineers,

Telephone: Chatham, 2669.

Agents and Printers: Mackays Ltd.

LONDON

ORDER FORM

"TUNNELLERS"

The Story of the Tunnelling Companies R.E. during the World War

BY

Captain W. GRANT GRIEVE and Mr. BERNARD NEWMAN

PRICE 13/- PER COPY, including postage

Date________

The Honorary Secretary,
Tunnellers' Old Comrades Association,
c/o The Institution of Mining and Metallurgy,
241, Salisbury House.
LONDON, E.C. 2.

Please send me as soon as it is published in March, 1936, ... cop(y)(ies) of the above book, in payment for which I enclose a remittance for £ : :

Name
(BLOCK LETTERS)

Full Postal Address

Cheques, drafts and orders to be made payable to T.O.C.A., and crossed "National Provincial Bank, Ltd."

THE INSTITUTION OF ROYAL ENGINEERS.

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

CONTENTS.

All communications for the Institution should be addressed to:—

The Secretary, The Institution of Royal Engineers, Chatham.

COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

(Incorporated by Royal Charter, 27th February, 1923.)

Patron:—H.M. THE KING.

President.

Maj.-Gen. Sir Hugh Bruce Williams, K.B.E., C.B., D.S.O., *p.s.c.* 1935

Vice-Presidents.

Maj.-Gen. R. N. Harvey, C.B., C.M.G., D.S.O., (*Col. Comdt. R.E.*) 1934
Maj.-Gen. D. S. Collins, D.S.O., (*D.F.W.*) 1936

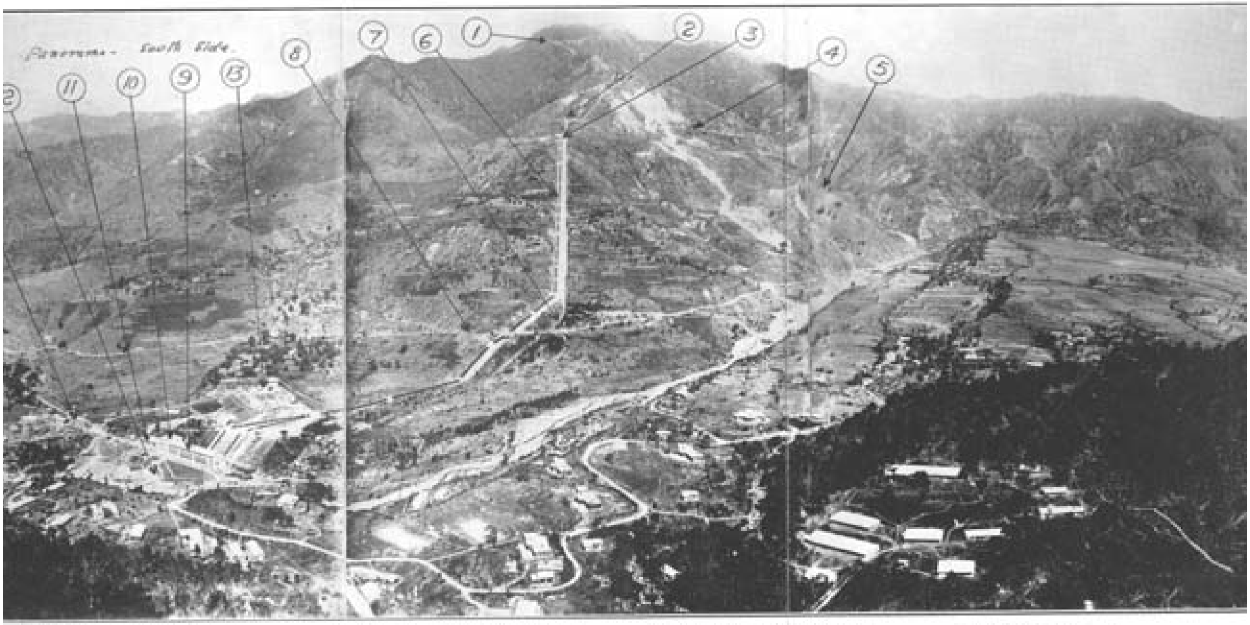
Elected.		*Ex-Officio.*
Bt. Col. P. K. Boulnois, O.B.E., M.C.	1933	Maj.-Gen. L. V. Bond, *p.s.c.* (*Comdt. S.M.E. & Inspr. R.E.*)
Bt. Lt.-Col. H. G. Eady, M.C., *p.s.c.*	1933	Col. A. W. Stokes, D.S.O., M.C. (*A.A.G., R.E.*).
Lt.-Col. G. Cheetham, D.S.O., M.C.	1933	Col. H. W. Tomlinson (*A.D.W.*).
Capt. E. H. T. Gayer	1933	Col. W. G. Tyrrell, D.S.O. (*A.D. Tn.*).
Brigdr. C. A. Bird, D.S.O., *p.s.c.*	1934	Col. F. J. C. Wyatt, O.B.E., M.C. (*R.E. Board*).
Col. W. Garforth, D.S.O., M.C.	1934	Col. G. N. Macready, C.M.G., D.S.O., O.B.E., M.C. (*G.S.*).
Brig. H. N. North, D.S.O., *A.D.C.*	1934	Major W. D. M. Christie (*C.I.C.*).
Bt. Lt.-Col. B. K. Young, M.C.	1934	Major J. R. T. Aldous, M.C., *p.s.c.* (*Staff Captain S.M.E.*).
Lt.-Col. W. R. Oxley, M.C., *p.s.c.*	1934	
Capt. D. C. Davey	1935	
Major H. P. W. Hutson, D.S.O., O.B.E., M.C. ...	1935	
Lt.-Col. R. S. Rait Kerr, D.S.O., M.C.	1935	
Col. G. B. O. Taylor, C.B.E.	1935	
Bt. Lt.-Col. C. A. West, D.S.O., M.C., *p.s.c.*	1935	
Col. R. G. P. Hunter, O.B.E.	1935	

Corresponding Members.

Col. J. E. Duigan, D.S.O., *p.s.c.*, N.Z.S.C. (late R.N. Zealand Engrs.)	28 10 24
Lieut.-Col. T. R. Williams, C.M.G., D.S.O. (Australian Staff Corps)	28 1 30
Major C. R. S. Stein (R.C.E.)	24 12 31

Secretary: Lieut.-Colonel E. V. Binney, D.S.O. ...... 15th June, 1934.

THE MANDI HYDRO-ELECTRIC SCHEME.



1—Winch Camp—top of upper incline.
2—Adit junction—top of lower haulage.
3—Tunnel exit and top of pipe-line.
4—Adit tramway.
5—Adit nullah.
6—Pipe-line.
7—Lower haulage.
8—Pathankot–Kulu road.
9—Turbine room.
10—Control block.
11—Switch annexe.
12—Tail race weir.
13—Step-up station.
14—Workshop.

The Mandi hydro electric scheme - captioned photo

All contributions for The R.E. Journal from officers on full pay (other than those serving in India), except Memoirs and Notices of Magazines, should be forwarded to the Editor in duplicate as laid down in K.R. 535 (c), together with a statement from the authority (if any) under whom the writer is immediately serving, that such authority has no objection to permission to publish being applied for. Officers serving in India should submit articles for permission to publish to the Commander-in-Chief in India, before dispatch to the Editor.

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

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

THE MANDI HYDRO-ELECTRIC SCHEME.
(UHL RIVER)

By Captain A. Guthrie, R.E.

It is thought that an account of the Mandi Hydro-Electric Scheme will be of interest to members of the Corps, not only for its technical aspects, but also because its inception and carrying through to a conclusion were due to the remarkable ability and personality of an officer of the Corps, the late Colonel B. C. Battye, D.S.O., R.E., and although it was carried out by the Public Works Department, R.E. officers had a considerable share in the work, six being employed on it at various times.

History.

To get into the picture it is necessary to go back to 1919. Coal prices were high, factory plant in the Punjab had been falling to pieces all through the war, money was plentiful and all seemed to favour a movement towards industrial development. Accordingly Sir Edward Maclagan, then Governor of the Punjab, was in a favourable position to initiate a detailed examination of the Punjab's industrial prospects, and, influenced possibly by the investigations then being carried out into the water-power resources of India by Mr. J. W. Meares, C.I.E., then Electrical Adviser to the Government of India, sponsored an inquiry into the economics of a hydro-electric development on the Sutlej River, with its concomitant transmission and distribution system covering a large area of the Punjab.

In 1919, Colonel Battye had returned to India and to an established reputation for experience in hydro-electric engineering, based on the very successful Simla plant which he had constructed in 1912–14. He was thus an obvious choice for the investigation the Punjab Government wished to conduct and shortly after arrival was appointed to take charge of this. He collected a small staff, including the writer, and during two years a very complete scheme for 80,000 kW was worked out in detail, full designs being prepared for headworks generation and transmission at 132,000 volts.

In the meantime, however, further exploration of the Punjab Himalayas had been commenced and as a result the Uhl River showed promise of being superior to the Sutlej, which scheme was accordingly pigeon-holed in about 1924. The work done on this was nevertheless by no means wasted, as it formed the foundation of what became the Punjab Hydro-Electric Branch, with a highly specialized staff capable of preparing other schemes, as well as destined to form the framework of a complete department.

The report on the Uhl River was in due course completed and submitted to Government, but by then financial conditions were less favourable and criticism of Government's activities in general more vocal, with the result that sanction to proceed was not granted until early 1926, and even then many head-shakings were indulged in by those who deprecated Government's embarking on the apparently dangerous experiment of electrical supply.

The general history of the scheme is that work was started in 1926 and came to an end in March, 1933, except for distribution which was still only partly finished. The original estimate was for Rs. 450 lacs (approximately £3¼ million sterling), but as time went on this crept up, as estimates have a way of doing, to about 600 lacs (some £4½ million sterling), which is believed to be round about the final figure. But this includes a considerable amount of work not directly productive for the first development, but essential for future extensions and which would present costly engineering difficulties if left until later.

There were at least two occasions when the Government seriously considered cutting their losses because they were nervous of the commitments they were facing; and since at the time practically the whole body of expert technical knowledge of the kind which alone could reassure them was, as far as the Punjab was concerned, within the Hydro-Electric Branch itself, a committee of inquiry of experts outside the Province was eventually appointed, which fortunately gave the situation its blessing, and work was allowed to proceed unhampered by other than sporadic opposition in the Punjab Council. It is, however, not too much to say that only the indomitable energy and patience of Colonel Battye and his supreme grasp of finance and technicalities saved the scheme from wreckage. But to-day the battle is forgotten and the Punjab is not a little proud of its possession.

General Design.

The Uhl River development is at present rated at 36,000 kW maximum continuous output, but the tunnel, pipeline and power-house building allow of an increase to 72,000 kW—the designs were framed throughout so as to permit future extensions. A further development of 48,000 kW is possible by taking the tail-race water through a second drop of 1,800 feet or so.

The site of the work is shown on the transmission map and the loop formed between the Uhl and the Beas suggests at a glance the existence of conditions favourable to water power. The Uhl has its source in glaciers at 16,000–20,000 ft. and does not rely on rain alone for its flow, so that only a relatively small diurnal storage reservoir is necessary. The operating head is 1,668 feet and a relatively small quantity of water is needed, some 400 cusecs at full load.

The generating portion of the scheme consists of :—

- (*a*) A headworks system in the Uhl Valley, comprising weirs, control gates, ducts, decantation chambers and trash racks for getting rid of suspended matter (a very important point with a high head if excessive wear on the turbines is to be avoided) and the reservoir.
- (*b*) The tunnel and surge shaft.
- (*c*) The pipeline.
- (*d*) The power house, turbines and generators.
- (*e*) The main switchgear.

and the transmission elements are :—

- (*a*) The step-up substation next to the power house.
- (*b*) The extra-high-tension transmission line and branch lines.
- (*c*) The step down substations.
- (*d*) The rural lines and the local distribution systems in the towns.

A word may perhaps be said here regarding the method of carrying out the construction. It was a Government undertaking and administered as the Hydro-Electric Branch of the Public Works Department, with its own Chief Engineer (Colonel Battye). All designs and specifications, and the preparation of all contracts for plant and machinery, were throughout undertaken by the design office in Lahore, christened the Engineering Circle. Actual construction devolved upon two other circles—one at the power house area and one for the whole transmission system. Adequate liaison was kept between design and execution and the system worked admirably, both sides being free to work on their own very different problems.

In describing the scheme in some detail it will be convenient and quite logical (although the reaction of every part of the scheme on the remainder was constantly felt during the design stage) to start at the load and work back to the generating end.

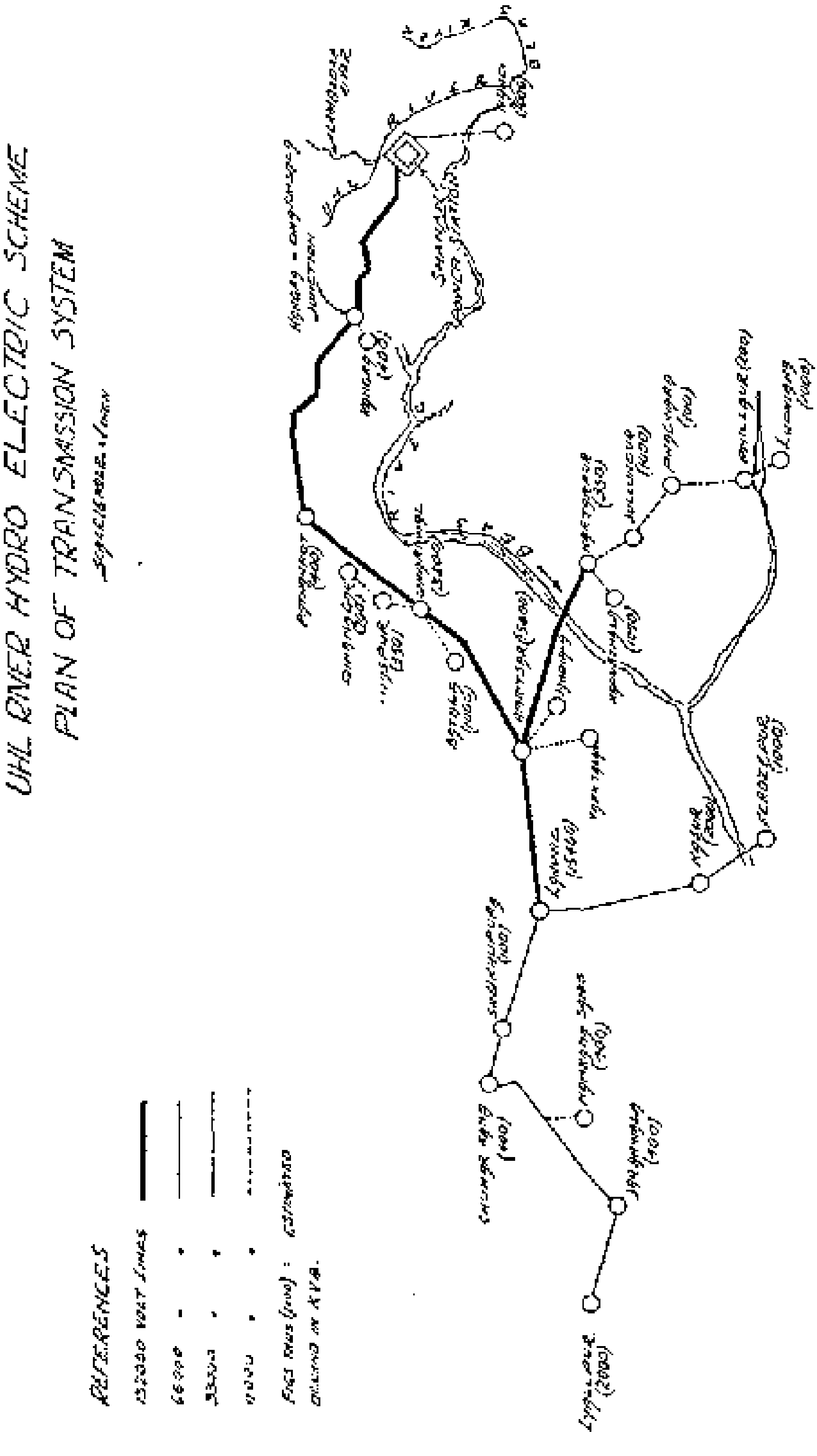
The first step in design was to fix an economic limitation for the transmission system, taking into account the interaction of capital cost, probable load and technical factors. Of these, the last was the simplest and gave one or two immediate criteria, the first of which was voltage. The work on the Sutlej Scheme had envisaged a trunk line voltage of 132 kV, the English grid had subsequently standardized on this, and, while certain systems in other parts of the world had gone to 220 kV, there were not many above 132 and there would have had to be some very cogent reason, such as a large block of demand, perhaps 300 miles from the power house, to justify exceptionally high voltages.

Lahore, at 190 miles from the power house, was roughly the centre of gravity of the load and 132 kV was very suitable for this distance, using synchronous condensers to limit the voltage variation; but as an alternative 110 kV with more synchronous condensers was investigated.

The load was, as always, problematical, and, although a great deal of research was carried out into the industrial state of the area to be covered, it was difficult to say what proportion of existing plant would convert to electrical operation and to what extent totally new demands would develop. And although one could confidently say that some day a demand for 50,000 kW would exist, the problem was whether it would be in ten years or thirty.

However, eventually from the mass of evidence accumulated, certain conclusions regarding load were arrived at—ultimately a matter of judgment and time alone will show how near they were—and it was decided to design for a power house output of 36,000 kW; diversity factor cancelled very nearly with line losses and the power to be delivered to substations roughly totalled to this figure. The substations and estimated load demands for design purposes, in kVA, are shown on the plan of the transmission system, under each town, the power factor of the substation loads being taken as ·85 lagging. These towns are the principal industrial areas of the central Punjab and no load of any size within effective reach of the transmission system was omitted.

These conclusions as to voltage limit and magnitude and locations of substation loads were, of course, of major importance—although they took a considerable time, the best part of six months, to arrive at—and enabled the final designs to be started (the designs for the project put up to Government for administrative sanction were, of course, preliminary and liable, as actually occurred, to considerable modification). The construction circle, however, had plenty to do, and indeed for yet another year, in getting itself organized, housed


UHL RIVER HYDRO ELECTRIC SCHEME
PLAN OF TRANSMISSION SYSTEM
REFERENCES
132000 VOLT LINES
66000 " "
33000 " "
11000 " "
FIGS THUS (1000) : ESTIMATED DEMAND IN K.V.A.
SHANAN POWER STATION

and officed, transportation problems dealt with, tunnelling plant erected and all construction plant assembled; and in fact was in no hurry for actual project designs.

TRANSMISSION SYSTEM.

To continue with the transmission system, the design had to be directed towards a further series of decisions on the following points, to mention only the most important :—

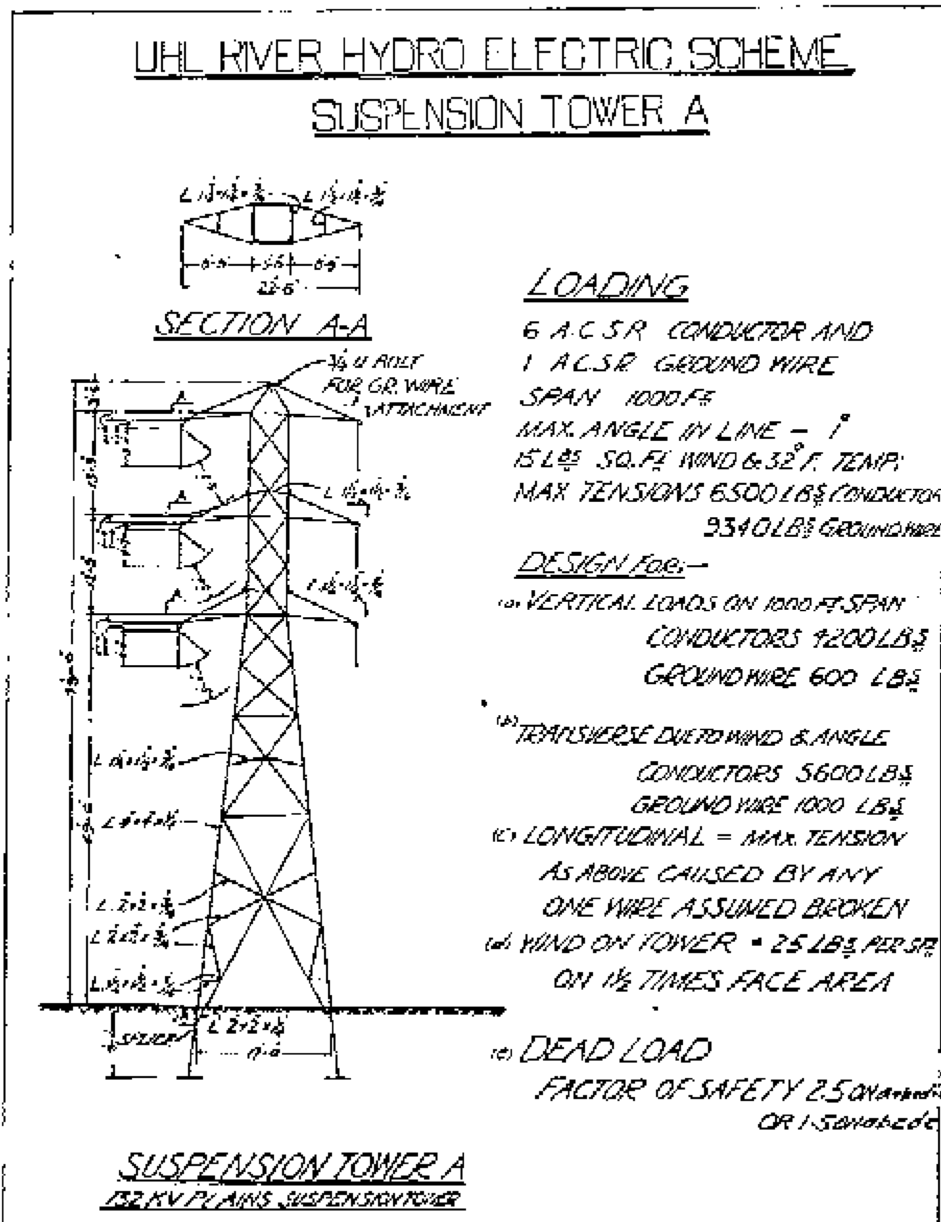
(*a*) Material of conductors—copper or aluminium steel; and their sizes.
(*b*) Voltages of branch lines.
(*c*) Heights and spacings of towers and spacing of conductors.
(*d*) Permissible voltage variation.
(*e*) Line losses and their financial effects.
(*f*) Capacity of synchronous condenser plant.

It would require a separate paper to give the progress of all this design in anything like detail, but the method roughly was to vary one factor at a time and study the financial effect; and a very large series of calculations extending well over a year eventually pointed to an optimum combination, resulting in a decision to adopt aluminium steel conductors, 132 kV from the power house to Lahore, 66 kV for the branch lines (with one at 33 kV) and 11 kV for rural lines. The synchronous condenser capacity which controls voltage conditions, while definite for the fully loaded scheme, was designed for installation in units of 10,000 kVA, to be put in at Lahore and Amritsar as the load builds up.

The trunk line (132 kV) is double circuit, carried on 80-ft. steel towers spaced 1,000 ft. in the plains (running up to 3,360 ft in the hills), with aluminium steel conductor (30 × ·102 al. over 7 × ·102 steel for hills and 30 × ·0935 al. over 7 × ·0935 steel for plains); ground wires, provided throughout, are also al. steel. The 66 kV branch lines are single circuit carried on towers 50 ft. high with al. steel conductors to suit the loading. Anchor towers are provided at intervals to give stability and isolate the effects of breaks in the wires. Insulators are of the disc type, the number per string varying from 9 on the hills trunk line to 5 on the 66 kV branches.

Certain river crossings called for special structures and heavy foundation work to enable the river to be crossed in a single span of about 2,000 ft. At the Beas crossing foundations, work was hampered by one of the piers being sunk over a complete construction engine, left in a borrow pit, where it had fallen and been buried, by the original builders of the railway in the 'sixties.

The substations at Kangra-Dharamsala, Pathankot, Dhariwal, Amritsar and Lahore are provided with automatic switchgear which


UHL RIVER HYDRO ELECTRIC SCHEME
SUSPENSION TOWER A
SECTION A-A
LOADING
6 A.C.S.R. CONDUCTOR AND
1 A.C.S.R. GROUND WIRE
SPAN 1000 FT.
MAX. ANGLE IN LINE — 1°
15 LBS. SQ. FT. WIND & 32° F. TEMP.
MAX. TENSIONS 6500 LBS. CONDUCTORS
9340 LBS. GROUND WIRE
DESIGN FOR:—
(a) VERTICAL LOADS ON 1000 FT. SPAN
CONDUCTORS 4200 LBS.
GROUND WIRE 600 LBS.
(b) TRANSVERSE DUE TO WIND & ANGLE
CONDUCTORS 5600 LBS.
GROUND WIRE 1000 LBS.
(c) LONGITUDINAL = MAX. TENSION
AS ABOVE CAUSED BY ANY
ONE WIRE ASSUMED BROKEN
(d) WIND ON TOWER = 25 LBS. PER SQ.
ON 1½ TIMES FACE AREA
(e) DEAD LOAD
FACTOR OF SAFETY 2.5 ON
SUSPENSION TOWER A
132 KV PLAINS SUSPENSION TOWER

on a fault cuts out the faulty circuit, between adjacent substations, leaving the good one in operation.

Substations, which are of the outdoor type, vary considerably in layout according to the size of the local load and whether the voltage is 132 kV, 66 kV or a junction of the two, but a strenuous effort was made to standardize on the transformer units even at the cost of putting in slightly excess capacity in some places. This resulted in lower costs per kVA and certainly has simplified the problem of spare units and spares in detail. Transformers are self-cooled, oil-immersed, three-phase units.

The substation switchgear normally contains automatically operated oil-circuit breakers (rupturing capacity 1½ million kVA for 132 kV) of the line voltage for feeding the H.T. side of the transformers, and indoor metal-clad gear for the 11,000 volt distribution. In addition there are hand-operated 132-or 66-kV isolating switches interlocked with O.C.B's for isolating the station completely, and at certain stations as mentioned above, automatic sectionalizing switches. All substations have their own railway sidings (except one), cranes, operators' quarters, water supply, etc., and they and the power house are interlinked by a special telephone system, run on steel poles, parallel to the transmission lines. This was with some difficulty allowed to be operated by the Branch, the Telegraph Department being at one time inclined to consider it as their prerogative.

POWER HOUSE.

Coming now to the power house area, the step-up is from 11 kV on the generators to 132 kV on the trunk line and the step-up station follows the substations in its general features, although two of the transformer banks here are 27,000 kVA 3 single-phase per bank and have auxiliary air cooling. The step-up station, on an area about 500 ft. by 200, is some 200 yards from the power house, which necessitated a cable subway to carry the 11kV paper-insulated lead-covered cables from the power house. This separation was dictated by the conformation of the ground, the locality being 4,000 feet above sea-level and *sub-montane* in character.

The power house contains at present four direct-coupled 12,000-kW B.T.H. generators driven by 16,000 h.p. single-runner overhung Pelton wheels (by Boving and Co.) at 428⅝ r.p.m. under an effective head at full load of 1,668 ft. The turbines are governed by a combination of gate control and deflector jet and an over-speed shut down mechanism is provided. The generators are 13,333 kVA at ·9 power factor, 11,000 volt star connected with automatic voltage control to 9,900 volts. The exciters, 88 kW at 230 volts D.C. are on the same shaft, and an auxiliary exciter (3·8 kW at 240 volts) is carried as a further shaft extension to give quick response voltage control as the load fluctuates; there is also an auxiliary motor-driven exciter. The charging current absorbed by the transmission system is of the order of 20,000 kVA, so that it is necessary to run two generators continuously even at times of light load.

From the generators run the 11,000-volt cables in ducts to the main switchgear, which is of the metal-clad draw-out type and housed in a separate switch-room. Above this and commanding a view of the turbine house is a control-room with an elaborate series of D.C. (200-v., battery or generated at choice) operated panels, by which complete remote control is maintained to all automatic switchgear—11,000-volt gear in the power house, the numerous 400-volt boards controlling local circuits and the 132,000-volt gear in the step-up substation. In addition, manual operation is, of course, possible should remote control fail.

An auxiliary turbine and 640-kVA 400-v. generator exists so that power house lighting and power is independent of the main generator supply. Motor generators, a battery system and interconnection of all these make failure of the lighting exciter and switch control systems almost impossible.

The relay system for automatic sectionalizing of the trunk line and also for generator and transformer protection is elaborate and covers every conceivable kind of fault, the intention being to isolate the fault with the utmost rapidity, while keeping alive the apparatus or transmission line circuit unaffected. Translay balanced current and overcurrent and earth leakage for transformers, overcurrent negative phase sequence, over-voltage and over-frequency for generators cover the main system of protection. All electrical gear was supplied and erected by the B.T.H. and the cables by Messrs. Callendars.

The power house building consists of three parts, namely, a machine house containing the generators, a three-storey control block, and a switch annexe for the main 11-kV gear. It has been designed on earthquake-proof principles—as indeed are all buildings in the area—and consists of a steel framework with very thin cement plaster and expanded metal walls. The foundations are mass and reinforced concrete, as are the tail race and weir spillway.

Civil Engineering.

Having considered the power house, it will be convenient to describe in general terms the civil engineering problems connected with the whole area, and the first point is that railhead was at Pathankot, 100 miles away, all construction plant and materials during the first two years having to come by lorry or bullock cart along the road, which eventually runs to Kulu and Ladakh. A narrow-gauge railway was, however, started by the North Western Railway in 1926 and in 1929, when the really heavy stuff was due to arrive, this part of the transportation problem was solved.

It was evident during the project estimate stage that there were going to be very considerable labour, housing and transportation problems, unless modern methods were adopted, and accordingly it was decided to use power in every way possible. So two subsidiary hydro-electric stations were rapidly built, one on each side of the hill, that in the power house area being 600 kW under 740 ft. head and that on the headworks side 500 kW at 120 ft. head. From these stations transmission was at 11,000-v. 3-phase A.C. all over the area, stepping down at six substations to the working voltage of 400. The following paragraphs cover the construction plant worked off this system.

The main transportation problem was the conveying of stores and plant to the various points up the pipeline (including the pipes themselves) and to the southern tunnel heading, and all the material for the headworks area and the north heading, *i.e.*, across the pass and down the other side. The levels to bear in mind are, nearly enough, power house 4,000 ft., Uhl River at the tunnel entrance, 6,000 ft., height of the pass across the intervening range of mountains 8,300 ft. In addition, quarries were established just above the pipeline which supplied aggregate for all the pipe anchors and power house foundations and this had to be brought down.

The heaviest load was 12½ tons (the automatic valves at the top of the pipeline at a point known as tunnel exit), and events justified the decision to go boldly for electric motor-driven cable-operated haulages, one from the power house to tunnel exit of 15-ton capacity (2,000 ft. lift), one from this point to the near side of the pass (2,300 ft. lift and 7½-ton capacity), and, from the other side of the pass down to the river, a third of 5-ton capacity and 2,300-ft. drop in two stages, with an electric winch at the top and another half-way down, the loaded trucks being transferred from one winch to the other. The pass across to the Uhl Valley was traversed by a 2 ft. 6 in.-gauge railway, 1½ miles long, worked by a Sentinel steam locomotive. This pass was completely snowed up every January and February, which shut down all goods carriage and made even foot traffic hazardous, and in 1933, the loco., after four years of sterling work, finished magnificently by being avalanched over a precipice, where its bones still lie 1,500 ft. below.

The haulages on the power house side were of the balanced type, that is, one car came up as the other dropped with a double-line crossing place at the middle of the run. Anyone who has ski-ed at Davos lately will have gone up to the Weissfluhjoch in exactly the same kind of thing (actually made by the same firm), although the cars are more palatial. The lower haulage, from the power house to tunnel exit, worked every day and most nights for three years and gave practically no trouble.

The next important power consumers were the two compressor stations for driving the tunnel headings—they were not only compressor stations, but substations for the tunnel electric power and light requirements, which will be considered in more detail later, and contained three compressor units for the south heading and two for the north, and motor generators and ventilating blowers. Other electrically-driven plant consisted of many concrete-mixers all over the area, two crushing and screening plants for aggregate, a workshop on each side of the hill, electric shunting locos., cranes, pumps, and a dragline excavator which operated on the power house site excavation and then went across the hill for the reservoir. Finally, of course, electric light everywhere, and, of immense value for the co-ordination of work, a thirty-line automatic telephone exchange and a manual one for Brot (the general name for the headworks area), with manuals for each tunnel heading. (A very complete paper on the construction plant was read by Col. Battye before the Punjab Engineering Congress in 1930.)

The general system of civil construction throughout the works was concrete, plain or reinforced, and the volume of this represented by the headworks, tunnel linings, pipe anchors and power house and other building foundations runs into enormous figures. It was consequently well worth while to establish a control of concrete quality and this was carried out by the Resident Engineer, through the medium of an elaborate system of specifying, sampling and testing. The ratios of cement, aggregate (coarse and fine) and water were laid down for each class of work and the various contractors rigidly held to this. Aggregate and sand was, of course, tested frequently, as was the cement purchased by the department and issued to the work. As a point of organization, it may be of interest that the Resident Engineer also was responsible for all major surveys and alignments, and the executive staff had not to bother with this except for subsidiary setting-out details.

Headworks.

To turn now to the headworks layout, the generating plant being rated at 36,000 kW and the head being about 1,700 ft., it was not difficult to arrive at the maximum amount of water to be handled, and with an assumed load factor and a study of the flow curves of the river the storage requirements were arrived at. The final decision regarding head and flow was a question of selecting the best combination of power house site and tunnel entrance and, with the above figures as a basis, a series of calculations were made to determine this. Actually, the form of the river valley fixed the tunnel entrance within fairly narrow limits and the tunnel exit and power house position were largely decided by the relative amounts of excavation involved in the latter, and by the choice of a satisfactory pipeline route, for which there were only three real alternatives. It may be further added that the tunnel entrance position was selected with an eye on the eventual building of a 200-ft. dam, should the plant capacity require to be extended, and the size of the tunnel also provides for this extra flow of water.

The headworks, *i.e.*, everything above the tunnel entrance, is shown in the plan of this area. It will be seen that, although the Uhl River gives the scheme its name and supplies the larger share of the water, a control weir is placed across a tributary—the Lambadag—whose contribution is considerable. Both are snow-fed streams obeying seasonal fluctuations as the snow melts, and also subject to sudden and intense floods of several hours' duration in the rainy season (August principally).

The Lambadag water having been brought into the Uhl by the weir and a short tunnel and duct, the combined waters flow past an intake gate with a weir (crest-level 6,005), and a control gate of the tilting type across the main river for regulating the intake flow.

This intake point is about a mile upstream of the tunnel, a considerable distance, but the alternative of locating it lower down would have meant heavy civil works and more difficult hydraulic conditions, particularly in times of heavy floods.

The water now enters a decantation chamber and stilling pond provided with a scour, so that most of the silt brought in is settled and at intervals can be run back to the river. After this comes a covered reinforced-concrete duct, about 2,000 ft. long, running into the forebay works which consist of two rapids and a flume, followed by the forebay proper with its control gates leading into the reservoir (capacity some 8 million cubic ft., about 25 ft. deep, roughly oblong and 1,200 ft. × 300 ft. in area). At the forebay there is an elaborate system of rotary trash racks, electrically operated and self-cleaning by hydraulic jets, which remove surface debris, which would otherwise reach the reservoir. Near the downstream end of the reservoir are two valves controlling the entrance to the tunnel, which can be fed either from the reservoir, or by an alternative duct joining the forebay to the tunnel direct, so that the reservoir can be cleaned or repaired. These valves are of the butterfly type, 8 ft. in diameter, and are hand-operated from a staging built above reservoir water-level.

The actual construction of this headworks layout presented the normal difficulties associated with excavation and concrete work in rocky riverbeds, and de-watering problems were always to the fore. Apart from this, it was a straightforward matter of heavy excavation in boulder soil, with a tremendous amount of blasting and a considerable quantity of R.C. work and gate and valve erection. The dragline excavator did very good work here but more as an appliance for moving heavy boulders than as a dragline.

Tunnel.

We will now turn to the tunnel.

It has already been indicated that the location of the entrance and exit required a great deal of study and the same may be said of its diameter and slope, the deciding upon of which called for the nice balancing of cost against losses in friction and therefore head. The ultimate choice was for a circular tunnel driven to 11 ft. 3 in. diameter and lined where necessary with 1 ft. of plain concrete (but rock conditions as found while driving led to a considerable amount of reinforcement being put in).

From the tunnel entrance in the Uhl Valley to the tunnel exit at the top of the pipeline was over 15,000 ft., a very long drive for two headings, and it was considered worth while to drive a 1,200-ft. adit, 8 ft. × 6 ft., from a side nullah on the south side of the mountain, thus giving two more faces to work on. This was a most fortunate decision as the heading from tunnel exit (actually two parallel bores for 1,000 ft.) was through extremely difficult rock, shattered and requiring timbering the whole way, and this heading had to be written-off completely as contributing to progress through the hill. At 1,000 ft. from the tunnel exit is located the surge shaft, 380 ft. deep from ground-level above, and furthermore the twin tunnels from tunnel exit to surge shaft base carried 6-ft. steel pipes the whole way—the pipeline can be said to start from the surge shaft—so that this locality had plenty to contend with without contributing to the main drive.

On the north side no true adit was possible and this heading, therefore, consisted of one face only with a subsidiary outlet (known as valve adit) running out downstream of the main portal from a point some 500 ft. in, where was located a chamber containing another 8-ft. butterfly valve for shutting off the tunnel flow. The object of this small adit was to provide an alternative mucking path when the completion of the duct from forebay and reservoir should close the reservoir route, and to give access to the tunnel valve during operation.

Thus the tunnel driving was split up into three portions.

(*a*) The north heading and valve adit.

(*b*) The two south headings, one to the north called "mid point" and one to the south called "surge shaft"; and the south adit.

(*c*) The surge shaft and pipe tunnels.

The geological structure of the mountain was far from homogeneous and bands of quartzite, gneiss and granite occurred at irregular intervals in the predominant rock, which was a grey mica schist, laminated in texture, exceedingly hard to drill but so lacking in real

UHL RIVER HYDRO ELECTRIC SCHEME
GENERAL PLAN OF HEAD WORKS

cohesion as to be prone to fall in large masses, to the very considerable danger of those working in the tunnel, while at many places, owing to the water percolation, it was found in disintegrated form, almost mud, which flowed into the tunnel as fast as it was removed and left enormous cavities in the roof. It was impossible to foresee all this in detail, and the plans for driving the tunnel were at first based on assumed conditions, but many expedients to overcome special difficulties had to be evolved as the work proceeded. Supports to the roof and sides were necessary on 75 per cent. of the drive, and steel frames with R.C. slabs were adopted, timber of any normal size being useless under the pressures.

The primary essential in the tunnel work was speed, since the driving alone, apart from concreting, was estimated to be a three-year job at least and could not start before 1928. Hence everything possible was done to increase the driving rate and a few factors will be enumerated.

1. Twenty-four hour working in 3 shifts of 8 hours each.
2. All drilling done by pneumatic drills. It was hoped to use bar-mounted drifters on a special travelling carriage, but they were too heavy for the labour to manage, and the wet jackhammer was soon standardized.
3. Charges fired electrically off lighting mains. (Gelignite used throughout, holes about 6 to 8 ft. deep.)
4. "Mucking" or removing débris from the face done by machine. Not uniformly successful as the mucking machine clogged and derailed rather easily, particularly in the north heading where water ran down-hill to the face.
5. Elaborate de-watering arrangements in the north heading, which ran downhill. The inflow was not large but a constant source of trouble and anxiety and only dealt with by having several small electric centrifugal pumps, easy to handle and move quickly up to the heading and away when blasting.
6. Electric loco. traction for hauling away the spoil—battery-operated forward and, in the north heading, trolley farther back where overhead wires could be slung safely.
7. Pneumatic sharpening of drill steel in a smithy at the tunnel mouth. ⅞-inch hollow hexagon steel was used throughout and was shanked and sharpened in Ingersoll Rand Leyner sharpeners, using special dies and formers.
8. High-grade ventilation so that the heading could be cleared quickly after the blast.

9. Electric light throughout.
10. A special travelling concreting frame, so designed that tunnel traffic could pass through it while concreting was going on. Pneumatic concrete placers were used to a limited extent.

In addition, there were many devices and details of organization which evolved as the work proceeded, all aimed at increasing footage.

It will be appreciated that all the plant enumerated was duplicated for each side of the hill, that for the exit end (located at the adit mouth) being about twice as much as for the north heading, as the former had two faces to work on.

The compressors were Browett-Lindley vertical two-stage, giving 600 cubic feet of free air at 100 lb. and absorbing 120 B.H.P. at 363 r.p.m., two sets in the north compressor house and three in the south, the compressed-air supply to the tunnel being through 4-in. and 6-in. Victaulic piping. The ventilating ducts were 16-in. diameter welded-steel flanged pipes in 10-ft. lengths and the duplex blowers were capable of delivering 3,000 cubic feet of air at 1,500 r.p.m. and 6,000 at 3,000 r.p.m.—one set on the north and two on the south.

The south adit was started in April, 1928, and this and its subsequent two headings, one towards the mid-point and the other back towards the surge shaft, were from the beginning to the end under the charge of Mr. N. V. Dorofieff, who has given a detailed account of his work in a most able paper submitted in 1933 to the Institute of Engineers, India, which gained the Viceroy's Prize.

His mid-point heading, *i.e.*, that working to the north, ran through cascades of water the whole time—which most fortunately drained naturally as the heading drove slightly up-hill—resulting in tons of débris being brought down from the roof at a number of places, one cavity being as large as a fair-sized cottage. The only solution eventually was to grout the mass up solid and tunnel through it after it had solidified.

The north heading in the Uhl Valley started in 1929, and the writer was fortunate enough to be given this to do and managed to start up and organize the work and drive the heading for 18 months, when it was given up on promotion to another charge.

Here the water was less but ran towards the heading and required a troublesome system of pumps and piping, and the upgrade also made the removal of spoil very slow as it taxed the battery locomotive to the utmost. But it was on the whole easier tunneling than the south heading, except possibly in winter as regards external difficulties, when the area was snow-bound and emergency stores and food for labour could only be got over the hill with great trouble. There were also one or two scares when the river was in high flood, and reached a dangerous level: from the point of view of flooding the heading completely, *via* the partially excavated reservoir, but the banks held and all was well.

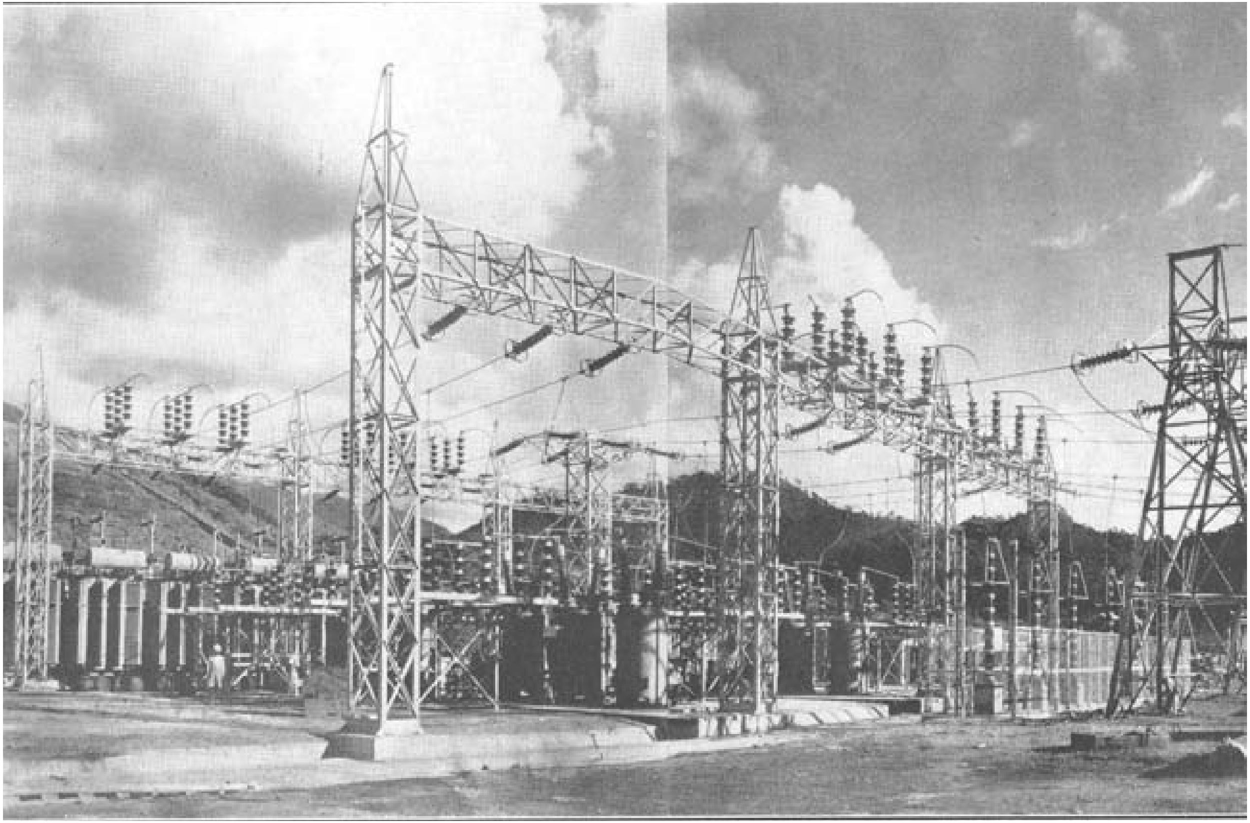
The main headings met on 1st March, 1932, and there was some cause for satisfaction when it was found that the error in alignment was only $\frac{1}{16}$-inch in level and $\frac{3}{4}$-inch in line. This may be attributed to the meticulous triangulation carried out by Mr. A. Bond, a retired civilian officer of the Survey of India, and to the painstaking line and level work done in the tunnel itself by the Resident Engineer, Mr. D. S. MacPhail, who was an officer in the Corps during the War. He had a great deal to contend with in the way of noise, vibration, dust, smoke and water, the worst of conditions for accurate survey and from the unwillingness of the tunnelling gangs who were working on a bonus, to stop tunnel traffic for his work. With the main driving finished, the back of the job was broken and the lining work and the surge shaft heading were able to quicken up, with the result that the tunnel was ready for filling in October.

A few words on the lining will perhaps be of interest. This had a double function, to reduce friction and to prevent leakage when, if ever, a 200-ft. dam should be built across the Uhl, thus putting the tunnel under considerable pressure. It was hoped that a plain concrete ring would suffice and that certain granitic sections could even be trimmed off and left unlined, but as the driving revealed the shattered nature of the rock, especially in the southern heading, it was decided to line throughout and grout under pressures of 110 lb. or 500 lb. depending on the circumstances, and beyond the mid-point to put in reinforcement with an extra 6-in. band of dense concrete applied with a cement gun. This was considered to be a job for experts who had done it before, and a Swiss firm with Italian labour carried it through.

HEADING.

The 380-ft. surge shaft which, as has been already indicated, was at the junction of the pipe tunnels and the tunnel proper, is of the Johnson differential type with a 60-ft. concrete riser and was sunk from above by ordinary methods using an electric winch, minehead gear and buckets. It was excavated to 12-ft. diameter at the top and 16 at the bottom and was lined with a foot of concrete. The rock was treacherous, although sufficiently hard to need blasting, and timber shoring had to be used. The bulk of this work was carried out by Lieut. (now Captain) N. Boddington, R.E., under Captain (now Major) R. D. Keane, R.E. These two officers were also responsible for most of the pipeline work.

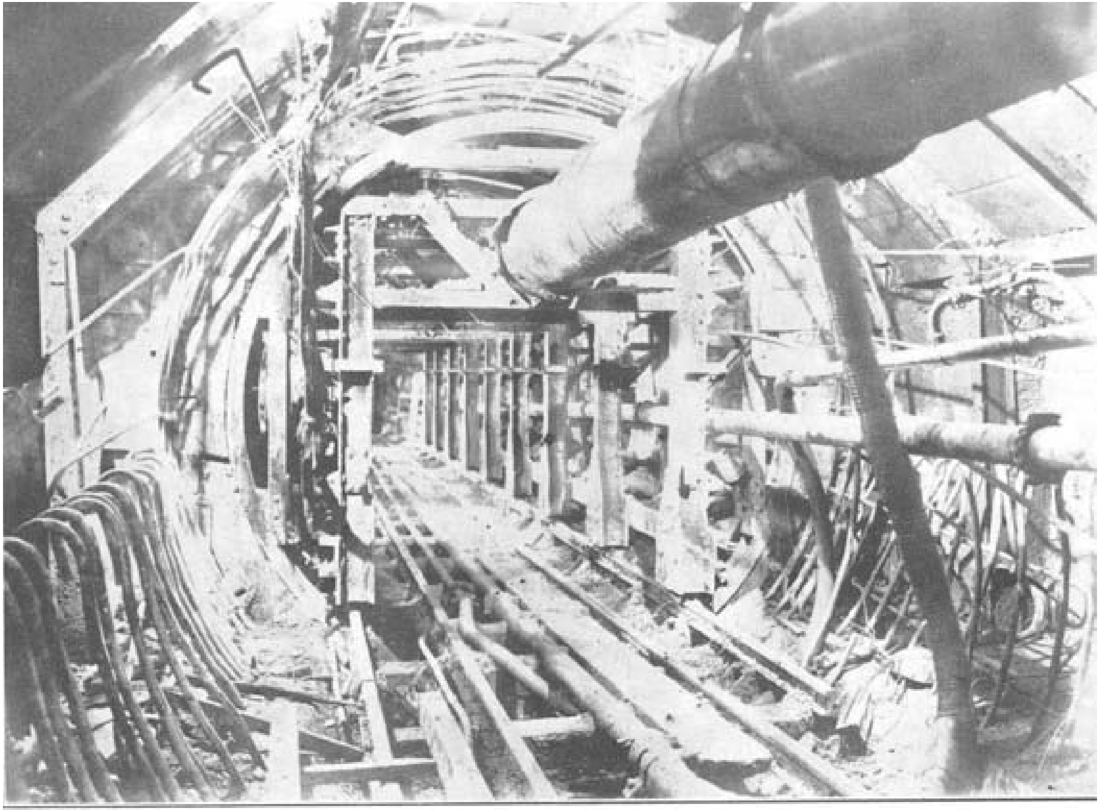
The Mandi hydro electric scheme - captioned photo



The Mandi hydro electric scheme - captioned photo


North heading after lining.

The Mandi hydro electric scheme - captioned photo



Tunnel concreting frame.

The Mandi hydro electric scheme - captioned photo

Pipeline.

The pipeline starts from the surge shaft base, in the form of two 6-ft. pipes, each running in what was its own tunnel, but now concreted up to form an anchorage with the hill. These pipe tunnels gave an immense amount of trouble, and subsidence of the hillside due to tunnelling was so serious as to crack the foundations of the lower incline winch house a hundred feet or so above, which had to be hastily abandoned and rebuilt above the danger area.

On emergence from the pipe tunnels the pipes each bifurcate into two of 4ft. 7in., which then connect with two massive streamline type cylindrical valves for automatically cutting off the tunnel water in the event of a pipe burst. One pair of 4 ft. 7-in. pipes belonging to one 6-ft. pipe is blanked off, as it is provided for future extensions. The other two pipes run down the hill parallel to the haulage incline and are embedded in massive concrete anchors at intervals of about 250 ft., expansion joints being provided between anchors. Intermediate supports are fixed over which the pipes are free to slide on expansion. The pipes are mild steel, riveted with inclined butt joints, and from 4 ft. 7-in. diameter at the top change to 3 ft. 7 in. just above the power house, where they are banded for extra strength. At the lowest anchor the two pipes again bifurcate into four of 2 ft. 7 in., one for each turbine, and each pipe is controlled by an electrically-operated valve.

The pipeline was given to the manufacturers to erect and presented little difficulty beyond good organization and transportation arrangements, which the haulageway was able to give. On test, less than a dozen rivets showed any leakage, which shows a very high standard of work on the part of the contractors (Ferrums, Ltd., of Kattowitz, Poland).

Details of the generating plant and transmission system have been given in the early part of this article.

Local Distribution.

It remains to say something about local distribution. Apart from any extensions since 1933, when the writer left the scheme, there were eventually 16 towns to be electrified and the work was given to Messrs. Callendars. There are, of course, special difficulties connected with wiring up Indian cities with their narrow and tortuous streets, and that these were overcome while observing safety considerations reflects great credit on the ingenuity and patience of this firm's engineers. (Callendars also built the whole of the trunk and branch lines to specifications framed by the department in consultation with Messrs. Kennedy and Donkin, of Westminster.) The surveying work for laying out the town systems was found to be extremely slow and costly by ordinary methods and eventually aerial survey was adopted with excellent results.

The cost of local distribution varied from Rs. 76,200 for Dinanagar, a fairly large village, to Rs. 5,95,700 for Kasur, a large town with many industries (the costs for Lahore and Amritsar were low, although these towns are the biggest in the area, as they were already electrified in the cities and only suburbs had to be done by the branch).

The distribution in the larger towns is at 11,000 volts, and then by 400, and by 400 direct in the smaller. A very simple type of sub-station was developed with straightforward metal-clad gear (by Messrs. Reyrolles) and indoor type Ferranti transformers standardized at three sizes—50, 100 and 200 kW.

TARIFFS.

As the electricity branch is not merely a bulk supplier but distributes down to individual consumers, except in certain towns, which already had private power companies (e.g., Lahore, Amritsar, Jullundur), the tariff has been framed in a very elaborate manner, varying from a bulk supply of 4,000 kW maximum demand at 11,000 volts down to an individual connected load of under 50 watts at 200 volts single-phase.

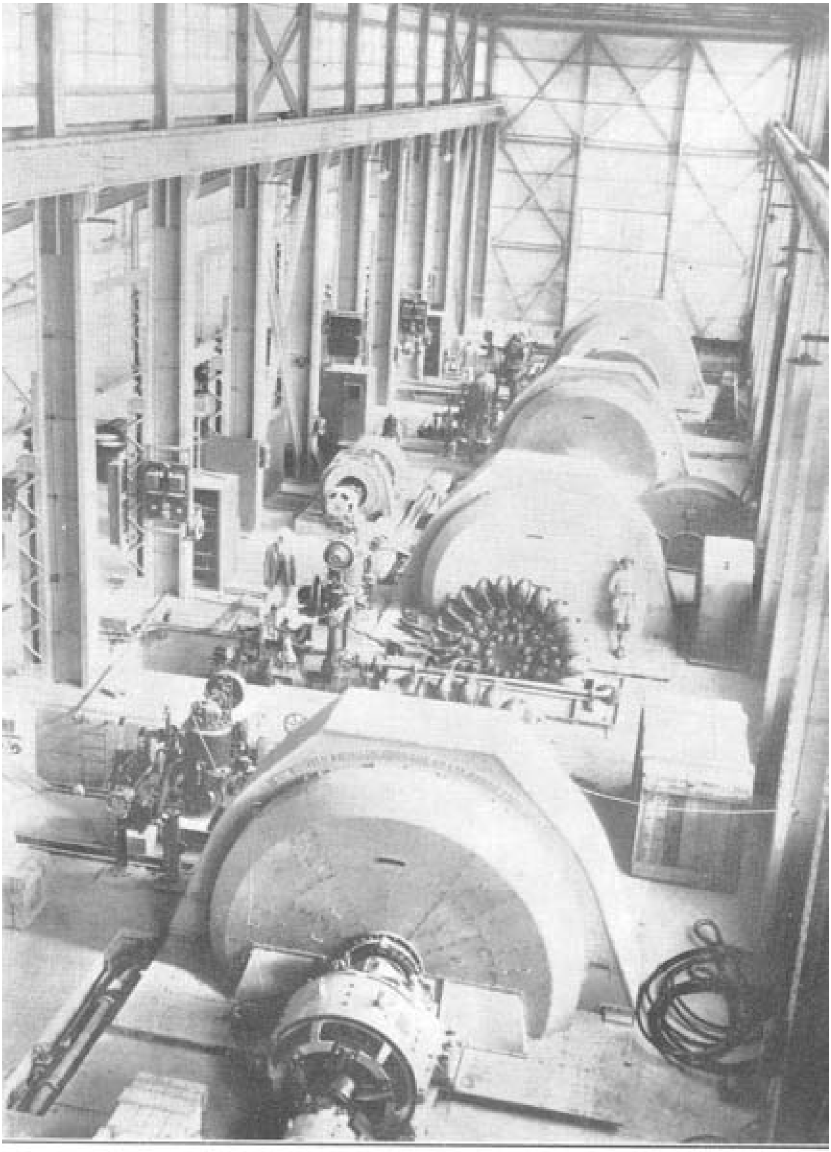
The system throughout, however, is the same—a two-part tariff with a demand element and an energy element—except for street lighting which is a three-part rate, consisting of a line charge per month per mile of line, plus a charge per lamp per month, by sizes, plus an energy charge per unit.

All distributed loads are divided into two classes, *viz.*, industrial and general. The former is for power connections (which may include up to 10 per cent. of lighting) at 3-phase 400 v. or 11,000 v., and ranges from 4 kW to 1,500 kW; while the general supply may be at 400 v. 3-phase or 230 v. single-phase at the option of the branch and ranges from 50 watts to 10 kW.

Bulk supply may be any maximum demand but is so far limited to special agreements with existing licensees.

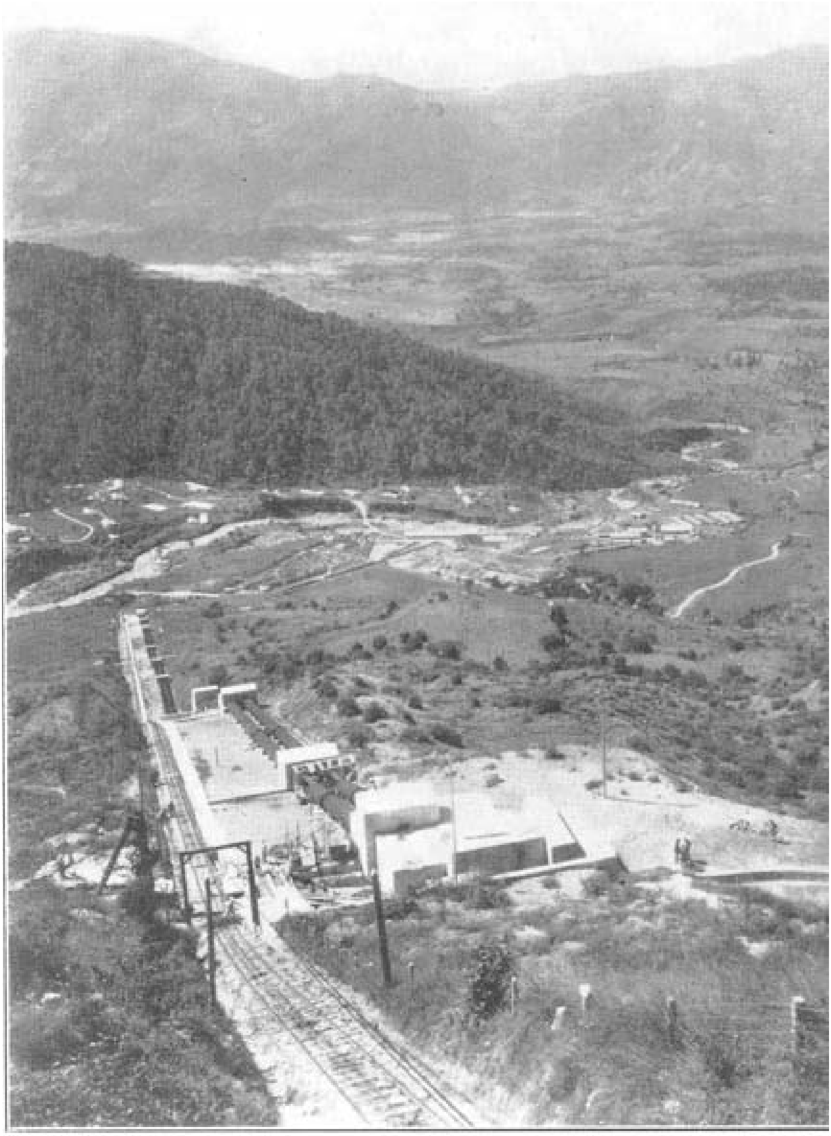
The comprehensive tariff system runs into too many pages, and is of no particular interest to reproduce in detail but the following examples will give an indication of what the Punjab public is having to pay. All are subject to 12½ per cent. reduction for quick settlement.

The "pie," for those who have not served in India is the smallest Indian unit of coinage. The rupee is 1s. 6d., there are 16 annas to the rupee and 12 pies to an anna, so that the pie is a little under a tenth of a penny.



Turbines and generators.

The Mandi hydro electric scheme - captioned photo



View of pipe line and haulageway.

The Mandi hydro electric scheme - captioned photo

(a) *General tariff.*

Connected load :

50 watts and under ..	.. 2 annas plus	..	5 annas a unit.
101–200	.. 8 annas plus	..	5 ,, ,,
501–1,000	.. 2 rupees plus	..	4 ,, ,,
2,001–3,000 ..	.. Rs. 4/8/0 plus	..	3 ,, ,,
5,001–6,000 ..	.. 8 rupees plus	..	2½ ,, ,,
Above 10,000 ..	.. ½ pie per watt connected load		plus 1½ annas a unit

(b) *Industrial tariff at 400 volts.*

Less than 4 kW max. demand ..	.. Rs. 8/3/0	..	plus 8½ pies a unit
71–130 kW ..	.. Rs. 6/1/0	..	plus 5½ ,, ,,
501–1,500	.. Rs. 4/3/0	..	plus 4 ,, ,,
Above 1,500 ..	.. Rs. 4/0/0	..	plus 3¾ ,, ,,
Above 1,500, if at 11,000 v.	Rs. 3/12/0	..	plus 3¾ ,, ,,

Bulk supply at 400 v. (power factor not to be less than ·85).

Up to 100	.. Rs. 10/0/0	..	plus 6 pies a unit
101–200	.. Rs. 9/0/0	..	plus 6 ,, ,,
501–1,000 kW max. demand	Rs. 7/0/0 per kW/month	..	plus 6 ,, ,,
2,001–3,000 ..	.. Rs. 5/0/0	..	plus 6 ,, ,,
Above 4,000 ..	.. Rs. 3/0/0	..	plus 6 ,, ,,

If at 11,000 volts, the energy charge remains 6 pies and the demand charge is reduced by ½ rupee.

From this it will be seen that a householder using say 60 units a month and having a connected load of 1,000 watts would pay Rs. 2 plus 60 × 4 annas = Rs. 17 a month.

A mill with 100 kW max. demand of motors, average load say 80 kW, working 8 hours a day and 24 full days a month and thus using 15,360 units would pay Rs. 6/1/0 × 100 for demand = Rs. 607 plus 15,360 × 5½ pies or Rs. 440 = Rs. 1,047.

A bulk supply of the same size and using the same number of units would pay 100 × Rs. 10 demand = Rs. 1,000 plus 15,360 × 6 pies = Rs. 480. Total Rs. 1,480.

The higher rate for the bulk supply as opposed to the industrial may appear surprising, but it is due to the fact that bulk supply is only given to licensed distributors and these are in a position to get a good load factor from their mixed load and can thus afford to pay a higher rate than an individual mill owner and still make a profit.

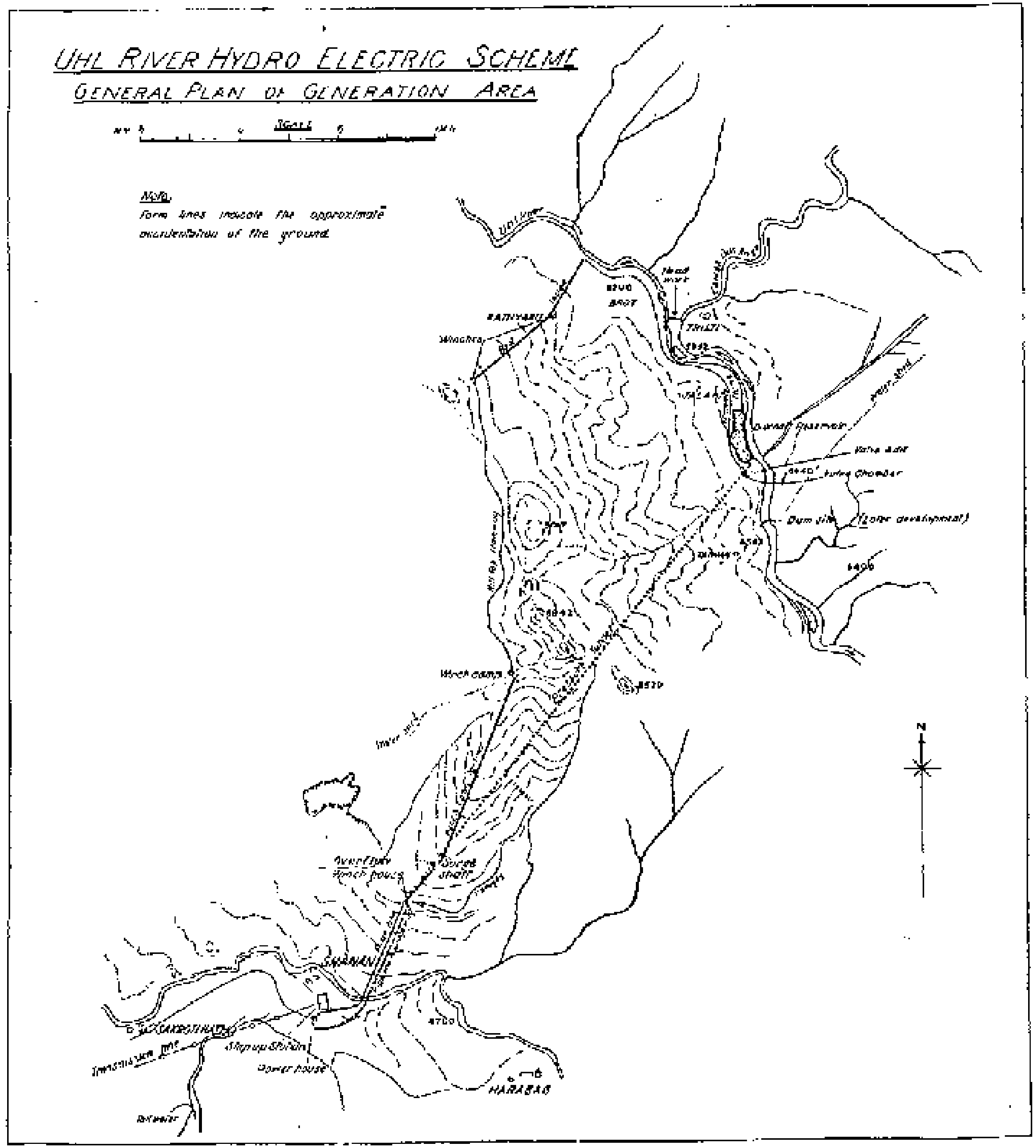
Operation.

The Lahore substation was energized with due formality on 1st March, 1933, the Viceroy performing the opening ceremony, and one by one other towns have been brought on as the local distributions were completed, the last having been given supply in October, 1934. Operating troubles have been remarkably few and not serious, except where on two occasions a line has been deliberately put out of commission by evildoers, politically aggrieved it is said. Throwing a chain across the cables is the device adopted—not, one would think, too easy to do from the ground, fifty feet below, or devoid of danger if the towers are climbed. There is, of course, no doubt that sabotage in time of trouble might be easy, as the towers themselves are isolated and would not be very difficult to bring down bodily. But this is inherent in all widespread transmission systems, and it is to be hoped that any unrest will not express itself in this particular way.

Figures showing the loading up of the scheme are not available but it is believed that it has been far more rapid than anticipated, to the extent that the necessity for the second development is being seriously considered. It is probable, therefore, that the maximum demand is reaching the neighbourhood of 20,000 kW which, after two years' operation, is extremely good progress and fully justifies the view held in this matter, against considerable opposition, by the late Colonel Battye.

UHL RIVER HYDRO ELECTRIC SCHEME

GENERAL PLAN OF GENERATION AREA



MECHANIZATION.

THE PART PLAYED AND TO BE PLAYED BY THE ROYAL ENGINEERS.

By COLONEL A. E. DAVIDSON, D.S.O., *A.D.C.*

I. THE PART PLAYED.

A. Pre-War.

BY mechanization is implied the application of mechanical power to the movement of personnel, material, or stores, on roads or across country, as distinct from transport on rails.

If one asks many of those interested or engaged in mechanization, "When did mechanization start?" one will receive a reply indicating the following lines of reasoning—"Well, I first became interested in it about the year so-and-so, so I suppose it must have started then or a little earlier."

Just to comfort those who think on such lines it may be as well to state that the French Army commenced to toy with mechanical vehicles in 1769, when a Cugnot three-wheeled tractor designed for gun haulage was tried at Paris. In the British Army, Boydell cross-country wheels were used in the Crimean War in 1855, Boydell tractors were reported on by the Ordnance Select Committee in 1856, the first Steam Sapper No. 1 was bought in 1869, and Steam Road Transport, run by the R.E., and equivalent in carrying capacity to three hundred 3-ton lorries, formed a not inconsiderable factor in the transport arrangements of the South African War of 1899 to 1902. Ammunition parks were mechanized in 1905 on a steam tractor basis; Divisional Supply Columns on a petrol lorry basis in 1910. A successful gun tractor on caterpillar tracks was made and tested in 1912.

Real progress, as in the case of flying, awaited the development of the light high-speed internal-combustion engine.

As an example of how little was known of the activities of this branch of the Army, an expert witness before the Armaments Enquiry of 1935 is reported to have stated, "In the Army at the outbreak of the 1914 war, there was, he believed, one single motor transport vehicle."

During and after the Crimean War of 1854-56 trials were made with various gun tractors, mainly by Gunners under the Superintendent of the Royal Carriage Factory, Woolwich Arsenal. At this period the only body for dealing with improvements to Army material was the Artillery Committee, and later the Ordnance Select Committee. Practically no progress in mechanization took place. The R.E. Committee did not come into being till 1862. It was formed to deal with pontooning, but subsequently took over other duties.

From 1869 to 1900 the R.E. were in sole and entire control of the Army's mechanical transport. It was used primarily as station transport and was only intended for use in rearward areas. Sappers worked in close touch with Gunners in siege trains, where one of the principal functions of the Sappers was to carry or provide the heavy timbers required for the gun platforms. The guns were drawn in trains, unmounted.

At first steam transport was looked on more as a means of mobile power for pumping, running workshops, drawing guns in trains, etc., rather than as general transport. Water shortage was a far greater problem than horse shortage.

The S. African War demonstrated that mechanical transport was of such utility that it must become a corporate part of Army transport.

As it was no longer an experiment it was decided that it was to be taken over by the Army's transport corps, the A.S.C. A Mechanical Transport Committee was formed at the War Office in 1900, and the R.E. handed over control, first of the operating side and then of the technical side, as suitable personnel became available. Right up to 1914, however, R.E. officers took a very considerable part in the technical side of the work, while searchlight vehicles were always run and driven by the Corps.

During the Great War of 1914-18 there was no official R.E. participation in mechanization other than in individual or isolated cases, which include the provision of searchlight vehicles, provision of M.T. in India in the early stages and the supply of motor-cyclist dispatch riders.

The Corps has, however, a considerable interest in the tank, which would not have come into being when it did but for the incisive writing of "Eye Witness," Major-General Sir Ernest Swinton.

Major-General Sir John Capper commanded the tank training centre, and Lieut.-General Sir Hugh Elles commanded the Royal Tank Corps in the Field in France.

B. Post-War.

Since the war various committees have dealt with the question of whether the Corps of Royal Engineers should or should not take a definite part in mechanization; the work to be carried out by the R.E.; the division of duties as between this and other Corps; the responsibilities of various members of the Army Council.

The net result has been that no specific function has been allotted to the Corps in the way of mechanization.

Eventually it was decided by the Army Council in 1924 that the design of tracked and fighting vehicles should be placed under the M.G.O., and the design of commercial types of vehicles under the Q.M.G. The respective directors concerned were the Director of Artillery and the D. of S. and T.

This arrangement was not found to be practicable, as the duties overlapped to a considerable extent, and in 1927 it was decided that all questions of design and experiment should be placed under the M.G.O., together with the supply of all M.T. vehicles not required by the R.A.S.C. The Q.M.G. was to supply and maintain R.A.S.C. vehicles.

On this a Directorate of Mechanization was instituted in 1927, and a Mechanical Warfare Board consisting of whole-time officers was also instituted to deal with the experimental and technical work. In 1934 its name was changed to Mechanization Board, with an alteration in its composition.

During this period a number of R.E. officers have been employed in their individual capacity in various posts in the Directorate of Mechanization, War Office; Mechanization Board; Designs Branch; and Mechanization Experimental Establishment. It was shown that the highest appointments in mechanization can be occupied by R.E. officers, when Lieut.-General Sir Ronald Charles was made M.G.O. in 1931, to be followed by Lieut.-General Sir Hugh Elles in 1934, and Major-General A. Brough was made Director of Mechanization in 1932.

Many R.E. officers have made considerable journeys to desert countries, either while on normal survey expeditions, road-making, on exploration bent, or as a way home on leave preferable to the crowded liner. In this way all-important road and driving experience has been obtained, particularly experience of hot climatic conditions. The more abnormal conditions can be encountered, the better for the Corps and the Army as a whole. We can hardly know too much about roads and tracks and driving in rough and undeveloped countries under Arctic or tropical conditions.

II. Present Time and Future.

What is the part that the R.E. can still play in Army mechanization?

As a Corps we are not concerned in the running of vehicles for general transport, nor are we responsible for repairs to the Army's vehicles. There are separate Corps to carry out these functions.

Assuming, however, that neither bulk transport nor major repairs in general are our function, let us look at what is being done by some other nations in the deserts under their control and see if there is not useful, if not essential, work for the R.E. to carry out.

Prior to the days of cross-country traction and long-distance aviation, the only practicable approach to the various Colonial possessions in N.E. Africa was by sea, and the French Colonial empire was not too well placed or served. The French were, however, quick to realize that this territory resembled a man's hand, with the fingers representing individual and separate colonies stretching out to the sea, but united inseparably by the palm of the hand—the French Sudan. Once this palm can be traversed freely in any direction, the separate colonies are all welded into one, with an enormous access of strength to the whole.

Hence it is no surprise to find that the French military authorities made repeated attempts to run automobiles in the Sahara from 1916, and a considerable corner was crossed about 1917 "with the aid of planks, shovels, draught camels, and elbow grease combined."

It was not till the winter of 1922-23 that a complete crossing of the Sahara, a distance of over 800 miles from water to water, was made by a Citroen convoy on half-track machines.

A more important crossing, however, was that of Estienne with a convoy of three Renault 6-wheeler pneumatic-tyred cars in the winter of 1923-24, as this established the fact that the ordinary commercial pneumatic-tyred vehicle, and not a special type, had conquered the desert.

Since then desert crossings have been multiplied, trials of cars and commercial vehicles have been carried out in the desert, and a system of regular communication on internal lines has been instituted, possibly the forerunner of a strategic trans continental railway.

The Italians, too, have executed motor convoy expeditions with very successful results in their territories west of the Egyptian Sudan. These are described in *L'occupazione di Cufra*, published in Italian.

An Eastern Odyssey, translated from the French by Major-General Sir Ernest Swinton, gives a stirring account of adventurous journeys into Central Asia on Citroen half-tracked vehicles.

No expeditions like these can be carried out without work which is essentially that of the Sapper reconnaissance mapping and position finding; the "bridging" or removal of obstacles; track construction or amelioration; water supply. Even on expeditions consisting of a couple of cars any or all of these may come into prominence, as shown in various accounts recently published in *The R.E. Journal*. Every Sapper can picture to himself how much assistance he could render on such occasions.

The conquest of the desert by low-pressure pneumatic-tyred vehicles as well as by special tracked vehicles no longer makes it necessary to follow soggy valleys to reach a military goal. The plains and deserts are free for our advance, and we must be prepared with knowledge, forethought and experience, to assist the Army to exploit the new broad avenues opened out for us by mechanization.

Turning to a somewhat smaller role, let us consider the work that could be performed by a R.E. mechanized unit working with a tank formation. Reconnaissance, improvement of routes, demolition of obstacles, particularly those in areas denied to tanks either naturally or artificially. The whole carried out with a "cavalry" mentality that does not scorn to take a "chukka" round to avoid an obstacle, rather than a Roman line which blunders through all obstacles to make the most direct route.

The desiderata required cover among other things :—

Experience in the selection of country best suited for various classes of vehicles. "Sands are not always what they seem."

Keeping M.T. on the road under difficult conditions of climate and terrain.

Practicability of existing roads and tracks for larger formations, and improvements that can be made to them in limited time.

Measures that can be taken—also with the time element in view—to improve the passage of obstacles by larger formations.

Measures for ensuring supplies.

Independence from bases.

Water supplies—how to find them, how to exploit them. (The subject of the Coopers Hill Memorial prize essay, 1935.)

Protection from climate, dust and sand.

Effects of altitude on man and vehicle.

All these are difficult to acquire at home, and every opportunity should be taken of tours of foreign service to gain experience under the most varied conditions possible.

Our field units have been mechanized ; they have been provided with power tools and appliances for the more rapid and economical execution of work in the field. We are using more and more mechanical plant on Works Services in general, and will do so in road-making in war in particular. We train and run our own drivers ; we always have to some degree.

We must carry out our own repairs as far as we can with the tools and workshop appliances supplied to our units.

Our duty to the Army is possibly more as individuals than as a Corps, although some of the latter aspects have been sketched above.

We have the best engineering training available to any Corps in the Army ; a University engineering degree course, which can be followed by an E. and M. course to balance theory and practice, and admission to current mechanization courses open to all arms. These give ample opportunities for getting into touch with civilian engineers in addition to the military side. These courses too are no bar to entry to the Staff College. They should in fact broaden considerably a *p.s.c.* officer's outlook towards mechanization.

We are trained in road construction, which should give us a wider view of the interaction of wheel and track on road, and of weights on bridges. We have great opportunities in our stations abroad of studying desert countries and tropical conditions whether definitely selected for survey or no.

Our broad and general engineering training and our practical work should make it easy to cope with the many new problems which arise continually in mechanical and automobile engineering. For example our experience of heavy-oil stationary engines, used so largely on R.E. works, has made the task of coping with modern high-speed Diesel road vehicle engines easier than if we had been educated on the petrol engine alone, and no doubt accounted for the fact that the first high-speed Diesel engines owned by the W.D. were fitted to R.E. vehicles in 1928.

In short what further opportunities could we desire to fit us to fill some of the posts that mechanization offers, organization, design, experiment, test or advice?

While mechanization is open to all in the Army, it obviously cannot be closed to those who have such opportunities as we have. It remains for us who are so fortunate in the training open to us to give of our best as required and not to turn down opportunity by questioning whither it leads. If it leads to the benefit of the Army it is clearly our duty to step in and prove the value of our training. We cannot take the attitude that, although we nursed this infant when it was young, it is no concern of ours now that it has grown out of all recognition, and we are no longer its sole preceptor and guardian.

THE WANA LADHA ROAD.

By Colonel C. V. S. Jackson, C.B.E.

A large proportion of the R.E. officers, who were serving in India in the years following the Waziristan War of 1919–20, found themselves at some time or other working on the extensive system of roads which was put in hand following those operations.

The chief roads built in those years were the circular road linking up Razmak with the Tochi Valley, and with the pre-war station of Jandola, and the road from Jandola through the Shahur Tangi to Sarwekai and Wana.

It is much to be wished that some of the officers concerned would write their experiences for the benefit of posterity. Stories, intensely interesting in themselves, were still current in Waziristan in the years 1932 and 1933, when I was C.R.E. there, but they are rapidly being forgotten, and even the sites of the camps which were household words in the post-war years are now scarcely remembered.

The completion of the Jandola–Wana road, and the re-occupation of Wana in 1930, brought into prominence the desirability of a link road between Wana and Razmak through the Khaisara. A spur road had already been constructed to Ladha in the Baddar Valley which took off from the main Jandola–Razmak road at Tauda China. This road was pushed on to the neighbourhood of Kaniguram by Lieut. E. J. Graham, R.E. The ultimate object of getting through to Wana was always borne in mind, but as the country beyond Kaniguram was closed to troops, the most suitable general route could only be guessed at.

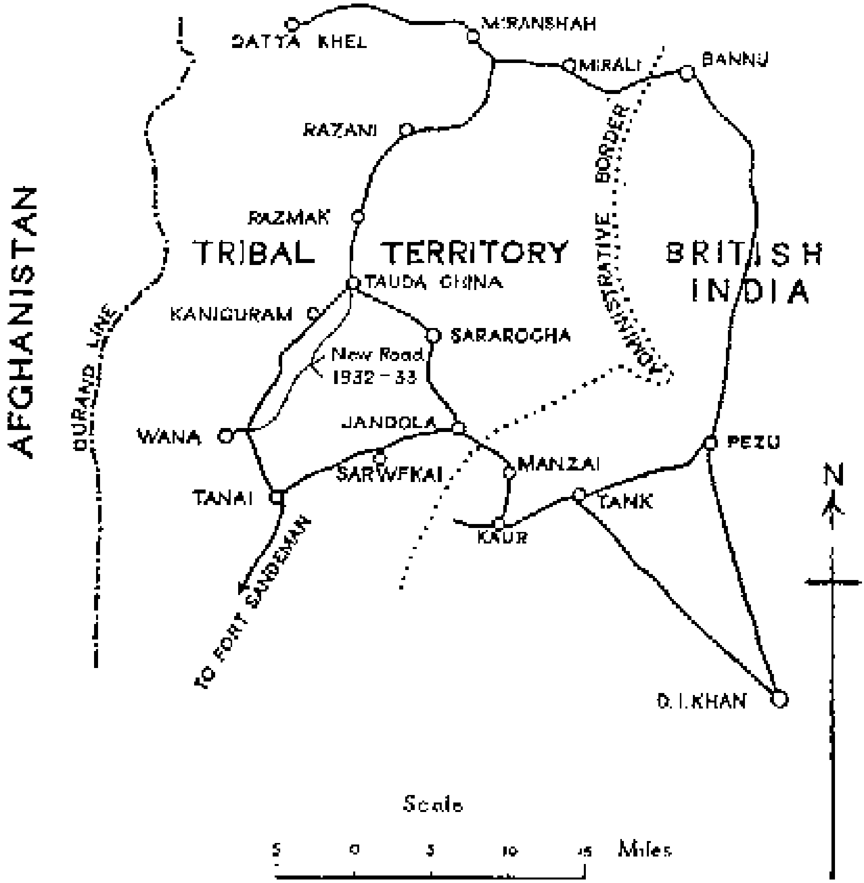
At the close of 1931, the Government of India gave their sanction to the construction of a "Class III unmetalled, unbridged road from the Bad Narai* (a small pass about two miles from Kaniguram) to Wana." The G. of I. added that the road was to be built as cheaply as possible.

Two passes, the Sherewangi Narai and the Lare Lar Narai, lead from the Baddar Valley to the Khaisara. That the road would have to cross one of these was obvious. At the Wana end there were several alternative routes, the most suitable of which could only be determined by reconnaissance. An examination of the map suggested possible routes along the Inzar Algad* the Wucha Tiarza, and the right and left banks of the Tiarza Algad.

A reconnaissance was arranged for March, 1931. Capt. W. G. Lang-Anderson, R.E., was in command, with Lieuts. R. K. Millar, R.E.,

* Narai = Pass; Algad = Watercourse.

SKETCH OF ROADS IN WAZIRISTAN



and R. I. C. Blenkinsop, R.E., as his assistants. As Lang-Anderson could not be present on the first day of the reconnaissance, his place on that day was taken by Capt. M. F. C. Martin, R.E.

The reconnaissance party was protected as far as the Khaisara by the Wana Brigade, which moved out to the Tiarza Narai. From there the party was escorted by a wing of South Waziristan Scouts to the vicinity of Mano Tsikai on the upper Baddar, where they came under the ægis of the Razmak Brigade. The whole operation occupied five days.

An escort of such a size, whilst no doubt gratifying to the sense of personal importance of the individuals whom it guards, is a nuisance. There is no way out of it—to move troops about in small packets is only asking for trouble—but on the other hand brigades cannot jump about mountains like platoons, nor can they stay out an extra day or so, on the spur of the moment, if the reconnaissance party decide that there is another bit of country which they would like to look at.

The reconnaissance party therefore has to conform in practice to the movements of the escort, which does not tend to make their job any easier.

In this particular instance every member of the party covered a distance of something like fifty miles in the five days. When it is remembered that this had to be done on foot, and involved a very fair imitation of mountain climbing, it will be understood that one of the first requisites of R.E. work on the Frontier is a good pair of legs.

All four of the routes mentioned above were explored as far as time and circumstances would permit, and the route on the left bank of the Tiarza was eventually decided upon. In coming to this decision both political and military considerations had to be taken into account.

On the map the Inzar route appeared to be the best from the engineering point of view, and the brief reconnaissance possible did not reveal any difficulties not shown on the map. This route, however, suffered from one very grave defect. It led through a debateable land claimed by both Wazirs and Mahsuds, and an attempt to construct a road there would have incurred the risk of a tribal war, which would have seriously interfered with road construction.

This is an aspect of engineering work on the Frontier which is perhaps not always realized till one has served there. Cases are always cropping up in which the obvious and easy course from the point of view of the Engineer is absolutely barred by political considerations. It is excessively galling to the Engineer, but it has to be accepted.

The route having been decided upon, as accurate an estimate of cost as was possible under the circumstances was prepared. The Government of India gave their sanction, and work was commenced in June, 1932, at the Bad Narai end of the road.

In that month Millar, whom I put in charge of the project directly under myself, established his headquarters at Ladha with a small staff of an S.D.O., two overseers and a clerk.

From now on the only soldiers allowed on the road were Millar and myself. Our escorts were composed of Mahsud *badraggas*, locals recruited by the political officer, who in return for twenty rupees a month protect the officer they are escorting from being shot, and take up the blood feud with his murderer should their efforts prove unsuccessful.

The Mahsud nation as a whole had by this time accepted the idea of the road, but it led through the heart of their country, and past Kaniguram, their most important city. Consequently, there was always the chance that, as Millar went on his daily round, some odd fanatic would show his patriotism by having a shot at him.

As may be imagined, the reconnaissance party had not had time to do more than produce a sketch of a practicable route. Anything in the way of a really detailed survey was impossible. Obviously, therefore, the first idea of Millar and myself was to go back over the whole route and get down to details. But here we found ourselves up against political considerations. Major Johnson, the Political Agent, flatly refused to let us go farther than three miles from road-head, and then only when he gave the word. As he explained to me, the whole district was deeply interested in the road, our every movement was closely watched, and our appearance anywhere would start all sorts of talk, rumours that someone's land was to be confiscated, or some cemetery violated, and finally quarrels among the various folk who considered that it was their right to undertake the road work and make their fortune.

The Mahsud, at that time, was, and possibly still is, under the impression that if he owns a particular bit of land, he has a hereditary right to undertake all contracts on or near it, and also that if he once secures a government contract, he has only to sit back and watch the rupees pouring into his bank account.

True, the country has progressed somewhat since the days when the Razmak road was built, when, as Brigadier Ogilvy told me, no contractor could join up his work to the next man's, for if he broke into his neighbour's cut, the latter promptly shot him. Still, in a country where tempers are quick and most men never stir abroad without a rifle and fifty rounds of ammunition, a very small spark may start a conflagration, and a conflagration would have defeated our main object, which was to get the road through as cheaply and quickly as possible.

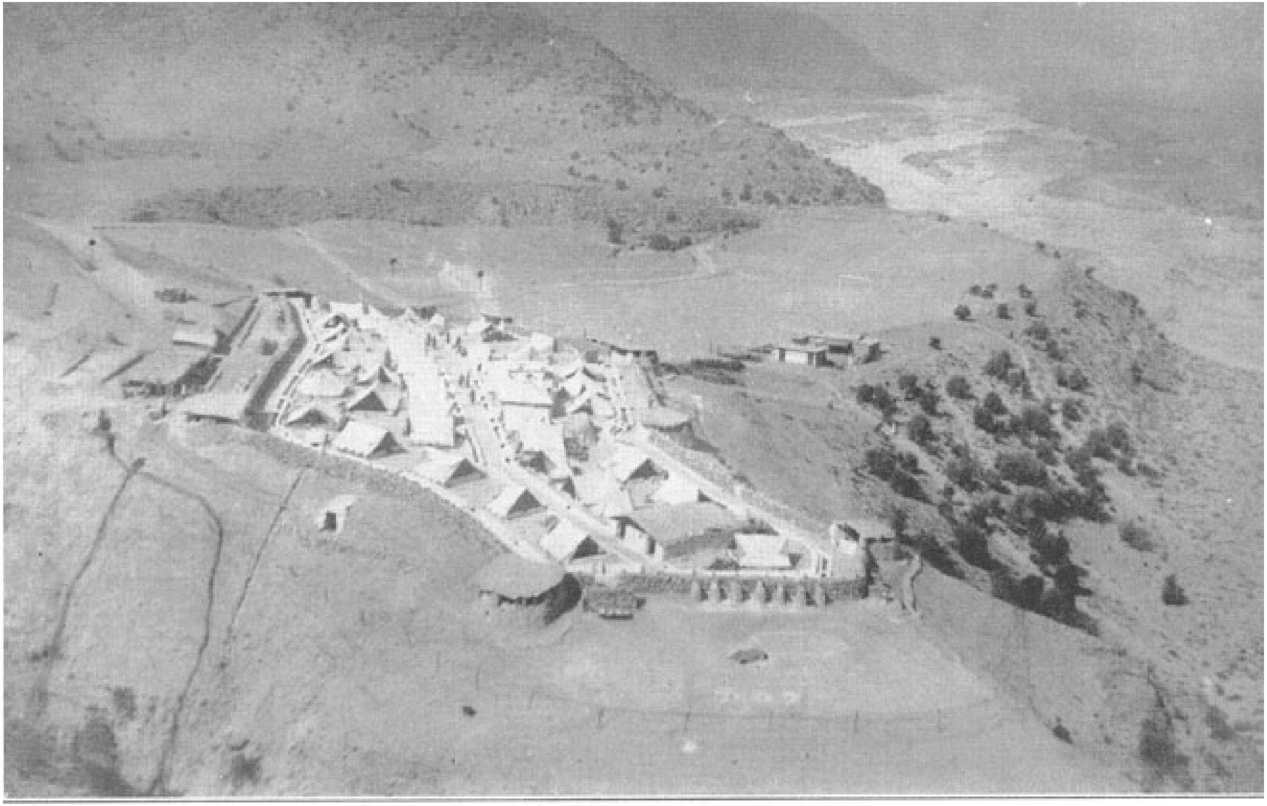
Our *modus operandi* was as follows—about every ten days or so Johnson, Millar and I would sally forth from road-head and would decide on another two miles of alignment, Millar and I working out the route roughly with a clinometer, and Johnson keeping us clear of possible trouble in respect of shrines, cemeteries and the like. We would then go on for another mile or so to make sure that we were not heading straight for a *cul-de sac*, and then return to camp.

The contractors whom Johnson had decided on for that particular stretch—there was no system of tendering—were called up to sign, or rather thumbprint, their contract documents. Then, while they collected their labour, drew their tools, etc., Millar would peg out the route with chain and level. In this way we got each section started with a minimum of fuss and talk.

Our progress on these occasions was awe-inspiring. We were generally accompanied by at least seventy men, all armed to the teeth, composed of our own *badraggas*, contractors and various locals, who came along to present petitions to the Political Agent, or to see what was happening. All these marched round us in a ring, and, as they invariably carried their rifles at a "flat slope," and consequently pointing directly at our heads, I confess to having felt con-

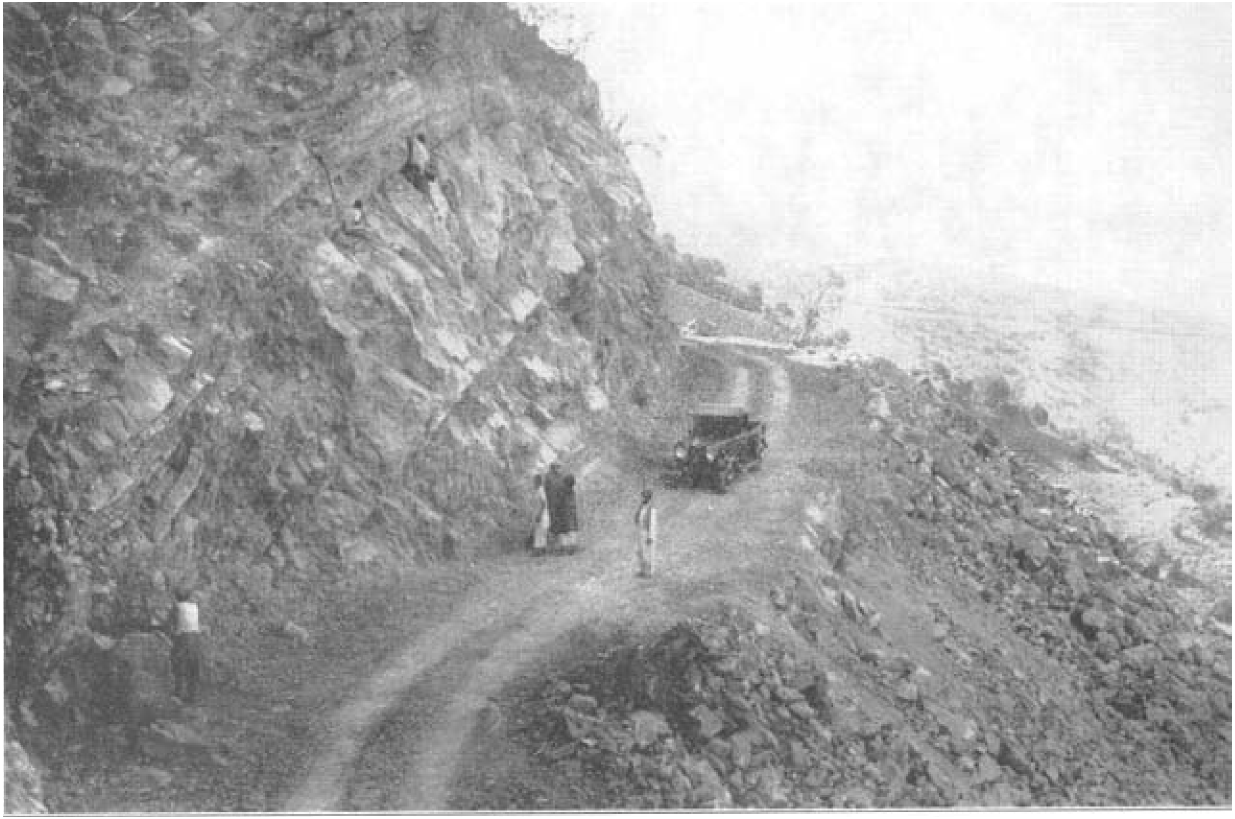
Badraggas.

The Wana Ladha road - Badraggas 1



Camp at Lower Tiarza.

The Wana Ladha road - Camp at Lower Tiarza.



The Wana Ladha road - Near the Tor Tangi. The finished road

Near the Tor Tangi. The first cut.

The Wana Ladha road - Near the Tor Tangi. The first cut.

siderable relief when the progress was over. Mercifully no rifle ever went off; I sometimes wondered what would have happened if it had. My own personal *badragga* had a pistol of which he was immensely proud. It had been buried for a couple of years, and rust had pitted the outside of the barrel a full eighth of an inch deep in places.

As may be imagined, working out a road alignment when one could not see round the corner, necessitated a good deal of guess-work. We went on the principle "when in doubt keep up." This for two reasons. The soil in that part of the world is mostly a conglomerate of pebbles and small boulders, and the mountain streams cut deep grooves with vertical sides, rising to a height of a hundred feet or more where the stream joins the main river. Also the cultivated land, which we desired as far as possible to avoid, lies, as can be imagined, on the lower slopes of the hills.

Labour was a great difficulty throughout. The Mahsud prefers fighting to digging, and the first request made by all our contractors was to be allowed to employ Kashmiri labour. To this the Political Agent objected for various reasons. In the end, however, he had to compromise and allow each contractor a ration of so many Kashmiris.

We also set our faces against the employment by contractors of downcountry *munshis*. Rightly or wrongly, we always suspected the latter of being responsible for the bulk of the complaints about final bills, which the contractors were always making. The bulk of our contractors—we had on an average eight to the mile—were illiterate, and it was a simple matter for the *munshi* to cover up his own inefficiency by persuading his employer that we had swindled him over the measurements of his work.

Work proceeded fairly smoothly, although there were several minor incidents. Three brothers, who had been allotted one contract, promptly started a quarrel among themselves, and work at their particular section was at a standstill until the Political Agent descended upon them, took security from all three to keep the peace, and gave their contract to another man; a Peshawari donkey-man, in the employ of another contractor, was killed, with three of his donkeys, by a Mills bomb thrown by some person unknown; and about every third day Millar's report contained the item: "All labour took the day off to attend the funeral of a man killed in a blood feud."

Touching blood feuds, Millar told me that while he was talking one day to a Mahsud, the latter pointed to a passer-by and remarked: "That man has a blood feud with me." "Aren't you afraid that he may try to do you in?" asked Millar. "Oh, no," replied the other, "he won't touch me on the road."

As all who have served in Waziristan know, it is an understood thing that British law and order prevail on the roads. The extension of this doctrine to the case in which the road is only a spitlocked trace, and the only representative of the Raj is an R.E. subaltern armed with a notebook, is, I think, a good instance of the pacifying effect of our rule.

All the staff of the road were accommodated at Ladha camp, to which they had to return daily before nightfall. The road was practicable for small lorries as far as the Bad Narai, though the river crossings frequently gave trouble in the rains. Beyond the Bad Narai, however, we had to walk or ride on *khassadar* ponies. Just below the Bad Narai the road alignment crossed the Baddar River, whose banks here are sheer for a height of a hundred feet or so. A deep cut had to be made, which took several months to complete, and as the work on the farther portion of the alignment progressed, the distance to walk to road-head lengthened out until eventually five or six hours a day were spent in merely going to and returning from work. It was not until October that Millar managed to man-handle a Ford van across the river, and so save several hours of walking.

None of our contractors had much spare cash, and they all appealed for advances of pay as soon as they had done any work at all, in some cases before they had even started. We early learned to cut these advances down to the bare minimum which would enable them to carry on. They were all pretty unbusinesslike, and were apt to take their advances as pocket-money, forgetting entirely that they would be deducted from their final bills. All final payments were received with a loud protest at their smallness, made as a matter of form if for no other reason.

The first serious difficulty was experienced with a party of contractors belonging to the Abdur Rahman Khel, who were given contracts in the neighbourhood of Mano Tsilai. These protested so loudly that they had been cheated that the P.A. asked me to re-measure their work. This I accordingly proceeded to do, in the presence of the P.A., the Political Naib Tehsildar, and two leading Urmar Khel Mahsuds of Kaniguram. We did not get much re-measuring done. The procedure early developed into a disquisition on elementary principles of mensuration, explained by me, in English, to the P.A., and passed on by him, in Pushtu, to the contractors. The day was very hot, and after a couple of hours everyone professed himself as perfectly satisfied with the correctness of Millar's original measurements, except the Abdur Rahman Khel. These latter fell back on their real argument, which was to the effect that they had undertaken Government work and found themselves out of pocket thereby. I daresay that they were, but it was entirely due to their own inefficient methods and nothing could be done about it. After a two-hours speech from their spokesman, who marked his points in the approved fashion by throwing pebbles on the ground, the Abdur Rahman Khel asked permission to receive what was still due to them and to depart forthwith. This was granted, though their section of the road was by no means finished.

By this time we were nearly at the point where the route would leave the course of the Baddar and lead W.S.W. for the Sherewangi Narai. The terrain here was much broken and covered with dense scrub, making it exceedingly difficult to get a view. It was evident that to find a practicable alignment would take considerably more time on the actual ground, than was available if we had to start from Ladha and return before nightfall.

After much cogitation Johnson decided that we might risk camping out for the night at Mano Tsilai. The utmost secrecy was preserved, and it was only when we started out that the O.C. Scouts at Ladha was told to send our kit after us, as we were not coming back. We passed the night somewhat nervously in an empty Mahsud house. The only attack, however, was from fleas.

Even with two whole days at our disposal it was exceedingly difficult to find a satisfactory alignment, and I eventually decided to give up the idea of making for the Sherewangi Narai direct, and to follow an old camel track to the Lare Lar Narai and thence along the ridge to the Sherewangi Narai. I have since learned from my successor that a better route can be found to the S.E. of that chosen by me, cutting out the detour by the Lare Lar Narai, and this route is, I believe, now being built.

The alignment chosen by me involved crossing a sizeable stream. Of course, the ideal spot for a bridge was already occupied by a cemetery, so we had to be content with a much inferior site.

In October Captain S. G. Hudson, R.E., came across from the Tochi with a view to taking over eventually from Millar, who was due to revert to the Home Establishment at the end of the year. His appearance was greeted with a howl of dismay by the Mahsuds. Millar, they said, knew their ways, but this new *sahib* would certainly cheat them. They were reassured and told that Millar was not due to leave for some time yet, and that meanwhile all final measurements would be made by him. History was to repeat itself next year when Hudson's relief appeared.

About this time a raid was made on the working parties by Wazirs from the Upper Khaisara Valley. They were driven off, however, without any casualties.

In November the road was through to the Sherewangi Narai, just in time to motor the E.-in-C. there on his first visit to Waziristan. We drank success to the road in sherry, and concealed the empty bottle in a cairn, for some future antiquarian to find.

Shortly before this Hudson had gone to Wana to make a start at that end. His camp was established at the old Tiarza Militia post, henceforth known as Lower Tiarza. Here the alignment was near the disputed Mahsud-Wazir Boundary. Wana itself is in Wazir country, and the P.A. refused to allow any tribal contractors to work, for fear of trouble between the two clans. For an all-too-brief period we were able to use directly employed gangs of Kashmiris and Khuttacks, and the work proceeded cheaply and speedily. We were soon in Mahsud country proper, and employing Mahsud contractors. Labour was again a difficulty, as this part of the country is waterless and sparsely populated. The lack of water, though a serious handicap to road construction, had one compensating advantage: there were no trees or scrub and one could see for miles.

At the end of December, Millar had completed measuring and paying for his end of the road, and was on the point of sailing for home, when one of his contractors complained to the P.A. that he had been cheated in his final bills.

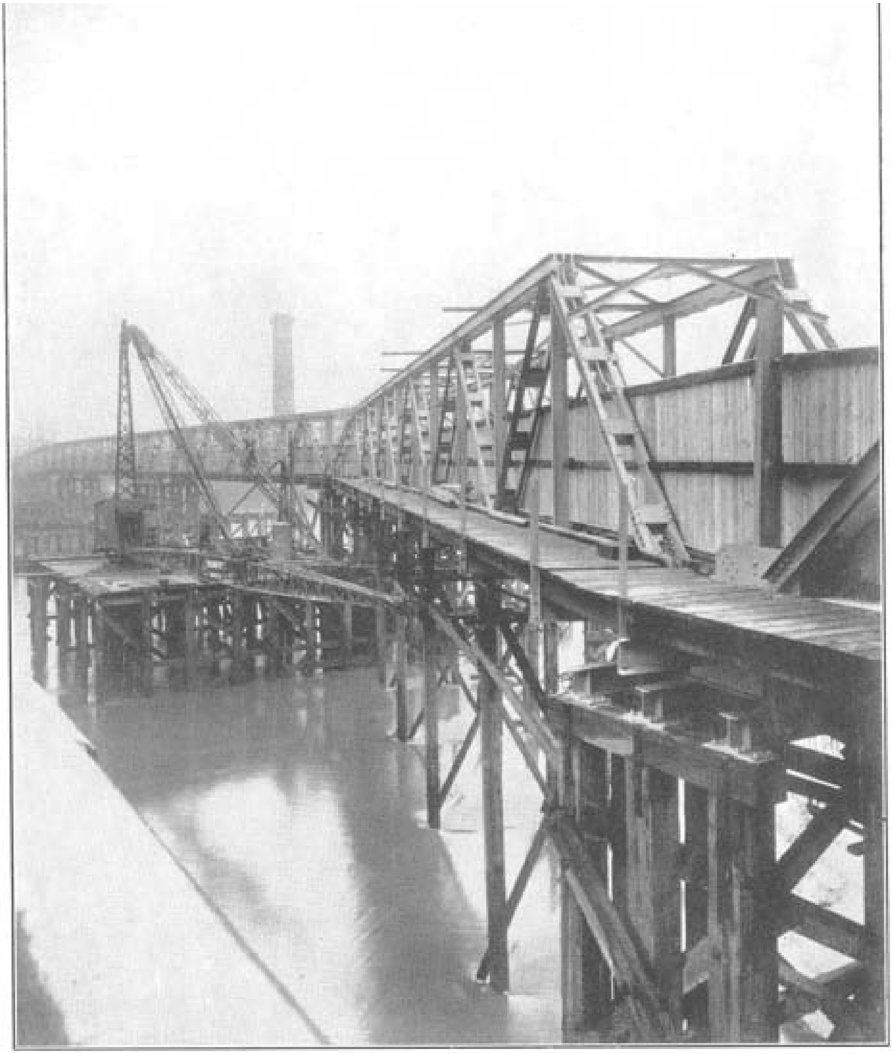
The contractor in question was a man of standing, and his action was at once known and discussed all down the road. The P.A. did not believe that there was much, if any, substance in the complaint, but the contractor was insistent, and Johnson eventually somewhat reluctantly asked me to re-measure the work, at the same time making the contractor lodge a sum of a hundred rupees, to be forfeited if the complaint proved to be groundless.

I was busy at Dera Ismail Khan at the time, and could not get up to that particular bit of the road for some three weeks, during which time the contractor thought better of it and withdrew his complaint. I confess that I was much relieved. I had implicit faith in Millar's measurements, and was convinced that the whole thing was a "try on." On the other hand traffic had been plying for some time on that particular bit, the original cutting edge would have been hard to find, and the smallest divergence between my results and Millar's would have been the signal for an endless crop of complaints from all the other contractors, who, although perfectly satisfied in the main, were not averse to getting a bit more money if they could.

In February, 1933, we were well up on the high ground above Lower Tiarza. Work was going along satisfactorily, accompanied, however, by the inevitable requests for extra advances, increase of rates, etc., etc. One contractor put in a moving appeal to be recompensed for a disastrous fire which had burnt down his camp, and destroyed *inter alia* several rifles. He was much hurt when Hudson demanded to see the remains of the rifles, and declined to believe that the latter had been completely reduced to ashes.

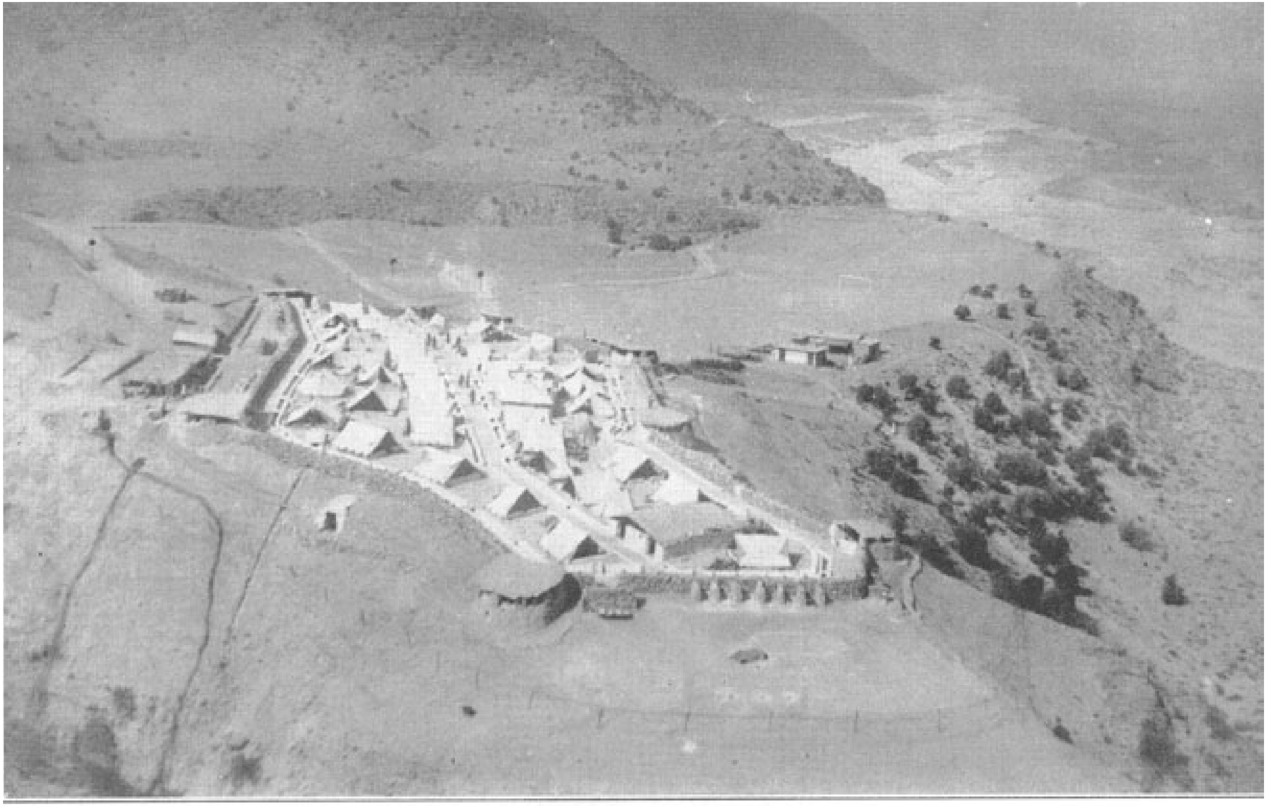
Then came the disturbances in Khost, when about a third of our labour migrated to Afghanistan to assist in an abortive revolt. This was eventually stopped after some six weeks, and our locals came back somewhat disgruntled with their attempt at king-making, which had cost them a good deal in cash, ammunition and casualties, with nothing to show for it.

We were by this time working along the side of the big *massif* to



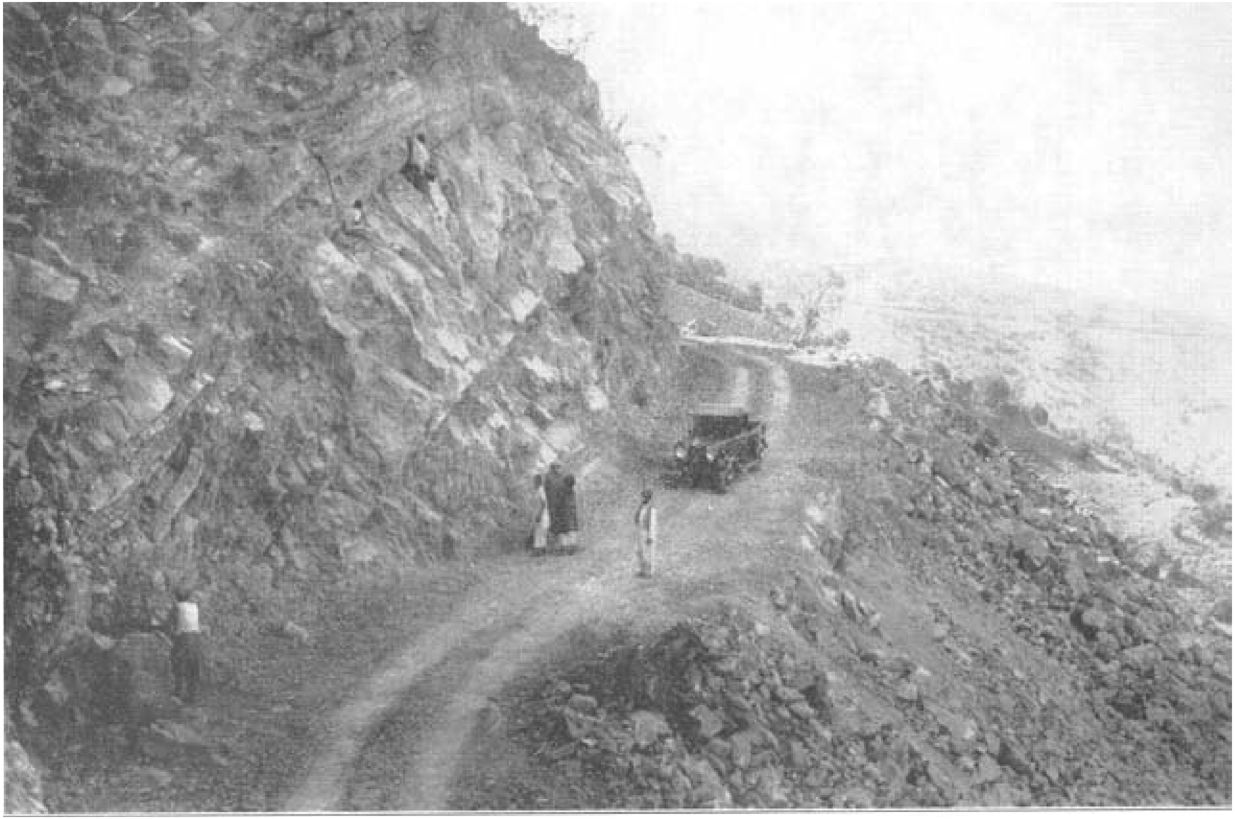
2.—Temporary footbridge nearing completion, showing contractor's gangway.

The work of the contracting engineer 2



Camp at Lower Tiarza.

The Wana Ladha road - Camp at Lower Tiarza.



The Wana Ladha road - Near the Tor Tangi. The finished road

Near the Tor Tangi. The first cut.

The Wana Ladha road - Near the Tor Tangi. The first cut.

the east of the Tiarza Valley, and had risen as we thought high enough to fetch the Tiarza Narai. As we advanced, however, we found ourselves forced higher and higher up the slopes by the very broken nature of the ground lower down. One particularly bad place, the Tor Tangi, was found to be impassable except at a height of several hundred feet above the point at which we had originally meant to cross it. This resulted in two hairpins, which could probably have been avoided if we could have seen round the corner in the first place.

Near this Tangi was another smaller one named by the *badraggas* Tim Tangi, after Hudson's dog. I wonder if the name still survives.

More labour difficulties ushered in the summer: in May several contractors refused to accept their final payments, the story that the G.E. had cheated them was retailed again, but quickly dropped, and the contractors took the line that the rates were too low. Some of them stood out for three weeks and more, but, in the end, they all came in and accepted their money with a good grace. Next came a scarcity of workmen. The summer is always a bad time for getting labour, as most of the locals are busy with their own fields. One of Hudson's reports to me contained the remark: "One contractor is starting in to construct a furlong of road by himself, a praiseworthy, if optimistic, effort."

In June Hudson hurt his back. A rock, on which he was sitting, slipped, and he got a nasty jolt on his spine. He thought nothing of it at the time, but the pain continued, and three weeks' leave in Kashmir did no good. Accordingly he went to Murree for treatment. Ionization, manipulation and various other processes did no good, and when he returned to the road in September he was in constant pain. He managed to carry on, however, until his departure for England in November.

Before his accident Hudson had introduced the Mahsuds to football. A match was played between a M.E.S. XI and an XI of *badraggas*. The latter introduced a variation of their own into the game. They ruled that a goal did not count if the ball was promptly returned into play after passing the goal-posts. They then reinforced their XI with an extra goalkeeper and a long-stop, and beat the M.E.S. 2—1.

Lieut. R. S. B. Ward, R.E., joined the staff of the road in June. His arrival produced the same outcry that had heralded Hudson's six months before—"who was this new *sahib*, and what did he know of their ways?" They insisted that final measurements must be left over till Hudson's return from leave, but when his absence was prolonged they changed their minds, and accepted Ward's measurements.

The base camp at Lower Tiarza was by this time inconveniently far back for work. A Ford van had been manhandled through the camp and was plying on the forward stretch of finished road, but there could be no through traffic till the camp was moved, as the latter occupied the site of an eventual hairpin bend. The South Waziristan Scouts went forward in August to a new camp on the Tiarza Narai. They were preceded by the P.A. and Ward, who camped there for the fortnight before their arrival, guarded by *badraggas*.

September saw the last serious upset to our plans. A war started up between the Mahsuds of the Lower Khaisara and the Wazirs who owned the country north of Sperkai. The P.A. decided that it must stop, took hostages from both sides, and to prevent any recurrence, proclaimed a no-man's-land about two miles long between Torwam and Sperkai.

The cessation of a brisk little campaign, more or less in the area in which we were trying to get on with road-making, was all to the good; but what was not so good was that, owing to this no-man's-land, the road had to be taken up the left bank of the *nullah* leading to Sherewangi Narai, instead of the much easier route by the right bank, as had at first been intended.

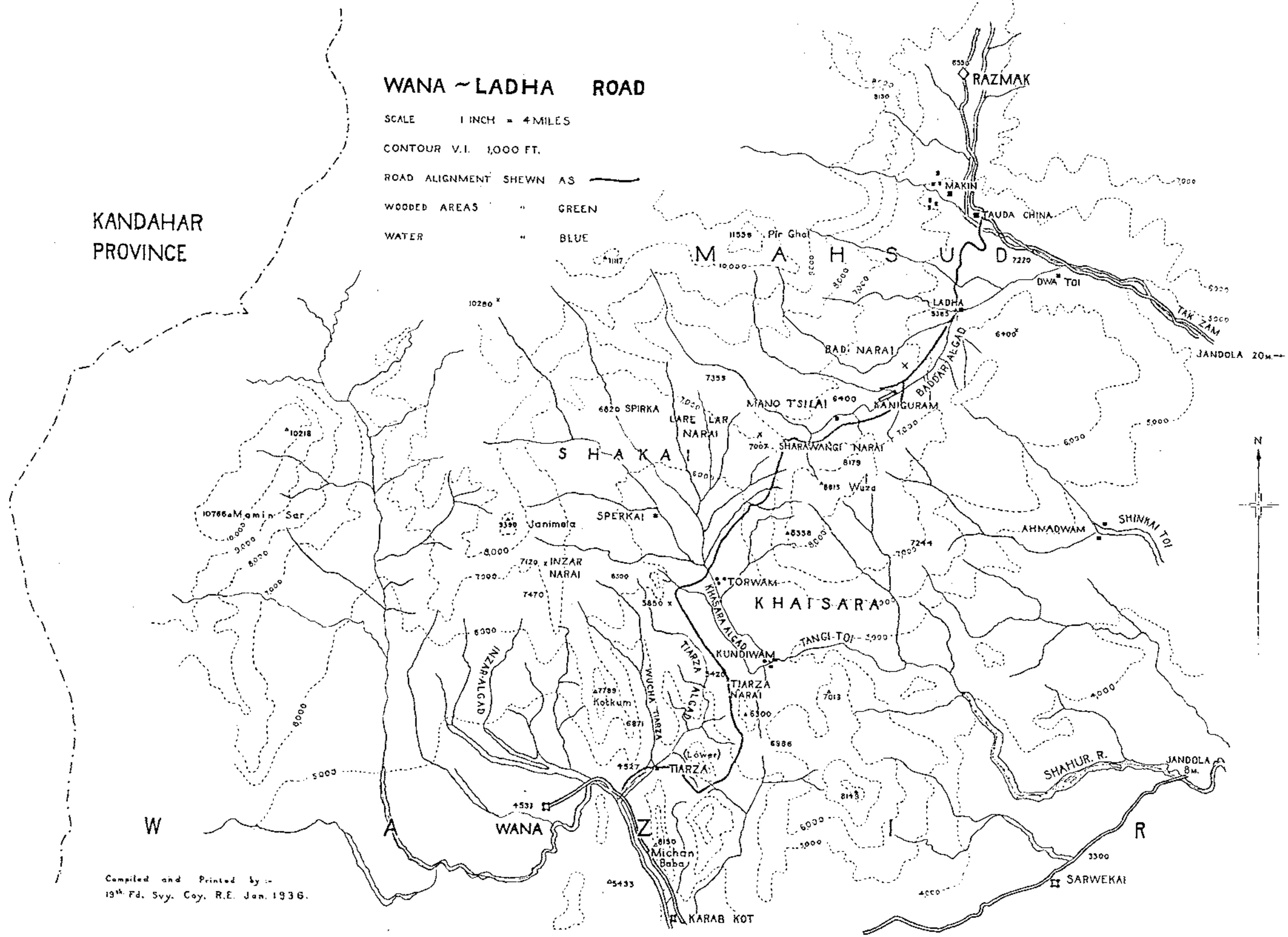
Hudson returned from sick leave in time to lay out the last lap to the Sherewangi. The Abdur Rahman Khel turned up again to take up contracts in this sector. Hudson, remembering the trouble of the previous year, had a couple of reserve contractors standing by. The Abdur Rahman Khel hearing of this, asked indignantly if they were not trusted. Hudson answered frankly "No," whereupon the A.R.K. laughed, got on with the job, and finished it without further trouble.

It fell to the lot of Ward to join up the two ends of the road. He got "through" in December. The first through trip was marred by an unfortunate accident. As the party was returning to camp from the Sherewangi, one of the rearguard, a *badragga jemadar* I think it was, was showing his revolver to his companion, a blacksmith, when the latter managed to let it off, hitting its owner. The blacksmith seeing what had happened lost his head, and started to run, when the *jemadar's* orderly, seeing his master fall, and his assailant running away, shot the blacksmith. The rest of the party, on hearing the shots, hurried back to find one man dead and one badly wounded. The relations of the two men were about equally distributed among the party, and a very ugly scene looked like developing, but Ward and the M.E.S. staff managed to keep things more or less quiet until the purely accidental nature of the shooting could be established.

The road was officially opened to traffic on January 9th, 1934.

On my last official visit to it in April the assembled Mahsuds unanimously petitioned that Ward might be put in charge of any further road-making, "as he knew their ways."

I have said nothing in this account of technical matters. I should


WANA ~ LADHA ROAD
SCALE 1 INCH = 4 MILES
CONTOUR V.I. 1,000 FT.
ROAD ALIGNMENT SHEWN AS
WOODED AREAS " GREEN
WATER " BLUE
KANDAHAR PROVINCE
RAZMAK
MAKIN
TAUDA CHINA
Pir Ghal
M A H S U D
DWA TOI
LADHA
TAK ZAM
JANDOLA 20M.
BADI NARAI
BADDAR ALGAD
MANO TSILAI
KANIGURAM
SPIRKA
LARE LAR NARAI
SHARAWANGI NARAI
S H A K A I
Wuza
Mamin Sar
Janimela
SPERKAI
AHMADWAM
SHINKAI TOI
INZAR NARAI
TORWAM
KHAISARA ALGAD
K H A I S A R A
TANGI TOI
KUNDIWAM
INZAR ALGAD
TIARZA ALGAD
TIARZA NARAI
WUCHA TIARZA
Kotkum
(Lower) TIARZA
SHAHUR R.
JANDOLA 8M.
W A Z I R
WANA
Michan Baba
KARAB KOT
SARWEKAI
N
Compiled and Printed by :-
19th Fd. Svy. Coy. R.E. Jan. 1936.

THE INDIVIDUAL TRAINING OF A.A. SEARCHLIGHT UNITS.

By LIEUT.-COLONEL M. F. GROVE-WHITE, D.S.O., O.B.E., *p.s.c.*, R.E.

1.—THE NEW PROBLEM.

WE are, at the moment, passing through a phase of expansion in the Corps, chiefly as a result of the creation of a number of new Anti-Aircraft Searchlight Units. It is accordingly necessary to consider the training of these units and to determine whether or not it can be conducted along the lines hitherto recognized as correct for other field units.

The personnel of A.A.S.L. units are soldiers and must be trained as such ; that is, they must be trained in drill, minor tactics and the use of their weapons. They are also Sappers and must be exercised, consequently, in military engineering and their trades. But in war they will be judged, not so much by their prowess as soldiers, nor by their skill in field engineering, but by their ability to deal with hostile aircraft.

Their training in anti-aircraft work, therefore, must have absolute priority over every other subject. But work against modern high-speed aircraft almost demands perfection in training ; second best is not good enough. Success or failure is a matter of seconds, and where a really good detachment will pick up and hold a target, a detachment only slightly less good may not pick it up at all. When we say, then, that anti-aircraft work must have absolute priority, we mean just that, no more and no less.

Unless and until detachments are efficient from an anti-aircraft point of view, military, field engineering and, to some extent, trade training must, unfortunately, go to the wall. If this principle is neglected, no matter how much we may dislike it, anti-aircraft units will not be efficient at their own job. They will be like the generals pilloried by Napoleon for seeing too many things at once, and will achieve about the same success.

This theory, if it is accepted, upsets ordinary ideas on Sapper training considerably. Normally, we assume that all Sappers are trained in military engineering, and so, in considering the composition of a unit, we lay great stress on trade qualifications and trade skill. But in the greater part of an anti-aircraft unit a man's trade is quite immaterial. It is his anti-aircraft skill that counts.

have liked to give interesting details of surfacing materials, and the use of road-making machines. I cannot, however, because the Government of India could not afford the first, and political considerations forbade the second.

I hear some reader remark: "Then what in the world is all this about? They got some picks and shovels, and some contractors, and made a road! They had the usual troubles with their labour, and that is all there is to it."

Certainly very few jobs go through perfectly smoothly from start to finish, and difficulty with contractors is an experience which every R.E. officer meets with at some time or other; but in a country like Waziristan, where the bulk of the inhabitants have lived, for generations, an isolated life in their own glens, their hand against every man, and every man's hand against them, such difficulties are accentuated, and one must watch one's step as one would never think of doing in other places. I confess that if I could have known, in the first twelve months, that the story of the road would eventually sound so tame, I would have felt much happier.

I think we all of us really liked the folk we came in contact with, and thoroughly enjoyed working with them, but they take some knowing. They combine a keen shrewdness, where their own interests are involved, with a childlike capacity to believe the most unlikely stories. Add to this a very touchy temperament, and a hereditary belief that the easiest solution of most problems is a well-aimed bullet, and one can understand how a chance word or act can start far-reaching trouble.

In all work on the Frontier the major responsibility rests on the shoulders of the R.E. subaltern or captain directly on the work. Three qualities are essential, meticulous straightness, perseverance and knowledge of the men he is dealing with.

Measuring and billing must be carried out to the last limits of accuracy, however trivial the sum involved may appear to be, and the R.E. officer must be prepared to watch, with cheerfulness, a carefully thought out plan abandoned for a reason unforeseen, and possibly, in his eyes, unimportant.

In conclusion, I must pay a tribute to one R.E. officer whose name has not so far been mentioned. I refer to the late Lt.-Col. G. H. J. G. Morris, M.C., R.E., C.R.E. Waziristan District from 1929 to 1931. He was concerned with all the preliminary details of the project from its inception, and was responsible for the arrangements of the reconnaissance which took place a fortnight after he died. He knew the district and its inhabitants intimately, and his death, brought on by a chill contracted while doing hard work when he was still suffering from the after-effects of influenza, was a great loss to Waziristan and to the Corps.

The peace and war establishments of A.A.S.L. units vary, but the peace establishment of a mobile company may be taken as an example. This consists of a company headquarters of 14 other ranks, of whom 2 (clerks) are tradesmen, 3 (1 storeman and 2 drivers M.T.) are pioneers R.E. and 2 are drivers I.C.; a company pool of 35 other ranks, which is merely intended to replace wastage during the training season, does not exist in war, and need not be considered further here; a repair party of 18 other ranks, including 1 blacksmith, 1 carpenter, 1 draughtsman, 1 electrician, 2 fitter-drivers, 2 instrument mechanics, 1 painter, 1 searchlight operator, 1 tinsmith and 1 turner, the whole being supervised by 2 mechanists E. and M.; and 2 sections.

Each section consists of section headquarters and 6 detachments. A section headquarters has 9 other ranks of whom 4 are tradesmen (carpenter, electrician, instrument mechanic and painter), 3 are pioneers R.E. acting as visual plotters or motor-cyclists, and 1 is a driver I.C. Each detachment consists of 9 other ranks, of whom 1, the lorry-driver, is supposed to be a fitter-driver; 1 (the projector controller) is an S.L.O.; 1 (the lamp attendant) is an electrician; 2 (the spotters) are electricians or S.L.O's, and 4 (including the listeners) are pioneers R.E.

The idea underlying this organization is that the tradesmen in a detachment should be able to carry out the minor repairs which can be tackled with hand tools, a blow-lamp and a soldering iron, being assisted by the personnel of section headquarters if necessary, while heavier repairs are undertaken by the company repair party with their workshop lorry. This repair work, however, is a secondary consideration in so far as the sections are concerned. So long as the spotters are good spotters it is convenient but not essential that they should be good tradesmen. The lamp attendant, it is true, must be an electrician or a searchlight operator, and the lorry-driver must be able to drive his lorry and keep it going steadily for stationary running but, beyond that, trades are not essential at all. What *is* essential is that the personnel of detachments should be efficient at their anti-aircraft duties and that the personnel of section headquarters should be proficient visual plotters or dispatch riders or both. The only other personnel who must really be tradesmen—and good tradesmen at that—are the men of the company repair party.

Hence, in a company, it is only necessary that 38 out of 193 other ranks should be tradesmen in Groups A to D. In an A.A.S.L. unit peace establishment, therefore, the trades establishment is relatively unimportant but a table of A.A. qualifications is indispensable. So far as is known no such table of A.A. qualifications has ever been published for any A.A. unit.

In considering the training of such a unit the minor problem is who are to be trained as tradesmen and how. The major problem is *who* is to be trained as a detachment commander, as a listener, as a sound locator director, as a spotter, as a projector controller, as a lorry-driver, as a visual plotter or as a dispatch rider, and *how*.

2.—WHO?

If, as has been asserted, successful A.A. work is a matter of seconds, it would seem natural to choose, for the various duties, men who are by nature most suited to them. This, however, is not always done. Cases have often occurred in which the new idea has been fallen-in, divided into groups of eight, and then told-off to duties by the orderly corporal or, with luck, by the C.S.M., in some such manner as: "You're a lorry-driver; you're a listener; you're a spotter," etc. This, of course, is not only grotesque but extremely reprehensible and argues slackness or ignorance on the part of whoever is responsible. The natural capacity of men for listening, spotting, mechanics or the like varies enormously and it is only after exhaustive tests to discover men's personal abilities that they should be allotted for training in the various duties. First, however, it is necessary to know the qualities which members of a section should possess.

3.—QUALIFICATIONS.

(*a*) *The Detachment Commander.*

This N.C.O., who may be a Serjeant, Lance-Serjeant, Corporal or even Lance-Corporal, must be carefully selected. In many ways he has responsibilities which are quite unusual. It must be remembered that, in war and, to a considerable extent, in peace, his detachment will be at least two miles away from any other detachment and probably much farther from his section headquarters. He may see his section serjeant once a day when he comes round with the rations; and his section officer once, or, if he is lucky, twice a day. He is not connected by telephone to anyone, nor has he any means of sending a message except by a runner on his feet. For most of the day, therefore, he must be prepared to act and think for himself, to accept responsibility, to meet emergencies as they arise, to preserve order and discipline in his detachment without assistance, and to devise and take the steps necessary for the security of his men and their equipment. His detachment is merely told to go to a certain spot and to be in action at a certain time. He has to settle his own time of parade, to make sure that he has everything necessary for working and living, to find his way to the site, to get his searchlight into action, to arrange his camp with due regard to health and sanitation, to see that his men are well fed (he is given camp kettles, a frying pan, a few knives and forks and other culinary utensils, and for the rest has to build his own field oven, etc.) and to be prepared to deal with hostile aircraft in any numbers or formations, by day or night, making an intelligent selection of his target in accordance with the tactical situation. In addition he must make the necessary dispositions to protect himself and his detachment from low-flying aircraft, hostile A.F.V's, or ill-disposed persons such as rifle thieves.

It will be seen, therefore, that a detachment commander must possess initiative, power of command and sense of responsibility in a very high degree. In fact, many men who would make good, steady, reliable section serjeants would be quite unsuitable as detachment commanders.

(*b*) *Lorry-Driver.*

The searchlight lorry-driver must have very superior qualifications. He is always on his own. In addition to being able to drive well, having a good traffic sense, and a thorough knowledge of the highway code, he must be able to keep a steady voltage for stationary running. He must be able to carry out ordinary maintenance on his lorry and dynamo and to diagnose faults correctly in his engine, transmission and electrical circuit, to use files, scraper, hack-saw, blow-lamp and soldering iron, and to mend punctures in tyres. In fact, his qualification must correspond to those laid down for a driver-mechanic, Class I. Above all, he must have a mechanical sense. In addition, he must have eyes like a hawk and ears of the same standard since, in action, his lorry is some 250 yards from the rest of the detachment and he must be constantly on the look-out for ill-disposed persons.

(*c*) *Spotters.*

These individuals must have a natural ability to judge the present position of an aeroplane in the sky from its sound. In addition, they must possess the power of seeing in the dark, voices like bulls, and the ability to use glasses which, it may be noted, is a gift not by any means conferred on everyone. This, however, is not all. Quick co-ordination of eye and voice and power of observation; that is, the gift of taking in what they have seen, is equally important as is, also, a clear enunciation.

(*d*) *Listeners.*

"Ears," obviously, are the chief qualifications required here. In the first place the man must not be "hard of hearing" in either ear. Next, the efficiency of the two ears should be fairly well balanced. It is important, also, that the listener should not be subject to headaches, colds in the head, toothache or any other ailment which may react on his ears or brain. Lastly, and most important, he must possess the binaural sense. For the benefit of the uninitiated it may be explained that this is the sense that enables any individual to turn and face an unseen source of sound. It is unnecessary to discuss its *raison d'être*; that is fully explained in the text-books on the subject. The point is, that an individual listening with the stethoscope tubes of a sound locator, as he turns the trumpets from side to side or up and down, across the source of sound, *feels* the sound passing from one side of his head to the other. Some feel it passing across their foreheads, and some round the back of their heads, but, alas, some never feel it at all, and they are no use as listeners.

(*e*) *Projector Controllers.*

These men, it must be remembered, are constantly watching the end of their beam which is extremely bright. When the target is found they have to see and follow it in the beam and it is very often a very small and faint object. Hence they must have eyes which can stand a glare and which can see a faint object in that glare. Many men's eyes water after a very short time and they are no use as projector controllers.

Further, they must have "hands," for the projector is well balanced and a very small movement of the control arm or hand-wheel may throw the beam right off the target.

Finally, they must have acute hearing, to enable them to catch and give effect to the directions of the spotters or sound-locator director.

(*f*) *The Sound-Locator Director.*

This man is generally the Junior N.C.O. of the detachment. His duty is to transmit orders to the projector controller whereby the apparent end of the beam is placed on the right part of the circumference of the ring sight. He must be able to judge the course of the target and also to estimate its position in relation to the beam, so that he can give the necessary directions as regards searching. The quality which he chiefly needs is intelligence.

(*g*) *The Lamp Attendant.*

This man may be a searchlight operator; that is, he has a trade corresponding, to all intents and purposes, to pioneer electrician. He must be fairly well educated and intelligent to enable him to learn the rudiments of electricity and magnetism. He must be cool so that he will not lose his head if anything goes wrong with the electrical circuit—a "short," for instance—and he must be observant and quick-witted, so that he can detect and deal with any minor breakdown immediately. If the fan stops or the positive head ceases to revolve, a great deal of damage may be done unless the defect is noticed at once.

4.—Selection.

On coming up for training in A.A.S.L. work, then, all men should be tested with a view to ascertaining their natural qualifications and should be allotted to duties accordingly. These tests, moreover, should be repeated at least once a year, since sight often tends to fail or hearing to become dull. A little thought and ingenuity will suggest many ways in which these tests can be carried out. It is proposed to give only a few examples here, since a complete list could never be compiled and would occupy far too much space if it could.

Since the efficiency of a detachment depends primarily on the work of the sound locator it is natural, first of all, to try to find good listeners.

An easy way of arranging an initial test is as follows. The man under test is stationed at some fixed distance—say six feet—from a suspended microphone in which a buzz, such as an ordinary mains buzz, can be induced. A simple control is introduced whereby the loudness of this buzz can be regulated—the switch being fitted with a graduated dial and pointer. It is desirable, also, to introduce a noiseless mercury switch whereby the buzz can be cut out altogether.

The man stands sideways to the microphone so that one of his ears is directly opposite to it. He may be provided with a switch whereby a small lamp is turned off and on. He is directed to turn on the lamp whenever he can no longer hear the buzz.

The buzz is then turned on fairly loudly and gradually reduced, being cut out altogether from time to time by means of the mercury switch. This prevents the man from imagining he is hearing when he is not, or, in any case, warns the instructor when imagination is playing too free a part. As soon as the buzz can no longer be heard the graduation on the dial is noted. The test is carried out several times on each ear in turn and the mean of the results for each ear is taken.

This test shows several things. It shows if the man's hearing is up to the average. It also shows if it is more or less the same in each ear. Further, it shows, by the speed with which the lamp is switched on and off, the quickness of reaction between ear, brain and hand.

Having passed this test successfully, the man is put on to the azimuth trumpets of a sound locator and is required to listen to the sound of a stationary buzzer. He is made to move the trumpets from side to side until he can recognize his binaural sense and has discovered his "binaural spot," which is the point in his head where the sound seems to be when the trumpets are pointing directly towards the buzzer. Having made these discoveries, if he ever does, he is put on to a sound locator and required to follow a moving buzzer. He is blindfolded or prevented in some other way from seeing it. The instructor, by following over the sights, can determine the accuracy with which the man is listening. This test is designed to discover to what extent the man, by keeping the sound on his "binaural spot," can succeed in following a moving target accurately.

Finally, the man is probably given a series of runs at an actual aeroplane, by day, with the "Instrument, Testing, Listeners," which is an article of equipment issued for the purpose and which automatically records on paper the accuracy of listening.

At the end of these tests, which can be varied almost indefinitely, it should be easy to pick out the best listeners.

At this stage, since the listeners are, as a rule, also the Lewis gunners,* it is advisable to test their capacity in this direction also. It is not always possible to carry out the test with live ammunition on the range, but this is not strictly necessary. Lieut. Paxton-Petty, R.E., has evolved an alternative method. In this an eccentrically-pivoted weight, made to revolve by a motor and flexible drive, is strapped to an A.A. Lewis gun in front of the mounting. This, when working, causes the gun to vibrate in much the same way as when it is being fired. Attached to the gun, also, is a spotlight of the type commonly used in the miniature range. The gun can be so arranged that the release of the bolt, by pressing the trigger, switches on the light and starts the vibrator. The gun can then be used without ammunition against a moving A.A.L.A. target, the position of the spotlight showing whether the gunner is taking a correct aim, swinging steadily and holding his gun firmly. Of course, if it is possible to carry out a test with live ammunition on the range, so much the better.

Now we come to the spotters. First we must test their power of seeing in the dark. This may be done by arranging a series of capital letters, cut out of cardboard or three-ply and painted black, on a board which is painted grey on, say, the left, gradually shading to black on the right.

The man under test is placed at some convenient distance from this board in a partially darkened room and asked to read the letters. The extent to which he can do this will give a very fair idea of the efficiency of his night sight. The test should be repeated several times with different arrangements of letters, since some are easier to read than others.

Next the power of using binoculars must be tested. This can be done by making him read writing of graduated size from a distance. It is useful to test his power of picking out a small object against a background of the same colour, such as a green ball on a lawn.

* In low-flying attack, where A.A. Lewis guns are likely to be of use, sound locators will be of little value. Hence, the listeners are the most suitable numbers to man the Lewis guns.

Finally, the clearness of the man's articulation must be tested by making him shout the ordinary spotters' directions such as "Right," "Left," "Up quick," etc., and seeing if these orders can be distinguished, even against the wind, at a range of from 30 to 50 yards. Some men fail dismally in this test.

It is not proposed to describe tests suitable for other numbers. Anyone can think them out for himself. The examples given above are sufficient to describe the way in which the problem may be tackled.

5.—How ?

By means of the tests already described the task for which each man is best suited can be determined. It is worth noting that the natural gifts of individuals vary enormously. Some men seem to pick out an unilluminated aeroplane on the darkest night at almost any height. These are worth their weight in gold as spotters. Others, again, seem naturally able to get "on sound" in any circumstances with uncanny accuracy and rapidity. They have also the gift for picking out the faintest aircraft sound from a welter of background noises. Nevertheless such men are few and far between and the general efficiency of an anti-aircraft searchlight unit must be based on thorough and intelligent individual training. Actual night work against aircraft is, of course, indispensable but an infinite amount of time and effort will be wasted unless men are properly trained first.

It is desirable, at this stage, to point out that the term "individual training" means just what it says—the training of the individual. It does not mean an attempt to reproduce collective training, in miniature, indoors. Yet one often sees the time, which should be devoted to individual training, used in working a miniature searchlight layout in a dark room. This at the best only trains detachment commanders.

(a) *General Training.*

In anti-aircraft work, as has been said above, success or failure may be a matter of seconds. Hence "delay action brains" may ruin everything. The first and most important step, therefore, is to speed up the intelligence and reactions of everyone involved. For this purpose the quickening-up exercises used in P.T. are extremely useful. Kim's Game, also, is excellent but it should not be made too simple. A man should not be required to observe that a penholder or a ball-bearing are on the tray, but that a yellow, varnished penholder with a Waverley nib and a steel ball-bearing of $1\frac{1}{8}$-in. diameter have been seen. Similarly, the number of objects can be increased and the time cut down until seeing is observing.

The children's game of "Snap" is an excellent exercise for the co-ordination of eye, brain and voice. As such it is of value to spotters. If played with cards bearing the silhouettes of aircraft, or with the pictures of aircraft recently printed on the cards contained in a well-known brand of cigarettes, it may assist in the recognition of aircraft as well.

Many other games can be invented to improve the co-ordination of hand and eye, eye and voice, hand and ear, etc.

(*b*) *Listeners.*

The individual training of listeners can only be done by making them listen to stationary and moving buzzers and to actual aircraft. Listening, however, as such, is of little value unless faults are constantly checked. It is easy enough for the instructor, by using the ring-sight, to do this. Each sound-locator director should know the idiosyncrasies of his listeners inside out and be prepared to allow for them. Some men are inclined, when tired, to listen behind or below, high or in front. Some have a personal error when the wind is blowing towards them; almost everyone has some individual peculiarity and these can all be corrected or allowed for.

For indoor training the Hart Teacher is valuable. This is a sound locator in which a buzz is induced in the ear-pieces corresponding with the movement across a dark room of an electrically-operated target. The locator is fitted with a spotlight attachment whereby the accuracy of listening can be determined.

Similarly, the Instrument, Testing, Listeners used out of doors against an aeroplane will show the accuracy of the listening in graphical form.

It should be noted that, however thorough the training, it is not usually possible to rely on listening, under service conditions, to a closer degree of accuracy than $2\frac{1}{2}°$. Now, the dispersion of the H.C.D. beam is supposed to be about $1\frac{1}{2}°$. Hence, with good listening there is something like a 10 to 1 chance against a beam being on target when it exposes. Even if the beam is slightly out of focus the chance will still be at least 5 to 1 against. Yet it is certain that the target will be somewhere near the beam and an intelligent search should find it. It is here that the skill of the sound-locator director, the projector controller and the spotters comes in.

(*c*) *The Sound-Locator Director.*

In the first place the sound-locator director should be able to judge the position of the target relative to the beam and direct the projector controller to search accordingly. The walking-stick method of training will help in this. Each man is equipped with a stick and conveyed to the nearest aerodrome. There he spends his time walking about with his eyes on the ground and his stick pointing to the sky, where, from its sound, he supposes an aeroplane to be. An occasional glance along the stick will enable him to correct his own mistakes. With such training, a man's capacity for locating aircraft by sound increases rapidly. This, combined with a knowledge of the listener's personal errors, should enable the sound-locator director to locate aircraft with a considerable degree of accuracy.

(*d*) *Spotters and Projector Controller.*

The spotters, watching the area of sky in the neighbourhood of the beam, may actually see the target when it is not illuminated, or may see a quick " flick-over " by their own, or another, beam. It is then their job to get their beam on to the target as quickly as possible.

To enable them to do this the first step is to train them to see in the dark and to use binoculars. A method of doing this has already been indicated.

The next most important point is to achieve a perfect understanding between the spotter and the projector controller. There is unlimited scope for games and gadgets here.

Chalking in the pig's eye is one way. Two blackboards are set up side by side at one end of the barrack-room. At the other end are two blindfolded projector controllers, each with a piece of chalk and each with his attendant spotter. On each blackboard is drawn a pig with only one eye. It is the task of each spotter to steer his projector controller's chalk into the vacant eye, using only authorized spotters' terms. The first home wins.

Another way is to take a model aeroplane fitted with buzzer and electric light, the whole mounted on the end of a pole. Manœuvre this across the parade ground on a dark night with the buzzer buzzing but the light only being switched on momentarily from time to time to represent a " flick-over."

The projector controller is equipped with a luminous disc on the end of another pole and takes up his position between the model aeroplane and the spotter. This disc represents the apparent end of the beam. It is the job of the spotter to see the " flick-over " and to get the disc to " cover " the model aeroplane using, of course, only authorized directions.

Yet another way. This requires a dark room which every company should possess ; minimum size, 40 ft. by 40 ft. by 10 ft. high. A projector is mounted in the centre, fitted with any form of torch which throws a more or less parallel beam. On the ceiling runs a target equipped with a buzzer. Failing this, a target on the end of a pole is carried round the room. The projector controller is blindfolded and his beam is directed by the spotter on to the target.

If an extra refinement is required the target on the ceiling can be made in the form of an electric railway.

It must be remembered that the projector controller must be taught to follow a target steadily. This, again, can be done in a dark room, the projector controller being trained to follow with his miniature beam either a model aeroplane or else a spot of light on the ceiling formed by the instructor's torch.

Similar forms of training can be multiplied indefinitely.

(e) Searchlight Operator.

Now for the S.L.O. His instruction is, of course, largely theoretical and consists of lectures on electricity and magnetism, the electric arc and the circuits with which he will have to deal. A certain amount of practical instruction, however, is necessary, particularly in regard to cable jointing and the running of an electric arc. A very easy way of teaching this last subject is to construct a sheet-iron cabinet in which the lamp can be mounted, provision being made for the operator to reach the controls. This cabinet is fitted with magic lantern lenses so that the image of the arc and the surrounding parts of the lamp can be projected on to a screen. In this way the instructor can readily demonstrate the effect of various faults and how to rectify them.

(f) Lorry-Drivers.

For the training of a lorry-driver a worn-out car or lorry chassis and dynamo are almost essential. These should be sectioned up and, if possible, so arranged that they can be slowly turned over by a motor. Small electric lamps mounted in the cylinder heads can be used to represent the sparks. In addition a Ciné-Kodak projector can be most useful, as the R.A.O.C. possess an excellent series of films dealing with various subjects such as the lubrication system, the working of the autovac., and the methods which should be employed in decarbonizing and grinding-in valves.

Working diagrams of the various parts of internal combustion engines and transmission systems can be obtained and are of considerable value, but the best way of teaching the parts and working is to make the students take to pieces the instructional chassis and dynamo and put them together again.

(g) Detachment Commanders.

Lastly we come to the detachment commanders. They, of course, must know something of everyone's job and a great deal in addition. Selection of the right target is the great problem. This *can* be taught by means of a miniature layout in a dark room. Better still, it is possible to train in this subject by daylight.

Spread out your detachment commanders in the drill hall or on the parade ground, in the form of a layout. Each is equipped with several sticks painted in different colours, such as red, blue, green, yellow, etc. Each is accompanied by a spotter to give warning of approaching targets. Several men are stationed out of sight behind buildings or behind doors. Each carries a disc on a pole, one side of the disc being painted in one of the above colours and the other side being half the same colour and the other half-black.

On a given signal one of these men advances towards the layout, showing the parti coloured side of his disc to indicate that he is unilluminated. All detachment commanders who consider that they should expose on the target point their sticks of the appropriate colour towards it. In due course, the target turns the plain side of his disc towards the layout to show that he has been picked up and is illuminated. Meanwhile, the other targets approach from the same or other directions. At any time the instructor can make the whole of the layout stand fast and point out the mistakes.

For recognition of aircraft the epidiascope is invaluable, as pages can be detached from Jane's *All the World's Aircraft* and other publications and shown on the screen. It is difficult, however, to obtain pictures of foreign aircraft as seen from the searchlights. Silhouettes of targets from this point of view will probably have to be compiled by company draughtsmen working from the sections, elevations and other pictures given in the books.

Incidentally the epidiascope can be used for many other phases of training.

So much for the detachment and now for the section headquarters. The duties of these men, apart from their administrative repair duties, consist of visual plotting and dispatch riding.

(*h*) *Visual Plotters and Dispatch Riders.*

No full description of the methods of training in visual plotting is possible without an exposition of the methods themselves, and this would take far too long. Suffice it to say, that, by the use of a model aeroplane mounted on a pole on wheels, conditions in the field can be closely reproduced.

As regards dispatch riding the actual manipulation of the motor-bicycle is, perhaps, the least important feature.

Map-reading is of vital importance, not only for dispatch riders but also for section serjeants, detachment commanders and all lorry-drivers. In an anti-aircraft unit all vehicles work so much independently that this skill in map-reading is absolutely necessary.

Traffic sense and the knowledge of the highway code are also essential for all riders and drivers. This can well be taught on a model of a typical piece of country with level crossings, bridges, traffic lights, Belisha beacons, cattle, pedestrians, dogs, vehicles, etc.

(*i*) *Manning Drill.*

The final stage of individual training is manning drill, in which each member of a detachment practises his duties in conjunction with the other members and in which the detachment commander has a chance to check faults and mistakes. The drill consists chiefly in engaging imaginary targets, the picture being painted from time to time by the instructor or detachment commander.

6.—CONCLUSION.

Enough has been said, it is hoped, to show the comprehensive nature of A.A. individual training. There is no reason why it should ever be dull, since it is so varied in character. So much can and should be done that time made available by cancellation of a night run, through the inability of aircraft to fly, should never be wasted.

In addition it is pointed out that nearly all individual training can be carried out in a drill hall, which is of particular importance to Territorial Army units.

Very few of the "gadgets" described can be obtained from Government sources. All must be improvised. It should always be possible, however, to obtain authority for local purchase while the necessary funds can be obtained from the Training Grant.

Only the fringe of individual A.A. training has so far been touched. It is a scientific subject which still offers infinite scope for thought and ingenuity.

Before demanding better equipment it is most necessary that we should make the best of what we have. Hence the importance of individual training which is destined, in the future, to occupy the time of such a large proportion of the Corps.

THE NIGERIA REGIMENT, R.W.A.F.F.

By MAJOR A. C. DUFF, M.C., *p.s.c.*, R.E.

SOME brief introduction, or perhaps apology, is needed for an article such as the following. It contains nothing of technical interest, and its various statements of facts and figures can be found in handbooks of West Africa, and War Office publications. But facts and figures tend to be dry, and they may become more palatable when served up with a little of the sauce of personal knowledge; and the task seemed the more worth attempting because so few R.E. officers have served in the past in Nigeria and because there does not remain a single one. The only appointment in the country open to a serving officer of the R.E. is that of Assistant Commandant of the Nigeria Regiment, a second-grade General Staff appointment, and under the laws of probability the chances of its being offered to a Sapper are about 20 to 1 against. The writer was the fortunate exception, and as he left part of his heart in Nigeria it is a labour of love to try to convey to others some idea of a country so little known and so delightful.

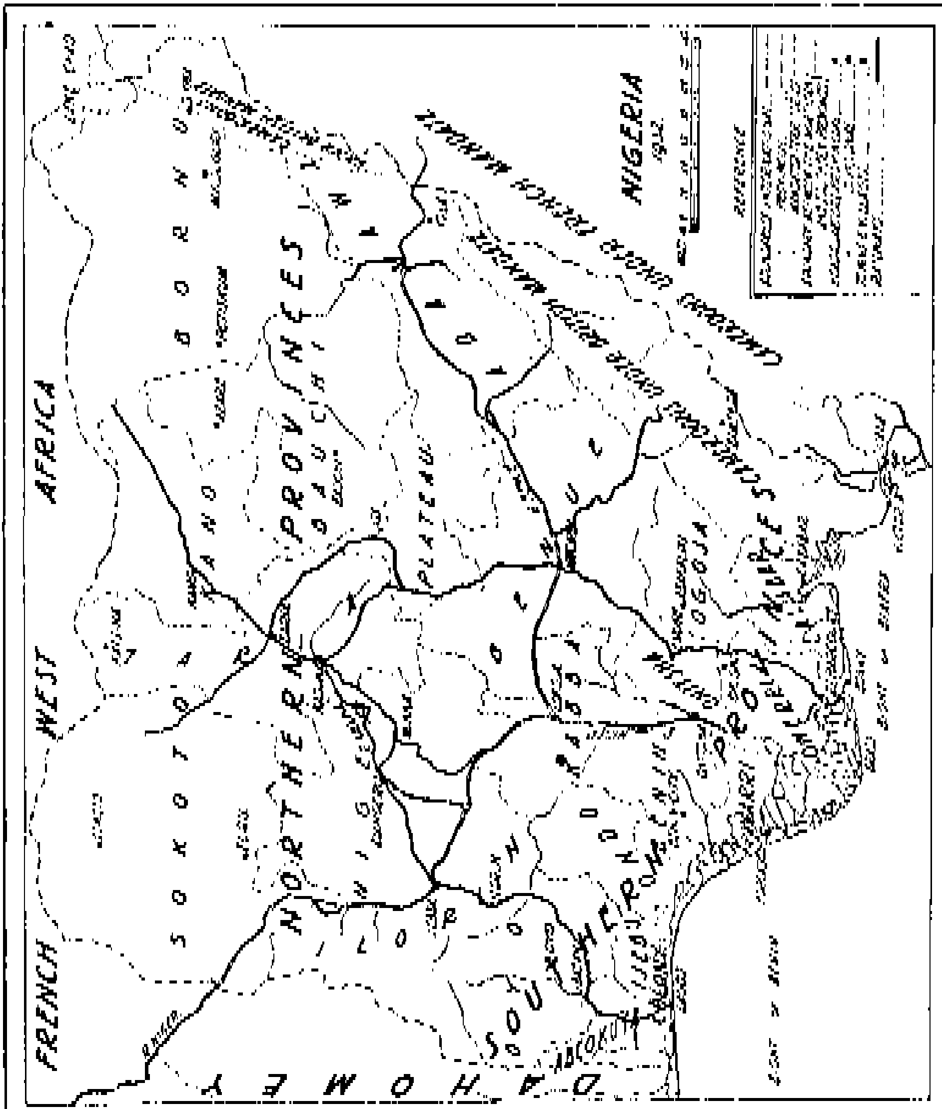
Nigeria is the largest—much the largest—of the British Colonies in West Africa, and it is also the most remote. The Elder-Dempster steamer that takes one out from England changes its course from south to east once it is round the "bulge" of Africa, and calls in succession at Freetown, the capital of Sierra Leone; Takoradi and Accra, the ports of the Gold Coast; and then at Lagos, the capital of Nigeria. The Gold Coast and Nigeria have no natural frontiers except the sea to the south. Both Colonies began by the occupation of a strip of coastline. Administration was slowly pushed inland, through difficult and unmapped country, until the "scramble for Africa" came to an end some thirty years ago, and Great Britain, France, and Germany proceeded to adjust and stabilize the boundaries of their Colonies, not without a good deal of friction. This process left Nigeria very much the same square block as it is to-day, for the addition of the Mandated Territory that used to be the German Cameroons added only a narrow strip down the eastern side (see map).

In West Africa all natural divisions, of climate, of vegetation and of race, run east and west, parallel to the coast. Colonization, on the contrary, took the form of penetration northward, based on a comparatively short length of coastline. As a result the administrative units, the Colonies, cut right across the natural lines of division, and are as lacking in homogeneity as they well could be. It is as impossible to generalize about Nigeria as it is to generalize about India.

Along the coast stretches a belt of mangrove swamp, anything up to thirty miles in depth, pierced only by the mouths of the rivers making their way to the sea. The loathsome qualities of a mangrove swamp baffle description. It is neither land nor water, but a slough of mud and dead branches and decayed vegetable matter, populated by snakes and land-crabs, and interlaced with the tangled roots of the mangrove trees. The roots come writhing up out of the mud in single filaments, and coalesce higher up to form the trunks of the trees. Over this morass broods, night and day, year in and year out, the same muggy, sticky heat. One wonders at the courage of the men who first dared to penetrate up the rivers, rivers whose course is only a connecting channel, indistinguishable to the eye, through a series of lagoons and backwaters. The few towns along the coast—Lagos, Bonny, Port Harcourt, Calabar—have been built where a patch of firm ground exists at or near the mouth of a river. One might almost say at the mouths of *a* river, for the Niger itself never reaches the sea as such, but breaks up into unnumbered mouths large and small, and its delta is half the coastline of Nigeria.

North of the mangrove swamps comes the belt of rain-forest. When the forest reaches its fullest growth the vegetation overhead is so thick that the sun's rays never strike the ground, and a large part of the vegetable and animal life that generally flourishes at ground level has transferred itself to the tree-tops, which have a botany and zoology all their own. Elsewhere in this belt the trees grow more sparsely, and the perennial rain makes the ground exceedingly fertile. This area, and the rather more open country immediately north of it, is the most densely populated part of Nigeria. Here is no country of great estates and of Emirs ruling over thousands of square miles, but an aggregation of small communities, independent and self-contained, speaking a large variety of languages and differing widely in their customs and beliefs. They are negroes, with no admixture of Semitic blood ; coal black, thick-lipped, woolly-haired. Fifty years ago this was the paradise of head-hunting, cannibalism, child-murder and human sacrifice. Now those days are nearly over, partly because of the widespread activities of missionary societies of all denominations, partly because of the heavy hand of Government.

North of the rain-forest the term " bush " adequately describes the rest of Nigeria. The farther north one goes the thinner the bush becomes, passing through the various stages of " orchard bush " with a visibility of twenty to a hundred yards, to the sparse, thorny scrub of the northern frontier. This is, of course, due to the decline in the rainfall. As one goes north the rainy season becomes shorter and shorter. Taken on an average through the Northern Provinces the rains begin in April, heralded by a series of violent tornadoes, and settle down to some hours of steady rain every day during



August and September. A second series of tornadoes brings them to an end, and from November to March is a period of drought. It is also the coldest season of the year. A cold wind—the *harmattan*—blows outwards from the Sahara, bringing night temperatures down on occasion to somewhere near freezing-point, and the wind is laden with finely divided dust which veils the hills in a blue mist.

The inhabitants of the Northern Provinces have next to nothing in common with the tribes of the coastal belt. They are negroid, but not negroes, and Moslems, not pagans. Their civilization is complex, highly organized and comparatively ancient. The principal Emirates are those of Bornu, Kano, Katsina and Sokoto, all of them independent kingdoms before they were incorporated by treaty in Northern Nigeria. The ruling caste are Filani, a non-negro strain which came in from somewhere to the north at some date unknown; light-coloured, fine-featured and straight-haired. Their administration is feudal; the Emirate is divided into districts, each under its own head, to whom the village heads are in their turn responsible. Outwardly the Emir's authority is entirely his own: he collects the revenue and apportions its expenditure. But behind each Emir sits the British Resident, responsible to the Governor, and though the Resident may officially be only the Emir's adviser, in the last resort his advice has to be accepted. This is the system of "indirect administration" that was devised by Lord Lugard, and in Northern Nigeria, where conditions were suitable, it is admittedly successful. The system aims at supporting any native authority that can be found; at supporting, guiding, restraining, encouraging; at remaining always in the background, yet retaining always the right to the last word; at producing ultimately a native administration so firmly based and so well constructed that it could maintain itself even if the British support was withdrawn. That day is not yet, but it is an ideal neither unattainable nor ignoble.

The Northern Provinces also differ from the Southern in that they have a common language—Hausa. There are certain exceptions, notably Kanuri, the language of Bornu Province, and Arabic, used for ceremonial and legal purposes; but throughout the north Hausa is a *lingua franca* that will carry one through. It is a simple and practical language, easy to learn and easy for Englishmen to speak, and every Government officer has to qualify in it.

One small area of the Northern Provinces deserves special mention—the Bauchi Plateau. It is remarkable both for its height above the sea, something over 5,000 feet instead of the 2,000 feet or so of the surrounding country; and because on it are concentrated all the Nigerian tin-mines, resulting in a large colony of non-official Europeans—mine-owners and mining engineers. Even in Nigeria, where everyone is hospitable, their hospitality is proverbial, and there were few more agreeable breaks in one's term of service than week-ends or short leave spent in one of their beautiful houses, looking out on miles and miles of open, rolling country, studded with outcrops of naked rock and scarred here and there with the workings of surface mines, to the serrated mountains beyond.

This very summary description of Nigeria must end with a few words about its administration, as one of the largest of the Crown

Colonies. The Northern Provinces are grouped under a Chief Commissioner at Kaduna, 550 miles up-country; the Southern Provinces under a Chief Commissioner at Enugu, down in the south-east. The seat of the Central Government is at Lagos, and there the Governor resides. His machinery of government consists of the Secretariat, run on much the same lines as a Government Department in Whitehall; the Executive Council, a small body consisting of the heads of the more important departments, corresponding roughly to the Cabinet at home; and the Legislative Council, a much larger affair whose members are partly officials nominated by the Governor and partly non-officials, British and African, elected by various constituent bodies—*e.g.*, the Chambers of Commerce, the principal townships, and the missionary societies. The official members are always in a majority, so that the Governor can secure the passage of any legislation that he considers essential. The heads of departments—legal, medical, public works, police, etc.—also live at Lagos, the sole exception of importance being the headquarters of the Nigeria Regiment, which is at Kaduna. It is the writer's (not very valuable) opinion that sooner or later the seat of Government will have to leave Lagos and move to Kaduna, for the same reasons that the seat of the Government of India had ultimately to be moved from Calcutta to Delhi.

Each of the West African Colonies maintains a military force which it supports entirely from its own finances. These units are the Gambia Company, the Sierra Leone Battalion, the Gold Coast Regiment (two battalions) and the Nigeria Regiment (six battalions); and together they compose the R.W.A.F.F.—the Royal West African Frontier Force. The purposes for which these units exist are three: the maintenance of internal security; defence against external aggression; and the provision of troops for use outside each particular colony to meet Imperial requirements.

When they were formed, some forty years ago, it was in view of the requirements of internal security only. In the early days, when the country was first being opened up, the civil power had continually to call for troops in its support, and the W.A.F.F. spent much of its time on active service. Nowadays it is a different story. The whole of Nigeria is under close administration, the police are efficient and are armed, and the network of roads and railways makes it possible to nip disaffection in the bud. During the last few years the Regiment has had to find, on an average, one "patrol" of one company each year, and the last occasion of serious rioting and loss of life was in the South-Eastern Provinces in 1930.

It is generally agreed that as a safeguard against external aggression the insurance is inadequate. The only case, however, in which the policy would be invoked is that of war with France, and that possibility is remote. If it came to the point the situation would be unpleasant, for the British West African Colonies are islands of varying sizes in the ocean of French West Africa, and our armed forces would be very much inferior numerically to those that could be brought against them. The struggle would centre round the only point of strategic value on the West Coast, Freetown, the harbour of Sierra Leone, which in time of war would provide for Great Britain the only good naval base between Gibraltar and Capetown.

The third purpose for which the R.W.A.F.F. exists, for use as reinforcements outside their Colonies, is mainly an afterthought, and is a by-product of the purposes of security and defence, in much the same way as the British Expeditionary Force is a by-product of the Cardwell system and the defence requirements of India. It is not difficult to imagine circumstances in which the liability might have to be met, but the existence of the liability does not, in fact, affect the strength or training of the R.W.A.F.F.

The Nigeria Regiment is much the largest formation of the R.W.A.F.F. It consists of a battery of light artillery, six battalions of infantry, a signalling school and a depot. Regimental Headquarters is at Kaduna, the capital of the Northern Provinces, and the Commandant is a substantive colonel. The higher organization of the regiment has been the subject of much controversy during the last few years. The writer was too deeply concerned in it to be able to discuss it dispassionately, and as the subject—for the time—is settled, discussion would be out of place.

Of the six battalions two are kept concentrated, one at Kaduna, in the north: one at Enugu, in the south. They are intended as reserves for use in emergency, and on the last occasion of a sudden alarm the Kaduna battalion was entrained and gone eight hours after the call for help arrived. The other battalions are dispersed, and have one or more companies on detachment at out-stations. As communications improve the number of out-stations decreases, for as far as internal security is concerned it is generally unnecessary to keep troops at a station provided they can reach that station in a day or so should occasion arise. The process is going on rapidly; four years ago there were fifteen military stations in Nigeria; now there are only eleven, and one of these is shortly to be given up. In a way it is a pity, for command of an out-station company is an exceedingly responsible and attractive job for a subaltern or junior captain; but there is no doubt that centralization makes for greater efficiency in training.

Training follows much the same lines as in a British battalion. The same annual weapon training course is fired, and approximately the same standard is reached. Collective training begins in October, and culminates in February in battalion and inter-battalion exercises. T.E.W.T's are run throughout the individual training period, half of them based on Nigeria Establishments and half on British

War Establishments. The latter is necessary to give officers some practice with the Establishments that they will have to use at promotion and staff college examinations. One important difference between the two is that the Nigeria Regiment has no wheeled or pack transport. The presence of tsetse fly makes it impossible to use horses except in certain restricted areas, and all first-line transport is by carriers. This even applies to the light battery; the heavier parts of their 4·5" hows. are carried on stretchers, a man at each corner of the stretcher. Carriers invariably carry the loads on their heads, not in their hands. If a man is given a letter to take he will as often as not put the letter on his head, put a large stone on top of the letter to keep it there, and thus transport it. Carriers though enlisted are unarmed, and on mobilization the majority would be newly recruited and undisciplined, so that no small part of a Battalion Commander's care would have to be directed to ensuring that his carriers should neither be exposed to enemy attack nor given any chance to drop their loads and stampede into the bush.

Another difference between training at home and training in West Africa is that in West Africa a good deal of attention has to be directed to bush warfare. The principles of war remain the same at all times and in all places, but in bush countries the principle of security in particular needs specialized application. The problem is that of the local security of a column on the march through country where the visibility to either flank is something less than a hundred yards and may be as little as six feet. The solution to this problem has been found in what amounts to a "battle drill," sections facing right or facing left, and flankers taking ground outwards or closing in on the column, on a series of whistle signals. It is not in any way abstruse and requires only a certain amount of practice.

The rank and file of the Regiment are long-service professional soldiers, attested for approximately the same periods of Colour and Reserve service as are British infantry. The Regiment recruits in the Northern Provinces only, on the assumption that natives of the Southern Provinces make inferior soldiers—an assumption that is disputed by some of the officers who had war experience with men of both types. The recruits are often spoken of as "Hausas," because most of them, though by no means all, speak Hausa as their native language, but racially they come from a great variety of tribes—Munshi, Dakerkerri, Bagerimi, Filani, Shua Arab, and a dozen others. The majority of recruits arrive at the depot semi-naked savages, and a proportion can speak no language in common with any of the depot staff. The physical standard is high, for there is never any difficulty in getting the numbers of recruits one wants, but a little recruiting, in the form of marches or a visit from a British officer, is sometimes undertaken to stimulate the intake from some tribe whose numbers in the Regiment are falling low.

As compared with British troops, West Africans learn slowly and age quickly. That they learn slowly is not difficult to understand, for they have no basis whatever of scientific knowledge on which to build. The British recruit may appear ignorant, but actually he knows a great deal. He knows that a rifle kills a man because a bullet comes out of the rifle; he knows that a clock goes because it contains mechanism, not because it is inhabited by a devil; he knows that if a night-bird flits past him in the dusk he need not consider the hypothesis that it is his Company Serjeant-Major taking the evening air. But all this has to be taught to the Nigerian recruit, and in the last case mentioned twenty years of teaching will not convince him. It is no wonder that he learns slowly. The recruit course at the depot lasts only six months, but until a man has done three years in the ranks he can hardly be called a trained soldier.

Also they age quickly, as all Africans appear to do. By the time they are forty few would be fit for active service. So long as they are serving with the Colours, and looked after and medically examined at intervals, they keep their condition fairly well, but when a man's Colour service is finished, and he goes back to his village, his fortnight's annual training is seldom enough to prevent his going fast downhill. Consequently in preparing mobilization plans it is imprudent to count on more than a small proportion of reservists for use in first-line formations.

A striking difference between Indian and Nigerian battalions is that when a man is enlisted in the Nigeria Regiment it is impressed on him that once he is a soldier his creed and race are immaterial. The men are mixed in the ranks without distinction, and the only concession made to religious convictions is that, as the majority of the men are Moslems, the principal Mohammedan feasts are observed as regimental holidays. It may be noted in passing that Islamic fervour is noticeably absent. Mohammedanism is fashionable because the great Emirs are Moslem, but religious observance is confined to the morning and evening prayers and a generally rather half-hearted observance of the Ramadan fast. It so happened in 1931 that the feast of Bairam, which ends the Ramadan fast, fell while the battalions of the Regiment were in camp doing inter-battalion training, and to allow the usual two days' holiday for the feast would have been exceedingly inconvenient. It was put to the senior N.C.O's that under the circumstances the two days' holiday might be postponed for a fortnight until the camp was over. Orthodoxy was outraged; Bairam must be celebrated on the correct day. But when an alternative proposal was put forward of four days' holiday when the camp was over, instead of two days' holiday at the proper time, it was carried with enthusiasm.

The highest rank that an African can reach is that of Battalion Serjeant-Major. Although on active service temporary command of a platoon would often devolve on a native N.C.O., those who would make platoon commanders are few and far between. There is no suitable class from which native officers could be drawn, and from the platoon upwards European assistance has to be provided.

Each battalion has a certain number of British officers and N.C.O's, seconded from their home units. This number varies widely from time to time, as at moments of financial stress the Government of Nigeria tends to fall back on the economy of reducing—" temporarily "—the proportion of Europeans in the Regiment; but it is near enough to the facts to say that in every battalion at a minimum the appointments of Commanding Officer, Adjutant, and Company Commander are always filled by British officers, with one other officer per company; and that the appointments of R.S.M., O.R.C.S., and C.S.M., are always filled by British N.C.O's. The Quartermasters are on a different footing, as they are retired from the British Service, and, though they retain military rank, are permanent and pensionable officials of the Nigerian Government.

The terms of service are attractive. An officer engages to serve the Government of Nigeria for one " tour " at a time. The duration of a tour is normally eighteen months, and after eighteen months he is entitled to eighteen weeks' leave in England. Passage out and passage home are free, and he receives full pay during his leave. If he then wishes to engage for a second time he may do so, provided that he has been recommended to return. This recommendation is only refused in the case of misconduct, inefficiency, or failure to pass during his first tour the regimental examination in Hausa, and though this examination is far from a formality, yet an officer of average linguistic ability can pass it after less than six months' work. After his second tour he may take on for a third, but after three consecutive tours he must return to his British unit for at least a year, nor may he do more than ten years—*i.e.*, five tours in all.

Financially the Colonial Office is generous, especially to the junior ranks. A subaltern's pay is approximately three times the home rates, and a captain's twice. For a major or lieutenant-colonel it is rather less advantageous. It must also be remembered that a large proportion of the officers hold local or temporary rank in the Nigeria Regiment superior to their substantive rank, and the appointment of lieut.-colonel in Nigeria is generally held by a substantive captain or junior major, and occasionally by a subaltern. A lieut.-colonel's appointment is worth, in pay, allowances, and kind, and in immunity from British income-tax, somewhere round £1,500 a year.

Pay as high as this is not given without reason, and the reason is the climate of the West Coast. It cannot be denied that it is unhealthy, mainly because of the presence everywhere of malaria. Malaria in itself can hardly be called either dangerous or painful, but in Africa malaria has an unpleasant tendency to culminate in an attack of blackwater fever, and blackwater is a serious matter, with a death-rate of about 25%. Avoiding fever is mainly a matter of taking trouble, and observing, without being fussy, the few simple and obvious precautions; mosquito-net at night, mosquito-boots in the evening, and five grains of quinine a day. The writer did not get his first touch of fever, and was not on the sick list for a day, until he had done one tour of nineteen months, and finished twenty months of his second tour.

As well as malaria there is a fine variety of tropical diseases which it is possible to contract; yellow fever, sleeping sickness, guinea worm, bilharzia, and plenty of others; but their incidence is so rare that an ordinary man does not lie awake at night thinking of them. The recipe for keeping fit is moderation in all things, nothing too much and nothing too little; work, exercise, sleep, food, drink. In a tropical country, even more than elsewhere, the golden mean is the thing to aim at.

The attractions of the R.W.A.F.F., in independence, sport and pay, are such that there is keen competition among junior officers to get there, and it has been possible to exercise selection to such a point that they may be considered a *corps d'élite*. The days are long gone when an officer going out to the West Coast was not unlikely to be asked: "What have you done?"

The Warrant and N.C.O's are also very much a picked body of men. Though the inducement of sport carries less weight with them, they have the additional attraction that their service in West Africa counts double towards pension. (Why a N.C.O's service should count double while an officer's does not is one of those nightmares of departmental logic to which there appears to be no answer.) There is also no hard-and-fast limit to the number of tours that they may do. It consequently happens that a senior N.C.O. who has served in Nigeria for a long time may have as many years to count towards pension as if he had enlisted at birth.

One aspect of an officer's duty which deserves mention is the insight he gets into value for money in military matters. There are no R.E., R.A.S.C., or R.A.O.C., on whom to indent. Everything has to be bought. A Company Commander proposing to take his company into camp for training has to work out his costs in rail transport, road transport, purchase of materials to build his camp, cattle and corn for his men's food, etc., and adjust them so as to come within his allotment from the Training Grant. To an officer on the Headquarters Staff of the Regiment this aspect is wider still. The Government of Nigeria votes, say £300,000, for the annual upkeep of the Regiment. This has to cover everything; pay, clothing, equipment and food for the native ranks; pay passages, and contribution to pension of the Europeans; arms, ammunition, and stores of every kind; buildings, transport, and training grant. One learns the cash prices of such things as H.E. shells, and a Vickers gun complete with tripod and spare parts. Or Government may ask for a reduction of £10,000 in personnel. Will it be better to dispense with ten captains, costed at £1,000 each, or fifteen subalterns at £700, or twenty N.C.O's at £500, or a combination of the three? It is a complicated and interesting business.

These facts and figures as to Nigeria and the Nigeria Regiment are enough—perhaps more than enough; but it would be wrong to stop without trying to describe the kind of life that one leads and to explain what makes it so attractive. The picture may be a little biased, for the writer was admittedly one of the more fortunately placed, and not every officer going out to West Africa could hope for so much interest and so much variety.

The amenities of everyday life are a consideration that carries weight, at a Headquarter Station in particular. The houses are big concrete bungalows, with long baths and electric light, a crowd of servants, and an acre and a half of garden. Note particularly the garden. Even a man who has taken no interest whatever in gardening can hardly fail to fall for it in West Africa. There is no need for patience; put the seeds in, and they will show green in thirty-six hours. Stroll round the garden at 6.30 a.m. in your dressing-gown, when the dew is still on the grass, and choose and pick, from your own tree, the grape-fruit that you will have for breakfast. Admire the snow-white blooms, just opening, of the Blushing Hibiscus, knowing that before sunset they will be hanging from the branches, crimson and dead. Roses grow as well as they do in England, and every garden is filled with flowering shrubs, mostly imported from the West Indies: Oleander, Pride of Barbados, Frangipani, Gold Mohur, Jacaranda, Bougainvillea, and Poinsettia.

Labour is cheap, and with a certain amount of labour it is not difficult to make a respectable grass lawn in front of the house, and on a hot evening it is a much cooler place to sit on than the veranda. There the semi-circle of long chairs is set after polo, and the guests come and go, and the servants hover round and keep the glasses filled and circulate the "small chop"—anchovies, prawns, sausages, and such-like; and the moon comes up, and the fruit-bats flit in and out of the mango-trees, and the crickets shrill endlessly.

The day begins early and ends early. Work is generally finished by 1.30. Then lunch, followed by sleep, frank and unashamed, till 4. A cup of tea to wake one up. Polo or squash, or golf or tennis. Drinks, dinner, a little dozing over a book. And so to bed.

Polo ranks high among the attractions of West Africa. At most military stations it is played three days a week through nine months of the year. The ponies are all country-bred and are all stallions, fast, light and handy. It is probably the least expensive polo in the world. The average price of a made pony, good enough to play in tournaments, is £12 to £15, and a raw "bush" pony can be bought for about a fiver. Most men keep two ponies or more, and on a good evening there will be six or seven chukkars. This is about as many as can be conveniently fitted in before dark, for the afternoons are so hot that to begin play before 4.30 p.m. is too disagreeable.

Second only to polo in the list of attractions is the shooting. Not big-game shooting, for that can hardly be said to exist in Nigeria; lion are so few that it is pure accident if one happens to come across them, and elephant only survive in extremely inaccessible places. But buck and gazelle—roan, cob, hartebeeste, etc.—are common, and with a certain amount of trouble it is possible to get "bush-cow"—the African dwarf buffalo—a cunning and dangerous brute. Almost anywhere in the north, moreover, one can have excellent fun with a shot-gun. Bush-fowl—a kind of francolin—and guinea-fowl are abundant wherever corn is grown, and more locally one finds bustard—greater and lesser—sand-grouse, and green pigeon. In certain places near the northern frontier, and at certain seasons, it is possible to get large bags of duck, geese and teal. Such shoots are immense fun, but they are not for fair-weather sportsmen. As often as not one has to stand waist-high or even breast-high in water, and water with leeches in it and mosquitoes over it; ejected cartridges floating reproachfully in a circle round one; and one's feet slipping and sticking in the mud as one struggles to turn and swing. But what are these little troubles when compared with a right-and-left out of spurwing geese: two semi-armoured ostriches crashing one after the other into the water. To the writer, Nigerian shooting will always be associated with guinea-fowl; with struggling through almost impenetrable undergrowth on the banks of the water-courses where they take refuge; with chasing them at full speed in the open, gasping for breath and blinded with sweat, while they ran in their hundreds in front of him for miles and miles; and with missing them ignominiously on the rare occasions when they offered an easy shot.

Life would become monotonous if spent continuously at one station, and the change afforded by "touring" is generally welcome. By "touring" is meant visits of inspection, of varying degrees of formality and of varying duration. To get from Kaduna to Zaria, the nearest military station, takes an hour and a half; to get from Kaduna to Yola, the most remote, takes—in the rains—three weeks. There are four means of transport: boat, rail, road and carrier.

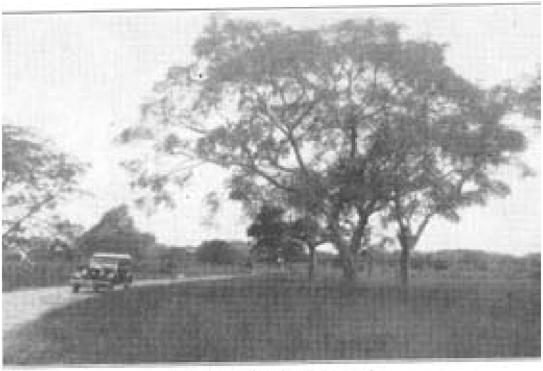
The first method, movement by water, is the oldest of the four. The pioneers of the country used flat-bottomed stern-wheelers to take them up the estuaries of the rivers and through the lagoons of the south, and the same type of craft still plies on the Niger and its

No. 1.—Village rest-house.

No. 2.—Dry-weather road. Log bridge over stream.

No. 3.—Rumfa after a tornado.


No. 4.—European's bush house.


No. 5.—Dry-weather road.


No. 6.—The Victoria River.

vast tributary, the Benue; reaching when the rivers are in flood not only the frontiers of Nigeria but French territory beyond them; making perhaps twenty miles a day on the up-stream journey and a hundred miles a day on their return. A big stern-wheeler is a comfortable craft, and a ten-day voyage in her can be most agreeable, but her small relation, the canoe, is better avoided.

The Nigerian railways provide little in the way of thrill, except when stray cattle wander on to the unfenced tracks. The main system consists of a big inverted V, with Kaduna as its apex, and Lagos and Port Harcourt as the starting-points of the legs. Trains do not follow each other at very close intervals; indeed two trains a week is the ordinary allowance. Nor do they proceed with any startling rapidity; the Ocean Mail Express leaves Kaduna at 11 p.m. on Thursday and arrives at Lagos, 500 miles away, at 6 a.m. on Saturday; always provided that there does not happen to be a wash-out anywhere on the line. In the rains it is not uncommon for a train to be a day or two late. The rolling stock provided for Europeans is comfortable, and there are restaurant cars, but even so travel by rail is unpleasant. The compartments are hot, the track is rough, the blue glass windows are depressing, and the spectacle through them of mile after mile of featureless bush is monotonous.

Neither river nor railway serve most of the military stations, and three-quarters of one's touring is done by car. The roads are divided into two classes; all-weather roads, which are maintained throughout the year; and dry weather roads, which are made up after the rains, and washed away, bridges and all, at the end of the dry season. Both classes have good surfaces, and one can average 35 to 40 m.p.h. in a big car. One is not impeded by traffic congestion. The writer used frequently to drive from Kaduna to Jos, 170 miles, and it was the exception rather than the rule to meet another car on the way. For touring purposes a big car is necessary. The rest houses, where one puts up for the night, offer only a roof, firewood, and water. One has to carry in the car servants, bedding, food, and cooking and mess utensils, and possibly a couple of cases of petrol as well. So that a Baby Austin will not meet the situation.

The fourth and last means of transport, tramping on foot with carriers for one's kit, is becoming less and less used as the rail and road systems steadily expand. It is not a convenient way of travel, for carriers are slow and the distance they can cover in a day is limited, but on the other hand one is brought very much more into contact with the inhabitants of the area through which one is passing.

Touring is spread fairly evenly through the year, but most officers of the Regiment also spend about a month every winter in camp. Camps for company, battalion, and sometimes inter-battalion training, are held in January and February, when there is little likelihood of rain. In order to avoid the monotony of "bush warfare" exercises, open ground is always selected, and as open ground is generally only to be found in the more hilly country, camp sites are usually agreeable ones. Officers and men live in *rumfas*, huts built of sticks and grass, and if by ill-chance an untimely tornado does happen to arrive there is not much left of the *rumfas* when it has finished.

It is a very strenuous time, and usually a very pleasant one. Out in the open training most of the day; perhaps a walk with a gun in the evening; and cold, clear nights, with the Crested Cranes' "aunk-aunk" overhead, and the Great Bear twisting his tail up into the northern sky.

Such is Nigeria as the writer saw it, and as he hopes to see it again some day. If it is suggested that his view is unduly rose-coloured, he can only say that that view is shared by the majority of the officers who are seconded to the R.W.A.F.F. A certain number, admittedly, find the life distasteful, and do not return for a second tour, and a good many others who enjoy it and would like to stay on are debarred by sickness or by the wishes of the Commanding Officers of their British units. But on the rest West Africa, with its freedom and its friendliness, its risks and its responsibilities, throws its fascination, and they do the full ten years that the War Office allows. When the ten years are over, and the time for parting comes, it is not a pleasant moment. One's last sight of Kaduna is the railway station on a hot, close night; the long platform bare under the electric lamps; the white coaches of the boat-train stretching away into the darkness. A compartment littered with kit and bedding, and a bunch of friends round the door. A whistle, a jerk, and the train starts; but instead of gathering way it crawls along at a foot-pace. The driver has seen the cluster of buglers in their red jackets at the end of the platform, and is in league with them to prolong the agony. As the train passes the buglers sound the Hausa Farewell, the long, melancholy call that is accorded only to an officer who will never, to the best of his belief, see Nigeria again. You must stand at the window and make such acknowledgment as you are able.

A NEW-MODEL ARMY.

By MAJOR F. E. FOWLE, M.C., R.E.

WHEN Kipling wrote *The Army of a Dream*, he was dreaming of a nation which had suddenly woken up to the national need for military service, and was fighting to get into the Army—you remember how the Guard picked only one in five of the pick of the Line, with no other privilege to offer them than that of living a harder life than anyone else. Nowadays we are trying to maintain an army of high quality from a nation which views all things military with the deepest distrust, and only by an extensive campaign of poster advertisement and personal solicitation, egged on by impassioned appeals from the W.O., can we prevent the Army slowly fading away.

If this is the case, with all the undoubted advantages which the Service has to offer over almost any other walk in life, there must be something wrong with the system, something fundamental that goes against the grain with the mentality of the average citizen. In the following article, written admittedly in rather the spirit of Kipling's story, we have endeavoured to suggest what this fundamental difficulty is, and to suggest a remedy which, fantastic as it sounds at first, will bear looking into a second time.

Briefly, our case is this. The day of the Regular Army as it is organized at present, with its barrack rooms, centralized messing, ten-thirty passes, and all that sort of thing, is passing, and its place must be taken before long by the Irregular, or shall we say the New-Model, Army, with its men and officers living where they like in the neighbourhood of their unit's headquarters.

This is a somewhat revolutionary suggestion, and good solid arguments must be produced to support it; later on we propose to sketch an outline of the system on which it might be applied.

Firstly, there is the general problem of why it is so difficult to get recruits for the Regular Army; with about 1,700,000 men unemployed, why is it that all the recruiting offices are not besieged by an army for whom there is no vacancy? There are a lot of reasons which can be and are put forward to explain this, but they all break down when we consider what happened in August and September, 1914; I do not think many people will deny, in spite of what it is fashionable to say, that the same thing would occur again in similar circumstances. Nobody attempts to deny that the Army looks after its members a great deal better than any civilian firm; the soldier's pay, if you reckon in all the hidden benefits in the way of rations, housing, sport and so on, compares very favourably with what he could earn outside; he "gets a month's holiday on full pay" to quote a recent poster (he gets nearer six weeks); he leads a healthy life; and yet men will not join. Now think for a moment of the Territorial; what inducement has he got to join? Financially, none at all; the whole of his training comes out of his spare time, and if he goes to camp he uses up the whole of his annual holiday. Yet men join the Territorial Army, 30,000 of them every year. Why? Partly because they like being soldiers and wearing a uniform, partly because of the annual fortnight's holiday in the open air; yet these same men would shy like startled horses if you asked them to join the Regular Army; why, again? Because they hate the idea of having to live in barracks, and give up the free evening and night to which they are accustomed; there is no privacy in a barracks, none of the "Englishman's home is his castle" by which they and all of us set such store. It is not the thought of being under discipline and having to do what you're told, but the knowledge that when you've done your day's work you are still not your own master, and that you've got to spend the rest of the day and all the night herded up with a whole lot of other men. Why does the "general labourer" work longer hours than the soldier in whose barracks he is working, and for less pay? Because, when he's finished, he goes back to his own home and is master of his fate until seven o'clock the next morning. If he feels like going to bed at six, he can, without eleven other men to keep him awake. If he has a wife, he can spend the evening with her; if he has not, he can spend it with a substitute, without the thought of a "pass" always at the back of his mind, interrupting his night just at the wrong moment.

Then there is another aspect of this question, and that is the steady drop in recent years in the average marrying age of the community. A man wants to marry a wife and settle down in a home of his own, not leave his wife with his people and go and see her at week-ends. We are still catering for a marrying age of 26 or 30. Ask any T.A. adjutant; he will tell you that one of his greatest difficulties in recruiting is the age limit for married allowances; consider our noble selves; about half the officers in the Corps are officially living in sin.

Now there is no use in shutting our eyes to all this, and carrying on in the same old way; the habits of mind of the citizen as we have outlined them will go on strengthening, and so surely will the difficulties of recruiting increase. If we want the Army to be up to strength, and up to the strength with men of the type we want, the men of 1914, we must cater for the mentality of the class from which that type is drawn. As the equipment of the Army becomes more and more scientific, so must we look for men of better intelligence to handle it, and unless we cater for them they will not be forthcoming. Already we have travelled a very long way on the road. What would the Duke of Cambridge have had to say to the soldier of the present day, going out of barracks in mufti, getting a month's leave at Christmas, living out of barracks with his wife; many of the remarks of the Duke have been preserved to us, but he would surely have produced something original! Each of these privileges was confidently predicted to be the end of discipline, yet they haven't proved so; nor were they introduced merely out of love for the soldier on the part of the War Office, but because it was realized that they had to be granted if the Army was to exist at all.

We can even quote the historical parallel which is so desirable in all controversial questions; it may be said we are arguing from the ridiculous to the sublime, but a parallel we must have. That parallel is the Sudan Defence Force, a Force recruited from all the tribes in North Africa, and organized on an entirely Irregular basis; all the soldier gets is his pay, his uniform and equipment, and his rations when he goes on service or manoeuvres. But this is quite a recent innovation: for the first twenty years of the existence of the Egyptian Army, the majority of the troops were Regulars, living under very much the same conditions as the soldier in England; the change has been made simply because it was found that the Irregular system produced the better soldier, and that is in a Force which must at all times be ready for active service at six hours' notice. If the system works for the African, is it too much to say that it will work with the Englishman? It will be said at once that discipline will go to the dogs, that the men will be no good, that they'll never learn their jobs, but that is merely repeating the "parrot-cry" which every innovation has called forth. The soldier married "off the strength" is none the worse for it; why should the ordinary man be any the worse living the life to which he has always been accustomed, the same life as any other citizen?

Remember that the new system is going to produce a better type of recruit to start with, one who is more to be trusted with liberty of action. "You'll never get the men on parade in time," you say. Why not? Our married friend turns up all right. Does the modern factory allow its men to roll up any old time they like? It does not; they get there in time or they lose their jobs; with the discipline of the Service to help you, the difficulty will hardly arise at all.

Now for the first and most obvious objection; where is the new soldier going to live? To house, say, ten thousand men, and their families, you need a very large town, and the neighbourhood of a large town cannot be a good training area. Perfectly true, but why crowd that number of men into one spot? Surely it is a relic of the bow-and-arrow age, when the whole art of war was to drill masses of men to manœuvre perfectly together, and when the general and his staff had no motor-cars to get around in? The position now is very different. For ten months in the year the soldier does individual, platoon, company and battalion training, when the proximity of other units is a hindrance rather than a help. The barracks are in the centre of the training area, with the result that the soldier spends half his time walking out far enough to get elbow room to do his training. How much more convenient it would be if the various units of, say, a division, were scattered in the small towns round the outside of the training area. Then each unit could get on to its own part of the training ground without having to worry about anyone else. When it came to the time for brigade or higher training, all the units could go into camp together anywhere on the area and fight battles to their hearts' content.

Where are the houses coming from? The houses will come all right if there is the demand for them. If a factory starts up on the edge of a country town, houses very soon start up to meet the needs of the increased population. With a Government subsidy to help, and a guarantee of continuous occupation, there need be no anxiety on that score, though admittedly there is a possibility of a certain amount of "lag."

But there is another aspect of this question that we mustn't lose sight of. Are we going to limit the distance which the soldier may live away from his headquarters? There is a sort of unwritten law at the present time that everyone "living out" must be within ten minutes of barracks, "in case they are wanted." What are they going to be wanted for? We are not going to mobilize at ten minutes' notice; if there is a crisis in barracks, if a fire breaks out or a lorry breaks loose, the orderly officer and the inlying piquet can deal with it; after all, the average fire orders for a battalion tell the fire-piquet to double to the scene of the fire, and the rest of the unit to fall in on their parade grounds, "in case they are wanted." If there really is a crisis, like a civil emergency or an instant threat of war, all you have to do is to put up tents and put the battalion on an ordinary manœuvre footing.

There seems to be no reason why the soldier should not live as far away from barracks as he likes, always provided that he gets there at the time he is told, and that he gets there entirely at his own expense. It is no uncommon thing for the civilian workman to go ten miles to his work every day, by bicycle if he is energetic, by 'bus if he is not. Here is a very important factor as affecting the housing situation.

Now how are we going to make this system work? So far all we have said is that officers and men live in their own houses or in lodgings just like anyone else.

To start with, the Depot must remain much as it is at present; a course of barrack-room life is essential, to inculcate habits of discipline, cleanliness and hygiene, and to get them so firmly implanted that they will not fade in the greater freedom of regimental life. (Here we might again quote from the ridiculous, where this system is in vogue.) The depot course might well be a couple of months longer than it is at present, to bring training in general to a rather higher standard.

Now for the crux of the whole matter, the actual fighting unit. For purposes of argument, we will take an infantry battalion, for whatever system is found to suit that will, with minor modifications, suit any other unit of comparable size, a Gunner brigade, a Divisional R.E., or a Tank battalion, remembering that it is a moral certainty that in a few more years there will be no more horses, except possibly in the Cavalry.

To start with, guards, fire-piquets and similar regimental duties will still have to be furnished; they will be found from an inlying piquet, say a platoon, who would live in a barrack room as at present, and be on duty for a week at a time; their tour of duty would thus be one week in every three or four months, just about right to keep their married life running smoothly. The feeding of the piquet would suffice to keep the quota of company cooks up to the scratch, always provided they receive their preliminary training at the Army school, and not, as at present, largely by experimenting on the soldiery.

The soldier would keep all his clothing and equipment at his own home, but as it would be impossible for him to wear one order of dress all day, he would have to keep a change or two in barracks, and for this purpose, company changing-rooms, provided with shower baths, and fitted with lockers for each man like a golf club-house would be built. For his midday meal, the soldier could either bring his food with him, or buy it at a regimental *cafétería*, run on the same lines as those in many modern factories.

Offices, stores, vehicle sheds and all those kind of things would, of course, have to be provided just as they are now, and would be locked up and left in the care of the inlying piquet at the end of the day. A bicycle shed, a good long one, would be a necessity, but so long as the rates of pay remain much as at present, the car-parking difficulty, which so often arises in the United States, need hardly be anticipated; doubtless the R.S.M. and the quartermaster-serjeants would come to duty in cars, but the number would not be large.

It will be noticed that the regimental institute is not mentioned as one of the economies to be expected; it will in fact be rather the reverse. The institute would become the most important building in the barracks, but run more as a regimental club, on the lines of some of the best T.A. club-rooms, and with less of the "soldiers' room" and "corporals' room" about it. Some rooms would, naturally, have to be reserved to the senior ranks, but with a less rigid distinction than there is at present; after all, discipline does not suffer because a subaltern and his colonel are both members of the "Rag".

The officers, too, would have to have a club or mess to act as a focus of regimental life, but it would not have any residential accommodation beyond a couple of rooms for the orderly officers. Even at the present day, the average mess is an enormous building inhabited by a few subalterns and perhaps a captain or two, and it really only functions as a mess at sherry-time in the morning and on guest-nights. A couple of waiters would keep the show going at ordinary times, the orderly officer would have his meals sent in from the *cafeteria*, and for guest-nights the necessary staff would be imported. Think of the saving to the pockets of the members!

Next we have to consider the training of this Irregular unit; how is this going to be arranged? Individual training during the winter, and the early stages of platoon and company training can be carried out just as well if not better in the isolated unit, but later on we have to get on to musketry and battalion training, field firing and all that.

England is too small a country for every battalion to have its own rifle range. But England is also too small to hold more than four artillery ranges as it is, and yet the Artillery do not let that worry them; they simply leave their own station and go to a practice-camp; so do the machine-gun companies of the Infantry. All that the Irregular Army will need is a rifle range in each brigade area, to which the battalions and other units in the area will move out in turn; every officer agrees that a unit camp does the unit more good than all the rest of the year put together, but the men do not like it because it is merely a repetition of their ordinary life in much more uncomfortable circumstances; under the system of the future, the men will look on camp in much the same way as the Territorial does now. Camps could be put on more of an active service basis than they are now, not in the way of comfort for the men, but for the training of the war organization of administration and supply; the soldier would draw rations for every day he spent in camp, without loss of the allowances he draws in normal times, so that he would look forward to camp as a financial benefit, and not, as in the case of the married man at present, a financial loss.

So far we have drawn a very pretty picture of the battalion at Home, with its officers and men living happily in their own houses with their wives and families. What is going to happen when the battalion goes abroad? You can hardly imagine the government paying to transport 350 families every year to Hong Kong, to say nothing of the utter impossibility of finding accommodation for them when they got there. The answer is an easy one, the battalion won't go abroad; why should it? We don't send our field companies abroad, we keep some abroad and some at home. Why not do the same with the Infantry? All our regiments now are formed of two linked battalions, one abroad and the other at home; the simple evolution is to convert them into a foreign service battalion and a home battalion, the officers and men changing round just as we do, *BUT*, the bachelors will go abroad and the married stay at home. We do not mean to suggest by this a scheme for improving the birth-rate, but that every man on joining will contract to spend three years of his first four years' service abroad *without his family*. In other words, the recruit, after completing one training season in the home battalion, will be sent abroad for a three-years tour, and no provision will be made for his family to accompany him; it is hardly likely that he will have acquired any family by that time, anyway.

For men who have extended or re-engaged, who would all be N.C.O's or potential N.C.O's, the system would be different, as for them married quarters would be provided abroad just as they are now, and they would alternate between the F.S. and the home battalions, just as officers can do at the present time. Of course, it would always be open to any man to volunteer for an extension of tour abroad, and if leave home after the three years were given, a considerable number would probably do so.

Thus the home battalion would consist of N.C.O's and men who have all done a tour of foreign service, plus a small proportion of recruits, while the F.S. battalion would be composed of men with one, two or three years' service but with every N.C.O. having the experience of a previous foreign tour behind him. One of the major objections to the present system, which is that in the event of a war in Europe the Expeditionary Force consists almost entirely of reservists and recruits, would thus disappear.

It is not unreasonable to believe that the term of colour service might be increased without detriment to the strength of the Army Reserve. At the present time the home battalion is rarely much more than fifty per cent. of establishment; if, as we believe, the new system would mean that the home battalion was always up to strength with a waiting list as well, the same output of reservists would be maintained even with a two-year increase in colour service.

One major problem remains to be considered, that of moves at home. The immediate absorption of so large a population in the new station certainly offers difficulties, but, seeing that an equal population will at the same moment be leaving, the enterprising house agent will almost certainly prove equal to the strain. Moves will have to be arranged well in advance, and will probably have to be a direct exchange between two stations, and not an all-round shuffle as is so often the case at present. There is no objection to this provided that, when the time for the next move comes round, a different pair of stations is selected.

It will be noticed at the end of this article, when we have endeavoured to touch lightly on the financial effect of our proposals, that we make no claim to any indirect economies arising out of a cutting down of administrative services. We must not lose sight of the fact that this New-Model Army of ours will still have the same essential function as the present one, to go to war. When it goes to war, it will require just the same administrative services and departments as it does at present, and if these are to function at the outbreak of war, they must exist in peace. It is tempting to suggest that we might cut down the R.A.S.C., or the Ordnance, but that offends at once against the principle.

There *are* economies in other directions to be expected, however, though not financial ones, and the greatest of these is "employed men." Think of the cooks, messing orderlies, room orderlies, serjeants' mess waiters, and all those kind of people who will now be able to come on parade like ordinary men; the coal fatigues, the ration fatigues, the cleaning-up fatigues, which will no longer be needed. In some units we know of this is going to raise the parade strength by thirty per cent.

Now in conclusion, let us try to give some idea of the financial effect of our revolutionary suggestions. Are they going to produce that most desirable result, an economy? On present-day scales of accommodation, almost certainly not, but how much longer is the present scale going to suffice? Considering the improvement in the standard of the soldiers' accommodation which has taken place in the past fifty years, can we say that finality has been reached? It is most improbable. It is no use pretending that the present scale of married quarters, fifty per cent. for serjeants and five per cent. for rank and file, is really enough; if the marrying age continues to drop, the scales will be nearer eighty per cent. and forty per cent., to say nothing of officers, if we are to hope to get the type of recruit we want. A hundred and seventy-five thousand pounds for married soldiers' quarters for one battalion! Few of the older members of the Finance Branch could stand a shock like that.

Now we have got a matter of a hundred million or so sunk in barracks all over the country, perhaps more. It is too much to expect any government to scrap that amount, and in any case the change over to the Irregular system would have to be gradual, and in its early stages largely experimental. But there is no use in blinking the fact that before long we shall have to start building new military stations; barracks in places like Plymouth and Portsmouth are, under modern training conditions, very unsatisfactory, and, with the development of mechanization and mobility, must become more unsatisfactory every year; sooner or later they will have to be replaced.

Now consider the cost of building a station for a battalion of the

New-Model Army as compared with a battalion of the present day. There will be a clear saving on barrack blocks, dining-rooms, and messes of somewhere about sixty thousand; accepting our figures for married quarters, a saving of another hundred and eighty thousand. What about the other side of the slate? Undoubtedly it will be necessary to subsidise the building of civilian houses to some extent, to maintain an adequate standard that shall be within the means of the soldier, and to give some control over the rent. On the basis of £250 each for twenty officers' houses, and £75 for 350 soldiers' houses, the subsidy will swallow up about thirty thousand, which leaves a capital saving of two hundred thousand towards the payment of lodging allowances, or seven thousand a year. To this must be added the saving in maintenance of the buildings which haven't been built (say £7,000 a year), and of the marriage and lodging allowances which even now have to be paid (about £3,250), or say a total of £17,000 per year. To put the whole battalion on the lodging list will run away with a round £29,500 a year, so that we are only £12,500 a year worse off. So, although we started on this paragraph without the least idea how it was going to work out, we are not so badly off, always remembering the basis of our main argument, that the soldier must go on costing more and more every year in any case.

Admittedly this article seems at first sight to border on the fantastic; to the standard General Service mind it certainly is fantastic. But we do submit that the G.S. mind with all its efforts to improve the lot of the soldier with better dining-rooms, more sports grounds, plain clothes passes and so on, is missing the real difficulty which confronts the recruiter, and that so long as we keep rigidly to our present organization and system, so long will that difficulty continue, and not only continue but grow greater year by year.

THE WORK OF THE CONTRACTING ENGINEER ILLUSTRATED BY THE PRESENT RECONSTRUCTION OF CHELSEA BRIDGE.

A Lecture delivered at the S.M.E. on 21st Nov., 1925, by
A. E. REID, Esq., D.SC., A.M.INST.C.E., A.M.I.MECH.E.

THE title of this paper is probably far too ambitious for the matter discussed under it. In order to give a thoroughly comprehensive account of the whole work carried out by the contracting engineer, not one paper, but dozens and even hundreds, would be required.

It may be said at the outset that there is a good deal of similarity between the work of the Corps of Royal Engineers and that of the contractor's Engineer. In each case a sound knowledge of almost every kind of constructional work is required, and technical qualifications must be varied and of high quality.

For the purpose of this paper it will be less confusing if foreign contract work is left out of consideration altogether. Most contractor's engineers have to spend long years abroad on large contracts, where the organization and the whole scheme of operations is radically different from those obtaining in this country.

In Great Britain it is customary for the plans and specifications for a new public works undertaking to be drawn up by the engineers of public authorities or by consulting engineers, most of the latter having their offices in London. The engineers issue specifications and call for tenders from contracting firms, and it is not until this happens that the work of the contractor's engineer begins. In some cases the estimate and tender is prepared almost entirely by the man who will subsequently carry out the work, should the tender be successful. It is becoming more common now, however, for a separate estimating department to be maintained by large firms of contractors, and in this case the estimator may have nothing to do with the work after the contract has been secured.

The estimator requires to have a very wide and comprehensive knowledge of prices of materials, labour charges, and every kind of cost entailed in the carrying out of the work with which he is concerned. Much of his pricing is of necessity done by comparing the new work under consideration with other work done in the past on similar lines, the new prices being varied to suit whatever variations in conditions there may be.

Although it might be supposed that the making up of a tender for a large undertaking, such as a bridge, would be very largely guess-work, such is by no means the case. It actually happens that the costs of certain classes of work can be very accurately *forecasted*. In order to be successful, an estimator must possess a degree of vision above the ordinary, since it is his business to foresee the complete plan of operations and to provide in his estimate for plant, tools and equipment sufficient for the needs of his proposed operations, and for the time programme adopted in fixing his tender prices.

In general, the cost of any large public works undertaking, such as a bridge, will be split into four main groups :—

1. Temporary works.
2. Permanent works.
3. Plant.
4. Overheads and contingencies.

Under temporary works is included all labour and materials required for the contract, which will not form part of the permanent structure. These will comprise temporary timber stagings of all kinds, provision of office and stores buildings, water supplies, and so on.

Permanent works comprise, as the heading clearly suggests, the items which form part of the completed structure, and which are paid for under the appropriate rates in the *Schedule of Quantities*.

Plant. The item for plant includes the cost of providing, operating and keeping in repair all cranes, pumps, winches, piling gear, barges, temporary rail track, wagons, etc.

The item for overheads and contingencies is rather different in essence from any of the other three headings. It is the item which will vary most widely with different firms, depending a good deal upon their estimate of the hidden risks entailed in the work to be carried out. It will also depend upon the intensity of the firm's desire to secure the work, as in some cases a firm will allow itself an estimated profit much lower than usual because of certain special conditions attaching to the proposed undertaking, or to the firm's own position at the time.

It would be unwise to give at the present stage a wider description of the estimator's activities and responsibilities than is given above. It will be better to proceed at once to examine the state of affairs obtaining after the estimator has finished his preliminary work, and the contract has been obtained on his estimated prices. Taking a concrete case as an illustration, we may turn to the reconstruction of Chelsea Bridge for an example.

The reconstruction of Chelsea Bridge resolves itself into the following main operations:—

1. The building of a temporary footbridge to carry passengers over the river during the course of the reconstruction.
2. The demolition of the old bridge, including superstructure and foundations.
3. The construction of a new bridge of the same general nature, that is, a suspension bridge on nearly the same centre line, and with the same number of piers and abutment supports.
4. The dismantling of the temporary footbridge after the completion of the new structure.
5. The withdrawal and removal of all temporary structures, such as piled stagings, etc.

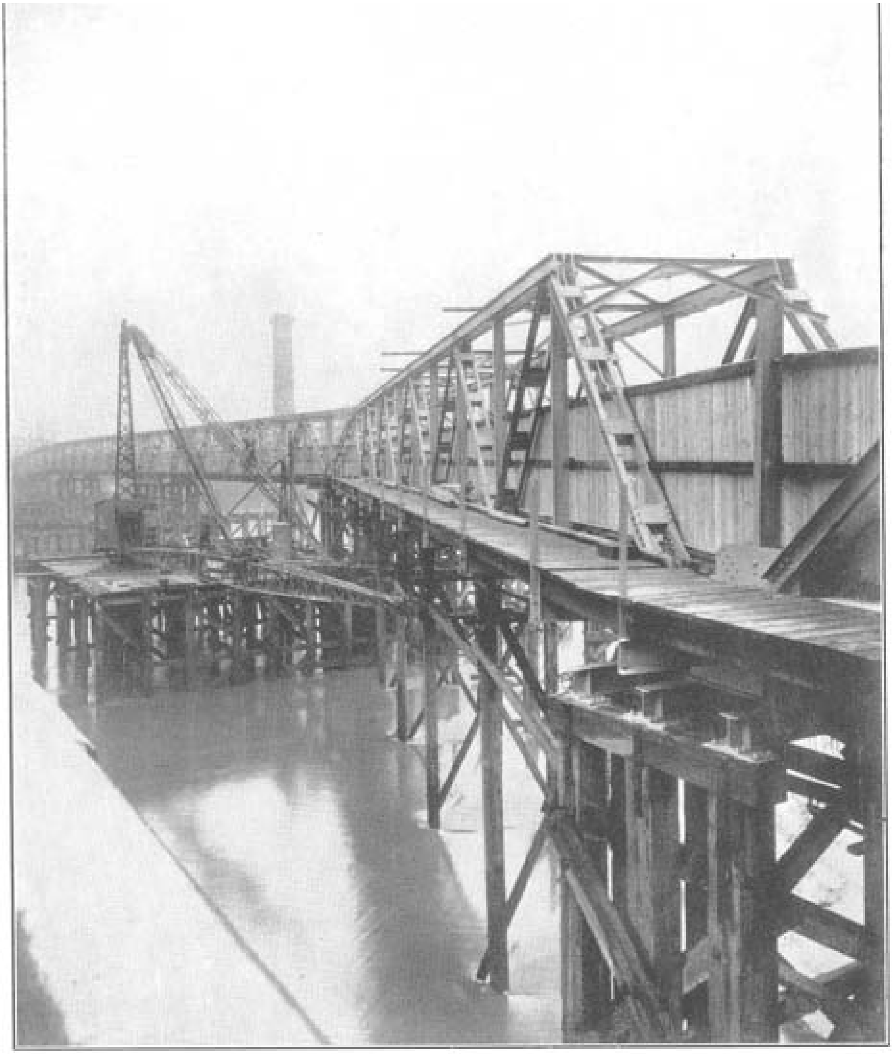
Temporary Footbridge.

The temporary footbridge is designed, built and maintained by the contractor. It is, actually, loaned to the authorities by the contractor for the duration of the contract, and is still his property when the work is completed.

The temporary bridge is a through type, girder bridge, designed for an equivalent uniform load of 84 lb. per square foot. The trusses are of the simple Warren type with verticals, the beams being specially strengthened to permit of cantilever erection. The spans are carried on groups of timber piles, driven into the bed of the river to a certain set. The temporary bridge is shown on the photographs 1 and 2 and so far as the steelwork is concerned does not require any special comments.

At this stage, however, it may be worth while saying a few words about the driving of piles, either for temporary structures of the kind under review, or for permanent work. Of all the operations undertaken by engineers, there is probably less exact scientific knowledge available about pile-driving than about any other of the many works carried out. For years engineers were quite content to work to empirical values given by technicians like Rankin and some others, and the various formulæ suggested and seriously sponsored by eminent authorities gave results which varied by as much as 200 per cent.

Quite recently a much more rational formula was evolved by Mr. A. Hiley, whose conclusions and arguments are fully set forth in a paper to the *Journal of the Institute of Structural Engineers* in the July and August issues 1930. The principle of the Hiley formula can be easily grasped by equating the work done by, say, a drop hammer, to the work done by the resistance of the ground against the set of the pile and the temporary compression or quake of the



2.—Temporary footbridge nearing completion, showing contractor's gangway.

The work of the contracting engineer 2

3.—Dismantling steel deck and hangers of old bridge. Temporary suspension bridge in position giving access to chains.

The work of the contracting engineer 3

pile and ground together. If the weight of the hammer is W tons, the fall H inches, and the efficiency of the blow E, then

$$WHE = R\left(S + \frac{C}{2}\right)$$

where R is resistance, S is the set in inches, and C is the temporary compression or quake of the pile and ground together.

The above is not the whole of the Hiley formula, but it contains the essential parts of it, and in most cases will give results accurate enough for all practical purposes, and much more accurate than any formula produced before it became known. Mr. Hiley gives tables for values of the efficiency to be expected for blows of all kinds upon most of the materials used in practice. Values are also given for the temporary compression, although these values can always be measured on the site. For estimating purposes only, the value of C may be taken as ·5 for timber piles driven by drop hammer, provided the length does not exceed 50 ft. Again for estimating purposes only, the temporary compression of timber piles 40 ft. to 50 ft. long in average ground will be of the order of ½-in.

Having found the resistance by the above formula, the result is usually divided by a factor of safety, which may be 2, 3 or 4, depending upon the degree of caution which the engineer wishes to observe.

Piles for the stagings at Chelsea Bridge were driven from a floating pontoon, having a steel pile frame 40 ft. high mounted upon it. The hammer or monkey is operated by a steam winch supplied with steam from a boiler mounted at the back of the unit.

Demolition of the Old Bridge.

Several important considerations had to be kept in view when arrangements for the demolition of the old bridge were being made. In the first place, no interference whatever with river traffic was allowed. Secondly, it was desirable that any plant put down for the demolition should, if possible, be retained for the construction of the new bridge. Thirdly, some working stages in the form of platforms would be required during the whole course of the operations. Consideration of these three points together seemed to suggest that long-jibbed Scotch derrick cranes should be erected at each end of the old piers and also at each abutment. These cranes would be carried on timber stagings and would be capable of handling any material in the old towers and the old piers, and similarly with new material at these points. An examination of the engineers' designs showed that the heaviest piece to be lifted into position would not exceed 14 tons. Accordingly, it was decided that derrick cranes having jibs 100 ft. long, and capable of lifting 14 tons, would be installed. These cranes are electrically driven. They are the central feature of the plant organization, and between them do 90 per cent. of all the work on the old and new bridges.

In demolishing the old suspension bridge, a very little thought will show that one must begin at the deck. When the towers are fixed as they were in the old Chelsea Bridge it is obvious that the deck can be cut in the centre and at the abutments and the bridge will still remain in position. So long as there is no large out-of-balance load on one side or the other of the towers the structure will still remain stable as the demolition of the deck proceeds. Arrangements for the taking down of Chelsea Bridge were made along these lines. Small derrick cranes were erected near the centre of the bridge and near the abutments before any cutting was done. A cut was made through the deck at each pier, and a barge was brought in alongside the pier in readiness for receiving material dropped through by the big derricks. The small derricks at the centre and abutments held on to the sections about to be cut; the section was then cut through by oxy-acetylene flame, and the derrick swung the piece on to a decauville truck which ran it back to the pier, where it was taken charge of by the big derricks and dropped into the barge. Photograph 3 shows the scheme in course of operation.

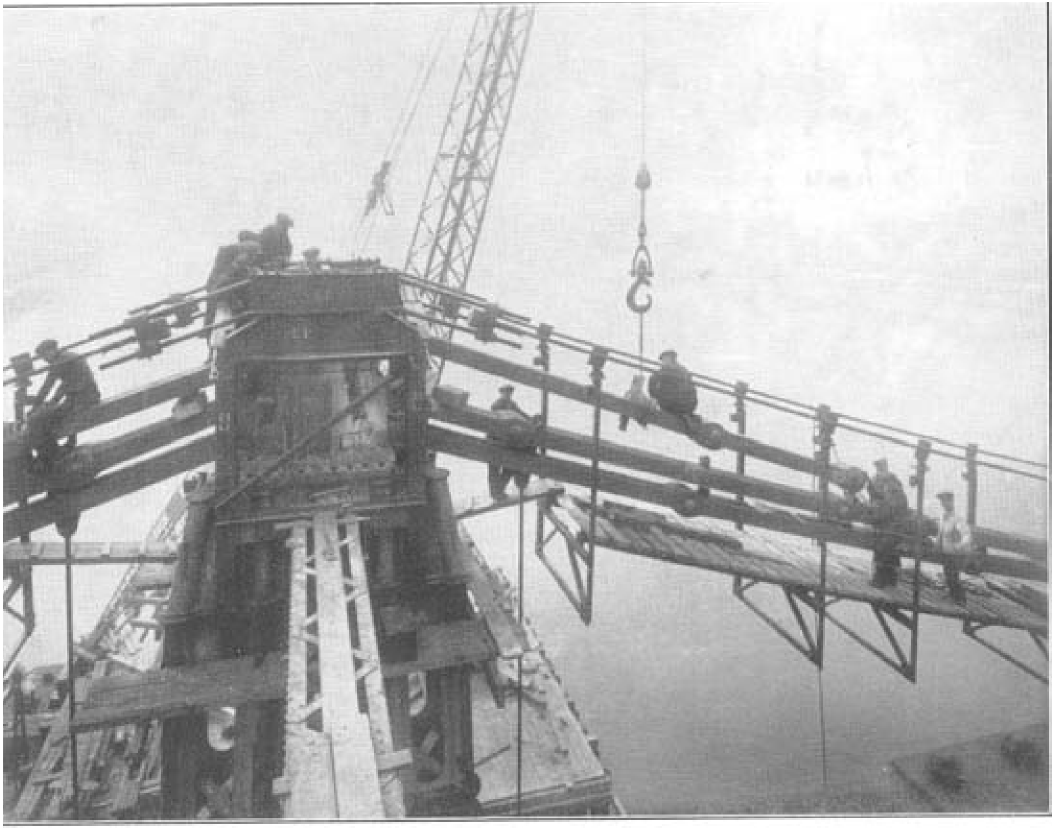
Care was taken to ensure that the out-of-balance load did not exceed more than a handful of tons, as severe stress would have been thrown upon the towers with the possibilities of serious movement or even collapse taking place. Observations were taken daily to find out whether the towers were moving out of the perpendicular. Some movement took place, but never more than $\frac{3}{4}$-in. in the whole length.

It is worth remarking here that the whole of the deck and hangers were taken down in 12 working days.

In passing, it may be mentioned that for the cutting up of old steelwork of this kind where the average weight of each piece is not less than, say, 30 cwt., something like 100 cubic feet of oxygen and 30 cubic feet of dissolved acetylene will be required for each ton of steel in the structure. If there is much cast-iron, these quantities will be more nearly 200 cubic feet of oxygen and 50 cubic feet of dissolved acetylene for each ton of cast-iron burned.

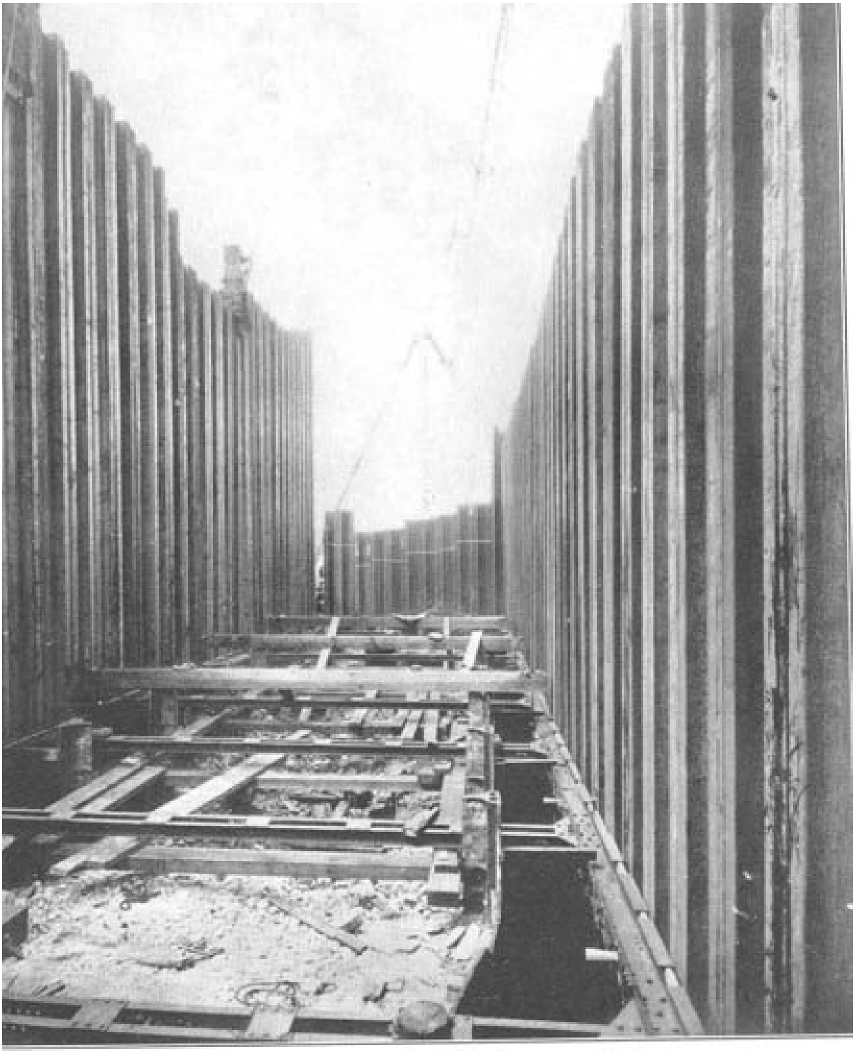
The demolition of the chains of the old bridge was the most important problem of the whole demolition undertaking. It was decided at a very early stage in the proceedings that a temporary suspended footbridge would be required in order to let the workmen have access to the chains at all points. Accordingly, special steel frames were made and fitted to the old towers and to the abutments to provide anchorages for wire ropes which would carry the hangers and platform of a suspended footbridge. Naturally, this footbridge had to be erected before any cutting was done on the deck.

It will be seen from the photographs that there were three separate



4.—Dismantling top chains.

The work of the contracting engineer 4



5.—Driving steel piles for cofferdam around old pier.

chains on each side of the old bridge, each chain weighing nearly 100 tons. It was decided that the uppermost chain should be wedged up from the second chain so as to take the stress out of it, after which it would be possible to remove the chain and proceed with the dismantling. The second chain was to be treated in the same way, namely, by wedging up from the bottom chain. Naturally the bottom chain also had to have the stress due to its own weight taken out before it could be dismantled, and this could only be done by packing up between the platform of the suspended footbridge and the underside of the chain, and then pulling up the wire ropes of the suspended footbridge, so as to lift the chain uniformly along its length. The pulling of the wire ropes was done by means of U-bolts and nuts carried upon the steel frames at the towers and abutments. It was found that approximately 10 in. of movement along the screws was necessary in order to lift the chains and take the dead load stress out of them. The actual time taken in dismantling the six chains was eight working days.

The dismantling of the towers should have been a very easy matter, but in actual fact was not. The designer of the old bridge had seen fit to provide long holding down bolts through the hollow columns of the towers, and had not only fitted holding-down bolts, but had filled up the hollow columns with concrete. This meant that at joints in the tower sections, portions of the cast-iron columns had to be burned away.

COFFERDAMS.

Having cleared the superstructure out of the way, the next job to be tackled was that of providing facilities for demolishing the old piers down to formation level and excavating below the old foundations to a depth at which good hard London clay would be likely to be found. Borings made before final designs for the bridge were prepared showed that good clay suitable for foundations would be found at about elevation —40 ft., that is, about 53 ft. below normal Thames high water, or about 58 ft. below maximum flood level.

The method laid down by the engineers for doing this work was the provision of cofferdams composed of interlocking steel piles driven down to the necessary depth. The actual design of the cofferdams was prepared by the contractors, this being the usual procedure in such cases. Formerly most cofferdams of this description had been strengthened against water pressure by timber walings and struts inserted at short intervals on the way down as excavation proceeded. In a few cases steel walings had been used, but the invariable practice was to employ timber struts across the dam. In the present case the contractors decided to provide all steel walings and struts so as to take full advantage of the natural strength of the steel piles against bending under the pressure of outside water.

Ultimately this scheme was modified by the provision of reinforced concrete for the two deepest frames. The reason for adopting reinforced concrete was partly in order to save expense and partly because it was impossible to determine beforehand what might have happened to the steel piles when they approached the depths at which the frames would be fitted. Any hidden obstacle would be capable of diverting the pile out of its true line and would result in the area of the dam being smaller than that allowed for, so that a steel frame of predetermined dimensions could not be fitted without extensive alteration. In the end, therefore, the cofferdam as constructed has five frames, spaced at intervals from top to bottom of 20 ft., 13 ft., 10 ft. and 8 ft. respectively.

In a paper of this description it is not possible to give full details of the method of calculating the spacing of walings and struts for frames such as these, and in any case there is no fixed set of formulæ available for general use. Each case must be considered entirely on its merits, and certain assumptions as to spacing must be made before detailed calculations can be completed. The spacing of the frames in the cofferdam resolves itself into a complicated problem for determining the stresses in a continuous beam, with zero loading at one end increasing uniformly to a load equal to the total head of water at the other end. There is no simple method of determining the spacings of the supports analytically. The best method is to adopt arbitrary values for the spacings and check the reactions and stresses produced by these spacings graphically. Two or three trials will usually be necessary in order to find the spacings which give the most uniform loadings, and when these are obtained approximately, it is possible to proceed with the detailed design of the cofferdam.

STEEL PILES.

For the driving of the steel piles for cofferdams it was decided to erect the two uppermost steel frames in position before attempting to pitch and drive the piles. The upper frame was laid across the old pier and firmly clamped in position. The second frame placed at a little above the ordinary low water was set at low tide all round the old pier, the struts, of course, being omitted and their place taken by short timber struts backing on the old pier itself. Thus excellent guides for the steel piles were provided and the pitching could be carefully guided and checked step by step.

Regarding the piles themselves, two popular sections were available, namely, the Larssen and the Krupp. On account of its greater flexibility the Dorman Long Krupp Section No. III was chosen. This pile has a weight of 32·56 lb. per sq. ft. and a section modulus of 31·29 in.^{3}. Since it was necessary to pitch all the piles in one dam before driving any of them very far, and since also the end row of

6.—Looking down into cofferdam, showing new foundation 58 feet below high water

The work of the contracting engineer 6

piles had to be driven some distance before the piles along the sides could be handled by the derrick cranes, a number of 3-in. diameter holes were provided at the upstream and downstream ends to act as sluices so that the dam would be free of water pressure until everything was ready for a closure to be made. At the proper time steel sluices faced with rubber were bolted over the holes in the piles and the structure began to function as a cofferdam.

The steel piles for the cofferdams were each 69 ft. long, and had to be driven approximately 38 ft. into the bed of the river. It was hoped that it would be possible to do all the driving with automatic double-acting steam hammers, but it became apparent very soon that the automatic hammer was not powerful enough to overcome the great resistance of London clay. The hammer used was that known as the McKiernan Terry No. 9B2, which delivers a blow of 8,000 ft.lb., the number of blows per minute being 140. When the penetration of the piles reached about 20 ft., that is, about 10 ft. through ballast and 10 ft. into the clay, the penetration was no better than 150 blows per inch. This represented very hard driving indeed, and very shortly the pile heads began to buckle under the tremendous rain of blows from the automatic hammer. It was supposed that the chief reason for the apparent heavy resistance was that the effect of the blow was dissipated to a very great extent in the pile itself, and that succeeding blows of the steam hammer more or less coincided with the elastic restitution of the pile, thus reducing the efficiency of the blow to a very large, but unknown, degree. It was conjectured that a smaller number of blows per minute with a heavier hammer would give better results.

Accordingly it was decided to replace the automatic hammer with old-fashioned drop hammers weighing three tons each and operated from standard pile frames mounted on the stagings. The 3-ton hammer was given a drop of from 6 ft. to 8 ft. with an effective blow (allowing for the efficiency of the drop) of from 20,000 to 30,000 ft. lb. Results obtained with the drop hammer were immediately effective, and it was found that whereas the driving with the automatic steam hammer weighing 3 tons was 150 blows per inch of penetration, a 3-ton drop hammer falling 6 ft. gave penetrations of four blows per inch. Later, as the total penetration into the clay increased, the sets obtained were of the order of 15 to 25 blows per inch. There was very much less buckling of piles under the drop hammer than there had been with the automatic steam hammer, however, and pile driving was eventually completed by the former method.

Demolition of Piers.

The demolition of the old piers of the bridge proved to be a tougher undertaking than had been expected. Very little information regarding the construction of the old piers was available from drawings or records. Consequently, the contractors had only approximate ideas of what they might find behind and below the iron casings of the piers.

It transpired that the old piers had been founded on timber piles approximately 14 in. x 14 in. in cross-section, and from 25 ft. to 35 ft. long. There were 83 such piles under each pier. Although no records of the methods of constructing the piers are available, an examination of the information gathered during demolition shows that the iron casing which completely surrounded the foundations was probably used as a cofferdam. It is supposed that the piles were driven from a floating staging, and that subsequently interlocking cast-iron sheet piles were dropped accurately into position round the piles and driven until the toes of the iron plates had penetrated the clay, which at the present day is about 10 ft. below the river-bed. The iron sheathing thus placed was probably provided with timber struts and pumped out so as to enable the builders to clear away most of the river mud around the timber piles.

The shallow bed thus formed was then filled with lime concrete and covered over with York stone, 12 in. in thickness. This York stone was carried directly on the timber piles and in turn carried the main bridge towers. The tower foundations were partly covered in with lime concrete, and the inner perimeter of the iron sheathing was filled to a depth of approximately 2 ft. with brickwork arranged in a series of arches with lateral struts in brickwork and iron. The whole construction was extremely strong, and the workmanship everywhere was of a very high quality.

In preparing a scheme for demolition it was at first suggested that the cast-iron plates forming the sheathing to the old piers should be cracked from the inside by means of explosives. Public authorities, however, preferred that explosives should not be used except in the last resort, and ultimately demolition was carried out by breaking up the brickwork inside the sheathing with pneumatic tools and cutting up the plates by oxy-acetylene burning.

The old elm piles could not be withdrawn owing to the necessity for preventing the formation of voids inside the cofferdam with the consequent tendency of the steel piles to be forced inwards. The piles, therefore, had to be cut off at intervals as excavation proceeded. This was done by augering, a machine augur driven by compressed air being used throughout.

PUMPING.

In cofferdams of the type under consideration where there is a considerable tidal variation, the leakage through the piles is fairly high. Normally, under a constant head, steel piles can be made almost completely watertight, but under tidal conditions this is more difficult, and it frequently happens that it is cheaper to provide high capacity pumps than to spend a lot of time and money in proofing the joints of the piles. Actually two pumps for each dam are provided. These have 4-in. delivery pipes, 5-in. suction pipes, and will deliver 350 gallons per minute each against a total head of 60 ft. They are specially designed for work in narrow trenches and dams. The electric motors are each direct-coupled to the pumps and are of 18 h.p.

In practice, it has been found that one pump can usually deal with incoming water, even at high tide, but naturally a reserve must be provided. In case of total breakdown of the electrical supply system, a stand-by steam pulsometer pump is installed for each cofferdam. Steam for the pulsometer pump can be raised in about an hour if necessary, as the fire in the boiler furnace is kept going continuously, although no head of steam is maintained.

Plant.

The provision and maintenance of plant is probably the most important part of the contracting engineer's work. In modern times power plant and machine tools are being used to an increasing degree, and it behoves the contractor's engineer to keep abreast of developments and to arrange his plant in the most economical way, and in such a manner that the maximum amount of work will be done with the least amount of plant movement.

The tendency nowadays is for most of the contractor's equipment to be electrically driven. This applies to cranes, concrete mixers, air compressors, and other items, including piling winches. In many cases it is convenient for the contractor to draw his power from a local supply authority, but many contractors prefer to have their own source of power supply, even in areas where public supply is available. The reason for this is that from time to time most contractors have work to do in areas where they must provide their own power.

In the case of Chelsea Bridge, although the site is in the heart of an up-to-date electricity supply area, it was decided to generate power on the contract, partly to avoid the heavy initial cost of main cables from the public supply system, and partly because the power units in use will be available for other contracts in the future at any point where they may be required.

The selection of power units depends naturally upon the load that may be expected. The contractor has nothing but his own experience to guide him in making his selection. So far as Chelsea contract is concerned, the total motor horse-power installed is approximately 600. About 100 h.p. of this is made up of stand-by motors, which are only brought into operation in the event of breakdown. The maximum possible load is therefore 500 h.p. Rather more than half of the latter total is made up of crane motors, of which there are eight hoisting and six slewing on the works. The balance of 250 h.p. installed is made up of compressor motors, pump motors, concrete mixer motors, and other small units. The assumption made is that rather less than half the total installed motor horsepower will be required to keep all the plant in running condition. It is practically impossible for all the motors to be brought on the line at the same instant, and experience shows that for every 100 h.p. of motors installed a power supply of rather less than 50 h.p. will be sufficient.

At Chelsea, for the 500 h.p. of motors, the generating sets have a total of 300 brake horse-power. The generating sets are high-speed diesel engines, three in number, each of 100 brake horse-power. The diesel engines are direct coupled to alternators supplying 3-phase 50-cycle alternating current at 440 volts. The engines are manufactured by Messrs. W. H. Allen, Sons & Co., Ltd., of Bedford, and run at 1,000 r.p.m. They are semi-portable, each set carrying its own water and oil cooling systems, electrical self-starter, and D.C. battery for operating the self-starter. These generating sets are carried on steel skids, and the complete units are mounted on timber supports laid along the ground. Though weighing about eight tons each, they are very easily moved from point to point, and are thus eminently suitable from the contractor's point of view. The sets are paralleled by dark synchronizing lamps, automatic voltage regulation being provided for the system. The cost of current, including fuel, lubricating oil, depreciation and attendance, is less than 1d. per unit.

TROUBLE IN THE BALKANS.

A Party of Amateurs Essay the Monte Carlo Rally.

By Lieutenant W. M. Coffey, R.E.

The Monte Carlo Rally is the last surviver of those great events of the old days—the continental road races. Not that the Rally is a race: it is a reliability trial, and the charm of it is that an entrant may choose, within limits, his own route, according to what he considers the capacity of his car.

The most exacting of the routes is Athens—Monte Carlo. One might mention here that in the fourteen years of the Rally's existence, only two entrants have succeeded in getting through from Athens, if one excludes 1934, when weather conditions were quite exceptional. The Balkan are about one hundred years behind the times, and in addition to that they are normally snowbound in January, when the Rally takes place. The Rally demands an average speed of 26 m.p.h. for three days and nights, and 31 m.p.h. for the last day and night. That means hard driving, when snow and mud are there to delay, and hard driving on Balkan roads means very careful attention to detail, or the car will collapse like a house of cards.

We set out to overcome all possible troubles liable to be caused by weather and road conditions. We were, we hoped, prepared for anything from blizzards to bandits. However, we were defeated by the usual factors, time and money: obviously, one never has enough money, but we felt we had enough time: after all, we had eighteen months in which to prepare.

It would be merely wearying to dwell on the months of preparation. The equipment of the car proceeded but slowly, much hindered by financial cold feet on the part of the owner. Things were made and scrapped; springing of fantastic design was adopted, tried, and conveniently forgotten, like many other things: such as that home-made body, which did not come up to expectations: and that first radiator, which became so sieve-like that finally it could weep itself dry in thirty minutes. In June, 1934, with about six months to go, the whole thing was scrapped (it had been an 18 h.p. Bean of 1927) and by good fortune the only 1929 18 h.p. Bean was obtained. This put a different complexion on things.

Work now proceeded apace. Set-up springs were fitted to increase the ground clearance: a steel shield was fixed under the front five feet of the chassis: skis which could be elevated and steered were made, to fit on the front axle: two different types of chains were made but most unfortunately were not tested, as there was no time. Other fittings included a second petrol tank, with independent feed, bringing our fuel capacity up to 26 gallons: a second dynamo and battery: a gearbox-driven tyre-pump: a windscreen heater: an enormous quantity of spares, and enough lamps and wiring for a small tattoo.

We had only eighteen months in which to prepare, so it was natural that we should miss the boat at Folkestone! But there were extenuating circumstances; we had laboured all night, and had not been cheered by the discovery, at one in the morning, that both the petrol tanks were leaking. And then the engine ran so badly that we wondered if we should ever reach Folkestone, let alone Athens. We got the car on to the afternoon cargo boat, and then got down to it. Tappets, plugs, magneto, carburettors, all were examined and adjusted or cleaned. And large portions of the air-heater, a diabolical array of piping designed to keep the interior of the car at a pleasant temperature, but whose only function was to make the feet red-hot, were consigned to the Channel.

Our landing at Boulogne was hardly a success; for ten minutes nothing would persuade the engine to fire. In order to go east from the town, one must ascend: this of course the car would not do: six new plugs failed to affect her at all, and it was not until the spare magneto was fitted that she would condescend to move. By this time we were all exhausted and somewhat annoyed; so we consulted that admirable companion, the Autocheque book, and found an hotel suitable to our means in St. Omer. It took a lot of finding, as our French was not in training, and we were, one feels, misunderstood.

Tuesday morning was foggy. It might be as well to note here that about 80 per cent. of our journeying on the Continent was done at night, in a fog, or in a snowstorm. We moved slowly and painfully over the flat and featureless French roads (flat does not refer to the surface) and we lunched at a wayside inn; the "patron" was very unhappy about the Saar—a burning question at that time—and for some reason he felt that one moustache between three of us was slightly inadequate. The Belgian frontier in the evening was not impressive: we overshot it and had to retrace our steps; the spare differential and crownwheel assembly in its case in the back of the car worried the Customs officials; our halting explanation was received with incredulous looks; their reply, as far as one could judge, was "But why do you need so many pyjamas?"

We dined at Florenville, and met our first real trouble. While parking the car, we were rather shaken by a considerable bump, and the sight of a wheel overtaking us on the wrong side; the reason for this is in obscurity, but anyhow there it was. We hastily ordered omelettes for six, and assured the inevitable man who has spent thirty years in England that we did not need assistance. The hub-plate and the wheel nuts were gone and the wheel was damaged, so we put on a spare without a hub-plate, and hoped it would be all right. As events turned out it was not. The omelettes were excellent.

By now we were very much behind schedule, so we decided to push on through the night. Apart from the fact that we lost ourselves and made a detour of about thirty miles, the night was uneventful. The dawn saw us at Karlsruhe, arguing fiercely as to which entrance to the boat-bridge was right; we took two wrong ones. At about eight o'clock a wheel was observed to be entering a field on the left of the road. . . .

In Stuttgart we found an hotel and, eventually, an engineering works, where we explained our desire for ten steel wheel nuts, a hub-plate, and repairs to two wheels. We had to wait for these till Friday afternoon, and time hung heavy. But we had shopping to do: we took our courage and our dictionary to a chemist, to buy linseed oil and amyl acetate, not to mention pyjamas and a pair of socks. The ubiquitous air-heater was further depleted of some few feet of pipe. Here we felt we made history by winning ten marks in the Winter Relief Lottery.

On Friday evening we were again on the road, though ice and snow being the rule we were not so much on as we should have liked to be. The Austrian Customs were pleased to see us, but thought we were an armoured car. They proved obdurate, however; they demanded one schilling: we had no change: very well, they would take sixty pfennig: we had fifty: for an hour, and the time was one a.m., with the mercury hiding away at the bottom of the thermometer, that ridiculous young man demanded ten pfennig, while we offered him dinars, pengoes, lei, drachmae, pence, lira, francs French and francs Belgian, and even a small coin which turned up mysteriously from nowhere, and subsequently was identified as a quantity of Turkish piastres; and still the fate of Austria hung in the balance; then he took the plunge, and accepted a French franc. And so over the Fern Pass to Innsbruck, where we left some more of the air-heater, so as to make room for the fourth and last member of the party, whom we dug out of bed at five o'clock of a very cold morning. We then slept, while he drove us in a series of skids up the Brenner Pass.

We breakfasted on Saturday morning at Brennero, at a thoroughly squalid eating-house; then we had to drive rather fast down those wonderful Italian roads, in order to catch the Athens boat at Brindisi on Sunday evening.

One feels that the subject of Italy has been many times exhausted already, and any comments we could make would be valueless. Still, there is one thing that comes to mind; except in the large towns, there is an apparent lack of any drainage system: in the streets of that most depressing port of Brindisi we washed the car at a pump and tried to forget the past. Many people helped: our Scottish member made a short speech and (there must have been about a dozen of them) gave them the equivalent of fourpence.

We have a very hazy recollection of Italy. Most of the time we slept: when we woke up, it was to see many lorries stuck in the snow and the Bean skidding amongst them: or the sad occasion when the long, straight traffic-less roads took their toll in the shape of a red-hot exhaust pipe and a burning scuttle, and we had to get out the fire-extinguishers: the level-crossing and its deaf guardian, how the gate was raised and the car went through, and then the trouble when the guardian did arrive: but over all the incredible, never to be stopped, leak of the water-pump gland.

The Lloyd Triestino *Galatea*, 5-cylinder Fiat Diesels, not only carried us to the Piræus, but also gave us packing for that vile water pump. She was a most luxurious boat, but rather haphazard; her entry into the harbour at Brindisi was, to say the least of it, spectacular, while the way she nestled into the quay at the Piræus was worthy of special mention: she nearly carried away a street lamp. The unloading of the car took years off our lives, and had better be glossed over. We were taken in tow by a very up-and-doing hotel courier, who stormed us through the Customs, and produced what he called the best petrol; judging by the residue on our filters, if body is any criterion, it was.

That night we met the Greek roads, and found them well up to expectations; never had we seen such huge pot-holes, and never before had we met tram-lines sitting on the road instead of in it.

Athens is a wonderful city: contrasts everywhere, the grandeur of the Parthenon, the sheer hideousness of the concrete buildings: the smart main streets, and the indescribable back parts. But the hotels are excellent and cheap, petrol is only 1s. 6d., there are good garages, and, surprisingly, good machine-shops.

It was here that we discovered that from Blackdown onwards there had been no oil in the gearbox: the only casualty being a stripped speedometer-drive pinion, and that speaks well for the gearbox. Some excellent machines were found in a glorified cow-shed, and a new pinion was made very quickly. There was much to be done in the way of last-minute adjustments: a lot of time was spent on the skis, which we feverishly removed the night before the start, having decided that they would infallibly remove themselves after the first twenty miles. We also abandoned the larger set of chains, having nowhere to carry them; these were complicated and cumbersome, but would almost certainly have been invaluable in deep snow: they were a modification of the overall tracks fitted to W.D. lorries, which tracks are, of course, quite unsuited to deep snow.

Incidentally, we were now reduced to only one shovel (R.E.), the other one having been decapitated when the second wheel came off.

Each day we saw the indefatigable secretary of the Greek Automobile Club, an admirable institution, whose idea of service can only be described as stupendous. Road reports were alarming: snow in quantities appeared to be falling in Macedonia, and Bulgaria sounded ominous.

The morning of the start, Saturday, January 19th, was sunny and warm; in solemn procession we crept through Athens, headed by the secretary's car, to the starting-place. Here we added quantities of rope to the cocoon on the luggage grid, which contained spares and tools for major repairs, and was, we hoped, "not wanted on voyage." The first two cars shot off, followed in more dignified fashion by us: as a matter of fact we nearly stalled; the fourth and last car passed us quite soon.

The road for the first 50 miles was excellent, and the Bean ran smoothly at about 55 m.p.h.; after about two hours we met the Riley, off the road and hanging by some miracle on a nearly vertical slope with a drop of some four hundred feet; the other two cars were there as well, and apparently the situation was well in hand, so at a signal from Riley we continued on our way. (Actually the Riley did break away, and went to the bottom, luckily not being very seriously damaged.)

Every village we came to was lined with people, which helped considerably, as it showed us the way out; apart from that there was nothing to distinguish between the road to Salonika, and the road to the nearest midden. One objectionable small boy threw a snowball which broke a sidescreen, which so enraged us that we completely revised our views on Greece.

We cooked our lunch while on the move—not so easy as we were doing about 40 m.p.h. over pot-holes—but we had to interrupt the meal in order to put out a fire. Presumably caused by a cigarette end, this threatened to destroy the body of the car, and was being very intimate with twenty gallons of petrol; one filler-extension had already melted off, so a trouser-leg was relentlessly commandeered as a bung.

The first real obstacle was the Thermopylæ Pass, which was objectionably like a cat-walk, and covered with snow—we felt the Spartans were even more spartan than history relates; the car took it very well, but our gratification suffered a rude setback when we met a bus, laden to an extent that would have severely shocked the Minister of Transport, at the summit. There is a view from the summit which beggars description; stretching into the distance from the foot of the mountain, whose side seems from the top to be vertical, is a great white road, leading straight as an arrow into Lamia. But that road is a snare and a delusion, as we found to our great discomfort after pursuing a zigzag course down the mountain-side.

At Larissa we topped up our petrol tanks with twelve gallons, in about half a minute, thanks to the efficient organization of Shell (Hellas), Ltd.

Beyond Tsitsilar, at about 10.30 p.m., we had to dig for the first time; the off-side wheels were in some three feet of snow at the side of the road, and for an hour we collected stones and built a way out; the chains were very useful, spread out as a mat. It was just after this that we found that the handbrake was frozen solid and resisted all efforts to move it.

We were now faced with the Castania Pass, which climbs from 1,000 ft. to 5,200 ft. in about five miles. It is a winding climb, with many sharp bends, and we had to keep in bottom gear; within a few hundred yards of the summit the instruments showed full oil pressure and an engine speed of 3,500 r.p.m.—and a big-end bearing gave a despairing crack. That was the finish of the Rally for us, repair being out of the question in the time at our disposal; so we had a meal, running the engine every ten minutes to prevent it from freezing, and awaited developments. They soon arrived—a cheerful Ford-lorry-load of police and soldiers, speaking only Greek, except for "Ford good car, no?" which was not greeted with applause; they had some cognac. . . . We demonstrated the Noise, murmured "Auto caput" and things like that, and they faded away down the Pass. We decided to try for Salonika, fifty miles away, so the Bean was urged on at 20 m.p.h., the maximum safe speed.

After about thirty-five miles of this wretched going, we arrived at a long stretch of badly drifted snow, through which our limited power was insufficient to drive; we were now on the Verria-Topsin road, which used to be called the worst road in Europe, but now at any rate that would be a complete misnomer. The road runs at sea-level along the coast, and is normally free from snow; we were unlucky. So, the time being 2.30 a.m., we went to sleep.

The situation had hardly been sublime before, but it was certainly now ridiculous; we had, of course, drained the radiator; we woke up in the morning frozen and furious; a blizzard was in full swing, the inside of the car was deep in snow, and there was no water to be seen for miles around; true, there was much snow: in fact, little else was in view: but we do not advise anyone who has not tried it, to suggest filling with snow a radiator, whose capacity is five gallons, to anyone else who has. The comic element now appeared; the ubiquitous "Chev," twelve years old, full of incredibly ancient Greeks, who spoke no known tongue, and a cheerful and apparently nerveless driver. We asked where water was to be had: he apparently knew, and invited one of us to go with him, so we got into his car, declining the invitation of the aged ones in the back to join them, and off we went. Back some four miles on our tracks we met the Vardar river; here, showed the driver proudly, was water; we agreed, but pointed out patiently that we should like something, we suggested an oil drum, in which to take it back; the local dredging engineer, dug out of his *igloo*, suggested in Græco-German that there might be one in Verria, but, of course, the road thither was now blocked. Then the driver remarked, always apparently, that for 200 drachmas (about 8s.) he was willing to drive us back to our car: when we had recovered consciousness we made an impassioned speech, which was obviously and fortunately not understood, and made a dramatic exit. However, we were soon met by the Bean, which had found water, and was now determined to reach Salonika; so we turned the car and pushed on.

With much digging we reached the rail crossing at Topsin, where the locals observed the Rally number plates, and feverishly set to work to dig us through their prize drift, which was some four feet deep, and pretty long. Here we were told in French that there was no hope of getting to Salonika, and in about half a mile we found that we were stuck in a snow-drift which extended at least as far as we could see.

We realized that it would be dark long before we could dig the car through, so, not relishing the thought of another night out, we looked round for assistance; at once a Greek appeared, a shepherd in a goatskin coat; now what we wanted were horses, so we drew a horse in the snow, and off sped the aged one, to return in course of time with two oxen. These we tied to the car, and they pulled, we pushed, and the engine did its best: nothing happened, but on the horizon there appeared a lorry, with about a dozen men slowly digging it towards us. That lorry had been sent by the Greek Auto Club to look for us, and never was a more welcome sight.

When a path had been dug as far as the Bean, we tied her to the back of the lorry, and off it went: we then untied the broken end of rope, and drove into Salonika. Here we learnt that the only road was blocked by a landslide, and we could not get beyond Nish; this meant, much to our disappointment, that we had to leave out quite the most interesting part of the trip, and take the car by train to some civilized place. So after repairing the big-end bearing we entrained for Budapest, whence we drove home.

It was a good trip, and we learnt a good deal, which should be very helpful next time: *but* we feel we must warn anyone who is thinking of doing the trip that the finance side looms largest of all the difficulties to be met with.

FLOODLIGHTING FOR MILITARY TATTOOS.

By CAPTAIN E. McDONALD, R.E.

THIS article is the fruit of experience gained at the "searchlight" tattoo which terminated the jubilee celebrations in Simla.

Searchlight is stressed advisedly, because searchlights, or rather the lack of them, was just what worried us when we began to work out the illumination required.

Even one or two service searchlights give you candlepower and to spare, and therefore peace of mind as to whether the turns will be reasonably illuminated or staged in semi-darkness. Too much rather than too little light is the usual trouble with these.

When, however, the nearest searchlights are one thousand miles away, and you have to find as well direct-current generators and motive power because the local supply is alternating; and having wheedled all this out of its reluctant custodians and railed it to Simla, have to lug it a thousand feet down a hillside in coolie loads, then you look for something simpler under the circumstances. We decided to use flood-lighting units, and as there must be lots similar to the ones we used available for hire, our experience may be of interest to anyone responsible for the lighting of similar shows in future.

THE CHOICE OF EQUIPMENT.

We began with rather hazy ideas as to what sort of floods, and how many, we would need, and how we should group them. Nor, indeed, at that early stage, could the producer tell us what he was going to produce or what size stage he was going to produce it on! Still, with everybody about to floodlight in some form or other throughout the Empire, we had to decide something, and place our orders before all the manufacturers' stocks were taken up.

As usual, theoretical calculations were not very helpful in the absence of previous experience. They never are, unless the data substituted in the formulæ are based on practical knowledge. One table told us that 4-foot candles was a suitable figure for pageants and tattoos. Perhaps it is, but we never discovered what kind of blaze it indicated. What we did find was that to produce it on even a modest-sized arena would just about take the cash allotted for the whole show, lights and everything else.

One proviso which the producer made really gave us the key to the solution. He wanted some lights at any rate to follow the performers in certain items. In the end we decided to man each light individually, and by concentrating them on the area occupied by the performers we hoped to ensure that some of these might be adequately illuminated some of the time.

Calculating this way we named a minimum number of 1000-watt floods (sixteen), which we said might just do, a figure which was, of course, accepted as an absolute maximum by the Committee.

It is well to remember, however, that there are floodlights and floodlights. Concurrently with our studies of lumens and covering power tables, we got hold of three possible types, each with a 1000-watt lamp. Briefly their cost was in the ratio of 1 : 2 : 3, but their relative value for the purpose we wanted was nearer *nil* : 1 : 3 if the notation may be forgiven. True, the cheapest had only an enamelled reflector, but both the others had allegedly parabolic silvered glass mirrors.

The moral, of course, is not to be tempted by specifications unsupported by guaranteed illumination data, not that the latter is much value except for comparative purposes.

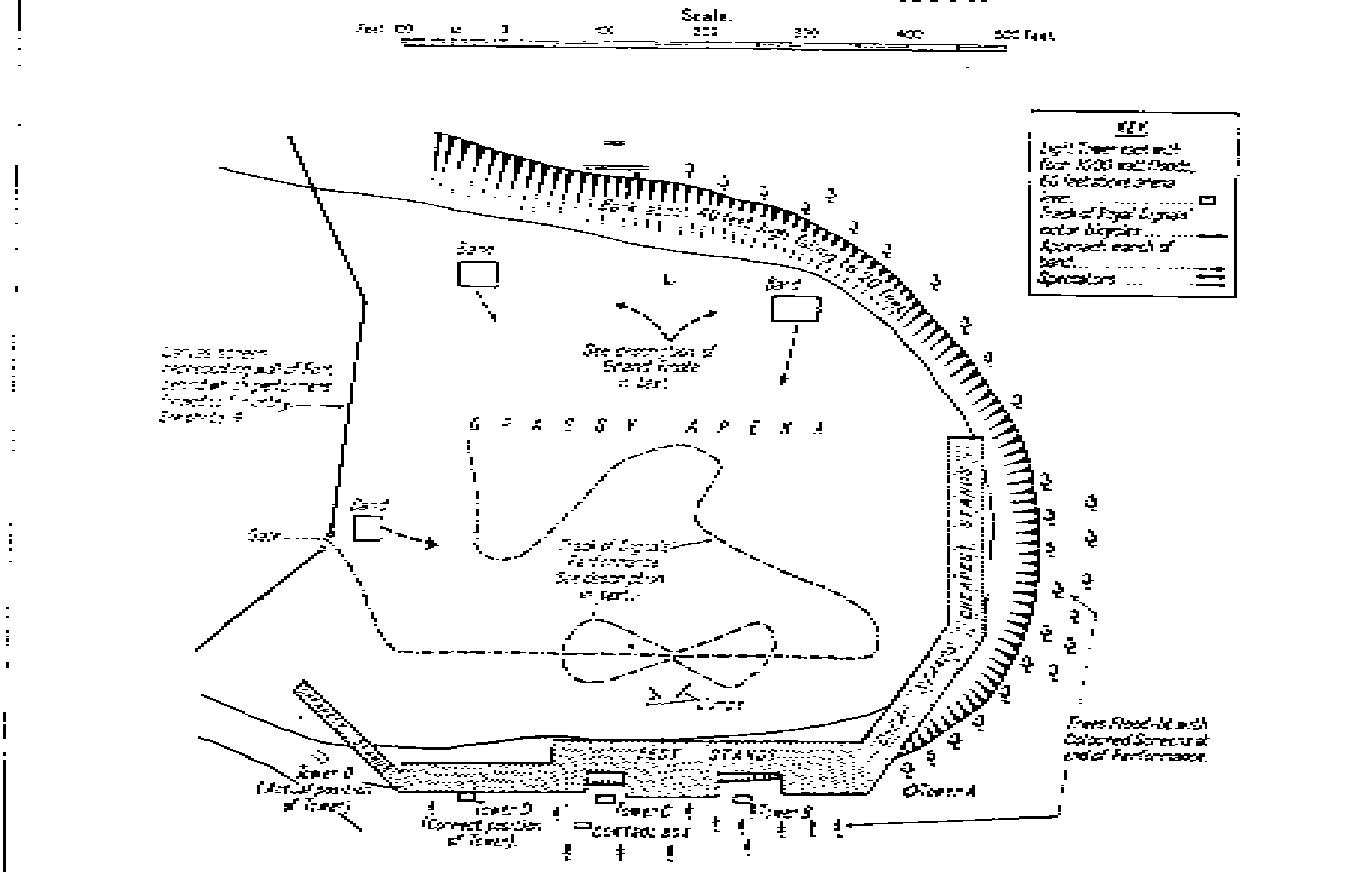
SITING OF EQUIPMENT.

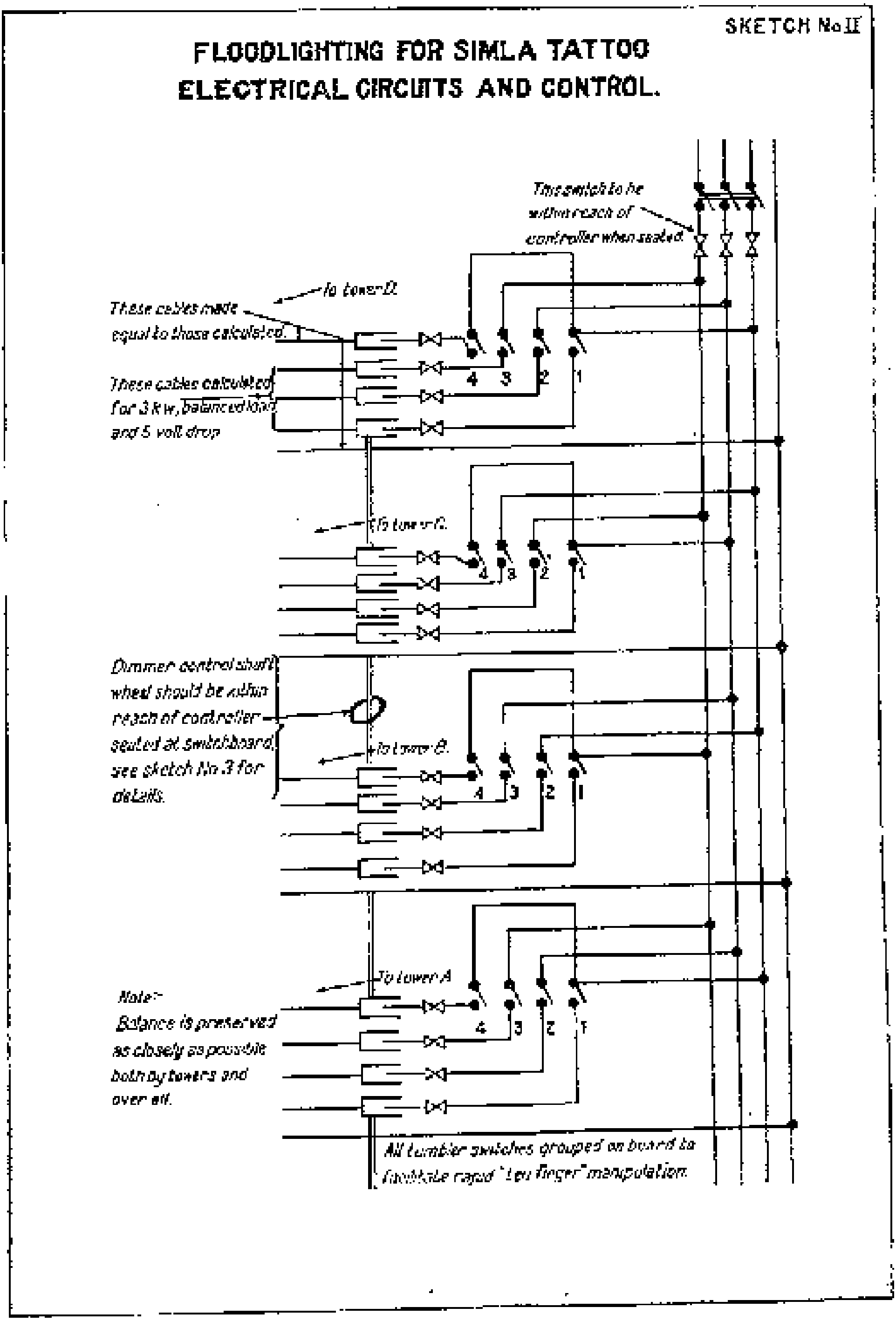
Our floods were, it will be seen, not to be used as floods, but as spotlights, capable of dispersion or concentration as required, while we were committed to sixteen for the area shown in the sketch No. 1.

Height.—Ground level is no use. There is a temptation to put them there to save money, but, apart from being most uneconomical in useful light output, it detracts horribly from the *effect* of the lighting, which should not be a mere alleviation of darkness. (This theme is elaborated later.) For, apart from the fact that only a small segment of the beam impinges directly on a man (but that incidentally right in his eyes)—the rest being reflected off the ground at very low efficiency, or passing over his head—the front ranks of a band put the rest in shade and the mass shadow of the whole tails off into infinity behind them. Lighting for shadow effect can be effective, but shadows from ground lights are certainly not. Then again ground lights search the whole depth of the arena at all times, a disadvantage which will be explained.

Our lights at Simla were 60 feet above arena level. That is just about right. Forty feet is an absolute minimum for real effect. Photos. Nos. 1 and 2 show the trestle towers, which No. 6 Army Troops Coy., K.G.O. Bengal S. and M., threw up very quickly in 4-inch timber dogged and fished. They served the purpose admirably, and we got quite a good price for the timber afterwards.

FLOOD LIGHTING FOR SIMLA TATTOO.




SKETCH No II
FLOODLIGHTING FOR SIMLA TATTOO
ELECTRICAL CIRCUITS AND CONTROL.
This switch to be within reach of controller when seated.
To tower D.
These cables made equal to those calculated.
These cables calculated for 3 kw, balanced load and 5 volt drop
4 3 2 1
To tower C.
4 3 2 1
Dimmer control shaft wheel should be within reach of controller seated at switchboard, see sketch No. 3 for details.
To tower B.
4 3 2 1
To tower A
Note:-
Balance is preserved as closely as possible both by towers and over all.
4 3 2 1
All tumbler switches grouped on board to facilitate rapid "ten finger" manipulation.

Tubular scaffolding, if available locally, might be a cheaper alternative.

Wing lights or single line?—A single line of lights behind the centre stands is preferable. The actual position of D tower in Sketch No. I inconvenienced the spectators in the ends of the centre stands when performers were marching close in parallel to the front. The extra side illumination of subjects by its lights was not worth it. The suggestion position would have been better. The wing stands get some glare, but then theirs are the cheaper seats, and they must expect less for their money. Of course the higher the lights the less the glare both to spectators and performers.

Grouping of lights.—Our sixteen lights were grouped in fours. This was by way of being a compromise between the most even intensity of illumination obtained by equal spacing of units along the whole front, and economy in wiring and structures and ease of control achieved by concentrating them.

CONTROL OF EQUIPMENT.

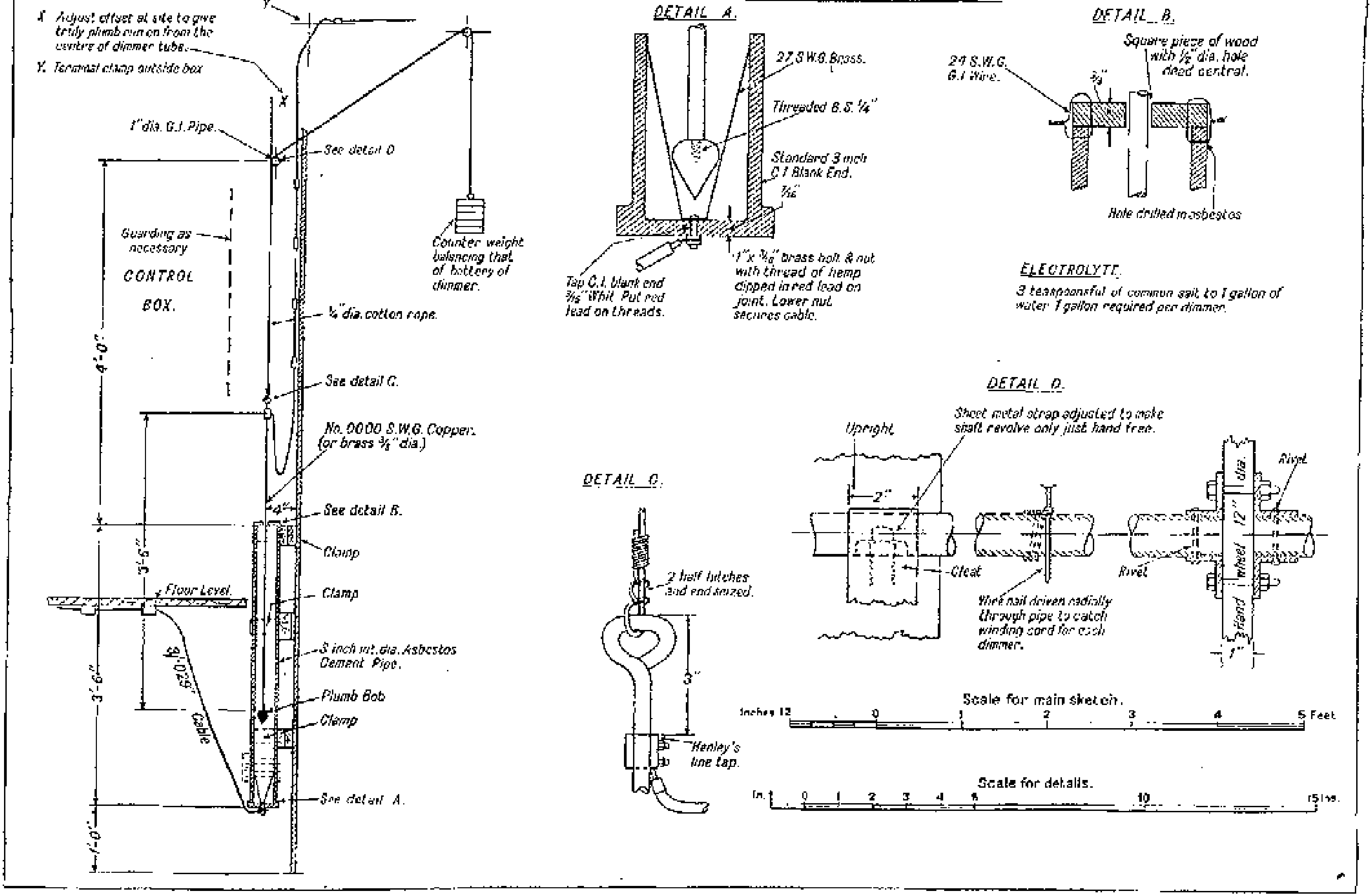
Electrical circuits.—See Sketch No. II. Three phases were taken to each tower from the switchboard in the director's box, cables being calculated as for a balanced load of 3 kilowatts and a voltage drop from the director's box of five volts. A different phase was taken to each of three lamps and a separate switchwire to the fourth. This and the neutral were made of size equal to the calculated cables. With this arrangement maximum economy of cabling was obtained, while allowing every light to be switched and fused individually from the director's box, localizing any fault thereby.

The out-of-balance light was taken off a different phase in each tower. So the maximum out-of-balance on the 16 kilowatt load was only one kilowatt. I have rather stressed this balance, because, from first to last, particularly if a fairly long feeder has to be put in to reach the ground, it makes for a very considerable saving in copper and, of course, if you have the bad luck to lose a phase during the show, you still have two-thirds of your lights distributed along the front. In addition to the switching of individual lamps, control could also be effected by dimming by means of a battery of simply constructed dimmers, details of which are given in Sketch No. III.

Control of movement.—See Photo. No. 3. The lights were capable of 90° right or left and 45° up or down traverse, and could be clamped in any position. We fitted as sighting tubes seven inches of one-inch pipe with cross wires at either end. With the aid of these the Sappers of No. 6 Company picked up and held their targets with ease. These sights were rather necessary. With fifteen other lights on the ground, individually manned, it is difficult for any operator to

SKETCH No. III

FLOOD LIGHTING FOR SIMLA TATTOO.
LIQUID RHEOSTAT TYPE DIMMER.
For currents up to 5 amps. at 230 volts.



be quite certain whether his is laid exactly where it is intended to be, and if the other fifteen are equally vague, the lot of them are apt to start wandering in a distressing fashion.

The senior operator in each tower had headphones on, and to him were passed orders as to targets, fitting colour screens, etc. One advantage of the switching remaining in the director's hands, however, was that, if any operator did make a bloomer and train on something best left hidden, he could be switched out until he recovered. However, such occasions were very few.

The colour screens, held in racks beside each operator, could be slipped into holders, bolted to the lights, in a few seconds, without disturbing the setting of the latter.

EFFECT.

The difference between effectively staged lighting and just lighting has already been touched on.

Merely switching on and off, or leaving lights on all the time is very dull. In fact, the programme might be equally well, or better, staged in daylight.

There are few items which cannot be effectively set off by appropriate treatment of the lighting in regard to intensity, colour or movement, or a combination of these. Above all, its application must be continually varied from item to item.

"Full-ons" and "black-outs."—These are very effective if not overdone, the first when you can cover the advance up stage of a turn, so that the performers are first disclosed already in position. This may easily be done by judicious siting and use of the seat lighting. Without blinding the spectators these lights can form a very effective curtain on the arena. Besides, if a printed programme is provided the audience wants to read it between items, and quite a lot can go on, meanwhile, at very close range without them spotting anything. All seat lights should therefore be controlled from the director's box.

Black-outs go well with the conclusion of a musical item which has worked up to a climax, the band stealing away under cover of darkness.

For both these movements, the arena lights as a whole must be controlled by a single switch in addition to the individual light control.

"Dim-ins" and "dim-outs."—They go best with bands marching out of the darkness on the far edge of the arena and returning whence they came on conclusion of their item. Modulation of the light in conjunction with the music—particularly that of pipes—lends a greater effect of distance. This treatment can be repeated several times in a programme and always seems to go down well.

Use of colour screens.—Red screens lend themselves best to colour lighting of troops—especially in full dress. Amber are effective for trees and other foliage. Half-and-half is a fair proportion.

It is in the manipulation of coloured lighting that individual switching is useful. As the red screens absorb quite 50% of the light emission, other colours slightly less, colour lighting is best employed on massed bands and tableaux close in. Here half the lights with plain glasses, distributed along the front, can hold the performers while the others are switched off and ordered to fit screens.

Thereafter the director can produce by individual switching any gradual or sudden transition from white to red. Further effects can be obtained, of course, in conjunction with controlled movements of groups of lights.

Controlled movement.—A brief description of two items actually carried out in the Simla tattoo will perhaps indicate best the possibilities of this in conjunction with switching.

(i) *Trick riding by Royal Signals motor-cyclists.*—The lighting for this worried us more than anything else. In the event we had plenty of light for the various stages of the item by using it as described. See Sketch No. I.

First the riders entered from the gate fairly close behind each other and did turns along a line parallel to the centre stands. As there were too many in the arena at one time to follow individually, the lights were laid on a series of white discs along the line, shown in Photo. No. 1, spaced to give as even an intensity of illumination as possible, and kept steady.

The intensity of illumination was approximately 1-foot candle on the line.

Next the ride closed up and did figures of eight, etc.—work requiring more exact judgment and therefore better light. The lights closed up on to the area covered by the dotted figure of eight in Sketch No. I, on which an intensity of about 1½ to 2-foot candles was obtained.

Next followed more ambitious individual stunts, there being never more than two men in the arena at one time but moving erratically over a wide area. Half the lights in each tower picked up the first entry and followed him until he left, the other half taking the second and so on. The intensity of illumination naturally varied over the course, but probably was not greater than 2 or less than ½-foot candle, but always sufficient for the spectators.

The climax was, of course, the jumping, on which by training all sixteen lights we produce 5-foot candles.

The riders were apparently not troubled by glare at all, and had all the light they required, and so apparently had the spectators.

(ii) *Grand Finale.*—This was a musical item, the general lighting scheme being to lead up in turn to the front the various bands

Photo No. 1.—Arena from Tower D during daylight rehearsal, showing Tower C and a corner of Tower A.

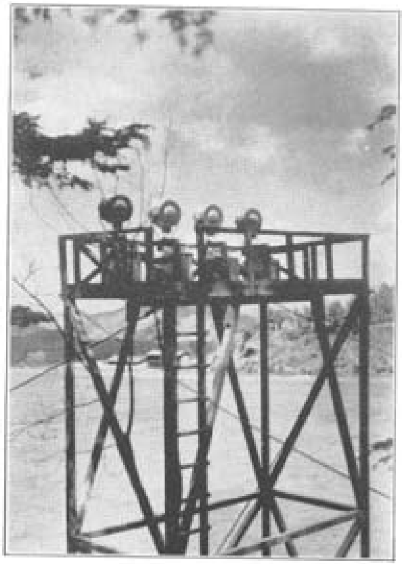


Photo No. 2.—Tower arrangement. Each light can traverse 90° right to left without interference with others.

Floodlighting for military tattoos

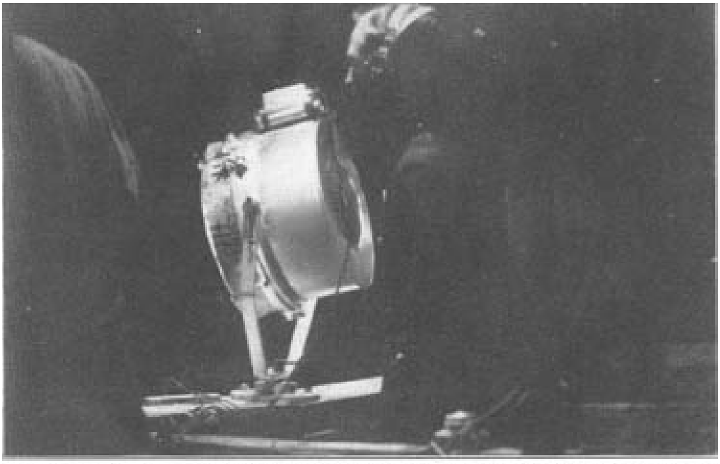


Photo No. 3.—Shows the sighting tube bolted to the left of the terminal box and the method of control.

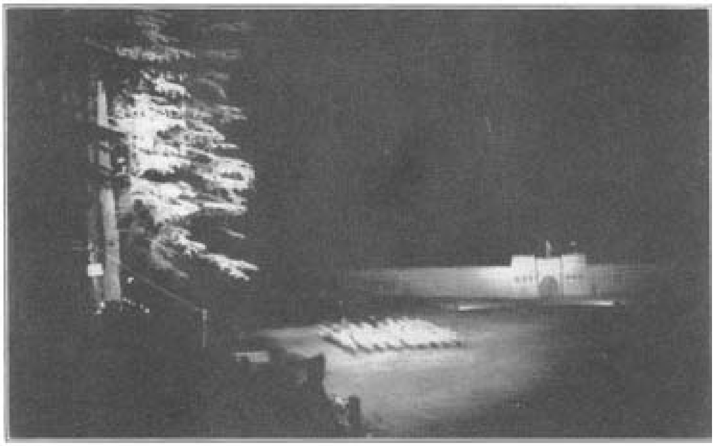


Photo No. 4.—Floods concentrated on band marching in foreground; separate fixed alignment lighting on gate (2 k.w.), and on flag (0·5 k.w.), but dimming from central control arranged for these likewise.

Floodlighting for military tattoos

scattered, *in darkness*, in various parts of the background. Strict control of movement was necessary to prevent lights inadvertently disclosing the wrong parties. Photo. No. 4 shows approximately what degree of contrast between illuminated and dark areas was possible. As each band in turn struck up, a proportion of the lights would lift on to it and lead it up to its position in mass, where the remaining lights would equalize over the assembled bodies, while the first light lifted again to lead in another party.

CONCLUSION.

Generally the installation proved entirely adequate for the purpose required. The illumination data of the floodlight used is given therefore in an appendix, from which the probable performance of other patterns may be estimated by comparison. Nevertheless, if time permits, the type proposed should be tried out—on the actual ground if possible.

For any other length of arena a proportionate number of lamps similarly grouped would be suitable.

As to depth of arena, that shown in Sketch No. 1 represents about the maximum which the equipment specified could have illuminated with any success. The disadvantage of too little depth has already been dealt with.

Having obtained the equipment, a great deal depends on its efficient adjustment, wrong focus and dusty surfaces reducing the efficiency by as much as 50%. Even wrong positioning of a non-symmetrical filament has its effect.

Some types of light can be fitted with alternative lamps giving different beam angles. We found that a 28° beam was better than the 12° alternative. By moving the lights as already described sufficient definition between lit and dark areas was obtained, while there was less diversity of illumination in the lit area itself. See Photo. No. 4. It is, of course, a recognized fact that, for equal mean intensity, an area with more even intensity appears better lit than one in which the light is patchy.

APPENDIX.

ILLUMINATION DATA OF FLOODLIGHTS USED FOR SIMLA TATTOO.

Type of Reflector ... Crystal glass with lead-backed silvering to Admiralty specification. Short focus parabolic, 18½ inch dia.

Focussing	3-way adjustable and height of lamp adjustable relative to axes of reflector.
Lamp	E.S., 1000-watt general lighting type.
Beam Angle	28°—25° according to focus.
Cut-off Angle	125°.
Beam Emission ...	5,700 lumens.
Total Light Emission	12,200 lumens.
Maximum Beam, C.P.	84,000 candles.

Note.—This last figure is not the *average* beam C.P. which is as high as 60,000 candles over 20°, while with the 12° beam obtainable from this flood with a different lamp, of equal wattage and about equal beam and total light emission, 300,000 candles are obtained over about 4°, and 270,000 over about 7°; but from there the intensity falls rapidly to the edge of the beam. Consequently with several 12° angle lights distributed on an area, the light is bound to be very patchy. Comparison of lights based on maximum beam candle-power is therefore most misleading and a polar diagram should be obtained if possible to aid in selection.

ISTORO NAL.

THE RECORD OF AN ATTEMPT TO CLIMB A PEAK IN CHITRAL BY CAPTAIN R. J. LAWDER, CHITRAL SCOUTS, AND THE LATE LIEUTENANT DENNIS HUNT, R.E.

(Reprinted by kind permission of *The Statesman.*)

CAPTAIN R. J. LAWDER, of the Chitral Scouts, and Mr. D. N. B. Hunt, Royal Engineers, both stationed at Chitral, have just returned from an attempt to climb Istoro Nal, a mountain 24,271 feet above sea-level, situated in the Tirich Mir group of the Hindu Kush range in the north of Chitral State. It was only owing to the kindness of His Highness Sir Shuja-ul-Mulk, K.C.I.E., the Mehtar of Chitral, in granting permission to make an attempt on this mountain, that it was possible to arrange an expedition.

The expedition, in spite of having had no previous experience of high altitude mountaineering, succeeded in establishing and maintaining a camp at 21,000 feet and from there reached a point at 24,000 feet, only 200 feet below the summit. The attempt had to be abandoned owing to lack of time and to the general exhaustion of both climbers and porters.

Considerable assistance was given by Colonel R. Schomberg, who was touring in Chitral prior to the expedition and who sent graphic descriptions of various aspects of the mountain to Mr. Hunt. From these reports and from Mr. Hunt's previous reconnaissance it was possible to select a route and thus much valuable time was saved.

Below is given a short account of the climb taken from the log kept by the expedition. Considerable distress was experienced on account of too rapid an ascent to high altitudes, owing to both officers being restricted regarding time. Both Captain Lawder and Mr. Hunt moved up from 5,000 feet to 21,000 feet in seven days.

THE EXPEDITION'S LOG.

July 28.—Moved from Uthul to Shogram, nine miles over the 13,000-foot Zani An Pass into the Tirich valley.

July 29.—Moved from Shogram to Sheyniak up the Tirich valley to the snout of the upper Tirich glacier, a distance of eight miles. Height 11,800 feet.

July 30.—Moved from Sheyniak along the upper Tirich glacier for five miles. Very bad going over moraines. Coolies were carrying about 60-lb. loads but took seven hours to complete the carry. Height 13,300 feet.

July 31.—Arrived at our Base Camp on the main glacier four and a half miles from our previous camp. From here we actually commenced the ascent. Height 14,900 feet.

August 1.—Moved to Camp I. A very long steep climb, the whole way up shale slopes. Most exhausting. The route as far as this camp had been previously reconnoitred by Hunt, so was comparatively plain sailing. Here camp had to be pitched on melting snow. Height 18,200 feet.

August 2.—No move was made, as it was decided to consolidate Camp I and make it as comfortable and safe as possible in the event of bad weather. The first signs of height were noticed in this camp and, to begin with, shortness of breath proved a great trial. The weather was cloudy and a light fall of snow occurred in the afternoon and evening.

August 3.—The proposed site for Camp II was reconnoitred and a site found at 21,000 feet. From Camp I the route lay over wide snow slopes to the foot of some 1,000-foot cliffs. From here a steep "Couloir" gave access to the top of the main ridge leading to the summit. This "Couloir" had been seen from the Base Camp and had been decided on as a possible line of approach.

The "Couloir" proved to be narrow and far from easy. It was steep, being 60 degrees in places. Snow varying in depth from six inches to two feet made climbing slow, and steps had to be cut in many places. A short but fierce snowstorm hampered progress, but the ridge was eventually reached at 1.15 p.m. It proved to be a knife-edge, which we had already suspected, with a 5,000-foot precipice on the far side dropping to the scarred and twisted upper branches of the main Tirich glacier. The view was magnificent. For the first time we saw the northern peaks of the Hindu Kush and beyond them the snow-covered mountains of Wakhan and Chinese Turkistan. We were immensely relieved to find a camp site, which from below had looked a very doubtful proposition; two enormous rocks perched on the knife-edge and between these there was just sufficient space for two small tents. After a rest a short reconnaissance was made up the ridge and a further cliff of 300 feet inspected: a possible route was noted and a return to Camp I was made by 4.15 p.m.

August 4.—Seven loads were taken up to Camp II under Lawder, who had not accompanied the reconnaissance the whole way the day before. A strong wind was blowing at Camp II. Porters carried up 30-lb. loads and made the carry in six hours. This was an excellent performance in view of the fact that it was a 3,000-foot carry over difficult going and starting from over 18,000 feet above sea-level. Glissading and tobogganing home over the snow slopes enabled the party to return to Camp I quickly, reaching it at 1.30 p.m.

August 5.—Seven more loads were dumped at the foot of the "Couloir" at a height of 19,500 feet, otherwise a day of rest.

August 6.—Established Camp II, all required loads were taken up and porters not required returned safely to Camp I. Six porters remained with us in Camp II in order to establish Camp III when this was found possible. This day and the day before had both been fine, but we feared wind.

August 7.—Owing to the cold at 8 a.m. a start was not made till 9.30, when the sun reached the camp. Between Camp II and the cliffs there were about 180 yards of steep snow slopes. A track was made across these slopes just below the ridge to the foot of the rock wall. This rock wall was the right-hand boundary of the snow "Couloir" which had been climbed to get to Camp II. It was a sheer cliff varying in height from 300 feet on the ridge to 500 feet at the bottom of the "Couloir," and was impossible to climb except for a chimney which led up from the ridge. With considerable difficulty a way was forced up this and the continuation of the ridge reconnoitred for about 50 yards. The party returned to camp at 1 p.m., as they were tired from the day before. It was very fortunate that this chimney did not prove more difficult, as a slip would have meant a fall to the glacier—several thousand feet below. For safety and to save time this was later roped with a permanent rope.

August 8.—In spite of the cold we were up by 6 and started at 7 a.m. Temperature 18°. We reached the top of the chimney by 8.50 and proceeded along the knife-edge, cutting steps about six feet below the crest. At 11 a.m. we were afraid of avalanches, a fear which proved groundless later, and so returned. On going down the chimney a permanent rope on *pitons* was fixed which was of the greatest help. We were greatly disgusted, as we had only made 150 yards' progress.

August 9.—Again made an early start. Cut steps for 200 yards from where we left off the day before. None of the porters was going well and all complained of the effects of height. Different porters were used each day to make up numbers on the rope and also to assist in cutting steps. Weather still fine. Another unsatisfactory day.

August 10.—Hunt went off alone with three porters as Lawder was not feeling well. He made a tremendous effort and succeeded in reaching a point where the knife-edge widened out a bit at a height of 22,500 feet. It was now possible to move along the top of the ridge and thus save cutting interminable steps. Previously, owing to the precipice on the far side, there had been a cornice the whole way along the ridge from the head of the chimney which had prevented us from using the top. Beyond this place we had reached on the ridge, the northern slopes of the mountain became less precipitous and it looked as if the way to the top would not be difficult. Weather was fine most of the day, though towards evening it looked threatening. Camp was reached at 4.45 p.m., having been left at 8 a.m. At least 400 yards of steps were cut this day. One of the most heartening days we had had so far.

August 11.—Up and off by 7 a.m. Temperature 23 degrees. All went well until the ridge, yesterday's farthest point, was reached. Then Lawder, who had been going badly for some time, was unable to proceed. After a short rest Hunt, with two coolies, went on up the ridge, which was snow covered, narrow, with steep slopes on each side. After 100 yards the ridge narrowed to a few inches wide, and the snow changed to ice with a steep slope on each side. This proved a much greater obstacle on the return than on the ascent, although it was only a matter of 30 yards long. The height of the ridge at this point was between 22,500 feet and 22,800 feet. Hunt and his coolies continued, finding the going very tiring, snow knee-deep the whole way. At 1.30, although the summit was only 400 feet away and about 200 feet higher, it was decided to turn back, as the party was so exhausted and owing to the deep snow further progress was impossible. Camp was reached at 5.15.

All being very exhausted it was decided to have a day's rest and, if the weather held, to have another attempt at the summit and then retire to the Base Camp.

August 12.—There were clouds and a very cold wind of great force which blew most of the day. Several coolies were suffering from frost-bitten feet and Hunt was suffering from a slight attack of snow blindness. Some spare stores were evacuated to the Base Camp. The prospects for the morrow were not good.

ATTEMPT ABANDONED.

August 13.—A high wind which made the ridge impossible. Hunt's snow blindness slightly worse. It was, therefore, with great reluctance decided to abandon the attempt and return to the Base Camp in one day. A late start was made and the "Couloir" was found to be both difficult and dangerous. The party was unroped. Hunt slipped, but was fortunate in being able to stop himself with his ice axe before he had gone far and only suffered a cut hand. After this the party roped, owing to crevasses which had opened on the snow field, and reached the Base Camp in safety at 4 p.m. Camp I had been moved the same day to the Base Camp.

August 14.—Moved from the Base Camp to Sheyniak.

August 15.—Moved from Sheyniak to Shogram, where the expedition disbanded. Hunt returned to Chitral and Captain Lawder proceeded on tour.

Istoro Nal was attempted by a partially-equipped party who were surveying the district in 1929. They succeeded in reaching a different col at 20,200 feet, but were unable to establish a camp there, as the Chitrali coolies would go no farther on account of their fear of fairies. The present expedition imported three Hunza men, who, though no better than the locals at climbing, introduced the competitive spirit and, owing to their indifference to the local fairies, inspired the Chitralis with a like indifference. Had outsiders not been employed there is little doubt that no camps would have been established above Camp I, and that only with the greatest difficulty. But owing to the presence of the three Hunza men there was great keenness amongst the Chitralis to become high camp porters, and those who went high did as well and better than the Hunza men.

Also in a large measure this keenness was due to the fine spirit inspired in them by Shahzada Khedive-ul-Mulk of Muliko, in whose province this mountain is situated. He gave the greatest assistance in making preliminary arrangements and in supplying rations for the expedition. An N.C.O., kindly lent by the Commandant of the Chitral Scouts, proved invaluable and relieved us of many supply and transport duties and generally supervised the running of the lower camps.

THE BREN LIGHT MACHINE-GUN.

(Communicated by the War Office. Crown Copyright Reserved.)

At the beginning of the Great War the only machine-gun in general use was a weapon weighing with its mounting somewhere about 100 lb. or more, and capable of prolonged fire at a high rate. Such weapons were the British Maxim and Vickers, the French Hotchkiss and the German Maxim. They were intended to be used in more or less fixed positions in support of the rifles which, in our army at any rate, formed the main source of infantry fire power at that time. Under the trench warfare conditions which so soon set in the weight and bulk of these heavy machine-guns were not serious objections, and their capacity for sustained fire was an advantage. They dominated the battlefield and it was obvious that they must become the mainstay of the defence. To meet the demand for more machine-guns the Lewis was brought in to supplement the Vickers, which could not be produced in sufficient quantities.

The Lewis was altogether different in character from the Vickers. It was air cooled and was fired from the shoulder or a low bipod rest. It was also magazine-fed and weighed, complete, about 30 lb. It was therefore essentially a more mobile weapon than the Vickers, although it had not its capacity for sustained fire. It was a weapon capable of being employed alongside the rifles or as a substitute for them under open warfare conditions, *i.e.*, it could be taken forward in the attacks, and a Lewis gunner could go practically anywhere that a rifleman could do. It was, however, still not possible to carry it by hand for long distances without fatigue.

The German version of this type of weapon was the so-called light Maxim. The French produced a gun called the Chauchat. All the above were light machine-guns with characteristics different from those of the heavy machine-guns in use hitherto.

Their advent in theory released the heavy machine-gun for use in the role for which its characteristics made it suitable. In practice, however, the reliability of the light machine-gun was not sufficient to justify this.

It was obvious that, if the light machine-gun could be still further lightened and its mechanical reliability improved, the fire power of the infantry, under all conditions, would be enormously increased. A single light machine-gun served by two men is the equivalent in fire power to 20 men armed with rifles; the limiting factor in multiplying the number being ammunition supply only. On the assumption that the target for these guns would continue to be the unarmoured man, the logical conclusion was to increase the number of guns to saturation point. Experience showed that a section of about six men can supply and keep in action for the requisite period of time one light machine-gun. The main duty of four of these six men is carriage of ammunition. Fewer men per gun or alternatively more guns per section means either loss of mobility by reason of the greater ammunition load per man, or loss of capacity to sustain fire in sufficient volume. Saturation point is therefore approximately one light machine-gun per six men. The latest experimental organizations have reached or are approaching this proportion. War experience having led to this conclusion, peace brought with it a period of renewed activity throughout the world in the field of light machine-gun design.

Vastly improved and lighter light machine-guns were produced and tried out all over the world. All had similar characteristics, a weight complete of about 20 lb., feed from a magazine holding 20 to 30 rounds, air cooling, generally, with some form of quick-change barrel and much simpler mechanism. Most of them were operated by gases taken from the barrel. An attempt was made by the old-established firm of Madsen to combine in one weapon the functions of both the light and heavy machine-gun. They proposed to achieve sustained fire by the process of ringing the changes on a series of quick-change air-cooled barrels. The light gun when used in the heavy role was mounted on a tripod weighing very little more than the gun itself. Stability was ensured by the use of spring buffering, and the form of the tripod was two widely-spread legs at the rear. This attempt led to a great advance in the design of equipment of this kind, but has not enabled the light machine-gun to compete with the heavy gun in its own field. Belt feed, water cooling and heavy barrels have advantages where sustained fire at high rates is required, and these features are incompatible with a really light and mobile weapon. It is, therefore, likely that the two types of gun will remain in use. For certain purposes, notably use by cavalry, however, a light machine-gun mounted on its light tripod can give sufficient sustained fire.

British trials of light machine guns to replace the Lewis began in 1922, but did not result in the adoption of any new weapon, although a modification of the light Browning was recommended should the need arise. A new series of trials was started in 1930 in view of the very rapid strides made in design and one of the guns selected for trials was the Z.B. made at Brno in Czecho-slovakia. This gun had already gained a very high reputation among those who had tried it, and very little experience showed that this reputation was well founded. It had qualities which made it altogether outstanding.

The change over from the nitrocellulose propellent, for which the gun had been developed, to cordite, brought with it certain troubles due to the heavy metallic fouling caused by this powder. This entailed certain modifications to the design. The British rimmed cartridge also caused a certain difficulty in the feed to and from the magazine. The gun modified to meet British requirements was called the Z.G.B. The trials were concluded in 1934, and in 1935 the gun was finally approved for adoption under the name Bren, a word formed from the initial letters of its birthplace Brno and of the British factory at Enfield, where it will be made.

The chief qualities of the Bren light machine-gun are low weight, *i.e.*, 21 lb. complete as compared to 31 lb. for the Lewis, extreme steadiness when firing, almost complete immunity from the effects of fouling, dirt and dust, great freedom from breakage and stoppages and the ability to maintain a high rate of fire for relatively long periods.

Its main features, which render the gun unique, are the system of buffering the moving and recoiling parts, and the arrangements for the collection and disposal of metallic fouling in the gas system.

The motive power of the Bren gun is gas trapped from the barrel through a port uncovered by the bullet in its passage. The bullet, in fact, corresponds to the piston-valve of a steam-engine. It is, perhaps, easiest to consider the sequence of events in the operation of the mechanism from the moment when the bullet passes the gas port (A, Fig. 3), and admits the gases from behind it. The gases are, of course, produced by the combustion of the propellent powder. From the gas port the gases pass through the gas regulator (B, Fig. 3). This regulator is provided with alternative passages of differing sizes to give control of the amount of gas passing and provide more or less power as required. This regulator can be rotated by means of the combination tool, to bring into use the aperture required and is then locked automatically. For manufacturing reasons the passages in the regulator are "dog-legged."

From the regulator the gases are directed to the rear in the form of a jet, into a chamber (C, Fig. 3) in the gas cylinder and impinge on the head of the piston (D, Fig. 3). A combination of impulse and pressure drives the piston along the cylinder and, through the piston extension, operates the breech mechanism. It will be seen that the chamber (C, Fig. 3) has ports in the cylinder wall which are covered by a sleeve. This sleeve is a working fitted on the outside of the gas cylinder, and also forms the means of attachment of the bipod legs. The ports in the chamber (C, Fig. 3) form receptacles for the metallic fouling (chiefly cupro-nickel from the bullet envelopes), carried in the form of vapour by the gases and deposited on the relatively cool gas cylinder and on the inner walls of the sleeve covering the ports. If the gun is now rocked on its bipod (as it is in normal handling) the

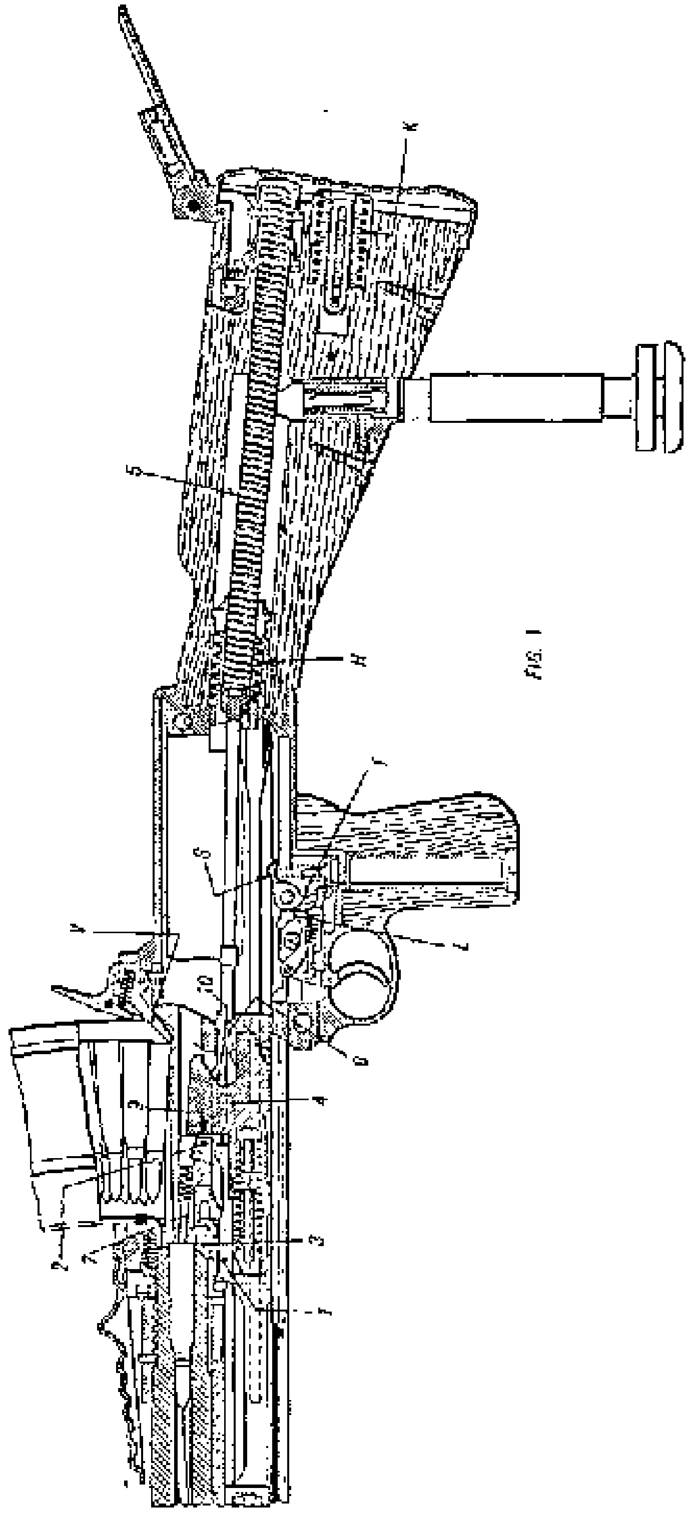


FIG. 1

rotation of the cylinder within the sleeve will cause the fouling in the ports to break up. The blast of the gases then drives the broken fragments out of the cylinder through the set of ports (E, Fig. 3) when these are uncovered by the backward movement of the piston. A cup-shaped shield in rear of the ports protects the firer from the fragments ejected. The gas cylinder is thus self-cleaning. Apart from the automatic action, fouling can be quickly removed simply with the point of a bullet by sliding off the bipod sleeve and pushing the accumulated fouling inwards from the ports, which are bevelled inwards to facilitate the operation.

Continuing the action of the mechanism, the piston extension shown in Fig. 1 (1 and 6) houses a component (4) which is supported in the piston extension by a helical cushioning spring interposed in the line of thrust of the piston. This serves to cushion the hammer blow, which would otherwise be given to the mechanism. This is an important factor affecting the smooth action, reliability and long life of this gun. An upward claw-like extension of the component (4) travels in a recess in the breech block above it (2, Fig. 1). After a short free backward movement of the component (4) the face (10) of its claw engages a bridge piece in the breech block recess, and draws down its rear end from its seating against the body of the gun, thus unlocking the breech. The front face of the breech block carries beneath it the extractor (3), by means of which the fired cartridge cases are withdrawn from the chamber in the barrel. The short free movement of the piston group mentioned above causes a cam surface on the piston extension to come into contact with the underside of the extractor and holds it rigidly in engagement with the rim of the cartridge. This mechanical grip of the cartridge, independently of springs, is another unique feature of the gun. There can be no failure to extract.

After unlocking the breech block, further backward movement occurs; the fired cartridge case in the grip of the extractor is withdrawn and carried backward some three inches when the upper part of its base is brought against the ejector V. Being held at the bottom by the extractor, the cartridge case is tipped downwards and ejected sharply from the gun through the passage provided in the piston extension and bottom of the body. The mechanism is now in the position shown in Fig. 2. Incidentally the point of the ejector is chisel-shaped and its action is to indent the base of the cartridge case in the vicinity of the cap chamber, and to prevent loose caps (a defect which manifests itself from time to time) from coming out on to the mechanism of the gun.

Fig. 2 shows the breech open and held by the sear (S) which has engaged with the "bent" formed in the under face of the piston extension. This is the normal "cocked" position, and that in which the mechanism stops on releasing the trigger or when the

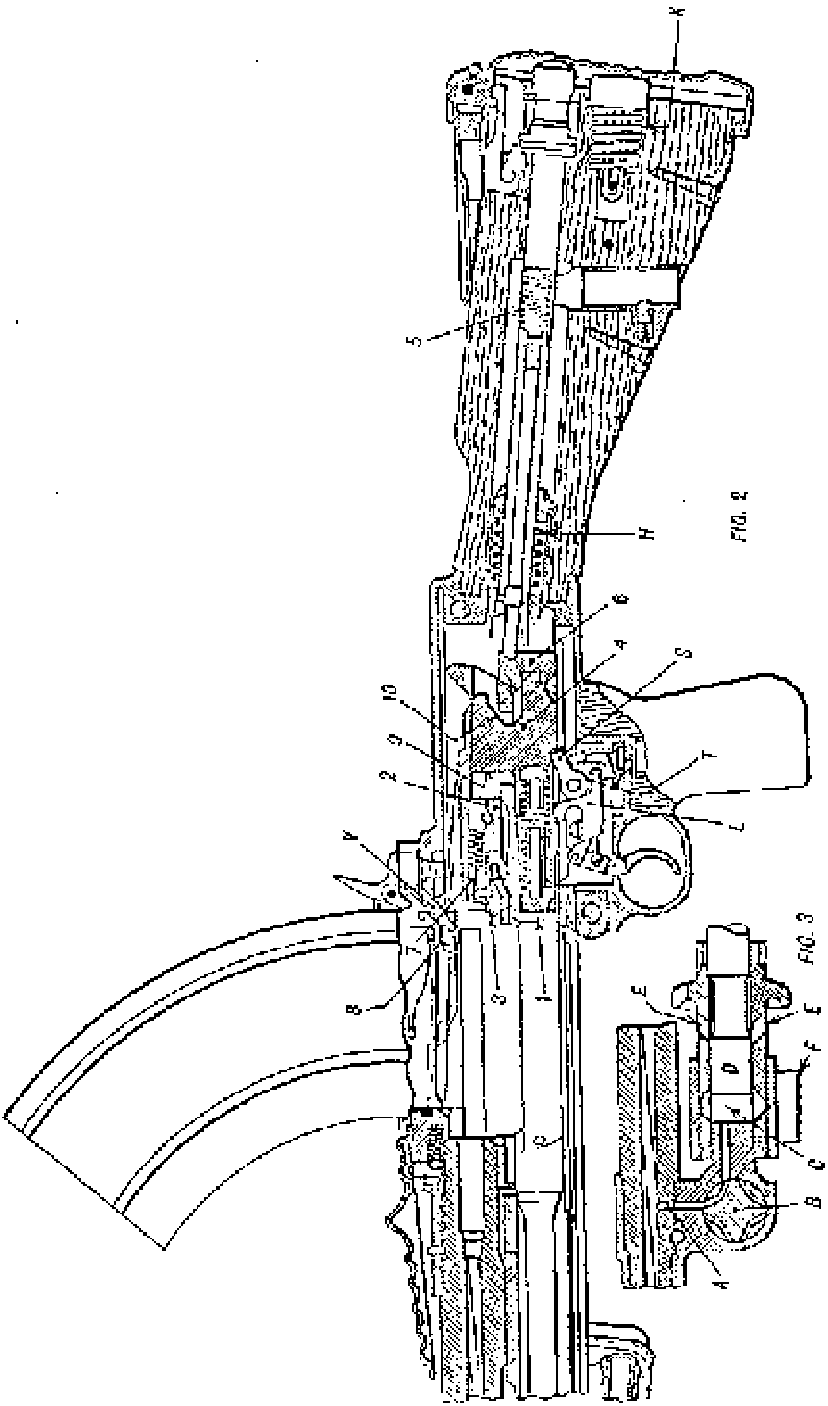


FIG. 2

FIG. 3

trigger mechanism is set for single shots. (The trigger mechanism provides for "Safe," "Single Shots" or "Continuous Fire," as may be required.) The backward movement of the piston-breech block group, acting through a push-rod, has compressed the return-spring (5), which is housed in the butt. Should the backward movement not be completely arrested by the return-spring the buffer-spring (H) comes into action, by making contact with the face (6) of the piston extension. This buffer-spring is also, in effect, interposed between the butt group and the body group and absorbs the slight recoil movement for which provision is made. A second buffer-spring is located (at K) between the butt and butt-plate.

On pressing the trigger the drag link (L) (shown in Fig. 2 in the position for single shots) is drawn forward. The hook on its rear end comes against the tooth (T) on the sear (S), rotates the latter and disengages it from the "bent" in the piston extension. The piston-breech block group is then free to move forward under the action of the return-spring. The breech block is carried forward, its front face meets the base of a cartridge in the mouth of the "overhead" magazine, sweeps it clear of the retaining lips downward and forward into the chamber of the barrel. In this movement the rim of the cartridge engages with the hook of the extractor (3). When right home in the chamber the rear end of the breech block is in a position to engage with the seating in the top of the body. The piston extension continues to move forward relatively to the breech block; the sloping top face of the portion (6) thus raises the rear end of the breech block into engagement with its seating and locks the breech. It will be observed that the nose on the upper part of the drag link (L) lies in a groove on the under side of the component (4) housed in the piston extension when the mechanism is set for single shots. As the piston group slides forward over the trigger mechanism, the rear end of the groove meets the nose of the drag link, depresses it and disengages the drag link from the sear (S). The sear then rises under the influence of its spring and is in a position to engage and hold the "bent" in the piston extension on its return to the rear. On releasing the trigger the hook on the rear end of the drag link again engages the tooth (T) of the sear. One pressure of the trigger, therefore, cannot fire more than one shot.

For continuous fire the safety catch is rotated and its half-moon shaped stem is set to the position shown in Fig. 1, *i.e.*, one corner bearing on the drag link and holding it in a fully depressed position.

The sear (S) resembles an inverted "L," of which the lower arm is in the form of a stirrup in which the drag link occupies the position of the foot. When set for single shots, the hook of the drag link (corresponding to the toe) is raised and engages with the top of the stirrup (the tooth T), action being as above described. When set

THE BREN LIGHT MACHINE-GUN.

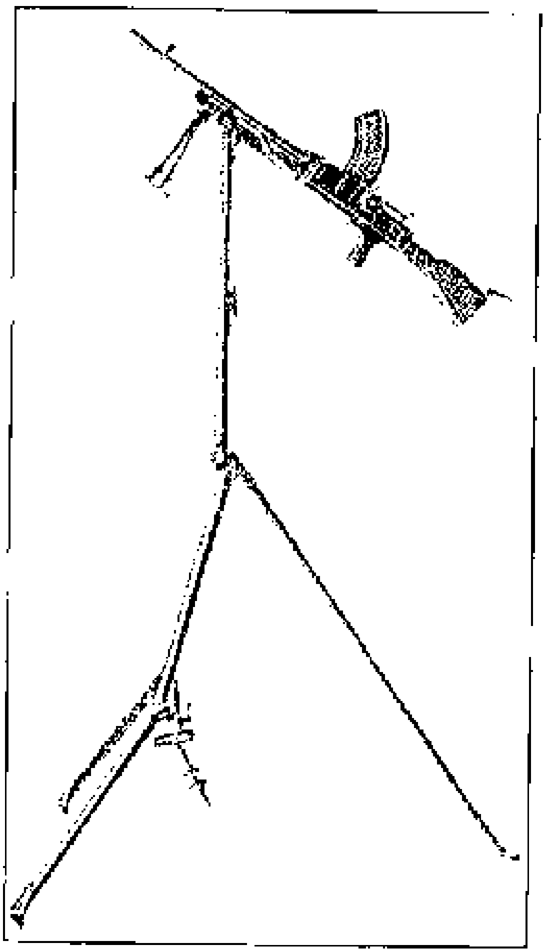
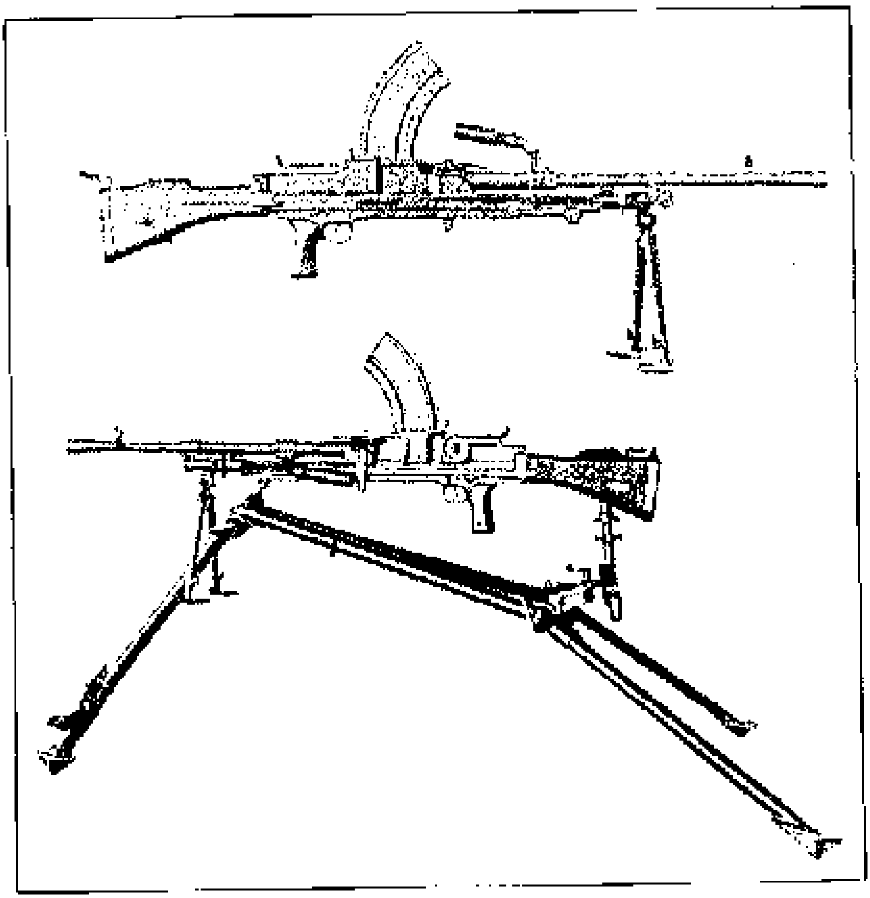


Fig. 4.



Figs. 5 and 6.

for continuous fire the bottom hook of the drag link engages the cross-bar of the stirrup and being held in this position by the safety catch, the nose of the drag link is withdrawn from the groove under the piston extension and the sear is not, therefore, tripped; it remains disengaged from the " bent " and the gun continues to fire so long as the trigger remains pressed or there is ammunition in the magazine. In an intermediate position of the safety catch the rear end of the drag link floats within the stirrup without engaging either the top or bottom thereof, and movement of the trigger has no effect on the sear, which remains in engagement with the " bent." This is the " safe " position.

On firing the last round in a magazine the platform (8, Fig. 2) descends into the cartridge-way. On the commencement of the next forward movement of the breech block its front end meets the magazine platform and is stopped in the breech open position, thus indicating the fact that the magazine is empty. On removing the empty magazine (with the hand previously holding the pistol-grip and pressing the trigger) the platform is withdrawn from the cartridge-way and the breech block released. It can, however, only move forward a very little way before it is stopped by the engagement of the sear with the " bent." On inserting a filled magazine in the magazine opening, the gun is once more ready to fire.

Figs. 4, 5 and 6 show the gun mounted for use in its three roles.

The extra two-piece leg required for anti-aircraft fire is normally carried in the main tubes of the tripod. A rifle can be used as a substitute if necessary, being fixed by the bayonet stud. The complete tripod weighs approximately 25 lb., and provides a wholly stable platform for indirect or overhead fire, or fire on fixed lines.

PROFESSIONAL NOTE.

107-TON METRE-GAUGE RAILWAY CRANE.

A SHORT description appeared in *The Royal Engineers Journal* for September, 1931, of a 105-ton railway breakdown crane made to a War Office specification by Messrs. Ransomes and Rapier, Limited, of Ipswich. A somewhat similar crane, which is illustrated in the two photographs reproduced herewith, has recently been completed by the same firm. Whereas, however, the earlier crane was built for a standard-gauge railway, the present one is for a metre-gauge track and is the largest in the world on such a gauge.

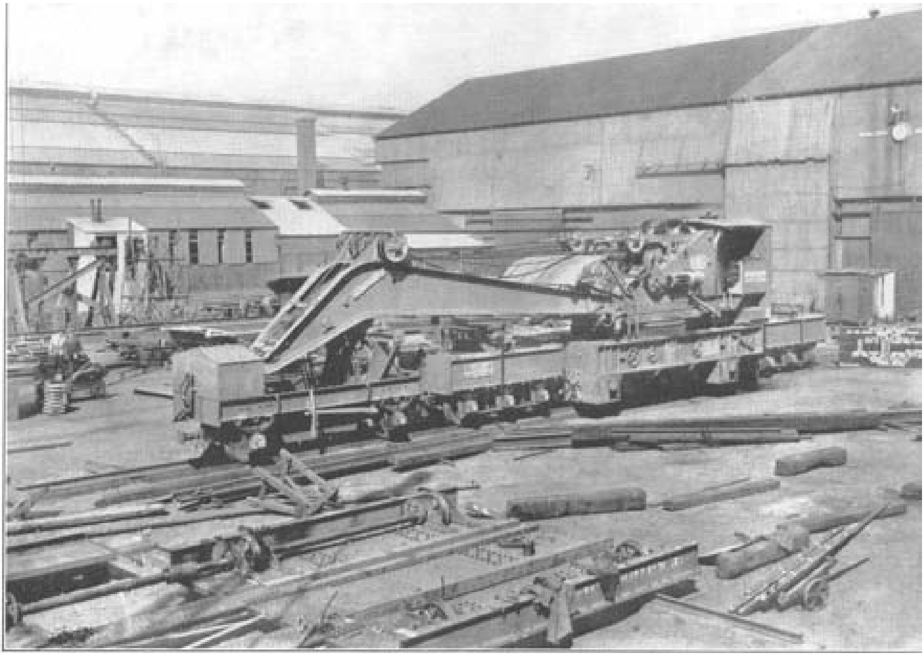
It was specified that when dismantled and packed for transport, all parts of the crane should come within the ordinary metre loading gauge, and this condition necessitated a special design of undercarriage which is taken to pieces for transport. When assembled and in travelling order, the crane considerably exceeds these limitations, its width being 11 ft. 2 in. and its height 16 ft. Its length overall is 76 ft. 9 in. A maximum axle loading of 18 tons was specified and this result is attained as before by the use of Stokes patent relieving bogies, which can be seen in the photographs, one at each end of the main crane carriage. A match truck carries the head of the jib and the lifting blocks, and the total weight of 175 tons in travelling order is thus distributed over 12 axles in all.

The design of the revolving part of the crane is similar to that of the earlier one. Minor improvements were made, however, by means of which it was found possible to dispense with the removable counterweight. A maximum load of 107 tons on the main hoist at 20 ft. radius was specified in this case, the test load being 126 tons. Important factors of safety were 6 for wire ropes, 5½ for the jib and 5 for other parts.

Owing to the narrowness of the gauge, the present crane is designed to operate only when propped. Four propping girders are carried in boxes which form part of the main carriage. Mechanical interlocks are provided which prevent the jib from being slewed until these girders are extended and supported by means of screw jacks. The base when propped is about 17 ft. square and the maximum load on any one prop is estimated at 155 tons. Special steel plates 4 ft.

No. 1.—Crane in working order, showing props.

107 ton metre guage railway crane



107 ton metre guage railway crane 2

by 8 ft. by 4 in. thick are carried to distribute this load on the ground.

The crane can propel itself on the level at a speed of 350 ft. a minute (4 m.p.h.) or it can be towed in train at speeds not exceeding 5 m.p.h. It will negotiate a curve of radius 300 ft. and super-elevation about one inch.

Despite the large loads that the crane can handle, it is an instrument of considerable precision and delicacy of control. By means of a special oil pump brake arrangement it can lower the maximum load smoothly at a rate not exceeding 2 in. per minute, through a distance of one sixteenth of an inch. It can also slew the maximum load at 20 ft. radius without jerk through a distance of three-quarters of an inch.

S.W.J.

A REMINISCENCE OF THE FIRST AFGHAN WAR.

With regard to the last entry in the notes in the article published in December, 1935, it has now been ascertained that Mrs. Mainwaring was the wife of E. R. Mainwaring, 16th Bengal Infantry, who later became a Major-General and died in 1868. The child, who was with her, later became Colonel E. P. Mainwaring, 39th Garwhal Rifles, and was the father of Mrs. Stagg, wife of Colonel M. Stagg, O.B.E., of the Corps. Mrs. Stagg's mother was a grand-daughter of Lady Sale, who was also one of the Badiabad hostages.

A PROPHECY BY LORD KITCHENER.

The following extract from *Glory and Downfall—Reminiscences of a Russian General Staff Officer*, by General P. A. Polovtsoff, Military Attaché in India, 1906, is of interest:—

"After lunch I had a long talk with Kitchener. He was very interested in our field fortifications during the Manchurian campaign. Having a good memory, I gave him all the details about the trenches in the three great battles of Liao-Yang, Sha-ho and Mukden.

"I was imbued with the sacred principles of strategy, taught in all staff colleges, that entrenchments always prove a decline of military art, and that all famous generals, from Alexander the Great to Napoleon, despised them, and won all their victories by manœuvring in the field.

"The young staff officers in Manchuria always criticized Kuropatkin for his love of fortifications. When I said this to Kitchener, he very emphatically said to me:

"'The next war will be a war of trenches.'

"This was in 1906."

(Communicated by Brig.-General Sir James Edmonds, Kt., C.B., C.M.G.)

CORRESPONDENCE.

WATER SUPPLY IN A DESERT COUNTRY.

Headquarters,
British Troops in Egypt,
Kasr el Nil,
Cairo, Egypt.
12th December, 1935.

The Editor, *The R.E. Journal*, S.M.E., Chatham.

SIR,

1. Lieutenant Drayson's essay on "Water Supply in a Desert Country," in *The R.E. Journal* for March, 1935, deals very thoroughly with the administrative factors involved, but does not dwell to any extent on the method of purification to be adopted. This is, however, the principal factor in deciding the type of equipment to be adopted and the time required after arrival at the camp before water is available. It seems, therefore, to merit further discussion.

2. There are at least four methods to be considered :—

(*a*) Chlorination with sterilizing powder.

(*b*) Chlorination with a portable chloronome and 10-lb. cylinders of gas.

(*c*) Filtration and treatment with chloramine (compounds of ammonia and chlorine) in the Elliott Mobile Water Purifier. This machine has given very satisfactory results on test and will probably soon become an article of standard equipment. It is described in Appendix 5 of the *Army Manual of Hygiene* and consists of an apparatus for making and introducing chloramine, a petrol engine driving a dynamo and pump, and duplicate cloth filters. The whole can easily be mounted on a 30-cwt. 6-wheeled chassis, and will deliver 1,200 gallons of water an hour from a depth of 10 ft. to a height of 20 ft. The treated water must be stored for an hour before use.

(*d*) Treatment with chloramine by the Harold-McKibbin method (Appendix 6, *A.M.H.*), *i.e.*, with tablets of ammonium chloride and chlorosene. Again at least one hour's storage before use is necessary.

3. In discussing these methods the following medical opinion recently pronounced in a War Office letter is of importance :—

> "It is *never* safe to attempt to render water fit for drinking
> "by the use of a sterilizant only. No matter how clear the water
> "may appear to be it must be filtered first."

This dictum affects methods of water supply in the field so vitally that it requires very close examination before being acceptable as practical policy. It precludes all the methods of purification mentioned above except the Elliott purifier and the regimental water-cart. No standard mobile filter plant to deal with 2,000 or more gallons an hour exists, and I know of no rapid method of extemporizing filters in the unlikely event of suitable media being found on site.

Ignoring for the moment this question of filtration, the article under discussion envisages the use of sterilizing powder—method (*a*) above. This method has many disadvantages and is really out of date. Horrock's box tests are necessary and, as military engineers always err on the safe side in their dosage, water so treated has a most unpleasant taste. Sterilizing powder (and also clarifying powder) deteriorates in store, and I know of several cases where officers have proceeded "into the blue" without making tests of the chemicals with which they were supplied before they started—with disastrous results.

The use of chlorine gas with a portable chloronome gives more consistent dosing and more palatable water, and the machine is very light and convenient. But it is not sufficiently proof against exposure and rough handling—valves corrode, rubber washers perish, connections leak, etc., etc., and consequently this method cannot at present be recommended. Research aimed at producing a gas apparatus sturdy enough for field use should be profitable.

The Elliott mobile purifier is an excellent apparatus but has two drawbacks. Its small output means that at least four 30-cwt. lorries with trailers or eight without would be required for the force under consideration and the time before water is available is rather long. Also, owing to the low suction lift—five feet—this plant is in addition to and not in place of other equipment—just as many pumps and tanks are required with it as without.

It is interesting to observe that the War Establishments Committee has proposed that Elliott purifiers should form part of the equipment of field hygiene sections and be operated by the R.A.M.C. and not the R.E. This division of responsibility appears wrong in principle, contrary to present practice and to *Engineer Training*, Vol. II, 1926, Chap. VIII, Sect. 60 (3). Engineers raise water to ground-level, store it, and distribute it, and will probably be asked to maintain and repair the dynamo, pump, etc., of the purifier. There is no point in introducing a second authority responsible for one link only in the middle of the chain of water supply from source to consumer.

The Harold-McKibbin chloramine treatment (of which I have no experience) appears to have none of the disadvantages of the other methods. No testing of the water is necessary and no extra equipment beyond a supply of tablets.

4. Table 12 on page 188 brings out clearly a point that is often overlooked—that water cannot in many cases be made available in quantity on the same evening that a water source is reached. There is first the time of erection of plant (not mentioned in the essay but a matter of an hour or two at least) then several hours for clarification if required, and finally filtration (if insisted upon) and sterilization. The period of half an hour used in column 8 of Table 12 is an absolute *minimum*, and longer periods are required to produce a palatable supply.

5. To summarize, information is badly needed on the following points :—

(*a*) Why is the responsibility for water supply divided in cases where the Elliott purifier is in use ?

(*b*) Is filtration always essential as the War Office has ruled (see ante) ? If so, is work proceeding on the production of mobile filters ?

Yours faithfully,
K. H. TUSON, *Captain, R.E.*

MODERN BRIDGING EQUIPMENT.

Valcartier Camp,
Quebec, Canada.
29th November, 1935.

To the Editor, *The R.E. Journal.*

DEAR SIR,

I have read with great interest Captain Daldy's article in the September number of *The R.E. Journal*, the subject of which is one I have always been very keen on.

In 1933 I submitted to the R.E. Board a design for heavy pontoon bridging equipment of which I enclose a copy, together with description, thinking the same might be of interest to you. One very essential point brought out in para. (*d*), page 421, *i.e.*, the desirability of a tracked vehicle without trailer, is taken care of in my design. The possibility of using exactly the same equipment differently assembled for both medium or heavy bridge appears also to be a step in the right direction. Another feature is that, should one section of the pontoon be damaged, the buoyancy of the whole is only slightly affected.

In the article by J.A.C. in the same number, there are also several points which interested me.

First, regarding saddle-loading *versus* gunwale-loading. In January, 1919, I was detailed to reconstruct a few bays of pontoon bridge from the Park of German bridging equipment at Ramersdorf. These were gunwale-loading pontoons, and as far as I can remember now, the baulks overlapped on the pontoon, so that those coming from the port side crossed the pontoon and engaged by means of cleats with the starboard gunwale, and *vice versa* with the baulks of the next bay.

This appeared to me to be an unsatisfactory arrangement, giving an appearance of rigidity which was not real and entailing longer baulks than would be required for saddle-loading.

With baulks bearing on the nearest gunwales of two adjacent pontoons it appears to me that there would be dangerous listing of pontoons, and distortion of bridge deck under a heavy concentrated load. Again with regard to clear waterway between pontoons; this may be of little importance in comparatively still water, but in a rapid tideway or current, especially with the deeper draught of heavy pontoons, the cables and anchors would have to be very much heavier than would otherwise be necessary. Referring to para. (c), page 427, I do not see how gunwale-loading would simplify construction of piers.

Incidentally I think the German rack gear for adjusting the transom of their service trestle was superior to our differential tackle.

Yours faithfully,

A. G. Ashford, *Major, C.E.*

Mechanized Heavy Pontoon Bridging Equipment.

Description.

The unit, which provides 18′ of heavy bridge (18 tons load) or 36′ of medium bridge (8·55 tons load), is carried on a suitable vehicle. Approx. overall dimensions of loaded vehicle, length 21′, width 9′, height 10′ 6″. It consists of

1. The pontoon, length O.A. 38′, depth 4′, beam at centre 9′ tapering to 7′ at ends, made in six sections nesting within one another in two sets of three sections each, constructed of Consuta fabric or metal. Couplings either similar to those used on existing bipartite pontoons, pintles and gudgeons, or eyes and pins, the upper coupling being on the gunwale and the lower just above the light water line (about 1′ from bottom). Each section has lifting rings at the corners.

2. The saddle is a box girder made in two sections, provided with dowel pins at the proper intervals, to engage with eyes in the ends

of the road bearers. It is secured to the pontoon by chocks and bolts on the transverse gunwales of each section.

3. Roadbearers consist of 9" x 5½" H-beams, 17' 9" long, having a section modulus of about 19.

4. Decking is made of timber 3" thick in panels 11' by 4' 6" secured to 2" x 2" angles. Four of the panels (used for the upper deck in heavy bridge) have the angles placed as a seat for the wheel guides, while in the other four panels the angles are placed so as to engage with one of the roadbearers to prevent lateral movement in the deck. When used in a medium bridge these panels are laid alternately.

5. Wheel guides 6" x 6" timber secured by bolts and wedges.

Unloading, Launching, etc.

The vehicle carries a crane, actuated by the main motor, for unloading the equipment. Where the banks are suitable, *i.e.*, a fairly regular slope and not too steep, the best method of construction is to place the pontoon sections in their correct relative positions perpendicular to the river, utilizing wheel guides or deck sections for ways, the whole pontoon being coupled up and the saddle shipped and secured before launching. If the banks are steep, it will be better to place each section separately in the water by means of the crane and couple up when afloat. Roadbearers and deck panels are all laid by crane.

WEIGHTS.

Heavy Bridge for Loads up to 18 Tons.

		lb.	
Pontoon :	Sections 1 and 6	500 each	
	" 2 and 5	700 "	
	" 4 and 3	800 "	
	Half pontoon (estimated)	2000 lb.	
	Whole pontoon	4000 "	4000
Saddle :	2 plates 28' x 13½" x 5/16"	806	
	2 channels 12" x 2·94" at 20·7 x 38' ..	1573	
		2379 say	2400
Roadbearers :	10 Beth beams 9" x 5½" x 20·5 lb., 18' long		3700
Deck Panels :	4' 6" x 11' x 3" double at 50 lb.	1237·5	
	4 pcs. 2" x 2" x 4' 6" lg. at 2·5 lb. ..	45·0	
		1282·5 x 4	5130
Wheel Guides :	2 x 6" x 6" x 18' at 50 lb. ..		450
		say	15680
			7 tons

Medium Bridge for Loads up to 8·55 Tons.

Half pontoon	2000 lb.
Half saddle	1300 „
Roadbearers, 5 Beth beams	1850 „
Deck, 3"	2565 „
Wheel guides	450 „
	8165 lb.
	3·65 tons

Displacement of pontoon at 3' 1½" draught	25·12 tons
Dead load	7 „
Available for live load	18·12 „
Displacement of half pontoon at 3' 1" draught ..	12·39 tons
Dead load	3·65 „
Available for live load	8·74 „

The Editor is informed that Major Ashford's proposals were very carefully considered by the R.E. Board. The chief difficulties in applying them were:

(*a*) The pontoon box sections would have to be very heavy to give sufficient rigidity.

(*b*) The proposal for transportation involves a special vehicle with a derrick jib. The width of the loaded vehicle is given as 9', which would not be gladly accepted by the Transport Branches.

(*c*) The superstructure for an 18' bay of heavy bridge weighs 11,680 lb., as against 7,670 lb. for a 21' bay of the present equipment. It must be remembered, however, that Major Ashford allows for double chessing.

The proposals, however, should prove of interest to R.E. officers who are interested in the design of pontoon equipment.

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, Horse Guards, Whitehall, S.W.1.*)

THE WAR IN THE AIR—VOL. V.

By H. A. JONES.

(Oxford University Press. Price 17s. 6d.)

Never, said the *Daily Telegraph* Air Correspondent, has the appearance of an official war history been so timely as the publication of the fifth volume of *The War in the Air*. And for the military engineer, Mr. H. A. Jones' narrative is of particular interest. A third of the book deals with the German air raids on Great Britain in 1917–1918. It describes these raids in detail, their conduct, their effects, material and moral, and the measures of defence and protection that were adopted. These last concern the military engineer very closely. From the home base to the front line, he is going to find his already multitudinous responsibilities added to still further by demands for shelter against air attack. Advice as to the form this shelter should take, its design and often its actual provision, will be expected from him. He cannot, therefore, afford to ignore any information that there is on the subject. The raids of the Great War may be a very poor representation of the offensive power of the air arm to-day, but as they are almost the only examples that we have, they clearly call for study. There must be some lessons to be learnt from them.

Perusal of *The War in the Air* will show at once that on military grounds, the German air-raid campaign was overwhelmingly justified by the results. It was not so much the material damage done in the hundred or so attacks which were made that counted, as the diversion of men and material to home defence that these attacks caused. The estimated actual amount of damage done from 1914 to 1918 was less than three million pounds and the total casualties were under five thousand. But the defensive organization that was maintained in Great Britain to meet the threat of air attack included over 450 A.A. guns, more than 600 searchlights, 376 aeroplanes and personnel totalling above 13,000; all this against a striking force of bombers that up to May, 1918, had never set out more than 27 strong and in the final raid of the 19th/20th May, totalled only 43. Also of great military importance, of course, was the effect of the raids on the output of munitions. This effect extended far beyond the limits, both in space and time, of the raid itself. Mr. H. A. Jones quotes some interesting figures from Woolwich Arsenal. On each of the nights, 24th and 25th September, 1917, fifteen or sixteen Gothas attacked, with London as their objective, and succeeded in dropping about 60 bombs on the capital though none apparently on the Arsenal. For the night 24th/25th September, the output in the filling factory fell to one-fifth of normal and on the next night, when the bombers were over England only about 1½ hours, it was between one-half and one-third. Although the air raids took place at night they affected the day shift that followed and the figures for the 25th September showed an output 25–30 per cent. below the normal. The loss of output was out of all proportion to the percentage of employees who stayed away from work and it was apparently typical of what was happening over a wide area. There is no doubt that the results of the German air raids of 1917–1918, were such as would warrant a repetition of the effort in a future campaign and, if the air attacks on England are co-ordinated with the military offensive on the continent, which was not the case in 1917–1918, the gains to be reaped will be even greater. The engineer's problem of minimizing the effects of air attack is certainly a live one.

In 1917–1918 the chief air missile to be guarded against was the bomb filled with high explosive. This was not the only type used by the Germans. Large numbers of incendiary bombs were dropped as well. The Germans had had high hopes of the effects of these on our densely populated areas but their hopes were not realized and the incendiary bomb was a complete failure. Now the idea of creating panic and disorder by starting numbers of fires is perfectly sound. It failed in this instance because either the design or the material of the bomb was not suitable for the purpose. We cannot count on a second failure of the incendiary bomb. In the years that have passed there is little doubt that a satisfactory article has been evolved. Protective measures then must take into account the incendiary bomb as well as the high explosive one, and in addition the new air missile, gas.

The War in the Air contains a great deal of information about the damage done in the raids. Bombs weighing from 50–1,000 kg. were dropped. Their effects are described fully. The damage done by the small bombs was to a great extent, though not entirely, limited to the building struck. With the larger bombs the destruction was much more widespread. One of them, weighing 300 kg., which was dropped on Camberwell during an airship raid in October, 1917, damaged about 200 houses. A 1,000-kg. bomb that hit No. 67, Warrington Crescent, Paddington, during the attack of 18th/19th February, 1918, demolished 23 houses and damaged 400 more. The 300-kg. bomb is a size that may well be used in quantity nowadays, and even the 1,000-kg. one may not be very uncommon. Either, with its widespread effects, will make anti-gas measures very difficult. There was no gas used in the 1917–1918 raids on England but it needs no imagination to realize how complicated will be the problem of keeping a building gas-tight when high explosive bombs of 500 lb. and upwards are being dropped at the same time. The addition of incendiary bombs, which are to be expected too, will make matters even more awkward.

The official attitude in 1917–1918, towards the provision of air raid shelters was that it was undesirable to encourage people to leave their homes to take shelter elsewhere. It was considered that a house offered a good protection against bomb splinters and the risk of heavy casualties was not so great when people remained at home as when they were crowded in shelters which could not be made proof against a direct hit. This somewhat complacent attitude does not seem to have met with full acceptance by the people. At any rate those in the East End of London, who were almost always in the path of the raiders, knew that the small houses in which they lived afforded little or no protection. So, in the autumn of 1917, when the moonlight aeroplane attacks began, there would be a movement from the East of tens of thousands of people in search of shelter on any night when an attack appeared possible. It was chiefly towards the West they went because that was not only the shortest way out of the danger area, but one well endowed also with shelters. Most popular of all were the 90 or so stations of the Underground railways: we read of 10,000 taking refuge in Old Street Underground Station one night at the end of September, 1917. The tunnels under the Thames, at Woolwich, Greenwich, Blackwall and Rotherhithe, also became favourite shelters, and police stations and other public buildings were made use of too. In all, there was accommodation for about 900,000 persons, but in many parts of London, especially the poorer districts, the available shelter remained insufficient. A proposal to build public dugouts in the parks was investigated but was rejected, partly because material and skilled labour could ill be spared and partly because it was thought that dugouts, which would be no more than splinter-proof, would not offer greater protection than a building. Instead, a scheme was devised by which local authorities were made responsible for the selection of buildings as air-raid shelters and for the additional protection by sandbagging windows and other openings of such buildings as did not afford adequate protection. The Government made a free issue of two million sandbags for the purpose but refused to meet the cost of other materials and of labour.

There is nothing in *The War in the Air* that inspires much confidence in the ordinary house as an air-raid shelter. It is splinter-proof and little else. And even in the cellars of a substantial building the protection may be to a great extent illusory. Though the cover overhead is adequate there will be the possibility of penetration alongside the building. An example of this is given in the destruction of Messrs. Odham's Printing Works in Long Acre by a 300-kg. bomb on the 28th January, 1918. The building which was being used as a shelter at the time was a substantial one with three concrete floors up to 9-in. thickness between the roof and the basement. Had the bomb struck through the roof the damage would probably have been confined to the upper floors. As it was the bomb went through a pavement right alongside the building and the whole force of the explosion was directed into the basement. The lower part of the main walls and the adjacent supporting piers were shattered, the immediate superstructure caved in, pulling out the upper floors. The shelterers were imprisoned in the debris; 38 were killed and 85 injured or burnt by the fire which broke out. This is the only example of its kind quoted. It is perhaps the only instance there was during the period. But the modern delay action bomb, with its very considerable penetrative capacity makes the occurrence a very likely possibility to-day. Advocates of a house as a shelter point to the ease with which a portion can be made gas tight. This is so but the chances of being able to keep rooms gas tight during an air attack of any magnitude must be small. Moreover, the fire danger which was not really experienced in the Great War, will make people disinclined to shut themselves in buildings. The alternative to the house is a trench. This is splinter-proof, blast-proof and fire proof and can be made gas tight. It does not, of course, afford protection against a direct hit and for this reason, which applies to practically every structure that is not 40 to 60 feet below ground, the bays or shelter compartments must be small so as to limit the effects of a burst on the trench.

After dealing with the German air raids on Great Britain, Mr. H. A. Jones describes in turn the air operations in Egypt, Darfur and Palestine, 1914–1917, the campaign in Mesopotamia, the air operations in Macedonia, 1916–1918, and the naval air operations in the Mediterranean and near Eastern waters, 1916–1918. He concludes the volume with a chapter of training developments at home and also in Egypt and Canada.

H.P.W.H.

AUSTRO-HUNGARY'S LAST WAR.

VOL. V.

Edited by the Austrian Ministry of National Defence and the War Archives: published by the *Militaerwissenschaftliche Mitteilungen*.

The period covered by this volume extends from August to December, 1916, and thus includes the warlike events of the last five months of an extraordinarily eventful year. These events are dealt with here in six sections, varying from 90 to 180 pages in length, relating to the war-fronts against Italy, Russia, Rumania, Russia, Rumania, and Italy respectively. The book is of special interest as containing practically the whole of the campaign against Rumania, perhaps the most instructive, and, considering its far-reaching results, the most important example of mobile warfare, which occurred during the course of the Great War.

As lately as the spring of 1916 the Central Powers had had matters sufficiently well in hand for them to be able to initiate the great offensives on Verdun and Asiago. The first-mentioned had failed in its object and come to a dead stop, after costing each side a third of a million casualties. The successful resistance of the fortress on the Meuse increased enormously the confidence of the French, while the Germans emerged from the struggle "wounded in body and soul." As regards the offensive in the South Tyrol, after its initial success it had been held by the Italians on the last mountain-peaks before the great Venetian plain. To gain the plain and the rear of the Isonzo army a fresh blow would have been necessary, but any such enterprise was prevented by the heavy defeats of Austro-Hungarian arms inflicted by the Russians at Luck and Okna, where 300,000 men were lost in less than a week. Operations were broken off at Arsiero and Asiago on June 24th, and a retirement of 10 kilometres took place, so as to disengage the divisions ordered north against Brussilow.

Further, the Entente had not allowed the success at Verdun to divert them from their powerful offensives on the Somme.

Since the spring the picture had thus changed entirely. The leadership of the Central Powers was now everywhere in fetters; their eastern and western fronts were being hammered; Cadorna in the south was preparing a new great offensive on the Isonzo; while a fresh foe, in the shape of Rumania, was threatening Hungary from the Southern Carpathians.

It is at this point that Vol. V starts. The world-situation in the summer of 1916 is first ably dealt with by the editor, Dr. Glaise-Horstenau. This account is of great interest, and contains only one "bloomer," and that perhaps pardonable, viz., that Great Britain (invariably called "England") was, above all its Allies, determined to carry on the war *à outrance* in order to strengthen its position as a world-power by acquiring the German colonies! There follows *The South-West Front in the first half of August*, 1916, in which events in the Tyrol are described by Major Heydendorff, while the 6th battle of the Isonzo falls to Colonel Brauner.

After the Austro-Hungarian offensive in the South Tyrol had been broken off, Cadorna at once decided to resume his offensive on the Isonzo, which the former had interrupted. He had for this purpose not only the advantage of vastly superior numbers, but also that of the interior lines. By August 4th, in support of the allied offensive on the Somme, he was able to launch towards Trieste a force of over 200 battalions, supported by 1,090 guns and 77 trench-mortar batteries. With these the Italians won in fourteen days of the heaviest fighting an area of 20 x 5 kilometres, and for the first time obtained a firm hold on the left bank. The road to Trieste was still closed, although the bridgehead of Goritz had been gained. The price was 50,000 casualties, against 40,000 lost by the defenders.

Colonel Brauner's account gains in importance as it gains in accuracy from the fact that he is dealing with trench-warfare, in which maps abound and every yard of the ground is known, and during the intervals in which war-diaries get a fair chance of being written up. In contrast with the rest of the front line, where rock hardly permitted the provision of dug-outs, or even of protection against the weather, and where in spite of their drawbacks the use of c.g.i. sheeting and of pasteboard-covered planks could not be avoided, Colonel Brauner praises the bridgehead of Goritz as a model of modern field fortification. Here it was possible to make adequate arrangements for the safety and comfort of the troops, mainly owing to the skilful use of electric plant. Electrical power was used not only for rock-borers, but also for lighting, heating and ventilation. Owing to shortage of labour, however, these advantages were mostly concentrated in the front line, and thus, as it turned out, constituted a grave weakness in the position.

When he judged the right time come for it General Boroevic ordered in turn the evacuation of the bridgehead, of the line of the river, and of the Doberdo plateau. This account of the battle shows it to have contained many instructive examples and tactical lessons, *e.g.*, of success not being exploited because not believed possible beforehand, and exploitation arranged for; of being satisfied with tactical success, and neglecting to push on and make it strategic; of sudden bold offensive, although eventually repulsed, still upsetting the enemy's plans; also of how a broken line can get mended again later, when troops, although theoretically put out of action, upset the rules by hanging on, as was also done at Gheluvelt when the Worcesters closed the broken line after the first wave of Germans had passed through it.

In *The Struggle in the East from the end of July to the end of August*, 1916, Major Czegka, for Volhynia, and Major Wisshaupt, for Eastern Galicia, give an account of the many Russian offensives, which followed upon their great successes at Luck and Okna. There is also a chapter interpolated on the formation of the "Hindenburg Front," which throws interesting sidelights on the question of command, and on the great people at the respective G.H.Q's, at Pless and Teschen. Arising from the disasters of the Brussilow offensive Falkenhayn and Conrad, the respective Chiefs of the Staff, both lost greatly in prestige, and the question arose between Berlin and Vienna as to whether the whole eastern front should not be placed under one man, and that man the popular idol, Hindenburg. Conrad resisted this plan strongly, fearing that a German Commander-in-Chief might be influenced unduly by considerations for Germany's safety and interests to the prejudice of Austro-Hungary. His own position was at the time none too secure, and General Boroevic, for one, received an "agreeable" letter from Vienna about the succession. Conrad, however, eventually weathered the storm, but had to give in over the unified command under a German general; Hindenburg taking over the eastern front on August 2nd, with the safeguarding proviso that German G.H.Q. would issue no orders to him relating to the sectors south of the Pripet without Austro-Hungarian G.H.Q. having previously agreed.

On August 27th, by Rumania's declaration of war, Austro-Hungary's almost intolerable burden was increased to war on four fronts. The Rumanians at once invaded Siebenbürgen, and General Arz was called upon to defend Hungary against a numerical superiority of ten to one. It was clear that with 700 kilometres of frontier to defend, the defence would have to be carried out offensively. In the midst of their tribulations Falkenhayn and Conrad had found time to work this out together and on July 28th it had been agreed to invade Rumania from north and south simultaneously, the former through the mountain-passes, the latter by the Bulgarians in the Dobruja, while Bucharest itself was to be the aim of a mixed army, including Turks, which was to be thrown over the Danube. These decisions, made before Rumania declared war, were of decisive importance, for they permitted the peaceful accumulation, in canals at two suitable points on the Danube, of all the stores necessary for the essential crossing, with bridging personnel and defence-flotilla complete. Falkenhayn, by the irony of fate, found himself commanding the 9th German Army, charged with forcing the passes.

The complete story of this campaign is told by Colonel Kiszling in two parts, *The Campaign in Siebenbürgen* and *The Conquest of Wallachia*. (For the battle of Arges *vide The R.E. Journal*, March, 1935, pp. 152-4.) Majors Czegka and Wisshaupt recount the Russian offensives in the autumn of 1916, and Major Heydendorff deals with the autumn battles against the Italians, viz., the 7th, 8th and 9th Isonzo, which brought plenty of hard fighting, but no gain to the Italians comparable with that of the 6th.

Minor subjects are also dealt with, such as the fighting in Albania.

The editor closes the volume with *Politics and War at New Year's Eve*, which, like his introductory article, is impressive in its grasp and its stark simplicity. The whole work bears evidence of compression, and it is in the nature of a relief, when a word of praise, like an escaping bubble, sometimes breaks to the surface in a concluding paragraph.

F.A.I.

THE HISTORY OF THE TYNE ELECTRICAL ENGINEERS, ROYAL ENGINEERS, 1884–1933.

(R. Ward and Sons, Ltd., Newcastle-upon-Tyne. 1st Edition.)

In the foreword to this Volume, Lieut.-Colonel E. H. E. Woodward, M.C., T.D., the late C.O., pays a deserving tribute to Captain L. E. C. M. Perowne, R.E., late Adjutant of the unit, who, when asked to produce a pamphlet on the past history of the unit for the benefit of recruits, set about the task with characteristic energy and amassed so much valuable information that it was thereupon decided to compile a complete history of the unit.

The Committee which was formed for this purpose under the Chairmanship of Major O. M. Short, R.E. (T.) (retd.), is to be congratulated on the results of its great labours in producing this comprehensive history, which should prove of deep interest not only to past and present members of the unit but also to all those who have ever had the privilege of being associated with it.

Illustrations are profuse and include many interesting groups, submarine-mining, coast defence and anti-aircraft activities, and portraits of all past Honorary Colonels and Commanding Officers, with an excellent reproduction of the portrait in oils by Mr. Cowan Dobson, R.B.A., of the late Colonel Ernest Robinson, C.B.E., T.D., D.L., *J.P.*, Commanding Officer, 1918–1925, and Honorary Colonel, 1930–1935, which was presented to him by past and present officers of the unit in 1926.

Included as Appendices are a complete list of the 196 officers who have held commissions in or been attached to the unit and detailed establishments of the unit at different stages throughout its history.

Chapter I traces the many activities of the unit from its original formation in 1884 as the first volunteer submarine-mining company until the abolition of submarine-mining in the Army in 1907, when the unit assumed the title of the Tyne Division R.E. (Volunteers) Electrical Engineers.

The description of the operation of submarine mining will recall many happy memories to old "subminers" of the Corps.

Chapter II records the vicissitudes of the unit following on the provisions of the "Territorial and Reserve Forces Act" of 1907, which resulted in its reduction to a single E.L. Company: the need for further companies, additional to units raised locally, for the Coast Defence of Portsmouth, was, however, recognized in 1911 when 3 E.L. Companies of the Tyne Division, E.E., R.E. (T.F.), were authorized and the unit thereupon assumed its present title of "Tyne Electrical Engineers, R.E."

Chapter III describes the activities of the Headquarters of the unit at North Shields throughout the Great War, 1914–1919.

The efficiency of the unit is well exemplified by the promptitude with which its special service section (10 officers and 172 O.R.) was embodied; this section paraded at full strength within 24 hours of receipt of orders for embodiment and the contingent of 8 officers and 103 O.R. allotted to Portsmouth was actually manning the C.D. Lights of those defences before dark on the following evening.

A thrilling account is herein given of the signal service rendered by the unit at the wreck of the hospital ship *Rohilla* off Whitby on 31st October, 1914, resulting in the rescue, in mountainous seas, of 50 survivors.

The chapter goes on to record the formation, early in 1915, of the Royal Marine Submarine-Miners for the operation and maintenance of minefields, to which many old submarine-mining officers and other ranks of the unit were posted, and describes the development of the Coastal and Anti-Aircraft Defences of Tyneside, Blyth and Sunderland.

Chapter IV deals very fully with the activities at the Depot of the unit from 1914–1919, at Gosport, where the great expansion of the unit actually took place.

During this period its strength was multiplied nearly 14 times, the 4 companies mobilized in 1914 giving birth to more than 60 subordinate units, scattered from

Cromarty to the banks of the Piave and in November, 1918, the unit comprised 143 officers and 5,000 other ranks, of whom 50 officers and 700 other ranks were serving overseas in A.A. or other specialist R.E. units.

The chapter ends with a wonderful record of honours awarded to members of the Tyne Electrical Engineers for services during the Great War.

Chapter V contains the history of the operations of No. 1 (London and Tyne) E. and M. Company in France and Germany from December, 1915, to December, 1919, including electric lighting of hospitals, installation of a printing establishment and laundry, manufacture of the first trench locomotive and maintenance of machinery, water supply, electric lighting and other specialist work.

Chapter VI traces the growth of the defensive A.A. organization at Home, in which the Tyne Electrical Engineers were destined to play so important a part, in conjunction with the London Electrical Engineers.

Among the many notable achievements of the unit herein recorded was its participation in the operations resulting in the destruction of Zeppelins L.15 in the Thames Estuary on 31st March, 1916, S.L.11 near Cuffley on 2nd September, 1916, L.31 at Potters Bar on 1st October, 1916, and L.34 at Hartlepool on 27th November, 1916.

Chapter VII records the development of the great organization of A.A. Searchlight units overseas which, by the end of the war, consisted of no less than 76 sections totalling about 2,000 all ranks, of which the greater portion was furnished by the T.E.E. and L.E.E.

One section of the former, under the command of Lieutenant R. P. Winter (the present Commanding Officer) was transferred in January, 1918, to the Italian E.F. for services on the Piave: this section was equipped with Galileo-Fiat searchlight equipment purchased from the Italian Government.

Chapters VIII and IX complete the history of the unit from 1919 to 1933, including its reconstruction after the Great War, as one Works Company and one E.L. Company, the raising of 2 E. and M. Companies in connection with the coal strike, 1921, the accomplishment in 1924 of its cherished ambition to return officially to A.A. work, the move from Clifford's Fort to its present Headquarters at Tynemouth in 1928, phenomenal successes at rifle shooting and the reorganization of the unit in 1932, as No. 1 (E.L. and W.) Company and 307th (Tyne) A.A. Searchlight Company, Tyne Electrical Engineers, R.E.

It is opportune that the publication of this inspiring history should coincide with the year in which the unit embarked upon the fiftieth year of its existence, a history without which no Military Library should be regarded as complete.

A.B.O.

THE HISTORY OF THE SIKH PIONEERS.

By Lieut.-General Sir George MacMunn, K.C.B., K.C.S.I., D.S.O.

(Sampson, Low, Marston & Co., Ltd. Price, £2 2s. 0d.)

This book concerns the history of a very distinguished Indian corps, with which many R.E. officers have come into contact. While the Sikh Pioneers could not claim the antiquity of the Madras Pioneers nor the formidable roll of battle honours of the Bombay Pioneers, they were undoubtedly the best known of the three corps, which came to an end in 1932. One reason is that, while the two older corps were the descendants of infantry battalions converted towards the end of the nineteenth century (except one newly raised about that time), the Sikhs were always Pioneers. The original two battalions were raised to meet a special need during the Mutiny (the shortage of engineer troops at Delhi owing to the defection of most of the Bengal Sappers and Miners), and the reputation gained then was enhanced in many frontier and overseas campaigns. In those days, Sapper and Miner companies had only 100 sappers and were too small to tackle much of the roadmaking always needed in Indian Frontier campaigns; the Indian infantry have never shown much aptitude for pick and shovel work. Consequently Pioneers were a necessity, and, as no others were available, no Frontier expedition of any size was without a battalion of Sikh Pioneers. The result was that they drew a very fine type of officer, and this again resulted in great efficiency, not only in their pioneer work, but as infantry pure and simple. A further point made by the author, with which all Sappers will agree, is that "the having of a full day's work, which even in comparatively recent times was not the case in everyday infantry battalions, did evoke more character and efficiency from the individual." In those days when the roadmaking required was somewhat elementary, and infantry training and equipment was much simpler than now, the 23rd and 32nd Pioneers showed that they could be masters of both branches of their work. Not only was their roadmaking and other work adequate, but they played a full and sometimes decisive part as infantry. Even when other pioneer battalions were formed, the epic feat of the relief of Chitral from Gilgit and their good work in Tibet still gave them a special standing. Up to this point they had always formed part of infantry brigades. Their becoming divisional troops in the reorganization of formations really marked the end of this phase, and, though till the Great War, and even after, they still considered themselves specialized infantry, their true role was that of technical troops subsidiary to the more skilled Sappers and Miners.

A very interesting aspect of the Sikh Pioneers, well brought out in the book, is that they were nearly all of a despised caste which, for social reasons, could not be enlisted in the Punjabi regiments, which were and are a very close trades union of tribes, who do not form a high proportion of the inhabitants of the Punjab. Their successful service in the army gave the Mazhbi Sikhs a great social uplift. This does not mean that they are accepted fully by other Sikhs, as many R.E. officers know only too well. It does, however, seem to show that, given good leadership, recruiting for the Indian Army need not really be confined to a few "martial" tribes.

The disbandment of the Pioneers in 1932 caused widespread regret, shared by all R.E. officers in India. Notoriously, the chief cause was finance. Sir George MacMunn has obvious doubts as to both the wisdom and permanence of this policy. It must be remembered that Indian Pioneers as a whole have been twice raised and twice absorbed into an increase of Sappers and Miners. Will they have a third incarnation? The engineer troops of an Indian division are now technically stronger than ever before, but perhaps they will still need, especially in the mountains where they are most likely to operate, a reserve of semi-skilled labour to help them. Will the infantry be able to provide this labour, or will labour corps raised *ad hoc* be efficient and reliable? Opinions differ; perhaps what we have at present is the best that can be done with the money available.

The book under review is based on material collected by the late Captain Spurgin, Sikh Pioneers, put into book form by Lt.-General Sir G. MacMunn. It is intended to be a record of and a memorial to the Corps. Such a record requires a frame of the general story of the origin and conduct of the wars, which comprise most of it. Perhaps owing to Sir George's great knowledge of the history of India and the Indian Army, this frame in some parts seems unnecessarily to dominate the actual record of the battalions. There is also a tendency to emphasize the infantry fighting of the Pioneers as compared with their technical work; the information available was probably more plentiful for the fighting than the digging, but Sappers will regret that the latter is usually referred to rather than recorded. The great bulk of the Pioneer work was done in co-operation with and under the direction of Sappers, though the latter appear little in the book. It is particularly regrettable in connection with the 34th Pioneers (later the Royal Battalion), who from 1914 to 1919 worked and fought hand in glove with the S. and M. Field Companies of the Lahore Division. Was not the "sap race" of the engineers and pioneers of three divisions up to the Turkish position at Hanna worthy of record? And the month long night work, which was a dominant feature of the deliberate advance, which enabled the Lahore Division to assault the two positions in the Khadairi Bend—dismissed in the book in a few inaccurate sentences?

There are curious omissions even in the purely fighting episodes; surely the fight at Palosina Kach in 1919 was worth a detailed narrative.

The most interesting chapters are those which describe most fully the actual doings of the Pioneers. The best perhaps are Chapter I—Origin of the Pioneers—where we learn that the first companies fought a successful action 20 days after being raised, having marched 200 miles in the interval—surely a record. Chapter II—Delhi—where the Pioneers supplied, as they did at Lucknow, the great bulk of the military labour at the siege, and part of the personnel at the Kashmir Gate; Chapter XIV—Chitral; and Chapter XVI—Tibet, among the frontier operations; the tenacity and endurance shown in the Relief of Chitral would alone give the Sikh Pioneers a high place in military annals; the China Expedition of 1860 and Abyssinia, 1867-8, are also good reading.

The last chapter, entitled "The Ringing to the Pioneer Evensong," has a melancholy interest of its own. The regrets expressed by the author will be echoed by all readers, but the Mazhbi Sikh still carries on in the Indian Army. The expression "Soldier and Sapper too," used on page 316, is perhaps not a very happy one, but we may promise the Mazhbis that, in their new home in the Royal Bombay Sappers and Miners, they will become even better sappers and perhaps no less good soldiers.

Something remains to be said about the book itself. It is well printed on good paper—as befits a memorial volume, but the author's colloquialisms and his frequent comments on subjects that have little connection with the story seem out of place here; it is well illustrated, but some sketches of the various actions would be welcome, and some of the maps have been reduced beyond legibility. There are also a great number of minor slips—even in the frontispiece, which shows Pioneers of the Indian Army in 1914, one of the regiments is misnumbered.

But these are perhaps only small blemishes on a fine story, which, owing to its subject, could not fail to be interesting, and which will certainly interest all R.E. Officers who worked with the Sikh Pioneers in the past, or who are working with Mazhbi Sikhs at present, and many others.

E.V.B.

FOUNDATIONS OF SOLDIERING.

A NEW STUDY OF REGIMENTAL SOLDIERING IN THE BRITISH ARMY.

By MAJOR M. K. WARDLE, D.S.O., M.C., The Leicestershire Regiment.

(Gale & Polden, Ltd. Price, 3s. 6d.)

A book of this kind was much needed, and thanks are due to the author for writing it. Everyone knows that it is the spirit of the soldier that counts. But we have hardly a book that treats primarily, and in a practical way, of the cultivation of the right spirit in the soldier, particularly the young officer. We take it for granted that the spirit is right. But however good it is, it can always be made better; and it is of interest that our military literature lags behind that of Germany in books of this kind. The book under review is easy to read and short, not much over 100 pages, besides some 50 pages of very useful appendices. The title is a bold one but is justified. The reader may not always agree with the author; but the ideals given in this book aim high, and if they could be only partly attained, it would be greatly to the benefit of our army.

The author has a good sense of proportion. He realizes that everything depends on the regimental officer. "First and foremost this book is about the junior regimental officer, who is the youngest commander in the army and therefore the father of all commanders."

For the first three years the platoon commander must be left in uninterrupted command of his platoon.

"It is a fine thing to command thirty men, to make them physically fit, to teach them that the side is greater than the player, and that there is nothing servile in enthusiastic and disciplined service; it is one of the good things in life to feel the comradeship of common effort, common hardship, common danger flow through a body of men who are fit for whatever call may be made upon them and whose manhood and fitness as a body of men are due to your own thought, enthusiasm and hard work." The reference to thirty men shows that the writer is thinking primarily of units abroad—but that is a detail. It is the spirit of this quotation that matters.

Chapters are devoted to subjects, such as barrack-room routine, platoon demonstrations, physical training, individual training, maintenance of organization on weak parades, elimination of the bad shot, tactical realism, etc., and give many valuable hints to the platoon commander, particularly as to how he should obtain the right soldierly spirit in his command. It may seem that the private soldier is to be subjected to excessive supervision, and everyone may not see eye to eye with the author in some of his suggestions; but none can fail to draw great help from them.

After three years as a platoon commander, the officer must definitely enter a new phase. He must be given wider interests.

"He must be made to feel 'Well, that's that; and now, what?' Within the unit there are a number of ways of meeting these growing pains. For the next couple of years he can go to the support company, or the signal section, or become intelligence officer, transport officer, weapon training officer, or work of an admirably educative nature can be found for him as assistant adjutant, assistant quartermaster, or assistant P.R.I. The insight gained at such an age, in such work as a live wire can find or make inside and outside the P.R.I.'s office, for instance, would often be of incalculable benefit both to the young officer and his unit. It is during these two years that we hope that he will begin to read and think, that he will develop a latent intellectual curiosity, and lay the foundations of a sound habit of criticism. He should be useful on the staff of regimental courses, and his teaching abilities should begin to blossom seriously."

Two or three chapters are devoted to the company commander and the battalion commander, particularly the latter. The battalion commander's responsibilities are admirably set out. Stress is laid on the importance of a "Platoon commanders' fortnight" conducted by the commanding officer himself.

The commanding officer is also reminded that he must tear himself away from his office, and good suggestions are made as to how more use could be made of the second-in-command to help the C.O. in his administrative duties. A very good chapter is devoted to the higher training of the regimental officer. One useful suggestion is to form a committee to assist the C.O. in this important subject.

"The acid test of a commanding officer's success is, indeed, the enthusiasm of his officers, from his second-in-command to the junior platoon commander." The commanding officer assisted by the senior officers of the regiment should be "planning the future of each officer systematically so as to increase his military value and forward his career to the utmost possible extent."

Though the infantry is the subject of the book, nearly everything in it is applicable to the other arms. It is a book that all regimental officers, from the youngest platoon, or equivalent, commander to the commanding officer himself, should study.

E.K.S.

"THIS, OUR ARMY"

A CRITICAL EXAMINATION

By CAPTAIN J. R. KENNEDY, M.C., R.A. (retd.), *p.s.c.*

(Hutchinson & Co., Ltd., London, 1935. Price 9s. 6d. net.)

The object of the writer is to show that the Army is—both in its tactical doctrine and its organization—unfitted for war and not worth the money spent on it. Captain Kennedy has passed through the Staff College and has since his retirement been editor of a Service periodical. He is, therefore, up to date in military matters.

It is a difficult book to review, but so much of what it contains is so obviously true that all who have the interests of the Nation at heart should read it. The pity is that though soldiers may read it, as many already have, with a smile, perhaps, at the outspokenness and regret at the overstatements—it may not reach, on account of these blemishes, those who are in a position to remedy the defects of which the writer complains. His method, too, is not one to appeal to those who might otherwise sympathize with his effort to awaken public interest in the reform of the Army and of the methods of that department of the National Government to whose hands the efficiency of the Army is entrusted. For instance, on pp. 27-32, the criticism of the Commander-in-Chief of the B.E.F. would probably cause a member of the Army Council, military or civil, to throw the book into the fire, whereby he would lose something of real value in the succeeding pages, something already known perhaps, but expressed with such directness that he might be tempted to read on and be forced to ask himself at the end whether there was not a great deal in what the author had had the temerity to put so bluntly. Unfortunately, the end is not so convincing as the rest of the book.

Captain Kennedy's chapters on "Army Promotion" and "Attempts at Promotion Reform" will be eye-openers to all but the victims of slow promotion since the war. Tables of comparison between the various arms are given and in his concluding remarks Capt. Kennedy writes:—"Thus the ages on promotion to the rank of "Colonel vary by more than ten years, and the service by approximately the same "amount. The oldest of all are the Artillery, who have yet the most skilled task to "perform, and with the Engineers share the hardest and most complicated type of "peace-time preparation, and who, accordingly, should not be further handicapped." He considers that many more officers in the senior ranks should have been compulsorily retired at the end of the Great War, when, as was authoritatively stated, "there was no likelihood of another war for ten years, by which time all officers of "over fifty years of age in 1919 would be too old to serve in it when it came, if it "did, and could, therefore, be removed at once."

Page 94 contains a criticism of the record of service of the newly designated C.I.G.S. which, though correct in a prophetic forecast of his attaining to the only higher appointment open to him when the words were written, would hardly rank as a tactful method of enlisting his support—should he ever reach that pinnacle—for the reforms which the writer advocates.

For the Cavalry arm Capt. Kennedy has no use whatever. In this and the following chapter—"Horses, their cost and influence," he points out that we are still spending over one million pounds per annum, which is double the amount spent on tank battalions, to say nothing of the indirect drain on Army funds. Capt. Kennedy is an admirer of the writings of Major-General J. F. C. Fuller—"the real author of the "Tank successes," and quotes his *dictum* that "the cavalry idea did us more harm "than lose us battles, for it nearly starved us into surrender. . . . the greatest "single item of tonnage was oats and hay, namely 5,438,602 tons, in addition to the "sea transport required for the horses themselves . . . the weight of ammunition "transported by sea was only 5,253,538 tons."

He then proceeds to discuss the "Inadequacy of our Air Defence," "Reserves" from the point of view of quantity as well as quality, and the Territorial Army. As regards the last he hits the nail on the head when on p. 180 he writes:—"Most of the "foolish treatment to which the T.A. is subjected is probably traceable to faulty "representation of the force at Army Headquarters. All the high commands of "the T.A. and many of the lesser ones go to Regular officers. . . . Four years as a "Territorial Adjutant does not qualify a Regular officer to have an understanding of "this peculiar force and in no way qualifies one of them to be its sole representative "at A.H.Q. What is most important is that its representatives should have a know- "ledge of the spirit of this force, of conditions in civil life and an unbounded store of "moral courage to get it its due" In other words, the Head of the Department should have Territorial Officers on his Staff. There are plenty of them now with war and peace experience fully qualified to act as his advisers.

There follow two chapters on "Official Training in Theory" and "Official Training in Practice," and others on "Mis-spending on Education." "The Inevitability of War," and "The General Staff and Mass Warfare," all of which contain much of general interest.

The concluding chapter—"The Future Land Forces"—is frankly disappointing. The writer would have done a real service if he had devoted more time and thought to this instead of enlarging on past errors. His solution of the problem of command is to put the Air Commander in supreme control of the joint effort, because "he will "have to dictate to the ground and sea units which he requires" for his campaign. He admits that "the solution is not a perfect one, but claims that it is a solution, "whereas the present system does not yet meet any of our post war problems and "goes counter to actual battlefield experience."

The book is well printed, easy to read, has a good index, and some illustrations and portraits. H.B-W.

PRACTICAL HORSEMANSHIP.

By Captain J. L. M. Barrett.

(H. F. and G. Witherby, Ltd. Price 6s.)

The author in his introduction, describes most aptly two styles of riding, the "born" and the "made," and explains fully in the ensuing chapters how the latter can be made more efficient and enjoyable than the former.

The chapters on the first riding lessons, seat and jumping, are orthodox and clearly put, but Plate 1, a good seat, shows the rider sitting too far back on the saddle and with his stirrups too short. In Plate 4, landing over a fence, the body is too far back and the arms away from the body. The positions shown in Plates 5, 7 and 8 are, however, excellent, especially the seat over a drop fence.

In the chapters on advanced jumping the average rider will do well to remember that it is the horse that jumps and not to study too deeply the theory on timing.

The chapter on difficult horses is full of sound advice and Plate 12 gives some good illustrations of various head carriages not often so clearly shown.

Perhaps the most original and instructive chapter is that on hints on buying for beginners For once the author does not merely paint the picture of the three-hundred-guinea hunter, but describes briefly the different grades and makes clear the difference between buying the young and the made horse.

The remarks on riding lessons for children should be thoroughly digested by all parents.

There are some useful appendixes, especially the one on the aids, although on page 180 there is an obvious mistake in the sequence of the canter.

In spite of some rather condensed chapters, notably that on bitting, the author has succeeded in producing a sound and practical book, attractively written and which is refreshingly free from those hypothetical theories so common in the modern books on this subject. D.W.A.C.

HIGH-SPEED DIESEL ENGINES.

By Arthur W. Judge, A.R.C.Sc., D.I.C., Wh.Sc., A.M.I.A.E.

Second Edition. (Chapman & Hall. Price 15s.).

This is a text-book by an acknowledged authority on a subject which is developing very rapidly at the present time. It is a second and revised edition of a book whose first edition appeared only two years ago.

An apology for the title of the book appears in the preface. The type of engine with which it deals is, of course, the compression-ignition engine of the small high speed variety, which is now being commercially developed as a rival to the petrol engine. Strictly speaking, the Diesel is only one type of compression-ignition engine, and not this particular type at all. But the term "Diesel engine" slips more easily off the tongue than "compression-ignition engine," and it has the approval of popular usage in this connection. It is certainly preferable to the ambiguous term "oil engine" which is also sometimes used.

For some 30 years the petrol engine was the only form of prime mover suitable for road vehicles and for aircraft, and it has become so much a part of modern life that its many drawbacks are accepted as a matter of course. But the petrol engine has never been completely unchallenged, and in the last few years the Diesel engine has been making its appearance as a very serious rival. In brief, the Diesel scores by using a cheaper and safer fuel and making it go farther, as well as by being superior to the petrol engine in certain matters affecting performance and reliability. Against this, it suffers by being heavier than the petrol engine, by being, at present, more expensive, by wearing itself out faster, and by being generally less pleasant in its behaviour. In popular parlance it "knocks like blazes and smells like a badger," a fact which may be immaterial to the commercial user or for military purposes, but which excites the prejudice of the private motorist, with consequent commercial repercussions. But modern developments are rapidly improving the Diesel engine in these respects.

In the commercial world, the change over from petrol to Diesel is well advanced. The Diesel engine has been adopted by London Transport and many other users of heavy vehicles, and at the Commercial Motor Show at Olympia this year the Diesel had a clear majority. Commercially, the petrol engine may now be regarded as obsolescent in vehicles of the heavy class, say over three tons. In the lighter classes, including motor-cars, the petrol engine is still supreme, although a 10 h.p. Diesel engine intended for light vans has been placed on the market this year.

For aircraft, the greater weight of the Diesel tells more heavily against it, although the lower consumption of fuel and the greatly reduced fire risk are powerful arguments on the other side.

Military vehicles from the heaviest tank to the motor-cycle, are at present driven by petrol—one fuel for the whole lot. But army equipment must necessarily follow commercial practice, and the time may come quite shortly when heavy petrol driven vehicles cease to be available, either in commercial manufacture or for impressment on mobilization. Whether, by that time, Diesel power will have become available in the lighter classes, remains to be seen. If not, it might be necessary to effect a partial change-over, and face the complication of supply and transport problems produced by the use of two fuels instead of one. A complete change over, if and when it can be made, will bring many advantages in its train, since two gallons of Diesel fuel will replace three gallons of petrol, and the fire risk on vehicles will be practically abolished. It will be unnecessary, for instance, to drain the tanks of vehicles on embarkation—a point which will appeal to anyone who has had to face the details involved in embarking a mechanized unit in time of war.

Mr. Judge's book is sub-titled as "An Elementary Text-book for Engineers, Students and Operators." It opens with a concise treatise on the theory of the compression-ignition engine, with special references to the high-speed variety, and devotes a chapter to a clearly stated comparison between this type of engine and its older rival the petrol engine. The particular problems to be solved in the design of a Diesel engine are then stated, and this is followed by the bulk of the reading matter, which consists of a comprehensive review of the various methods adopted by designers and manufacturers to solve these problems. A number of engines and engine parts are described in detail and figures and curves of performance given in many cases. This is the ephemeral part of the book, calling for constant revision.

It is well up to date at the moment. The concluding chapters deal with care and maintenance of engines and with fuels.

There is an interesting appendix giving the experience of the L.G.O.C. in their early trials with Diesel-engined buses.

The book is well indexed and has a comprehensive bibliography. It is well illustrated with photographs and drawings, though a few of these suffer from being reproduced on too small a scale for their detail.

The book is marred by a number of misprints. A few important sentences are quite incomprehensible unless approached in a strictly cross-word spirit.

The book can be recommended to anyone wanting to bring himself up to date in the subject, or needing a handy summary of the last ten years' developments in this branch of engineering. It should be particularly useful, for instance, to officers starting the long E. and M. course.

It is definitely a text-book as opposed to a handbook. The dust cover carries an announcement of a book to appear shortly by the same author, entitled *High-Speed Diesel Engine Maintenance*, which presumably will be the complementary handbook.

W.H.W.

MAGAZINES.

THE MILITARY ENGINEER.

(*September–October*, 1935.)—1. *Chemical agents in aid of demolitions.*—Capt. Waitt's well-informed article is of particular interest to military engineers. It deals with a subject that has not as yet received the attention it deserves. There is no doubt that the mechanization of warfare has increased the importance of demolitions and since the chief purpose of these is to delay, and chemical agents, particularly those of the mustard gas type, can assist this delaying action very materially, the use of these agents with demolitions calls for careful study. Capt. Waitt believes that there are great possibilities in this direction. He says that in wars of the future we must expect to meet demolitions contaminated with mustard gas or lewisite. Few will disagree. A road crater placed where deviation is impossible has important delaying powers. The larger the crater the more difficult its negotiation will be. Add mustard gas to it and to the ground around and it becomes a still more formidable barrier. Application of the chemical agent presents few difficulties. Both mustard gas and lewisite are simple to use. Their characteristics are different and under varying climatic conditions one or the other may be the more suitable. These points are brought out in the article and also the many methods of application. Small containers fired statically with an explosive charge, detonated electrically or by time fuse, are said to be most satisfactory for use with demolitions.

As examples of the possibilities of contamination, Capt. Waitt discusses first the German withdrawal in March, 1917, to the Hindenburg Line. The preparatory demolitions, which covered a belt 15 kilometres in width, had been very thorough and despite brilliant work in restoring roads and bridges and in pushing forward the light railways, the rate of advance of the French was reduced to an average of three miles a day. But suppose the withdrawal had been made a few months later. Then the Germans would have had mustard gas at their disposal. If, wherever they had blown up a road or destroyed a bridge they had also contaminated the ground around, the rate of advance would probably have been reduced to two miles per day, or even less. This withdrawal to the Hindenburg Line was a deliberate one. The next example is of a force retreating under pressure. Suppose it had been necessary for the German rearguard to delay the British advance at the Somme for a longer period to relieve pressure on their retiring forces. Where the British crossed the river at Brie, six gaps had to be bridged across the canal and river, and some of them were of considerable width and over a swift-flowing stream. The operation began on the morning of 18th March, and by the 20th the British were fairly across. The passage could never have been made so rapidly had the area been gassed. Every part of the bridging, from the reconnaissance to the completion of the bridge would have had to be done in anti-gas equipment and some attempt at decontamination would have had to be made before construction was started. A figure of 25 to 40 per cent. is suggested as the reduction in work output due to the gas masks alone.

That mustard gas can be used to advantage in demolitions is obvious. Study on these lines should, as Captain Waitt says, pay high dividends.

2. *Crossing Barbed-wire Entanglements* by Marshall Gray. The writer describes an expedient devised in France in August, 1918, for crossing the German wire-entanglements. The method consisted in the use of a mat of chicken netting. Carried as a roll to the obstacle, the end was dropped on the near side and the mat lifted on top of the wire and unrolled by two men who walked over it. Demonstrations over wire belts about 30 feet wide and irregular in height were successful, a platoon crossing in under two minutes.

The writer does not say whether the method was ever actually used in battle.

3. *Mapping by the use of Aerial Photographs* by B. B. Talley.—A review of equipment, instruments, methods and results of mapping with aerial photographs.

H.P.W.H.

REVUE MILITAIRE SUISSE.

(*October-November*, 1935.)—1. *Un novateur en art militaire : le colonel Lawrence.*

Lieut.-Colonel Mayer has written a review of a translation, by Henri Thies, of Captain Liddell Hart's book *Lawrence in Arabia.* The translation, on the whole, is a good one, but a defective arrangement of the type makes it difficult to distinguish between Liddell Hart's and Lawrence's personal opinions.

There has been a good deal of disagreement about Lawrence. Some people have regarded him as a mysterious person utilized as a spy by the Intelligence Service, some have considered him to be a great captain, others merely a simple adventurer. But, in any case, he has attracted attention by the originality of his thoughts and deeds, by his obvious qualities of character, energy, intelligence and heart, by the first-rate part that he played as adviser and chief in the revolt of the Arabs against the Turks and by the successes that he obtained.

Lawrence was not intended for the profession of arms. His independence of spirit barred him from being exclusive in his studies or aspirations. He was interested in archæology, in castles, churches and fortifications. The latter led him on to the study of military operations.

When leading his Arab contingent against the Turks, Lawrence was aware that irregular warfare could only be carried on with limited numbers. In October, 1918, a force of 3,000 Arabs succeeded in immobilizing a Turkish force of ten times its numbers. Lawrence realized that the loss of men meant little to the Turks, but that loss of material meant a great deal He consequently concentrated his efforts on the destruction of a bridge, a rail, a locomotive, or a gun, rather than on killing Turks.

The writer sees, in Lawrence's life, an example that the Swiss might well follow. Unlike that of most continental nations, the Swiss army is one in which the officers are half-civilians and half-soldiers. Outside the army, they are required to keep up the plasticity of their intellect, and it is this precious quality that helps them to command when they put on their uniform.

2. *Le tribunal fédéral s'oppose au " noyautage " et au sabotage de l'armée par les communistes.* By Captain Thilo.

In the spring of 1934, one Jules Humbert-Droz, held a " Marxist course " in the *maison du peuple* at Lausanne. The course was organized by the Swiss communist party. It was continued in the winter of 1934–35, and such subjects were selected for discussion as "The struggle of the working-class against an imperialist war," "Revolutionary work in the army," etc.

The Council of State of the Canton Vaud placed a ban on these courses. Humbert-Droz and other members of the Swiss communist party appealed against the order of the Council, as a violation of the liberty of individuals, but the order was upheld by the Federal Tribunal.

3. *Les services de renseignements, de liaison et de transmission dans le régiment d'infanterie.* By Lieut. Koelliker.

In this study, the writer proposes a detailed and practical organization of the intelligence, liaison, and signal services. It is based strictly on official regulations and has been sanctioned by the commander of the 1st division.

The duties of the different services are as follows:—

The signal service ensures communication between commanders by technical means or messengers.

The liaison service ensures collaboration of commanders by means of liaison agents.

The intelligence service merely collects information, studies and distributes it. For this purpose it makes use of the signal and liaison services.

The telephone is only one of many means of sending messages, all of which can be used when occasion requires. Three forms of messages are recognized: the written, the oral, and the signalled message. Each has its advantages and disadvantages.

The writer has worked out a suitable organization for a signal unit. As regards liaison, the writer lays stress on the importance of having a reliable officer as a liaison agent, as he is the representative of his chief, and must see, judge, appreciate and interpret as his chief would do. This requires special training.

The intelligence service is dealt with at some length. The four duties of the intelligence service are: (1) collection of information, (2) its study and analysis, (3) furnishing information to those concerned, (4) keeping secrets.

Three kinds of information are necessary to a commander: (1) concerning the enemy (very difficult to practise in peacetime), (2) concerning one's own troops, (3) concerning the ground.

The writer closes this instalment with a full detail of the intelligence service in an infantry regiment.

(*December*, 1935.)—1. *Projectiles et bouches à feu.*

General Rouquerol discusses the relative merits of a gun of small calibre with a large supply of munitions and a powerful gun with a limited supply of heavy shells.

During the World War the great variety of targets to be destroyed gave birth to a number of special types of ordnance greater than had ever been known before. These types could, roughly, be divided into two classes: long-range and short-range guns.

In the course of the war, rifle-grenades, small guns and small mortars were added to the pre-war infantry weapons, but, although these weapons were efficient, there came a point when infantry had to await the collaboration of the artillery before they could make a further advance.

The tendency has been for the range of artillery to keep on increasing. This has led to a difficulty in keeping touch between the infantry in the front line and the batteries several thousand yards back. Instances occurred during the war when artillery was unable to fire at enemy trenches fifty yards away from their own trenches.

In order to destroy entanglements, heavy bursting charges are needed. Heavy bursting charges preclude thick steel walls to shells, without which high velocities are not possible.

The writer concludes with the opinion that attempts should not be made to increase the range of trench mortars and similar high-angle-fire weapons, but that the two classes of ordnance, intended for short- and long-range fire respectively, should be kept entirely separate.

2. *Défense active. Défense passive.*

R. Jaques discusses the question of the protection of civil populations against attacks by aircraft, by active as well as by passive methods.

The theories of General Douhet, viz., of seeking a final decision in the air only, are not considered practicable by most people nowadays. It is also probable that the craze for gigantic aircraft will soon die out. The chances of a successful air-attack will, in future, depend upon surprise.

It has been calculated that, after sighting an enemy squadron at a height of 5,000 metres, it would take a defending squadron 19 minutes, in favourable circumstances, to come into contact with the attacker. During that time the latter would have flown 87 km. and would doubtless have reached an important strategic objective.

From the point of view of the defence, the proportional advantage in speed possessed by a fighting plane over a bomber has gradually diminished since the end of the war. A bomber is also in a position to put up a stout defence against a fighter. Thus, considering aerial defence only against aerial attack, the advantage has increased in favour of the attacker.

With regard to anti-aircraft guns, the latter have increased greatly in efficiency since the war, but at the cost of an enormous expenditure of ammunition. A rich country may be able to equip itself with a powerful anti-aircraft artillery and an unlimited supply of shells varying from 20 mm. to 15·5 cm. But a poor country like Switzerland cannot afford such a luxury, and will have to rely on a system of mobile anti-aircraft guns that can change their position rapidly and disconcert the attacker by surprise action.

In concluding, the writer lays stress on the point that the active military defence of a country has not, as its object, the destruction of enemy aircraft in aerial combat, but the prevention of its accomplishing its mission of bombardment.

3. *Nouveaux procédés de tir à la mitrailleuse.*

Captain Nicolas describes a system of indirect laying with a machine-gun.

4. *Les services de renseignements, de liaison et de transmissions dans le régiment d'infanterie.*

Lieut. Koelliker concludes his article in this number. He gives a detailed list of the equipment, stationery, instruments and maps required in the intelligence service of a regiment, and also gives particulars of a course of instruction, both for the individual and the group.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*October*, 1935.)—1. *La tecnica idraulica sul nostro fronte nella grande guerra.* By Colonel Magrini.

A number of schemes were worked out early in the war for utilizing the rivers near the Austro-Italian frontier for flooding areas as a protective measure, and for protecting the country occupied by Italian troops from floods.

The following were some of the schemes worked out :—

(1). The flooding of the country between the old and the new Piave, to protect the Venetian plain.

(2). Flooding the country between the Piave and the *Lemene*, to protect the coastal region east of the Mestre-Portogruaro Railway.

(3). An inundation of the Adige-Mincio line, as a possible line of defence.

(4). The construction of a navigable canal from the Po to Venice and the Laguna di Grado, to furnish supplies to the troops on the Carso.

(5). Arrangements for making the Venice lagoon accessible to a squadron of big ships.

2. *Un esempio di cooperazione fanteria-artiglieria durante la grande guerra.*

General Porro describes the efficient co-operation between the 3rd Infantry

Regiment and the 23rd Regiment of field artillery in the operations of Mount Kuk and the Vodice between May and August, 1917. Six plans illustrate the text.

3. *Gli zappatori artieri nella guerra di movimento.*

Major Riccardo describes the changes that have taken place in mobile warfare since pre-war days and asks himself what duties artisan sappers will be expected to carry out in future warfare.

As regards organization, it is not likely that there will be much variation from the present system.

In the mobile warfare of the future, sappers will be called upon to make good the damage done by aeroplanes and by enemy troops and guns, also to intercept, destroy, and block the enemy's progress. On the Italian frontier one of their duties will be to block the dangerous gaps between the larger units that hold the front line. In general the writer considers that a higher technical specialization is called for.

4. *Il calore di esplosione della pentrite e della T4.*

Dr. Tonegutti describes a series of experiments carried out to determine the amount of heat caused by the explosion of "pentrite" and "T4" respectively. "T4" is the name given in Italy to an explosive generally known as "hexogen."

5. *Criteri di valutazione e di scelta dei ponti metallici scomponibili.* By Major Leonardi.

The writer compares the different types of metal bridges; *i.e.*, girder bridges with horizontal booms, arched bridges and suspension bridges, with regard to their use in the field. He considers that for spans up to 40 metres, the plain supported girder is best, whereas for larger spans, arched or suspension bridges are more suitable. Simplicity of erection is more important than reduction in size and weight of each individual piece.

He arrives at the following general conclusions:—

(1). Each element of a bridge must be simple and easy to handle.

(2). Its dimensions must be small, except in the case of prism-shaped elements.

(3) The weight must not exceed 300 to 350 kg. for each of a limited number of elements.

(4). The majority of the elements should weigh less than 100 to 150 kg.

(5). Most of the elements should be rectilinear in shape.

The depth of a girder should not exceed 1/10th or 1/12th of its span. This means that in the case of a girder exceeding 40 metres in span, the length of each individual element would be excessive.

A rectangular girder offers the advantage of having a number of similar panels, but too much stress need not be laid on this point. There is no difficulty in providing detailed working drawings for an arched bridge.

As regards damage to bridges, experience on both the French and Italian fronts shows that metal military bridges suffered from bombs very little damage that could not easily be repaired. Cases of bridges having been broken completely in two are very rare indeed.

6. *Questioni d'artiglieria nella stampa estera.*

The editor records the opinions expressed in *La France Militaire* by Generals Challéat and Culmann with regard to the artillery of the future. The Chaco war has shown the remarkable efficacy of the Stokes-Brandt mortar of 81 mm., with a range of about 3,000 metres, while field artillery of smaller calibre than 105 mm. has given indifferent results. From this fact it has been concluded that, when all field artillery has been motorized, there will be no *raison d'être* for any calibre between the 47-mm. anti-tank gun and the 105-mm. gun.

General Challéat is not satisfied with this conclusion and wants further information about the use of the 75-mm. gun before condemning a gun that proved so efficient in the Great War. He considers that the best organization for divisional artillery would be as follows:

One regiment of two groups of 75's (range: 12 km.) and one group with interchangeable tubes—75/17 mm., as artillery for infantry regiments.

One regiment of two groups of 105's, with curved trajectory, and one group of 75's (range: 14½ km.), for combined action and anti-aircraft work.

General Calmann has different ideas on the subject. He does not consider the 75-mm. gun sufficiently powerful, but thinks that the French artillery should gradually be re-armed with a gun-howitzer for all-round use, such as the "Creusot" 85 mm., or the "Bofors" 90 mm.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*September–October*, 1935.)—1. *Le trans-saharien.* By Captain Simon.

A description of the project for the Trans-Saharan Railway.

The idea of a railway connecting the north coast of Africa with the west coast is more than a century old. Various routes have been reconnoitred, but no definite progress was made till 1928. During the winter of 1928–29, four separate missions carried out reconnaissances of alternative alignments. It was recognized that no Trans-Saharan railway could pay its way unless it tapped the rich portion of the French Sudan irrigated by the Niger.

Of three alignments reconnoitred across the Sahara, the most westerly one was found to be the shortest and cheapest.

The starting-point will be Bou Arfa, the present railhead in Eastern Morocco. A railway, on the standard gauge, has already been constructed as far as this for the development of mines. From Bou Arfa the railway will run approximately due south across the Sahara desert, for 1,912 km., to Im Tassit, which is the junction of the three alignments from the north and north-east, a well-watered district in the Sudan. At Im Tassit the railway will branch in two, the western branch going up the valley of the Niger, through Timbuktu, to Segou; the eastern branch going down the Niger valley to Niamey (565 km. from Im Tassit). From Niamey the line may eventually be extended through Nigeria, *via* Sokoto and Kano to French Equatorial Africa.

The cost of the Trans-Saharan railway is estimated at 3,187 million francs, and it is expected that it will take eight years to construct, allowing for a partial or complete cessation of work during the four hottest months of the year.

The main difficulties in connection with the line are: (1) sand dunes, (2) wind in sandy regions, (3) absence of water. Similar difficulties have been overcome by the Russians on the Trans-Siberian Railway, and by the British on the Trans-Australian Railway. By using Diesel engines of 1,500 h.p. with electric transmission, the water question can be simplified. A few water-tank wagons would supply the water required for the personnel.

Goods traffic would consist mainly of ground nuts, cotton, wool and livestock. Sisal and gum will be exported in smaller quantities.

The writer considers that after the first 25 years the revenue from the railway would cover its working costs, and that at the end of 60 years the initial shortage of working costs and the capital cost would be paid off.

2. *Étude sur les téléfériques.* By Captain Leygue.

This is a first instalment (93 pages) of an article on aerial ropeways. The use of ropeways in the field dates back to the Great War, during which they were employed to a considerable extent on the Italian and the Macedonian fronts.

For military ropeways a certain amount of information can be obtained from civil manufacturers, but not all that is required. Manufacturers do not pay sufficient attention to facility of transport and rapidity of construction.

The writer's object, in this article, is to sketch the most important points in connection with ropeways that have not been dealt with in text-books, or, if they have been dealt with, are of fundamental importance, such as the equilibrium of cables loaded vertically.

In this instalment the following points are dealt with, and methods of calculation are given in detail:—

I. Chief characteristics of ropeways.

II. General methods of calculation:

(a) Fatigue of cables.

(b) Adherence of cables to pulleys.

(c) Form and tension of cables.

(d) Influence of friction.

3. *Enquête sur la radiesthésie.*

The *Revue du Génie Militaire* has asked a number of geologists and mining engineers to state their candid opinion about the science of *radiesthésie.*

M. Gignoux, professor of geology at Grenoble University, considers that water-diviners owe their success, if any, either to luck or to knowledge of geological conditions. Divining rods, pendulums and other mysterious instruments, are so much humbug merely intended to deceive the public.

M. Moret, professor of geology at Grenoble, does not go so far as to say that everything connected with water-divining is nonsense or fraud, but it appears to him that dowsers trust entirely to chance for their results. In his experience they have nearly always been wrong with regard to the presence of water and its depth below ground, or with subterranean currents.

M. Abrard, sub-director of the geological laboratory in the Natural History Museum, considers that in 80% of the cases that have come to his notice, water-diviners have been wrong. There is no doubt of the movement of the divining-rod in certain circumstances, but the movement is not caused by currents of water. There are, certainly, some conscientious dowsers, but there are others who merely exploit the credulity of the public.

M. Weckel, engineer in the Algerian public works, states that the results obtained by water-diviners in Algeria have been very poor.

Two other reports are somewhat similar.

4. *Exercice sur la carte (Sapeurs-Mineurs). Passage de la Seine à Ablon.*

A scheme set to reserve (Sapper and Miner) officers for crossing the Seine, including the project for a bridge to carry 4-ton loads.

A.S.H.

REVUE MILITAIRE FRANÇAISE.

(*October, 1935.*)—*Guerre d'hier et de demain, défensive et motorisation,* by General Pichon, discusses the possibilities of a sudden attack by completely mechanized forces; a form of surprise which is ever present in the minds of Continental General Staffs. The petrol engine has revolutionized modern war as completely as the invention of gunpowder revolutionized the old feudal methods. But has it conferred all its advantages on the offensive? Not at all.

The author refers to the Austrian General Eimannsberger's recent theories, envisaging forces of 10,000 to 15,000 tanks at work. That such numbers are too fantastic he disproves by recalling that in artillery ammunition alone, in the 10-day bombardment on the Aisne in April, 1917, some 200,000 tons of metal were hurled into the air and gone beyond recall. In metal alone the tanks would have given better value. May we not also recall that the British plans for 1919 provided for a tank force of 9,000 to 10,000 vehicles? To-day, when the mass production of motor vehicles has reached such high achievement, most of the Great Powers could turn out armoured vehicles on a greater scale even than this.

General Pichon does not enter into such considerations as the overcrowding of roads, supply of petrol, and tactical control of such forces; even with cross-country capabilities, tanks must still pass the natural defiles caused by mountains and rivers. He treats the subject in a very general way, and although he gives five selected examples, sketching various dispositions to meet tank invasions, he does not lead us very far.

The subject presents a vast field of study.

Quelques Réflexions sur l'Evolution de la Tactique, by Lieut.-Colonel Lançon, deals with the development of tactics during the Great War. Written in an interesting manner, the article describes how the earlier tactics of the war, after disastrous losses of the finest material on both sides, were forcibly changed from infantry waves hurled against machine-guns and wire to artillery-pounding of the hostile defences, thence to the creeping barrages moving as a protective wall in front of the assaulting infantry, and finally to the tactics of the tank.

The author points out that, with each outbreak of war, we have to apply either the tactics evolved from preceding wars which no longer suit the present moment, or the tactics of a new school hitherto untried. But no one can do otherwise; and the best line to take is to study the recent past as well as the present developments, and endeavour to look into the future.

It was found that even when the artillery and its munitions were multiplied to an undreamed-of extent, there still remained sufficient machine-guns in the hostile defence to hold up the attack. Barbed wire, being immobile, might be cut to pieces, but machine-guns remained mobile, and could be sheltered during the storm of shells and brought into action in time to sweep the attacking infantry. Portable trench mortars, culminating in the Stokes gun, which could accompany the infantry, were considered to be the best answer to the ubiquitous machine-gun, until the tank was evolved and properly handled. This new weapon could not only deal with the machine-gun on more than even terms; it could make breaches in the barbed wire.

The tank, says the author, immediately revealed itself as the ideal weapon to accompany the infantry, and the most economical. Immediately after the war, tactical studies were somewhat forsaken. The French rested on their laurels; the Germans were plunged too deeply into chaos to undertake theoretical studies. But this period of repose was of short duration, and as soon as they had had time to re-establish themselves, the General Staffs set about evolving new doctrines.

The outstanding requirement was to increase both the offensive and the defensive power of infantry. On the defensive side, the French increased both the quantity and the quality of the automatic armament of their infantry. The infantry must be made more powerful, without being overloaded, and more independent of artillery without usurping artillery functions.

The *Germans*, the author says, are content to develop the *minenwerfers* and support-batteries with which they finished the war.

On the subject of the all-mechanized divisions, the author regards these as the storm-troops of the future, brought up for a special purpose, and withdrawn when they have fulfilled this purpose, to rest and re-fit, leaving the ordinary divisions to consolidate and make good; the latter having greater defensive than offensive powers. Armies will be able to indulge in only a few of these expensive divisions, but there will certainly be the two distinct types.

Colonel Lançon concludes by saying that "at the present time, owing to the incessant progress of science, all of whose achievements almost inevitably transform themselves into agents of destruction, tactics become continually endowed with more and more redoubtable weapons, and every military organization, wishing merely to keep pace with the dangers which increase around it, must constantly be revised."

Introduction à une étude de l'organisation militaire espagnole, by Commandant Morel, is a short article summarizing the present conditions of the Spanish military system. There is an appendix giving details of the army organization and composition.

Under the heading of Foreign Military News, this number contains a short account of Italy's "autostrades," which were begun in 1922. These magnificent roads are proving to be very uneconomical, and the Italian Government finds itself obliged to subsidize the companies concerned in them. Strategically they may be useful;

commercially they are not a success, and it seems that similar projects for Southern Italy have been abandoned. It may be that the Government, having got a good strategic artery in the north, is not particularly interested in similar developments in the south.

(*November*, 1935.)—*Les Systèmes Fortifiés dans la Défense de la France depuis 300 ans*, is the continuation, from the September number, of Commandant L. Montigny's interesting article on the development of French frontier fortification. This instalment describes the system from 1873 to 1914, and deals chiefly with the work of General Seré de Rivières.

De Rivières was secretary of the Defence Committee appointed in 1872 to draw up a new scheme of defence for the frontiers. Owing to the loss of Alsace and Lorraine, France had to consider an entirely fresh problem. Under the presidency of Marshal MacMahon, succeeded by Marshal Canrobert, this Committee included Generals Durand de Villers, Frossard and Cadart. General Seré de Rivières' name stands out as the chief author of the new system of fortification of the frontier which resulted from the Franco-German War of 1870-71.

De Rivières held that German strategy would have two aims: either a rapid invasion of France through Lorraine and the Champagne to Paris; or the conquest of Franche-Comté, as a preliminary to the conquest of Switzerland and to German domination of Europe. For the defence of Lorraine, it was proposed to reinforce the Meuse positions with a curtain of permanent fortification impervious not only to cavalry raids but to strong columns of all arms. Where the ground offered no facilities, gaps or "trouées" were to be purposely left, so as to entice the invader into directions in which he would expose himself to attacks in flank. Hence the famous Trouée de Charmes, Trouée de Belfort, etc. Behind the curtain, which was also to act as a protective screen against interference with the French concentration, the French armies were to be massed with the Meuse in front of them.

For the invasion of the Franche-Comté, the Germans would advance either by the passes of the Vosges between Epinal and the Ballon d'Alsace, or by the Trouée de Belfort, which extended from the Ballon d'Alsace to Pont-de-Roide; or possibly by both these routes simultaneously.

The idea of a German invasion by violation of Belgian neutrality was not then considered likely; the tearing up of solemn treaties had not become fashionable.

The article then describes in detail and with sketch-maps, the system proposed by Seré de Rivières. The estimated cost was about 100,000,000 francs (about one-fifth of the present-day equivalent). It is to be noted that de Rivières never intended his works to be in any sense enclosed fortresses, which might entrap field armies, as had happened so recently; nor were they to be so extensive as to absorb large garrisons. They were based on a close liaison between the garrisons and the field forces, and "on a strategic defensive which did not exclude offensive tactics." France, at that time, was not thinking of an offensive on the grand scale.

In spite of the heavy indemnity which France had to pay to Germany, money for the new works was forthcoming. Seré de Rivières was made Director of Engineer Services at the War Ministry in 1874, and from then until 1880 he supervised the works. In 1880 he was placed on the retired list, his work unfinished. There followed a period of retrogression. The lessons of the past were forgotten. But the degree of security which he achieved for the French frontier had its effect; the Germans turned to the Belgian route and, in spite of the great wheel it involved, preferred it to the dangers of the fortified system of Lorraine.

Attention was then drawn to the Franco-Belgian frontier, but little was done to strengthen the system there.

De la Sambre à l'Oise is another of Captain Thoumin's essays in military geography, describing a region which has attracted numerous invasions, and has an interest, both historical and military, for many readers. The author is very adept at describing the features of large areas; he makes it easy for the reader to visualize the striking differences which the ground surface presents, and the characteristics which do not need the eye of an expert to distinguish. Just as in our own country each shire has its distinct differences, so in the country described in this article, there are marked characteristics in the Vermandois, the Cambrésis, the Laonnois or the Thiérache. These characteristics had their influence upon the military operations of the last war, as they had upon many previous campaigns.

La Grande Chapelle de l'École Militaire, by Robert Laulan, is the first instalment of an account by the author of an article on the Petite Chapelle of the same establishment which appeared in the November, 1934, number of this review.

It is of interest to archæologists only.

(*December*, 1935.)—Commandant Montigny concludes his series of articles, *Les systèmes fortifiés dans la défense de la France depuis 300 ans.* This very interesting series is brought to a close with an account of the changes made by successive Governments in Seré de Rivières' system from 1885 to 1914, and of the influences of the fortified system on the operations of the Great War, and lastly, with a review of the present-day aspect of fortifications.

The changes which took place after 1885 were due to the introduction of high-explosive shells, and the general development of artillery. The forts, instead of being " great batteries of artillery enclosed with their infantry support," became " the principal *points d'appui* of infantry " ; and artillery distributed in the intervals between the forts superseded the guns concentrated in the forts themselves. Masonry structures had to be replaced by concrete and armoured protection. The cost of all this transformation limited very severely the use of permanent fortification. Further, French views on the employment of armies underwent considerable changes. The development of railways, the increasing size of Continental armies, the speeding-up of mobilization plans, and, above all, the growth of confidence in the French military machine, changed the French doctrines from an active defence to a decidedly strong offensive.

Fortifications, therefore, went out of fashion. Some, of course, had to be maintained, and, if maintained, they had to be kept up-to-date.

A new Commission, in 1899, re-classified the existing forts. The 1st class consisted of those works which played an important part in the national defence ; they were to be furnished with permanent garrisons and munitions necessary for a long resistance ; they must be kept constantly up to date. Such were Verdun, Epinal, Toul and Belfort.

The 2nd class consisted of those works which were only to serve as supports for active field forces operating in their neighbourhood ; they were only to be maintained and equipped so far as finances permitted.

The 3rd class consisted of fortifications which might be used if need be ; they were neither to be maintained nor armed.

Fortifications were indeed going out of fashion ; yet was it not on France's fortified frontier that the Germans made least progress ? Was it not their very belief in the strength of that frontier which made the Germans seek solution in the long sweep through Belgium ? The rapid fate of Liège and Namur shattered the reputation of those formidable places, but Maubeuge, with only one modern fort in its perimeter, held out from 25th August to 7th September and kept nearly two German Corps from the decisive battle of the Marne.

The author describes the state of the permanent fortifications in 1914, and then the influence of these works on the course of the war.

The four great fortresses, Verdun, Toul, Épinal and Belfort, with their curtains of lesser works, effectively protected the French concentration. The German wheel in the north was, broadly speaking, pivoted on Verdun, which, when the Third Army fell back, became practically invested. Attempts to get in behind by attacking Troyon, between 7th-20th September, were frustrated by the successful resistance of the forts and the arrival of reinforcements. The loss of St. Mihiel and the creation of the sharp salient there deprived Verdun of essential communications in 1916.

After Morhange, de Castelnau's Second Army was in full retreat towards the south-west. The German Sixth Army endeavoured to drive it south-east, away from the fortifications of the Grand Couronné, although these were works of a semi-permanent nature, hastily executed. But the Second Army refused to be manœuvred away and the Germans had to change front.

Later on, it was the existence of the fortified positions in Lorraine which enabled Joffre to withdraw in succession three army corps and two cavalry divisions to reinforce his left and centre. On the other hand, Manonviller, the most modern fort of all, fell after 54 hours' bombardment; it was in too isolated a position.

"The fortified region of Verdun held out against the most furious attacks ever witnessed." It gave the Commander-in-Chief liberty of action; "it had a decided influence on the conduct of field operations."

The lessons of the war, therefore, show that isolated fortresses, unsupported by the field armies, did not fulfil their role, while those which were supported, such as Verdun, and the whole eastern line, had a decisive influence. This does not mean to say that field armies must therefore pin themselves to propping up fortresses or else giving them up as wasted; but it does imply that fortresses must be sited and designed in the closest concordance with the general strategic plan.

Turning lastly to a consideration of the present-day systems, the author naturally does not give us any account of the new French fortifications, but he discusses at some length valuable propositions which are of great interest to students of strategy. He condemns the isolated fortress or organization in regions where means of communication are plentiful. Such works are easily submerged, and can only be effective for the duration of their resistance. There are, to-day, however, means of replenishing supplies by air; even wounded or exhausted troops might be removed by the same means, in order to prolong the resistance. This consumption of air force would not commend itself to the Commander-in-Chief for any prolonged period.

The fortified system of to-day consists of fortified regions, selected for their adaptability to the general strategic plan. These regions will combine the aid of natural obstacles—rivers, mountains, swamps, lakes, forests, etc.—with a system of organized works sited in breadth and depth, and furnished with ample lateral and axial communications. Full use is to be made of artificial barriers—canals, inundations, smoke and gas screens, minefields, etc. Such works, though costly, need not be so expensive as the solid masonry works of Seré de Rivières or Brialmont; they can be more easily maintained; they give wider security for the same expenditure. Many of the works can be left for completion when the period of tension begins, so long as the framework is permanently constituted.

"The fortified system of a country is a tool in the hands of the High Command; the fortified region, another in those of the subordinate commanders; the permanent work is yet another at the disposal of the chief of its garrison."

Les Combats autour de Lille en 1914, by Captain Van Belle. In General Seré de Rivières' revision of the French fortifications after 1870 Lille was converted into an important fortress to cover the region between the Scarpe and the Lys, and to flank the Maubeuge-Valenciennes position. The fortress consisted of a central core—the town itself, surrounded by bastioned ramparts, and a citadel—and a belt of works at a distance of 4 to 7 kilometres, 8 forts and 13 batteries were built. But none of these works was brought up to date. There were also to be 18 additional works and 53 batteries to be built by civil labour in the intervals between the forts when mobilization began. A garrison of 15,000 men and 415 guns were allotted. Lille would thus have been a place of considerable military importance.

Financial reasons prevented the modernization of the whole of the French fortresses and it was decided, early in 1914, to de-class Lille among others. There was a good deal of opposition to this on the part of those who believed that the Germans intended to make a wider sweep in the north than the General Staff allowed. But Joffre held to his decision. On 1st August Lille was converted officially into an open town; but no measures had been taken to remove its large stock of war material.

Lille was the headquarters of the 1st Region and the 1st Army Corps in peacetime.

General Percin was appointed to command, and took up his duties on 5th August. These consisted of the military command of the area, and the various depots within it, the collection and dispatch of drafts from the depots. For the defence of these he had received no instructions. Moreover, 10,000 rifles and 1,000,000 rounds had already been sent off to the Belgian Army, and 45 sections of machine guns and 75 guns to the French Armies. But the development of the German invasion of Belgium made it necessary to include the 1st Region in the Zone of the Armies, and thus General Percin came under the Commander-in-Chief's orders. Joffre hastened to form a screen of Territorial troops (81st, 82nd and 84th Divisions) from Dunkerque to Maubeuge, in order to protect his railway communications in the north.

General Percin hastily took measures for the defence of Lille, much to the alarm of the inhabitants. The General had at his disposal some 15,800 infantry in the depots, 2 squadrons of the 6th Chasseurs, 1 battery of Territorial artillery, and the permanent garrison of 900 gunners distributed among the forts. Of material, he had 340 guns of various calibre, 2,280 rifles dated 1886, and 100,000 dated 1874. On 19th August he ordered the town's ramparts to be repaired; and a provisional battalion to be formed by each of the eight depots. To these were added next day three batteries of 75's, three batteries of foot artillery and two squadrons of Cuirassiers, lent by General Herment from the depots at Douai.

On the evening of 21st August, General Herment was sent by General d'Amade to organize the defence of the whole group of towns—Lille, Roubaix and Tourcoing, and General Percin was superseded. This involved a much wider extension of the defence. Four more provisional battalions, and four more companies were formed from the infantry depots, and two cyclist squadrons from the depot of the 6th Chasseurs. Seventeen batteries of 120-mm. guns, seven of 95 mm. and four of 90 mm. were also improvised from the resources left in the Region. A park of 300 motor vehicles for the rapid transport of two battalions was also organized. These energetic measures were admirably carried out. But in the meantime the civil authorities, who had become thoroughly alarmed by the prospect of the German approach and had lost confidence in General Percin's measures, were bringing pressure on the War Minister to evacuate the troops from the whole region. Their efforts were successful. A telegram reached Herment at 3.30 p.m. on the 24th ordering the immediate evacuation of the area Lille-Roubaix-Tourcoing. This decision was taken without consulting Joffre, although the 1st Region had been placed in the Zone of the Armies on 17th August. The fate of Liège, the stories of German atrocities on the civil population and the seemingly ubiquitous appearance of German troopers had shaken the townspeople of Lille, and the civil authorities had not backed the military.

The region had to be cleared by 6 a.m. on the 25th; this left General Herment only 18 hours. Naturally the withdrawal was sheer confusion. Very little of the stores and arms could be got away in the time, and 400 guns, 53,000 rifles, 1,000,000 cartridges, 400 tons of explosive, 600 horses, and 5,000 sets of equipment were left behind for the Germans. Fortunately, the latter were unable to take advantage of this, and the civil authorities managed to evacuate all of it gradually by train by 2nd September.

This hasty withdrawal, unwarranted by enemy pressure, seriously undermined the morale of the troops, and added to the general feeling of helplessness in the north, where the German onrush, already formidable, became greatly exaggerated.

No Germans appeared in Lille until 26th August, when a single patrol passed through. On 31st August an officer arrived and announced the approach of a "strong garrison," but only 200 men arrived on 2nd September and took possession of the Hôtel de Ville. The Préfet du Nord ordered the evacuation of all men of military age from 20 to 48 years. On 3rd September a Landwehr battalion and a squadron of cavalry entered the town, but only stayed two days. On the 11th and 12th September a few Uhlans passed through, but nothing more was seen of the Germans until 4th October.

Then, when the Germans stood fast on the Aisne, the race to the sea began, and

French and Germans vied with each other to get round their respective flanks. The north became the scene of ever increasing activity as troops were rushed up, until finally the line was closed to the sea.

Lille was a rich prize. Its vast resources, its well-equipped factories of textile goods, and its important focus of road and railway communication made it an objective of the first order. General de Maud'huy's Detachment was hurrying to preserve it; the Crown Prince of Bavaria's Sixth Army was rushing up to secure it. A small mixed detachment of all arms was sent on 3rd October to cover Lille for three days, in order to allow the detrainment of the XXI Corps from Lorraine.

On 3rd October, Prince Karl von Wrede, purporting to be an emissary from the approaching Sixth Army, was sent to Lille to demand the "surrender of the fortress." He was conducted to the commander of the small mixed force then in front of Lille, who informed him that there was neither Commandant nor garrison in Lille; it was an open town. It appears that this flag of truce was merely a reconnaissance device, but there was no proof of this at the time and the envoy was allowed to return to his lines.

By the 4th October the Germans had reached the southern suburb of Fives, and the leading troops of the French 13th Division were arriving on the opposite side. For the next two days active skirmishing went on, and the Germans were driven back. But de Maud'huy had other risks to encounter, and the growing strength of the German Sixth Army and the rapidity of its extension northwards made it necessary to draw back the elements of the XXI Corps, which had gone to the rescue of Lille. Lille was evacuated on the 9th, and all the males of military age who could get away crowded out along the roads towards Bethune.

The story is to be continued in another instalment.

La Grande Chapelle de l'École Militaire, by Robert Laulan, is concluded in this number. W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*November*, 1935.)—1. *La défense nationale en Belgique depuis* 1830 (I). By Major Mersch.

The first chapter of this article deals with the national defence of Belgium between 1830 and 1839.

Belgian independence was proclaimed by the provisional government on the 4th October, 1830. At that time there was, practically, no national army. To guard against the perils of a Dutch invasion an army of volunteers was hastily extemporized. The country was divided into four districts. The troops in these districts were called, respectively, the armies of Flanders, of the Scheldt, of the Meuse, and of Luxembourg.

In August, 1831, hostilities broke out with Holland, and the so-called ten-days campaign might have ended in disaster for Belgium if France and Great Britain had not intervened to conclude an armistice. Holland, however, refused to sign the treaty drawn up between the five powers and Belgium, and Belgium was obliged to keep her army on a war footing. A militia law was passed in 1832, fixing the war strength of the militia at 80,000. A military school for officers was created in 1834.

Relations with Holland continued strained for several years. In 1838, however, the king of Holland, finding he could not obtain better terms, declared his readiness to adhere to the treaty of 1831. In April, 1839, the Great Powers compelled Belgium to sign a treaty determining the frontier between the two countries, somewhat to the disadvantage of Belgium.

2. *Le conflit du Gran Chaco*. By Captain Materne.

The quarrel between Bolivia and Paraguay over the Gran Chaco dates back to 1852. In spite of all attempts to settle it, it reached an acute stage in 1932. The questions in dispute were complicated by economic interests, viz.: the possession of mines and oilfields.

After a brief description of the two countries, the writer discusses the cause of the conflict. Bolivia and Paraguay were the heritage of former Spanish colonies, and the boundary between them had never been determined. Bolivia has always been anxious to find an outlet to the Atlantic along the Paraguay river, the upper reaches of which are only navigable during part of the year. In 1904, after an unfortunate war with Chile, she was deprived of territory that gave her an outlet to the Pacific. The question of the boundaries of the Chaco, which is claimed by Paraguay, is a complicated one, and it led to the outbreak of hostilities between the two countries in June, 1932.

The Gran Chaco is a region about the size of France, with barely 50,000 inhabitants. A large part of it is covered with dense forest. Water is brackish during the rainy season, and there is practically none during the dry season.

The account of the military operations is taken from an article by Lieut. Farnsworth of the U.S.A. Artillery, in the *Infantry Journal* for June, 1935.

The Bolivian army consisted of two army corps (50,000 men); the Paraguayan army of three army corps (42,000 men).

The operations can be divided into three phases:—

The first phase lasted from the outbreak of hostilities to the retirement of the Bolivian army to Fort Ballivian, in December, 1933. During these operations a young lieutenant-colonel, Estigarribia, rose to the supreme command of the Paraguay army. General Peneranda succeeded General Kundt at the head of the Bolivian army. The operations cost the Bolivians 30,000 casualties and the Paraguayans 15,000 (killed, wounded, and prisoners).

After an armistice lasting 80 days, hostilities re-commenced, and the second phase lasted till the end of 1934, when Fort Ballivian surrendered to the Paraguayans with 8,000 prisoners and a large booty. The losses in the first two phases amounted to 45,000 Bolivians and 20,000 Paraguayans.

The third phase, from December, 1934, to March, 1935, included the pursuit of the Bolivian army from Fort Ballivian to their last entrenched position at Villa Montes. Here the Bolivians found themselves clear of the jungle in a country and a climate that suited them. Both nations were pretty well exhausted, and the war was at a deadlock.

At this point the four southern South American nations offered their mediation, at the instance of the League of Nations, and obtained a suspension of hostilities.

3. *Renseignements sur les matériels d'artillerie et les mi. de grande puissance issus de la guerre.* By Major Colsoulle.

This is a first instalment of an article in which the writer gives a descriptive list of the different kinds of ordnance, in the armies of the Great Powers, ranging from heavy machine-guns to field-guns and howitzers. The information is gathered from British, American, French and German journals.

The first class mentioned are heavy machine-guns of 12-to 14-mm. bore for use against aircraft, of which the F.N. Browning is a sample. The latter, which has been adopted by the United States and Holland, fires various types of bullets, including an armour-piercing tracer bullet.

The next class, known as "canons-mitrailleuses" are guns of calibres between 20 and 25 mm. (about 1 inch). Thirteen important firms manufacture them, and they have the advantages and disadvantages of being a compromise. They fire solid projectiles against tanks, and explosive shells against aeroplanes. The "Oerlikon" gun of 20 mm. on a Carden-Loyd mounting, has been tried in Great Britain. The 20-mm. "Madsen" has been adopted in Germany and in many other countries.

Next we get infantry ordnance of calibres between 30 and 50 mm., mainly intended for anti-tank work. These are sub-divided into numerous smaller classes:—

(*a*) Guns between 31 and 40 mm., on various types of mountings.

(*b*) 47-mm. guns. Of these, the latest "Vickers" has a higher muzzle-velocity than any of the others, but has a slower rate of fire.

(*c*) Guns and mortars for infantry accompaniment, of 70 to 76 mm. These have lower velocities than (*b*) and are not primarily intended for action against tanks or aircraft.

(*d*) Infantry gun-howitzers, with interchangeable tubes. These are the most original development of small-bore artillery. The idea is to give the infantry an arm of accompaniment as well as an anti-tank weapon, all in one. The calibres vary between 30 and 50 mm. The 25·4/70 mm. "Vickers-Armstrong" is an extreme example of this type. In this gun the 70-mm. howitzer barrel is not removable, and, when required, the 25·4 mm. gun barrel is inserted inside it.

As regards penetration, 45 mm. armour is proof against all anti-tank guns, except the "Bofors" 35 and 45; 30-mm. armour is not proof against the heavier anti-tank guns, and 10-mm. armour is not proof against any weapon within a range of 500 metres.

(*e*) Mountain guns and howitzers.

Modern mountain howitzers have about double the range of those dating back to the war, without a proportional increase in weight. Italy has adopted the "Ansaldo," Switzerland the "M 30 Bofors," the U.S.A. the "Pack-Howitzer M 1." All three are of 75-mm. bore. Other types are the "Schneider" short 105-mm. gun, and the 75-mm. gun-howitzer.

(*December*, 1935.)—1. *La défense nationale en Belgique depuis* 1830. (II).

Major Mersch gives us a second instalment of this article, in which he traces the history of the national defence of Belgium between 1839 and 1870. During the first portion of this period Belgium dreaded an invasion by Holland, and organized her defences accordingly. But the relations between the two countries gradually improved, and the danger of an invasion from the north gradually diminished. On the other hand, the accession to power of Louis Napoleon in 1848 introduced a fresh source of danger from the side of France. A new system of defence was worked out in 1851, based on the following ideas: (1) the abolition of fortresses no longer required, (2) retention of fortresses for defence, (3) organization of an army of 100,000 men, of whom 60,000 were to form the field army, and 40,000 the reserve, (4) creation of an entrenched camp round Antwerp. Later on, these ideas were somewhat modified. In 1867, Napoleon III took little pains to conceal his annexationist views, of absorbing Belgium to counterbalance the extension of Prussian power after the defeat of the Austrians at Sadowa. Belgian policy became entirely concentrated on the defensive.

There was, however, a movement in the country to criticize the attitude of the Government, and it was at this time that Lieut.-Colonel Brialmont (who was subsequently to rise to fame as one of the greatest authorities on fortification) came to the fore and criticized the methods of recruiting and the low standard of recruits obtained.

In June, 1870, a law was passed fixing the maximum strength of the field army at 12,000 men. The defences of Antwerp were strengthened to some extent.

2. *Renseignements sur les matériels d'artillerie et les mi. de grande puissance issus de la guerre.*

Major Colsoulle here continues his article on modern ordnance. In this instalment he deals with four different types:—

I. Light field-guns and howitzers.

These are mostly of 75-mm. calibre as regards guns and 105 mm. as regards howitzers, and of intermediate bores for gun-howitzers. The range of guns has not greatly increased since the termination of hostilities, but their field of fire has been increased to 40° or 60° by the adoption of a forked trail. Illustrations are given of the "Vickers-Armstrong" and the "Watertown" field-gun.

The gun-howitzer tends to solve the problem of a single weapon for divisional artillery. The 85-mm. "Schneider" and the 90-mm. and "Bofors" are examples of this class.

The 105-mm. "Vickers-Armstrong" is illustrated as a type of light field-howitzer.

II. Heavy field-guns and howitzers. There are three classes of this type:

The 105-mm. field-gun (of which the "Schneider" is an example), mainly intended for corps artillery.

The 150 to 155-mm. field-gun. ("Schneider," "Vickers-Armstrong," and others.)

Heavy field-howitzers of 150 to 155-mm. bore.

III. Heavy guns and howitzers of over 155-mm. bore.

There is not much information available about these, but the 240-mm. "Schneider" gun is remarkable for its record range of 52,000 metres, and its initial velocity of 1,065 m. per second.

IV. Anti-aircraft guns.

The smaller types of these guns have bores varying from 37 to 47 mm. An illustration is given of the 40-mm. "Vickers-Armstrong."

For firing at aerial targets at medium and high altitudes, a bore of 75 mm. has been universally adopted. A special description is given of the "Schneider" anti-aircraft field-gun.

A few anti-aircraft guns of larger calibres have been built (80 to 120 mm.). Their characteristics are much the same as those of the 75's, but they fire a heavier shell.

A so-called "Stratospheric" gun of 105 mm., with a vertical range of 16,000 metres, is said to be under trial in the United States.

(*January, 1936.*)—1. *La défense nationale en Belgique depuis* 1830. (III.)

In the third chapter on this subject Major Mersch deals with the period between 1870 and 1914.

The lessons learnt from the Franco-German war of 1870 led to the re-organization of 1873. A scheme prepared by a military sub-commission was, however, cut down. The contingent for 1874 was fixed at 100,000 men (a maximum annual levy of 12,000 men). This left matters in an unsatisfactory state; compulsory service having been declared unacceptable. Eventually the annual contingent was raised to 13,300 men, a figure that was retained until 1909. A number of new forts were built between 1878 and 1900.

In 1888, the Government, having come to the conclusion that 100,000 men were insufficient for a mobilized army, decided to increase the number to 130,000 by re-organizing the National Reserve. But the organization of the field army in two corps was not maintained, and, acting on Brialmont's suggestion, the divisional organization was reverted to in 1892.

If there was any doubt that, in a future war, Belgian territory would be over-run by French or German armies, that doubt was dispelled in 1887. By that time the first line of forts commanding the passages connecting the Rhine and the Seine; Verdun, Toul, Epinal and Belfort, had been completed, and the Germans had countered with the forts at Metz and Thionville. This left the valley of the Meuse as the only clear line of advance.

The organization of forts in the valley of the Meuse was entrusted to Brialmont. Under his directions Liége and Namur were each encircled by a girdle of forts. To prevent Liége from being turned, Brialmont wished to add forts at Huy and Visé. The fort at Visé was, however, never built; its absence was seriously felt in 1914.

The problem of strategic railways was examined in 1894, dropped in 1899, taken up again in 1908, and only decided when the Great War broke out.

Various projects for re-organization of the army were taken up between 1886 and 1896. In 1902 the principle of voluntary engagement was accepted. Important modifications were made in the Antwerp defences in 1900.

As regards armament, the "Albini" rifle was replaced by the Mauser in 1889. In 1905, the artillery was rearmed with the 75 mm. "Krupp" quick-firing gun.

2. *Le Général Chapelié et le Major Bailly.* By M. L. Leconte.

A biography of General Chapelié and of Major Bailly, who were, respectively, commandant and second-in-command of the Military School at Brussels, when the school was first started in 1834.

3. *Les matériels d'artillerie et les mat. de grande puissance issus de la guerre.* (III.)

In this number Major Colsoulle deals with the improvements carried out in artillery material since 1914–1918. These come under the following headings: (a) Increase of range, (b) Increase of horizontal field of fire, (c) Increased rapidity of fire, (d) Mechanical traction.

Increase of range has been obtained by increasing the muzzle velocity, lengthening the gun-barrel, increasing the vertical field of fire and improving the shape of the projectile.

To avoid too great an increase in the weight of the gun, various methods have been devised, viz.: (a) an improvement in the quality of steel (b) a process known as "auto-frettage," *i.e.*, submitting the tube to internal hydraulic pressure greater than the maximum pressure it will have to stand when fired, and (c) braking at the muzzle. There are various methods of producing the latter effect, either by drilling holes through the barrel near the muzzle, or by adding an extra piece resembling the rose of a watering-can.

Guns in use during the war had a lateral field of fire of only about 6°. Nowadays by the use of forked trails, fields of fire of 40° and 50° can be obtained without undue increase of weight. The 105-mm. "Schneider L/31" has a field of fire of 80°. Besides the ordinary wheeled carriage with single or double trail, there are mountings for all-round fire specially for use against aircraft.

To increase the rate of fire, various devices have been introduced for rapidly opening and closing the breech and for ejecting the cartridge-case. In the smaller guns, cartridge-bands or chargers are used.

High rates of fire and high muzzle velocities produce an undue strain on the brakes and a rapid wear of the rifling. To save wear and tear each gun should have a series of varying charges. Maximum charges should not be used when the same result can be obtained with a smaller charge fired at a higher angle. Interchangeable linings may also be used. Tests in the U.S.A. show that such linings should be renewed after 1,000 rounds.

The mechanical traction of guns gives rise to a number of problems. The provision of a sufficient number of tractors with wheels or caterpillar tracks is one of them. A supply of fuel that can be produced or obtained in the country in war-time is another. For heavy loads, additional axles, twin wheels, pneumatic tyres and special springing arrangements are required.

The U.S.A. have taken the lead in motorizing their artillery; Great Britain has done a great deal in motorizing its light artillery. The problem can be solved in three different ways: (1) by carrying the gun on a lorry: (2) by towing it by means of a tractor; (3) by the use of a self-propelled gun-mounting. The latter method has a serious disadvantage: a stalled engine on the field of battle means a gun out of action.—*(To be continued.)*

4. *Aide-mémoire de l'officier d'artillerie.*

This article, by Lieut.-Colonel Vermaelen, is here concluded.

5. *Le sport motorisé en Allemagne.* (1.) By Lieut. Dmjeart.

Under the Nazi Government in Germany, a great impetus has been given to motorized sport, in which every encouragement is given to the youth of the country to make themselves proficient in the driving of cars and motor cycles. The training is not entirely of a sportive character; instruction is given on military lines.

There are numerous semi-military or sporting organizations directed by Government. They are all controlled by the O.N.S. (Oberste nationale Sportbehörde für die deutsche Sport). This organization issues permits of three classes: (1) for motor-cycles, (2) lorries, (3) cars and motor-cycles.

The German motor industry is encouraged to produce vehicles, not necessarily for cross-country use, but of a type that is not entirely tied down to use on roads.

The National-Socialist Automobile corps has become a kind of reserve for the motorized services of the army. It has at its disposal 26 schools of instruction. These provide courses for 200 to 400 pupils, lasting 8 weeks, and the courses follow each other continuously. Special instruction is given in cross-country work on motor-cycles. A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*October, 1935.*)—*The Development of our Tactics from 1914 to the present day*, by Major-General von Pitreich (*concluded*). This deals with mobile warfare, and consists of notes on and elucidations of the Austrian Regulations (familiarly known as the "F. u. G."), especially Part XI (1930) *The Combat*, which contains three sections, on the attack in mobile warfare, the attack against a prepared position in mobile warfare, and the defence in mobile warfare, respectively. The author's "Deductions for the Future," boiled down as they are to two and a half pages, are altogether admirable and worth committing to memory. General Pitreich does not belong to the school that believes that the tank and the aeroplane are destined to supersede, as chief bearers of the fight, artillery and machine-guns, as the latter have already superseded the rifle, but is content to demand for the troops the most efficient possible anti-aircraft and anti-tank defence.

The Defence of the British Empire, by Lieut. Field-Marshal Schäfer. This able exposition, which includes tables and sketches, runs to 22 magazine pages—a small pamphlet in fact—and could be recommended for study to every M.P. and every Staff College candidate. The author treats first of the structure of the Empire, its needs and dependences. In this part he quotes freely from the lecture by the economic expert, Mr. C. E. Fayle, on "Economic Aspects of Empire Defence," which appeared in the *R.U.S.I. Journal* for May, 1934. In parenthesis, it would be a pity to deprive readers of this journal of the information that in order to explain to foreign readers the nature of the Royal United Service Institution, which has no counterpart abroad, it has to be referred to as "the London Casino of the armed forces." The second sub-head treats of the organization of imperial defence, and quotes mainly from a speech by Lord Londonderry as Secretary of State for Air, regarding the functions of the Committee of Imperial Defence, the Chiefs of Staff Sub-Committee, the Co-ordination and other committees, and the Imperial Defence College. Under "the present military strength of the British Empire" is given also the distribution of the army and air force, and comparative naval strengths of the Great Powers. The writer then deals separately with the great questions of India and of the Pacific, and sums up finally in objective fashion.

Upon his showing the complete picture is not rosy, for there are many weak points and the British Empire has competitors and enemies, open and concealed, in many places, especially the Mediterranean, N. Africa, S.W. Asia, and the Pacific. The deduction seems inevitable:—"If it ever came to a serious struggle in distant parts of the world Great Britain would need strong and dependable allies in Europe in order to keep her hands free."

The Old German Empire. Colonel Heller here discusses two books which have recently appeared, dealing with this subject, and which furnish evidence of a wide divergence of views as to what the Old German Empire really was. The author of one of these works, Johannes Haller, says:—"The greatest phenomenon in German history, the living epic of the nation, and later for centuries the dream of its aspiration, has become nowadays an idea strange to its people, incomprehensible to most, a fatal delusion to many, to one man vexation, to his neighbour folly."

Haller makes it his business to show that the empire of the Ottos and the Staufen was no romantic dream, but a bold and well-conceived, but at the same time reasonable policy. It aimed at producing "the all powerful State."

The writer of the second book, Ricarda Huch, gives her story the title of the "Roman Empire of German Nationality," and sees in its history the bringer of civilization and peace, and in its underlying idea a spiritual reality in which Rome's world supremacy and universal Christianity were united to form an organic whole.

Typical of the differing standpoints are the attitudes of the respective authors towards the Hapsburgs. To Ricarda Huch the glorious monarchy of the Hapsburgs carried on and furthered the universal idea during the decline of the Holy Roman Empire. Haller regards the Hapsburgs as a foreign domination by rulers who saw in the German Empire only an advanced rampart of their own house.

Colonel Heller warmly recommends both works, with the reservation that their judgments are to be accepted with caution.

The first automatic electric aiming-arrangements for anti-aircraft guns, by Capt. Schneider. According to the electro-technical monthly *Praktisches Wissen,* Nos. 11 and 12, 1934, the Swedish army has now introduced mobile anti-aircraft artillery in which the shooting elements are completely automatically determined and transmitted electrically to the gun. The rate of fire of these automatic A.A. guns is up to 150 rounds per minute. With muzzle velocities of 750 to 800 m/sec. the heights attained are from 9,000 to 12,400 metres. It is understood that the Czecho-Slovakian army has also introduced automatic aiming for A.A. artillery.

Capt. Schneider writes this article to point out that these introductions are not innovations, since the problems involved were all satisfactorily solved by Dr. Zelisko as far back as 1916, in time for their practical solutions to be thoroughly tried out in the Great War. Dr. Zelisko started on his work in 1915, and had got so far with his proposals, arrangements and trials, as to be able in December, 1916, to lecture on the subject at the Electro Technical Institute in Vienna to an audience which included the Inspector-General of Artillery. The Austro-Hungarian War Ministry then assisted him in the task of equipping a four-gun battery with his central aiming apparatus.

The author then discusses and explains with diagrams the problems which had to be tackled as regards ranging, elevation, deflection and fuse-setting. All of these having been satisfactorily dealt with and the equipment manufactured and adequately tested, the first completely automatic anti aircraft battery of four 8-cm. guns went into position on the Italian front near Gorgo di Molini on February 21st, 1918. The oil-engine dynamo combination was held in reserve after the first few days owing to H.T. being available on the spot. The battery remained in action for eight months with automatic working. This included a change of position for the Piave offensive.

In October the guns were left in the line, while the aiming arrangements were withdrawn to the Arsenal in Vienna for application to a battery of improved A.A. guns having a muzzle velocity of 900 m/sec. against the 480 m/sec. of the original guns, a figure so low as to account for the battery's often enforced inactivity against the Italian airmen.

About the correctness of Dr. Zelisko's principles, however, as about their successful application, and the thorough reliability of the equipment in war there remains no doubt. It needed only better guns to establish its worth.

Training in Gas-protection, by Major Hirsch. This article, by an officer who has had nearly twenty years' experience of gas-protection, is intended mainly for the assistance of regimental gas-officers, but it will be found instructive by all. For further study reference is made to Hanslian's *Chemical Warfare* (v. *The R.E. Journal,* March, 1928, p. 152), Meyer's *Gas-warfare and War gases,* Müller's *The Chemical Arm* (6th edition, 1933, Verlag Chemie, Berlin), and the monthly magazine *Gas-protection and Air-protection* (Berlin).

It is worthy of note that Major Hirsch leads off with the duties of a gas-officer, the training of all ranks, and gas-discipline, subjects relegated by our own official *Defence against Gas* to the last two pages before the appendixes. His remarks about gas-discipline certainly gain in impressiveness by being placed at the beginning. "The maintenance of the fighting efficiency of the soldier, while wearing his gas mask, and under the immediate threat of effective enemy gas, makes very high demands on the soldier's strength, moral and physical. Troops can be equal to these demands only when they possess a high degree of gas-discipline. The foundations of this gas-discipline are rooted in skill in the use of, familiarity with, and absolute confidence in their gas-masks, and a knowledge of the nature of gas and of its limitations. Gas-discipline ensures in the moment of danger that the appropriate measures of protection are undertaken in perfect peace of mind, and that the soldier's fighting efficiency remains unimpaired. This state of affairs can be built up and attained only by training and practice." Chapter II deals with war-gases under the sub-heads:—classification by the nature of effect; properties and characteristics of the most important war gases (v. also Hanslian pp. 36-62); and newly-discovered war-gases. The latter seem to resemble the traditional snakes in Ireland, for the author says that, in spite of ever recurring sensational newspaper reports, not one single chemical combination has been discovered since the war which has turned out to be an improvement on the gases which during the war completely proved their worth.

Chapter III deals with forms of gas-attack under the headings of gas-shell, projectors, cylinders, candles, spraying from aircraft and other vehicles, and gas-bombs. As regards gas shelling, it appears from the various types of gas-shell bombardment here described that ideas are tending more towards what the W.O. lays down in *Defence against Gas* in that gas surprise as applied to areas, and not to points, appears to be dropping out. The fact is that ground and weather conditions generally combine to make these gas barrages with non-persistent shell ineffective, and that they are better replaced either by harassing fire, or by bombardment with persistent gas, i.e. mustard.—(*To be concluded.*)

Ammunition supply in the Great War and in future. An article in the *Rivista di Artiglieria e Genio* heaps instance upon instance to show how great a part was played in the Great War by the adequacy, or generally inadequacy, of the ammunition supply. In future we shall strive for mobile warfare, but nevertheless position warfare is bound to come again locally. We shall then have mass armies again. The supply of these with ammunition will be an improvement on that of the Great War because armament industries have been in the meantime organized, because communications have improved, and also transport. Ammunition will be delivered by cross-country vehicles, and also by aeroplanes. Against these good points must be reckoned that consumption will be higher. This problem will remain with us until projectiles are replaced by rays!

Reorganization of Rapid Troops. It is reported that after several years of trials the Italian "Rapid" Division, consisting of cavalry, cyclists, artillery, tanks, with motorized infantry, pioneers and signals, is now being reorganized so as to separate horse from motor transport. The two brigades composing the division instead of being alike in their composition become almost entirely different, viz.: one brigade of tanks, mechanized artillery and machine-guns, and one brigade of cavalry, cyclists and horsed artillery. This change introduces the possibility of two "rapid" divisions by interchange of brigades, becoming converted into one cavalry division and one mechanized division. *The Supreme Military Railway Commission in France.* The object of this body is in the case of war to decide upon the best military utilization of all the railways in France. Its composition is given here as taken from the *Temps*, 20th February, 1935.

To Peace through being prepared for War. This, which has been better said in Latin, is the title of the first annual (1934) of the German Society for Defence Politics and Defence Sciences (Hanseatischer Verlag, Hamburg: in paper covers, 3 marks 60 pf.). It consists of a number of essays on military aspects of the national life by well-known writers, the whole arranged by Lieut-General von Cochenhausen. The object of the society is to awaken amongst the German people understanding of the necessity for sufficient armed forces. The reviewer, Colonel von Dragoni, praises the work highly, noting especially the absence therefrom of anything in the way of inflammatory or bellicose utterances. He enters, however, a soldier's mild protest against "too much science," and incidentally does a public service by tilting at the modern fashion, grotesquely overdone, of prefixing "Defence" (*Wehr*) to many common words and expressions, so that not only defence power, defence thought, defence politics, defence science, and many more, are constantly met with, but even "defence geopolitics." Under which fearsome title Colonel von Dragoni discovers to be hidden no more than "our good old military geography."

The World's Fear of War. Lieut.-General von Metzsch in a pamphlet of 60 pages says that the world's fear of war can be banished only when all statesmen, by means of sound defensive policy, have been able to give expression to and bring about the acceptance of the people's will to peace. A preliminary condition for this state of affairs is the readiness for self-defence, in case of necessity, but not the readiness to attack.

(November, 1935.)—The Thrust on Siedlec, the tragedy of the Austro-Hungarian army in September, 1914, by General Heye. *Note.* The spelling of the name of this town, originally Siedlce, appears now to be crystallizing into Siedlec.

This account is a short extract from Vol. I of *The History of the (Prussian) Landwehr Corps*, 1914–18, better known as Woyrsch's Corps, which formed up on the extreme left of the Austro-Hungarian armies in Poland in September, 1914. The history of this Corps has been written by General Heye, who was at that time its Chief of Staff, so that what he has to say about the vexed question of whether a thrust should be made on Siedlec, in order to pinch out Warsaw, and when, and how, and also of the attempt as made, would naturally be of interest to Austrian readers. Actually he says little or nothing that is new, but his sidelights are illuminating. For instance, that for many years a certain professor in the Prussian Staff College had taught many hundreds of officers, who later were in responsible positions in the Great War, that the Austro-Hungarian Empire would fall to pieces as soon as the old Emperor Francis Joseph closed his eyes: that such a fate was a natural and inevitable historical development, against which it was not only of no use striving, but to do so would be positively detrimental to newer nations full of life and of pure race. With such teachings many German officers, if only unconsciously, entered the war with prejudices against their Austro-Hungarian allies, which contributed to increase the cleavage between them. This surprising statement by General Heye would alone account for what Austrian officers, from Conrad downwards, felt and found hard to put up with in their allies, something which had constantly to be struggled against and which must always have been an obstacle to full co-operation.

General Heye thinks that Conrad was right in attempting the offensive solution of his task, even without the German co-operation, which had been part of his original plan, and says handsomely enough, "Conrad sought in seventeen days of the heaviest fighting to conquer. He succeeded in his intention of firmly engaging the Russian and holding him fast. For that we Germans must thank him and his army."

The tragedy was that the Austro-Hungarian forces in the absence of the complementary German thrust from the north-west, made their thrust on Siedlec alone, that it foundered against overwhelming odds, and that their losses were so enormous that their armies were, as General Heye says, "reduced to slag."

Training in Gas-protection (concluded). Deals with the Service pattern Gas-mask M34, construction of filter, container and packing, method of wearing mask, fitting, gas-chamber test, disinfection, maintenance, and storage: describes also the Oxygen apparatus, and the complete overalls designed for protection against vesicants. Finally is dealt with the practical training of all ranks in gas protection, including the choice and training of special personnel in gas detection and recognition.

Pneumatic Practice Equipment for Automatic Weapons. Major-General Pummerer describes a welcome product of the Austrian Weapon factory in Steyr, viz.: an attachment to the machine gun which does away with the necessity of expending much service live ammunition in the training of the machine-gunner. As the adapter used with the service rifle made musketry possible inside barracks and with cheaper ammunition owing to the reduction of calibre, so this invention has done the same for machine-gunnery, solving at the same time the additional difficult problems of fire being maintained at the same rate as with service ammunition, and the same nature and amount of shaking being reproduced. Drive is from an electrically-driven compressor or from a compressed-air cylinder. The application of the apparatus to the machine gun is carried out simply, after removal of the breech-block and insertion of the smooth liner: it is simple to use: its accuracy corresponds with range, which is from 10 to 30 metres as a rule, but can be considerably increased: single rounds can be fired as well as series up to 40 rounds, the content of the magazine:

calibre = ·175 in. The chief recommendation the writer gives is that the machine-gunner feels the same when using the pneumatic practice-attachment as with the real article.

The 1st Imperial Rifles in the Russian Campaign, 1914–15. This is regimental history of a fine fighting Tyrolese corps, and simply told. In less than a year they lost ten and a half thousand officers and men, out of twelve thousand. Incidentally, Baron Schneider mentions that when Italy declared war the four regiments of Tyrolese *Kaiser-Jäger* begged to be transferred from the Russian to the Italian front, so as to defend their native country in the mountains they knew. They were kept, however, in the plains and swamps of Galicia, while a German Alpine Corps was hastily raised and sent to the Tyrol, though not to man the mountain front, but only to act as a reserve, its use being strictly limited by the politicians, since Germany had not yet declared war on Italy.

The remaining articles in this number are:—*The Technical Principles for the Siting of Funiculars*, in which Major Krüpl discusses also types, design, time of erection, and carrying capacity of these indispensable adjuncts of mountain warfare; the concluding instalment of Colonel Zellner's *Tactical Exercise, No. 2*; and a note on *Field firing on the grand scale by combined arms.* According to the *Corriere della Sera* this exercise, which took place in the valley of the Nons after the Italian manœuvres, was carried out by a division to which corps artillery had been allotted, also an Army Artillery Group, tanks and aeroplanes. The infantry itself was most completely equipped with 65-mm. infantry-accompanying artillery on mules, 63-mm. trench-mortars, anti-tank guns, 47-mm. guns, and also new heavy machine guns (8 mm.). There are also reviews of *The History of the Landwehr Corps, 1914–18*, by General Heye, which inspired the first article in this number, and of *War without an Army*, a title which is not fiction, but fact, since in this book General of Gendarmerie Fischer gives an account of how, the supply of troops having run out, he and his policemen defended the Bukovina against the Russians' attacks, making up by activity, skill and ingenuity what they lacked in numbers, training and arms. For moral effect against the Russians this small band of heroes even imitated the noise of machine gun fire by using rattles and the noise of artillery by discharging the saluting-pieces used normally in every village for making joyful noises at church festivals. In war the true leader's touch is soon recognized even by the rank and file of the other side, and our own troops retiring in 1914, referred quite cheerily to "Old One O'Clock." In the Bukovina, Fischer's talents and accomplishments were soon recognized and led the Russians eventually to their last, and lowest, resort—a price on his head, 50,000 roubles dead, 100,000 alive. Fortunately no money had to be paid out on this account.

(*December, 1935.*) *A successful and an unsuccessful breakthrough by the Russians*, by Major-General Steinitz. The two events referred to occurred during the time that the Austro-Hungarian front was stabilized along the River Strypa, a tributary of the Dniester, in June, 1916, and in the winter of 1915–16 respectively. The same Russian Corps (the IInd) made both attacks, and at no great distance apart. These two attacks on the Strypa position are important because they serve as milestones in the history of the development of position warfare, and the experience that they afforded helped to pave the way to a fundamental change in defence methods. Further, a Russian account of both battles exists, written by Colonel Nesnamow, and greatly assisting towards a correct appreciation.

The Russians' first attack came on December 29th, 1915. It was a complete strategic surprise, being preceded by no concentration of heavy artillery, no bombardment and no wire-cutting. Nine days later, and after five days of heavy fighting, they called the fight off, having lost over 13,500 officers and men. There is now little doubt that the Austrians learnt from their success the wrong lesson, in that they attributed it to holding a strongly fortified line in strength. They spent the next five months in improving the fortifications.

On June 4th, the Russians began their second attempt on the Strypa line. This time they started with two days' heavy artillery bombardment; they had active artillery observation from aeroplanes, took photographs and dropped bombs. During a pause in the fire their patrols came out to ascertain the exact state of the wire. On the 6th June the assault came with such vehemence that the position was overrun, and the Russian Army Commander ordered the IInd Corps to swing right, roll up the Austrian line and bring about mobile warfare. Passive defence, with the front line held by large numbers and only small sector reserves, was the undoing of the Austrians. Many of them were captured in their front-line dugouts, just as the Germans were a month later on the Somme. Their failure taught them a new, deeper and less rigid way of holding the front, just as the Russians learnt from the failure of their first attempt on the Strypa line the necessity of systematic artillery preparation.

Command, and the means at its disposition, by Colonel Rendulic. The first part of the Austrian Field Service Regulations to appear was that for which the greatest need was felt to exist, viz.: Part XI. The Combat. Since its publication other parts have appeared one by one, the latest of which, Part I, deals with Command, and the means over which it disposes. These subjects have of necessity been already dealt with to some extent in the Parts previously published. Part I collects and concentrates all the generalizations on these subjects which the earlier Parts contain, lays down the principles thereof, and should clear up in officers' minds many points which hitherto appeared to be taken for granted. The relationship between and the duties and responsibilities of Commander and of Chief of the Staff are laid down, but it is also established that the troops themselves are the chief means in the hand of leadership. If position warfare caused this fact to be lost sight of as far as the infantry are concerned, these Regulations, envisaging mobile warfare, lay down clearly that the chief task in battle falls to the infantry, and that infantry decides the battle. Troops in armoured vehicles are not regarded as a separate arm, but as part of the infantry or cavalry, as the case may be. The increase, owing to mechanization, in the number of the engineer's tasks is recognized by laying down that the engineers must often be motorized.

Finally, as regards Command, it has two main tasks:—

(1) To hold itself free from every system, and always to choose that method of procedure which best suits the existing circumstances.

(2) In all its measures to be guided by the intention of surprising the enemy.

Tank-troops in the framework of the operation of an Army, continues the account from the September number of Lieut.-Colonel Michoux's study of a concrete case, the object of which was to show infantry officers something of the "seldom studied problem" of the distribution, incorporation and employment of tanks. The general idea is:—As a continuation of the situation at the time of the battle of the Marne in 1914, "South," before the superior numbers of "North," retires to the south away from Paris. "North" collects in the area Amiens—Beauvais—Gisors, a new Army (the 10th), its assembly being covered by a Cavalry Corps on the Seine. The object of this army is to pass round Paris on the west, crossing the Seine between Paris and Vernon, to march *via* Rambouillet on Orleans, and to strike "South's" line of communications on its left flank. The time is the end of May, and all bridges over the Seine are down. Opposing the 10th Army on the left bank of the Seine are only portions of a mechanized division, but other troops are on the way from Champagne and Verdun. The 10th Army's operations are dealt with by Lieut.-Colonel Michoux under the heads (1) The crossing of the Seine and creation of an Army bridge-head. (2) Bridging. (3) Capture of Rambouillet Forest. (4) Offensive in the open country south of the River Orge.

The 10th Army consists of 3 Corps of four divisions each, and has had allotted to it from the General Reserve 8 tank battalions (in four regiments), 2 tank-transport coys, and 1 Army tank park.

This instalment gives the arrangements for the Seine crossing and the detailed orders for the same issued by the left-hand Corps.—(*To be concluded.*)

Rubber, by M. Hevler. The story of rubber is attractively told, from its discovery in Brazil by the Indians in the milky juice of the hevea, and their use of it for making objects watertight. For three hundred years the use of rubber was limited to the neighbourhood of the wild rubber trees, since Nature's own solvent, the latex, curdled and could not survive transport. About 1800, a new era arrived when a solvent for rubber was found in ether and oil of turpentine, and rubber could then be sent all over the world. The drawbacks of hardening and stickiness remained, until it was discovered what wonders could be worked by vulcanization, or the addition of a percentage of sulphur. This success made the tyre possible. A further development led to the insulator, ebonite, which has found its way into very many trades. Wild rubber could not keep up with the enormously increased demand, and it was supplemented by the product of rubber-plantations, mostly on the other side of the world, viz.: in Southern Asia. Eventually the automobile, followed by the aeroplane, brought rubber on to a level of importance in the world's markets with iron, steel and cotton. Synthetic rubber was a child of the blockade in Germany. Rubber had been long known as a hydrocarbon in the Acetylene series, a polymer of Isoprene, C_5H_8, viz.:—$(C_5H_8)n$, and the Germans found themselves forced to manufacture it, or something as near to it as they could get. Owing to the expense of production the fate of synthetic rubber was sealed as soon as the war was over, although substitutes had been produced from cheaper materials like calcium carbide. Since the war rubber has made one more great step forward, in that by adding a small proportion of ammonia it has become possible to preserve the original latex during transport, and at the same time do away with the necessity for an artificial solvent. The milky juice containing the rubber can now be delivered either in tanks like petroleum, or, further condensed, as a paste in barrels.

The remainder of this number contains *The Book of Honour of our Artillery*, a compilation by many well-known gunner officers, in which great deeds by the artillery are related: *The Armed Forces of China*, by Professor Parske of Berlin, which goes to show that China is no longer as weak as it was, and grows stronger every year, the National Government having made great improvements especially in the army and air forces: *Night or Day Marches?* and *War-profits and Economics*, the gist of which is that war-profits have always been a feature of war, that they harm the national economy and reduce the purchasing power of money. They have often been largely fictitious, and have led to the destruction of capital. They have also brought about over-consumption and rise in prices. War economics will, therefore, strive to keep down war-profits, but there is another way of dealing with them! This method is left to the reader's imagination.

The following are reviewed:—

General Douhet's Doctrine of War. Colonel Vauthier has brought out a book (Berger-Levrault, Paris), with this title, containing extracts from General Douhet's writings, and notes by himself to elucidate the doctrine that in the warfare of the future the result of the struggle in the air will be decisive. Marshal Pétain says in his preface, " Douhet's work is an inexhaustible source of ideas. Let us beware of lightly calling utopist and dreamer one who will perhaps one day be recognized as a prophet! "

The British Army, by Capt. J. R. Kennedy. This is the latest to appear of the series, " Foreign Armies shown by Photograph," published by L. Voggenreiter-Verlag, Potsdam, 62 photographs, 2 marks. Colonel Angelis praises these pictures, which are really admirable, and points out that in addition to the instruction they provide, one can even recognize clearly from them the spirit animating the whole, especially the happy bond that exists between man, horse and equipment.

Experience of War—a Report in Three Volumes, by W. Bloem, published by Grethlein and Co., Leipzig, is interesting for several reasons. The author was a playwright and stage-manager, who had gained a name with novels of the war of 1870-71, when he took the field in 1914. As a captain in the Reserve, and at the age of forty-six, he joined the Brandenburg Grenadiers, and marched through Belgium in von Kluck's Army. In these books he does not attempt war-history, but strives conscientiously to record what he himself experienced, considering it a duty to others and to posterity that such experiences should be recorded. What with the initial advance, the Marne, the Carpathians, Verdun and the final retreat, being wounded as a company commander and again as a battalion commander, he certainly got his *nostrum plenum* of fighting. The Austrian reviewer considers that for a Prussian officer he is unusually sharp in his criticism of the lofty, but sighs nevertheless for an Austrian writer of like experience and equal talent.

F.A.I.

WEHRTECHNISCHE MONATSHEFTE.

(Formerly *Wehr und Waffen.*)

(October, 1935.)—*The Effect of Explosive Bombs*, by Dr. Heidinger. Apart from splinter effect, which is slight with bombs, and apart from the poisonous effect of the gases of detonation, which "belongs to another page," the effect of explosive bombs can be divided up into (*a*) force of impact, (*b*) pressure of the detonation gases, and (*c*) the air and earth shock which is felt by objects surrounding the point where the explosion occurs, but possibly remote from it (known as the "distant effect"). These three cases are here dealt with mathematically, with special reference to Lieut.-Colonel Justrow's "fundamental work" in his *Construction and Effect of Aerial Bombs* (*v. The R.E. Journal*, March, 1928, p. 182 and June, 1928, pp. 361–365), and in the case of (*c*) to Meuer's formula (*v. The R.E. Journal*, December, 1935, p. 719). The article gives also an extensive bibliography on the subject.

The utility for Army purposes of civil M.T. vehicles depending on their state of wear, by Dr. Hanft. The expense of motorizing the peace time army is so great that there is no possibility of any nation facing the task of holding ready in peace time the M.T. vehicles which will be required on mobilization, even if there were not the further prohibitive factor of such vehicles growing out-of-date.

As an aid to determining the suitability for further use Dr. Hanft then gives a number of diagrams showing according to the time in use the amount of wear on various parts, cylinder, piston, piston-rings and crankshaft, of the engines of a "Wanderer" motor-cycle, a Graham car and a Hille lorry. These investigations of the amount of engine-wear show that under normal conditions the rate of wear of an engine is slow, so that after 50,000 kilometres no essential replacements need be undertaken, as long as the vehicle has been properly driven and looked after. The curves of wear here published show that for similar use beyond the mileage named, the engine will soon require a general overhaul, which will take considerable time. The writer proposes accordingly that civil motor-transport according to the mileage run be classified as (*a*) fit for the front (*b*) fit for the line of communications, or (*c*) fit for home service.

The Vallier-Heydenreich Standard Curves for change of gas-pressure and velocity in the barrel compared with Piezo Indicator diagrams. Capt. Paschen, who was permitted to be present at the making of a Piezo indicator gas-pressure diagram of the firing of a rifle at the Zeiss-Ikon works in Dresden, finds large discrepancies of the results when compared with Heydenreich's curves. He anticipates similar discrepancies when the Piezo indicator comes to be used for recording gas-pressure and velocity in long guns.

The Importance of the German Brown Coal Industry Association for Germany's War Economics, by K. Metzel. It was said on the side of the Allies that they were carried to victory on the waves of oil. The world power Oil will play in the next war an even more decisive role, but Germany will be less affected thereby. The advance of science and of technics has given Germany in its fields of brown coal an almost inexhaustible source of oil, and of by-products which are of importance for war. Based on the consumption of 1934, the National Geological Institute has estimated that Germany's brown coal will last her for 400 years.

As an example of its utilization, the hydrification branch of the Leuna Works worked up in 1934 about 280,000 tons of raw brown coal for the manufacture of petrol, and the production of the latter in 1935 is expected to be 300,000 tons. Stationary Diesel engines already work on home produced tar-oils. Problems still to be solved are the production of town gas from brown coal, and also that of oil for aircraft Diesel engines, of which Germany is still importing 20,000 tons a year.

The subject is fully dealt with in " Fifty years of Central German Brown Coal Mining " (Verlag W. Knapp, Halle a.d. Saale), published by the Association to commemorate its jubilee.

Motor Vehicles for War purposes. This article, which deals in succession with motorized troops, mechanized troops, and tanks, is of a somewhat elementary nature, except where it enumerates the principal tanks under the headings of the different nations. Against France's 5,200 tanks, Russia's 1,300, and Great Britain's 600, Germany had none, and was obliged to represent them on manœuvres by structures of wood and cardboard. " Now having thrown off our fetters we are in a position to develop this arm in accordance with its importance, with the added advantage of using the most perfect of its kind straight off."

Disused Mines in the Service of War economic preparation. The reference is to potash mines, and some indication of how the proposals contained in this article came to be made can be gathered from the following figures. The value of Germany's export of potash fell from 67 million marks in 1929 to 23·4 million marks in 1932; her total production of potash fell from 1·4 million tons in 1930 to ·9 million tons in 1931. A mining director now writes proposing the use of the idle potash mines (after boring, re-building and excavating, where necessary) as stores for a year's supply of all national necessities for war, raw materials, petrol, explosives, medical stores, clothing, food, etc., in fact everything the nation needs, excepting the products of heavy industry and building materials. He points out that as these mines lie in the heart of Germany, in Hanover, Thüringen and Saxony, by the time the enemy got as far as that the war might well be considered over. The editor in a footnote politely points out the extravagance of these proposals, but he is not sure that they would not be a good idea as regards storing ammunition.

The remaining articles in this number are *Technical Difficulties in the conduct of Mechanised Formations*, in which Major Bertkau has to defend a misunderstood remark of his, that Germany, in starting the mechanization of her army so late in the day, " has suffered no harm through being spared her share in the initial troubles attending the development of mechanized vehicles," and *The Book of Honour of our Artillery*, in which the Editor of *W.M.*, himself a gunner officer and an ordnance expert, reviews sympathetically the Austrian work bearing this title, and writes appreciatively of the achievements of the Austro-Hungarian artillery, the officers of which he says, " were to a great extent engineers who knew their jobs." Lieut.-Colonel Justrow thinks, however, that the claim that " Austro-Hungary in the equipment of its heavy high angle fire artillery and especially in its ammunition led all armies," would be hard to substantiate, and points, as proof to the contrary, to the Austro-Hungarian 42-cm. Howitzer, a coastal gun, during the war with difficulty adapted for field service and which remained always difficult of transport, while on the other hand the German 42-cm. mortar had before the war been constructed throughout for M.T. transport and service in the field.

The book is heartily recommended as the work of real soldiers, who occupied before and during the war situations full of responsibility and rich in experience.

A new development this month is in the number of periodicals reviewed and in the space given to each. They include seven German (of which one deals with the navy and three with the air force), the *Bulletin Belge des Sciences Militaires*, five French (including the *Revue du Génie Militaire*), and the two journals, infantry and cavalry from Washington.

[*November*, 1935.]—*The Vexed Question of the Shrapnel Helmet*. Lieut.-Colonel Justrow investigates the amount of protection afforded by the shrapnel helmet in the past, and finds it to have been very small. In future it will be even less still, owing to the decreased importance attributed to shrapnel generally, and the replacement of the leaden by a steel bullet. He points out, from a comparison of the sectional areas of head and helmet, the large number of misses which the shrapnel helmet converts into hits, and also the many cases of increased injury to the head caused by the helmet bulging and splintering. In order to attempt to keep pace with improved ammunition and fire effect the shrapnel helmet will have to be made heavier. Will the disadvantages of a heavier shrapnel helmet, both to the wearer and in manufacture, really be compensated for by its advantages? Would the loss of protection be so great as to rule out a lighter helmet, of aluminium or even of leather?

World Economics and World Armament, by Count Brockdorff. An interesting article of a somewhat unusual type. It looks upon the Great War as not having ended in 1918, but as having been carried on by other means ever since. This World's Economic War broke out openly in the autumn of 1929, with the material and economic crisis of the United States and the cessation of that country's granting enormous credits abroad. Foreign trade dwindled and unemployment figures rose. There followed a period of small measures, since the politicians were unable to read the writing on the wall.

Two years later, in September, 1931, came the second act, when the pound crashed. It dawned on the politicians that this was no small crisis, but implied a world-wide economic struggle, the end of which it was impossible to foresee. Provisional measures became permanent measures. The time came of co-ordinated systems of blockade by peaceful means. The third act will arrive as soon as tariff walls have become so continuous as to afford no gaps, and all exports and imports have ceased. Then will follow that product of over-industrialization which Anatole France foretold when he made a Prime Minister of the future say to Parliament, "Gentlemen, I demand war with Nigritia, because it will not buy our boots." Or, as Count Brockdorff puts it, "Then in a desperate state a strong nation will remember that the sword can also be used as a lever to open the closed doors of the markets of a foreign nation. It was not from want of weapons that the German Empire capitulated in 1918, but for want of will-power. The German will-power has again awakened, and strides towards new decisions."

Preparation and Repair of Equipment at the Front, by Capt. Wesemann. Even in moving warfare it is not possible to imagine dispensing altogether with transportable repair shops. In stationary warfare, to which we are bound to come, in spite of the soldier's training and his desire to the contrary, as soon as one side has to defend itself against superior numbers, a very strong case can be made out for small workshops close up to and well distributed along the front. According to Capt. Wesemann after one day of a battle on the grand scale the following will have become unserviceable;—about 2,200 guns, 2 to 3,000 vehicles, 3 to 4,000 m.g's, and 100,000 to 150,000 rifles. According to his figures, also, of these there can be repaired;—in workshops immediately behind the front 30% to 40%, in larger workshops farther back, 20% to 30%, in the home country, 10% to 15%, the rest being irreparable. At such a time the demands on transport are extremely heavy, and the saving on this item due to having small transportable workshops well forward would be very great. The saving of time is also a great consideration. The writer would also include in the work of these repair shops the loading and filling of ammunition, *i.e.*, the assembling of elements which have been sent up separately from the base. Here, however, the editor points out that it is harder to follow him, as the objections are obvious. Ammunition should be made up in peace and security, and not among the disturbances of war.

Gas Supply appropriate to Modern Conditions, by Capt. Ruprecht. In this case the most important condition is that future wars will no longer start with a formal declaration and military action on land, but probably with a surprise attack from the air. In such an attack the hostile airmen may be relied upon to pay special attention to gasometers, both to deprive the civil population of their light, and to affect their will to war. In fact, here is our old friend *Schrecklichkeit* back again!

Capt. Ruprecht pleads accordingly for (1) gasometers to be placed underground, as they were built during the War for the German dirigibles (2) pit coal to be used for gas making instead of brown coal (but see *The R.E. Journal*, December, 1935, p. 724, where Dr. Pothmann made out a good case to the contrary), and (3) the revival of an eight-year-old scheme for a long-range supply of gas to the whole of Germany by a network of mains radiating from a single central supply station in the Ruhr coal-fields.

The successful use of long-distance high-pressure gas mains in America and in Germany, where since 1913 a pipe-line 270 miles long and 8 to 16 inches in diameter has supplied 2½ million people, is mentioned by Capt. G. MacL. Ross in *The R.E. Journal*, March, 1927, p. 118, in discussing bulk generation at collieries.

Germany needs a Research Institute for National War Strength. On the grounds that the Great War demonstrated the insufficiency of German's preparedness for war, and that the prospect of a fresh ordeal by fire of the nation compels one to ask if every step has been taken in preparation therefor, Lieut.-Colonel Justrow seconds a proposal made by Capt. Henning, and asks when a National Research Institute for war-strength is to be founded. Such an institute would undertake a struggle with uncertainty and human inefficiency, and would freely assist in its work "the most important of the nation's ministries." Its purpose would accordingly be to open up every sphere of human and technical power among the people, to set its own tasks therein, to test their results carefully, and to make on a small scale trials as to utility for war. The idea of the necessity of a research institute of this description will make headway only gradually, for it has no past and no tradition, but only the definite task of discovering quite new means of fighting, new methods of battle, fresh raw materials and processes of manufacture, in preparation for the war of the future.

Aluminium and National Defence. That same Wöhler, who broke down the existing (imaginary) barrier between inorganic and organic chemistry, in that he first made a typically organic compound, urea, $CO(NH_2)_2$ out of its typically inorganic isomer, ammonium cyanate, NH_4CNO, was also the first to produce in 1827, out of one of the widest spread constituents of the earth's crust, a grey metallic powder, aluminium. In 1854 Bunsen made aluminium by electrolysis. Thirty years later, after the invention of the electric furnace, it became of universal use, and was so easily produced that its price fell in fifty years from 1,600 marks per kilo to 1 mark 60 pf. per kilo. In 1929, the world's production had risen to 264,000 tons per year, of which Germany and Canada produced one-eighth each. There are now forty-four alloys of aluminium on the market (for the properties of duralumin, lautal, etc., *v.* *The R.E. Journal*, September, 1928, p. 527), their use having grown enormously with the advent of the automobile and aviation. Its principal source is an hydrated alumina (Bauxite), which contains also an aluminate of iron, and which in the desired state of goodness Germany possesses only to a small extent. Large quantities of Bauxite are therefore still imported, but only for cheapness' sake, since an "Aluminium Centre," which conducts research and encourages development, has worked out all the processes for obtaining from ordinary alumina the total amount of aluminium which Germany needs in war, thus obviating the necessity for import.

Orientation. Dr. Mouths explains why orientation by means of the sun is by no means as simple as some people suppose. He also mentions the most accurate method of orienting the guns of a battery, viz.: by laying them all on the same star. Then, indeed, the barrels are truly parallel.

International Automobile Exhibitions in Paris and London, October, 1935. Short notes take these two exhibitions mostly together. The German automobile industry was represented for the first time also in London by several firms (Mercedes-Benz, D.K.W., Wanderer, Horch, Adler, and for accessories, Bosch): the number of different types of car was still very great, fifty to sixty; frames were still lower, especially in lorries: more firms have gone over to the central tube frame: exhaust-pipes were even used as frame-parts: tyres have hardly changed: there is a rise in engine power: diesels are still used only for lorries, but with them are preferred: swinging-axles are mostly in front, except for cross-country six-wheelers: Campbell's Blue Bird was an attraction: attendance good, but no crowd.

Wood gas as source of power for M.T. Describes with diagrams the 3-ton Vomag lorry used, and gives an account of the series of trials which took place under Professor Kühne at the Technical High School, Munich, in 1934. At full load 36 litres of petrol or 87 kilos of wood were used per 100 km. This works out at present prices to 9·62 marks for the petrol and 4·17 marks for the gas. Hence is established the saving by using wood gas generators instead of oil-engines for lorries and omnibuses running long distances—for fuel only, and at present prices.

Signals. In *The Professional Army, France's Striking Force* (Voggenreiter's Verlag, Potsdam), Lieut.-Colonel de Gaulle says:—"R/T in the field has made such progress that in future cable, visual, and the runner are superseded, signals will be confined to radio-telephony alone." The book was apparently written for Germans.

Additions this month to the magazines reviewed are the *Field Artillery Journal*, and *Army Ordnance*, both from Washington, *The R.E. Journal*, and the *Militært Tidskrift* (Denmark).

(*December*, 1935.) *Coal as a Military Economic Factor*, by Major Hedler. The adoption of coal as fuel in the place of wood and charcoal brought about a fundamental change in the whole realm of economic development, a change, however, which only gradually became apparent. The situation changed first in that country which both possessed coal and knew how to use it—Great Britain. In 1609, Dudley used pit-coal instead of charcoal for the first time in the iron industry. Thus began an undreamt-of rise in manufactures. Great Britain was the cradle of the fundamental inventions and improvements in the most important trade means of production in the world. In England at the beginning of the 18th century a most urgent requirement of mining, the steam-engine, was invented, and James Watt perfected it. There followed a time of economic development in England, hardly paralleled in the history of the world. The perfection of the steam engine had a vast influence on all branches of economics—mining; the obtaining and working-up of raw materials of every kind, wood, metal, stone, earths; textiles, and especially the chemical industry. Similarly, means of communication were perfected. Great Britain's war and trade fleets became more capable, more seaworthy, speedier, and thus superior to the fleets of other nations. Thus England became the first marine, colonial, trading and industrial power in the world. In which position it knew not only how to maintain itself, but also to expand and grow stronger. In this state of affairs no further fundamental change could come until another nation also possessing the necessary coal should find itself having the necessary political preliminary conditions such as had existed in England's case. So it happened to Germany, which had the further advantage of possessing great forests. United politically in 1871, as a result of the victorious war against France, Germany was able in the short time of forty years gradually to overhaul and pass Great Britain in the matter of key-industries. Germany's enormous rise in the production of pit and brown coal from 38 million tons in 1871 to 277 million tons in 1913, is a measure of Germany's economic development during that period.

The Great War showed the power gained from the possession of raw materials, and the danger which lies in being dependent thereon. The writer expresses his astonishment that in a country like Germany, poor in raw materials, these dangers were not apprehended and guarded against, and he quotes the Secretary of State for Internal Affairs, Clemens von Delbrück, upon Germany's economic unpreparedness for war in 1914. The simple explanation, which he misses, is that in Germany, as elsewhere, no one envisaged a war of any duration. Germany may well have been economically prepared for the war her leaders expected, viz.: one that was to be over by the autumn. The Entente, further, under-estimated the time required to break down Germany's resistance by blockade, through overlooking the might of Germany's coal, by means of which she was able not only to keep her industries going, but later on by exporting coal to neutrals she was able to keep them neutral, in spite of British influence and threats. In return, Germany got ores, metals and provisions. By 1916, Germany was exporting over 25 million tons in the year of pit and brown coal, coke and brickettes. The writer quotes stirring appeals by Lloyd George and Marshal Foch to the British miners, which show a correct appreciation of coal's importance, and laments that no such understanding prevailed on the other side, so that not only did the German troops in retirement neglect to destroy the mines at Béthune, but that they did not even shoot them up afterwards.

Painful as is the loss of the Upper Silesian coalfields, Germany remains the greatest coal-owner in Europe, producing in 1934, 262 million tons against Great Britain's 224 millions. The upward tendency of production in both countries shows an improvement of extraordinary significance when compared with economic development in most other countries. That which has taken place in Germany, at the very time when her economic position is almost hopeless, is due to an undying belief in the nation's future, and in confidence that under strong leadership Germany will triumph over all difficulties.

From the experiences of the Great War and also of the Italo-Abyssinian war it can be maintained without exaggeration that wars can be carried on only upon the basis of a sufficient coal supply, and that the suitability of a country as an ally depends upon the amount of coal it possesses.

A Railway "Coup-de Main" on Verdun in August, 1914? by W. H. Conrad. Since the Schlieffen Plan failed many have written attacking its soundness. The most obvious alternative, without violating Switzerland, would perhaps have been to attack the French line of fortresses, as the elder Moltke intended. Lieut.-Colonel Justrow, in his *Feldherr und Kriegstechnik* (published by Stalling), pointed out the weaknesses of the Schlieffen Plan from a technical standpoint, and in another of his works he suggested that a rapid concentric attack on Verdun would certainly have brought the Germans important initial successes.

In this article a railway engineer discusses the railway situation and conditions west of Metz in August, 1914, and especially the lines leading from the German frontier to Verdun, in order to show how easy it would have been for the Germans to carry out at that time a *coup-de-main* on Verdun by means of the railway. That the possibility of such an enterprise should be contemplated at all postulates definite proofs that no real military control of the railways concerned existed at that time, and that the railway personnel on those lines was by no means friendly to war. Herr Conrad assures us on these points. It is noteworthy that he proposes for his raid, not armoured trains, but ordinary rolling stock, running on the peace schedule.

The remaining articles in this number are:—*Measurement of the Resistance of the Projectile in the Bore*, a mathematical article, with pressure diagrams, in which R. Kutterer discusses the known methods of determination, and proposes a new method of direct measurement, which he has developed. Shortly, he uses the oscillatory arrangement, and determines by means of an electrical inductive method the velocity of the barrel when free (i.e., slung). From the resulting velocity time curve by differentiating once he gets a resistance curve. *Artillery Fire without Observation, and Weather and other Corrections*, by Capt. von Kremnaler. *Shrapnel used by Heavy Artillery*, a ballistical example. There is also a note on *Synthetic Rubber*, as made by the Russians. Using the complicated Divinyl process they seem to have stopped short at Betadien, C_4H_6. With the American Acetylene process they arrived at a rubber called Sovpren, which at present has the disadvantages of smelling horribly and easily getting hard. A third process utilizes earth-oil gases. There is also a flattering review of the *Mémorial de l'Artillerie française*.

F.A.I.

VIERTELJAHRESHEFTE FÜR PIONIERE.

(*November*, 1935.)—*The Opposed Crossing by the IIIrd Corps of the Danube at Semendria*, by Major Bessell. After Austro-Hungary's first disastrous offensives against Serbia in 1914 the Serbian front was re-established along the Danube, and remained quietly there until the Central Powers, in order to open up a safe route communicating with Turkey, decided to eliminate Serbia from the war altogether, and re-commenced in October, 1915, the conquest of that country. It was no longer a purely Austro-Hungarian affair. This time there was a composite group of armies under a German commander-in-chief, Mackensen, and the plan he executed was for the 11th German Army and the 3rd Austro Hungarian Army, assembled in Southern Hungary, to invade Serbia due south across the Danube, the former east and the latter west of Belgrade, while the 1st Bulgarian Army invaded from Sofia by moving due west on Nisch. Mackensen was at Allenstein on September 16th, when he received his orders, and his Chief-of-the-Staff elect, Major General von Seeckt, was also in East Prussia. The happy couple reported at Temesvar two days later, and found that their troops had already started arriving in the assembly areas.

The crossing here described by Major Bessell with orders, tasks and distribution of the pioneers, narrative and maps, is the ferrying of the IIIrd, the right hand corps of the 11th German Army, which took part on two divisional fronts, at Semendria, 30 miles downstream from Belgrade. The conditions were, a river one kilometre broad, of varying current strengths, and 15 to 30 feet deep. Semendria was known to be one of the strongest enemy points, but there was the great advantage for the attacker of a large and heavily-wooded island. Care was taken to gain this island unharmed, so that the strip of water remaining to be crossed was only a fraction of the total width. Ferrying was ordered to start on October 9th, at 3.45 a.m., and in the left sector, where this was done, three battalions were across and forming bridge-head by 6.30 a.m. In the right sector, however, there was delay and trouble. Fifty-three pontoons with nearly 1,000 infantry on board, being an hour late, were caught by daylight afloat, and came under heavy infantry and artillery fire. What with this, and also misjudging the strength of the current, much increased by three days' heavy rain, only 10 pontoons got across, and ferrying was then stopped. Landing bridges were started on both banks immediately. By October 16th the 11th German Army was across the Danube, but still without a bridge behind it. On the 17th a floating-bridge of lighters made up at Budapest arrived, and was built in by the 20th.

Once the Armies were over the Danube, and in the case of the 3rd Army over the Save as well, the conquest of Serbia, carried out brilliantly from start to finish, was over in one and a half months "so to speak with the watch in one's hand." The contribution of the pioneers to this result was indispensable, and their work received due praise from the C.-in-C., but something more is necessary to explain how two Armies could carry out successfully the crossing of a difficult river against opposition in less than one month from the date of the operation being decided upon. This explanation is fortunately available. The writer says that a representative of German G.H.Q. (the party most interested in the success of the enterprise), Lieut.-Col. Hentsch, later to become Q.M.G. of Mackensen's Group, had been occupied in South Hungary since April, 1915, in studying the problem from every side, and in months of thorough and unobtrusive reconnaissance, had worked it out in such detail that it "hardly needed more than the troops to arrive for its immediate execution."

Machine-tools for Field Engineers, by Major Dybilasz. Seeks the general principles which should guide in the equipping of field engineers with machinery-driven tools, and also in the nature of those tools. It is no longer a question of the desirability of the mechanization of engineer field units, it is now generally recognized that such mechanization is absolutely necessary (*unbedingt erforderlich*). There is disagreement only as to how wide this mechanization should be. Even on this point there is unanimity in deciding that field companies should be laden with machinery as lightly as possible, and should carry with them always only the machinery and power-tools necessary for jobs that have to be carried out immediately. Of fundamental importance in this matter is the question of specialist *versus* general utility engineer. The experiences of the last war point to the latter. Field companies must remain G.S., and whether fully or partly motorized will have the same mechanical equipment. Bridging and other units whose work is farther back can have mechanical equipment partly different from that of the field companies, and of greater scope. The point to be aimed at, with respect to replacements both of personnel and material, is to have a common stock of similar machines. Beyond what is common to all units, companies will require special tools for special tasks, *e.g.*, for mountain or fortress warfare.

The writer then considers the question of drive, the oil-engine, diesel *v.* carburettor; pneumatic, piston-compressor *v.* rotatory, and electric; and shows two photographs of trailer-units. As regards the tools themselves he refers to a previous article (*vide The R.E. Journal*, December, 1934, pp. 672-4), adding only thereto a boring-hammer in which the piston is brought back by lightly compressed air, while the forward stroke is caused by explosion, and rammers, pneumatic, explosion or diesel, for pile-driving, also a pneumatic hand rammer. The photographs include boring, slotting and forging tools, and a 33-h.p. outboard-motor mounted on a pontoon.

Employment and Training of the Motorized Field Company, by Capt. Meltzer. Two examples from 1914 show how useful motorized engineers would then have been. When in August the bulk of the German 8th Army advanced against the Russian 1st Army at Gumbinnen, it had only one Corps to protect its right flank against the advancing Russian 2nd Army. As this corps was unable to hold up the Russians the Germans had to break off the battle of Gumbinnen. If motorized engineers had been available to block south of Allenstein, in ground which was specially suitable for such an operation, the fateful order for the German retirement behind the Vistula would not have been necessary. Similarly, the gap between the German 1st and 2nd Armies at the battle of the Marne could have been closed quicker and more effectively if motorized engineers had been available for blocking the enemy's advance. The battle of the Ourcq could then have been carried to a victorious end. After these two impressive examples of how motorized engineers would have altered the course of events, Capt. Meltzer assures us that the warfare of the future will probably produce similar situations and opportunities more often than hitherto. He then investigates the enlarged sphere of utility of the engineers owing to their being carried in mechanical transport, and shows that it will lead to a greater degree of independence, and to the necessity of providing for their own defence against aircraft and a.f.v's. The basis of his demands is that the motorization of field companies is not merely a new and more pleasant means of progression, but something which opens up fresh fields and possibilities. In order to be equal to his new higher tasks the motorized field engineer must be animated by something of the proverbial cavalry spirit.

French Views on the Employment of Pioneers during the Movements of Motorized Formations, consists of extracts from *Règlement sur la manœuvre et l'emploi du génie*, Part II, and the *Manuel du gradé du génie*, 1931 (using the latter, owing to its later date, especially where the two authorities differ), the object being to show German readers, who have as yet no official publications on the subject, the great importance attached by the French to the correct use of the engineers forming part of their motorized divisions.

The remaining articles in this number are *The Training of the Section commander*, and *Practical Training of the Pioneers on M.T. Vehicles*, from which it appears that in the German Army the pioneers drive their own motor transport. There are also included the title-page and preface, reproduced in facsimile of a work on the *Design of Fortresses*, dated 1703, but first published in 1589; a list of *Technical Terms used in Permanent Fortification*, compiled by Major Binter, with definitions and illustrations. It includes also short notes on Vauban, Brialmont, Cochorn and other great fortification experts, and gives the characteristics of the different schools of permanent fortification. And, finally, the accounts of two examples of good breakdown work done recently by the German pioneers:—(1) The clearing, which lasted a fortnight, of the débris when a railway tunnel under construction in Berlin collapsed last August, burying nineteen workmen; (2) Demolitions hurriedly undertaken to prevent the spreading of the fire which destroyed the Wireless Exhibition in the same month. On both occasions mechanical tools proved invaluable, especially motor-saws for cutting out round timbers up to 20 in. in diameter, and the sweating flame apparatus for cutting through steel sheet lining.

F. A.I.

THE INDIAN FORESTER.

September, 1935.—This number presents a new feature in the form of a technical crossword; but there is more serious matter in the shape of an article on the increasing use of timber substitutes in Burma. The problem that exercises the author is that steel and concrete are ousting timber to such an extent that there will be no market for much of the teak now being grown in Government plantations. Forest officers have of necessity to look far forward, and the following extract is an example: "Improvements in the manufacture of substitutes may be noticed every day, and by A.D. 2080, when these plantations are mature, substitutes will have improved out of all knowledge." The author makes certain suggestions of a practical nature. The subject is interesting to engineers as well as foresters, and is further discussed in the November number (*vide infra*).

The "Capture of a python" deserves notice, as well as "*Vitex peduncularis* and blackwater fever"; the leaves of this tree are said to be a certain remedy for the disease—undoubted cures are specified. Unfortunately for the lay reader, the description of the tree itself is given in rather technical language, and we are not told its vernacular names.

October. "Metal spraying on wood" is given a large space. The process consists in the discharge of innumerable particles of some metal with a low melting-point, such as tin, from a kind of pistol, the volatilization of the metal being effected by oxy-acetylene flame. Several experiments, with a view to testing the resistance of timber so treated to moisture, are described. The experiments cannot be said to be very successful from this point of view.

On the other hand, a new system of fluid impregnation into timbers, details of which are not given, is claimed to be more successful. Sapwood treated by this process is said to be as durable as heartwood. Whereas up to date, 45 % or 50% of timber in pine logs felled for conversion into sleepers was rejected in the forest, practically the whole of this wastage will now be usable. The Railway Board is quoted as stating that a saving of 8 annas per sleeper will be effected by this system of impregnation, while the life of such members will be considerably extended.

"Nedungayam Bridge" is a good example of work carried out by the Forest Engineering Division of the Madras Forest Division. The bridge is over the Karimpuzha river in Malabar, and so the article will be of interest to those Sappers who served against the Moplah rebels in 1922. It consists of four lattice girders, 62 feet long, and is designed for a moving load of 15 tons.

"Fridera," a cryptogram which embodies the initials of the Forest Research Institute, Dehra Dun, is a composition invented and patented by Dr. S. Krishna, for strengthening timber in immediate contact with iron, for example in spiked sleepers. It is claimed that it doubles the holding power of a spike, that it lengthens the life of a spiked sleeper, and that it loses none of its efficiency in extreme heat and cold.

November.—Mr. Kamesam contributes an article on small dimension stock. His idea, already tried in an Indian State, suggests a means whereby the Indian peasant can occupy his spare time, and add to his income, by supplying manufacturers of wooden articles, *e.g.*, bed-legs, with suitably sized blanks, which he could turn out at negligible cost once he had invested capital in a hand-saw (value, say, Rs. 2). The source of supply would be the wastage consequent on the extraction of larger stock, such as sleepers.

The "Thondakulam elephant" is a good big-game story.

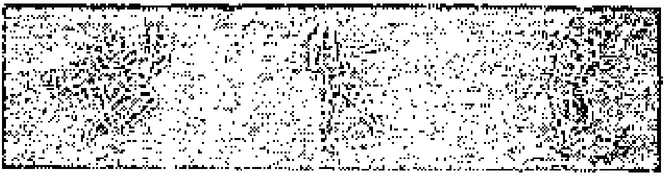
In Editorial Notes we learn that the "Comité Internationale du Bois," at a meeting in Paris in July last, discussed the advisability of combating by propaganda the increasing use of substitutes for wood. But, it may be asked, could the world's available forests possibly meet the demand for timber, were the use of substitutes checked? From almost every part of the world comes the cry of the depletion of forests, with which afforestation, at its present intensity, cannot possibly keep pace. The very next excerpt in the notes, an article on "wood fuel *versus* cowdung," remarks that "whatever forest growth was easily accessible in the plains in the past has mostly disappeared and is becoming scanty in the vicinity of populated areas in the hills." While this remains the case, in India, timber substitutes must be found or timber will have to be imported.

"Roads in hilly country," an extract from *Indian Engineering*, deserves study, while an article on "Land Reclamation on the Lower Jhelum Canal," from the same paper, tells how the problem caused by the increasing alkalization of irrigated land has been successfully solved.

December.—An article on the Jubbal State forests in the Panjab Himalayas is of interest, especially to those of us who have served in Simla—there is a close-up view of the "Chur," that outstanding height 20 miles S.E. of the summer capital. Another article on aerial reconnaissance deserves mention as showing what aviation can do with regard to the exploitation of forests. A previous ground reconnaissance had lasted for some weeks, had cost some thousands of rupees, and had involved some deaths owing to the unhealthy nature of the country. Aerial reconnaissance with the aid of 1" maps, proved capable of locating all important clumps of timber that seemed worth a visit on foot, and the observers from a height of about 1,000 feet were able to identify the main species, *e.g.*, teak, *sin* and bamboo. The flights lasted for two days, and cost Rs. 600 only.

But pride of place in this number must be given to a photo, with description, of a timber bridge built by the students of the Balaghat forest school. The bridge consists of a central span of 33', and two side spans each of half that length, and is presumably designed for medium loads. Practically the whole of the work, as well as 11 furlongs of road alignment and construction, were carried out by students, numbering, according to the photo, about 48.

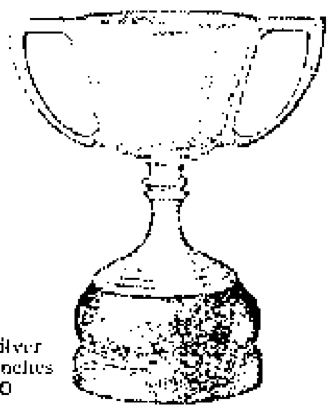
F.C.M.



TROPHIES

Sterling Silver
Height 13 inches
£10.10.0

Sterling Silver
Diameter 8 inches
£7.0.0



Sterling Silver
Height 7½ inches
£5.5.0

From The Goldsmiths & Silversmiths Company are distinguished by excellence of design, craftsmanship, and value. An opportunity to show you the latest Prize Cups, Bowls, etc., would be appreciated, or an illustrated Catalogue will be sent on request.

THE GOLDSMITHS & SILVERSMITHS COMPANY LTD.

Jewellers & Silversmiths to H.M. The King

112 REGENT STREET, LONDON, W.1

(Corner of Glasshouse Street—No other address)