THE ROYAL ENGINEERS JOURNAL.—SEPTEMBER, 1934. Pages 361—504.

The Royal Engineers Journal.

VOL. XLVIII. SEPTEMBER, 1934.

CHATHAM:
THE INSTITUTION OF ROYAL ENGINEERS,
TELEPHONE: CHATHAM, 2669.
AGENTS AND PRINTERS: MACKAYS LTD.

LONDON:
HUGH REES, LTD., 5, REGENT STREET, S.W.1.

All Correspondence connected with Advertisements should be addressed to
C. ROWLEY, LTD., ADVERTISEMENT CONTROLLERS, R.E. JOURNAL,
5 & 6, AVENUE CHAMBERS, SOUTHAMPTON ROW, W.C.1.
TELEPHONE: HOLBORN 2807.

A

Crown 8vo, cloth gilt, 500 pages.

ELEVENTH EDITION.

FIFTY-FIFTH THOUSAND.

THE

TRUTH OF CHRISTIANITY

BY

LT.-COL. W. H. TURTON, D.S.O. (late R.E.).

EXTRACT FROM PREFACE

I have again carefully revised the whole book, and have made several slight improvements, the most important being in Chapters iii, v., xxi., xxiv. The additional arguments noticed are shown in *italics* in the Index of Subjects.

2/- net.

OF ALL BOOKSELLERS.

In Dominions Overseas, 2/6. In United States, $1.00.

The book has been translated into Japanese, Italian, Chinese and Arabic. Leaflets, with press notices like this, A.—*Church of England* (chiefly), B.—*Roman Catholic*, C.—*Protestant* will be sent gratis to anyone who cares to see them, or to give them to friends, on writing to Lt.-Col. Turton, 19 Caledonia Place, Clifton, Bristol.

LONDON

WELLS GARDNER, DARTON & CO., LIMITED,

3 PATERNOSTER BUILDINGS.

By the *same Author* "THE PLANTAGENET ANCESTRY." A large work with over 7,000 of the ancestors of Elizabeth Plantagenet, d. of Edward IV. Intended chiefly for Libraries.

Messrs. PHILLIMORE & Co. Two Guineas, net.

"THE SHELLS OF PORT ALFRED, S. AFRICA," giving the descriptions of many new species, with over 900 enlarged photographs.

OXFORD UNIVERSITY PRESS. 18s. net.

OPINIONS OF THE PRESS

"In such times as this, a work at such a cost is as marvellous as the book is admirable. Parents of lads entering their teens—the doubting stage—should make a point of placing a copy in their hands."—*Daily Mail*, 26th January, 1920.

"Really excellent little work."—*Daily News*, 26th Sept., 1902.

"We welcome a new edition. . . . The appeal of the book is evidently one to common sense, and the success it has met is fully deserved. There is a healthy lay atmosphere about Col. Turton's arguments which renders them we fancy peculiarly effective."—*Pall Mall Gazette*, 11th March, 1907.

"It is difficult to know whether to admire most the logical precision with which he marshals his facts and enforces his conclusions, or the charming candour, and freshness of style, which make his book so readable."—*Liverpool Daily Post*, 14th March, 1907.

"This is a new edition, thoroughly revised, of Lt.-Col. Turton's famous book. . . . We are specially struck with the detached manner in which he examines the case, he holds the scales evenly and is not rhetorical. Any one who has any power of reasoning at all can follow him clearly from start to finish."—*Bristol Times and Mirror*, 18th Feb., 1907.

"It is a book for the hour, and needs to be circulated by thousands . . . straightforward, manly, and convincing."—*Schoolmaster*, 27th March, 1909.

"This well-reasoned work appeals to common sense, it is candid and convincing."—*Labour News*, 16th Jan., 1925.

Church of England

"Nothing need be added to our previous commendations of a work which has proved singularly serviceable, except to remark with approbation that its price has been lowered."—*Church Times*, 12th Dec., 1919.

"If you want a simple book of Christian Apologetics, get Turton's 'The Truth of Christianity.'"—*Church Times*, 7th April, 1933.

"We have repeatedly expressed our sense of the merit of Col. Turton's book."—*Guardian*, 9th Dec., 1908.

. . . "It deserves to be pointed out in more than a word, that every new edition is really such in a special degree. Col. Turton seems to devote the greater part of his leisure to the perfecting of his work, and never to be satisfied. Thus a thought is developed here, an argument strengthened there, and fresh illustrations are added as one edition succeeds another."—*English Churchman*, 12th Dec., 1912.

"The present edition has again been carefully revised throughout, and full use has been made of the most recent developments of scientific knowledge. The valuable character of Lt.-Col.

Turton's work is now so well known that it requires little recommendation."—*Record*, 9th Oct., 1931.

"There is no padding and no unnecessary rhetoric. All the available space is filled with good solid reasoning, put in simple language which an intelligent artisan can follow as easily as an educated person."—*Church Family Newspaper*, 3rd Oct., 1902.

"Few works of Christian apologetic have proved so useful. . . . All the argument is lucid, and no questionable assumptions are introduced."—*Commonwealth*, May, 1926.

"This is a text-book on Christian Evidence we would readily place in the hands of the lay-worker as an essential part of his equipment."—*Lay Reader*, Dec., 1912.

"We have often privately recommended this work to seekers after truth who have written to us in perplexity."—*Church Monthly*, Jan., 1932.

"It has done work of an inestimable value in defence of the Christian Faith in the face of every kind of criticism and antagonism."—*Church Union Gazette*, Nov., 1931.

"It is one of the best books of its class, readable, candid, convincing and thorough. It would be cheering news to hear that it had been widely read."—*Church Intelligencer*, Oct., 1905.

"This is the kind of book which strengthens believers and makes converts. It is one which should be placed within the reach of every lad at that period of his life when he begins to think for himself."—*The* (Church Lads) *Brigade*, Oct., 1905.

"We have never met with any book which can be more confidently recommended."—*Church Army Review*, Dec., 1925.

"It offers an admirable, thorough and terse examination of the more important arguments for and against believing in our Holy Religion. It should be in the hands of every teacher and preacher."—*Irish Churchman*, 22nd Aug., 1931.

"This book is an old friend of mine. . . . I have constantly found it most serviceable. . . . I know of no better book of its kind; it is reasonable, candid, and convincing, and admirably lacking in controversial bitterness."—*Fiery Cross*, Dec., 1931.

"There is no book of this class known to *The Canadian Teacher* so complete and conclusive. Every teacher should have a copy."—*Canadian Teacher*, Toronto, Dec., 1920.

"Its excellent index makes it extraordinarily easy to lay ones finger upon any specific point; we tested it, for instance, on this point, the contrast between the Incarnation and Hindu incarnations. In a moment we have been able to find the gist of the whole matter accurately stated in a few words."—*Calcutta Diocesan Record*, Jan., 1913.

Roman Catholic

"The gallant Colonel is a non-Catholic, but the subject matter of his book is so admirable that hardly a Catholic periodi-

cal in the country has failed to Commend it, and that with high and unqualified praise."—*The Tablet*, Oct., 1925.

"We most heartily wish that a copy of it could be found in the library of every Catholic family, school, and institution."—*Catholic Times*, Jan., 1909. (Sixth notice).

Presbyterian

"One does not know what to admire most in the book—the accurate knowledge gathered from so many fields, the clear reasoning, the sound judgment, or the fine spirit which animates the whole."—*Christian Leader*, 15th June, 1905.

Nonconformist

"He is eminently fair to opponents, clear in statement, and convincing in argument for his own case, and his standpoint is unmistakably evangelical. His style suits his work, being calm, lucid and simple."—*Methodist Times*, 22nd Aug., 1901.

"On the whole it is the best popular summary that we have met. It excels in definiteness of purpose, in clearness of statement, in moderation and in conciseness."—*Baptist Times*, 24th Oct., 1902.

"To the evangelical reader the book will be a delight; more modernist readers will turn to the book, we believe, time after time, in treating almost any religious subject, to find clear and reasoned statements of views, which, although not theirs, must be taken into account."—*Liverpool Congregational Monthly*, Dec., 1925.

"It is the fairest and most lucid treatment of the arguments for and against 'orthodoxy' that we know of."—*Christian Life and Unitarian Herald*, 8th Dec., 1906.

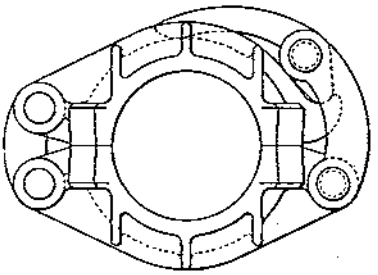
Agnostic

"The present edition makes fifty-five thousand copies—a fact that is almost as welcome to the Rationalist as doubtless it is to the polemical Colonel. It is all to the good that the Christian should examine the foundations of his religion. . . . And the Rationalist, he too, likes to have at his finger tips in the arguments for Theism, Free will, Miracles, Immortality, Biblical inspiration and the other components of the Christian scheme of things. They are all to be found in the 'Truth of Christianity.'—*Literary Guide and Rationalistic Review*, Nov., 1931.

"This remarkable volume contains over 500 pages with scarcely a dull one among them. The author's easy flow of unlaboured thought, his facility of expression, and his fine gift of exposition, carry the reader on in spite of himself. . . Differ as we may from much that is in the gallant Colonel's volume, we gladly pay him the respect due to frankness, cleverness and transparency of mind and motive, and thank him for putting his own side of a great subject so simply and interestingly, and without prejudice or bitterness."—*New Age*, 3rd Aug., 1905.

H. R. LITTLE, PRINTER, CLIFTON, BRISTOL 8

VICTAULIC



FOR many years the Victaulic Joint has been known as a self-sealing, quickly made and flexible joint. It has been adopted extensively and used for pipe lines in all parts of the world, in sizes from 1" to 60" diameter and for all pressures.

In order to reduce still further the already short fixing time, a new design of housing has been introduced for use with pipes 1" to 6" diameter. By the complete elimination of bolts and nuts the new type housing can be snapped into place immediately.

This new Victaulic Joint is therefore automatically self-sealing and automatically fastened mechanically in a few seconds. It positively couples the pipes together.

It should be understood, of course, that the standard Victaulic Joint is still being manufactured in large quantities and is being supplied for permanent mains. It is thought, however, that the increased speed of laying which is obtained with the new Toggle Joint will be found to be of the utmost value in field work, emergency pipe line laying and fire services, where it is desirable to carry out the work as quickly as possible.

VICTAULIC COMPANY Ltd.

KINGS BUILDINGS, DEAN STANLEY ST.
WESTMINSTER, LONDON, S.W.1

Work of the Royal Engineers in the European War, 1914-1919.

For sale in the office of the Secretary, Institution of Royal Engineers, Chatham.

COMPRISING THE FOLLOWING VOLUMES :—

Bridging.—With 3 maps, 59 photographs and 31 plates. Price 12s. (to members, 3s.).

Military Mining.—With 25 photographs and 62 plates. Price 12s. 6d. (to members, 3s. 9d.).

Geological Work on the Western Front.—With 19 plates and 9 photographs. Limited to 500 copies. Price 15s. (to members, 5s.).

Signal Service in the European War, 1914 to 1918, The.—(By special arrangement with the Signals Association) R. E. Priestley, M.C., B.A. (late Major, R.E.). With 2 photos and 20 plates. Price 12s. 6d. (to members, 5s. 3d.).

Supply of Engineer Stores and Equipment.—Price 7s. (to members, 1s. 9d.).

Water Supply (Egypt and Palestine).—With 7 maps, 6 photos, 10 plates, and 20 sketches in the text. Price 8s. (to members, 2s. 6d.).

Water Supply (France).—With 10 maps, 37 photographs and 41 plates. Price 16s. (to members, 5s.). "A simply invaluable compendium of the work done in this vital respect on the Western Front."—*Spectator.*

Work under the Director of Works (France).—With 6 maps and 71 plates. Price 21s. (to members, 7s. 3d.).

"Miscellaneous," comprising :—(1) The Organization of the Corps, 1914-1918. (2) Engineer Intelligence. (3) Camouflage. (4) Concrete Defences and Factories. (5) Forward Communications. (6) Machinery, Workshops and Electricity. (7) Inundations. (8) Anti-Aircraft Searchlights. (9) Schools. With 105 Plates and Photographs. Price 20s. (to members, 6s. 6d., plus 9d. postage). "A mine of interest and value."—*The Daily Telegraph.*

Descriptive Accounts of Foreign Stations.—The following pamphlets have been revised and reprinted and are available, price to members, 1s. each :—

Bermuda (1923); *Ceylon* (1923); *Egypt* (1923); *Gibraltar* (1922) (see also *Supplement to R.E. Journal*, November, 1927); *Malta* (1928); *Mauritius* (1922) (see also *R.E. Journal*, March, 1931); *Sierra Leone* (1922); *Singapore* (1930).

Jamaica (1928) (Typescript only), 6d.

Notes on the China Command (*Hong Kong, Peking, Shanghai, Tientsin, Wei-hai-Wai*) (1929-30), 1s. 6d.

Notes for Officers Proceeding to India (1930), (3s. 6d. each; to members 2s. 4d.).

Studies of German Defences near Lille.—By Major B. T. Wilson, D.S.O. (with 35 maps and plans and 24 photos). Price 5s. (post free).

An Outline of the Egyptian and Palestine Campaigns, 1914 to 1918.—By Major-General Sir M. G. E. Bowman-Manifold, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*, late R.E. Seventh Edition, 1929. With 17 maps and sketches. Price 4s. 6d. (post free).

History of the Corps of Royal Engineers.—Vols. I and II, by Major-General Whitworth Porter, R.E. Vol. III, by Colonel Sir Charles M. Watson, K.C.M.G., C.B., M.A., late R.E. Three Vols. £1 10s. (to members, 12s. 6d.) (post free).

History of Submarine Mining in the British Army.—By Brig.-General W. Baker Brown, C.B. Price 5s. (to members, 3s. 4d.) (post free).

A History of R.E. Cricket.—By Captain R. S. Rait Kerr, D.S.O., M.C., R.E. (with 8 plates). Price 5s. 4d. post free.

History of the 7th (Field) Company, Royal Engineers.—By Capt. H. A. Baker, M.C., R.E. Price 1s. 6d. (post free).

History of the 12th Company, Royal Engineers.—By Lieut. M. R. Caldwell, R.E. (Illustrated.) Price 7s. 8d. (to R.E.s 3s. 2d.) post free.

"65 R.E." History of the 65th Company, Royal Engineers.—Price 5s. (post free 5s. 4d.).

History of the 20th (Field) Company, Royal Bombay Sappers and Miners.—By Major H. W. R. Hamilton, D.S.O., M.C., R.E. Price 2s., post free.

The Early Years of the Ordnance Survey.—By Colonel Sir Charles Close, K.B.E., C.B., C.M.G., SC.D., F.R.S. (illustrated). Price 6s. (to members 4s. 6d.) post free.

General Sir Charles Pasley, K.C.B., F.R.S., D.C.L., Colonel Commandant, R.E., 1780-1861.—Price 1s. 6d., post free.

To F. P. BAKER & Co. Ltd.

"In ending, I must thank you for the trouble and worry you have saved me with regard to my outfit, and for the very efficient manner in which you packed my kit."

An unique "Service"

FOR anyone proceeding abroad to a new station we have a file of unbiased reports *from* Officers stationed at practically every place abroad, where H.M. Services are called upon to serve.

These reports are not the usual handbook or tourist information, but deal with everything appertaining to each station, (*sic*) quarters—bachelor or married—servants, ayahs and wages, what kit to take and what to leave behind, whether furniture can be hired locally, nearest Hill stations and costs, what games, shooting, fishing, hunting, polo, pig-sticking or racing, social amenities of station, clubs, gymkhanas, and subscriptions and a lot of other "helpful" information.

The single officer therefore learns what kit he'll need and what he can avoid getting. The married know what to take out and what they can get locally—all of these reports are the actual unbiased reports of Officers serving in the stations.

We have all heard of people who take out electric fittings and find only oil lamps, and vice versa; in dozens of ways we can help very greatly—if you will bear this service of ours in mind or get it better known we shall be most grateful.

This "Information File" of ours is the result of over 67 years' experience and many years' organization on our customers' behalf.

F. P. Baker & Co. Ltd.

ESTABLISHED 1765 BOND COURT — EAST INDIA MERCHANTS 1765

2, UPPER JAMES ST. (Close to Piccadilly Circus) GOLDEN SQUARE, W.1.

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.

Brig.-Gen. Sir James E. Edmonds, *Kt.*, C.B., C.M.G. 1931

Vice-Presidents.

Maj.-Gen. Sir Hugh Bruce-Williams, K.C.B., D.S.O., *p.s.c.*, *Col.-Comdt. R.E.* 1934
Maj.-Gen. W. G. S. Dobbie, C.B., C.M.G., D.S.O., *p.s.c.* (*Comdt. S.M.E. & Inspr. R.E.*) ...1934

Elected.

Maj.-Gen. A. Brough, C.B., C.M.G., C.B.E., D.S.O. 1932
Col. P. J. Mackesy, D.S.O., M.C., *p.s.c.* 1932
Brigdr. F. S. G. Piggott, D.S.O., *p.s.c.* 1932
Maj.-Gen. G. C. Williams, C.M.G., D.S.O., *p.s.c.* 1932
Col. R. A. Boger 1932
Lt.-Col. P. K. Boulnois, O.B.E., M.C. 1933
Bt. Lt.-Col. H. G. Eady, M.C., *p.s.c.* 1933
Maj.-Gen. R. N. Harvey, C.B., C.M.G., D.S.O. ... 1933
Major G. Cheetham, D.S.O., M.C. 1933
Capt. E. H. T. Gayer 1933
Col. C. A. Bird, D.S.O., *p.s.c.* 1934
Brigdr. L. V. Bond, *p.s.c.* 1934
Col. W. Garforth, D.S.O., M.C. 1934
Brig. H. N. North, D.S.O. 1934
Bt. Lt.-Col. B. K. Young, M.C. 1934

Ex-Officio.

Maj.-Gen. R. L. B. Thompson, C.B., C.M.G., D.S.O., (*D.W.*).
Col. A. W. Stokes, D.S.O., M.C. (*A.A.G., R.E.*).
Col. H. W. Tomlinson (*A.D.W.*).
Col. W. G. Tyrrell, D.S.O. (*A.D. Tn.*).
Col. G. F. B. Goldney, C.M.G., D.S.O. (*R.E. Board*).
Col. M. N. MacLeod, D.S.O., M.C. (*G.S.*).
Major W. D. M. Christie (*C.I.C.*).
Major C. P. Worsfold, M.C., *p.s.c.* (*Staff Captain S.M.E.*).

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. Sir Tannatt W. Edgeworth David, K.B.E., C.M.G., D.S.O., F.R.S. 12 1 26
Lieut.-Col. T. R. Williams, C.M.G., D.S.O. (Australian Staff Corps) 28 1 30
Major C. A. S. Stein (R.C.E.) 24 10 33

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

2,150—1-9-34.

All contributions for The R.E. Journal from officers on full pay, except Memoirs and Notices of Magazines, should be forwarded to the Editor in duplicate, as laid down in K.R. 522c, and Amendment No. 41 thereto, for illustrations, 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.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c quoted above.

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

MILITARY BRIDGING EQUIPMENT.

A Lecture delivered at the Institution of Civil Engineers in March, 1934, *by* LIEUT.-COLONEL AND BREVET COLONEL A. P. SAYER, D.S.O., R.E.

[*Note.*—Owing to restrictions of space only a few of the slides are reproduced and parts of the lecture have been summarized.]

INTRODUCTION.

FOR effective action in the field an army must have not only the power of movement but also a reasonable freedom to use that power. It must therefore be capable of overcoming the restrictions imposed by natural and other obstacles.

In a well-developed country the existing facilities might perhaps suffice if the forbearance or inefficiency of the enemy could be counted upon; in undeveloped country even that remote possibility is lacking. Our army has to be prepared to operate in any part of the world, developed or undeveloped, and must contain in itself the ability and the means to provide its own crossings when obstacles are encountered. It is those obstacles that require bridging that are considered here.

As the subject of military bridging as a whole is too wide to be dealt with adequately in the time available, only that part which differs most materially from normal civil practice will be considered. All reference to railway bridging, the repair of damaged bridges and the construction of temporary road bridges from ordinary material, will be omitted. Though they probably comprise at least half the bridging operations carried out during a campaign, they are not peculiar to the military engineer.

That leaves the specialized form of military bridging that employs equipment, that is to say material specially designed and provided

beforehand in a form that can accompany the troops in the field so that it can be formed into bridge rapidly, directly it is required. This supplies the means, while instruction and training in its use supplies the ability, for the army to provide its own crossings.

The first part will deal with those factors that particularly distinguish this class of bridging from normal practice and the chief considerations affecting its design. The second part will describe the different forms of equipment now provided for our army and finally a few points of detail and special forms of construction that may be of interest will be mentioned.

PART I.

FACTORS IN DESIGN.

Military bridges are essentially temporary structures; some may remain in position "for the duration," others for a few weeks or days, while some will only be required for an hour or two. In the case of bridges built from equipment, particularly mobile equipment, the material may have to be erected, dismantled and re-erected a number of times. Such bridges may be temporary but their components must be of a reasonably permanent nature or at least must be robust and resistant to constant handling and use.

To be available when required the material must be transportable. For mobile equipment, the bridges must be divisible into components that will suit the class of transport that can accompany the formation to be served; non-mobile equipment must conform to the limiting loads, both in weight and size, of standard military transport vehicles.

The choice of materials is affected by the probability of supplies being available at some future date. It is not possible to provide and maintain in peacetime all the equipment likely to be required when expansion of the army takes place in war and casualties in material must be replaced. When the emergency arises other and probably more important services will be competing for special or limited supplies and the most important must have precedence.

All these and other factors affect the design of bridging equipment, but there is one factor which distinguishes military bridging more than any other and that is the Time Factor. In its widest aspect it covers production, training, transport, construction and life. More particularly it makes ease of handling and speed of construction essential features. It demands adaptability so that a variety of sites and spans can be dealt with and it requires the designer to eliminate the need for all calculations at site, to avoid complicated joints or intricate fastenings and to reduce to a minimum the number of different parts.

Considerations.

Those general remarks must suffice for the primary factors affecting the design and the next point is the considerations that determine the load capacity, the types and the forms of bridge required.

Load capacity. Taking load capacity first, obviously it is army loads that we have to deal with and for equipment purposes only those army loads that will normally be included in or will serve the army in the field. Obviously also any increase in the loads with the

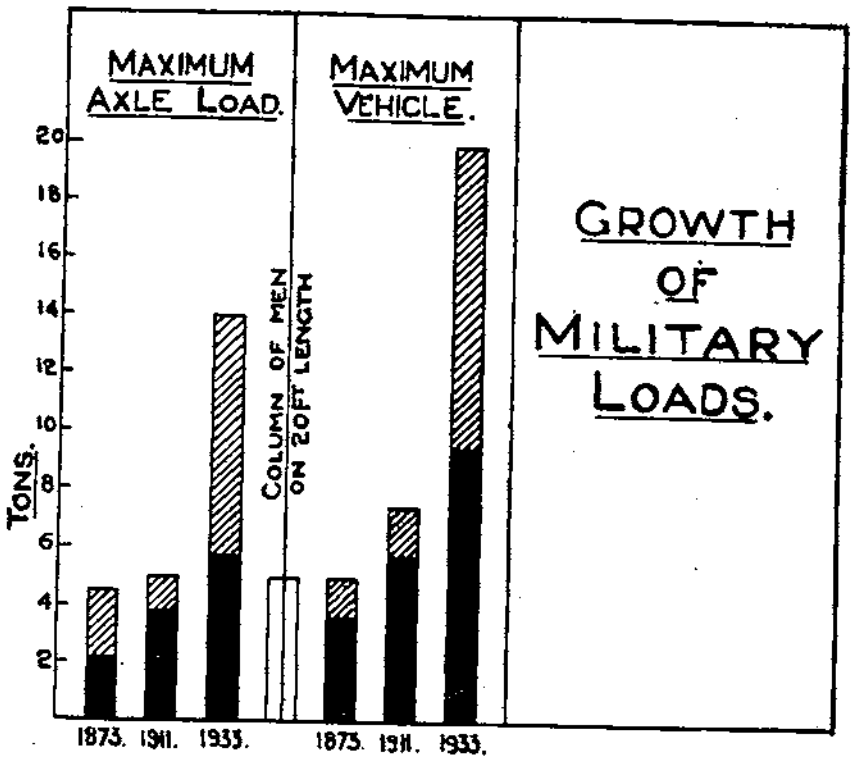


PLATE 1.

army must be reflected in the capacity of the bridging equipment. It will be appropriate then, if we wish to see why our bridging equipment has developed recently, to examine the growth of military loads in recent years. For this purpose Plate I has been prepared to illustrate roughly the changes that have taken place in the past 50 odd years. This diagram shows both maximum single axle loads and maximum vehicle loads and in the centre is indicated the effect of a column of infantry for comparison.

The figures for 1873, 1911 and 1933 have been taken. The maxima for 1873 continued in force almost up to 1900 and represent

the purely horse transport era. The figures for 1911 show mechanical transport just beginning to make its presence felt but chiefly in the rear areas. In the present-day figures, mechanical transport is, of course, predominant in its effect throughout the army.

In this diagram the blocked-in portions of the columns refer to the primary fighting formations of the mobile field army, while the hatched parts cover all those special weapons required on occasions only and the heavier vehicles that are included in the rear services of the army in the field. For example the 1873 maxima of the field army was produced by the Bakery Wagon while the 64-pdr. gun M.L.R. produced the heaviest loads with the army in the field, being more in the nature of a siege piece than a normal field weapon. In 1911 similarly the figures are due to the 60-pdr. gun and a 7½-ton tractor respectively. In the present-day figures no account is taken of weapons like the heavy tank and the super-heavy guns that were employed during the last war; such abnormal loads cannot influence the provision of equipment for normal conditions and have therefore been omitted from this comparison. That diagram presents an indisputable case for the development of our bridging equipment; the increase in loads is somewhat remarkable but apart from that point there are two important inferences to be drawn from these figures.

In the first place it shows the need for carrying more bridging equipment with the field army. When loads were in the neighbourhood of those of 1873 it was quite possible to supplement equipment by rapid construction with materials found locally. For loads of that nature timber structures are simple and lashed or nailed joints adequate. For present-day loads, however, "stick and string" methods are out of the question, rough joints are impossible and timber structures most complicated. Complication can be overcome by the substitution of steel for timber, but that does not lend itself to rapid field joints nor is one likely to find, near the selected site, plantations of R.S.J's or thickets of bars, flats and angles.

Even without bringing in the argument of the time factor and the greater effect of delay on the rapid-moving modern weapons, the case for more bridging equipment with the field army of the present day can be justified.

The second point is the increase in the range of loads now to be dealt with. While the maximum has gone up the minimum still has to be considered. The man, the horse and horse transport must be provided for as well as the tank, the heavy gun and the motor-lorry. With a limited range of loads as in 1873 it is quite possible to produce one set of material that can be used with reasonable speed and economy to form a bridge for the light loads, or, alternatively, assembled in a different way, can deal with the heavier loads without undue complication. With present-day loads the range is too great

and more than one form of equipment is essential; the number of forms will depend on tactical considerations, both as regards how the bridges are to be used and what loads will have to use them.

This brings us to the question of the subdivision of army loads into groups or classes. Fortunately for the designer of bridges, tactical requirements in performance place definite limits on the weight of weapons and vehicles included in the different formations that constitute an army in the field. Tactical considerations also require that certain normal formations should be capable of movement as a whole; such formations will need bridges to serve them. In our army the division is the primary fighting formation and therefore a bridge is required that can deal with all the loads included in a division. This class of loads is the keystone of the classification and is known as the medium class.

In rear of the division, heavier weapons and vehicles are included in corps and army formations and on the lines of communication. They form a Heavy class and this class can cover all loads with the army in the field and its rear services. Should special weapons or vehicles beyond the limits of this class be developed for special purposes or for a particular campaign, a Super-Heavy load class would have to be considered, but for normal conditions no provision need be made for it in the bridging equipment.

At the other side of the division, brigades or groups of a similar mobility prepare the way for its advance. Such formations will often operate independently or may have to force a crossing to clear the way for the division and for them a class of Light loads can be defined.

The individual mounted man or the pack animal must also be capable of independent action and for them a Pack class can be specified for bridging purposes, and in the same way a Foot or Assault bridge will be required on occasion to deal with men in single file.

We have then, determined primarily by tactical considerations, five distinct load classes each of which may require a suitable bridge but not necessarily a separate form of equipment.

Plate II compares these load classes in a somewhat arbitrary manner. It is based on the effect produced by continuous columns of the heaviest vehicles or loads in each class. It shows the comparison on spans of 150 feet (hatched) and over and also on spans of 30 feet (blocked in); for shorter spans, of course, the individual load rather than the column becomes the ruling factor.

As a matter of interest these load classes may be illustrated by the form of transport included. In the Foot class the man carries his own immediate requirements; in the Pack class, as its name implies, transport is effected by pack animals. For the Light class, horsed vehicles and the 30-cwt. lorry, for the Medium the 3-ton

lorry form the transport basis, while multi-wheeled lorries of six to eight tons capacity may be expected in the Heavy class.

Before leaving this question of load classification it may be of interest to compare our loads with a civil standard and for this purpose, Plate III compares our Heavy and Medium classes with the B.S.I. bridge load unit. You will see that the Heavy class corresponds to a multiple of from 11 to 12, and the Medium of from 6 to 7½ of the standard train as against 15 laid down by the Ministry of

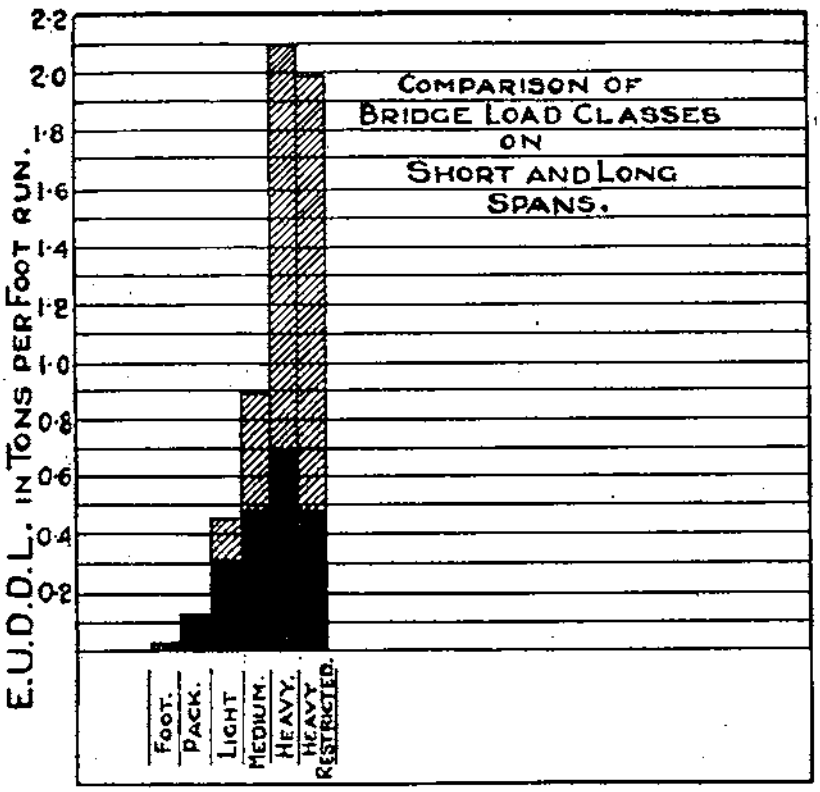


PLATE II.

Transport for the minimum highway bridge in this country. Here again the short spans have been omitted as the standard train is hardly applicable and the symmetry of the curves would be lost by carrying them further. Incidentally the dotted curve brings the present colonial standard loading into the comparison.

Types of bridge required. That must do for the question of loads and the next consideration is that of the type of bridge needed. As already stated our bridges cannot be designed for any particular span or site; they must be adaptable to suit a variety of sites and conditions.

With the water gap as the most common obstacle in the form of rivers and streams, a bridge with floating supports obviously offers the maximum of adaptability without affecting its load capacity. It can be designed with a fixed length of bay and adapted in length by multiplication of the number of bays; alternatively if the quantity available is insufficient, ferry rafts can be substituted for a bridge. The floating bridge is therefore adopted as the basic form of our equipment. This type, however, is not suitable for all conditions

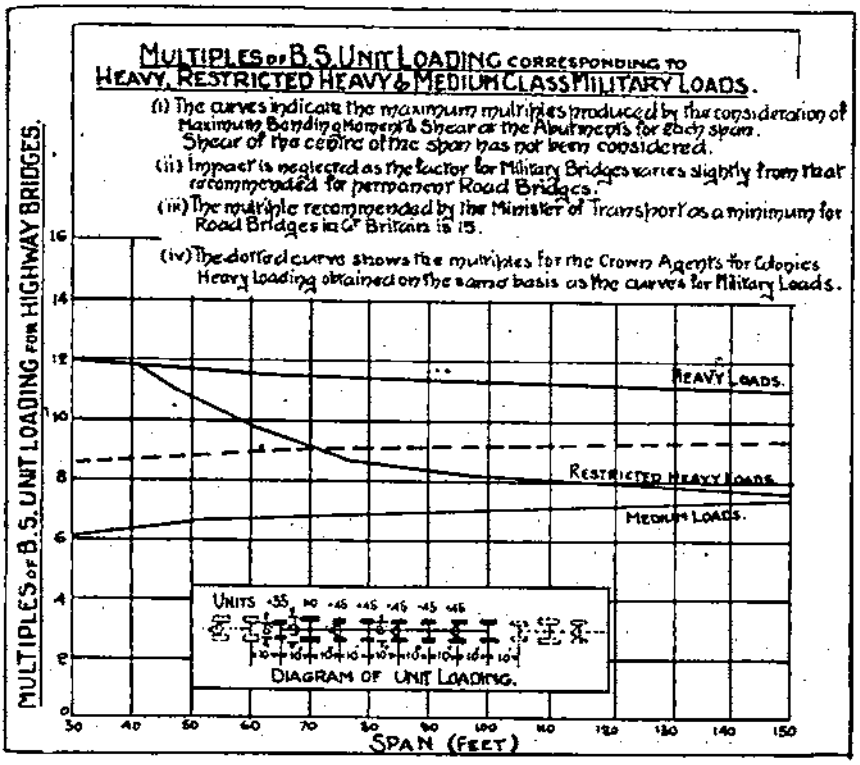


PLATE III.

as it requires reasonable access at no great height above water-level. It is useless for dry gaps, seldom applicable to high-banked canals, deep *nullahs* or mountain streams and often unsuited to filling gaps in damaged bridges. Even with fixed supports in the form of portable trestles to replace the floating piers it cannot compete with all such cases and for semi-permanent works on the lines of communication it involves excessive maintenance. For such cases some form of single-span bridge is needed and our floating bridge equipment must be supplemented by portable girder bridges.

Girder bridge equipment must be adaptable in span in the same way as other equipment. At first sight it may appear that, for the same load capacity, little variation in length of a girder is compatible with economy of design. It must be remembered, however, that for our purposes the term economy must be applied to the whole of the material carried, rather than to an individual girder that forms part of it. One pattern of girder that can be used for any span from 50 to 150 feet may well prove more economical than three or four patterns designed for particular spans within that range. Further, when men's lives are at stake and the supply of the forward troops is dependent on rapid bridging, the term economy has a wider meaning than cost or weight of material. Apart from that side of the question, there are two distinct methods by which some degree of adaptability of girder bridges can be achieved. Firstly by varying the number of girders used and secondly by varying the strength of individual members of the girders. The former can best be employed with "Over" bridges, where the decking is carried on top of the girders. This method is the more suitable for the forward bridges where the time factor rules out complications of construction at site.

The second method can be applied in the case of the less temporary structures in the rear areas where the girders can be built up from their components at site. For such cases, careful design, supported by tabular details of construction for the various forms and loads, can restrict the complications to within reasonable limits, but the need for care in the design must be emphasized.

Our bridging equipment then must include adaptable girder spans as well as floating bridge material.

Enemy Action. The third consideration is the effect of enemy interference. The degree of enemy action likely to be met determines to a great extent the forms of bridging equipment required with the army in the field. This consideration practically never affects civil bridging projects but with us must be taken into account both in the design and in the use of our bridges.

With no enemy interference anticipated, the simplest procedure is, of course, to construct bridges capable of taking all the loads in the force, using the mobile equipment for the purpose while the slower construction of the more permanent bridges is in progress. If, on the other hand, there is an active enemy on the far side of the obstacle disputing your advance, then a fighting crossing will have to be made. The handling of heavy parts, their assembly into bridge and the fixing of accurate joints is not a pleasant occupation under direct fire, in fact it is an impossibility.

For the fighting crossing, as in all other tactical operations, the lighter formations must prepare or clear the way for the heavier. It is a case of proceeding by stages; first the actual assault across

the obstacle, then the supporting and strengthening of the assaulting troops with sufficient man and weapon power to enable them to push back the enemy and so reduce his opportunities of interference. With reduced interference, heavier bridges can be formed and heavier formations passed across until the stage is reached where the whole fighting formation is established on the far side. At this stage, the crossing changes from a fighting one to a passage under conditions of indirect or air-observed shell-fire normal to forward area work. For its advance, the force will require its mobile equipment and therefore it must be replaced by rapidly constructed temporary bridges until such time as more permanent construction for the supply routes can be undertaken.

Three general forms of bridging equipment can therefore be visualized. First, mobile fighting equipment with the fighting formations. Secondly, rapidly erectable temporary bridge equipment that can be sent up from the rear when needed, which can count on some prior preparations at site and rely on some mechanical aids. Thirdly, material to form semi-permanent bridges which can be erected with full mechanical aids in conditions more nearly approaching a peace operation.

In the same way as these general classes can be more or less defined so can the different forms comprising the mobile fighting equipment. They are all subject to enemy fire; from the form used in the assault which may encounter direct and concentrated rifle and machine-gun fire as well as artillery fire, through heavier forms exposed to directly observed artillery and distant machine-gun fire, to the heaviest which must always expect shell-fire. Apart from ease of handling and speed of assembly the design must provide for the structure of the equipment being resistant to the effect of this fire or of being capable of continuing in use under it for a sufficient time. It must also take into consideration ease of repair in the field.

That must suffice for the general considerations and in Part II we will consider the actual provision now made and how it satisfies these conditions.

Part II.

PRESENT-DAY EQUIPMENT.

Some ten or so years ago, the aftermath of the war had left our army in a very unsatisfactory position as regards bridging equipment. For mobile work it had only the pre-war pontoon equipment, excellent in its way, but completely outgrown by the army loads. In addition there was a quantity of heavy bridging material produced during the war chiefly of the semi-permanent type. Much of this

was not entirely suited to the post-war conditions, though it could serve for the time being should the need arise. There was, however, a new type of temporary girder-bridge equipment in prospect which promised, and subsequently proved, to be very satisfactory.

With this state of affairs the obvious urgent need was to produce new mobile equipment suited to the new load conditions. This work has been one of the activities during recent years of the R.E. Board and its experimental establishments. With the introduction into the service last December of the last of the four types that complete the range of mobile equipment, the most urgent need has been met. While we do not imagine that we have arrived at finality in this respect, we have felt it possible to turn our attention to the improvement of the temporary bridge material and re-design the semi-permanent.

Let us now consider the four types of mobile fighting equipment our army now possesses and the temporary girder equipment in its present form. The re-design of the latter has not reached a sufficiently advanced stage to permit more than a reference to the directions in which improvement is contemplated, and no details of the new forms of the semi-permanent bridge equipment can yet be given as various patterns are still under consideration.

Kapok Equipment. Taking the floating bridge equipments first, the lightest and simplest form is the Kapok Assault-Bridge Equipment that provides a floating foot-bridge for infantry in single file. As its name implies, it is a fighting bridge, for use in the immediate presence of the enemy and therefore everything is sacrificed to ease and speed of handling and launching.

Simplicity is the keynote of this design; there are only two essential parts, the float and the deck section, though some light guys and perhaps life lines make its launching and use easier. Each part is no more than a single man load, they join together automatically and the complete bridge can be carried easily and launched across the stream without previous access to the far bank. The bays are six feet and the length can therefore be varied by multiples of that amount. No special transport is needed.

The float is a canvas bolster stuffed with Kapok and therefore retains its buoyancy for a long time, even after absorbing concentrated rifle or machine-gun fire. A wooden saddle with a fixed central bar is strapped to the bolster and on to this bar the deck pieces clip automatically; they are released when required by lifting the catch. (Slides 4, 5 and 6 illustrate this equipment, but only No. 6 is reproduced as Photo No. 1.)

Folding-Boat Equipment. The Folding Boats provide the next form of equipment; this has several uses, each with a different function.

The first method of use provides single-boat ferries which may be

of value for an assault crossing. It has the advantage of giving a crossing on a wide front and the landing-points on the far bank can be varied at will; it produces small groups of men on the far side as against the trickle produced by the Kapok.

Its next use is in the form of free ferries of double boat rafts, capable of carrying those particular vehicles and weapons required in the early stages of the assault. The term free ferry is not intended to suggest that we contemplate charging fares for crossing by other means, but rather that the ferry is not tied to a particular crossing-place and needs no fixed landing-stages.

This equipment will also provide raft ferries, capable of carrying all light loads, working between fixed landing-stages and finally, if sufficient material is available, a complete bridge of the same capacity.

The forward use of this equipment demands speed of getting it into action; on the other hand even the Light Load class requires fair sized floats. In general it may be said that robustness and long life must give way to lightness of construction and ease of handling.

Slide 7 showed the equipment in its transport or, rather, showed the long parts on a normal trailer which is towed by a lorry containing the smaller parts. Each boat rests on rollers and is held firmly in position but is easily released.

Slide 8 showed the boat open and being carried; opening takes only a matter of a second or two by pulling the sides outwards, when they are held by struts or spreaders that fix almost automatically. No thwarts are used but essential fittings such as rowlocks, cleats, etc., are provided. The boat is made of plywood with the hinges of balata fabric attached in a special manner.

In Slide 9 the boat was shown in use, ferrying a party of infantry. Its crew consists of four men rowing, standing, and a commander steering with a stern oar; apart from the crew, 20 fully armed men can be carried. Embarkation and landing is done over the ends rather than the sides and the absence of thwarts gives a free passage.

Slide 10 (reproduced as Photo No. 2) brings us to the second method of use; the free ferry, known as the tracked raft, to distinguish it from the decked raft, shown later. No decking is provided, only wheel tracks; these tracks have hinged extensions that can be raised and lowered to form ramps for embarking or landing. The boats here are used parallel to the tracks which are carried by transoms that rest on all four gunnels.

Slide 11 showed this raft more in detail and in particular the underside of the end tracks, showing the projecting leg which takes the weight before the boat can ground.

In this form of raft, the full value of the buoyancy of the boats cannot be utilized; the critical load is produced as the vehicle comes

on over the loading ramps, when the boats tip and the ends would dip under with the heavier loads. The particular vehicles necessary in the early stages of the crossing can, however, all use this form of raft.

We now come to the more complete method of employing this equipment, namely, as a decked raft ferry or as a bridge.

In this form it can carry all light loads and the full safe buoyancy of the boats is made use of. This is done by linking them in pairs, side by side, so that the heaviest loads are always distributed between two boats. In the case of the ferry, each landing-stage terminates in a boat and the two-boat raft is joined to it, boat to boat. A similar junction is made in bridge, which really consists of the two landing-stages with the gap filled in by a sufficient number of rafts.

Slide 12 illustrated a decked raft ferry in action ; the boats in this case are transverse to the deck roadway. The boats are connected by wooden roadbearers resting on the gunnels ; on top, wooden deck planks are held down by ribbands along each side and on to these ribbands and the roadbearers below are fixed the hinge clamps that join the raft to the landing-stage. These clamps transmit part of the load on one boat to the boat alongside and still allow good articulation ; their action can be seen better in the next slide.

Slide 13 (Photo No. 3) gives a view of this equipment in bridge ; you see the boats linked in pairs and you will notice the free articulation allowed by the hinges. Incidentally this hinge forms a simple and rapid means of connecting and disconnecting the rafts. At the ends a trestle support is shown and this, with the nearest boat connected to it by the half floating bay, is the normal form of the landing-stage that is provided if a ferry is used.

One more picture (Slide 14) of this equipment showed a Light bridge from one of its approaches. This picture was chosen because it gives an idea of the way in which the light steel trestle can adapt itself to awkward conditions. One leg of the trestle has its footing some three or four feet lower than the other ; its stability is not affected however. This trestle is exactly the same, except for strength and weight, as the trestle that forms part of the Pontoon Equipment which is dealt with next.

Pontoon and Trestle Equipment. We now come to the third and perhaps the most important form of floating-bridge equipment, namely, the Pontoon Equipment. This is definitely a dual-purpose equipment in that in one form of assembly it can deal with Medium loads, and in another form with Heavy loads. It can therefore form a bridge for the division, or a bridge to carry all the vehicles and weapons of the army in the field.

The basis of this equipment is, of course, the pontoon itself, which must provide the buoyancy, stability and strength necessary for the

somewhat considerable loads to be carried. Naturally a certain amount of bulk and weight must be expected and handling and transport have some considerable say in the design.

Slide 15 (Photo No. 4) shows this equipment on its transport, a 3-ton lorry and 4-wheeled trailer, each provided with special bodies or fittings, carrying two pontoons and other parts. For a medium bridge two pontoons are joined stern to stern to form the pier, seven special steel joists join it to the next pier and carry the decking. One such pier and one bay of superstructure, together with the anchors, cables and other stores, are carried by one of these transport units.

The pontoon is a strongly framed wooden structure, covered with Consuta plywood on bottom, sides and deck; it is provided with special couplings to join the two into one pier. Each pontoon is about 22 feet long and weighs some 1,400 pounds; in bridge, they are spaced at 21 feet intervals and each carries a central saddle on which the roadbearer joists rest. The specially shaped scow bows are designed so that the pontoon rides, rather than parts the stream and provides the minimum of resistance. Single pontoons can be rowed and used as boats, and piers connected together to form rafts can also be propelled by rowing.

The roadbearer joists are I beams of special steel to keep them within man-handling limits, while providing the necessary strength. They are carried on the trailer under the pontoon; in a similar position on the lorry are carried the decking chesses. The weight of one bay of superstructure is roughly two tons.

(Slides 16, 17 and 18, showed the construction of a medium raft, a medium bridge in action and a ferry raft working.)

As already mentioned, the pontoon equipment can be used for carrying Heavy loads also: in this form, the floating piers are doubled by connecting two medium piers side by side and the roadway is carried on eleven instead of seven joists.

Slide 19 showed the detail of a heavy pier; the two piers are joined by the special members with a saddle carried centrally on which the roadbearer joists rest. This picture also shows how the bridge articulates under the load which in this case is a medium tank; this free articulation is one of the features of the design.

Slide 20 (Photo No. 5) shows a heavy raft ferry in operation; it gives a better general idea of the heavy form of construction which is the same for raft as for bridge.

This equipment is also provided with trestles for use at the ends of a floating bridge when there is not sufficient depth of water or to replace the floating supports in conditions where they cannot be used. In one of the slides shown, the old pattern trestle is in use; this trestle is capable of carrying medium loads and has to be used in pairs to form a pier to carry heavy loads. A new design has recently

been introduced which is slightly lighter but is capable of carrying either the heavy or the medium loads when used singly.

Slide 21 (Photo No. 6) gives a picture of this trestle. 40-ton steel is used for the legs and transom, both of which are box sections; the transom can slide up or down the legs for height adjustment and rests on special pins inserted in the appropriate holes in the legs. Jacks are provided for effecting this movement when in bridge; tubular struts are also provided for holding the trestle vertical, and steel shoes, which can articulate slightly on the feet, allow of the legs taking up a firm footing even under water.

More detail of the trestle was shown in Slide 22 (this slide is reproduced as Plate No. 1 in the *Summary of Engineer and Signal Information*, No. 7, 1934); the construction of the leg and transom are seen, and the transom pin, the jacks and the strut fixing are also clear. The trestle complete weighs about 10 cwt. and for transport can easily be separated into its various components.

That completes the floating-bridge material and the forms of girder equipment come next.

Small Box Girder. One form of girder equipment known as the Small Box Girder is included in the range of mobile bridging equipment. This is the latest addition to the service, as it was only finally adopted at the end of 1933, and though it is the youngest it is at least as interesting as the other forms and it possesses some features worthy of note.

With a pair of girders, medium loads can be carried over gaps up to 64-feet span; the girders can be launched without previous access to the far bank; the whole of the material can be transported in three lorries and the time of construction from lorry to completed bridge need not exceed 30 minutes.

Each girder is divided into four sections and in Slide 23 (Photo No. 7) is seen a complete girder with certain accessories carried on one lorry. Two lorries like this and a third to carry the decking, etc., is all the transport needed for the complete bridge.

The two centre sections are rectangular; on either side is a triangular section for the end of the girder. On top is a light member with a wheel on the end; this is the launching nose which is shown in action in one of the next slides. The other fittings to complete the girder are also carried on the lorry.

Slide 24 (Photo No. 8) shows the bridge complete and in use. The four parts of the girder on this side can be distinguished; a hornbeam or triangular section at each end and two box sections in the middle. The sections are joined by special pins at top and bottom on each side; they are shown in detail later. The deck rests directly on top of the girders and is made up in panels of convenient size for rapid handling. Though the deck of the bridge slopes up from each end there is no camber on the girders; this avoids the need for selection

and check to see that each part is the right way up and allows the sections to be used either way up, thereby saving appreciable time in assembly; details of construction are shown later.

Slide 25 showed a girder in process of launching. An extension piece known as a launching nose is fixed at each end by means of a special cradle; they can be fixed at various angles in the vertical plane to suit the particular site. The girder rests on a small fixed roller over which it is pushed forward by the party, while they at the same time bear down on the rear end and rear nose. With this live and active counterweight properly applied the forward launching nose will take a good bearing on the far bank before it dips. When this has happened, men can be sent over the girder to help at the far side by lifting and pulling till the end of the girder itself can be settled on a bank seat; the removal of the noses and cradles then completes the launch and the operation can be repeated for the next girder.

That completes the range of the mobile fighting equipment and we pass on to the temporary and the semi-permanent patterns.

These two classes of bridge equipment are non-mobile in so far as they are not permanently provided with transport vehicles and do not accompany the fighting formations. Their design, however, particularly in the case of the temporary class, provides for rapid and simple loading into normal types of army vehicles.

Large Box Girder. The temporary type is provided for by the Large Box Girder Equipment, the original idea and design for which are attributable to Lt.-Colonel Martel. The basic idea of this type is the self-stable girder which can be broken up into short lengths for easy handling and transport. The sections are joined together by pins with no nuts or other fixings to be tightened up. The assembly of the girders at site is therefore extremely rapid and simple and the length can be varied to suit the gap. As the roadway rests directly on the girders, the number used, up to the limit of width of the decking, can be varied to suit the load and the span concerned; the girders need no inter-connection and the load is distributed to them by the transverse decking.

Slide 26 (Photo No. 9). Special end sections are provided to take the maximum shear stresses; apart from these, all the centre or box sections are similar and interchangeable. The bridge has a distinct camber which, unlike the Small Box Girder that has just been described, is in this case given by the girders themselves; it is provided for by making the upper members of each box section slightly longer than the bottom. This slight but distinct arch form allows for the bedding in of the pin connectors under constant heavy loading.

Slide 27 (Photo No. 10) showing one method of transport, gives a good idea of the box sections and the method of connecting them. The sections are built up of mild steel sections, riveted together;

at each end are projecting ears for the pin connectors; they are alternately or diagonally double or single so that a single ear on one section engages with a double ear on the next section. At each junction four pins form the joint, one being inserted from each side at top and at bottom. The top and the bottom faces are flat without any projecting rivet-heads; the former to provide for the bearing surface for the decking and the latter to provide a flat surface to pass over the launching rollers.

The sections are 8 feet long, 4 feet deep and 2½ feet wide; a maximum of four can be used under the standard military roadway, but more can be used with special deck planking if a wider or a double traffic road is required. Each section weighs about 12½ cwt.

The roadway is limited by heavy curbs or wheel guides and a recent modification has provided for a footway at each side and a handrail.

For purposes of transport, a set of this equipment is divided into transport units; one lorry and trailer as shown carries the complete parts for an eight-feet length of four-girder bridge. Similar units provide for the end sections and the set also includes simple launching gear comprising derrick, tackles, winches, etc., which are carried in a separate transport unit.

The maximum spans for the different load classes that can be provided by means of these girders, using two, three or four in bridge, are not quoted here; the reason is that since it was produced the loads have increased and a revision of the design is in progress, at the present time and until trials have been completed satisfactorily it is not advisable to prophesy its actual performance.

Semi-permanent Bridges. The last class of equipment is that for the semi-permanent bridges; this class must be dismissed in a somewhat summary manner as no details can yet be given. Short spans, up to the limit of length permissible on the transport vehicles that can be employed in the rear areas, are dealt with by means of simple joist spans. Above this limit, built-up girders are necessary and the building up must be done at site; standardization and simplicity are therefore essential features.

At the present time examination and practical trials of some types are in progress and it is too early to give any details of the form that will be adopted to replace those excellent war-time productions like the Inglis and Hopkins patterns.

That must suffice for the actual bridging equipment now provided, or in prospect for our army; there is, of course, other bridging material and plant provided in the nature of accessories and appliances for bridging generally, but they do not fall within the scope of this lecture.

Part III.

Quantity of Equipment. The foregoing has given some brief description of our bridging equipment, but no mention has been made of the quantity provided, nor the formations in which it is carried. That is not the concern of the engineer; it is a matter for the tactician rather than the technician to determine. There are, however, two points worthy of note in this connection.

First, the mobile equipment, at any rate, will probably spend the majority of a campaign on wheels rather than in bridge. When

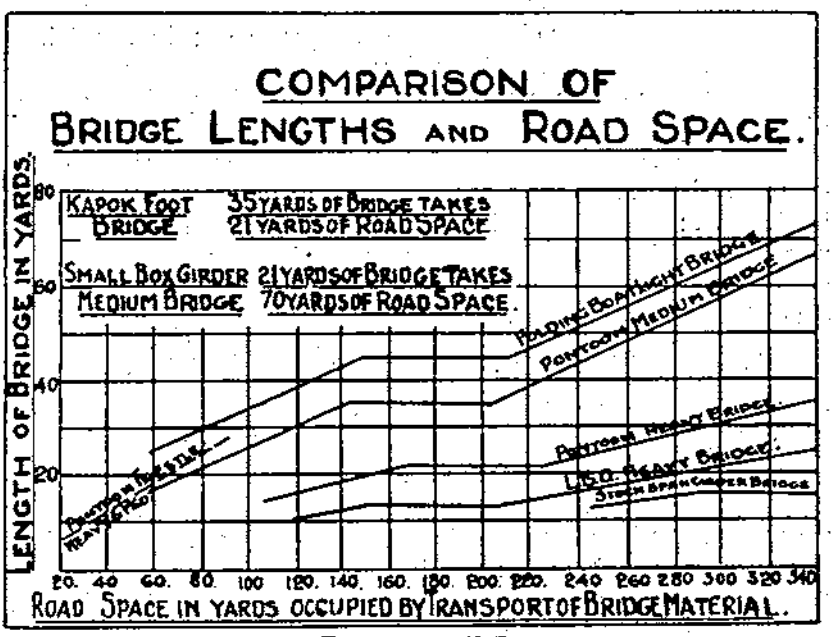


PLATE IV

needed, it is, of course, badly needed and everyone shouts for as much as he can get; when not in use it is merely an encumbrance to the fighting troops that dilutes the strength of the force and adds to its difficulties of movement and protection.

Secondly, though the introduction of motor transport has increased our difficulties as regards design, it has assisted the use of that equipment in another way. With motor transport the bridging equipment can move more rapidly than the force as a whole and therefore it can be held further back without loss of time in getting it into action when needed.

To give some idea of the problem presented, Plate IV gives a comparison between length of bridge and length of road space

occupied by the different forms of equipment. Absolute accuracy is not claimed for the diagram, but it represents the position reasonably. The road lengths given are for normal movement under service conditions, and the picture speaks for itself; it will be realized that the tactician has a problem to face in deciding the quantity and type of bridging equipment that should accompany the fighting troops.

Pontoons. There are several points in connection with the design of Pontoons that might be discussed. Controversy has always raged, and probably will continue, on the subject of metal or wooden construction, on saddle versus gunnel loading and decked versus open boats. We, for our primary equipment, adhere to wooden construction, saddle loading and decked pontoons; in our lighter equipment, though, we have been forced to gunnel loading and open boats by reason of the special construction and the special functions of this equipment.

One of the factors that decided us on wooden construction was the greater resistance to small arms fire and the greater ease of repair in the field; the plywood is to a large extent self-closing to bullet punctures, which can also be plugged very simply, while metal skins are apt to tear. Plywood is, however, not ideal for all the climatic conditions in which our army may have to operate, particularly as the pontoons in transport cannot be protected from the direct rays of the sun, nor even in store can they be protected from the effects of very low humidity. While we are satisfied that the present design is the most satisfactory for general service, we would not be averse to a substitute for the plywood skin for use in special conditions if a suitable one could be found. Various metal or alloy sheetings have been or are being tested; some fail on the weight for strength question, some on insufficient resistance to corrosion without continuous maintenance and some on unsuitability for combining with the present framework.

Box Girders. Though a rough description of the two types of Box Girders that we are using has already been given, some details of the developments that have taken place in recent years and those now contemplated may be of interest.

Martel's design of the Large Box Girder introduced a novel idea, which, for military purposes, was of great value; its speed and simplicity of construction at site cannot be approached by any other form of composite girder known to us, and it is a very economical form from the military standpoint.

The basic idea is, of course, repeated in the Small Box Girder; the original experimental pattern followed the design very closely, except for its dimensions. Later patterns have been fined down by the use of 40-ton steel in place of mild steel; the projecting ears which were liable to damage or distortion in careless handling,

Photo No. 1.

Photo No. 2.

Military bridging equipment 1-2

Photo No. 3.

Photo No. 4.

Military bridging equipment 3-4

Photo No. 5

Photo No. 6.

Military bridging equipment 5-6

Photo No. 7.

Photo No. 8.

Military bridging equipment 7-8

Photo No. 9.

Photo No. 10.

Military bridging equipment 9-10

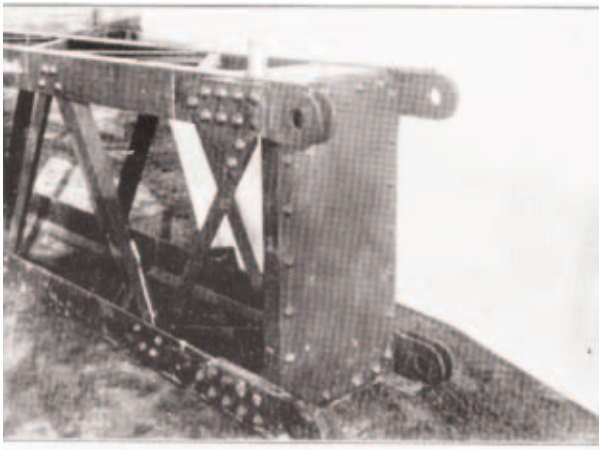


Photo No. 11.

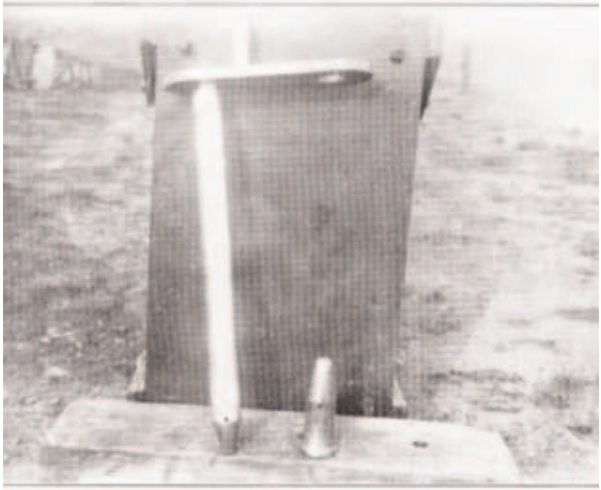


Photo No. 12.

were removed, which involved changes in the connecting pins. Finally welding has replaced riveting and thereby permitted a further fining down of the structure.

Slide 29 (Photo No. 11) shows the original form of the end of a section and one of the pins; you will notice the single and the double ears and the riveted construction.

In Slide 30 (Photo No. 12) is seen the diaphragm at the end of a later section which has no ears; the pinholes are through the actual flange members. The link-pin used in this case is shown beside one of the old type pins; the pin inserted through the pinhole projects sufficiently to engage in the hole in the link of the pin inserted from the other side. The diaphragm is provided with dowels to engage in holes in the diaphragm of the next section; they serve to take a part of the shear stress, but their main object is to position the sections in assembly to make the insertion of the pins easy.

Slides 31 and 32 showed the latest box and end sections: these are not reproduced.

In the revision of the design of the large box girder to suit present-day load conditions, we are working on much the same lines as have proved successful with the smaller one. We cannot pretend that there are not difficulties; there are and they centre chiefly round the matter of welding.

Welding. We realize that we are aiming rather high in that our practice is perhaps ahead of normal commercial practice in employing welding for such structures and such material. We are satisfied that we can design suitable welded joints and can align or place our members to the best advantage. We know the difficulties of inspection and supervision of welded work and to some extent we provide for them by the factor of safety employed, but good welding is still essential. In a small way we have shown that experienced and conscientious welders can produce the required results, and we certainly hope that the practice of welding has come to stay. For our work it has definite advantages in reducing weight but, unless manufacturers become more ready to undertake it and skilled operators more readily available, we shall be defeated by production difficulties.

The development of welded construction and the devising of adequate means of checking the work are, therefore, directions in which we are anxious to see progress made.

In conclusion it was intimated that the R.E. Board was ready to welcome any suggestions or ideas that might help it to produce the best forms of equipment, or to adapt new ideas to the service of the army. It is realized that progress makes finality in design impossible and that improved methods of manufacture, new materials and new methods of employing them may simplify designs or improve performance.

TEMPORARY ROADS DEPARTMENT—V.

BUILDING ROADS BY NATIVE LABOUR.

By "ROADSURVEY."

TOWARDS the end of 1929, the onset of the now famous World Crisis caused a severe curtailment of all road construction on the Gold Coast. Several completed surveys had to be beaconed and left. Amongst these surveys was one in the Northern Territories through two famous "swamps," the "Sambruno" and the "Tankwiddi."

The decision to abandon the construction of this line was a keen disappointment to the Sappers working on it, because it would have been the first time that they had had an opportunity to tackle one of these very formidable obstacles.

These "swamps" are not "swamps" as understood in England. They are caused by large rivers, possibly non-existent in the dry season, overflowing their banks during the rains and flooding the surrounding flat country. The result is a belt of *flowing* water varying in width from two to five miles, and in depth from two to six feet or more.

These "swamps," as can easily be imagined, form a nasty obstacle to a road. The Sappers were, therefore, very keen to tackle the construction problem, more especially in the case of the Sambruno, where two previous roads built by other departments on a different line had both disappeared, complete with bridges and culverts, in each case, in the course of a single terrific storm.

The local political officers, who were anxious to get an all-weather road through, put forward a proposal to construct the line by political labour, under an Ordinance which stipulated that all fully-grown men should put in 24 days in the year on construction and maintenance of roads. Unfortunately, the League of Nations was in session and working overtime on the abolition of slavery, under which heading they included all free labour. The political officers' scheme, therefore, fell down for obvious reasons.

By January, 1930, another factor, or rather, millions of factors,

appeared on the scene—locusts ! A swarm of locusts has to be seen to be believed, and the damage that they can do is amazing.

Waves of these pests had appeared in the dry seasons 1927/28 and 1928/29, but had passed on after doing an immense amount of damage. In each case, however, a famine had been staved off, only by the timely appearance of the early corn crops.

Unfortunately, the locusts of the 1929/30 vintage became " broody " and settled down in millions to lay their eggs, so that not only could the previous conditions of food shortage be expected, but it was safe to suppose that the young locusts, hatching out, would dispose of the early corn crops, and make matters very much worse.

The natives were appalled. One of their ancient philosophers had said, " If locusts appear, they will come for three consecutive years, and the third year they will do their job properly." This looked suspiciously like the third year, and all the mathematicians were agreed that it was !

The Government were, therefore, faced with the necessity of importing large quantities of foodstuffs for issue to the population, in case a famine arose. Furthermore, they could expect no repayment from the people, whose activities were confined to the growing of food and the disposal of wives by barter.

Genius then raised its head, and proposals were put forward (a) to import the necessary food for issue to the people in the most affected areas, (b) to raise a party of men from the same areas and pay them 6d. a day to work on the roads. On completion of the work, the labourers were to purchase food from the Government for their families with the money earned on roadwork. The suggestion bore the stamp of brilliance, with more than a hint of " something for nothing " about it, as far as the Government was concerned !

By the end of January, the O.C. T.R.D. was informed that this proposal would be adopted and that the areas selected for work were the Sambruno and Tankwiddi swamps. He was asked if he could undertake the supervision of the work and of the " untrained " labour. He offered to detail to the work a Section Officer then engaged on survey in the Northern Territories, but pointed out that this officer would require the assistance of at least two European road foremen from the Public Works Department. He was told that there would be no difficulty about this, but that, as there was reason to believe that the labour would, in practice, not be quite so voluntary as might be imagined, it was desirable that the administration and actual supervision of the labour should be left in the hands of the political officer of the district.

The T.R.D. were then asked to put forward a scheme for the work.

The O.C. joined his section officer at Sambruno and, with a temperature of over 100° in the mud rest house, they reverted to type, and produced the inevitable "f" with its attendant list of stores and tables. This was accepted without question as a masterpiece; a new experience for an "f" project.

The work consisted, roughly, of two sections: (a) the completion of 120,000 cubic yards of earthworks and (b) the production of 1,000 cubic yards of rock for the masonry bridges, which were to be constructed later by contract. The Sapper was to be responsible for tools and stores, laying out all levels and tasks; the political officer (D.C.) was to be responsible for the labour and for seeing that the work was done.

As soon as the scheme was approved the collection of labour and stores was hurried forward. There was every need for haste, as it was considered essential that a start should be made by the end of February, in order to complete the work before the rains set in. Some of the labour had to trek 130 miles to the work, and all stores had to be transported 160 miles by rail and 360 miles by road.

The scheme asked for 1,500 labourers, and with these it was hoped to complete the work in eight weeks. Actually, however, only 1,000 were recruited, and these had assembled by the end of February. The D.C. and the Sapper camped together at Sambruno.

The first snag was supervision. For administrative purposes it was not practicable to concentrate the labour, which was spread out over 12 miles of work. Only one P.W.D. foreman arrived, and in two days retired sick from the effects of the sun, and never returned! The same fate overtook the second when he arrived a fortnight later. The Sapper was thus left with only his survey party (all Africans) to assist him. An African leveller, and an African chainman were, therefore, made Hon. Foremen, and in less than a week became expert in the use of boning rods, straight edges and spirit levels.

The chainman started badly, as he developed the unfortunate habit of using a spirit level as a mallet for knocking in pegs! However, when he outgrew this habit, he was worth his weight in gold.

Both these Africans could, after careful tuition and at some considerable risk, be employed to assist in firing charges for blasting rock.

When the labour had assembled, it was found to consist 75 per cent. of the Fra-Fra tribe, and the remainder miscellaneous Grunshis and Dagartis. The D.C. divided them up into parties of 24, each under a headman. The headman in each case was the senior in

tribal rank and frequently the least suited for the job, so that most of these headmen were subsequently replaced by labourers from the survey party, who, by virtue of their Government uniform, enjoyed a very exalted prestige.

From the 1,000 men available, 800 men were detailed to the earthworks, and 200 to the job of drilling holes in granite outcrops, from which it was proposed to obtain the rock required for the masonry bridges.

When it came to issuing tools, the Sapper realized for the first time how really unskilled, unskilled labour could be.

Picks and shovels and earth baskets were issued to the earthwork parties, and demonstrations of their use given. Shovels were soon accepted as such, but it was at least three days before the novelty of picks wore itself out. The natives clung tenaciously to their own ideas of how these weird instruments should be used. Most of them threw away the helves, and used the head in both hands to scrape the ground. One dusky stalwart collected three heads (all upside down) on one helve, and swung it furiously, cheered on by his two weaponless brother "pickers." Not a few considered the helves as heaven-sent weapons for settling outstanding accounts and most of the early casualties were due to cracked heads!

When the rock-drilling party commenced work, nothing would induce them to turn the hexagon steel drill in the hole after each blow with a hammer. Neither would they use water to cool the drill, with the result that 30 per cent. of the drills became fixed in the holes and had to be blasted out. The remainder of the drills blunted rapidly, and the three blacksmiths imported from Ashanti were kept very busy.

The first set of holes was eventually completed and when the Sapper had "done his stuff" with gelignite, the labourers were profoundly impressed. They were filled with pride and joy to think that they were assisting in such a demonstration of noise and flying rock. They, therefore, set to in earnest and the work rushed ahead. Undoubtedly another feature that much appealed to them was that, as they were allowed to work in pairs, one man (holding the drill) was continuously in the sitting position!

Misfires with charges were rare, about 0·5 per cent., but when one did occur it was usual to drill another hole about eight inches from the failure and blow it out. One party engaged on this work discovered that it was easier to drill through the earth tamping of the old hole, than to drill a fresh one. When stopped, they had got within a foot of the detonator of the "dud" charge!

If the rock-drilling went with a swing, the earthworks were exactly the reverse. At the start, as the Sapper and the D.C. proceeded along the work they were everywhere greeted with

prolonged cheers and song and dance. This was excellent, but the Sapper noted with alarm a new feature. Every Fra-Fra gang was supplied with its own "musician," who played a native instrument like a banjo and was provided with all the remaining ingredients of a jazz band, attached to his person at the elbows, wrists, knees and ankles. These musicians drew normal wages, which was only fair, as they worked much harder than the labourers to whom they played.

The D.C. explained that the Fra-Fras would work better if provided with the stimulus of music (???). This was hardly true, as it was quite obvious that whilst enjoying the music to the full the stalwarts vied with each other only in singing and dancing and made no attempt to work.

The initial daily tasks were one cubic yard per man, the idea being that by the end of a week the task should be increased to two cubic yards and should remain at that figure. At the end of the first day the Dagartis had almost completed their tasks, but the musical fraternity had not completed a quarter of theirs.

For five days this "roadmakers' jamboree" continued. No doubt the sight of so much good cheer would have gladdened the eyes of the League of Nations Anti-Slavery Committee, but it filled the Sapper with gloom. The non-musical section were now completing two yards a man by early afternoon, while the others could only show half a yard by dark.

A long argument ensued. The Sapper ruthlessly wanted all musicians sacked or, better still, given a pick to play with. Hard facts were on his side and the musicians disappeared *en bloc*.

The Fra-Fras, who considered that they had now established their right not to finish their tasks, continued to give trouble. The D.C. therefore played a trump card. He summoned the local Fra-Fra Chief from Bolgatanga, and informed him that his men would probably work better with their chief looking on to encourage them. The Chief respectfully begged to disagree, but the D.C., with courtesy and firmness, provided a chair in the sun where he could watch the progress. As the Chief got hotter and hotter, he called on his staff officers to encourage the labourers more and more. After two days the Chief was allowed to depart home, having been told that his presence would be required again if there was any falling off in the work. This information he passed on to those concerned, and there was no falling off in the output.

From this point the work pursued a more normal course. It was necessary to reduce the rock-drilling party and increase the earthworks party, the earthworks having got well behindhand during the "massed band" period.

The next hitch occurred over the removal of two large Baobab

trees which stood on the centre line of the road close to the Sambruno rest house. Trees are very scarce in the N.T* and are closely mixed up with the various religions.

As soon as it was noised abroad that the trees were to be removed a deputation from the Chief of Sambruno waited upon the D.C. and informed him that the " spirits " of the Chief dwelt in one tree, the larger of the two, and those of his Lord Chancellor in the other. Should either tree be removed, both the Chief and his Chancellor would certainly die.

The D.C. was in a quandary, and suggested taking the road round the trees. The Sapper loathed the idea of putting a silly kink in a mile-long tangent. However, there did not appear to be much option, until it was tentatively suggested that possibly the spirits could be induced to take up their residence in some bigger trees about half a mile away. The Chief was very dubious, but retired to consult his Elders. He later reported that it might be possible, but pointed out the grave risks that would be run by all taking part in the moving. Out of respect for the " D.C. Master," he would make the attempt.

Thereupon, two parties, about fifty strong, took station round the " old " trees and the " new " ones, and commenced a most mournful wail or dirge, to the accompaniment of drums and the now unemployed musicians. The wailing went on ceaselessly. By day it was bad; by night it was appalling. After two days and nights even the Sapper was converted to the idea of 50 kinks rather than proceed with the ceremony. There was, moreover, no stop press news to say how the operation was going or when it might be expected to stop. The D.C.'s cook thought a week would see it through; one of the blacksmiths thought at least ten days. However, on the third morning the Chief appeared, and very hoarse of voice, reported a complete success. The trees were then removed.

At this stage the D.C. had to leave for Tamale, 120 miles away, to sit for a Law examination, and during his absence the " Overlord Chief " of the district (the " Na ") decided to visit the work. The first intimation of the visit that the Sapper received was an enormous procession approaching the rest house with a terrific clamour of yet more " music." His first thought was that the " massed bands " had broken out in worse form than before. He then noticed the leader, who by the size of his umbrella alone (about five square yards) was clearly someone out of the ordinary. The police orderly informed him that it was, in fact, a " Big Chief Too-much."

In the absence of the D.C. it devolved upon the Sapper to act as host.

The opening stages of the " Palaver " followed the accepted

* Northern territories.

rules for such meetings. The Chief, through an interpreter, expressed his great pleasure at seeing the Sapper and presented a "dash" consisting of a sheep, chicken and eggs. The Sapper protested his pleasure at the meeting and produced a return "dash" in cash representing the market value of the Chief's "dash" plus 10 per cent. (a local rule). In assessing the return dash it was usual to ignore all eggs, since the cook would report later that 95 per cent. of them floated in water!

It then appeared that the Sapper was well and the Chief "sick for head and sick for belly." After a few more questions and answers the Sapper diagnosed the case as a straightforward one and presented the Chief with two "Livingstone Rousers" (enormous pills supplied in large quantities by the M.O. and similar in action to a naval depth charge).

From this point the interview took an awkward turn.

The Chief liked the road.

The Sapper thought the work was going very slowly.

The Chief thought that this was entirely due to the Sapper's idea in building the road so high in the air.

The Sapper pointed out how useless the road would be during the rains if it was not high in the air.

The Chief countered by pointing out that he personally had no intention of leaving his village during the rains, much less using the road. He further supposed that the more sensible of his people would follow his example.

Against this flood of logic, the Sapper felt rather lost, but as a last effort he explained how, if the locusts caused a famine, the Government could send food to the Chief and his people only if the lorries could "walk" on a dry road. This appeal to the stomach turned the scales. A minor riot broke out amongst the Chief and his sub-chiefs. When this subsided the Chief informed the Sapper that he had just given instructions for the work to be hurried on. The party then proceeded to break up.

The Chief had throughout the long-drawn-out proceedings been sitting on a dilapidated camp chair belonging to the Sapper. A small boy now seized it, put it on his head and proceeded after the Chief. The orderly, who was told to rescue the chair, could only mutter, "Big Chief Too-much" and had clearly no intention of moving in the matter. A Moshi haversack boy, however, having no local connections, rushed up and seized the chair. A commotion ensued during which the Chief was understood to thank the Sapper for the chair and to say that he was going to take it away with him.

"Tell the old . . ."

Another passionate outburst of argument followed. From the look of horror on the Chief's face, and the faces of his followers, the

Sapper feared that the Moshi was overdoing things or, (horrible thought), giving a literal translation of his words. Suddenly, the Chief bowed, informed the company that the chair would remain, and departed.

At the end of a month the labour was due to be replaced by a fresh crowd, but as work was still well behindhand, and as the first party were now quite intimate with the functions of their tools, it was considered essential to keep them on the work and not replace them. Only the Grunshis and Dagartis, whose villages were over a hundred miles away, and who from the first had produced excellent work, were relieved.

As soon as the Fra-Fras heard that they would not be relieved, a minor mutiny set in and desertions commenced. Police were drafted to the scene to enforce work and make certain that tasks were completed, and the minor chiefs assembled and made personally responsible that their men did not desert by night. This put an end to that trouble.

The next incident was a quarrel between two rival headmen and their followers over a mammy. A brawl ensued in which one of the headmen and the mammy were filled full of poisoned arrows, and the victors dashed over the French border, five miles away, to avoid arrest for murder. This was unfortunate, as it meant the loss of about 20 men. The followers of the dead man and woman, not trusting to the law, proceeded after the victors to try to settle the question firsthand. This meant the loss of another twenty labourers.

Towards the end of the work, the feeding of the labour became a very serious problem. The country was particularly barren and the population very scattered. The production and transport of food was put on to the minor chiefs. As time went on, food had to be transported from farther and farther afield. In the end it was being headloaded from villages 90 miles from the scene of work. Several times it looked as though the feeding of the labourers was advancing the date of the famine, which the locusts were expected to produce. However, the chiefs, bored though they may have been with the road, played up manfully, and the food, although scarce, never completely failed.

A grim pastime that devolved on the D.C. was the payment of the labour. The men earned 6d. a day, and at the end of each week received an advance of pay of 1s. 6d.—the balance being paid to them on the completion of the work. In the N.T. cowries are frequently used as money, and the most usual coins are nickel ones of face value one-tenth-penny, a halfpenny, and a penny. Change of a shilling or two-shilling piece was very difficult to obtain, while a pound note had no value at all. The D.C. therefore had to

pay 1,000 men weekly advances of 1s. 6d. in pennies and one-tenths of pennies—a heartrending proceeding!

By the middle of May, only a fortnight behind schedule, the earthworks were completed, much to the relief of the Sapper and the D.C., to say nothing of the labourers, annoyed and bored as they were at the madness of the white man who insisted on building roads nine feet in the air. They were convinced that the "new" road would suffer the same fate as its predecessors and disappear *en masse* at the beginning of the rains.

In this, however, they were disappointed. The rain came with a vengeance, and several inches more than the highest recorded, but the road stood firm, with the exception of one pier of a treble 30-foot span bridge, which collapsed through scour. On the conclusion of the rains this was repaired and *mirabile dictu*, the whole road is intact to the present day.

It is hardly necessary to add, that the Government did not get "something for nothing" after all. The natives got their pay, but they bought no corn, for there was no famine!

(*To be concluded.*)

Temporary roads department - V

Mud volcanoes. Active one in foreground. Extinct one behind.

Air, sea and land in Burma

AIR, SEA AND LAND IN BURMA.

By CAPTAIN A. G. WYATT, R.E.

THE following is an account of a reconnaissance for extra landing grounds carried out in Burma during November and December of last year, and is of interest if only to show how aircraft can help in the rapid execution of this type of work.

I propose to divide the article into three parts showing :—

A. The necessity for the work.
B. A short account of the tour.
C. General.

A. THE NECESSITY FOR THE WORK.

In recent years Burma has definitely come "on the map" as being a most important link in the chain of world communications by air. At present three nations, England, France and Holland, are flying regular services to the East, all of them using at least two main refuelling stations in Burma, namely, Akyab and Rangoon.

Besides these regular air routes, all the aerial "globe-trotters," stunt-flyers and many long-distance record-breakers make use of her to pass over, or to refuel at, or frequently to crash into.

As time goes on it is reasonable to suppose that more main routes will be formed and that companies already established will increase the numbers and types of their machines.

In addition the existing lack of land communications in Burma and the great expenditure required to make good this lack, necessitating heavy jungle clearing and the building of innumerable bridges, will tend to the adoption of the cheaper method of air transport for her internal use.

At present landing grounds in Burma are at Akyab, Sandoway, Bassein, Rangoon, Moulmein, Tavoy, Kadwe, Mergui and Victoria Point, at an average distance apart of 150 miles. Of these grounds those at Sandoway, Bassein, Kadwe and Victoria Point are not too good during the monsoon owing to water-logging of the ground. Also, out of the above grounds, only two are used with any regularity, namely, Akyab and Rangoon. In order to get an idea why this should be, the reader should turn to the map. It will then be seen that Burma is divided into two halves, the Northern and the

Southern, both of which have a big backbone of mountains running parallel to the coast, and terminating at Pagoda Point in the north and at Victoria Point in the south half. Both coast lines are also fully exposed to the whole force of the S.W. monsoon from the middle of May to the end of October, during which period cyclones, smaller revolving storms, an average rainfall of 200 inches and poor visibility all combine to make the sea coast route one of very real danger.

However, on the eastern side of the mountain ranges, the force of the monsoon is greatly reduced and hence the big air-liners of to-day, after leaving Akyab, strike straight over the Yomas and then fly in the comparative peace of the Irrawaddy Valley to Rangoon. From Rangoon they again strike over the mountains to avoid the monsoon, but this time they have to fly over non-British territory.

Now these air-liners are equipped with all the modern means for blind flying, D/F wireless and operator, the necessary navigational instruments, and, what is far more to the point, two pilots, *i.e.*, two pairs of eyes. They are also multi-engined machines and capable of travelling long distances without having to refuel.

Consider next the small machine with a single engine and a single pilot with no relief and no second pair of eyes to help him ; such a machine as a small taxi aeroplane or a privately-owned tourer. The choice then lies in either flying over a large range of hills, blind-flying of the very worst order once caught in the monsoon clouds, and always with the chance that the machine may be forced down by the sheer weight of rain into the impenetrable forests below ; or else to follow a well-defined coast route with a surf edge showing up clear in bad visibility and a reasonable chance that, if a forced landing is made, it will be on a beach and near habitation. There are plenty of villages along the coast but very few in the jungles. Where there are villages there are also open fields, in which some sort of crash landing can be made, if the worst comes to the worst.

The probability is that the wise pilot of the small machine will prefer the risks of the coast route to the chances of an unknown grave in the forests.

It would appear from the above that no pilot has a hope of getting through in the monsoon, and though this is not so, as witness the flights of Amy Johnson, Cobham and Kingsford Smith, yet it must be remembered that these are some of the most skilled pilots of to-day and even they had their bad moments, Cobham calling it " flying into a wall of death."

The decision has now been made to try and improve this coast route by making a number of emergency grounds at approximately 50-mile intervals, thus insuring some safety for machines. It is expected that the larger machines will also benefit, though at present they say they prefer the old route over the hills.

The idea is that a pilot, flying along the coast in bad weather

and seeing a thick storm coming up ahead, will sit down on the nearest landing ground until the storm passes; then when the visibility improves he can continue the flight. Generally the maximum effect of the storm passes in an hour or two and there is a clear spell for perhaps an hour, during which time 100 miles will have been flown.

The present system is for the machine to wait at one of the established grounds until weather reports state that the area between that and the next ground, perhaps 200 miles away, is clear. It may be days before a clear weather report is received as the meteorologists take no notice of the small intervals of clear weather, nor can they be expected to. Under these conditions the pilot must just take a chance and hope for the best.

Such was the main idea evolved and in the early part of 1933 a quick preliminary reconnaissance by aeroplane was carried out, and a few sites were definitely selected; whilst elsewhere, certain areas only were chosen, in which a closer search was required before a final selection could be made. It was decided that 16 new grounds were required.

B. A Short Account of the Tour.

Before going farther, it might be as well to explain very briefly what is required of an emergency ground and some of the pitfalls to be avoided in selecting one.

(*a*) *Size and Shape.*

Generally speaking, the larger the ground the better. The size depends on air approaches. If the approaches are good, enabling the machine to touch down close to the boundary of the ground, then a rectangular ground of 500 yards in any direction is suitable. It should be remembered that the average gliding-in angle of an aeroplane is on a slope of about 1/15.

Often, however, due to cost of land or natural features, it is impossible to get a rectangular ground, and then an L- or T-shaped ground can be selected, with one of the arms running in the direction of the prevailing wind.

It may not always be possible to get 500 yards, but the length should not be reduced below 400 yards, and it is better to give 600 yards if possible.

(*b*) *Gradient.*

Slopes on the ground should not exceed 1/50.

(*c*) *Surface.*

The surface should be sufficiently smooth that a motor-car can be driven over it at about 25 m.p.h. without undue discomfort. A

sandy surface is preferable to a clay one, as during rains it is less liable to become water-logged. It is also an advantage if grass will grow as it tends to compact the surface still more.

(*d*) *Boundaries and Corner Markings.*

The area of the land should be slightly larger all round than the actual landing area. In other words, the corner-angle markings of the ground which denote the actual area for landing should be inside the land boundary pillars. It is not desirable that a ditch, borrow pit, hedge, etc., should be immediately adjacent to the landing area edges, but there should be a space of at least 50 feet between them.

(*e*) *Accessibility.*

Other considerations being equal, preference should be given to sites which are near roads and villages.

No ground should be chosen which lies among hills and which would be difficult to find or approach in bad weather.

For this particular reconnaissance a further essential was that the grounds should be close to the sea coast.

(*f*) *General.*

Experience has shown that grounds put down on paddy-fields or swampy areas are not only very expensive in initial cost, due to the heavy filling required to raise the normal surface, but are unsatisfactory afterwards owing to water-logging during the rains. The temptation to the unwary is great, as from the air cultivated land looks so flat and smooth, that it appears to be a natural landing ground.

Very broken ground should also be avoided as it may require heavy filling in places to bring up the level, and this filling will be a source of trouble for at least three years due to subsidence during and after rains.

Ground covered by trees is also unsatisfactory since the roots must be dug out during clearing and then the holes so formed must be filled in, followed by the same disadvantages as above.

Air approaches must always be studied carefully. It is no use having a perfect ground if the end of the arms are facing straight on to a nearby hill or wireless mast.

Having, it is hoped, put the reader into the picture as regards the reasons for the work and some of the snags to be avoided, it is now possible to give some account of how the work was carried out.

In October, 1933, I was called upon to go and make the final selections for the various grounds, get in touch with the Burma P.W.D., who would have to make them, get out rough estimates of costs and make enquiries about the cost of land acquisition.

On arrival at Delhi, I was attached to R.A.F. Headquarters for a

few weeks, during which time I was given all the facts of the case and supplied with maps, charts, previous notes and instructions. I was also told that a flying-boat and a launch were being put at my disposal at Akyab. Visions rose in my mind of the launch stuck firmly on a rock and the flying-boat a crumpled wreck, all through my unaided efforts, and speculation then turned on whether I might not get something really special in bowlers!

On November 2nd I left for Akyab; a rather complicated journey by train, river, train, and sea, taking me *via* Chittagong.

Arriving at Akyab aboard the s.s. *Elephanta*, I was informed by the port officer that no launch had yet appeared for me and that news had come in that the flying-boat was held up in Rangoon with engine trouble. There seemed very little use in staying at Akyab, so hastily wiring to Rangoon to hold up sailing of the launch and to the O.C. of the flying-boat to remain at Rangoon, I informed H.Q. at Delhi that there was a breakdown of plans and that I was proceeding to Rangoon by *Elephanta*.

Afterwards I heard that this wire had arrived mutilated and read that I was proceeding to Rangoon by elephant. Frantic calculations based on elephants at the gallop showed that the journey was still likely to take some weeks, but luckily the meaning was eventually deciphered!

On my arrival in Rangoon the Marine Superintendent, who was responsible for the preparation of the launch, met me on board with the news that he had only just been informed that the launch was required for the northern coast and that, as cyclones were still prevalent, he could not allow her to go as she was not sufficiently sea-worthy. There was much more to the same effect, and I eventually went with him to see her. She was only a river launch and I quickly decided that the sea was no place for her.

Looking round the harbour, I enquired about the cost of hiring one or two different vessels, which looked as if they would be suitable, only to be told some staggering figure for each. The cheapest was Rs.2,000 per day. At that time I expected to require the vessel for at least three months.

The Superintendent then informed me that H.M.I.S. *Cornwallis*, a Royal Indian Marine sloop, was due in Rangoon within a day or two. It seemed to me that here was a possible solution. She was a Government ship with not too deep a draught and was bound to know the waters. I soon found that there was no objection to her use from any of the Government of Burma officials, so I telegraphed for Government of India permission to be given.

Meantime I had met the O.C. flying-boat, who was heavily engaged in changing the engine, and he promised to be ready in three days' time. A really fine bit of work was done on this occasion. The old engine taken out and a new one substituted in one day, the boat

remaining at moorings in the stream the whole time and only improvized tackle and the normal crew of two officers and three men being available.

On November 11th I visited further officials, chiefly P.W.D., and decided to settle the ground at Kyaikto straight away as the S.D.O. in charge of the area was going on tour almost immediately.

As the flying-boat was not yet ready and as the problem of the ground seemed to be a simple one I decided to go by train. The journey of 80 miles took over six hours!

I spent a day selecting the site and quickly realized how necessary a preliminary view by air was. The whole area was undulating ground covered with a low scrub about ten feet high and intersected by streams, and it was necessary to climb various trees to get an idea of the ground. Why is it that the only trees are nearly always either unclimbable or infested with red ants?

Eventually a site was selected, a rough estimate drawn up, and I returned to Rangoon on the 13th. Three days for one ground.

By this time *Cornwallis* had arrived and someone had broken the news to her officers that they were for " a nice long cruise round Burma "! As they were expecting to return to Bombay for Christmas and had arranged for their wives and families to come out from Home, the news was naturally received with considerable gloom.

However, it seems to be the lot of the N.O. to suffer these shocks all through his service, and they quickly rallied and did everything in their power to help.

A meeting was arranged between the Captain, Commander Mare, O.C. flying-boat and myself, and ways and means were decided upon. *Cornwallis* was to act as depot ship and would carry spare petrol, oil, spare parts and stores for the flying-boat as well as accommodating me. After much discussion a plan of action was drawn up (see Table I), which I think explains itself.

This having been settled there was still plenty to do whilst waiting permission from G. of I. for *Cornwallis* to proceed. As can be seen from the table the efficient working of the plan depended on many items. The P.W.D. representatives, together with the Lands Records Officers, had to be in the right places at the right times. In some cases this meant a three-day journey for them. Petrol and oil and coal *en route* had to be thought of and tides had also to be remembered.

The ensuing days were spent in seeing heads of departments and getting them to issue the necessary orders. I soon learnt that it pays to go first to the biggest noise of each department, however elusive he may be.

During this time a short trip was taken by flying-boat to Bassein to arrange about launches for the Executive Engineer to be able to join *Cornwallis* at Pagoda Point.

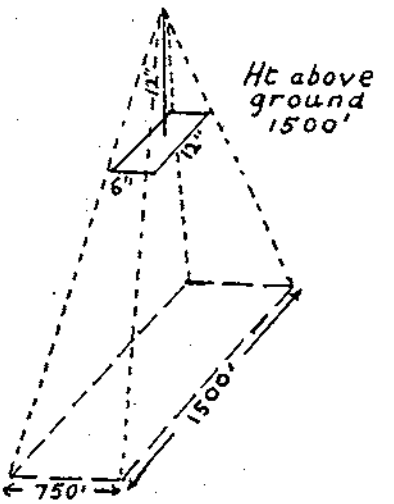
Another trip was taken to Gyaw and Ye on the southern coast, and a rough idea formed of where the grounds would be situated. The Executive Engineer at Moulmein was given the pin-points and asked to run a line of levels over the areas so that an idea might be formed, when I came back from the northern trip, as to the possibilities of making grounds, since the areas were too covered by scrub to see from the air.

Eventually, on November 25th, permission came from G. of I. to use *Cornwallis* and Z-day was fixed for November 26th and this was telegraphed to all concerned.

The tour went like clockwork and we had no delays. Eleven days to do seven grounds.

Only once was I not able to decide from the air exactly where the ground should go. This was at Black Point, where on inspection from the ground the area turned out to be too swampy, but luckily I had spotted an alternative site when in the air and this turned out to be satisfactory.

In order to form some idea from the air as to where the boundaries of the ground would come, I used a bit of wood 12 in. by 6 in. attached from the centre to a piece of string 12 in. long.



With the end of the string held in the teeth and the aeroplane flying at 1,500 feet, and by leaning over the front cockpit so as to get a more or less vertical view, it was quickly possible to decide what area would be covered on the ground.

Throughout, the weather was perfect and, aided by this and the helpful attitude of everybody, I was back in Rangoon on December 7th.

On leaving Akyab for the return flight to Rangoon the flying-boat

had a very heavy load aboard. Five hundred gallons of petrol, five men and all their baggage, and we had only just staggered up off the water when the port engine magneto cut out. An exciting moment!

As *Cornwallis*, when she arrived back in Rangoon, had to clean boilers, a job requiring nearly two weeks, and as the waters in which I now proposed to travel were very shallow and poorly charted, I decided to go ahead without her on the southern trip.

After four days of intensive office visiting, a steam launch, *Curtana*, was borrowed from the Government of Burma at a cost of Rs.130 per day, and a rough programme had been drawn up and telegraphed to all concerned.

Owing to the unknown character of much of the country south of Mergui, the paucity of maps and accurate charts and the sketchy nature of most of the reports on this area from the previous reconnaissance, it was impossible to get out a very definite programme; but a framework was evolved upon which to work, and actually very few additions or alterations were made. Table II gives the programme as actually carried out.

Curtana was based on Mergui and as she had not got sufficient coal and water capacity to do the trip from Mergui to Rangoon and back along the coast, even by coaling in Rangoon, it was decided that she should meet us at Heinzie Basin.

Even more careful forethought had to be given to the preparations for this trip as, in addition to the points mentioned before, we had to mess ourselves and the question of tides and the possibilities of night sailing had to be considered very carefully.

On December 14th we set out again. As we had to carry all our baggage for the entire trip as well as spares, food, etc., until we met *Curtana*, the result was that the flying-boat had an extremely substantial load on board as we left the harbour, but this time she took it with not even a hiccup from the engines.

As expected, the most difficult part was met south of Mergui, especially in the neighbourhood of Kisseraing I. The coast line here is extremely difficult to follow owing to the large mangrove swamps that stretch out many miles to sea. The archipelago is a maze of islands with their swamps also intermingling with the swamps from the mainland, and through them all run tortuous channels of the sea and winding creeks, so that to chart this area accurately is impossible. As the islands are all submerged mountain tops crowned with dense forests of trees, some of which tower up 125 feet, and with an undergrowth so thick that the only way to get along is by cutting a tunnel through, it is impossible to get more than a very rough idea of the lie of the land from an aeroplane, and flat land is extremely rare. In the few instances where the land is flat and not pure swamp there are paddy-fields, which during rain—and here 240 inches in

six months is the rule—become once more the swamp they have recently been reclaimed from.

Luckily I was eventually able to find an area where some thinning had taken place, probably by natives in search of rough cultivation, and by careful search it was found possible to put down an L-shaped ground on fairly high land.

The remaining grounds were not very difficult to find, and by December 22nd the reconnaissance was complete. Nine days to do eight grounds, and this, I think, shows up the advantage of an aeroplane when compared with the three days for one ground without.

The launch returned to Mergui, having done sterling work under the guidance of her European skipper, and I went in the flying-boat to Victoria Point, where we decided to spend Christmas. Mr. Russel, a rubber planter, welcomed us to his bungalow and gave us a wonderful time complete with turkey and pudding and shooting thrown in.

On Boxing day we left and flew direct to Rangoon, 540 miles in six hours, flying by compass all the way. We had eight changes of course to allow for wind drift owing to various storms we encountered, and our last course, set 100 miles south of Rangoon, took us dead over the Shwe Dagon Pagoda—a very fine bit of navigation.

After a few days in Rangoon, seeing those officials who were not away on leave, I left by sea for Calcutta and arrived back in Delhi on January 4th, just two months after I had left it. During this time I had covered about 7,500 miles by various methods and seen a large amount of Burma from an unusual angle.

C. General.

In this section I do not propose to do more than give a quick glance at some of the more striking impressions I got in Burma, and to give a short description of one or two interesting places seen during the tour.

The first thing that struck me was how green Burma was compared to the burnt-up-looking plains of India. This was closely followed by an impression that there was a lot of dead fish about somewhere. There was, and it is the same everywhere in Burma. The natives make a paste, called *Napee*, out of old fish, the older and the stronger the better. I was told that if you can stomach the smell the paste is good. Probably a stomach that is not affected by the smell would like that sort of thing.

Next I was greatly impressed by the clean, gaily-dressed natives, always ready to laugh, and free of all craving for the everlasting *backsheesh* of the East. Furthermore, two natives conversing together do not shout at each other as if separated by several miles,

as does the Indian, but they talk in normal tones. To anyone who has been out East this comes as a pleasant shock.

Before leaving the people, I must mention the Burmese women. Cheerful, independent, the equals of their men-folk and pretty as dolls, with their gay dresses and bright flowers in the hair, they add a decorative touch to any scene.

Rangoon, I thought, was the most Westernized city I have seen out East. The streets are broad, straight and with tarred surfaces and there is a noticeable lack of bullock-carts. The shops and offices in the European centre are big, fine buildings, with no poky native shops tucked away in the corners or between the blocks.

At this time of year, when the rains have ceased and the sun is not too powerful, the climate is perfect, with just sufficient cold by night to make a blanket a necessity and just sufficient heat by day to make a bathe a luxury.

The scenery in Burma is delightful and I wished that I had more time to linger by the way to enjoy it. As it was, what with looking for landing grounds, inspecting the sites when found, and then writing up the detailed reports, I had but little time left to study scenic effects.

The southern coast is a more luxuriant one than the northern, and here in the archipelago the scene is an ever-changing one of greens and blues, from the distant blue-green of the further islands to the varied, vivid greens of the different mangrove trees on the edges of the nearer islands and the darker greens of the forests rising up behind; whilst the sea changes from the prussian blue of the deeper waters to the pale blue of the reflected sky in the shallows. So clear is the water that gaily-coloured fishes can be seen swimming deep among the rocks.

It is among these islands that there is a most interesting group known as the Marble Rocks. These are pure limestone rocks standing straight up out of the water to a height of close on 1,000 feet. Limestone in this area is very rare and it looks as if some giant had picked up these rocks somewhere and dumped them here when he got tired. It is possible to navigate a ship close up alongside practically anywhere, but it is not of much use as the cliffs are so sheer that it is impossible to climb them. A further peculiarity is that inside these islands are landlocked lagoons and ponds, connected, it is presumed, to the sea by tunnels below water level. But so high and steep are the cliffs both on the outside of the islands and the inside that no one has been able to penetrate to any of the lagoons except the largest one. Into this it is only possible to get at dead low water through a tunnel, so low that it is advisable to lie in the boat and pull it through by holding on to the rough edges of the roof. This lagoon is visited at certain seasons of the year by the Malays, who camp on the inside and climb the cliffs, where possible,

for the edible nests of the swallows that build in their thousands round them. These nests are much prized by the Chinese.

It is only by flying over them that the other lagoons have been found, and I believe that I am the first person to photograph them.

It was near these islands that I first saw the Selones, a strange race of sea-gypsies unconnected with any other race and with a language peculiar to themselves. They are very wild and shy, wear practically no clothes, and live entirely on fishes and by fishing. Their skin, through long association with the sea, has developed a scaly growth not unlike a fish's scales, and the children learn to swim before they walk. There are colonies of them in Mergui and Victoria Point and at these places they have become sufficiently civilized to wear rather more clothes and to mingle with other people but, as always happens, civilization is killing them off.

Up and down the Burma coast, but more frequently in the north, are mud volcanoes. These occur as frequently under water as on land and, whilst flying along, a huge gout of mud is often seen to shoot up under water and then gradually spread over the surface until the water is discoloured over an area of about a mile. The larger ones are, of course, a danger to shipping as a complete island may appear in a few days and as quickly disappear.

In accordance with the best practice, I will finish with a little tale and deduce a moral if I can.

It occurred on Christmas Day at Victoria Point. A rogue elephant had been raiding the crops of the villagers for some days past and was doing immense damage. On Christmas Day, about tea time, news came that he was again in some fields only about half a mile away from the bungalow. O.C. flying-boat and I collected Russell's armoury and set out to get him. Unfortunately the brute had gone into some thick jungle and we could not get at him. We tried until it began to get dark and then decided to go home. On the way a luckless snipe got up under our feet, there was a burst of fire and a mangled corpse. The only moral that I can think of is: "If you cannot get the big things make sure of the small." If you cannot find a big landing ground make sure that the smaller one is really good.

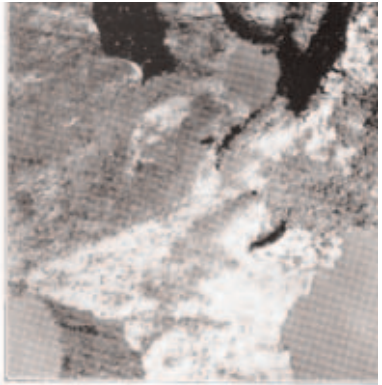
TABLE I.—PROGRAMME FOR NORTHERN TOUR.

N.B.—No night sailing possible. *N.B.*—Parts of the programme at which I was present are in *italics*.

DATE.	H.M.I.S. "CORNWALLIS."	FLYING-BOAT.	P.W.D.
Z	Leave Rangoon 1100 for Pagoda Point.	*At Rangoon.*	Exen Bassein leaves by launch for Pagoda Point.
Z+1	1. Arrive Pagoda Pt. 0900. Pick up Exen Bassein. 2. *Spend night at Pagoda Pt.*	1. *Leave Rangoon* 0730, *fly to Pagoda Pt. and Black Pt. and land by Cornwallis* 1100. 2. Spend night at Bassein and re-fuel.	1. Exen Bassein meets *Cornwallis* 0900. 2. *Inspect Pagoda Pt.* 1100 *and return on board.*
Z+2	1. *Leave Pagoda Pt.* 0600, *arrive Black Pt.* 1300. 2. *Spend night at Black Pt.*	At Bassein.	1. *Inspect Black Pt. site.* Exen returns overland to Bassein. 2. S.D.O. Sandoway leaves Sandoway for Gwa by road.
Z+3	1. Leave Black Pt. 0600, arrive Gwa 1300 hrs. 2. *Spend night at Gwa.*	1. Leave Bassein 0730. Land alongside *Cornwallis en route.* 2. *Fly to Gwa and land there by* 0900. 3. Spend night at Andrew Bay.	1. *S.D.O. inspects Gwa site and returns aboard Cornwallis.*
Z+4	1. *Leave Gwa* 0600, *arrive Andrew Bay* 1600. *Spend night there.*	At Andrew Bay.	1. S.D.O. remains on board *Cornwallis.*
Z+5	*At Andrew Bay.*	1. *Fly over Napoli and Pantaw I. and return to Bay.* 2. Re-fuel from *Cornwallis.*	1. *S.D.O. inspects site chosen on morning flight* 2. S.D.O. returns Sandoway. 3. Exen Akyab leaves Akyab for Kyaupyu by launch.
Z+6	1. Leave Andrew Bay 0530, arrive Kyaukpyu 1600 hrs. 2. *Spend night at Kyaukpyu.*	1. *Wyatt arrives aboard* 0530. *Leave moorings* 0730, *arrive Kyaukpyu* 0845. *Land.* 2. Proceed Akyab for night. Overhaul.	1. *Exen Akyab inspects Kyaukpyu site* 1100. 2. Stays night aboard launch.
Z+7	1. *Leave Kyaukpyu* 0600, *arrive Akyab* 1200.	At Akyab. Overhaul and re-fuel.	1. Exen arrives at Akyab by launch 1500.
Z+8	*At Akyab.*	At Akyab. Overhaul.	1. Exen Akyab leaves by launch for Alanthangyaw 2300.
Z+9	1. Leave Akyab 0530, arrive Alanthangyaw 1300. 2. *Spend night there.*	1. *Fly to Alanthangyaw* 0600. *Land.* 2. Return Akyab.	1. *Exen inspects site and returns by launch to Cornwallis* 1400. 2. Returns to Akyab by launch.
Z+10	1. *Leave Alanthangyaw* 0600, *arrive Cox's Bazaar* 1200. 2. *Leave Cox's Bazaar* 2100.	At Akyab.	1. *Asst. Eng. Cox's Bazaar inspects site* 1400.
Z+11	1. *Arrive Akyab* 0900. 2. Stay 3 days to coal and for minor repairs.	1. Leave Akyab 0800 and photo Alanthangyaw site. 2. Return Akyab and re-fuel. 3. *Leave Akyab* 1130 *and photo sites on way back, arriving Rangoon* 1600 *hrs.*	*Nil.*

Exen = Executive Engineer.

Marble Rocks.



Lagoons.

Marble Rocks - Lagoons

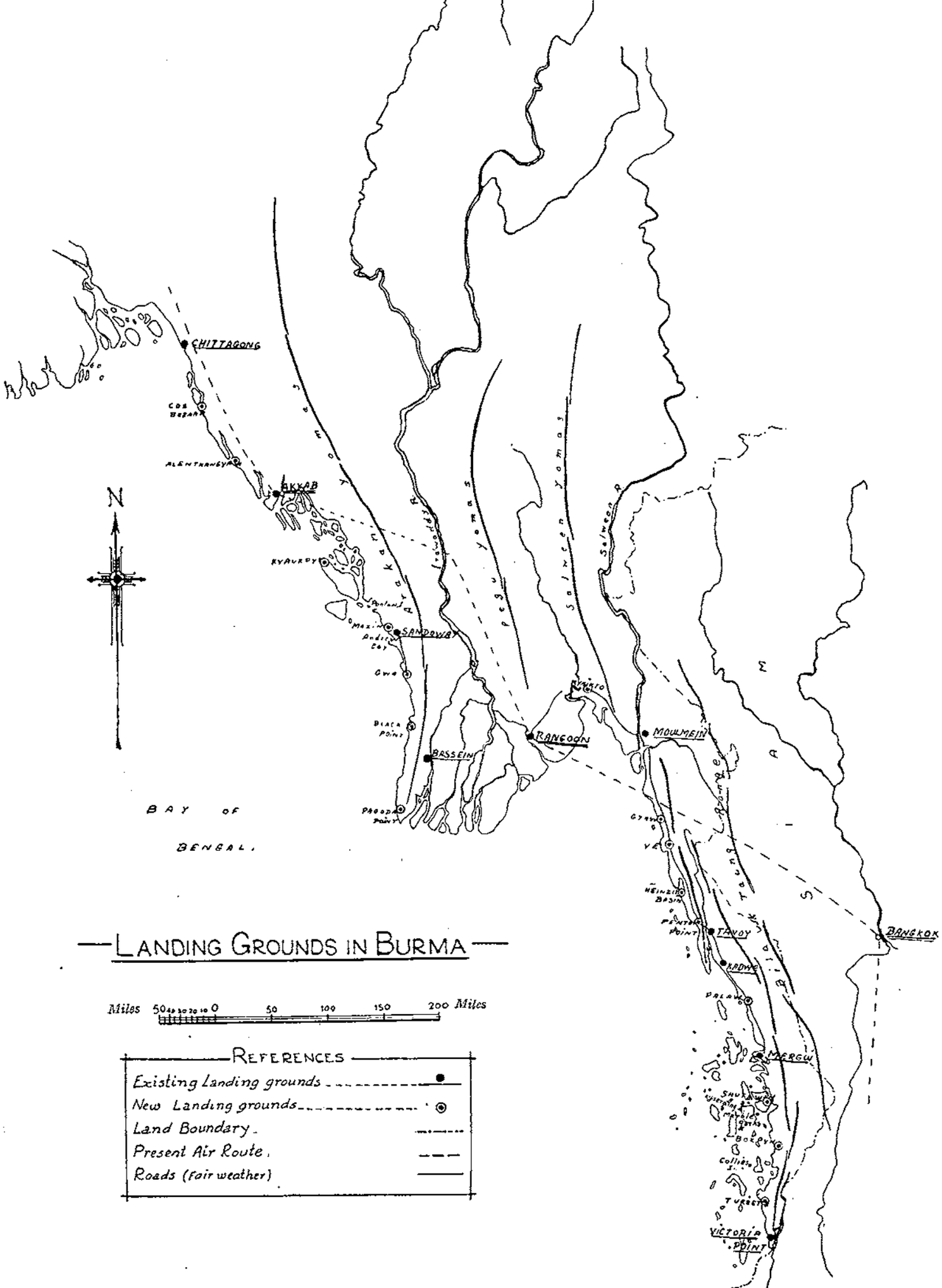
H.M.I.S. Cornwallis.

S. 1151.

S.S. Cartona.

VARIOUS MEANS OF CONVEYANCE

Various means of conveyance



LANDING GROUNDS IN BURMA

Miles 50 40 30 20 10 0 50 100 150 200 Miles

REFERENCES

- Existing Landing grounds
- New Landing grounds
- Land Boundary
- Present Air Route
- Roads (fair weather)

TABLE II.—PROGRAMME FOR SOUTHERN TOUR.

DATE.	LAUNCH.	FLYING-BOAT.	P.W.D.
Z—1	Leave Mergui for Heinzie Basin.	*At Rangoon.*	1. Exen Moulmein leaves for Gyaw by road. 2. Exen Tavoy joins launch at Mergui.
Z	En route to Heinzie.	1. *Leave Rangoon* 0830, *arrive Gyaw* 1100. *Land.* 2. *Leave Gyaw* 1400, *arrive Ye* 1430. *Spend night.*	1. *Exen Moulmein inspects Gyaw ground* 1100, *returning to Moulmein.* 2. *S.D.O. Ye inspects Ye ground* 1600.
Z+1	1. Arrive Heinzie 0700. 2. *Leave Heinzie* 1500, *arrive Fenton Pt.* 1900. *Spend night.*	1. *Leave Ye* 0930 *for Fenton Pt. and back to Heinzie. Land alongside launch* 1130. 2. Spend night at Tavoy and re-fuel.	1. *Exen Tavoy inspects Heinzie ground and returns to launch.*
Z+2	1. Leave Fenton Pt. 1000 for Palaw R. entrance, *arrive* 2300. *Spend night.*	1. Leave Tavoy 0930, land alongside launch 1000. 2. *Fly over Palaw area and return to launch* 1400. 3. Spend night at Mergui. Re-fuel and overhaul.	1. *Exen Tavoy inspects Nabule and Fenton Pt.* 6600. *Return to launch* 1000.
Z+3	1. *Enter Palaw R. on flood* 0530. 2. *Leave Palaw on ebb* 1100, *arrive Mergui* 1400. 3. Coal and water. *Spend night.*	At Mergui. Overhaul.	1. *Exen Tavoy inspects Palaw ground* 0700. *Return to launch* 1000. 2. Exen Tavoy hands over to S.D.O. Mergui at Mergui.
Z+4	1. Leave Mergui on low water at 0800. 2. Arrive off N. end Kisseraing 1300. *Spend night.*	1. *Leave Mergui* 0800 *and look for ground in Kisseraing area.* 2. *Land alongside launch* 1330. 3. Return Mergui and re-fuel.	1. S.D.O. leaves in launch.
Z+5	1. Pass through Celerity Passage on flood, anchor S. end passage 1100. 2. *Leave* 1600 *and anchor Marble Rocks* 1800.	1. Leave Mergui 0730, arrive at launch. 2. *Fly over Bokpyn and return to launch.* 3. *Pick up S.D.O. and fly to Sautkwin and land.* 4. *Return to launch* 1300. 5. Return Mergui and re-fuel.	1. *Inspect ground at Sautkwin. Return to launch.* 2. *Inspect alternative site on Kisseraing. Return to launch* 1600.
Z+6	1. *Leave Marble Rocks* 0600. *Enter Bokpyn on flood* 0930. 2. *Leave Bokpyn* 1200 *and anchor off Collies I.* 1600. *Spend night.*	At Mergui.	1. *Inspect Bokpyn site and return to launch* 1200.
Z+7	1. *Leave Collies* 0530, arrive Turrets 1000. 2. *Spend night.*	1. Leave Mergui 0900. Land at launch *en route.* 2. *Fly over Turrets and land.* 3. Spend night at Turrets.	1. *Inspect site and start survey.*
Z+8	1. Leave Turrets 1400. 2. Return Mergui.	1. *Leave Turrets* 1400. 2. *Arrive Victoria Point* 1600.	1. *Complete Survey.* 2. S.D.O. returns to Mergui.

LIEUTENANT-COLONEL JOHN BY, R.E.

A BIOGRAPHY of Lieut.-Colonel John By, R.E., was published in *The R.E. Journal* for September, 1932, p. 522. The following information about memorials to the founder of Bytown has kindly been supplied by Major G. R. Turner, M.C., D.C.M., R.C.E.; for the photographs, we are indebted to the Secretary of the Historic Sites and Monuments Board of the Department of the Interior, Ottawa.

Photograph "A" represents the memorial which is erected on the site of Colonel By's house in Major's Hill Park, Ottawa, which consists of two memorial stones taken from the arch of the old Sappers and Miners' bridge, over the Rideau Canal, on its demolition for "Connaught Place," July 24th, 1912. One stone bears the "Coat of Arms of the Royal British Engineers," the other "Lieut.-Colonel J. By, Comm. Royal Eng."

A bronze tablet is affixed to these memorial stones bearing the following inscription :—

> "To commemorate Lt.-Col. John By, R.E., Founder of Bytown, Ottawa, the Federal Capital of the Dominion of Canada, Builder of the Rideau Canal, 1826–32, Comdg. Royal British Engineers. This Tablet is erected on the site of his house on Major's Hill, by the Historic Landmarks Association of Canada, May, 1915."

This was unveiled May 27th, 1915, by Field-Marshal H.R.H. The Duke of Connaught and Strathearn, K.G., Governor-General of Canada.

Photograph "B." This represents a monument to Colonel By, unveiled on 17th August, 1926. The memorial consists of a block of granite erected on the bank of the Rideau Canal in Colonel By Park, facing the monument to Champlain on Nepean Point. It was unveiled with due ceremony "To the memory of the Father of the Capital City of Canada," as part of the Centenary celebrations of the foundation of the city. Amongst those who performed the ceremony was Miss Eva Reid, "a descendant of one of Colonel By's original Engineers in Ottawa." Colonel Clyde Caldwell, Royal Canadian Engineers, representing the Royal Engineers, placed a wreath, bearing the inscription, "From the officers of the Royal Engineers," at the foot of the memorial.

Photograph "C" represents a tablet which is placed on the north side of the present bridge which spans the Rideau Canal, and which replaced the old Sappers and Miners' bridge demolished in 1912.

Photograph "A."

Photograph "B."

John By, A-B

Photograph "C."

John By, C

THE 15th FIELD TROOP AT HAIFA, SEPTEMBER 23rd, 1918.

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

FOR the story of a cavalry charge to live in history, one of two things is necessary: it must catch the fancy of a poet or of an artist. Everybody knows of the charge of the Greys at Waterloo, the Light Brigade at Balaclava, the 21st at Omdurman, or the Dorset Yeomanry at Agagia. But how many other charges have there been in the past, even in the quite recent past, which only the most earnest student of military history has ever heard of? Take one of the most recent campaigns of all, Palestine in 1917 and 1918, and see how many cavalry charges you can find; there were the charge of the 4th Australian Light Horse Brigade at Beersheba, the Worcesters and Warwicks at Huj, the 6th Brigade at El Mughair, the Jodhpur Lancers in the Jordan Valley, the 2nd Lancers on the morning of September 20th at the Musmus Pass, the 4th Light Horse Brigade at Semakh, over unknown ground in the dark, the 15th Brigade at Haifa, the 2nd Lancers again at Irbid and, finally, the closing action of the war, the charge of two weak regiments of the 15th Brigade at Haritan on the 26th of October, over rocky ground against nearly 3,000 entrenched Turks. That is not a bad record on which to base the argument that cavalry are no more use in modern war! And let it be remembered that in every case, except that of the 2nd Lancers at Irbid, which was an attempt to take on unshaken infantry without any covering fire, the charge was decisive. Nor were the odds to be faced by the men who took part in these attacks any less than in some of the most famous charges in military history.

However, it is not the purposes of this article to enter into an argument as to the future employment of the mounted arm, but to draw attention to one particular mounted attack which must for ourselves be almost unique, as among the units which took part in it was the 15th Field Troop, R.E. This was the charge of the 15th Imperial Service Cavalry Brigade at Haifa, on the afternoon of September 23rd, 1918.

When, on the 20th of September, the 4th and 5th Cavalry Divisions reached the line of the Afule-Semakh road, and virtually netted the whole of the Seventh and Eighth Turkish armies, the Turkish garrison of Haifa had been left behind. A half-hearted attempt to attack the 13th Brigade near Nazareth on the night of the 21st/22nd was

repulsed by the 18th Lancers with some loss, but it was clear that the Haifa garrison must be dealt with before the northward advance could be continued.

An optimistic attempt was made on the 22nd to induce the enemy to surrender by means of a force of a Rolls-Royce, four armoured cars and a C.R.A., but this effort failed rather ignominiously with the loss of the Rolls-Royce and very nearly of the C.R.A. and it became evident that serious steps would have to be taken to deal with the garrison.

Accordingly, before dawn on the morning of the 23rd of September, the 5th Cavalry Division moved out from Afule, the 13th Brigade directed on Acre and the 15th on Haifa, with the 14th Brigade in support behind the 15th. The 15th Brigade, which at that time had only two regiments, Jodhpur and Mysore Lancers, had with it the Essex Battery and the 15th Field Troop of the 5th Field Squadron, which the writer had the honour to command.

The 15th Troop, under the command of Lieut. R. C. Crawford, R.E. (their second subaltern, Lieut. Dickinson, had gone to hospital two days earlier), spent an exciting morning during the Brigade's advance examining and removing divers mines from bridges along the railway, a job in which Squadron headquarters saw no reason to take any undue interest.

By about three o'clock in the afternoon the 15th Brigade was concentrated under cover of some orchards about 1½ miles from the edge of the gardens by which Haifa was surrounded. Reconnaissance had disclosed that the enemy infantry were holding the edge of the gardens in force, but without any wire obstacles, that the Nahr el Mukatta on the right was unfordable, that the enemy guns were posted mostly on the northern end of the Carmel ridge, and that the Turks probably had machine-guns along the lower slopes in advance of their main position, covering it from the flank. What was not known, however, was the condition of the tributary of the Mukatta which came down from the Carmel ridge midway between the Brigade and the Turkish position; near the road and river bridges it was known to be fordable, but no patrol could get near it on the direct line that the attack was to take. This lack of information was within an ace of causing disaster.

Brig.-General C. R. Harbord, commanding the 15th Brigade, with the approval of the Divisional Commander who had established his headquarters about half a mile in rear on a spur of the main range, decided to take the risk of a mounted attack, in the hope of securing a quick decision and avoiding the casualties which a dismounted attack on such a position without adequate artillery support (the Essex was the only battery in the Division) must have entailed. His plan was to send one squadron of Mysore, supported by one squadron of the Sherwood Rangers from the 14th Brigade, to climb

the Carmel range and make a mounted attack along the level ground at the top against the enemy guns, while one squadron of Mysore crossed the Mahr el Mukatta farther south, to make a wide turning movement with a view to a mounted attack along the sea coast, where the river was known to be easily fordable, against the enemy's left rear. The main attack was to be made along the defile between the mountains and the river, a gap of about a mile or rather less, by the four squadrons of the Jodhpur Lancers, supported by the fire of the Essex Battery, the machine-gun squadron, and the remaining two squadrons of Mysore.

During the pause which ensued while the two flank attacks were getting into position, Lieut. Crawford went back to Brigade Headquarters for orders and, being told to follow up as soon as the attack had succeeded to organize the water supply in Haifa for the division, remained at headquarters to watch developments. Lieut.-Colonel Hyler Holden, who was to lead the Jodhpur charge, saw the 15th Troop standing to their horses, and asked Sergeant Hearne if his men could join him in the charge. Hearne replied joyfully that he'd love to if only he could get hold of some form of weapon to stick the enemy with. Colonel Holden answered that he had had plenty of casualties and the Sappers could help themselves if they didn't take too long about it. That was enough for Hearne, and in a very few moments the troop was mounted and armed, the majority of them with lances, while those who could not get lances had to be content with swords; the fact that none of them had ever had any training in the *arme blanche* mattered not a bit. Their horses were good enough, for the majority were mounted on some of the best of the South Notts Hussars' horses, which had been most illegally exchanged when the latter regiment went to France in the spring of the same year.

Their riding and their troop drill, too, were of an uncommonly high standard, for the squadron had been training behind the line for three months before the advance started.

Colonel Holden placed the troop on the right of his line and, a few minutes later, the Essex battery opened fire, and the four squadrons of Jodhpur and the 15th Troop trotted forward through the orchards into the open.

From divisional headquarters the charge was a magnificent spectacle, even though all that could be seen of the men was a quick-moving cloud of dust. Scarcely had the dust begun to rise, as the line broke into a canter, than twelve little white shrapnel clouds appeared above it, beautifully spaced and a perfect height above the ground, but, mercifully, a hundred yards over. Again and again the line of bursts appeared, but the Turks were deceived by the pace of the attack as the canter became a gallop, and they never succeeded in shortening that vital hundred yards. As the dust cloud

moved nearer and nearer to the distant strip of green marking the Turkish position, the shrapnel bursts came faster and faster and more and more irregularly until, for the last half-mile, many were bursting hundreds of feet in the air while others burst on graze half a mile behind the line, as the Turk's nerves began to give way: at the end you could see that each gun-team was simply pointing its piece in the general direction of the enemy and loosing it off as fast as it could be loaded. But few cavalry charges would ever have succeeded without this vital moral effect, and the Turk's nerves were also being strained by the sight of the Mysore and Sherwood Rangers' attack coming directly at them along the top of the ridge, while their guns were mostly pointing at the Jodhpur charge in the valley.

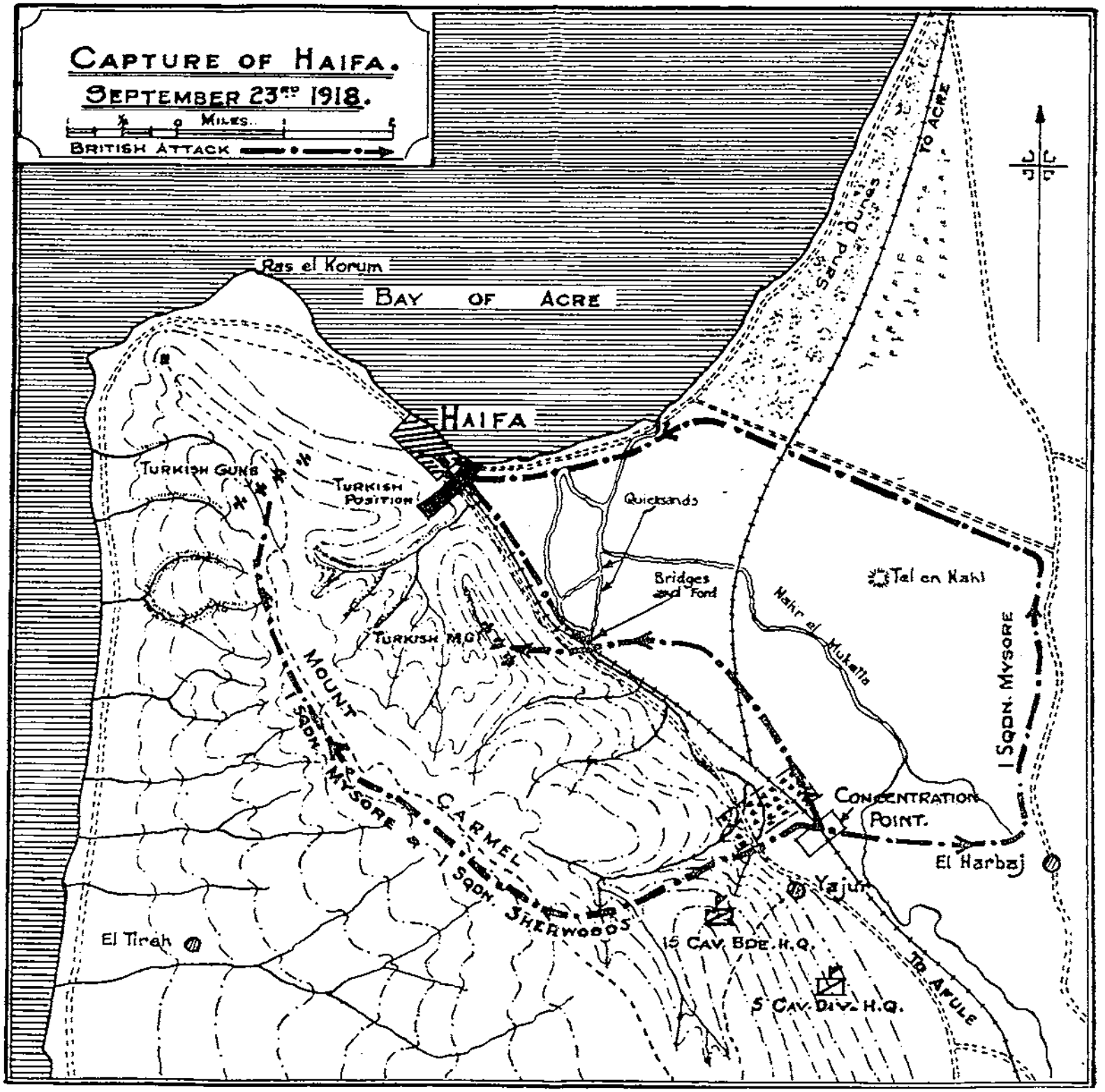
But the most critical phase of the Jodhpur charge was hidden in the dust; we saw the dust cloud suddenly extend towards the left, and seem to move on nearer to the slopes of the mountain, but we could not see what was going on.

I have said that a tributary of the river crossed the front of attack, and though believed to be easily fordable, could not be reconnoitred. It was shallow all right, but the bottom turned out to be a quicksand, into which the ground scouts in front were swallowed up, two of them being drowned. Fortunately the scouts had been far enough in front for Colonel Holden to realize the situation in time, and with fine decision he swung his squadrons to the left to cross by the two bridges and through the stream immediately below. At the same moment the enemy machine-guns, which had evidently been posted with the express object of taking advantage of the delay which the obstacle would cause, opened an enfilade fire. Nearly all the casualties suffered by the Jodhpurs occurred at this point, and that the casualties were not far heavier was due solely to the promptitude with which Colonel Holden wheeled his two left squadrons to ride down the machine-guns while he led the two remaining squadrons and the 15th Troop against the main Turkish position.

Suddenly we realized that the dust cloud had disappeared among the distant trees and that the Turkish guns had ceased firing; the attack had succeeded, and in a few moments Brigade and Divisional headquarters were galloping up the Haifa road.

The Johdpur squadrons had gone on to comb out the town, but we found the 15th Troop dismounted a short distance behind the Turkish trenches, guarding a mixed collection of prisoners, and variously loaded with trophies of the hunt. To all_intents and purposes the men were drunk, almost incapable of coherent speech, blind drunk with sheer excitement; it was quite a quarter of an hour before it was possible to get a clear account of what had happened from anyone, and a good half-hour before they came back to earth sufficiently to carry on with the business of the day.

The actual casualties inflicted by the troop were not unduly heavy,


CAPTURE OF HAIFA.
SEPTEMBER 23rd 1918.
MILES
BRITISH ATTACK
Ras el Korum
BAY OF ACRE
HAIFA
TO ACRE
TURKISH GUNS
TURKISH POSITION
Quicksands
Bridges and Ford
Tel en Kahl
Nahr el Mukalla
TURKISH M.G.
MOUNT CARMEL
1 SQDN. MYSORE
1 SQDN. SHERWOODS
1 SQDN. MYSORE
CONCENTRATION POINT.
El Harbaj
Yajur
El Tireh
15 CAV. BDE. H.Q.
5 CAV. DIV. H.Q.
To AFULE

which is hardly surprising, for a nine-foot spear is an unhandy weapon when you have never handled one before; in fact, only one indubitably dead Turk could really be proved to belong to them, and there was some doubt as to whether he had been slain according to the strict rules of the game; it was darkly rumoured that the shoeing-smith, preferring a club to a lance, had cast away the latter and met the enemy with a clubbed rifle and smitten him on the head. But for all that, they were entitled to their full share in the glory of the charge, and from their immediate companions they certainly got it. Probably the only unhappy man in the division that night was Bob Crawford, whose zeal to get more work to do had led to his missing one of the most unique events in the history of the Corps.

The Haifa charge was undoubtedly a very gallant affair, pressed home in face of the fire of 17 guns, two of them six-inch, an unknown number of infantry (1,350 prisoners were captured) and an enfilade machine-gun fire. The covering fire, and the synchronization of the subsidiary charges of Mysore and the Sherwoods, were a model of successful organization, but even so, one can hardly refrain from quoting from Colonel Wavell: "The attack . . . could hardly have succeeded had not the Turks been fighting under the shadow of disaster, and shaken by the knowledge that their eventual defeat was inevitable." The casualties, thanks to the sustained pace of the charge, the initial error of the Turkish guns, and the prompt measures taken to deal with the enfilading machine-guns, were surprisingly light (3 killed and 34 wounded, and 60 horses killed and 83 wounded), but among the killed was the gallant Indian commander of the Jodhpur Lancers, killed at the head of his regiment by the first burst from the machine-guns. It was a sad fact that each of the charges carried out by the regiment should result in the death of their commander, for Colonel Holden was killed leading the charge at Haritan in the last action of the war.

A MEMORANDUM ON THE ACCOUNTS BY THE ENGINEER DEPARTMENT.

By THE LATE FIELD-MARSHAL SIR JOHN FOX BURGOYNE, BART., G.C.B.

[*This memorandum has been found in manuscript among old records. It is undated, but is bound in an old French newspaper of 26th February, 1817. At that time, Sir J. F. Burgoyne was a lieut.-colonel, Royal Engineers, and Chief Engineer of the British Army of Occupation, France. The words shown in italics are underlined in the manuscript, which is in Sir John Burgoyne's handwriting.*]

MEM^A ON ACCOUNTS BY THE ENGINEER DEPARTMENT.

ALL Officers of Engineers being subject to be concerned in Accounts, it is neceſsary for them to ascertain the best mode of keeping clear of the disagreeable circumstances, or at best, troublesome references which so frequently arise from irregularities, however innocently they may have been caused.

The following points must be introduced into all Vouchers to make them regular.

1. The nature of the Work for which the expence is incurred.
2. The Authority, and its date, by which it is executed.
3. The Receipt of every person receiving payment.
4. One or two Witneſses to the Payment.
5. A certificate from the superintending Officer that the work was executed as stated, or the materials furnished, and in case of Ordnance Works from the Officer of Engineers 2^nd^ in command on the spot, also.
6. An order of Payment.
7. A certificate of a Magistrate or two merchants in case of materials or work furnished by Civilians, that the prices charged are just and reasonable, and according to the custom of the country.
8. Where Payments are made in a foreign currency the rate compared with English money will be specified.

With regard to the 3^d^ Article, the receipt must be signed by every person *nominally* mentioned without exception, either as workman, or furnishing materials; but where Pay Lists are made out in maſs, which they can only be for gangs of Slaves, or for

Military Working Parties of *Labourers* (but not for Soldier Artificers), then the receipt is only signed by some one duly authorised to receive and distribute the money, as, the Quarter Master, or Captain of the Company etc.

In the field, and in payments from the extraordinaries of an Army, the *date* of the Order from the Command[g] General for the execution of the work, is frequently omitted, but a demand for it is always then to be expected from the Auditors of the accounts when poſsible, therefore a written order should be obtained for each specific Service and at all events a general one authorising the Comiſsary to pay accounts certified by the Engineers, and on such occasions, the order of payment, which is always from the Commanding Engineer, is usually dispensed with, the dispension of the duties rendering this form difficult to comply with, and in that case the Senior Officer present should certify the Vouchers.

It will be dangerous to neglect any of the other Articles.

Accounts will not paſs, also, without attention is paid to many *forms* which often appear unimportant to persons unacquainted with these matters, viz. :—

1. Every Voucher must be made out in Triplicate.
2. The Duplicates and Triplicates must be exact copies of the originals ; for instance the names in a Pay List must stand in the same order and succeſsion and not be transposed nor differ.
3. The sums must be accurately calculated and cast up.
4. Every individual signature must be authentic ; if two or more of the signatures, or even croſses are by the same hand, the account will be deemed irregular.
5. The Pay lists, for the Military Working Parties, as Labourers, in maſs, must be made separate for each different Regiment or Corps ; but for the Soldier Artificers where each man signs his own receipt, they may be together in one Pay List, although of different Regiments.
6. The accounts of different places must be kept entirely distinct, although they should be carried on by the same Officer.
7. The prices paid either for Labour or Materials must be according to the King's or Government Regulations, as in Military Pay lists, etc. The following circumstances will shew how neceſsary it is to attend to such rules.

An Officer of Engineers had the superintendance of the works of two neighbouring Islands in the West Indies, and being allowed a Clerk and Office for the two, removed with them as occasion required from one Island to the other. To simplify as much as poſsible, the expence of the Clerk and Office were charged in the accounts of one Island only, where the principal works were carrying on. The

account was disallowed and the amount of this expence charged against the Officer, for the whole of the periods that he was attending the duties on the other Island as shewn on the Monthly Returns.

Colonel Maskelsan* R^l Eng^rs was found guilty by a Court Martial of disobedience of the orders of the Board of Ordnance: but, the Court added, that as it appeared that the irregularity was, as it was meant, an advantage to the service, no additional expence occurred, and could prove no benefit to himself, it sentenced him to be only reprimanded. He received, however, in consequence a severe reprimand from the Commander in Chief and never was again employed.

Every thing that can tend to have the least appearance of fraud or deception must be avoided, without regard to the convenience of individuals; such as, different names being introduced from those absolutely performing the service, etc., nor must any such proceedings be tolerated although even decidedly for the advantage of the Service, before it is first openly stated, and regular authority for it obtained. An Officer of Engineers must be not only honest, but free from suspicion.

In Ordnance Works, difficulties respecting the forms of Accounts are rarely felt, as there is usually a Storekeeper, Clerk of the Works, or Commiſsary employed expreſsly for the purpose of keeping them and who perfectly understands the buſineſs;—Works are sometimes commenced however, without such aſsistance, and in that case, as well as eternally in the field, the Officer of Engineers will have to see the proper forms adopted, and much confusion will arise and trouble eventually accrue to him if he should not know how to prevent irregularities.

By Government Regulations no money is ever to be expended on *the Ordnance Account*, except what has been specifically authorised by the Board, in order that the expences of that Department may be fully met by the annual Estimates—No order or authority whatever can justify a deviation from this Regulation.

All expences for Works or other Services that a Command^g General may be pleased to order, must be paid by the Treasury through the Commiſsariat Department, and charged to the extraordinaries of the Army.

The most convenient mode of effecting this has been found to be, by an order from the Commander of the Forces to the Commiſsary General to furnish all neceſsary materials upon the requisition of the Commanding Engineer, and to pay all the workmen and persons employed on the certificate of different Officers of the Corps—this should be in writing or in general Orders, as the authority of the Commiſsary General to make the Payments.

* This appears to refer to John Mackelcan; if so, the court-martial seems to have done him little permanent harm, as he died a General.

In the case of a large Army or detached Services, the Commiſsaries at such different stations, or of the Divisions of the Army, are ordered by the Commiſsary General to pay the expenses incurred and certified by the Engineers attached to the same station.

Where the works are sufficiently extensive, an adequate number of the Commiſsariat Department are expreſsly appointed to settle the Engineer accounts.

By this means the Accounts are thrown into their proper channel, the Commiſsariat Department; and the Officers of Engineers are kept clear of them; they will have nothing whatever to do with any payments, nor with the purchase or price of materials, they will make requisitions for what is neceſsary of the latter, and will certify to the quantity delivered, and see that they are of proper quality.

Every poſsible effort should be made to resist any attempt to make the Officers of Engineers enter further into the accounts; it will interfere with their other duties, is incompatible with their situation, and will only lead them to trouble and disrepute. The Officers of the Quarter Master General's Department are very properly expreſsly ordered to have nothing to do with accounts.

Any money going through a person's hands to pay to others, renders him a Public Accountant and he or his heirs may be called upon at any distance of time for regular Vouchers accounting for its expenditure and most violent measures immediately adopted if they are not produced—Every one therefore should avoid as much as poſsible putting himself in this case;—If it is unavoidable, he must take every precaution to have the neceſsary Vouchers completed regularly, to keep for *himself* a perfect copy, with all the authentic signatures (which will be a fourth copy) until they shall be finally audited and paſsed.

Even when the keeping the accounts rests with the Civil Departments, it is still neceſsary that the Officer of Engineers should understand their forms, for it is his duty and will save him many future references, to see that the proper forms are complied with in all those which he certifies, besides that many Pay lists and Vouchers are frequently required to be made out in his Office and sent to the Commiſsary for payment. He should make it a principal object to prevent the accounts getting into arrears, or into a state of irregularity or confusion. Even when the money cannot be immediately paid, the Pay lists and Accounts should be carefully made out and preserved by the proper persons, for payment. These observations relate particularly to active Services in the Field, to Sieges, etc., where these points are more apt to be neglected, and on which occasions the persons employed always look up to the Engineers to see that they get their due.

In order to account satisfactorily for every branch of expence incurred in carrying on works, it is recommended to every Officer of Engineers in charge of them, to keep in a book, when poſsible, a copy of all Vouchers, that is Pay Lists and Bills; a second book should contain a daily report of the distribution of every person, by numbers and trades, employed in the Department—a third for the Receipt and Iſsues of Stores and Materials, specifying the Service for which they were required; and a fourth compiled from the above three, daily, or weekly, where each specific work will be claſsed on a separate Page, and under a separate head, in which will be entered the account of all expenses incurred for such object, both in Workmen and Materials, as near as can be ascertained, but so as to account for every thing that appears on the Vouchers. This will give at any future time a distinct account of all expences incurred by the Department, and with the Weekly Progreſs, useful information for future Estimates.

J. F. BURGOYNE,
Lt.-Col. R^l Eng^rs.

Officers of Engineers should avoid, if poſsible, certifying or signing to incomplete accounts. On Service it is just poſsible that this may be unavoidable, and that it should be neceſsary to sign accounts in blank or not completely filled up at the time, in that case he should make and preserve an Abstract, shewing the number of persons employed, the dates, the Service and the Sums, and a Mem^m of the reason why the account was signed when incomplete, in case any future reference should be made to him;—indeed if an Officer were to keep a book of such Abstracts of all accounts he certifies which he usually may do, even when he cannot keep regular copies, it might at future periods be very useful to him in case of reference.

J.F.B.

THE NORTHERN FRONTIER OF INDIA.

A Lecture delivered at the School of Military Engineering, Chatham, on 12th January, 1933, by LIEUT.-COLONEL C. E. BRUCE, C.S.I., C.I.E., C.B.E.

GENERAL.

I HAVE thought it might be useful and also perhaps of interest for me to tell what I can of those provinces which for about eleven hundred miles form the northern frontier of the Indian Empire, *i.e.*, nearly twice the length of the better-known N.W. Frontier.

In the early eighties of last century the frontier in parts of this region became a burning question between Great Britain and Russia, with China and Afghanistan also involved, but to-day one can safely say that the political and military problems of this region bulk small in our Indian affairs. That is doubtless the reason why so little is known of this area. The recent riots in Kashmir have, however, drawn attention to it.

Ladakh, Baltistan, and Gilgit are all provinces of the Kashmir and Jammu State, one of the Indian States under its own ruler. Chitral is a small State under its own ruler, included in the N.W.F. Province. The foreign countries bordering this region are Tibet, Chinese Turkestan (Sinkiang) and Afghan Wakhan. Russian Turkestan, now the Soviet Republic of Turkmenistan, lies north of the narrow Wakhan Pamir. Afghanistan lies west of Chitral.

The Russian advance towards India first began to alarm British public opinion in the early sixties of last century, for in 1863 Tashkent was taken by the Russians, and in 1868 Bokhara was subjugated by Russia and her boundaries extended to the River Oxus. During the next ten years or so various explorers and missions from Russian Turkestan and from British India were fishing in the troubled waters of these uplands of Central Asia, until the situation was stabilized by several boundary commissions between 1885 and 1895, when the Russian-Afghan and Afghan-Indian frontiers were delimited. The names of Forsyth, Younghusband, Holdich, Wahab, and Lumsden are connected with these events. A wedge of buffer territory was successfully left between the Indian Empire and Russian Turkestan, comprising a projecting piece of Sinkiang (Chinese) north of Hunza which joins the long isolated valley of Afghan Wakhan running north of Chitral and Hunza.

Gilgit and Chitral came into prominence in the eighteen-eighties, solely owing to fears of Russian aggression in the Pamirs, and I have no doubt that this is the only reason they were ever incorporated into the sphere of influence of British India. If it had not been for Russia the local rajahs, *mirs* and *mehtars* of that region might still have been cutting each other's throats and dealing in raids and slavery as they had been for hundreds of years.

Owing to these factors, a British Agency was established in Gilgit from 1877 to 1881, when it closed down, but was re-established in 1889 with Kashmir State troops as the visible support of our power, and since 1895 Chitral has been occupied by a garrison from the regular Indian Army with a Political Agent in residence.

HISTORY.

Kashmir was, as all know, at one time the summer resort of the Moghul rulers of India. After the decay of the Moghul Empire, it came under Afghanistan until in 1819 the Sikhs under Ranjit Singh seized it.

The Dogra dynasty of Kashmir and Jammu have provided four Maharajahs :—Gulab Singh; his son, Ranbir Singh; his son, Partab Singh; and his nephew, the present Maharajah Hari Singh.

Gulab Singh was one of the ministers of the Sikh, Ranjit Singh, and was given Jammu State to rule. He extended his territories by conquering Ladakh from Tibet and annexing Baltistan from its local rajahs, 1834-1841.

In 1846 he obtained Kashmir itself. Kashmir was handed over to the East India Company by the Sikhs after the Sikh wars as an equivalent for part of the war indemnity which they could not pay. Gulab Singh of Jammu offered to find the money (one *crore* or then one million pounds), and the Governor-General of India, preferring cash and the friendship of the powerful Dogra Prince, handed over Kashmir to him. A contemporary writer, Captain Knight, described Gulab Singh as the " most thorough ruffian that ever was created," and bemoaned handing over the " paradise of the Indies."

Gulab Singh even tried to conquer Tibet, but his Army, under a very famous Dogra General, Zorawar Singh, was annihilated in a three-days winter battle on the desert plateau of Rudok in 1841.

Since this date the territories of Ladakh and Baltistan have remained unchanged and undisturbed by war.

GILGIT.

In 1852, after the Dogras had taken over Gilgit from the Sikhs, they were driven out of Gilgit territory, *i.e.*, south-east of the Indus, by the local Dard rulers of Yasin and Hunza. The Dogra garrison

of 2,000 men were all killed or enslaved. It was reconquered by Maharajah Ranbir Singh in 1860, and from then on until the Hunza-Naga expedition of 1891 there was continual fighting in and around Gilgit.

The internal security of Gilgit was finally secured in 1891, when Colonel Durand, the British Political Agent, led Kashmir troops with a stiffening from the Indian Army against the recalcitrant *Mirs* of Hunza and Naga.

Gilgit, a province of Kashmir under a Dogra Wazir-i-Wazirat, now includes Astor-Chilas-Gilgit-Haramosh-Hunza-Naga-Panial-Ghizar and Yasin right up to the borders of Chitral.

The outlying portions are most certainly only kept under Kashmir suzerainty by British influence.

It is a noticeable fact that Ladakh, Baltistan and Gilgit are ruled by a small Hindu Dogra ruling class of a different race and nationality and religion to the bulk of the people.

CHITRAL.

About 1880 Aman-ul-Mulk, as *Mehtar* of Chitral, had risen to power. He was an ideal ruler for such a country, ruthless, very cruel, but a strong man. The first British concern with the country arose when Aman-ul-Mulk, to avoid annexation by Afghanistan, tendered his allegiance to Kashmir and so came under the sway of the Gilgit Agency. The object of the Government of India was to prevent any further Russian advance, and to control the northern passes of Chitral.

In 1892 Aman-ul-Mulk died and this led to a welter of murder and fratricide in which four *Mehtars* of Chitral were expended in three years, and finally led up to the Siege of Chitral, in which the British Agent of Gilgit was besieged in 1895. After the relief by a small column from Gilgit, large forces arrived from India *via* the Malakand and the whole country was pacified. A new *Mehtar* was installed, and a political agent of Chitral was appointed with a permanent garrison of regular troops. Chitral is now within the N.W.F. Province and is independent of Kashmir and the Gilgit Agency.

ETHNOLOGY.

LADAKH. THE LADAKHI.

The inhabitants of Ladakh are of Tartar origin and Buddhist religion, exactly as in Tibet. In fact they are Tibetans, and were at one time under Tibetan rule. They still look to Lhasa as regards their religion. I have always found them very cheery, willing, and

hard working. They are very dirty, but in the higher parts of Ladakh they do not smell, owing, I suppose, to the cold. They have typical Mongolian features, but very dark black and red complexions, not yellow like Chinese, owing I think to the wind and sun and snow.

They keep their population down by practising polyandry, but even so they must live a very hard life, existing largely on uncooked barley-meal dough. Barley is the only thing they can grow at the altitudes in which they live, between 11,000 and 15,000 feet, and often they have little or no fuel.

BALTISTAN. THE BALTI.

The Baltis are of the Mussalman religion, and some authorities say they are of pure Tartar origin and, like the Ladakhis, akin to the Tibetans. Others, however, say they are mixed Aryan and Tartar, and that the Dards, an Aryan race who invaded and populated Chitral and Gilgit a hundred years or so B.C., also occupied Baltistan and have since been swamped by Tartars from Tibet. They live in a considerably softer climate than the Ladakhis, and although their country is over-populated owing to their polygamous family life, they are probably better fed than the Ladakhis. This, combined with climate and religion, has certainly produced a difference in appearance and character. The Balti is a taller man with rather less Mongolian features and paler and sallower complexion, but to my mind not nearly so attractive, for he is more sophisticated, less willing to work, not such a good weight-carrier and not nearly so cheerful; moreover his aroma is strong, and, like the Kashmiri, he has a great affinity for small animal life, *i.e.*, he is generally verminous. He is generally fairly chicken-hearted.

GILGIT AND CHITRAL. THE DARD.

The inhabitants of Haramosh, Astor, Gilgit, Hunza, Yasin and Chitral are all of the Dard race. There are several castes, depending partly on admixture with aboriginal inhabitants hundreds or thousands of years ago. The Dard is an Aryan, and has a much more European cast of countenance, with finer, straighter features, and often an acquiline nose, brown or even red hair and hazel or blue eyes. They are tall, well built and active. They seem pretty hot-tempered on occasion.

The Dard is a far tougher and more virile fighting man than either Balti or Ladakhi, and has in the past put up hard fights in defence of his native valleys. But even so he is not comparable to his next-door neighbour on the west, the Pathan, in warlike qualities, and has little of the Pathan's tenacity or ruthlessness, with the exception of

the men of Hunza. The Dards are splendid mountaineers with great endurance.

One can get a fair idea of national character by watching the reaction of one's Kashmiri servants to the other hill people. The Kashmiri is the most arrant coward, knave, rogue and bully in creation. Now in Ladakh my Kashmiris used to bully the poor innocent Ladakhis on all occasions and issue the most bumptious orders unless one stopped them. In Baltistan it was more like dealings between equals, although the Kashmiri would put it across the villager of the remoter hills. But in Dardistan or Gilgit, the Kashmiri behaves with the utmost deference to the local man even in the most remote *nullah*, knowing full well he would get a knife between his shoulder-blades at the least provocation.

Geography.

Frontiers, passes, routes.

Ladakh, Baltistan, Gilgit, and Chitral are all high mountain regions, very sparsely inhabited. There are here, in successive lines, some of the highest mountain ranges in the world, and each route into Indian territory from Tibet, Chinese Turkestan, Russian or Afghan territory crosses not merely one high mountain pass, but a whole series of high passes, with unbridged or ill-bridged rivers or torrents between. In fact we have here the most perfect natural frontier in the world. Its efficacy is proved by the fact that none of the great historical, or for that matter pre-historical, invasions of India have come across this northern frontier. All have come by the North-West Frontier.

From the military point of view the most important factor is the communications of this region, involving questions of passes, rivers, and supplies.

First of all, on the east there is a barrier of the high cold desert of Tibet and Ladakh, the uninhabited Chang Tang, Lingz Tang and Dipsang Plateau, the altitude of which varies from 15,000 to 17,000 feet. It is uninhabited and impassable except for small well-organized caravans.

Then comes the Karakoram range, the highest range in the world, with peaks of over 28,000 feet (notably K_2). Then the Hindu Kush with the Haramosh spur (24,270 feet), Rakaposhi and Tirich Mir of over 25,000 feet, and further south, Nanga Parbat (26,620 feet). Nanga Parbat is probably the most beautiful and striking mountain mass in the world, for there is no other peak of over 17,000 feet or having permanent snows within the same circle of vision.

The only passes worthy of note over these outer barriers are :— the Karakoram Pass, 18,270 feet, by which runs the famous age-old

trade route from Yarkand and Central Asia, to Leh, Srinagar and India. It is passable for ponies or yaks in summer, June or July to September, when it is practically free of snow. But both north and south of it are other and more difficult passes, such as the Sasir La, and the Chang La. This is the only feasible route into Ladakh from Chinese Turkistan.

Into Baltistan there are no feasible passes.

We then come to the approaches to Gilgit. There are only three passes we need consider: the Mintaka, 15,430 feet, and the Kilik, 15,850 feet, leading from the Taghdunbash Pamir of Chinese Turkistan into the Hunza valley of Gilgit, and the Darkot, 15,800 feet, from Wakhan into Yasin. In favourable weather ponies and yaks can traverse these passes, otherwise coolies are necessary.

Leading into Chitral from Afghan Wakhan, a few miles north of which lies the bogey of Russia, is the Baroghil Pass, 12,460 feet. There are one or two other very difficult passes of 17,000 to 18,000 feet.

Inside the outer mountain barriers are the Kailas Range, the Ladakh Range, the Zaskar Range, and the Great Himalaya Range, all ranges whose summits run to over 20,000 feet, and whose passes lie between 11,000 and 16,000 and 17,000 feet.

A further great barrier is the River Indus, which flows from Tibet in a great westerly sweep through Ladakh and Baltistan and then southerly through Gilgit to the N.W.F. Province. It is fordable in one or two places in Ladakh, and then has only two or three bridges or ferries in the course of some 600 miles.

All practicable routes into Kashmir from the outer provinces go either over the Zoji La, 11,300 feet, or the Burzil Baj, 13,700 feet. Both are snow-bound and practically closed to traffic from mid-October to April or May.

The only tracks open to proper pack animal traffic in this whole region are the Leh treaty road, the Gilgit road, and the Chitral-Malakand road, and of course they are only used by pack convoys in the summer months. Moreover, considering them as military links, in each case there are a number of critical bridges, cliffs or defiles where with very little effort the route could be utterly broken up and only repaired by weeks of work.

I think I have said enough to indicate the type of communications and their limitations and difficulties.

SUPPLIES.

There is one other military point, and that is the question of supplies.

Throughout Ladakh, all the high parts of Baltistan, Gilgit, and Chitral, the food grown barely supplies the needs of the population;

in fact many of the Baltis are definitely undernourished, and usually for the last month or two before the grain harvest they have to live on dried fruit. In a very few of the lower fertile oases a surplus of fruit is grown and exported.

One may definitely say that no military force could live on the country anywhere in these border provinces.

MILITARY FORCES, POPULATION, ETC.

	Population.	*Local fighting men.*
Ladakh	21,000	*Nil*
Baltistan	58,000	*Nil*
Gilgit	58,000	6,000
Chitral	70 to 80,000	6,000

The Gilgitis and Chitralis if well led fight reasonably well, but with none of the determination of the Pathan. They are fond of scheming and intrigue and might possibly afford a field for hostile propaganda if British influence were withdrawn.

Our military forces maintained on this 1,100 miles length of frontier are :—

Ladakh.

A platoon or so of Kashmir State Infantry, merely kept there as treasury guard.

Baltistan.

A similar guard at Skardu, the centre of Government for the Province of Ladakh which includes Baltistan.

There are no police; all law and order depends on the village headmen, the *Gopa* in Ladakh.

Gilgit.

One Mountain Battery and one Infantry Battalion of the Kashmir State Forces are maintained in the Gilgit Agency at Bunji and Gilgit, also 600 Gilgit Scouts and Levies in Hunza, Naga, Yasin and Chilas.

The nearest reinforcements in Kashmir and Jammu are 1 Cavalry Regiment, 2 Mountain Batteries, and 5 Infantry Battalions, all State Forces, and from Abbottabad 1 Gurkha Battalion is available from the Indian Army.

Chitral.

A garrison from the regular Indian Army of 1 Section of Mountain Artillery and 1 Infantry Battalion, and 1 Section of S. and M. is maintained in the Chitral Area, also about 1,100 Scouts and Levies.

The nearest British reinforcements are at Nowshera and Peshawar.

MILITARY PROBLEMS AND DEDUCTIONS.

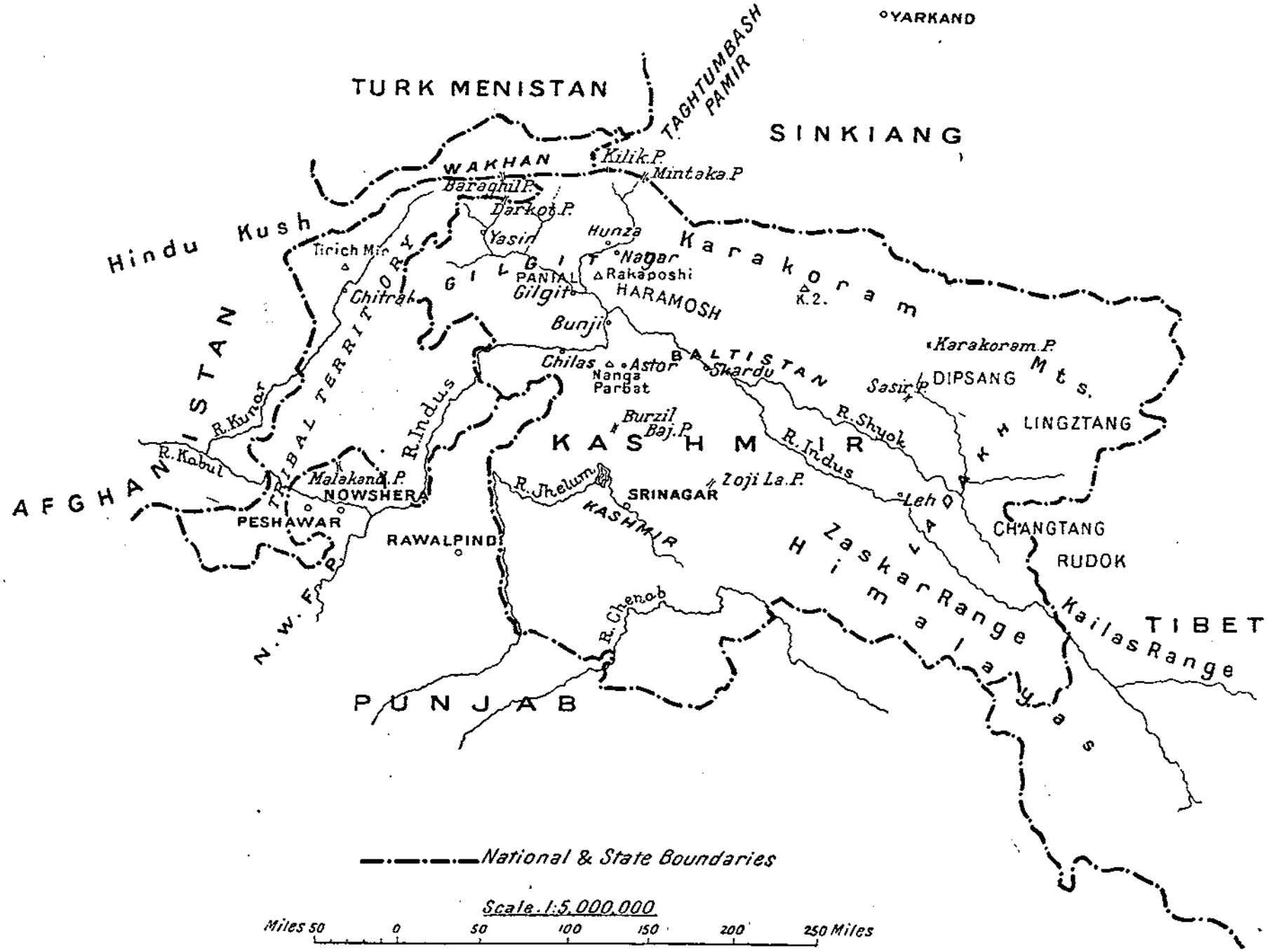
In Ladakh and Baltistan it can safely be said that there is no risk of either external invasion or raid, or of internal trouble. Tibet and Chinese Turkestan are our neighbours. Neither have any military forces capable of making any threat, nor will the communications from these countries allow of any military movements. There is practically no communication with Rudok (Tibet) at all. Small caravans of sheep carrying salt or borax occasionally move up and down the Indus Valley. Trading caravans of possibly 50 to 100 animals move from Yarkand to Leh during the summer months, but no bigger columns could move owing to supply difficulties without enormous preliminary preparations.

As regards Gilgit and Chitral external threats might come from the north, for the buffer of Afghan Wakhan is narrow. But such threats to my mind could only be by propaganda and not by force, because the routes, only open for a few months in the year, are not even organized on the scale of the Yarkand-Leh trade route. Movement of any but a small party of a dozen or so men or animals is practically impossible, owing to supply problems and physical obstacles of the routes.

Propaganda might result in unrest, and these Dard tribes, although not nearly so numerous or warlike as the Pathans, have shown themselves in the past capable of trouble. But for 35 years now there has been no trouble, and so long as British Political Agents reside in Gilgit and Chitral with the small military forces now there, even the most skilful attempts are unlikely to provoke any unrest.

There is the risk of propaganda stirring up the unadministered tribes of the Indus Valley, and the districts of Darel and Tangir nearest to the Gilgit Agency are a preoccupation.

But so far I believe no propaganda here has met with any success, probably less than among the Pathan tribes and in Afghanistan.


YARKAND
TURK MENISTAN
TAGHTUMBASH PAMIR
SINKIANG
WAKHAN
Kilik P.
Mintaka P.
Baraghil P.
Darkot P.
Yasin
Hunza
Nagar
Rakaposhi
Hindu Kush
Karakoram
Tirich Mir
Chitral
GILGIT
PANIAL
Gilgit
HARAMOSH
K.2.
Bunji
Karakorem P.
Chilas
Astor
Nanga Parbat
BALTISTAN
Skardu
Sasir
DIPSANG
Mts.
LINGZTANG
R. Shyok
R. Indus
Burzil
Baj. P.
KASHMIR
R. Kunar
R. Kabul
R. Indus
Malakand P.
NOWSHERA
PESHAWAR
R. Jhelum
SRINAGAR
Zoji La. P.
Leh
AFGHANISTAN
TRIBAL TERRITORY
RAWALPINDI
KASHMIR
Zaskar Range
Himalayas
CHANGTANG
RUDOK
N.W.F.P.
R. Chenab
Kailas Range
TIBET
PUNJAB
National & State Boundaries
Scale 1:5,000,000
Miles 50 0 50 100 150 200 250 Miles

1912.

1929.

Weather and works

WEATHER AND WORKS.

By COLONEL F. C. MOLESWORTH.

THIS is not intended as an exhaustive treatise on the reactions between weather and building works; such a treatise would run into volumes. The object is to give a few instances within the writer's knowledge where weather has affected building in India, which, it is hoped, may be of use to R.E. officers serving in that country and possibly to those in other overseas stations.

At home, building operations are not affected by the weather to anything like the same extent, a long frost or unusually deep snow being perhaps the only factors likely to upset the programme. In India, heavy rain may not only stop work on a building, but may also destroy the bricks in course of manufacture for its completion. In many hill stations work has to be entirely shut down for months in the winter, as frost and snow, and particularly the interruption to traffic caused by the latter, render building impossible.

It generally seems to happen that when a newcomer asks about the weather at a station, he is told that it is abnormal for that time of year—hotter than usual or else colder, more rain or less rain than in a normal year; it is seldom that he will be told that the weather is about the average. But such statements must be received with caution. Most people, even those who have been some years in a place, can seldom give the annual rainfall with accuracy, and are generally extremely vague as to how the rainfall is distributed throughout the year. Here it should be noted that the Indian Meteorological Department is in a position to give very valuable figures on the subject, detailing the average temperature, average rainfall, direction and force of wind for every month of the year, with much other useful information.

To take the case of Rawalpindi, in the Punjab: the average annual rainfall is about 34 inches, divided between summer and winter in the proportion of about two to one. The summer rainfall has been known to be over 30% in defect, while, on the other hand, the monsoon rainfall of 1919 exceeded 43 inches. It may be interesting to go round the calendar, and note the variations of weather likely to be encountered.

The winter rains begin with astonishing regularity at or near Christmas. Considerable falls take place thereafter at intervals until

March or April. The intervals may be as close together as a week or ten days, in which case the damage done to bricks drying in the sun may be serious. In the depth of winter it takes at least ten days for sun-dried bricks to be ready for the kiln, and heavy rain falling within this period reduces them to shapeless masses of mud. If one's luck is dead out, one suffers a succession of bad out-turns of bricks and, of course, not only is this the case with Government brickfields, but private enterprises suffer in the same way, and so it is no unusual thing to get at least a partial brick famine coinciding with the close of the financial year. One obvious solution is to keep a very large reserve of bricks, but this would mean the locking up of capital; another would be the erection of drying sheds, but the advantage of these would be largely nullified by the greater length of time it would take the bricks to dry.

The longest rainfall within the writer's knowledge was one which occurred between March 9th and 18th, 1911, over the N.W. Frontier Province, and a great part of the Punjab. The writer was, at the time, at Nowshera in the N.W.F.P. The approach of heavy rain was foretold by local *shikaris* in rather a peculiar way. Normally at this season a migration of *kulan*, a kind of crane, takes place from south to north; in 1911 the migration took place as usual, but on the following day the *kulan* were observed to be returning in scattered and disordered groups. The local *shikaris* put this down to severe weather in the mountains and predicted three days of rain. As it turned out, there were not three, but ten, days of rain, during which it desisted for hardly an hour. Rain penetrated every kind of roof, flat earth, tiled or concrete, even finding its way through rivet holes in corrugated iron. For some years previously, the M.E.S., for reasons of economy, had been building sun-dried brick walls, with an outer skin of burnt bricks. In most buildings of this nature, at all exposed, the burnt brick facing peeled off like the skin of an orange. The appearance of most Indian troops lines, which up to that time had been built by the units themselves, foreshadowed the devastated areas of the war. Nullah beds, which one regarded as perpetually dry, became muddy torrents. When the rain finally stopped, there was, of course, not a sun-dried brick left in the place.

The rain had a curious sequel in the station of Nowshera, where there is a very large proportion of saltpetre and similar substances in the soil. This shows up as a white efflorescence on the ground after any heavy rain, but on this occasion the efflorescence ascended even to the roofs of buildings. The process of burning bricks does not eliminate the salts in the soil, and so thoroughly had bricks been saturated that they exuded salts together with fragments of brick dust. This was particularly noticeable in the roofs of certain officers' quarters, consisting of flat earth on burnt tiles, which rained down a

mixture of tile-dust, saltpetre and whitewash. This particular evil has been largely reduced by the adoption of cement white ant-proof courses, which prevent the rise of moisture from the soil.

Another unexpected result was the uprooting of a large number of tamarisk trees along the Grand Trunk roadside. This tree is a large, shady evergreen, with leaves not unlike a pine. It gets its vernacular name, *farash*, meaning carpet-spreader, from its deposit of leaves on the ground below. These particular trees must have been from 50 to 60 years old. They were situated a few feet from the edge of the metalling, below the berm, and in every case fell outwards from the road, a fact which proves that they were not blown down. The explanation seems to be that the ground grew so sodden that the roots refused to hold, and the weight of the trees, which had a slight lean outwards, pulled them over.

To return, however, to the sample station of Rawalpindi. By the end of March the winter rains are lessening in frequency and intensity. April is often rainless, and would be one of the best months for work, were it not that labour goes off to the harvest. Formerly, in this and the following months, transport was hard to obtain, as the annual move of British troops to the hills absorbed a good deal, but this shortage is very much less acute than it was since motor transport came into fashion. From this time to the break of the monsoon, the weather is generally, though not always, rainless. Meteorological records show that an appreciable fraction of an inch is the average for May. A G.E. gambling on the weather remaining fine up to the break of the monsoon, made inadequate arrangements to protect the interior of a church which he was re-roofing, with the result that the organ was damaged to the extent of Rs. 5,000 by an untimely rainstorm.

During these months the weather is unpleasantly hot. A day shade temperature for Rawalpindi of 118° is the maximum recorded there which, however, is generally a few degrees cooler than less fortunate places such as Peshawar or Tank. The night temperature is little less. Normally the hot weather culminates in a few days of overpowering heat, and then the monsoon bursts.

The date of this event varies within wide limits. From the time that the monsoon breaks at Colombo, an event always recorded in Indian newspapers, it takes from two to three weeks to reach Bombay, and from two to three weeks more to reach Rawalpindi. But it often fails to reach the Punjab in its first stride, and indeed has been known to fail altogether. References to past diaries give dates between June 15th and August 8th for the break of the monsoon at Rawalpindi, but it has sometimes been hard to decide which of a series of dust and rain storms has actually been the break.

During the monsoon rain falls normally for two or three days at a time, and then there will be a break, during which the weather will

become unpleasantly sultry, although the actual maximum temperature of the pre-monsoon is rarely equalled. Here, again, conditions vary greatly from year to year. The average rainfall for the monsoon is about 24 inches; the highest monsoon rainfall of recent years occurred in 1919, when 43 inches fell in six weeks; curiously enough, as recorded above, the monsoon was abnormally late that year.

In spite of the heavy rainfall, building work does not suffer to anything like the same extent as in the cold weather. Sun-dried bricks are, of course, liable to destruction, but this liability is largely set off by the rapidity with which they dry. The monsoon is the time, *par excellence*, for road metalling; in the Deccan it used to be the custom to leave all road re-metalling until that time, as one could count on sufficient heavy showers to avoid the necessity of probably very expensive carriage of water.

On the coast the severity of the monsoon is, of course, much greater, and that at Bombay in 1914 will live long in the memory of those who happened to be there. The defences at the time consisted to a great extent of batteries on islands in the harbour. At these batteries there was accommodation for three or four men only, it being assumed that, on mobilization, tents would suffice for the remainder of the garrisons. The possibility of mobilization taking place during the monsoon, when tents would be quite impossible, had apparently never been envisaged. On July 30th, 1914, mobilization was ordered, and the G.E. defences had to arrange at once for the erection of temporary shelters; the loading and unloading of corrugated iron sheets on the small steamers available to cross the three or four miles of very rough sea forming in itself no inconsiderable task.

And here may be cited an example of good staff work and of the ever-ready state of the S. and M. On the afternoon of August 1st the G.E. Defences asked the A.C.R.E. Bombay (the late Lieut.-Colonel Watson, V.C.) for a section of S. and M. to help. Within 18 hours a half-company of the 3rd S. and M. had arrived from Kirkee. This was, I think, the first move of troops in India caused by the Great War.

With the cessation of the monsoon—generally about the middle of September—comes a period of dry weather. Unfortunately, conditions are then most favourable for the anopheles mosquito; hence at this period malaria is prevalent, and one's staff and work-people suffer accordingly. Nights are beginning to get cold, with greater liability to chill, which is very apt to bring out malaria.

From this time on till late December, the weather is generally fine, becoming gradually colder, ground frosts setting in at night in November. But rain is not unknown. As an example of the vagaries of the climate, it was decided, in 1928, to hold the Northern

Command manœuvres in late November, as for some years previously there had been rain at the usual period, mid-December. On this occasion rain fell between November 28th and December 2nd, causing the postponement of manœuvres though not their final abandonment. It ought to be added that transport on these occasions has to make use almost entirely of unmetalled roads, which become morasses in wet weather.

Rawalpindi has been given as an example, but even at a comparatively short distance, climatic conditions are very different. At Peshawar, for instance, 110 miles to the west, the monsoon not infrequently fails entirely. A low ridge known as the Margala Ridge,* about 20 miles W.N.W. of Rawalpindi, seems to hold up a great deal of moisture, and in some years the country to windward will be damp and green while that to leeward is dry and brown.

Snow has been known to fall, though very rarely, in the plains of Northern India. On January 31st, 1911, snow fell in Nowshera, less than 1,000 feet above sea-level. On the same date in 1929, there was a fall in Rawalpindi, which did not entirely melt until noon after the night in which it had fallen. When it is remembered that the shade temperature runs up to 118° or more in these places in summer, it will be realized that India is indeed a land of contrasts.

At Murree, distant 37 miles by road from Rawalpindi, and 5,000 feet above it, weather conditions are naturally very different: the same cycle takes place, but rainfall is much greater, and precipitation in winter takes the form of snow. Roofs there are generally calculated for four feet of snow, but although much greater depths of snow have been recorded, the writer is aware of no case where a roof has been crushed in by the weight of snow.

The only case of serious damage by snow within his knowledge was a rather peculiar one. Four long stables, with corrugated iron roofs, had been built at Khaira Gali, side by side, parallel to and on a spur, there being, perhaps, two feet space between the eaves of adjacent buildings. The two outer stables were pushed right over outwards, apparently by the accumulation of snow in the V between the roofs. On the upper side of the roofs were wind-ties of 2 in. by ¼-in. flat iron; these had been twisted through an angle of more than 90° in places, while some of the rivets connecting the ties to the sheeting had been sheared through. The moral of the story lies in the fact that the periodical clearing of snow had been abolished the previous year as a measure of economy.

The temperature in hill stations is, of course, lower than that in adjoining plains stations, but in autumn a curious reversal often

* This ridge is named from the Margala or "Cut-throat" Pass, so called from its sinister reputation for dacoities in pre-British times. A.H.Q., with a lamentable ignorance of the language, or else a very sardonic sense of humour, named the Gunner lines in Rawalpindi "Margala Barracks."

takes place, sometimes for weeks on end. Murree, for instance, has been known to be 15° hotter than Rawalpindi. It may be mentioned here, however, that the officially recorded temperature is not that at ground level, and that ground frosts may occur when the air temperature is as much as 40°F.

Before leaving the subject of temperature, the effect of a thatched roof over a tent may be noted. During every hot weather concentration of troops on the N.W. Frontier, Sappers are always inundated with demands for such protection. During the Great War, these shades were made the subject of experiment, when it was found that no appreciable diminution takes place, and that at temperatures below 90°F. a rise actually takes place.

Mention of rainfall leads naturally to the subject of floods, which, in India, seem to exceed all reasonable allowances. In 1926 a railway bridge over the Narbada was destroyed by a flood which beat all previous records by fifty feet, records going back for 70 years. But they do not always wait for 70 years; indeed, it is almost a commonplace that as soon as a bridge is completed a record flood comes along. An instance may be quoted where a small bridge, just north of Chakdara on the Chitral road, was completed on Saturday. On Sunday, the bridge and engineers were photographed together. On Monday came a record flood, and when it subsided all that was left of the bridge was a lump of concrete which had once been an abutment.

In the earlier days of railway-making in India, cases occurred where rivers deserted their ancient channels, over which expensive bridges had been built, to make new courses elsewhere, incidentally breaching long stretches of the line: new bridges had, therefore, to be built, or else the river had to be coaxed back to its former bed by elaborate training works.

But even floods may be made to do their bit. The writer had once the interesting job of protecting the abutment of the Connaught bridge at Chakdara from being scoured away by the River Swat.*

Briefly stated, the protective works consisted of a series of dry stone *bunds* enclosed in wire netting, built across the deepest and swiftest part of the river. By means of these, the main current was diverted into a safe channel, and floods began to silt up the deep holes where the main stream had formerly flowed. Willow trees were planted on the sandbank that emerged at the end of the flood season. The accompanying photos show the growth of dry land and trees in 16 years.

Most Sappers can probably record instances of phenomenal wind; here are some examples. A cooking shed for Indian troops, consisting of a curved corrugated iron roof on brick pillars, with tie-rods going down through the pillars to below ground-level, was lifted

* These works were described in the *The R.E. Journal* for February, 1913.

into the air by a storm in 1920, one end of the shed alone, which formed an anchor, preventing it from a distant flight. It was calculated that the upward pressure of the wind must have been about 36 lb. to the square foot. In the same year, a brick wall, as far as memory serves about 10 ft. high and 13½ in. thick, with buttresses, at Chaklala, near Rawalpindi, was blown over; the pressure in this case must have been about 52 lb. to the square foot, allowing nothing for the adhesion of the mortar. The humour of the situation lay in the fact that a circular had just been received from A.H.Q., stating that the maximum wind pressure ever recorded in that part of India was 9 lb. per square foot, and that 10 lb. was all that need be reckoned on.

In the hills, terrific up-draughts are sometimes experienced, especially on spurs which, for fairly obvious reasons, form sites for barrack buildings. At one such place, Khanspur by name, a rush of wind caught an exposed verandah with a sheet iron roof, tore it from the main building, and doubled it back on itself with the verandah posts pointing vertically upwards.

Violent thunderstorms are very common in these hill stations; most buildings are protected by lightning conductors consisting of a flat strip of galvanized iron connecting roofs with moist ground or water-pipes. Only one case, and that a most peculiar one, is known to the writer, of a building actually being struck by lightning. At a hill station, Bara Gali by name, a small ration store was struck, a hole two or three feet long being made in the wooden shingled roof, and a corresponding hole in the concrete floor of the verandah, parts of which were thrown up with such force as to stick firmly in the underside of the roof. There was very little iron in the building, and no iron rod or other member was touched. Moreover, the building was situated between two much higher ones, both with iron roofs, surrounded by much taller spruce trees, a variety which is itself very liable to be struck.

The chief value of these notes to officers not serving in N. India lies in the fact that the freaks and vagaries of weather recorded took place in a climate which is regarded as one of the most stable in the world.

THE CONSTRUCTION OF RAISED MAPS.

By LIEUTENANT D. M. ELEY, R.E.

1. INTRODUCTORY.

IN the Model Room at the Senior Officers' School, Sheerness, a certain amount of work is done on the construction of raised maps. A number of maps of an imaginary area have been turned out for use in training, and during the early months of 1934 two special maps were made, one of the Eastern Command Training Area in Bedfordshire and Cambridge, the other of the Tidworth Tattoo Arena.

The following is a description of the methods used in the construction of these maps.

2. EQUIPMENT.

No special equipment is required for the production of these maps, which are made in a disused hut furnished entirely with articles of normal supply. Six-foot tables form the work benches, a stove is installed for drying as well as for warming purposes, and the only special tool is a treadle fret-saw which is used for making models of buildings on large-scale maps.

Appendix I gives a list of the equipment required.

3. CONSIDERATIONS OF SIZE AND SCALE OF MAPS.

(*i*) *Horizontal.*

Raised maps may be made of any size and to any scale, the only serious limiting factor being labour.

When the complete map is large, it is advisable to make it in sections, for apart from considerations of portability, large areas of the paper materials used tend to warp out of shape in the making. This is especially the case if the map is of a very flat area, as it then lacks the strength given by hill corrugations.

Experience has shown that the best size for a section is of the order of 5 ft. to 6 ft., but one 12 ft. by 6 ft. has been made, and at the other extreme, a specimen model 18 in. square.

(*ii*) *Vertical.*

Again, there are no reasonable limits to the vertical scale that may be adopted.

When small horizontal scales are used and the area does not contain any marked hill features, it is almost essential to exaggerate the vertical scale, or the completed map will probably be of little more use for training purposes than a straightforward enlargement of the Ordnance Survey map.

Exaggeration also gives in most cases the extra stiffness that has been mentioned as coming from hill corrugations.

To what extent exaggeration can be made without prejudice to the usefulness of the map as the reproduction of a particular area it is difficult to say, but it is thought that a ratio of about 12 is the maximum for an area lying below about 800 ft.

4. Short Description of Method of Construction.

From a full-sized plan of the area to be reproduced the modeller makes a sand model, called the " mould."

The map is built up on this mould by pasting on in alternate layers brown paper and papier mâché torn into small pieces.

When dry, it is lifted off the mould, and completed by colouring and drawing in the detail.

When a raised map of an imaginary piece of country is required, a plan is hardly necessary, and work may begin with modelling the surface of the mould.

A map of this kind is best designed with four sections, differing as to their main features but with all sixteen sides the same shape. By putting the sections together in different positions many different maps may be obtained, and the chief disadvantage of the raised map as compared with the sand-table largely overcome.

5. Preparation of Plan.

The full-sized plan mentioned above is a simple enlargement of the map of the area to be reproduced, gridded in about 4-in. squares, and showing only the contours at not greater than 100 ft. V.I. and the rivers and streams.

6. Construction of Mould.

(i) The mould is made on a stiff baseboard, and its sides are built up of wooden laths which are afterwards replaced by the wooden frame carrying the completed map.

It is preferable to use a baseboard of such a size that it will just fit inside this frame, as the latter can then be made of any depth required without the need for using extra sand in the mould, but this leads to waste of timber and can rarely be done.

(ii) The mould is built up contour by contour, the laths supporting the sides in the first stage being of the depth taken to represent the contour interval.

The first laths are nailed down to the baseboard to the size of the map required, so forming a shallow tray which is then filled level with sand firmly pressed down.

The surface of this sand represents the level of the particular contour next below the least height of ground on the whole map, irrespective of the least height on the section under construction.

(iii) Further laths are added on top of the first and more sand filled in until the contour level next below the least height of ground on the section is reached (see Fig. 1).

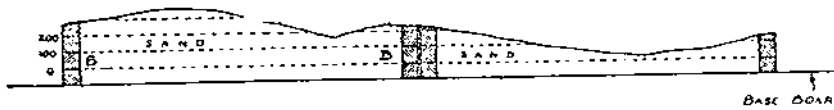


FIGURE 1.—Note: A small base-board might have been fitted into B B, and two layers of sand saved.

(iv) The grid mentioned in para. 5 is then marked out on the surface of the sand with straight-edge and scriber (see Plate I) and the next contour is drawn in by eye from the plan.

Another lath, corresponding to this contour, is then nailed along the sides between the points where the contour cuts them, and a layer of sand filled in, moulded roughly to the shape of the contour by hand and trimmed with a trowel.

(v) This procedure is repeated until the level of the highest contour on the section is reached.

The mould then has the appearance of a series of steps. Plate I shows this stage in the construction of the mould for the north-west section of the Eastern Command Training Area map. The photograph was taken from the north side of the section, and it is interesting to compare it with the tracing of the O.S. layered map of the same area (Plate II).

(vi) The process as described so far would appear to be entirely one of building up the steps of sand. In practice, time and labour are saved by cutting sand away where there are small areas lying below the level of any particular contour.

In Plate I the small area in the left foreground was cut out in this way, as were the smaller re-entrants from the large valley running up the centre.

(vii) Before any further work can be done on the mould, the sides of built-up laths must be replaced by the wooden frame which will carry the completed map (see Fig. 2).

The top of each side of the frame is carved to the shape of the ground at the edge of the section, and matched with the adjoining side of the next section.

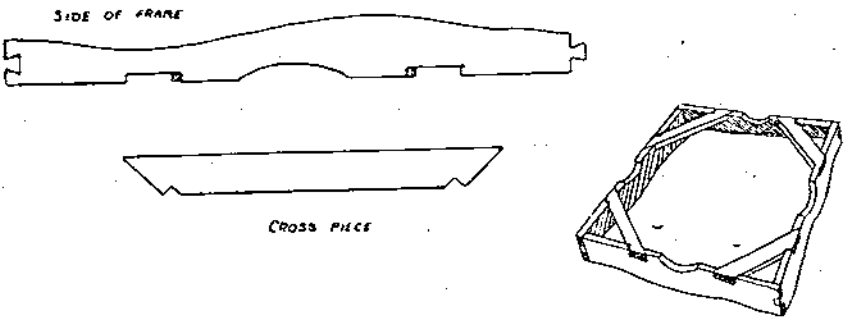


FIGURE 2.—Detail of a frame.

(viii) The next, and last, stage in the construction of the mould is probably the most difficult of the whole process.

Starting from the top, sand is built into the steps, across the valleys and over the topmost contour levels, and smoothed to the actual shape of the ground, the folds in the finished surface running into the curves of the top of the frame. A continual check must be kept on the depth of sand added, the method of doing so being devised to suit the features on the map.

7. CONSTRUCTION OF THE MAP.

(i) The map is a permanent reproduction in paper materials of the surface of the mould.

Brown paper, papier mâché, and paste made from flour and water are used. (For details, see Appendix I.)

(ii) Brown paper forms the first layer. It is torn roughly into small pieces—the more pronounced the hill features on the mould, the smaller the pieces—well pasted on both sides until softened, and laid on the surface of the sand.

The first pieces are carried well down the sides of the frame, and the whole of the mould is then covered, each piece of paper overlapping its neighbour by about 50% and being smoothed well down into the folds in the surface, avoiding air bubbles.

(iii) This process is then repeated without pause, using papier mâché for the second layer, and again the first pieces must be carried well down the sides of the frame.

Three layers of brown paper and two of papier mâché, applied alternately, are normally required, but more may be added if the section is a large one, in which case it must be remembered that the

last layer must be of brown paper. The map is then left to dry.

(iv) The drying process cannot be hurried without risk of serious warping and lifting of the paper, and takes at least a week.

A close watch must be kept on the map, and it may be necessary to retard the process if any serious loss of shape is seen to be taking place.

It should be noted that frost can have as bad an effect on the map in this respect as excessive warmth.

(v) When dry, the map on its frame is lifted off the mould, but before it is ready for the finishing touches there will usually be a number of small adjustments to be made, due to uneven drying-out of the paper. These are as follows :—

Air Bubbles.—May be removed by slitting with a sharp knife or razor blade, and pasting more paper over the cut.

Contraction.—The paper will often contract and lift between two features or along the edges of the section.

The fault may be removed by cutting through as before, and pasting more paper into the hollows ; or a brass wood-screw may be passed through the highest feature and screwed down into an extra cross-piece fixed inside the frame until the paper is drawn into the correct shape. The head of the screw is then papered over.

8. FINISHING.

Before the map is handed over to the draughtsman, a colour-wash of green distemper is sprayed over the whole surface, followed by patches of brown and dark blue on the hill-tops to add to the relief.

When this is dry, the draughtsman lays over the surface the original grid, in the form of a network of string fastened to the frame with drawing-pins.

The detail required is transferred from the map and in the case of the smaller scales is all shown by drawing, with the exception of woods and orchards. These are represented by patches of green moss, which may be glued directly to the surface of the map, or first glued to a sheet of paper from which the shapes of the various woods are cut and pasted to the map.

Plate III shows the north-west section of the map of the Eastern Command Training Area with the drawing of the detail completed.

Appendix II gives details of colours and materials used.

9. ALTERNATIVE METHODS OF CONSTRUCTION.

The methods already described cannot be improved upon for speed or cheapness when only a very limited number of reproductions of a map is required.

A sand mould can be used for three reproductions at most. Each time the completed map is lifted off the mould, repairs will be necessary to the edges of the sand, but the surface generally suffers little, the paste from the papering tending to consolidate it.

When, however, a large number of reproductions of a map is required, the mould must be made of more lasting form, and one of the easiest materials to work is plaster-of-Paris.

Construction of Mould in Plaster-of-Paris.

A sand mould is first made as already described, enclosed in its frame. Another frame is then made, the curves on its edges reversed so that it fits exactly on top of the first.

The surface of the sand is then coated with a thin layer of paraffin-wax or candle-grease, applied hot with a brush, and the two frames are battened together (see Fig. 3).

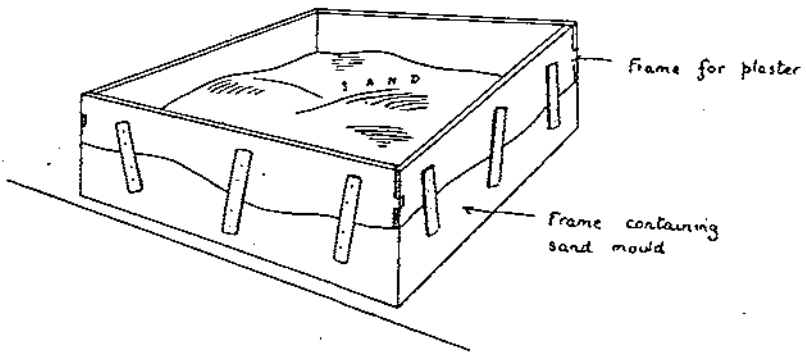


FIGURE 3.—Frame fixed above mould ready for plaster to be poured in.

Liquid plaster-of-Paris is then poured into the upper frame, care being taken that the surface of the sand is not disturbed, and pieces of canvas are put in at close intervals to form a reinforcement in the body of the plaster.

The plaster used is moulders' plaster-of-Paris, which sets very quickly. The process has, therefore, to be carried out with speed, and it is usual to have at least four men employed, mixing the plaster and pouring in.

When set, this plaster " negative " in its frame is lifted off the sand mould and is ready for the next stage.

Construction of Map from Plaster " Negative."

The frame for the map is the same shape as the frame for the original sand mould, and therefore fits exactly over the frame of the plaster " negative."

The two frames are battened together as before, and papering is carried out as already described, with the exception that the paper is pasted on the inside of the frame.

There is one other variation. The paste tends to stick the paper to the plaster, and pieces of the latter would be pulled off with the map if an insulating layer were not interposed.

The first layer is, therefore, of "target paper," brown paper and papier mâché then following in the usual way.

Use of Cement for Mould.

Cement may be used instead of plaster-of-Paris in exactly the same way, except that the use of wax and of target paper is not necessary.

10. Maps for Special Purposes.

(i) A map of the Tidworth Tattoo Arena has been made for use in planning various parts of the programme.

The scale adopted was 25 ft. to 1 mile with no vertical exaggeration, and the map was made in two sections, each 12 ft. by 6 ft. Parts of the area were very flat, and many difficulties in the form of warping were met. A number of cross-pieces had to be fixed inside the frame, both to stiffen it and to carry packing to support the map itself.

As much detail as possible has been shown, wooden models of part of Tidworth House and of the Tattoo grandstand being made, trees represented by dyed loofah cut to about the same size and shape as a port glass, and all fences being modelled.

(ii) A map of an area in North Wales has also been made, for use in training in mountain warfare.

(iii) For instruction in elementary map-reading it has been suggested that a map of an imaginary piece of country, or a reproduction of a local area which could be visited by the students, would be useful if part of the detail were replaced by detachable labels describing the geographical features, and the contours drawn on the surface.

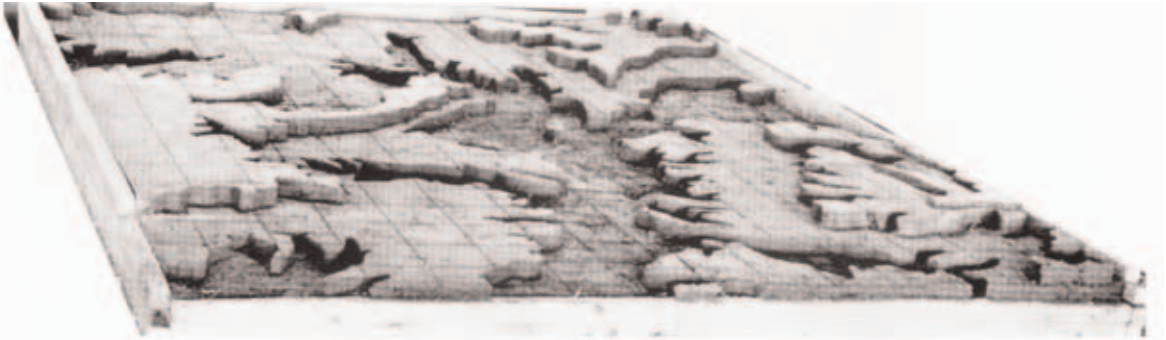
The design of such a map is in hand.

(iv) Most special requirements may be met by similar variations in the finishing, the methods of construction of the map itself differing but little from those described.

APPENDIX I.

Tools and Stores.

1. *Tools.*		
Brushes, distemper	2	For paste.
Buckets	2	Ditto.
Paint sprays	3	For distemper. "Flit" guns are cheap and efficient.
Shovels, R.E.	1	
Straight-edge, 10 ft.	1	
Trowels, large and small ...	2	



North.

Plate I.—First stage in construction of model completed. Eastern Command Training Area. North-west Section. 4-in. (i.e., 1 mile) grid marked on sand.

Compare with Plate II.

The construction of raised maps - North

Plate III.—Completed raised map.

The construction of raised maps - Completed raised map

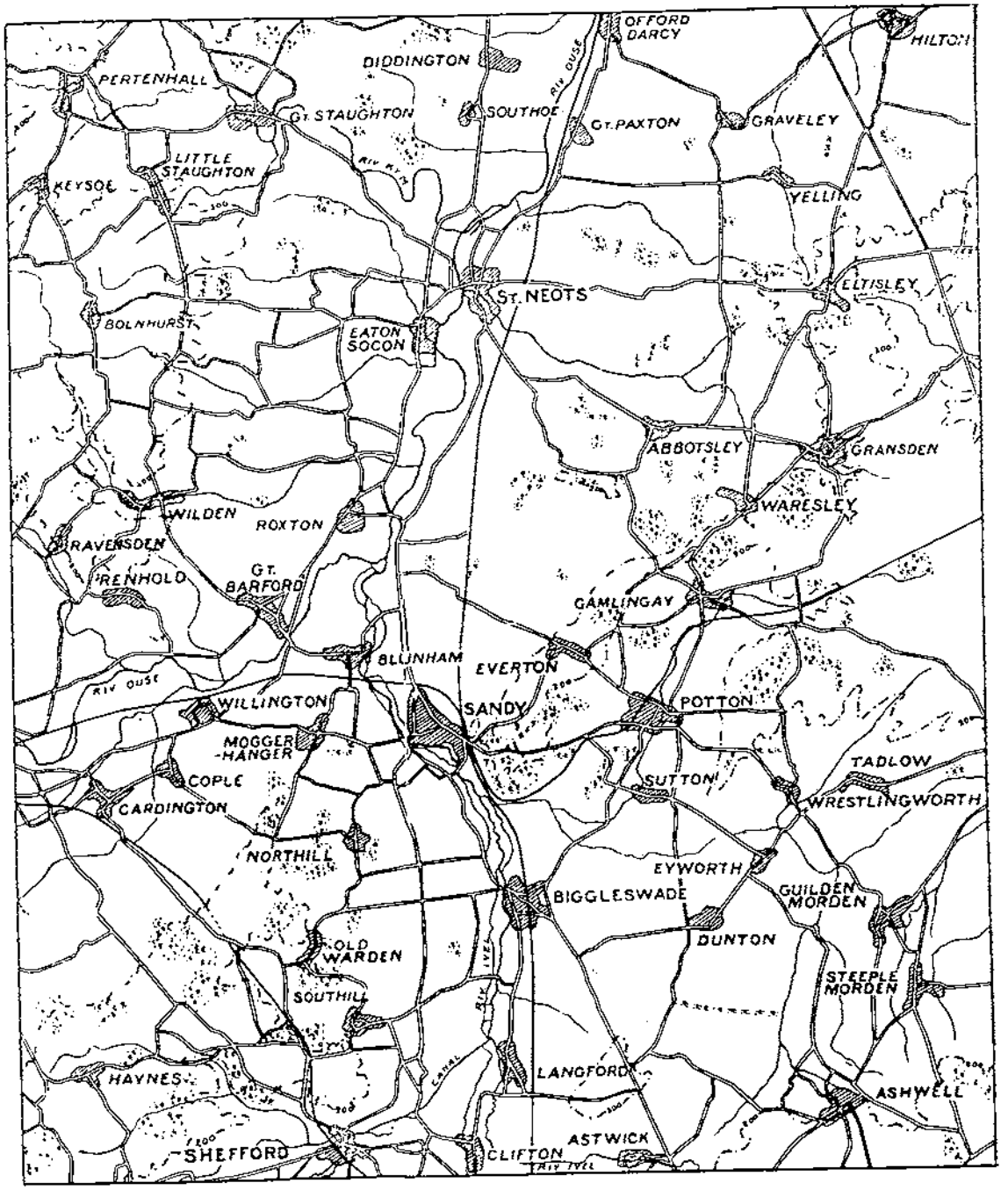


PLATE II

PART OF EASTERN COMMAND TRAINING AREA.

(Based upon the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office.)

(Mackays Ltd., Chatham.)

2. *Stores.*

Brown paper	Obtained from H.M. Stationery Office, price about £2 10s. for 5 cwt. (2d. per sheet).
Papier mâché	From any paper mills, price from 30s. to £2 per bale of 500 sheets (sheets 2 ft. square).
Target paper	From Messrs. McQueen's, of Glasgow, price about £2 5s. for 50 quires (sheets 37 in. by 27 in.).
Sand	Moulders' sand (sand and clay in approximately equal quantities).
Timber	For baseboard (1½ in.), frames and laths (1 in.).

Flour, glue, etc.

The cost of the stores for a raised map 12 ft. by 10 ft., in four sections, will not be more than £3.

APPENDIX II.

Materials and Colours Used in Finishing.

Background ...	Green	"Robbialac" distemper.
Hills	Blue and brown ...	,, ,,
Roads (all classes) ...	Yellow	,, ,,
Built-up areas ...	Grey inside black edging	Drawing ink.
Railways	White hatched with black	,, ,,
Rivers	Ultramarine ...	,, ,,
Place-names ...	White	,, ,,
Woods and orchards	Green moss... ...	(Obtainable from any florist, as used for wreaths, price 4½d. per packet.)

THE PEROXIDE HYPOTHESIS OF "PINKING."

By CAPTAIN O. STURT, R.E.

[*An article on pinking, by Captain K. A. Lindsay, R.E., appeared in "The R.E. Journal" of December,* 1930. *The present article includes certain new information on the same subject.*]

"PINKING," or "fuel knock," in a petrol engine is well known to everybody who drives a car and almost any garage hand can diagnose the symptoms; but there are very few people who have any clear idea as to what it really is, or why any of the known cures are effective.

Recent research by the late Professor Callendar and others has resulted in an hypothesis being worked out which allows of a logical explanation of most of the observed facts, and which, if not a completely satisfactory explanation, is such a great advance on any previous hypotheses that it deserves to be better known.

THE OBSERVED PHENOMENA OF "PINKING."

Pinking manifests itself as a rapid rise of pressure in the cylinder which occurs at about the same point in the explosion stroke as the normal maximum pressure occurs (see diagram). The "flame speed" when pinking occurs is roughly four times that of the flame speed of the ordinary combustion of petrol under similar conditions. Flame speed velocities are largely dependent on the conditions of turbulence in the engine and the degree of intimate mixture between fuel and air. For ordinary combustion this flame speed may vary from 50 to 200 feet per second, so that the pinking flame speed varies between 200 and 800 feet per second.

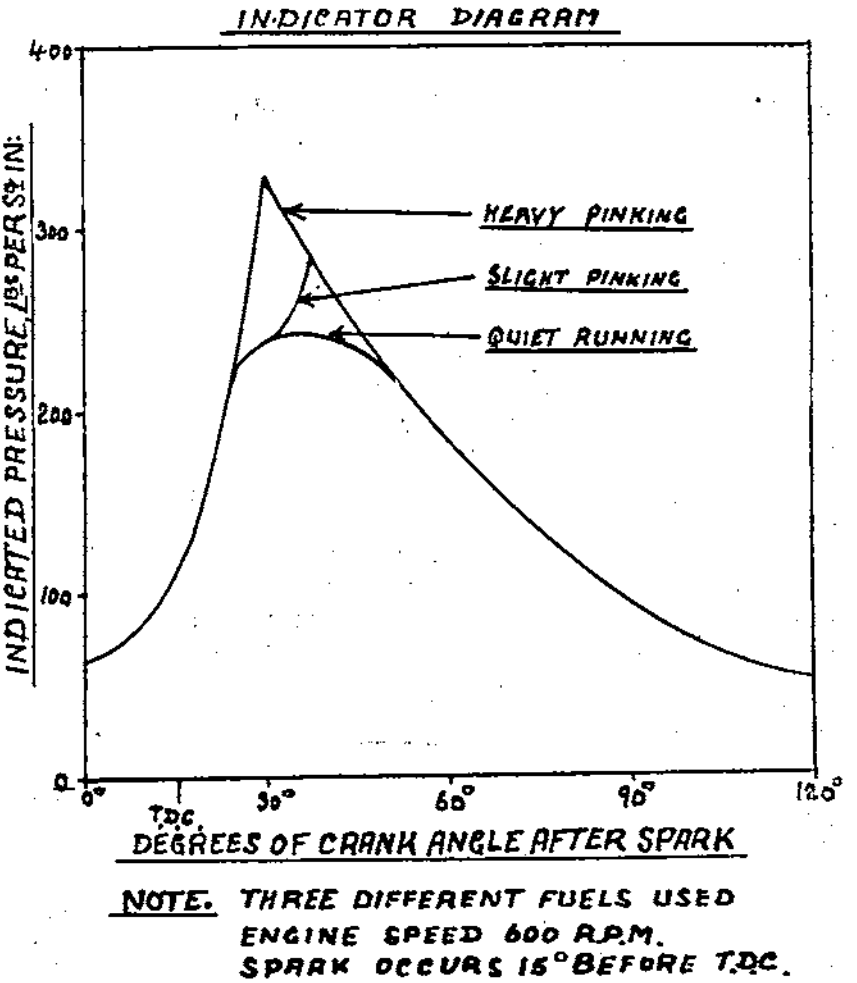
TWO POPULAR FALLACIES.

If the above facts are accepted, we are able to rule out two popular explanations of pinking.

Pinking is not pre-ignition, though pre-ignition may occur in an engine from other causes. For, if it were pre-ignition, it would occur earlier in the explosion stroke than it has been found to do.

Pinking is not a detonation, though the belief that it is has been, and still is, widely held. The flame speed of a true detonation is from 5,000 to 10,000 feet per second, and the explosive gas is fired by an

adiabatic* compression wave; while the flame speed in a pink is under 1,000 feet per second and the method of flame propagation is quite different. It is improbable that a detonation has ever occurred in a small petrol engine. There are a few cases on record where it is believed that a true detonation wave has been set up in



large internal combustion engines. The result in every case has been the wrecking of the engine.

Factors Affecting Pinking.

A consideration of the various conditions which are known to cause, or prevent, pinking will take us a step farther.

(1) The propensity of a hydro-carbon fuel to pink depends to a

* Without the transference of heat to or from the surroundings.

considerable extent on its composition. One containing a high percentage of long chain compounds, like N-hexane (C_6H_{14}) or N-heptane (C_7H_{16}), will be a ready pinker, while a fuel composed chiefly of ring compounds such as benzene (C_6H_6) and cyclo-hexane (C_6H_{12}) will be a "non-pinker."

The alcohols (CH_3OH and C_2H_5OH) are excellent non-pinkers, and the addition of a percentage of alcohol to a petrol will improve its anti-pinking qualities to a marked degree.

(2) The addition of a small percentage of exhaust gas from a previous explosion to the explosive mixture will decrease the liability of the engine to pink. This is the real reason why an increase of the compression ratio produces pinking. For when the compression ratio is raised, the amount of burnt gas which is left over from the last explosion, and is mixed with the new explosive vapour, is reduced. It is this burnt gas admixture and not the actual compression ratio which affects pinking; and if it is arranged to add extra burnt gas to the explosive mixture, a fuel which normally pinks at about 6 : 1 will not even pink in an engine with a compression ratio of as much as 12 : 1.

(3) Various substances, if added to the explosive mixture, greatly improve its anti-pinking qualities.

Some of the best known of these substances are lead ethyl [$Pb(C_2H_5)_4$] and water.

Petrol doped with lead ethyl is now a common commercial product. An emulsion of 7% of water with petrol makes a good fuel with excellent anti-pinking properties; while a few drops of water injected into the induction pipe is a well-known and very efficacious cure for pinking.

(4) Certain substances, such, for example, as bromine, promote pinking and, if present even in quite small quantities in an otherwise good fuel, will make it unusable in an ordinary engine.

(5) The design of the engine has an effect on the liability to pink. A high degree of turbulence in the mixture in a cylinder tends to reduce pinking, but it gives a rough engine (which is often mistaken for pinking) due to the high rate of burning induced by the rapid motion of the gas. It is interesting to note that it is possible to design an engine with such a high turbulence that the engine will not work, as the spark is blown out by the very rapidly-moving gas. If there is a hot spot (such as an exhaust valve) which is well away from the spark, or the engine is running very hot, the engine is more liable to pink than if it were running cool or if the spark occurred near the hot spot.

(6) An increase of the engine speed will reduce pinking.

(7) A retardation of the spark will often decrease pinking.

(8) An engine will pink more readily if there is a deposit of carbon on the piston and cylinder head than if they are clean.

The Peroxide Hypothesis.

When a hydro-carbon vapour is compressed adiabatically, small liquid globules are formed. If these globules are kept at a fairly high temperature in the presence of oxygen, certain peroxides are formed such, for example, as benzoyl peroxide $[(C_6H_5CO)_2O_2]$.

These peroxides are unstable compounds and burn at a very rapid rate and, if this burning takes place while the crank is near top dead-centre, a rapid rise of pressure results, which gives a sharp hammer-like blow on the piston—the well-known "pink-knock."

How does this hypothesis agree with the observed facts? First it can be proved experimentally that when there is pinking in an engine peroxides are actually formed, and further, then, when pinking does not occur, peroxides are either not formed at all or only in relatively small quantities. The above does not, of course, prove that these peroxides cause pinking; but it seems sufficient to justify us in considering how far this hypothesis will explain the eight observed facts about pinking mentioned above.

(1) It can be shown that all the fuels which are ready pinkers form peroxides easily, and conversely, that those which do not pink readily are slow to form peroxides.

(2) It is reasonable to suppose that if the "mixture" air is diluted by inert exhaust gases, there will be less oxygen in contact with the peroxide-forming globules.

It is also possible that some of the products of combustion may act as anti-peroxide formers, but this is a point on which further investigation is required. Water, which is present in exhaust gases as one of the products of combustion, is certainly a good anti-knock agent; but it has been shown that even an exhaust gas which has been cooled and dried has definite anti-knock properties.

(3) Lead ethyl, and certain other substances, can be proved to check the formation of peroxides. The action of these substances can be explained as follows.

If A is a substance liable to form peroxides and B is a substance which checks the formation of peroxides, then

$$A + B + O_2 \longrightarrow AO_2 + B.$$

B now attacks the peroxide formed and

$$AO_2 + B \longrightarrow AO + BO.$$

These oxides now interact and

$$AO + BO \longrightarrow A + B + O_2,$$ which is back to where we started.

This at first sight might seem unlikely, but a similar cycle of reactions is quite common in chemistry.

Water is the only substance which does not completely fit in with the peroxide hypothesis. As far as experiments have gone, water

has very little effect on the formation of peroxides, yet it has a very marked effect on pinking. This effect is greater than it would be if the "anti-knock" properties were only due to the dilution of the oxygen by the steam. The observed effect of water on pinking will have to be fully explained before the peroxide hypothesis can be promoted to the status of a theory.

(4) The group of substances which promote pinking are catalysts which also promote the formation of peroxides.

(5) Heat and time are required for the formation of peroxides and one would therefore expect to find that pinking is worse where there is a hot pocket of gas which is not burnt till fairly late in the explosion. And this is exactly what is found to happen.

(6) As peroxides take time to form, any reduction in the time available for them to form should improve matters.

This is found to be the case in practice, as an increase in the engine speed does reduce pinking.

(7) It is doubtful if retarding the spark checks the formation of peroxide, but they do not get a chance to burn until the piston has begun to move down, so that the "hammer-blow," instead of striking on the rigid vertical crank, is cushioned by the movement of the piston; and the "knock" which is the audible sign of pinking is thus avoided.

(8) The fact that a dirty engine will pink more readily than a clean one is explained by the fact that the carbon deposit increases the effective compression ratio. Further the carbon deposit slows up the flow of heat to the cooling water and results in the engine running hotter.

It is also probable that sometimes the knock heard in a dirty engine is a pre-ignition knock caused by a piece of red-hot carbon causing the charge to fire before the spark occurs.

ANTI-KNOCK FUELS.

The importance of the development of a non-pinking fuel lies in the fact that the efficiencies that can be obtained in a petrol engine are limited by the compression ratios which can be used, and these in turn are controlled by the "pinking" propensities of fuels used in the engine.

Racing engines using alcohol as a fuel are now designed with compression ratios as high as 18 : 1.

The most promising non-pinking fuels are :—

(*a*) Petrol doped with lead ethyl (about 6 c.c. per gallon). The commercial lead ethyl dope usually also contains ethylene dibromide ($C_2H_4Br_2$) and monochlor naphthalene ($C_{10}H_7Cl$). The first of these substances is introduced to counteract the corrosive effect of the lead which is liberated from the lead ethyl: while the second is

used to dissolve any gum which may be deposited in the cylinder. Lead ethyl is poisonous but, in the small quantities in which it is present in a doped petrol, it is not objectionable.

(*b*) Petrol mixed with alcohol. About 20% of alcohol is a suitable mixture. Cheap synthetic methyl-alcohol can now be made from coal.

(*c*) A coal or shale distillate. These fuels contain a high percentage of ring compounds and are therefore good non-pinkers.

An excellent fuel can be made from coal either by the low temperature carbonization or the hydrogenation process.

These fuels can also be mixed with petrol to give good anti-knock fuels.

(*d*) Petrol emulsified with about 7% of water. A disc emulsifier produces an emulsion which will remain stable for long periods.

Octane Numbers.

The anti-knock properties of a fuel are usually expressed in terms of its "octane number," and a brief explanation of this expression might be useful.

It has been found that N-heptane (C_7H_{16}), which is a straight chain compound, is an extremely ready pinker, while an iso-octane (C_8H_{18}), which is a synthetic hydro-carbon, is a very good non-pinker. A fuel is said to have an octane number of, say, 80, if a mixture of 80% iso-octane and 20% heptane has the same propensity to pink as the fuel in question. Thus the higher the octane number of a fuel, the better it is from an anti-knock point of view.

The following are the approximate octane numbers of various types of fuel:—

A good petrol	70
A bad petrol	62
15% alcohol, 85% bad petrol	71
25% alcohol, 75% good petrol	77 or higher
7% water in a good petrol	75 " "
A good petrol doped with lead ethyl	77 " "
A mixture of benzene (coal product) and a fair petrol	74 " "

A WEEK'S HOLIDAY IN THE DESERT.

By LIEUTENANT A. W. G. DOBBIE, R.E.

WHEN there appears in the paper a statement that " Mr. So-and-So has set off on a desert trip with the object of, etc.," there at once arises in the mind a picture of a caravan of Arabs leading laden camels, headed by a few white men, trudging wearily over soft sand, such as one finds at the more popular seaside resorts in England. The sun is blazing down, the desert is smooth and level as far as the eye can see, with perhaps a mirage of an oasis visible in the distance. There is no sign of life, animal or vegetable, and the silence is broken only by the guttural remarks of the camel men, or the grumbling of the camels. There is a deadly monotony everywhere.

In reality, such is by no means the case. The desert consists of many types of geological formations, from sheer rocky cliffs, 2,000 feet high, which have withstood the corrosive effects of long-vanished rivers, to sand dunes, into which one sinks ankle deep. One frequently finds areas containing desert scrub, or perhaps a few palm trees, and it is by no means rare to see signs of animal life, camel or gazelle, birds and butterflies.

The following account is of a short desert trip, taken by four officers during the Easter recess, 1934. It is of no outstanding interest or in any way unique, but merely shows that a very interesting holiday can be had for a small financial outlay, and that parts of the country can be seen which are never visited during the normal course of army life.

OBJECT OF TRIP.

The object of this trip was to try to find a new route from Cairo through the coastal range to Hurghada, on the Red Sea. Most of the country we hoped to traverse had been visited by the Desert Survey of Egypt and the F.D.A.,* and a year previously an M.T. convoy of the Royal Tank Corps had, with R.A.F. assistance, covered more or less the same ground as we proposed to cover.

COMPOSITION OF PARTY.

The party was to consist of four officers and two cars. Three of the party were detailed off for special jobs—navigator, mechanic

* Frontier Districts Administration.

and cook—while the fourth was the odd job man. A party of this size is a very convenient one, as it is not unwieldy, can be self-contained for 600 miles, and when in bad going, sufficient man power is available to help manhandle the cars out of soft sand. The member in charge of each job was entirely responsible for producing the materials and for all arrangements connected with them. The preparation was thus decentralized entirely, and so the work of each individual was reduced to a minimum.

Vehicles.

The cars we proposed to use were both Fords, 24 h.p. This simplified the spare parts question considerably, and we knew from previous experience that Fords are excellent cars in the desert. One was a tourer, 1933 model, and the other a van, 1930 model. The latter was the more convenient of the two as its carrying capacity was greater, and having a flat bottom, the packing of stores, especially of petrol tins, was simplified.

Both were fitted with big low-pressure tyres, nine inches wide, and so could cross soft sand in which a car fitted with normal tyres would stick. These tyres were of the utmost value to us and saved us endless time and fatigue. The van was hired at the cost of 110 piastres per day (£1 2s. 6d.). We carried a comprehensive set of spare parts, such as front and rear springs, inner tubes and outer-covers (in addition to the normal spare wheels), ignition parts, spare coils and condensers, valves and valve springs, puncture repair outfits, rubber joints for the water jacket, a tin of "Stop Leak" for the radiator, fan belts, gaskets, etc. Altogether a very formidable list. These we hired from a shop in Cairo and paid five per cent. of their value if unused and, of course, the full value of any article we took into use.

Food.

The food question was fairly simple. As we were on a holiday and expense, within reason, was not of paramount importance, the cook decided that a few luxuries in the messing, would make all the difference between enjoying the meals and merely eating them. This, in turn, would reflect on the tempers of the party and the enjoyment of the whole trip. Merely another example of an army marching on its stomach.

The menu was as follows:—

Breakfast Two rashers of bacon, two eggs and fried bread. Tea, milk and sugar. Margarine and marmalade.

Elevenses. Biscuits, chocolate and lime juice.

Lunch. Sardines, tongue, cheese, bread, margarine, biscuits and lime juice.

Tea. This meal was usually dispensed with, because we used to stop for the night at about 1700 hours and promptly set about preparing for supper, while the mechanic looked over the cars and executed running repairs. The cook, however, generally made tea for the party.

Supper. Either fried sausages, mashed potatoes and boiled onions, or bully stew containing bully beef, potatoes, onions and some tinned vegetable.

For sweet, there was tinned fruit and tinned cream with whisky and gin for liquid refreshment.

Most of the food was tinned. The eggs were packed in salt, and the bread wrapped up in greaseproof paper and newspaper.

The cooking stove was an old 4-gallon petrol tin with half of one side cut away and an 8-inch circular hole cut in the top. Wood was the fuel used, which we brought with us. This is a most satisfactory stove for an expedition of this nature, because it is scarcely affected by wind or sand and is much hotter and more foolproof than a Primus. The cost of messing worked out at 20 piastres (4s.) per head per day.

The water was carried in new 2-gallon petrol tins, kindly lent us by the Shell Co. We carried 12 gallons, which, with the ration of half-gallon per man per day, gave us a large reserve. Washing and shaving were dispensed with.

KIT.

The kit we took was reduced to a minimum. We wore shorts or grey flannel trousers and shirt, carrying a sweater and greatcoat for the evening. A valise containing three or four blankets and a small suitcase with a change of clothing was sufficient.

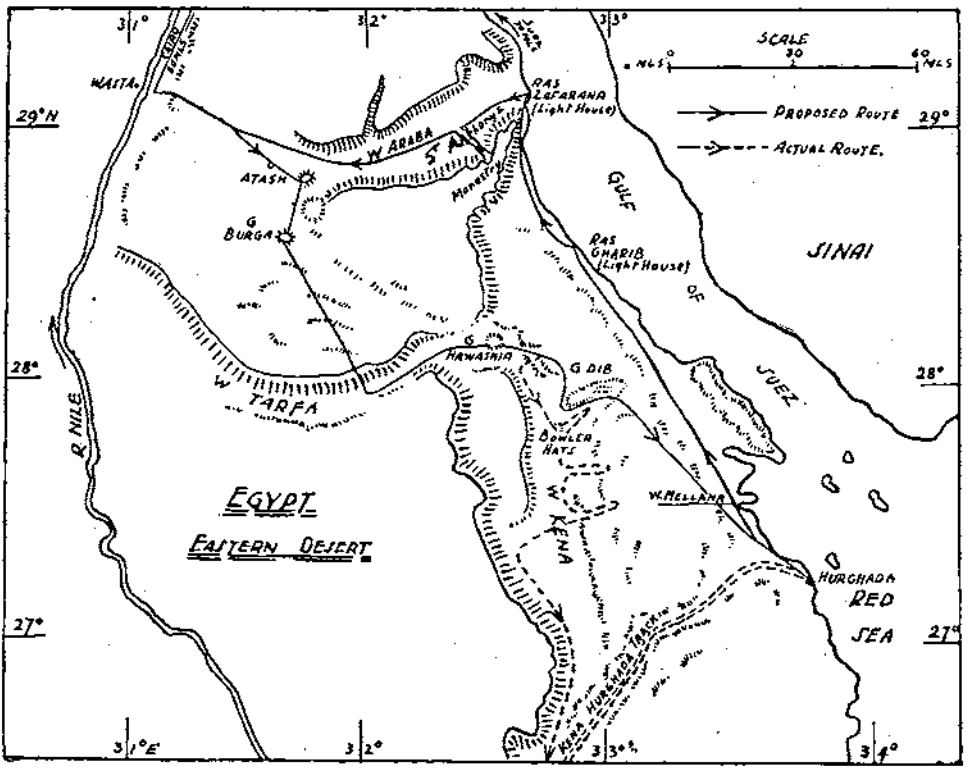
ROUTE.

The route we proposed to take is shown on the accompanying sketch. We obtained maps of the locality from the F.D.A., but were warned that they were extremely inaccurate in parts, as we found to our cost. The distance of Hurghada from Cairo by our proposed route was 370 miles. We carried petrol for 500 miles only in 2-gallon tins, because at Hurghada we knew we could replenish our water and petrol supply.

For navigation we had the ordinary service compass and protractor and the speedometers on the cars. We were to drive on compass

bearing and as each leg was at least 15 miles long, the delay caused by stopping and walking away from the car to obtain accurate bearings was small. We had been warned by the R.T.C. that there was a certain amount of iron-stone in one locality which would upset the navigation, but this area must have been small and we noticed no eccentric behaviour of the compasses.

In case we got into serious difficulties we had left our route with



an officer in Cairo with instructions that unless he heard from us by a certain date he was to take steps to have a search party sent out for us. This would probably have consisted of R.A.F. machines.

The Journey.

Having made all arrangements possible, we set out at 0900 hours on March 28th. The first stage of the journey was along a mud road to a native village on the East bank of the Nile, opposite Wasta. Here we filled up our petrol tanks and so set off into the desert. The next 30 miles was along a well-defined desert track down the Wadi Araba. The going was excellent, and with our air wheels, we averaged 30 m.p.h. When our speedometers showed us that we

had gone the requisite distance, we stopped and took a compass bearing on our new leg. The desert was flat and the horizon was about six miles distant, so we picked up a point on which to drive and moved off again. Here, we had to go more slowly; there were numerous small *wadi* beds containing desert scrub, crossing our line, the negotiation of which necessitated slowing down to five m.p.h. All went well and at 1500 hours we made Gebel Atash.

From there we moved off on a fresh bearing hoping to reach Gebel Burga before the night, but at 1600 hours the van broke the master leaf of the rear spring. We then discovered that one of the secondary leaves was missing, thus throwing an extra strain on the counter-lever portion of the master leaf, and this, combined with the heavy load and the jolting, had proved too much. We were thus forced to camp there for the night, having gone 114 miles from Cairo. We drew up under the lea of a conical-shaped hill and set to work to change the spring. Our spare parts contained no rear spring complete, but fortunately we had a spare master leaf. It was a fairly simple task to remove and dismantle the spring, but altogether a different matter to re-assemble it without the assistance of a vice with which to compress it. We worked from 5 to 10 p.m. that night and from 5 to 9 a.m. next morning before we were ready for the road again. Although we had repaired the damage, we had not cured the cause, namely the missing leaf, as we were not carrying a spare one to insert. For this reason we lightened the van as much as possible at the expense of the tourer.

The night had been cold and we were grateful for all our blankets, but from now on the weather became stuffy and airless. The nights were warm enough to sit about after supper without great-coats. There was a faint haze, which grew worse each day, and somewhat impeded the navigation.

We left our camp site at 1000 hours on March 29th, and reached Gebel Burga from where we took a fresh bearing. The nature of the country from here on changed entirely, and it was extremely difficult to keep our line at all accurately. The going consisted of good hard gravel, on rolling downs, the *wadis* between each hill being 200 feet deep, extremely steep (the average gradient being 1 in 3), and strewn with massive boulders. On several occasions we descended into these wadis only to find we could not get out of them on the other side, and so had to retrace our steps. The length of this leg was 26 miles and it took us three hours to do it. The end of this leg took us on to the brow of a hill escarpment (1,000 feet high), with a vertical face forming the northern boundary of the W. Tarfa. This cliff was broken at intervals by re-entrants with precipitous sides. After searching for an hour, we at last discovered a possible descent with a gradient of 1 in 1½. As we were unable to see whether the re-entrant led easily into the Wadi Tarfa, one car only was sent

down to reconnoitre, and on giving the O.K. signal the other soon joined it.

Once in the Wadi Tarfa the going was fair. There were numerous bushes and scrubs and patches of very soft sand, but all went well, and at about 1730 hours we reached Gebel Hawashia. Our day's run was only 76 miles and we had taken 7½ hours to do it, with only one rest of 30 minutes. The night was warm and we were in high spirits, having covered, without mishap, a very difficult piece of country. Up to here we had followed very approximately the route of the R.T.C., but from now on we wished to try a new line of country, about which little was known. The map, up to date, had been fairly accurate.

We moved off at 0730 hours next morning, March 30th, and quickly found ourselves in difficulties. The country consisted of small hills 100-200 feet high, separated by sandy *wadis*. These hills seem to have been thrown together at random, and it was impossible to keep on our bearing. After about 1½ hours of this, we had to abandon them and head for the Wadi Kena. Here the going was excellent, and we sped along at 40 m.p.h. We stopped for a belated "elevenses" at the two pimples we named the "Bowler Hats." These were marked on the map with surprising accuracy. From here we wished to skirt the south face of Gebel Dib, and so gain what the map showed as a large plain. We set off and reached the foot of the Gebel without incident, but from here the going became appalling. It resembled the moraine of a glacier, and after pushing through it in bottom gear for several miles, we were forced to turn back and return to the Bowler Hats.

After a consultation we decided to try to find another route through the coastal range. The map showed a possible route through it, joining the Wadi Kena about 10 miles south of the Bowler Hats. Owing to the inaccuracy of the map, we found great difficulty in locating what appeared to be the start of this route. The floor of the *wadi* up which we went was soft and sandy, but it presented no difficulty—thanks to our big tyres. The wadi became narrower, and the hills on either side more precipitous, until there was just room enough for the cars. Suddenly on rounding a shoulder projecting into this *wadi*, we came upon a vertical wall of rock—a complete dead end. With considerable difficulty we turned the cars and retraced our steps to the Wadi Kena.

We thought it inadvisable to continue searching for this route, because we could only make guesses as to which was the correct *wadi*, and our petrol supply was becoming uncomfortably low. but we decided to make one more effort to get through the hills, which, in our biased eyes, appeared extremely unfriendly and aloof. We knew that the R.T.C. convoy had, with R.A.F. assistance, found the Wadi Mellaha possible, and so we turned south again and

made for this *wadi*. Here again, we were badly served by the maps. We thought we had found the Mellaha, but after going up it for five miles it split into four *sub-wadis*, of which we chose the biggest, but after another six or eight miles, it, too, came to a dead end and so back we went to the Wadi Kena.

On discussing this later we were convinced that we had found the Wadi Mellaha, and given sufficient petrol, we could have explored every minor *wadi* until we hit on the route. It was not safe to send each car off by itself to reconnoitre in case it broke down and was unable to be repaired without assistance, although this would have saved petrol.

For this reason we had definitely to give up our original idea and to run south until we struck the Kena-Hurghada track. The place where this track crossed the Wadi Kena was off our map and so, as we approached its estimated locality, we went in line, with about half a mile between the cars.

We moved off at 1610 hours, heading south, along the Wadi Kena. The going varied from gravel to scrub and soft sand. We averaged about 15 m.p.h. and at 1815 hours we decided to halt for the night. The weather was cloudy and stuffy, so thinking there might be rain during the night, we camped on a small hill, above the level of the *wadi* bed.

We were all tired and disappointed and after supper turned in early. We had covered 170 miles that day.

We moved off at 0720 hours on the 31st, and, adopting the formation mentioned above in order to avoid over-running and so missing the Hurghada-Kena track, we struck it after 20 miles. There was an old ruined fortress near, which had been built to safeguard this caravan route from marauding Bedouin. We then turned N.E. and followed the track to Hurghada.

It was excellent going in parts; over one stretch of 10 miles we averaged 47 m.p.h. The track led through the coastal range, which consisted of black and red stone. The mountains towered 3,000 and 4,000 feet above us, but owing to the mist which had been growing denser for the last three days, we were unable to see much or to take photographs. After 100 miles from striking the track we reached Hurghada.

HURGHADA.

This place exists only for the oil wells. It is barren and unfertile, with no natural water supply. There is a smell of petrol in the air, to which we become rapidly accustomed, and after a couple of hours failed to notice. There are about 80 Europeans, of which about 40 are British, the remaining being Maltese, French, etc. The water is brought by tanker from Suez, and so there are no gardens or trees, as every drop is required for other purposes. There is a

native population for the running of the pumps, workshops, etc., who seemed to be happy and well cared for.

There is the usual club, with tennis courts and golf course, which is the hub of the place. The inhabitants were kindness itself to us, and made us thoroughly at home from the moment we arrived. We were given a bathing-hut on the sea shore for our quarters, where we quickly settled down and removed our four-day beards, and then had a very enjoyable and necessary bathe.

After making ourselves more or less respectable we took the cars to replenish our petrol and water supply. Having done thus, we repaired to the club where we imbibed beer in large quantities.

The next morning, April 1st, we were shown over the oil field. The wells consist of pipes driven into the ground, in many cases up to 3,000 or 4,000 feet. The pumps are of the plunger type, and actuated by reciprocating wire cables which are led away to a prime mover, which may be a ¼-mile away, and attached to a great flywheel, which in turn is driven by a crude oil or gas engine. The oil, on reaching the surface, is piped to an electric dessicator, which extracts any water, and then taken to a central reservoir, from which it is pumped into tankers and shipped to Suez for refining. The output of Hurghada, is approximately 2,000 tons of crude oil per day.

The Journey Home.

We left Hurghada at midday and followed the coast northwards. The weather was stuffier than ever, and black clouds were coming up behind us along the coastal range. There was a track of sorts, but the going was exceedingly bad, there being numerous small *wadis* from the hills, leading to the sea. Our average speed along this coast was 12 m.p.h. At about 1540 hours it started to rain and a quarter of an hour later it came down in torrents. The centre of the storm was over the hills, which were blotted out by dense black clouds.

Among these clouds appeared patches of dull red, which we took to be sand raised by the wind. The lightning seemed to be continuous among the hills, and the sea became an emerald green. The whole picture presented a wonderful but terrifying example of the forces of nature. Fortunately the worst of the storm passed quickly and by 1540 hours we reached Ras Gharib lighthouse. We knocked up the keepers who took us in and made us very welcome. We were given the office in which to sleep and the kitchen with all its appurtenances where we could prepare the meals. The lighthouse was manned by two Englishmen and three natives. The crew stay there for about a year and are then transferred, individually, to another lighthouse in the Red Sea. Like the inhabitants of Hurghada, they are supplied by boat from Suez with all their food and drink.

We moved off next morning, April 2nd, at 0800 hours, first having been shown over the lighthouse and having had the mechanism explained to us. The going was the same as the previous day, but we were fresh and the storm had cleared the air so we were in better spirits. We met a patrol of the F.D.A. who gave us some letters to take to Zafarana, which we reached at about midday.

From here we turned west, up the Wadi Araba, and after 20 miles turned south to visit St. Anthony's monastery.

We reached it at 1500 hours and were shown over the place by a large number of monks, who insisted on giving us mint tea and rolling cigarettes for us. There are about 20 monks in the monastery, and some natives, who carry out all the menial tasks. The monastery is Coptic and was built by St. Anthony. There is a spring of pure water which emerges from the rock inside the monastery walls. This spring has never been known to run dry. There is an excellent garden, where the monks grow fruit and vegetables and fodder for the goats which supply the milk.

We stayed about 1½ hours and then moved off and camped for the night about 10 miles away. As this was our last night the supper was on a more lavish scale than usual, and we were badly "food-logged" when we turned in.

We moved off on the 3rd at about 0830 hours and after an uneventful run reached Cairo at 1500 hours. We had covered about 850 miles in seven days, and were all beginning to feel the strain.

The cars throughout had behaved splendidly, never boiling or complaining of the very rough treatment to which they were subjected. The tyres had stood up to their work and amply repaid us for their extra cost. We had had no punctures or mechanical breakdowns, with the exception of the rear spring on the first day. The radiators had shown no sign of leaking and the engines had only used a quart of oil between them.

The petrol consumption of the tourer was 16 m.p.g. and of the van 21 m.p.g.

The cost of the whole expedition worked out at about £7 10s. per head, including the hire of car, petrol, food, etc.

The whole trip had been extremely interesting and we had seen a large amount of country which was well off the beaten track. In addition, we had been given a small insight into the lives of a community who are marooned far from their fellows, and could feel only admiration for their cheery outlook under unpleasant and boring circumstances.

In conclusion, the object in describing this trip is to show that a most enjoyable, if somewhat strenuous, holiday can be had by anyone who has a love of seeing new parts of the world and a few spare pounds to spend.

1.—Mending the broken spring.

2.—Sub-wadi of Wadi Tarfa.

3.—Camp at G. Hamrahia.

A week's holiday in the desert 1-3

4.—"Edwinnes."

5.—Tourer stuck in soft sand. N.B.—Sand ladders in use.

6.—The entrance to St. Anthony's Monastery.

A week's holiday in the desert 4-6

PROFESSIONAL NOTES.

CENTRAL HEATING AT ROYAL MILITARY COLLEGE, SANDHURST.

THE following is a summary of an article entitled "Central Heating at the Royal Military College, Sandhurst," by Lieut.-Colonel H. M. Fordham, M.C., R.E., and Lieut. (I.R.E.M.) H. E. Williams, R.E., which appeared in the *Builder* for April 6th, 1934.

The article describes a recent central heating installation which presents a number of novel features, and which has proved very satisfactory and economical in working. The museum and library at Sandhurst comprises a main hall and four auxiliary rooms, previously heated by means of slow-combustion stoves which were unsightly, productive of dust and not very efficient. It is estimated that the attendant spent three hours a day in firing the stoves and cleaning up the dust.

The new installation consists of a normal hot-water radiator system, with flow and return pipes in floor ducts covered with open grids. The boiler is fired by one of the small automatic stokers, several of which have been placed on the market in the last three or four years and which have attained a good deal of popularity.

The stoker consists of a hopper into which the fuel is thrown, and from which it is fed intermittently to the furnace by means of a worm conveyor driven by a small electric motor. The motor is controlled by a thermostat which is placed in a suitable place in the building and which can be set to give any desired air temperature. In this case it is set at 60°F. by day and 50°F. at night. A small forced draught fan also works all the time coal is being fed into the fire.

A master-control ensures that the water temperature in the boiler will not rise excessively if the thermostat fails to act, and a Venner time switch is incorporated to bring the coal feed and draught fan into action periodically for short spells so that the fire shall not die out during prolonged warm periods.

Another interesting feature of the installation is that the boiler is lagged by means of two very thin sheets of aluminium foil, covered with the usual galvanized casing. The use of aluminium foil for heat insulating purposes has recently come into considerable prominence.

The system has been found very reliable and effective. The quantity of fuel burnt is little less than was the case with the old stoves but small coal costing 18s. 6d. per ton is used in lieu of coke at 27s. 6d. per ton, and a saving of some 30% in fuel costs is anticipated, after allowing for the electric power used by the motor. The museum is far cleaner and the attendant need spend only half an hour once a day in removing clinker and refilling the hopper.

Where supplies of cheap small coal are available and labour is scarce or expensive, the installation of these automatic stokers on hot-water boilers is worthy of investigation, and may be justified economically.

SLIDE RULES FOR COMMERCIAL CALCULATIONS.

IN recent years there have been considerable strides made in the design and production of a British Slide Rule, and to-day it is possible to purchase such a rule, which is definitely better than foreign-made rules as regards clearness, accuracy, smoothness of motion and price.

Messrs. A. G. Thornton, of Manchester, have been the pioneers of many notable improvements in recent years, and it is felt that a few notes on these improvements might be of interest to R.E. officers.

The majority of us started with a simple slide rule carrying only what are generally termed the A, B, C and D scales; some have further recognized the value of the additional "Log-Log" scales for certain engineering problems.

In its original form the "Log-Log" scale was placed on the rule without particular reference to the Indices of the A and D scales, and a piece of jugglery was required to transfer from the upper "Log-Log" scale to the lower one.

In the rules now made by Messrs. Thornton "e" = 2·7183 is placed immediately above the right index of scale A, and below the left index of scale D, and this slight modification has not only cut out all jugglery, but has enabled direct readings of e^x and $\log_e x$ to be taken.

In the latest pattern rule the two "Log-Log" scales are placed together above scale A, and in addition to the usual Sine, Tangent and Logarithm scales on the back of the slide, room has been found on the face for a Cubing and a Reciprocal scale; in addition the rules can be provided with Volt and Dynamo scales in conjunction with a special Index pointer.

Hitherto the "Log-Log" scale has only extended to 1·10 in the lower direction, and this limitation has robbed the slide-rule of much useful application to Commercial work in connection with rates of

interest, depreciation, sinking fund charges, assurance, etc. In order to deal with rates of interest between 1% and 10% an additional " Log-Log " scale was deemed to be necessary, until Messrs. Thornton recently developed a highly ingenious Differential Scale only a fraction of an inch long, which very simply and accurately enables quantities of the nature of $\left(1 + \frac{R}{100}\right)^n$ for values of R between 0 and 10 to be evaluated.

The theory of the " Log-Log " rule, and the Differential Scale was dealt with in a very clear article in *The Engineer* of April 7th, 1933, and Messrs. Thornton publish a very lucid book, *Instructions on the use of the Differential Scale for Commercial Calculations.*

The rules produced by Messrs. A. G. Thornton, King Street West, Manchester, vary from the very highly specialized " P.I.C. " Engineer-Commerce slide rule down to the simple " Log-Log " rule as used by most engineers; the latter is obtainable with the new Differential Scale for Commercial Calculations.

It is satisfactory to know that whereas a few years ago drawing instruments and slide rules sold in the United Kingdom were almost entirely of foreign manufacture, to-day British firms are competing satisfactorily as regards price and precision, and in some directions the design is ahead of that produced abroad.

R.S.R.K.

MOASCAR POWER STATION, ISMAILIA.

On May 1st, 1933, a new War Department power station began operating at Moascar, near Ismailia. The station contains three oil engine generating sets, two Ruston and Hornsby-B.T.H. sets of 75-kw. capacity each, and one Allen-Crompton Parkinson set of 120-kw. capacity.

The station was built to supply the military barracks area, the R.A.F. barracks and aerodrome, the airship base and mooring mast. The load includes the supply of electricity for the lighting of the area, and the power requirements of a waterworks, workshops, a bakery, pumps for aerodrome watering, an extensive irrigation system and sewage works. The total population supplied is about 4,000.

An existing building was used to house the plant, but the roof was too low, and it was removed, altered and re-erected to give a clear height of 22 feet. The 42nd Field Company, R.E., undertook the task of erecting a five-ton travelling crane. The installation of the machinery was carried out by the local works staff with directly-

employed labour. Some difficulties were encountered, owing to the facts that two of the generating sets and the switchboard had been intended for another service and that the sets generated at unsuitable voltages. The distribution of electricity in the area had been overhead at 220 volts A.C. 3-phase 3-wire 50 cycles, but the new sets generated at 230/400 volts A.C., and the opportunity was taken to convert the W.D. distribution to this 4-wire system. The more distant parts of the area are supplied by means of step-up transformers and 3,000-volt cables. The change-over was effected without interrupting the supply for more than two hours.

The station superintendent is an R.E. military mechanist. A somewhat cosmopolitan staff consists of Greek and Italian charge hands, one of whom is on each shift with an Egyptian engine driver, a station fitter and a cleaner. No prolonged interruption of supply has occurred since the change-over from civil supply was made and the maximum demand on the station has been as high as 174 kw.

The following are the main results of the first eleven months of operation :—

Units generated	511,125.
Fuel consumption	0·735 lb. per k.w.h.
Lubrication oil consumption	1,400 B.H.P. hours a gallon.
Units used in auxiliaries ..	8%.
Total cost per unit supplied (including capital charges)	1·82d.

An article by Captain K. H. Tuson, R.E., describing the station in some detail appeared in *The Electrical Times* of 21st September, 1933.

K.H.T.

Major-General George Frederick Leycesler Marshall, CIE, Late Royal (Bengal), Engineers.

MEMOIR.

MAJOR-GENERAL GEORGE FREDERICK LEYCESTER MARSHALL, C.I.E.

MAJOR-GENERAL GEORGE FREDERICK LEYCESTER MARSHALL, C.I.E., who died on the 7th March, 1934, at the great age of 97, was the second son of the Rev. William Knox Marshall, Prebendary of Hereford. He was born on the 27th March, 1843, and was educated at Clapham Grammar School. In the autumn of 1858, he passed the entrance examination for the Military College at Addiscombe, which he joined in February, 1859. In June, 1860, he was given a commission in the Bengal Engineers.

The next year and a half he spent at the S.M.E. at Chatham, and in the spring of 1862, he received orders to join at Calcutta, after a few months of practical training on a railway. On 1st April, 1862, he was, in common with all officers of the Bengal Engineers, transferred to the Royal Engineers. In August, 1862, he embarked at Gravesend in the *Agamemnon*, one of Green's Line, a fine three-masted ship of 1,500 tons; the voyage to Calcutta took 77 days.

After a short stay at Calcutta he joined the Sappers and Miners at Roorkee. In the following autumn (1863) he had a bad attack of jungle fever, following on a night spent out in the Sewaliks watching for a tiger. He recovered from the attack in time to march that autumn with the Sappers and Miners to Lahore, and thence to Jhelum, from which place he was sent in command of two companies to Peshawar to relieve the detachment there.

Soon after reaching Peshawar he was ordered to report himself for service in the Public Works Department. The sub-division which he had to look after was a very large and interesting one, including the frontier forts, Mackeson, Jamrud, Michni, Shabkadr and Abazai, and the stations of Hoti Mardan, Nowshera, Attock and Campbellpur, besides Peshawar itself, with its ten regiments and five batteries of artillery.

That autumn (1864) he was transferred to the North-West Provinces Irrigation Branch and posted to the Rohilkhand-Tarai Survey Division. In 1865 he was transferred to the Eastern Jumna Canal and placed in charge of the first sub-division and headworks.

He remained there three years, when after a severe attack of fever, he was ordered home on medical certificate for two years.

On his return to India in 1870, he was put in charge of the Aligarh division of the Ganges Canal, and then of the Bulandshah Division, after which he was put in charge of a special Survey Division for the drainage of the Upper Ganges–Jumna Doab. As the hot weather came on and the season's work of the Division was completed, he was sent for to Headquarters and appointed Assistant Secretary to Government in the Public Works Department, Irrigation Branch. The Lieutenant-Governor of the Provinces was at that time Sir William Muir, K.C.S.I., and as Assistant Secretary, Marshall accompanied his camp each year on the winter season tours, and so became acquainted with his family. He was promoted captain on 1st April, 1874. In 1874, he married Elizabeth Huntly, second daughter of his chief. Shortly afterwards, Marshall was appointed private secretary to the Lieutenant-Governor, but as the latter's term of office was nearly at an end, a couple of months later Marshall was given charge of the Cawnpore division of the Ganges Canal. Later on he was again called to Headquarters as Assistant Secretary, under the new Lieutenant-Governor, Sir John Strachey, K.C.S.I., and on the completion of the Agra Canal, he was deputed to make arrangements for the opening ceremony which was performed by the Lieutenant-Governor.

In 1878, Marshall was appointed Assistant Secretary to the Government of India, and served at first in that capacity, and later on as Under-Secretary at Simla and Calcutta for the next nine years, till in 1887 he was appointed Secretary to the Agent Governor-General in Rajputana and Chief Commissioner of Ajmir. He had been promoted major on 1st July, 1881. In 1888 he was appointed to the similar post in Central India, in addition, and held both appointments till 1892, having been promoted to Lieut.-Colonel in 1890. The Headquarters of Rajputana at Abu, and those of Central India at Indore were forty hours' journey apart by rail, and the works to be inspected were spread over an area considerably exceeding three hundred thousand square miles, so that the charge entailed a great amount of travelling.

It was during these years that Rajputana had to endure one of the worst famines of last century: it was a famine of water, as well as of food, for the Ajmir lake, the source of the city water-supply, dried up and the great tamarind trees, the pride of Ajmir, died from want of moisture. The situation was dealt with early and well, and among the many thousands of unfortunates who flocked to the relief works to be fed by Government there was comparatively little suffering.

In June, 1892, Marshall was appointed Chief Engineer and Secretary to the Government of the Punjab, and a few months

later, received the Companionship of the Order of the Indian Empire in acknowledgment of his work in Rajputana. He was promoted colonel in 1893 and major-general on 1st April, 1897. In November, 1897, his health failing, Marshall resigned his appointment, and retired from the army with the rank of Major-General.

He was an enthusiastic naturalist and published two books, *Bird Nesting in India* and *The Butterflies of India, Burmah and Ceylon*.

His wife died in 1913. He leaves one son, Major W. M. K. Marshall, Gordon Highlanders (Retd.).

W.M.K.M.

Major-General Marshall was the last survivor of those originally commissioned in the Bengal Engineers. The last of the Madras Engineers had predeceased him. Of the Bombay Engineers only one remains—Lt.-Col. J. H. R. Cruickshank, who was commissioned in June, 1858. With General Marshall's death, therefore, the old corps of military engineers of the Hon. East India Company comes almost to an end.

E.W.C.S.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

THE HUNDRED DAYS (1815).

By PHILIP GUEDALLA.

(Peter Davies. Price 5s.)

There are probably few short periods of history of greater interest and of more importance to the history of Europe than those amazing, hurried days of Napoleon's great gamble. With his peculiarly clear-cut style, the author gives a most dramatic picture of the landing and the subsequent advance to Paris, an advance of ever-increasing enthusiasm and changing allegiances. But one is impressed at once with the alteration in the Emperor himself. He was no longer the man of clear vision and rapid decisions: he was tired, somewhat petulant, and at times almost bewildered. "I work on their imaginations," he had said: "when that fails, I shall "cease to exist." Perhaps that was true, and their imaginations had been dulled or could not be really revived. He had seen, before even leaving Elba, that some quick, spectacular success would be necessary: he had believed that the loss of Belgium must be the dominating feeling of humiliation to the nation as a whole, and that the capture of Brussels was therefore the surest means of reanimating imaginations. But now, "somehow his powers of action seemed to be impaired by all the "unaccustomed obstacles. He tired more easily; his nerves were jangled—and "sometimes he seemed depressed. The old faith in himself had left him, France "was no longer the familiar instrument that he had once known, responsive to his "lightest touch and vibrant with revolutionary energy. Twenty years of war had "left the country listless. Even the brilliant adventure of his escape from Elba "somehow failed to stir it. For his fellow-countrymen had grown strangely passive: "as he ruefully remarked, 'They let me come just as they let the others go.'"

The author also paints a vivid picture of the mysterious personality of Fouché, always intriguing and undermining the position of the Emperor, while he consolidated his own, and waiting, like some great spider, for the inevitable moment of Napoleon's downfall and his own consequent rise to power.

A very interesting military note has been added as a form of appendix. The Napoleonic legend, Mr. Guedalla maintains, has always represented the Waterloo campaign as one in which Napoleon only just lost through the faults of various subordinates, and in which the Allies were successful, in spite of their own glaring errors. Napoleon's own writings have, perhaps naturally, strengthened this conception. Napoleon "closes with a solemn catalogue of ten major errors committed "by the Allied commanders. Nothing, indeed, was wanting except their final defeat; "and the reader is left to conclude that their victory was a gross violation of the rules "of war."

This is an absorbing study, and is aided by the excellence of production of the publishers, while the addition of several hitherto unpublished pictures of Waterloo and of the personalities concerned from the collections of His Majesty and of the Duke of Wellington will make bibliophiles, as well as students of history, wish to have this book on their shelves.

IMPERIAL POLICING.

By Major-General Sir Charles W. Gwynn, K.C.B., C.M.G., D.S.O.

(MacMillan & Co., Ltd. Price 10s. 6d.)

From every point of view, it is an extremely good thing that this book has been written. It is not until one sees collected together the accounts of the various activities of the Services in peace-time that one realizes the unceasing work in policing the Empire and in the maintenance of the peace and security of the widely-divergent types of peoples that live together in certain parts of it. Perhaps the most striking aspect of this book is that this work is so often the result of the role of the Services as peacemaker between warring local factions.

The author starts by laying down the nature of the army's police duties and the principles and doctrines underlying these duties, and he explains clearly the difficult position of the military when called upon to assist in any form of civil trouble. Then he starts the history of a period of so-called peace for the British Army, but a period comprising Amritsar, Egypt, 1919, the Moplah rebellion, Chanak, Khartum, 1924, Shanghai, 1927, Peshawar District, 1930, the Burmese rebellion, 1930–32, and Cyprus, 1931. He analyses the causes and the methods adopted for the restoration of order in a clear, unbiased way, which is particularly valuable in his summing up of General Dyer's action at Amritsar.

To most readers Palestine and Cyprus will probably be the most interesting. In Palestine almost every lesson for the civil and Service member can be learned. There was a case of an important civilian administrative experiment coupled with an equally important Service administrative experiment. Trouble ensued, which was only solved by the closest co-operation between all the Services concerned and which certainly produced lessons for the future control of any such country.

The most striking lesson from this book is to see the misconception in the minds of many people of what modern weapons can do. The aeroplane is a perfect means of quick transport to move ground troops to nip risings in the bud, as Palestine demonstrated: it is of little value for the actual quelling of riots. The combination of the air and the ground troop is the keynote of dealing with such a situation. Similarly Palestine, and particularly Peshawar, showed that the civil administrators were inclined to look on the armoured car as the invulnerable panacea of all rioting ills, completely forgetting that the armoured car depends almost entirely on its mobility for its security.

It is to be hoped that this book will have a large public. It explains clearly the vital necessity of the Services for policing purposes, and it deduces from the troubles dealt with fundamental lessons for the civil administrator and all branches of the Services, and the greatest of these lessons is that prevention is easier to effect than cure.

TANK WARFARE.

(Der Kampfwagenkrieg.)

By General von Eimannsberger.

(J. F. Lehmann's, Munich. 1934. Price, 9 marks.)

This book deals with one of the three great questions regarding the warfare of the future, which are a legacy of the Great War, viz., that of mechanization, or whether and to what extent the armoured motor-vehicle on wheels or tracks will change the conduct of war. With this question are bound up two more great questions, viz., that of the air, or whether the war of the future will be decided by air forces before land and sea forces have come into action, and that of economic mobilization, which becomes increasingly difficult, the more it is gone into, because its principles threaten in times of war to upset the whole structure of the existing economic order.

In order, in this book, to deal with the first question alone, a certain finality has

to be assumed as regards the other two. The author assumes that for the present, at any rate, the effect of the air fleets of both parties at the commencement of war will not be the compelling of one party to peace. He also assumes that the economic conduct of war will be prepared provisionally, as it is done by all free nations at the present time, and that its full development will be reached only after war has broken out.

Beyond mentioning his rank the author says nothing of his qualifications for performing his self-imposed task. He even confesses to a lack of all experience of tanks, an admission which with British readers would probably be fatal to the book's success. With German and Austrian readers, on the other hand, the matter stands on quite a different footing. Seeing that to the armies of their respective countries the Treaty of Versailles forbade the possession of tanks, the latter will look upon the author's modest disclaimer of any experience with these weapons as hardly necessary. They will accept his rank as a guarantee of his military experience and judgment.

General Eimannsberger himself tells us the sources of his information, the " Battles of the Great War " series, produced by the German National Archives: Vol. 31, *The Tank Battle of Cambrai ;* Vol. 32, *German Victories of* 1918 ; Vol. 33, *Increasing Difficulties ;* Vol. 34, *The Last German Attack ;* Vol. 35, *The Turn of Fate ;* Vol. 36, *The Catastrophe of the 8th August,* 1918 ; the admirable *Tank Pocket-books,* 1926, 1927 and 1930, compiled by the late Major Heigl (*v. R.E. Journal,* December, 1926, and March, 1928) ; Major Bruchmüller's *The German Artillery in the Break-through Battles of the World War* (this is the officer who, according to Colonel MacLeod, for the excellence of his field survey methods, enabling registration to be dispensed with, was judged by the Germans to have been a main cause of the success of von Hutier's army on the 21st March, 1918, and who received from them in appreciation the nickname of " Durchbruchmüller ") ; Winston Churchill's *The World Crisis,* 1916–18 ; Dutil's *Les Chars d'Assaut pendant la Guerre* 1915–18 ; Major-General Fuller's *Tanks in the Great War* ; and others. So far, so good ; but a further recommendation to the attention of English readers must be furnished by an attempt to remedy the author's omission of any reference to his own services. He had already started before the war on the teaching side, and as a captain was an instructor at the Artillery Academy at Mödling, became a major early in 1915 and commanded first a battery, and then an artillery group at Monte Pasubio, after the Italians had joined in. From the front Major von E. was taken back to instruct at the War School for Commanding Officers at Brixen, returning to the front later as Artillery Representative at XV. Corps H.Q. As such he took part in the Austro-German successful crossing of the Piave, 15.6.18. After the war, in spite of the vigour with which the " axe " was plied in Austria as elsewhere, Colonel von Eimannsberger found that even an army reduced to 30,000 men needed him, first as Commandant of the Gunnery School at Bruck a/d Mur, and, before retirement, as Inspector of Artillery. He reached the highest rank possible in the Austrian Army of to-day, General of Artillery, a title adopted from the Germans in place of the former " Master of Ordnance."

The author's method of treatment is as follows :—the first third of the book is historical, dealing with the tank battles of the Great War, under the following heads : (*a*) development of principles of tank employment from the tank's first appearance in the Somme battle up to the date of Cambrai ; (*b*) employment in the battles in Flanders, August to November, 1917 ; (*c*) the battle of Cambrai ; (*d*) the failure of the tank in defence, 21st March, 1918 ; (*e*) tanks in the encounter battle ; the success of the Renaults near Villers-Cotterets, 3.6.18 ; (*f*) the tank battle of Soissons, 18th–31st July, 1918 ; (*g*) the battle of Amiens, 8th August, 1918 ; (*h*) the German retreat.

The whole of the foregoing is a model of writing, concise and clear. The author's separate conclusions for attacker and for defender, which follow most of the sub-heads dealt with, are so logical and definite as never to appear dogmatic. Facts are marshalled in such a way that the reader is led to the conclusions before they are formulated for him.

A dozen pages follow in which a *résumé* is made of deductions from the battle happenings of the preceding chapter. The author calls it "Striking the Balance, 1918," and in his next chapter called "Checking the Balance," he tests the results arrived at by recounting the stories of two German offensives, the most successful of all, on the Chemin des Dames, 27th May, 1918, and the most disastrous, that in Champagne, nineteen days later. Here he answers the question, "What is the use of finding new methods of attack when so great a success was possible to the Germans on the 27th May, with the artillery attack at its high-water mark (lasting 2½ hours only), but with no tanks at all?" General von Eimannsberger thinks that the attack on the Chemin des Dames would have failed if the French had known of it beforehand and withdrawn, as they did in the later fight, or as part of the British Third Army had done near Monchy in March. He considers that the method of the German attack on the Chemin des Dames can serve as no model for the future. In three offensive battles only was there complete surprise, viz., at Cambrai, at Soissons and at Amiens, at all of which battles the tanks went forward without previous artillery bombardment.

Chapter V deals shortly with the development of the tank since the war, both technically and tactically. One-quarter of the book is then occupied with A.T. defence, and the last quarter with the attack, the latter being dealt with in an original manner. The conditions and assumptions necessary when writing of the defence are considered out of place when treating of anything so positive as the attack, so a live example is chosen. The author takes a well-known battle—the German Black Day, 8th August, 1918—and re-fights it on August 8th, 193– with an adequate number of tanks on the one side, and modern A.T. defence on the other, within the limitations imposed by working on a 1 in 300,000 map. The Germans are called "East," while the French and British for simplicity become one, and are called "West." The author describes the battle from the standpoint of the latter. He breaks it off at 9 p.m. on the first day, just when the Commander-in-Chief of the West, having broken through East's second position, 16 km. behind the first, sees himself compelled by darkness to give up the allurements of Guise, le Cateau and Cambrai, highly desirable objects for seizing in view of the coming tank battle of the morrow.

The last chapter sums up lucidly. The author does not think that the war of the early future is going to be settled in the air to the exclusion of all other forces, nor that it is going to be fought out by tank fleets alone. He thinks that civilized nations fighting in normal country will use tanks in increasing numbers as part of mixed rapid formations and possibly as complete and independent army reserves. The latter would then be, so to speak, a revival of the old "army cavalry," and, like them, capable of bringing about a decision by means of their superior speed, when brought into play at the right place and time.

General von Eimannsberger has written a book eminently sane, shirking no question of detail, and nowhere sensational. His figures run high, but he works out his logistics in a way that brings home to the reader how war has become more than ever a Q matter. The book has educational value, not only for what the author says, but for the way in which he expresses himself.

F.A.I.

AIR SURVEYS.

(Provisional Edition.)

Chapter XII of the *Survey of India Handbook of Topography.*

(Published by order of Brigadier H. J. COUCHMAN, D.S.O., M.C., Surveyor-General of India. Price 1s. 9d.)

This is the first occasion on which air surveys have been included in the official handbook of the Survey of India. An air survey party first appeared in the Annual

Report of 1925–26. This method of survey has been in regular use on the Frontier for some years, chiefly in places where ground work presented special difficulties, either for political reasons or from the inaccessibility of the area. For city surveys it has been employed for a still longer period and has proved effective where complicated buildings and streets are concerned such as are found in Oriental towns.

The air work is carried out by the R.A.F., who also develop the films and supply an index locating the photos before handing them over to the Survey of India to plot.

As is well known, the British method of plotting air photos has not followed the system adopted by some countries on the Continent. This latter involves the employment of complicated, costly and cumbersome stereo-plotting machines which have not so far found favour with the W.O. Instead, a graphic method, involving a certain amount of computation, has been evolved and is now more or less standardized as the "Arundel" method. It necessitates less ground control and practically no apparatus beyond that used by the ordinary draughtsman with the addition of a comparatively simple stereoscope. It is certainly much more practical and better suited to service conditions than the Continental methods and, provided the flying is properly carried out, can give very good results.

The pamphlet under review contains a description of the Arundel method modified to suit Indian conditions. There is also an account of the compilation of maps from oblique photos by a modification of the Canadian method. It includes a graphic method of determining heights as a basis for contouring, which is actually carried out by sketching with the stereoscope. It is specially adapted to trans-frontier work where the ground is inaccessible and a minimum of control is available. The accuracy may not be high but it provides a tolerable map of an area otherwise unobtainable.

The pamphlet is also a handbook of the routine to be followed by an air survey party, as constituted in the Survey of India. It is intended, however, to be read in conjunction with the professional papers published by the W.O. and the Air Survey Committee. An appendix contains a syllabus of a thirteen weeks' course of instruction. Stress is laid on the point that no one should be instructed who is not fully versed in all that appertains to ground survey.

Apart from the provision of the necessary ground control, a great deal of work involving the expenditure of a considerable amount of time has to be done on the photos in the office in order to produce an accurate map. It cannot be said to be the rapid process one would expect from the speed at which the photos are taken. From a Service point of view, in this respect, air photography, as a map-producing agency, is disappointingly slow, though much faster than ordinary ground work.

One wonders if, in actual practice, it will not be found necessary in order to keep a moving army supplied with maps, to make a preliminary map hastily constructed by rough and ready means, which would be locally relatively correct, and which would serve its purpose, while a second edition would be plotted with all possible refinement at a later date. If time is available, by all means produce the most accurate map possible. When time is not available, but the photos are available, the question is what should be done.

H.L.C.

THREE LIVES.

(William Heinemann Ltd. Price 10s. 6d.)

Stephen Foot calls his autobiography *Three Lives* which describe his activities in oil production before the war, the war itself, and school-mastering after the war. Having known the author well before the war and having worked closely with him during the war, I was very interested to see how his boundless energy applied itself with equal zeal and success in such very diverse occupations.

His first "life" will probably appeal most to the military reader and particularly

to the Sapper. It describes pioneering work in foreign countries, prospecting for oil for the Shell Company—a short stay at Singapore—and then to Mexico. There he met the usual difficulties of a pioneer, occasional failures but more successes, struggles with an oil gusher, and threats from a revolution in Tampico. But he overcame his difficulties and became the trusted agent of the great Shell Company. Many of our Corps still look back and read and think of the days when a young Sapper could go abroad and carry out pioneering work of this nature. It is still occasionally possible, but unfortunately civilization, mechanization and specialization have largely robbed the pioneer of most of his initiative and excitement. The plans are worked out in London, a specialist is sent out to execute the work and he is provided with all modern methods of transport and machinery to carry it through. The Sapper is a general practitioner and in the past he has executed great works abroad using his own initiative and enterprise, but he cannot compete to-day with the specialist sent out from home bringing with him every modern mechanical means of assistance to carry out the work. Foot's first life describes the tail-end of pioneering days, he received a good deal of assistance from London but most of his success was due to his drive and initiative as a pioneer. One has to go far afield to-day to re-live the life of a pre-war pioneer.

His second life, dealing with his war work, reveals an important fact which is not always realized by military students. It is referred to in some detail in my book *In the Wake of the Tank*, and full credit is given there to Major Foot.

There were two main problems in the world war—concealed machine-guns and supply problems. All military officers realized the former difficulty at once and the tank provided the solution, though some of the more senior officers were slow to appreciate that it was the answer to the machine-gun. The supply difficulty was less apparent to the military mind and it is here that Foot's previous commercial training was of value to him. This problem was a vital one at each stage, from the field or the factory to the firing line. When advancing over shell-torn ground the troops could not obtain the supplies in the necessary quantities unless the latter arrived in tractors. Farther back it was efficiency that counted. Horses could transport the loads but the forage necessary for their upkeep occupied a very large share of the available shipping tonnage. Mechanical vehicles would have effected a huge saving because the quantity of petrol required to transport a certain load is very small compared to the forage that horses need to move the same load. It was Stephen Foot who was the first to realize this vital point and he describes it (among other things) clearly and modestly in his " second life."

His third life, dealing with education, strikes a subject about which many of us have spent very little thought. We accept schooling as a necessary evil to go through when we are young and to pay for when later we become parents. Stephen Foot has applied the same individual thought and action to this subject as he did to oil or warfare. It is curious what a lot a man can see when he has trained himself not to accept the normal course as the only and inevitable one. Some of his views and ideas have already influenced public school-teaching in the country. Schoolmasters are probably the most ultra-conservative body in England—far more so than soldiers and they are bad enough. He will have an uphill task to reform them, but I think he will meet with a fair measure of success. One thing is certain, and that is that he will have backing from the younger generation, many of whom are determined to force the pace and cut adrift from the older conceptions, in many different ways. There are many old-fashioned ideas in school-teaching and Foot gives constructive proposals in his book for eradicating them.

Every book which is written by a man who possesses initiative and imagination is worth reading. To these qualities, Stephen Foot adds practical success in three walks of life, and his book should be read by all thoughtful people who like having their minds stimulated above the normal level of everyday life.

G.Le.Q.M.

A PRACTICAL DIGEST OF MILITARY LAW.

By CAPTAIN R. TOWNSHEND-STEPHENS.

(Sifton Praed. Price 8s. 6d.)

This little book is aptly named. It is digestible and even appetising. Few soldiers approach the subject of military law with any degree of relish. The author shows how some quiet humour as well as interest may be extracted from the subject. He writes in excellent style so that unlike many books with a similar purpose this is most readable. The author was at one time Assistant Judge-Advocate-General. He was also joint author with Sir Lushington Stephen, LL.M., of a *Digest of Evidence in Military Cases*. He is, therefore, well qualified to write on the subject.

It is not intended that the reader should regard a perusal of this book as absolving him from a study of the *Manual of Military Law*. It does, however, serve as a most useful introduction to the Manual. By its arrangement it brings together in the appropriate place the "Commandments," the "Modus Operandi" and the "Counsels of Perfection," as the author terms the *Army Act*, the *Rules of Procedure*, and the *King's Regulations*.

Out of some 230 pages about 80 are devoted to courts-martial. These are so well arranged and treat the subject so comprehensively from "Arrest" to "Promulgation," that there should be a notable drop in the work of the J.A.G.'s department when this book gets into circulation. There are also chapters on Evidence, Civil Rights and Liabilities, Enlistment, and Conduct Sheets which are particularly worthy of commendation. They bring to notice the principal points clearly and concisely without being mere summaries.

Among the appendices is a mock court-martial with over a hundred errors in it. This should appeal to Staff College candidates. For them, too, is set forth a method of study with examination questions and the answers thereto.

The book should be invaluable not only to Staff College candidates, but to all officers who may be concerned with courts-martial whether as member, prosecutor, president, or even confirming officer. In the words of Field Marshal Sir Claud Jacob, G.C.B., G.C.M.G., K.C.S.I., who writes the foreword, "It is superior to anything of its kind which has been published, and is strongly recommended to officers of all branches of the service."

C.P.W.

GENERAL REPORT, SURVEY OF INDIA, 1933.

Published by order of BRIGADIER H. J. COUCHMAN, D.S.O., M.C., Surveyor-General of India.

During the year under review, as compared with 1930–31, the area topographically surveyed has been reduced from 57,582 square miles to 34,650 square miles. This reduction is, of course, due to the drastic curtailment in expenditure and the consequent reduction of staff employed on field work. Surveys and maps, so essential to development, are always the first to suffer.

With a view to expediting the delayed programme of mapping in 1913 a considerable reduction of scale below the standard 1-inch was sanctioned over a large area. It is interesting to note that there is a tendency to revert to the 1-inch scale on account of the pressing requirements of geologists and engineers and in accordance with the modern military view that this is the smallest scale suitable for tactical operations. "Moreover," to quote the Report, "some areas already surveyed on the smaller scales have had to be re-surveyed on a larger scale." The writer remembers how this view was forcibly put forward in 1912, only to be turned down. But the official attitude towards military scales has altered since then.

The Dehra Dun Observatory has continued the bi-weekly longitude observations using time signals from Bordeaux and Rugby, thus obtaining two independent values.

After three years' work observations for variation of latitude have been discontinued. The variation has been found to be much greater than at the international stations —this is attributed to abnormal refraction due to meteorological causes and possibly to the proximity of the mountains.

The usual tables showing the out-turn and cost rates of topographical surveys on various scales, together with the cost of fair drawing, are given.

Captain D. R. Crone, R.E., has designed an attachment for the F-8 survey camera by which portions of the horizon on either side the same negative can be photographed from which it should be possible to find the tilt. No details of the apparatus are given.

From small beginnings air survey is taking its place among the regular methods of mapping, especially on the Frontier where the ground is often inaccessible to the surveyor except when supported by a military expedition. Some 2,300 square miles were surveyed by this method during the year.

Attention is drawn to the remarkable results which can be obtained by infra-red photography and two comparative specimens of the same view, one taken with the ordinary panchromatic plate and orange filter and the other taken with an infra-red plate and filter. The difference in the amount of minute detail in the latter case is astonishing. Unfortunately, owing to the slowness of the infra-red plates as at present made, this method is not applicable to air work where rapid exposure is essential to obviate the effects of vibration and motion of the plane. No doubt, some day the plate-makers will overcome this defect. H.L.C.

INSTRUCTION PROVISOIRE SUR L'ORGANISATION ET LA MISE EN ŒUVRE DES DESTRUCTIONS.

(Charles Lavauzelle et Cie. Paris. 1933.)

This little manual of 70 pages is published by the French General Staff as a supplement to the *Provisional Instruction on the Tactical Employment of Higher Formations*, superseding a previous provisional edition, issued in 1926.

It is not a text-book of instruction in the details of demolitions, but an outline of the principles on which destructions on a large scale should be carried out when required as a part of the plan of operations.

The study of large-scale destruction is now a very important phase of the strategic plan. It is essentially a defensive measure, and as such is liable to be less attractive than other measures, but in future warfare, with large numbers of armoured and motorized vehicles on both sides, it will be of increasing importance to multiply the obstacles to an enemy's successful advance.

The subject is, of course, not modern. Cæsar's accounts of his campaigns were full of the " laying-waste " of many countries, but these were measures of revenge rather than strategical devices to protect a retirement. Wellington's devastation in his retreat to the Torres Vedras position is familiar to us all. The Germans gave a classic example in systematic destruction when they retired in March, 1917, on the Arras-Noyon front. Brutally thorough though this was, it was undoubtedly a successful means of creating a wide No Man's Land which contained no cover of any kind, and over which their opponents could only advance slowly and with full exposure until they could go to earth again.

In the next war, should operations revert to trench warfare again—and this is likely to happen so long as defensive weapons keep pace with offensive—we shall undoubtedly see positions organized in much greater depth than before, with a front-line lightly held. It is very doubtful if either side will willingly pulverize the opposite territory, making it a sea of mud for its own advance. But if a retreat is enforced the defenders will endeavour to create those conditions for their adversary by a systematic destruction over a wide area.

This little manual, therefore, deals with a very important subject.

In the preface, we are reminded that destructions are of a strategical or tactical nature. Those of a strategical nature are designed with the object of hindering the enemy's use of the essential communications, while those of a tactical nature aim at delaying his bringing forward supplies, and hampering his infantry as far as possible from getting away from their starting-point. Cavalry and infantry cannot be long delayed in their progress, except by artillery and rifle fire, but if tactical destruction is combined with a natural obstacle, its effect is greatly increased.

In the hurry and confusion of a retreat, the best prepared schemes are liable to go astray, and it would be impossible that a large-scale plan of destruction could be carried out in its entirety exactly as planned. Hence there is all the more need for careful and thorough preparation in peace-time. Like all engineering problems, destruction requires the most careful preparation. In a country like France, where the probable theatre of operations is known beforehand and can be studied in every detail, the preparation of defence schemes can be carried to a very high degree of advancement in peace-time, and we may be sure that by studying French manuals on such a subject as this we shall not be missing any point bearing on it.

The pamphlet is divided conveniently into four parts. Part I consists of seven short chapters, and deals with definitions and general principles. Part II, with two chapters, deals with the peace-time preparation of the destructions required in the initial plan. Part III, also with two chapters, deals with the employment of destructions by the Armies, and Part IV with the carrying out of destructions by explosives. An appendix gives a pro-forma for a detailed project.

It will be noticed that the term "destruction" is used rather than demolition, which, as generally accepted, has a more limited significance.

In 1914, a great many bridge demolitions were only partially effective, owing partly to a shortage of explosives and therefore to insufficient charges, but also to the prevalent idea that the bridges might soon be required again for an Allied advance. The manual under review makes a strong point of this. "Neglect to destroy, or only partially to destroy, a work for the reason that it might be utilized by our own forces in case of recapture of the lost ground is to incur the risk of seeing the enemy take advantage of the facilities left to him, and then in his retreat carry out the destructions which we ourselves have not dared to effect."

Ill-considered or hastily prepared schemes of destruction may very well prove to offer increased facilities to the progress of motorized vehicles by clearing the ground. As the manual says, "the choice of objects for destruction is of prime importance. Better not to use destruction on ground which does not lend itself to it, than to give the defenders an impression of security which does not exist."

In Part I, Chapter II, are described the three principal means of destruction—by mechanical agencies, by fire, by explosives. Only the systematic destruction of bridges over an unfordable stream or uncrossable ravine can delay infantry, cavalry, or horse-drawn artillery, and then only if such gaps are kept under fire. It is the passage of the heavy artillery and motor-transport which can be most effectively interrupted. It is a waste of time, and especially of explosives, to destroy points which can be easily circumvented. The cratering of cross-roads on open downland, for example, is sheer waste of effort.

The preparation of demolitions by explosives requires a general study on the map and a detailed study on the ground. Every plan drawn up on a map without reconnaissance of the ground is incomplete, and in most cases is likely to involve serious mistakes in execution. This is a precept which is obvious enough in its statement, but which is frequently neglected in actual warfare.

"Every scheme of destruction includes, besides orders concerning communications, special arrangements for each of the different services, artillery, engineers, signals, light railways, aviation, supplies, etc."

"The conception of the plan differs according to the situation under consideration: such as covering a defensive system on which it has been decided to await the enemy's

attack, or a barrier combined with a manœuvre of retreat, or more usually, with a delaying action to gain the time necessary for the re-grouping of the troops and to enable the retreat to be limited; or the covering of a wing on which a reduction of forces is desired, etc."

"The elaboration of the plan involves the following sequence of operations:—

(*a*) Instructions from the Higher Command as to the devastated areas to be created, taking care to specify the most important one of these.

(*b*) Studies with a view to the working-out of a rapid outline for the latter case.

(*c*) Detailed studies for the preparation of demolitions of the first order (those which, in case of need, will give the least but *effective* obstacle on a given front in the shortest time).

(*d*) Studies for the drawing-up of a preliminary scheme of additional destructions.

(*e*) Detailed studies for each area, for these additional destructions.

(*f*) Preparatory measures.

(*g*) Mobilization measures.

(*h*) Measures for carrying out the actual work.

These different studies are carried through in four stages, as closely consecutive as possible. In the first stage, a rapid scheme is drawn up, in the shortest time, for the most important area. The second stage is the preparation of the destructions classified under (*c*) above. The third is the preparation of the advanced scheme (*d*); and the fourth is the preparation of the project under (*e*). All these projects require thorough reconnaissance, and a close scrutiny by the Higher Command, in order to control the quantity of personnel required both for technical work and protection during execution, of material and of transport."

Enough has been quoted from this little work to show the wide field covered, and how carefully the French intend that destruction schemes shall be worked out. Destructions, in the French sense, do not concern the Engineers alone; the railway authorities, the civil authorities, the canals and waterways, signals, air service, etc., are all involved.

A large scheme, worked out on such lines, would form a very useful Staff exercise. We have hitherto never contemplated the deliberate destruction of a large area of our own country as a measure of protection in war; and the subject is dismissed very briefly in our manual of Demolitions and Mining. No more useful help than the French pamphlet could be turned to by anyone who had to draw up such an exercise.

W.H.K.

REPORT ON THE MANŒUVRES OF THE 2ND (SWISS) DIVISION.

By Colonel H. Roost, Corps Commander.

(*Allgemeine Schweizerische Militärzeitung*, April, 1934.)

The general idea upon which these manœuvres were based was simple and, inasmuch as the capital of the country lies only 50 kilometres from the nearest frontier, eminently practical. At the point in question the frontier runs S.W.–N.E. for a stretch of 60 km., and parallel to it on the Swiss side lie, end to end, the lakes of Neuchatel and Brienne, forming a barrier which stretches the same distance, being interrupted only by the strip of land, 6 km. broad, which separates the two lakes. The defence of this defile, which points at the capital, only 30 km. distant, therefore suggests itself for a military exercise. On this occasion the task of forcing the defile was allotted to the 2nd Division as part of an imaginary Red army invading Switzerland. With the Red forces (imaginary) north and south of it also driving Blue slowly back all along the line, the 2nd Division reaches on the 1st September a general line 5 km. before the defile. Blue's resistance has everywhere stiffened, and the 2nd Division finds a Blue Light Division in position to contest the passage. The isthmus is 7 km. long, and carries, winding between wooded heights, the Zihl canal, which connects the two lakes.

The relative strengths of attacker (Red) and defender (Blue) are:—battalions, 12 to 6; guns, 66 (including heavies) to 24 (field artillery only); machine-guns, 108 to 93; automatic rifles, 262 to 176. In aeroplane strength the sides are equal, having 6 reconnaissance machines and 5 fighters each. Blue's extra Cavalry Brigade (2 regts. + 1 cyclist bn.) and extra m.g. units bring up his total strength to 6,200 fighting men against Red's 9,200.

The engineers were distributed as follows:—Red: 2 coys. sappers, 1 bn. pontoniers, 1 telegraph coy., 1 mounted telegraph section, 1 wireless detachment, 1 carrier-pigeon detachment. Blue: sapper bn. H.Q. + 2 coys., 1 mounted telegraph coy. (less 1 section), 1 wireless detachment, 1 carrier-pigeon detachment. Red has, in addition, 1 artillery observation coy. and 1 balloon coy.

The course of the operations ran as follows:—Blue's measures of defence covering the defile; Blue's withdrawal into the defile, and occupation of a new position there; Red's attack on the covering position; Red's advance to the Zihl canal; Blue's further retirement to a line clear of the defile; Red's crossing of the canal; Red's attack on Blue's third position; Blue's defence and the counter-strokes prepared.

The three positions occupied in succession by the Blue Light Division were dictated by Corps Orders to accord with the changing general situation. The first position, covering the defile on the west side, was occupied as part of the general front of the Blue forces in their retirement from the frontier towards the capital. The second position, inside the defile, was taken up in order to shorten the front and to make more certain of preventing Red from striking through the defile at the flank and rear of the rest of the Blue corps, which had continued to retire. The third position, covering the defile on the east side, was occupied because the continued retirement of Blue north and south of the lakes had put the defenders of the defile themselves in jeopardy. The threat to the flank and rear of the rest of the Blue corps no longer existed, but a new one had arisen, in that Red, pushing round the lakes, now threatened the Light Division's own line of retreat.

The report itself is a model as to clearness and conciseness, the former being assisted and the latter to a great extent being achieved by the Corps' standpoint being maintained throughout, and hence the exclusion of all written material issued by the lower formations. So-called "Critical Remarks" by the Director conclude the pamphlet. They are of the mildest. In any case their sting would be drawn by the introductory statement that not criticisms, but only war, can decide whether arrangements were right or wrong.

The seven maps which cover the three and a half days' exercise are much to be praised.

F.A.I.

ESSENTIAL INSTRUCTIONS FOR WAR.

THE CHINESE FIELD SERVICE REGULATIONS.

Chen Chung Yao Wu Ling, to give it its proper title, was issued by the Nanking Government in 1930, and corresponds to some extent to *F.S.R.*, Vols. I and II, though it also contains much that may be found only in our *Manual of Movement* and other specialized publications. Its interest lies not so much in illustrating Chinese military methods, which rarely conform to the book, as in showing to what extent the Chinese military authorities are under the influence of foreign training methods, notably those of Germany and Japan.

The Celestial Ministry of War has attempted, however, to cram too much into a pocket volume of some 600 paragraphs; it fails to enunciate many important principles, while illustrating others in excessive detail. For instance, air co-operation is dismissed with "Aircraft are only allotted to formations for special tasks, on completion of which they revert to G.H.Q. control." At the same time, 84 paragraphs are devoted to transportation. An Asiatic note is struck by the advocacy of "severe punishments to intimidate the inhabitants of enemy territory," while the functions of the branches of the Staff are not touched upon. Both attack and defence, con-

sidered in the West as among the essentials of war, are ignored altogether. Throughout the book, however, runs the fear of interference from an unexpected quarter, not excepting the lines of communication; in this, the authors are, perhaps unconsciously, thoroughly up to date.

The subject matter is treated as follows :—

General	8 paras.
Order of Battle and Distribution of Troops... ...	2 ,,
Orders, Messages and Reports	70 ,,
Reconnaissance	49 ,,
Intelligence	13 ,,
Protection (the chief aim of the Chinese soldier)	118 ,,
Troop Movements	68 ,,
Quartering	55 ,,
Intercommunication	52 ,,
Supplies; Medical and Veterinary Services ...	75 ,,
Clearing the Battlefield	9 ,,
Rail and Ship Transportation	84 ,,
Gendarmerie (Provost duties)	6 ,,
War Diaries and Records	9 ,,

There are also 18 appendices.

The following subjects, dealt with in *F.S.R.*, Vols. I and II, are not treated :— Organization of the Services, and Maintenance of the Forces in the field. Censorship. Road transport. Prisoners. Civilians employed with an army. Money and accounts. Characteristics of fighting troops. Attack. Defence. Night operations.

In spite of this, it is laid down that, " Battle is the basis of all action, and the chief object of an army." The following principles are enunciated :—

" Implicit obedience, so long as the individual on the spot shall follow instructions in accordance with the circumstances obtaining." " Co-operation of all arms, and of individuals." " Initiative of subordinates." " Superior force, both moral and material, at the decisive point." " Well-trained troops, imbued with the offensive spirit, are always (*sic*) able to overcome material forces, and hold the passport to success in war."

The commander " should be possessed of a tranquil and kindly disposition, firmness of purpose, and eminent knowledge." " Inaction and irresolution are more dangerous than mistakes in method." Surprise is advocated : " It is necessary to have a mind full of ideas and original notions."

The headings of appreciations correspond closely to those in *Training Regulations*, viz. :—

The Object.
The Ground.
Information with regard to the enemy and our own troops.
Courses open to the Enemy. (Those open to us are not mentioned, although it is laid down that the initiative must be retained.)
Habits and Characteristics of the Enemy. (Curiously enough, this ends the Appreciation.)

With regard to aircraft, it is lightly remarked that " commanders of all ranks must devise means of intercommunication with the air." It is not stated how such means, once devised, are to be supplied, but they are classified as Wireless Telegraphy, Visual, and Liaison Officers.

For Operation Orders, two doubtful expedients are given in the name of secrecy :—

(1) All times, referred to in the order, are left blank, and communicated at the last moment to units. The use of zero hour would appear much simpler.

(2) No general order is issued, but separate orders are sent to each unit, co-operation being sacrificed to surprise.

Messengers travel at graduated speeds according to the urgency of their message, thus :—

Mounted D.R.	Ordinary message.		8 km. per hour.
	Urgent	,,	10 ,, ,, ,,
	Very ,,	,,	"The fastest pace of which the horse is capable, but not exceeding 20 km. per hour."
Dismounted.	Ordinary	,,	5 km. per hour.
	Urgent	,,	6 ,, ,, ,,
	Very ,,	,,	"The fastest pace of which the body is capable."
Bicyclist.			12 km. per hour, flat rate.

The twelve-hour clock is used in orders and messages, with the following strange complication: according to Chinese reckoning, a day lasts from dawn to dawn, so that 5 a.m. during the night 15/16 of a winter month might be described as "five o'clock on the night of the 15th," while in the summer it would be "five o'clock on the morning of the 16th."

Nothing is said about infantry reconnaissance, although reconnaissance by other arms, especially cavalry, is treated quite fully. Instructions to reconnoitring troops, however, are not dealt with, nor is it brought out that they must be given definite questions to answer.

The two ideographs which have been adopted to translate the word "intelligence" mean literally "spies' reports," and from the Chinese point of view espionage is the chief means by which tactical, as well as strategical, information is to be obtained. It is laid down that "espionage is the business of all formations," but it is not clear whether it is to be carried out by fighting men in plain clothes or by agents acting under subordinate commanders.

There is no limit, according to these regulations, to the nature of question which a prisoner may be expected to answer, even to the designation and movements of his own unit.

Whether at the halt or on the move, each battalion must detail a machine-gun platoon and look-out post for protection against aircraft; "but," naïvely adds the book, "this may entail risk to neighbouring friendly troops."

Advanced Guards are not expected to advance by bounds, but march at the same rate as the Main Body and at a fixed distance in front of it. They are divided into Main Guard, Vanguard, Point Company and Point; the size of force being protected is not discussed. The following distances are given for a division and seem curiously short :—

Head of Main Guard to head of	Vanguard	700 to 1,200 metres.	
,, ,, Vanguard	,, ,, ,,	Point Coy.	300 ,, 400 ,,
,, ,, Point Coy.	,, ,, ,,	Point	300 ,, 400 ,,

Flank Guards, if they have to take up a position to cover the march of the main force, are expected to be able to catch it up again. Mobile troops are only mentioned in the sentence, "Some cavalry may be added to the flank guard for reconnaissance purposes." "Rearguards," it says, "normally march in rear of the main body," but other positions of the rearguard are not described. "Should the unexpected happen, the whole rearguard may have to be sacrificed." The use of mobile troops is again ignored, as are also demolitions and the sequence of withdrawal.

The Chinese being advocates of the *défensive à outrance*, it is not unnatural that outposts should be treated at relatively great length. The use of machine-guns depends merely on "the degree of resistance," but field searchlights will be disposed on the outpost position. Members of sentry groups are never to leave go of their rifles, and must remain standing unless otherwise ordered. Strangely enough, they will be issued with hand-grenades for the occasion. "Persons who fail to reply after being three times challenged by a sentry will be killed at once." Piquets are relieved

every 24 hours, when the old and new piquets will detail a combined patrol to go over the ground together. No mention is made of standing to arms and sending out patrols before daylight.

Rates of march are given as follows :—

Dismounted troops, quick time, or artillery at the walk	86 metres per minute.
Dismounted troops, double time	145 ,, ,, ,,
Mounted troops at the walk	100 ,, ,, ,,
Mounted troops or artillery, at the trot ...	200 ,, ,, ,,
Mounted troops or artillery, at the gallop ...	300 ,, ,, ,,
Columns of motor vehicles	12 km. per hour.

In forced marches, besides reducing the rest periods, it is permissible to increase the pace. Concerning the time at which a march should begin, " To start before dawn in a known country is preferable to arriving after sunset in a strange country." The vehicles of balloon troops will move by bounds (this presumably means that balloons will be sent up at points on the line of march), but the bulk of the personnel are placed in the quandary of having to proceed on foot. In the case of other air units, the personnel " should be transported by motor vehicles, if available." Divisional second-line transport is divided into " Light," consisting of replenishments for " A " echelon of units, and " Heavy," which maintains " B " echelon. Traffic control is only mentioned in connection with the eventuality of two columns crossing each other's line of march, when it is suggested that each column should alternately pass a unit over the crossing-place.

In connection with march discipline, it is permitted to march in a broader formation than fours if the road is wide enough. On the command " March at ease," men may at their individual discretion unfix their bayonets, need not keep step, and do not have to attend to their dressing in fours. The column may march on either side of the road, but will keep to the left when meeting another column. " Packs may be removed only if there is extra transport to carry them." In hot weather the strange alternatives are offered of attaching flaps to head-dresses or else removing them altogether. As touching the care of the men, " bellies must not be empty," and persons must precede the column to make the inhabitants of villages fill buckets and water the troops as they pass through. Halts, after a first halt one hour subsequent to starting, are made as the occasion arises.

Quartering generally means billeting, but if bivouacs have to be adopted, they must be camouflaged ; and the engineer's task is not lightened by the necessity for " camouflaging all roads in the vicinity of bivouacs." It is thought necessary to lay down that " troops must never bivouac upon the surface of a road."

Wireless and line telegraphy are described, but radio-telephony is not mentioned. Bare wire is normally used for lines. Pigeons are dealt with at length. They should be dispatched in pairs, " being susceptible to weather and birds of prey " ; their range is given as 200 to 300 km. from stationary lofts, and their average speed as 1 km. a minute. The range of messenger dogs, however, is said to be only 2 km., and their speed 200 to 300 metres per minute. Wireless messages will generally be in cypher, but important decisions or dispositions must not be sent by wireless at all. It is laid down that " Commanders must deeply impress their subordinates with the extreme propriety of paying due attention to thoughtfulness about the signal system."

The principle of living on the country is well ingrained in Chinese armies, and the only supply echelons referred to are :—

(1) Rations carried on the man.
(2) Rations carried on unit vehicles.
(3) Rations carried in divisional supply vehicles.
(4) Field depots, which are formed only when a force halts for some time.

While on the move, supplies in unit and formation vehicles will be consumed, and the vehicles refilled as occasion arises ; at the halt, supplies on wheels will be conserved,

and the troops will forage. Divisional commanders may at their discretion requisition additional supply vehicles, and may draw cash in bulk for victualling their formations. Finally, " commanders must issue the necessary orders to avoid cooking matters leading to a lack of preparedness or causing confusion."

Ammunition echelons are similar to those for supplies, but no system of replenishment is described.

With regard to the medical services, the " slightly sick " will follow behind their own units, while serious cases will optimistically be relegated to the care of " the nearest hospital or local official." In action, regimental aid posts will close down as soon as divisional dressing stations have been established, unit stretcher-bearers helping to carry the wounded straight back to the dressing stations. Further evacuation is not gone into.

Veterinary casualties are treated analogously to human cases, the " local official " being made to take his fair share of the burden. There are unit horse salvage stations and divisional sick horse reception stations; at the base are veterinary hospitals, but it is not made clear how a casualty ever reaches them.

Under " Transportation," railway and ship movements are considered, but road transport is not dealt with. Railways are described as having a tactical as well as a strategic value, being used both in pursuit and in withdrawals. Armoured trains still exercise a spell over the Chinese mind, and large forces are visualized as moving in armoured or semi-armoured wagons, protected by advanced guard trains and scouts in railway armoured cars. For rail movements, the " British " system is given as the standard, and trains should be made up for various types of unit. During a long journey, horses should be fed in their trucks, and their legs should be rubbed without detraining them—difficult and perilous proceedings. The seeds of chaos are sown in the rule that " minor demolitions, interrupting traffic merely for a day or two, may be authorized by divisional commanders." This section omits any reference to supply trains, evacuation of casualties or the principles of movement control.

On board ship, discipline is summed up in the words: " Smoking, washing the face, and so forth, must be done in a definite place; the ship must not be fouled." Disembarkations in the presence of the enemy are smoothly passed over. The " first flight " will land in the sequence Infantry and Engineers—Cavalry—Transport; presumably the four " pom-poms " of a Chinese battalion are assumed to provide sufficient artillery support for them.

Provost duties resemble those of the British Army except that no provision is made for civilians to make complaints about the behaviour of the troops.

War diaries are kept by all units down to companies; they are not secret, and secret information must be kept in another file " till no longer secret."

This is an unpractical book written for modern war by persons without a first-hand knowledge of it.

J.V.D-H.

TRAVERSE SURVEYS.

By J. A. STORY, F.R.G.S., F.A.S.I.

(Unwin Bros., Ltd. Price, 4s. 6d. net.)

This book deals with three types of traverse :—

(*a*) Chain Traverse.

(*b*) Compass Traverse.

(*c*) Theodolite Traverse. (With steel tapes or chains on the surface of the ground.)

The author assumes that the reader knows nothing of traverse work and explains every detail of each method in a manner which can be easily understood by the complete tyro.

He claims that traversing is more accurate than chain survey for land survey work. This may be so, but it is also probably more expensive, and certainly requires a higher degree of skill from the surveyor.

He insists, quite rightly, on the paramount importance of working to a form which is thoroughly understood by the computers and draughtsmen responsible for the office work.

The forms he submits are an advance on the G.S.G.S. forms now authorized for use, but are not as good as the forms used by the Gold Coast Survey Department. It is hoped that the latter forms will be shortly available to members of the Corps in a textbook on Cadastral Survey, now in course of compilation by the Survey School, S.M.E.

The author mentions that the standard of accuracy of linear and angular measurements should be the same, and gives one example, but does not lay down the standards of accuracy for any particular work.

The book only covers the elementary part of the subject and does not deal with chainage in catenary, which has now been established as more accurate and less expensive than chainage on the surface of the ground where the terrain is broken in character or where obstacles such as hedges lie athwart the traverse line. The treatment of the subject is an advance on the chapter on traverses in Close's *Text Book of Topographical Surveying*, being less complicated and more up to date.

In effect, an excellent introductory to the subject of traversing for the beginner. There is nothing in the book which the young officer would not know at the end of his survey course at the S.M.E., with the possible exception of chain traverses.

F.K.S.

THE ARMY AND NAVY CLUB, 1837-1933.

By Captain C. W. Firebrace, F.S.A.

(John Murray. Price 12s.)

The appearance of this book should be welcomed by all true friends of the Rag: it satisfies a much-wanted need, and is a reminder of the approaching centenary of the Club's inception.

The author was in the 7th Hussars and a Fellow of the Society of Antiquaries. His love of research accounts for the meticulous regard for accuracy and the affectionate interest in his subject, which are evident in the compilation of the book, and he has leavened a most interesting array of facts and statistics by much amusing anecdote.

The first chapter, which deals with the genesis of clubs in general and of the Rag in particular, will appeal to all clubmen. The subsequent chapters set forth in detail all the vicissitudes of the club—personal, material, and financial—from 1838 to 1933.

In the account of the present site, the author's search for truth, as opposed to hearsay, has made him an unwilling iconoclast. Many of us have cherished the tradition that Nell Gwynne occupied a house on our present site, and may almost have venerated her as our patron saint. The author has had to shatter this illusion and pull her from her pedestal, as her habitat has been proven to have been elsewhere. As some solace, he has provided another Mary Magdalene, and we must transfer our allegiance to Moll Davis, who did live where the Club now stands.

Proper place is found for the story of Billy Duff's explosion at the rag and famish supper provided one night for him at the Club, from which the nickname of the Rag emanated.

The financial ups and downs are very illuminating to those who may find themselves on the committees of their clubs, and show how careful management by keen and hardworking members of committee can raise a club from lean times to a period of peculiar prosperity. The Rag is especially fortunate in being the owner of its freehold property, and is in a position to wipe off its mortgages in due course.

The last chapter ends with a salutary hint as to the necessity of the Club keeping abreast with the habits of the times. Some of us, who have reached the autumn of life, have a natural prejudice against innovations, but the modern needs of the newer

and future generations must be met if the Club is to maintain its present undoubted attraction.

It is good to see that the author has paid tribute to the lady secretary, Miss Vennard; it is well deserved, and will be endorsed by all who have been members since her connection with the Club commenced.

The latter portion of the book is devoted to some exhaustive and interesting Appendices—a list of Patrons, Presidents, Trustees, and Chairmen of Committee: a list of distinguished members with a short note of the attainments and achievements of each: the Roll of Honour: and a complete Catalogue of the Club's possessions in pictures, prints, precious books, and various *objets d'art*.

The prologue to the book is a charming foreword by Col. Sir Simeon Stuart, Chairman of Committee in 1923. As epilogue, there is a list of authorities referred to in writing the book, and an excellent index.

The book is not only a full record of fact, but is lightly written, and makes a very readable story: the illustrations are sufficient and well chosen. It is the author's swan song, for sad to say, Captain Firebrace died soon after its publication—nor could he have wished to make a better parting gift to the Club, of which he was an old and loyal member.

E.E.B.M.

DOGS OF WAR.

By F. YATES-BROWN.

(Peter Davies. 6s.)

On the jacket of this book we are informed that by it Beverley Nichols is confuted. It is therefore as a reply to *Cry Havoc* that *Dogs of War* must primarily be judged. It must be said at once that we cannot agree that Major Yates-Brown has answered, much less confuted, Mr. Beverley Nichols' challenging volume. Frankly we are disappointed, for the conversation between Major Yates-Brown and the Quaker Mr. Mennel reported, verbatim in *Cry Havoc*, gave promise of better things. While the author's known predilections for Yogi-ism might have warned us to the contrary, Major Yates-Brown's service and experience would lead us to expect a realist attitude.

Mr. Beverley Nichols is an idealist, and it is in the extension of his theories into the realms of reality that the incompleteness of his arguments is demonstrated. But he is an honest idealist. He rides his dream-horse straight at his fences, but he brushes them badly, and he would be brought to earth if his horse were flesh and blood. It is only his unity of purpose which makes him fail to realize how he has got clear, but his honesty makes him wonder frequently whether it is really true that he is safely over.

Major Yates-Brown, however, sad as it is to say it of a cavalryman, does not ride the same straight line. He is too prone to turn up the lane to look at the sunrise at Vallambrosa, or to see the liquifaction of the blood of St. Januarius; while the view of a fresh fox in the person of Sir Norman Angell, or one of the author's numerous pacifist correspondents, sets him off with a wild "halloo," forgetting that Mr. Beverley Nichols is his true quarry. Over his jumping powder by the anteroom fender he must tell us what he did at Manshera in 1920. All very interesting, no doubt, but it does not get us far in the matter of an answer to *Cry Havoc*.

Major Yates-Brown rightly indicates that the root of the problem is not the question of pacifism or militarism, but internationalism *versus* nationalism. From the point of view that we hate war, and would gladly welcome any other efficient and less destructive method of settling differences, the majority of us are pacifists. But even here Major Yates-Brown cannot ride straight. "Another war? The idea "brings with it a feeling of horror and despair," hardly rings true when we read elsewhere, "War represents the deep and honourable craving of man for the super-"natural," and find approval of William James', "A deadly listlessness would come "over men's imaginations of the future if they could seriously be brought to believe

" that never again would war trouble human history." Thus we are not helped much on the question of pacifism *versus* militarism.

On the question between nationalism and internationalism Major Yates-Brown is more decisive. " The whole pacifist case rests on a denial of nationality. And " nationality is a living force in Europe. In England it is slumbering, and it would, " I believe, awake in Mr. Nichols and in most of his generation if the need arose." It is on the alternatives to nationalism that Mr. Nichols seems least sure of himself. His experience of the Assembly of the League of Nations was no more happy than that of his critic, and, while he expresses himself willing to fight in an international army, he is doubtful of the power that would direct it. Major Yates-Brown pertinently asks are we to " trust the future of the British Empire, let alone the destinies of the " world," to Messieurs Paul Boncour, Benes and Politis, with Lord Cecil of Chelwood and Professor Gilbert Murray, distinguished statesmen though they be? Here is more the realism we had hoped for.

What it has to do with the purpose of the book is not quite clear, but in Chapter VI Major Yates-Brown breaks off into a consideration of the type of forces with which Great Britain should provide herself, and how the conflicting claims of the various services are to be met. " I would enter a note of warning," he writes, " against any " facile amateur opinion about the respective roles to be played by the three forces. " The problems of defence with which we are faced cannot be solved by civilians " or by any public discussion." . . . " Instead of a dictator for war I suggest we " should have a dictator for peace . . . Lord Allenby might be a defence dictator— " or Lord Beatty, or Aircraftsman T. E. Shaw. Whoever the man was, he would " have a free hand after the total cost of our defence has been voted by Parliament." An attractive idea, but would it work with our Parliamentary system of control of national expenditure, and is a representative of one service the best judge when the military heads of the three services disagree? But there, Major Yates-Brown has led us and his dogs of war off after still a fresh fox, and Mr. Beverley Nichols is many fields away still riding his dream-horse, still unconsciously brushing his fences, and never really clearing them or taking them by the roots. R.P.P-W.

HOW TO LIVE IN ENGLAND ON A PENSION

By " MAUSER."

(Published by " Mauser," 11, Queen Victoria Street, E.C.4. 3s. 6d.)

A great many officers will be glad to have this book, and those who have to contemplate retirement before their sons and daughters have completed their schooling will find what " Mauser " has to say invaluable to them in making their plans.

The author takes the typical case of an officer retiring as a Lieut.-Colonel with an Indian pension and a family of two children still to be provided for at school. The domestic problems of such individuals are very real, and fall upon them, in a great many cases, before they have realized their full meaning.

It is in the nature of human beings that far-seeing preparations for retirement do not appeal during the earlier years, and Service men in particular find it difficult to set aside anything at all to supplement their pensions. The expenses of their continual moves, of their double homes, of the position they have to maintain, are problems which do not confront the ordinary stay-at-home professional man. The latter can build up his home as he goes, and usually goes on until he is 65 or more. So the problems which " Mauser " discusses are unknown to the general public, and his book, therefore, strikes a friendly, intimate note which all Service readers will appreciate. The style is very brisk and well adapted to the subject; typical of the men to whom it appeals, men who have been accustomed to facing difficulties cheerfully and overcoming them with determination.

The book is well arranged in twelve chapters. Chapter I defines the kind of cases which the author has in view, and opens the subject in much the same way in which a confident speaker puts himself on good terms with his audience.

Chapter II discusses "Where to Settle Down." This is one of the most important questions the "settler" has to solve, for any mistakes made cannot be rectified without much expense.

Chapter III, on "The Nature of the House," goes into the question of old or new houses, and houses built to owner's requirements. The practical points discussed here are sound common sense, and those accustomed to Indian conditions of life will appreciate every paragraph.

Chapter IV, on "How to Acquire the House," gives points of comparison between the alternatives of buying a house by private mortgage through a solicitor or by going to a building society. The author dismisses the third alternative of renting a house for the very good reason that houses to rent are almost extinct. He advocates the building society and explains why.

Chapter V deals with furnishing the house. Some valuable hints are given here, and even those who have had previous experience will be wise to read through this.

Chapter VI, "Finance (Incomings)," explains how the £800 pension falls away before the recipient gets it—although the Indian portion of it is issued intact.

Chapter VII, "Finance (Outgoings)," is perhaps the most contentious part of the book, since there are many different views on budgeting the limited income. Mauser" probably receives more letters on this chapter than on any other (and he invites correspondence).

Chapter VIII, on "Education," chiefly interests those whose retirement is still some way off, since little can be done in this direction when once the Sam Browne belt has been discarded.

Chapter IX, "Employments and Additions to Income," is very interesting, and most readers will feel inclined to turn to this first. The subject might fill many chapters, but the author has wisely limited himself to a few typical suggestions, and discusses in detail one method of employment which he has himself embarked upon. He makes no bones about it; there are no jobs waiting for the retired Service man. His value as a State servant counts for nothing in the keen competition outside; but he has gained the very valuable asset of self-reliance, and need not despair. To make one's own job is "Mauser's" advice; to avoid stagnation and general helplessness at all costs is the essential thing.

Chapter X, "Savings," is for junior officers.

Chapter XI, "Hobbies," gives hints on a few methods of occupying time, the gist of them all being "to keep fit"—mentally and physically.

Chapter XII, "The Maid of All Work," discusses home-truths about the domestic type which is nowadays so often the substitute for the capable, long-serving class of servant of the previous generation.

Those who do not enjoy the extra Indian element in their pensions need not despair because "Mauser" emphasizes the importance of this addition in the typical case he discusses. Many families are wrestling successfully with the problem on the ordinary basic pension, but the author of this book is careful to explain that he must of necessity argue a specific case. The path can be rendered less stony by taking thought early in life, and the numerous forms of life insurance are well worth studying with a view to lightening the burdens when retirement comes or to providing education when school bills would otherwise be prohibitive.

"Mauser" makes numerous apologies for seeming to intrude on personal matters, but his readers will readily absolve him from any such implication. He could not write the book without reference to details, and it is the practical details which he has the courage to give which make the book so helpful. Throughout, he appears as a friendly adviser, understanding all the problems of the retired or retiring soldier, and giving him the benefit of his experience. His book is recommended to all officers, but especially to those who still have the opportunity of laying the foundations for their retirement.

W.H.K.

MAGAZINES.

THE INDIAN FORESTER.

(*February*, *March* and *April*, 1934.)—In these three numbers there is much of interest to Sappers.

"Producer Gas from Charcoal" for motor vehicles receives notice in all three numbers; that for April refers to the journey of two 1-ton motor-vans from Haifa to Kabul, using for fuel charcoal purchased from villages *en route*. The cost of fuel for such vehicles amounts to only 10% of that of petrol, but against this must be set off a higher first cost and a reduced carrying capacity, owing to the greater size and weight of the generating apparatus.

The March number gives tentative grading rules for structural timber, suggested by the Forest Research Institute at Dehra Dun. Such timbers are divided into three classes (or four if one includes "culls" which could be used for temporary structures and in places where strength is not the first consideration). No. 1 Structural Grade timbers, the safe stresses of which are 55% greater than those of culls, have to pass a very severe test as regards size and position of knots and shakes, and as regards the divergence of the grain from the straight, and one wonders to what extent this very meticulous examination and sorting affect overhead charges.

The February number describes a simply made roller winch in use in Burman villages, and the March number an extract from *The Times* on the subject of Empire timber. Of the 18,000,000 cu. ft. of soft woods used annually in this country, only 2% is grown locally, and not more than 8% comes from the Empire. One difficulty as regards shipping timber from Canada lies in the fact that it is generally impossible to find return cargoes.

The Indian Forester devotes a large proportion of its space to *shikar* and similar articles, and the numbers under review are no exception. The ringing of ducks in Dhar State, initiated by the late Maharajah to investigate duck migration, resulted in some marked birds being captured in Siberia. There is an interesting account of the start of a silver fox farm in Scotland, a venture by a retired Indian forester, while in the February number are given the proceedings of the International conference for the protection of *fauna* and *flora* in Africa, held in London in 1933, an inestimable service in the preservation of species which would otherwise seem doomed to rapid extinction.

(*May*, 1934.)—A technical journal of the nature of *The Indian Forester* naturally contains a great deal which is not "understanded of the people," and a layman has to pause frequently in his perusal of the journal to wonder at the diversity of knowledge required of a forest officer; one is, however, tempted to ask what a "wild evaporimeter" (p. 335) is and how it differs from the domesticated variety.

Of interest specially to engineers in this number is a table showing the results of durability tests of Indian timbers against fungus and termite attacks; as also the transcript of a paper read at the National Fire Brigades' Association at Eastbourne, on the subject of wooden doors as a fire protection. Railway engineers will probably find the article on "Creosoted Sleepers" of great value.

Of more general interest is an article on "Erosion in the Siwaliks," with photos showing the appalling devastation due to the destruction of forests; the report of the inaugural meeting of the Society for the preservation of wild life in S. India (to which we wish every success); and lastly a description of very successful measures for the destruction of prickly pear in the Mewar States. The author, an Indian member of the Service, describes how a certain cochineal insect was introduced to the

prickly pear, with the result apparently of the complete extermination of the pest in the area within two years. All who have been unfortunate enough to come into contact with the prickly pear will congratulate the author on his success.

(*June*, 1934.)—In the June number the parts most interesting to us lie in the "Extracts." Game preservation in Burma and proposals for the extension of existing and the establishment of additional wild life sanctuaries is one of them. Another is a paragraph on plywood; it is noted that six-ply cedar-wood formed the coffin of an Egyptian king in 3,000 B.C. A transcript of a lecture on timber houses is worth reading, and finally we may notice the use of red cedar roofing tiles, both in British Columbia and in this country, which are said to compete with clay tiles in weatherproofness, durability, appearance and cost.

F.C.M.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1934.)—A review of Professor Banse's book, *Raum und Volk im Weltkriege*, opens this number. The reviewer is anonymous. This book created a great stir throughout Europe, and although it received enthusiastic support in Germany, it was officially suppressed, but not until a large number of copies had been sold. The substance of the book preaches the doctrine that Germany must give the sword dominion over the pen. The reviewer gives a detailed analysis of the book, but does not comment on it. Banse describes English heroism as passive rather than active. What would the English people do in case of invasion, he asks. They would certainly defend themselves tenaciously, but they would probably surrender to famine. Banse says that Germany, by neglecting to seize Holland, enabled England to blockade the German fleet and protect her own shores.

General Armengaud contributes a long article, *La reconnaissance de l'ennemi par l'armée de l'air et la manœuvre stratégique des armées de terre.* The first duty of a General is to obtain information about the enemy. Cavalry is no longer able to conduct long-distance reconnaissance. This is now the duty of the air service. The writer gives a short review of the air reconnaissance work of 1914 and of the period after June, 1918—the whole interval between is without interest inasmuch as long-distance reconnaissance was of no avail. Air reconnaissance did little towards informing Joffre as to the assembly and march of the German armies towards the frontier and through Belgium. It did not contribute its news in time for the Higher Command to modify their dispositions, but it did point out the danger of envelopment and the direction to be given to the strategic retreat of the French armies. (The author does not mention that it was the British air service which first gave notice of von Kluck's change of direction to the south-east.) In 1918, the results were more satisfactory, due to the experience gained and the better equipment. Owing to the increasing motorization of modern armies it will be more difficult for an attacker to hide his movements from air observation, whereas a stationary enemy on the defensive, with a wide front and great depth, will be very difficult to reconnoitre. The article winds up with a plea for greater expansion and better organization of the French Air Force.

Lieut.-Colonel Henry Martin contributes an article entitled *L'Interprétation et la Synthèse des Renseignements par un 2me Bureau de Corps d'Armée.* He takes as a typical case the operations of an army corps in retreat; an example studied in 1933 at the refresher course for reserve staff officers at the École Supérieure de Guerre. The situation opens with an imaginary Xth Corps finding itself on the left wing of the French armies south of Amiens, analogous to the situation at the end of August, 1914. This is a concrete example and the author gives the reports which the intelligence section would present to the corps commander. Stress is laid on eliminating any hypotheses not based on known facts.

An article by Lieut.-Colonel Delmas on *Yugo-Slavia and the Yugo-Slavian Army* is

of interest. The Balkan States have lost nothing of their importance since the war; on the contrary, they have become more significant. Yugo-Slavia, embracing the stubborn Serbian race, has set to work to reorganize on modern lines, and is building up a national force with great care and resolution. By the end of the Great War, the Serbians had had six years' fighting, and had proved their valour in the field; and the young men of to-day are strongly imbued with the traditions of their fathers. They are of peasant stock, and armies raised from such material are always redoubtable. The Yugo-Slavian Army now forms 17 infantry and 2 cavalry divisions. The number of infantry battalions in a division varies from 8 to 12, but there is only one infantry brigade per division. There are no divisional engineers; in fact, the technical troops seem to be very scanty; they are organized in four brigades. The article is worth reading to remind us of what our old allies the Serbians have become.

(*May*, 1934.)—*La Stratégie Allemande en* 1918 is continued in a fifth article by General Loizeau, describing the predicament in which Ludendorff found himself in the middle of June. The three German thrusts of March, April and May had resulted in creating deep pockets in the Allied line which multiplied dangerous flanks for the Germans so long as the Allies had reserves left to take advantage of these situations. This was the crux of the whole problem. The Germans had not succeeded in wearing down the Allies; the German reserves were being used up at a greater rate than the Allies', until, by mid-June, Ludendorff had only Prince Rupprecht's reserves untouched, and these he was saving for what was to be his decisive attack in Flanders. The Crown Prince's Group of armies had penetrated into a deep pocket at Château-Thierry with very poor communications behind, and the Group was pressing Ludendorff to withdraw to a better position. This was felt to be impossible without further ruin to the already shaken morale of the troops. To continue the offensive without prospect of a decision would be fatal; to make the big attack in Flanders before the Allied reserves had been much further reduced would be equally disastrous. To improve the situation in the Château-Thierry pocket required further attacks on the Marne and in the Reims sector. Ludendorff decided on the latter, still hoping to be able to carry out his "Hagen" attack in Flanders later. The attacks on the Marne and at Reims failed, and were immediately followed by the French counter-stroke on July 18th. Rupprecht's reserves in the north were drawn upon, and as each division came down, the chances for the great attack in Flanders diminished, until finally the Germans were thrown on the defensive everywhere. The article is clear and concise; and shows once again that the successive steps towards Germany's defeat were due to causes in the field—mistaken strategy, lack of sufficient troops, morale shaken by defeat and failure, more stubborn fighting qualities in their opponents—rather than to a breakdown in the civilian will-power at home, as the Germans still maintain.

Franchissement des Cours d'eau en période de mouvement: la bataille de la Meuse (25 *au* 28 *Août* 1914) is continued in a fourth article by General Bailly and Chef d'Escadron Gazin. This is chiefly a narrative of events; there is little comment. Details of the German arrangements for crossing and the French dispositions for defending the crossing-places were given in a previous article (February, 1934), and this would have to be referred to for any proper understanding of the present instalment. Two good sketch-maps are included.

Données Statistiques sur les Forces Françaises 1914–1918, by Lieut.-Colonel Larcher, is the first of two articles giving some interesting data on the French effectives, the number of the higher formations and some analysis of the casualties. The article is accompanied by some useful tables and graphs. It is interesting to note that, in spite of all the opinions that the man-power of France was rapidly waning, the effective strength in the French armies at the end of the war remained at 2,846,000 men: actually 150,000 more than in the middle of 1915. The great efforts made by the British armies to take the pressure off the French in 1917 and 1918 had not been without result.

La Carte de l'Algérie, by Jean Martin, describes the evolution of the present map of Algeria, a work which the author says has occupied a hundred years. Actually, of course, the modern product is the outcome of much more recent work, due to the more rapid development of Algeria and the facilities for carrying the survey farther into the field. Military topographers accompanied all the French columns engaged in the occupation of Algeria. Since the Great War, a 1/200,000 map has been completed for the whole of Algeria, Tunis and a part of Morocco.

(*June*, 1934.)—General Loizeau concludes his series of articles on *La Stratégie Allemande en* 1918 in this number. Early in August, Ludendorff had no more reserves to spare and had to renounce his projected attack in Flanders which was to be the decisive victory for Germany. Now came the great British effort of August 8th. Ludendorff was taken by surprise, for he doubted the capacity of the Allies to launch a big offensive so soon after his hammer-blows. August 8th destroyed his hopes of finding a strategic expedient by which he might yet restore the situation. The Crown Prince, as before, urged a progressive retirement to shorten the line. Ludendorff accepted the proposal in a modified form, but too late to give himself time and space in which to carry out the retirement. Not only had his troops lost their fighting value, but he had lost his strategical liberty. He abandoned the teachings of Moltke and Schlieffen. Great organizer as he was, he interfered in too many details, and gave himself no time for reflection. General Loizeau's articles bring out the weak points in the German strategy of 1918 with remarkable clearness and facility.

La Frontière du Rhin, by Jacques Ancel, is a short politico-geographical account of France's most important borderline. The article is full of interesting facts, among them the rapidly-increasing importance of Strasbourg as a French port, the terminus of practical navigation. The tonnage using this port has multiplied threefold since 1913 and now amounts to 5,000,000 tons a year.

The series of articles under the title of *Franchissement des Cours d'Eau en période de mouvement*, by General Bailly and Chef d'Escadron Gazin, is brought to a close in this number. The article describes briefly the German pursuit after the Meuse, August 29th to 31st, and then discusses the lessons to be learnt from the whole operations between the French and German 4th Armies across the Meuse. The French demolition of bridges was not as thorough as had been intended. The chief cause of this was lack of sufficient explosives. It seems that the peace-time arrangements—so carefully prepared in the French manner—were drawn up with a view to a partial destruction only, not the total ruin of the bridges. This was in conformity with the idea of a French offensive, which might have required the rapid repair of the bridges for their own use again. The Germans prepared the bridges on the Marne in the same way. This insufficiency of explosives was general throughout the operations and caused many bridges to fall intact into German hands. One of the results of insufficient demolition is the rapid release of the enemy's mobile bridging equipment for increasing his crossings over the next obstacle.

The article also contains an instructive comparison, in much detail, between the passage of the Meuse in 1914 and that of the Marne in 1918. The value of tanks to the defence is emphasized; these can take part in the battle before the attackers can get theirs across the river.

This series of articles is of particular interest to engineer officers.

Données Statistiques sur les Forces Françaises 1914–1918, by Lieut.-Colonel Larcher, is concluded in this number. This second article analyses the lengths of front allotted to divisions at various periods, the number of divisions engaged in the various battles and the number of times they were engaged. There are also tables of statistics on the French losses in different battles. The total losses in 1914 alone amounted to 955,000 men, considerably more than the whole peace strength of the French Army before the war.

Analyses of casualties are notoriously difficult to compute, but this article shows some interesting figures which have been carefully worked out.

Vauban is the subject of an article by Lieut. Chombart de Lauwe. The tercentenary of Vauban's birth was celebrated throughout France in May, 1933. The story of his career is briefly but clearly outlined, and his characteristics emphasized. He was a great man, a skilful engineer, an able soldier, careful of his men; a good patriot, anxious to do all he could to improve the people's lot; and was endowed with a broad mind capable of seeing ahead.

(*July*, 1934.)—This number opens with a long article (48 pages) on *La doctrine militaire Allemande*, by Colonel Réné Altmayer. The author reviews the whole trend of German strategical doctrine, from Frederick the Great to the present day. He considers that the German school of military thought of to-day has not radically changed from that of Schlieffen and Moltke. He thinks that in the next war Germany will adhere to the envelopment theory and endeavour to bring off success by a great intensification of military means, making full use of all modern productions.

The story of the development of German strategical thought from the date of the remarkable recovery after Jena is always of intense interest, though nobody took much notice of it until 1870. Colonel Altmayer shows clearly how this doctrine was developed under the elder Moltke, then Schlieffen, and finally the lesser Moltke up to 1914. Clausewitz was always the German basis. The greatest consolidation of the German school was achieved during the long reign of Schlieffen as Chief of the General Staff. He held the office for 15 years: "Can we wonder," says Colonel Altmayer, "at the degree of preparation to which the German Army reached in 1914?"

The article refers extensively to the German manual *Führung und Gefecht der Verbunderen Waffen*, which first appeared in 1921 and is commonly known in French circles as *Le Fug*. The German form of the offensive remains the same: the outflanking and envelopment of the enemy. "To close, to grip, to destroy." The enemy's front must be held down, while the point of application of the blow must be on the wings.

There is nothing specially new going on, therefore, in the German military mind in the direction of strategical ideas. But the writer of the article winds up with a reminder that Germany won in 1866 and 1870 because she worked hard beforehand.

La Recherche des Renseignements et Leur Diffusion par un 2me Bureau de Corps d'Armée, by Lieut.-Colonel Henry Martin, is a companion article to one by the same author which appeared in the April number. "A few minutes' synthesis requires several hours' analysis" is the author's opening adaptation of an older historical dictum. It is an interesting article on the sifting of the various forms of information which reach the intelligence staff of a corps; and the methods by which such information should be produced, firstly for the General in command, and secondly for circulation to neighbouring formations and subordinate units.

The concluding article in this number is the *Evolution des Forces Militaires Italiennes de 1929 à 1934*, by Commandant Morel; a short account of the lines on which the Italian forces have been organized during the last five years. Fascism has proved a favourable ground for improvement in Italian military organization, but the economical pressure, as in all countries, has restricted the possibilities.

The article is difficult to read and seems unnecessarily complex; the reader will probably glean what he wants more readily from the appendices and the sketch-map.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*April*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914–18. *L'attaque de l'abri du Grand Père.* By Lieut.-General Baltia.

The writer describes the fighting that took place round the ruins of the Grand Père farm, on the 7th, 8th and 9th March, 1918. The fighting was characteristic of position warfare.

2. *Comment faut-il monter un exercice de mécanisme avec chars au camp de Beverloo.*

Captain Vandereycken describes a set of exercises to illustrate the co-operation between infantry and tanks.

3. *Aide-mémoire à l'usage du chef de section de mi.*

Notes, by Lieut. Mélon, for the use of machine-gun commanders.

4. *Coopération des armes.*

In this article Major Sottiaux deals with the co-operation between infantry and artillery.

5. *La défense contre le péril aérien.* By Captain Calberg.

Ever since 1921, an Italian officer, General Douhet, has propounded his doctrine of an independent air force, his motto being: "Defensive on land and at sea, offensive in the air." The general principle that he advocates is that the air force will act by surprise before any declaration of war, by

(1) destroying enemy aircraft, on the ground, in its bases,
(2) paralysing, by its destructions, both army and navy,
(3) striking terror into the civil population.

General Douhet's views are brought out in a book, *The War of* 19 . . ., which describes a conflict between Germany, which has adopted his ideas, and France, which has discarded them. The offensive air force consists of 1,500 aeroplanes, having a radius of action of 1,000 km., and carrying loads varying from 1 to 3 tons. The aeroplanes have a maximum speed of 250 km. per hour and can fly at a height of 7,000 metres.

Captain Calberg has an open mind on the value of this doctrine, but consoles himself with the reflection that, once a danger is known, it can be met. He describes, briefly, how the various great powers have set about to meet the air menace, and then goes on to say what Belgium can do in this direction.

Belgium is greatly handicapped by the short distance of its important centres from the frontier, and the consequent difficulty of guarding against surprise. It requires anti-aircraft artillery and an air force of fast fighting planes, as large as its limited budget will allow.

The greater part of the article is devoted to passive defence, to prevent the terrorizing of the civil population.

6. *La jurisprudence en matière de pensions d'invalidité du temps de paix.*

Captain Temmerman points out that tuberculosis is the greatest cause of unfitness in the army and makes suggestions for tracing the origin of the trouble and for dealing with it once it has made its appearance.

(*May*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914–18. *Le combat d'Eede-Molen* (7th October, 1914).

Lieut.-Colonel Oor describes his experiences while in command of an armoured-car, in October, 1914, in harassing a detachment of heavy Bavarian cavalry under the command of Major von Tannstein and, particularly, the fight at Eede-Molen on the 7th October. He points out the inaccuracies in the German account of this engagement.

2. *Les manœuvres françaises avec unités motorisées.*

Captain Defraiteur describes two sets of manœuvres carried out by the French Army in September, 1932, in the neighbourhood of the camps of Mailly and Châlons-sur-Marne.

In the first part of the manœuvres a motorized blue force attacked a non-motorized red force: in the second part a partially-motorized blue force operated against the same red force. The main lesson gained from the manœuvres was that, in the offensive, a motorized force has the great advantage of shortening the preliminaries of the battle and, by its mobility, keeping the enemy at arm's-length from the main body. In the defensive, a motorized force can seize a favourable opportunity for operating against the enemy's flank, and so compel him to retreat.

3. *Étude méthodologique de la formation des observateurs terrestres d'artillerie.*
Captain Jacques gives details of recent orders issued for the instruction and training of ground observers for the artillery.

4. *Les caractéristiques de l'organisation militaire britannique.*
Colonel Nerincx gives an account of the organization of the British Army, dealing at first with the army as a whole, and then with the different branches of the service.

In summing up, the writer considers that Great Britain has made the most of a numerically weak army for ensuring the safety of a vast empire. In order to make a serious military effort, she would have to fall back on her territorial army. It would take time to get the latter ready for service, so that, in the circumstances, the British Government has done well not to enter into any commitments that would require the employment of any force other than the Navy.

5. *Les troupes du parti national-socialiste allemand.*
Captain Callens begins this article with a brief history of the Nazi movement. One of the first meetings was held in Munich in November, 1921. The Communists tried to break it up, when Hitler, at the head of forty resolute men, ejected the interrupters. At the end of 1932, the formations of the party numbered half a million, and they now number over a million.

They consist of the following organizations :—

(1) Storm troops (S.A.—*Sturmabteilungen*).
(2) Protection detachments (S.S.—*Schutzstaffeln*).
(3) Hitlerite youth (H.J.—*Hitlerjugend*).

The object of the S.A. is to create a new Germany, to inculcate a spirit of discipline, and to fight everything opposed to the Nazi movement. The organization is on military lines.

The S.S. is a separate organization, created in 1925, and is a kind of police force at the disposal of the party. Its number is limited to one-tenth of the strength of the S.A.

The H.J. is an organization of young people of both sexes, from 7 to 18 years old, who are transferred to one of the other branches when they reach the age of 18. Their number is estimated at 1,500,000.

(*June*, 1934.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914–18.
Captain Rousseaux gives an account of a successful raid carried out under his leadership (when a 2nd-lieutenant) in the night of the 21st/22nd June, 1918. The Belgian Army had taken over what had previously been a back area occupied by the British. In the No-man's-land between the Belgian and the German trenches stood a blockhouse, known as Adam House, originally constructed by the British. The object of the raid was to ascertain if Adam House was occupied by the enemy, and to bring back prisoners.

How the raid was successfully carried out, and eight prisoners were brought back, is well told by the writer.

2. *Les opérations militaires à la frontière est de la province orientale pendant la guerre* 1914–18. By Lieut. Bayot.
This is the first instalment of an account of the defensive operations on the eastern frontier of the Belgian Congo against the Germans in Tanganyika. The frontier in question (shown on a sketch map) extended from the south-west corner of Uganda to Lake Kivu, through the latter along the Ruzizi river to Lake Tanganyika, continuing southwards through this lake.

The frontier was defended naturally by the lakes and by marshes, and (as has since been confirmed by von Lettow-Vorbeck's book) the Germans had no intention of attacking it seriously; their main operations being directed against the British in Uganda and the Uganda Railway.

The Belgian defence was directed by Commissary-General Henry, who had under his orders a nominal force of 35 Europeans and 1,800 natives. The writer describes

the events on the frontier up to the 4th October, the bombardment of Baraka and Uvira by German lake-steamers in October, and attempts made by the enemy up to the 26th November, 1914.

3. *Tir fusant en chambre.* By Major de Ceuninck.

4. *Mélanges aéronautiques.*

Colonel Desmet gives his views on a number of points connected with aviation. He refers to the doctrine propounded by the Italian General Douhet, of a war carried out entirely by an air force, which has a solid and logical basis, although it does not apply to all nations. In any case, it is impossible nowadays to conceive any strategical or tactical operation without the co-operation of aircraft.

The writer discusses the aerial warfare of the future under different heads. Aeroplane construction is undergoing perpetual change, and no nation can afford to keep up a large air force, and remain up to date in all respects. It is better to expand an air force rapidly at short notice. For instance, it is said that eighteen German works will be able to construct 2,300 aeroplanes per month when called upon to do so.

Colonel Desmet concludes with a reference to the Conference for the Limitation and Reduction of Armaments, in which, as regards aeronautics, there is no possibility of coming to an agreement.

5. *La radiogoniométrie à bord des aéronefs et son intérêt militaire.*

In this article Captain Miette deals with the navigation of aircraft by radiogoniometry. In this method use is made of high-frequency electromagnetic fields produced by wireless transmitters. The gonio receiver shows the direction of the components of the field, and hence the direction of the transmitting station.

Some special devices are also described, *e.g.*, the system adopted by Wiley Post in his nocturnal transatlantic flight, and the "Homing Device" adopted by Sir John Grierson in his "Gypsy Moth."

6. *Aperçu sur la cavalerie allemande.*

Lieut. Dinjeart gives us a first instalment of an article on the German cavalry.

Under the Versailles Treaty, Germany is allowed a regular standing army of 100,000 men. Included in this number are 18 regiments of cavalry and 21 regiments of infantry, a preponderance of cavalry unknown in any modern army. Besides the 18 regiments of army cavalry (*Heereskavallerie*), grouped in three divisions, there are seven independent squadrons of divisional cavalry (*Truppenkavallerie*). The new German cavalry has not retained the names of the old imperial arm, *e.g.*, guard, hussars, dragoons and Uhlans: each regiment now has a number. But the connection with the old army is kept up in the squadrons, each of the 97 squadrons of the *Reichswehr* keeps up the traditions of one of the regiments of the army of 1914.

The writer goes on to deal with the composition, organization and distribution of the various cavalry units, their armament, uniform and equipment.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*March–April*, 1934.)—1. *Organizzazione ed esecuzione della controbatteria in guerra di movimento.*

This is the first instalment of an article by General Fautilli on counter-battery work in a war of movement. He has divided his study into three parts:—

(1) How a battery may be put out of action.

(2) Organization and function of a counter-battery group.

(3) Organization and function of the counter-battery of a large unit.

In this part he deals with the first sub-head.

2. *Motorizzazione e meccanizzazione nell' esercito francese.*

In the January number the problem of mechanization in the British Army was dealt with. Lieut.-Colonel Infante now shows how far the same problem has affected

the French Army. He makes it clear that by mechanization he means the introduction of armoured mechanical contrivances, self-contained and self-propelled, such as tanks and armoured cars, that replace the other arms, at least partially. By motorization he means the replacement of the horse or mule by motor vehicles, tractors, etc.

Opinions are divided as to the amount of mechanization that is desirable in the French Army. General Camon was one of the first advocates of motorization, in 1925. In 1929 General Allehaut declared himself in favour of a very extended motorization, but he was averse to the introduction of entirely mechanized large units.

After a long delay, France seems to have decided now upon an extensive motorization of her army and a partial mechanization of her mounted troops. While maintaining the greater part of her divisions on a normal basis, she is contemplating the following changes :—

Motorizing a large proportion of all arms, in particular 65% of the artillery and 20% of the infantry.

Organizing 4 to 6 infantry divisions on an entirely motorized basis.

Converting 4 out of 6 cavalry divisions into light mixed divisions.

Considering the formation of mechanized brigades independently from the other arms.

3. *La guerra di mina nel conflitto mondiale. Previsioni per il futuro.*

Captain Izzo mentions four instances on the Austro-Italian front in which mining operations were carried out on a large scale.

The Col di Lama gave the Austrians a good observation post, overlooking the Italian trenches. The Italians drove a long gallery underneath it and, after three months' continuous labour, fired a mine under the Austrian post, which they captured and held. In the three other instances mining and counter-mining operations were carried on by both sides with varying success.

On the French front mine warfare was carried on from the end of 1914 onwards. It reached its maximum intensity in 1916. After that the moral strain on the troops was found to be so great, and the results obtained so slight in proportion to the energy expended, that both sides gradually dropped it. During the progress of mine warfare, charges continued to be increased until 20,000 kg. of explosive came to be looked upon as a normal charge.

Mines may or may not find a place in future warfare, but the experience gained in the World War is well worth studying.

4. *Bersagli dell' artiglieria da campagna e metodi di tiro più convenienti per neutralizzarli.* By Colonel Berardi.

Instructions for finding targets for field artillery, such as machine-gun emplacements, and the best methods for putting them out of action.

5. *La telefonia interurbana ed il suo impiego in caso di guerra.* By Lieut.-Colonel Gatta.

The inter-urban telephone system in Italy was inaugurated in 1898 with the opening of the Milan–Turin line. It developed steadily until 1925, when the Fascist Government gave it a vigorous impetus. Under the new system all new lines were erected as underground cables, and aerial lines were gradually replaced by underground ones. The projected series of lines will be completed in 1934.

The total length of cable laid is 90,969 km., and has cost about one milliard lire. Seventy-five per cent. of the circuits are furnished with Pupin coils, 80% are amplified.

An interesting item in the telephone system is the cable connecting Sardinia with the mainland. It has only two wires, and is 270 km. long.

The latter part of the article is devoted to the use of the telephone system in case of war. Various points are touched upon, such as the allotment of definite circuits to the larger units, the discipline in the traffic, extra work thrown on the lines,

provision for secrecy, protection against interruption by aircraft, and provision of a specialized military staff.

(*May*, 1934.)—1. *Organizzazione ed esecuzione della controbatteria, in guerra di movimento.*

General Fautilli concludes his article in this number. Referring to the distribution of a group of guns, he considers that they should not occupy a frontage exceeding one-tenth of the probable range of fire. With a range of 7 to 10 km., the front should not exceed 700 m., the depth 400 m., and the distance between batteries 100 m.

In Italy, as well as in certain other countries, counter-battery is organized in an army corps, and it is only in exceptional circumstances, such as mountain warfare, that it would be relegated to divisions. It is, in fact, the main duty of corps artillery.

The article is devoted to a study of the best distribution of guns, to observation, intercommunication, a central register of information, zones of action, organization of command and fire action.

2. *L'osservazione aerostatica.*

Lieut.-Colonel Liuzzi asks the question whether observation from captive balloons is likely to be necessary in the future, as it has been in the past. He gives the answer in the affirmative, and proceeds to give his reasons.

A balloon must be anchored at a distance of 6 to 8 km. from the enemy front line: its height must be regulated by circumstances, but is not likely to exceed 1,500 m. The angle of view should not be flatter than 1 in 10. Compared with an aeroplane, a balloon offers a much better and steadier view. It is not, however, suited for work in high mountains, nor is it adapted to operations in the movement stage.

The writer next deals with the various objects for balloon observation, and the methods of signalling. The usual methods would be by telephone with the higher commands and with the artillery, and by visual signalling with the troops in the front line. As regards the control of captive balloons, they should—in the writer's opinion—be directly under the orders of the artillery commander, and not under the divisional or corps commanders. As a rule, a corps artillery commander would have one observation balloon under his orders, an army commander might have two or three.

We then come to the instruments, maps and equipment necessary for an observer, the methods of measuring angles and distances from a single balloon, or from two balloons working in conjunction.

Lastly, we come to the defence of captive balloons. The main danger to which they are exposed is from aeroplanes, armed with machine-guns firing incendiary bullets. In France, defence is provided by posting three (two-gun) groups of anti-aircraft machine-guns, capable of all-round fire, forming an equilateral triangle, with sides not exceeding 500 m. in length. Modern automatic arms are, however, inefficient at heights exceeding 1,000 m., so that the strata above that level must be swept by anti-aircraft artillery.

3. *La intercettazione telefonica sul campo.* By Lieut.-Colonel Ravazzoni and Captain de Falco.

It is not often that it will be possible, in warfare, to tap an enemy telephone wire direct, but, where an earth return is used, opportunities may occur of intercepting messages by utilizing either part of the current in the ground, or the phenomena of induction. The methods that may be used are described in this article, as well as the constitution of an intercepting post.

Although it is hoped that a future war will be a war of manœuvre, it is probable that it will be carried out on a continuous front, behind which both belligerents will endeavour to out-manœuvre each other. It is likely, therefore, that telephonic communication will play a large part in future operations, and there will always be scope for intercepting enemy messages.

4. *Giuoco balistico a tempo.* By Lieut.-Colonel Balotta.

5. *Lo sviluppo della motorizzazione e della meccanizzazione nell' esercito degli Stati Uniti.*

Under the " National Recovery Act," intended to solve the problem of the economic crisis in the United States, an important part is being given to the motorization and mechanization of the army. The programme is in course of execution, and when completed, the American Army will be almost entirely motorized and provided with the most up-to-date mechanical equipment. The cavalry is being largely motorized, on two different lines. In one case the horse is being entirely replaced by the armoured car, in another case arrangements are made to convey the horses in special wagons (carrying eight horses apiece), towed by lorries. A squadron of the 7th Cavalry Regiment made an experimental march on these latter lines in the " Big Bend " of Texas last year. Carrying their own fuel and supplies, 200 men and 170 horses covered a distance of 616 miles in ten days.

Like the British Army, the American Army has experimented with completely mechanized formations, but these have not been kept up, and the tendency in America is rather to mechanize the cavalry than to mechanize a force of all arms.

Tanks and armoured cars have been developed to a considerable extent. Fifteen tons is considered the limiting weight for a medium tank. A light tank of 7·5 tons was introduced in 1928. The ultra-light tank has not yet been developed, but the appearance of the Vickers-Carden-Loyd Patrol Tank in England has been followed with great interest. The various types of Christie tanks are convertible, that is, the chain track is removable, and the cars can run at high speed on wheels on a good road. A type of armoured car that is being experimented with is the Citroen-Kegresse half-track car, a type that has found favour in France. The Diesel engine is coming into more extended use for armoured cars.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*March–April*, 1934.)—1. *Un pont de bâteaux en matériel* 1915 *construit à Marmande par un détachement du 6e génie.*

The national road No. 133, from France to Spain, crossed the Garonne, at Marmande, by means of a suspension bridge, 200 m. long, built about 1850. The bridge was not strong enough to carry modern traffic, and it was decided, in 1930, to replace it by a new semi-rigid bridge of up-to-date design.

The French War Department was asked to construct a military boat-bridge of standard equipment, and maintain it during the ten months of reconstruction. Some bridging material of 1915 pattern was available, which admitted of the construction of a bridge for 7-ton loads (the old bridge could carry 6-ton loads) without offering too great resistance to the current during a spate. The boat-bridge was constructed about 100 m. downstream of the permanent structure by a detachment of the 6th Regiment of Engineers, which arrived on the 14th November, 1931.

The construction of the bridge is described and is illustrated by eight photographs and some sketches. Allowance had to be made for considerable differences of level during floods by adjustable ramps, and arrangements were made for rapidly dismantling the bridge during exceptional floods, when traffic was taken across by ferry. On the left bank approach the roadway was carried on piles, driven into the gravel bed, the levels of the transoms being adjustable.

In the right bank ramp, where the depth of water was considerable, three adjustable trestles were carried on boats. To avoid numerous changes in the level of the ramps, the transoms were fixed in two positions only, one 1·40 metres above the other. The floating portion of the bridge was made up in rafts.

2. *Une grande offensive vue par un officier télégraphiste.*

Chef de Battn. Durand relates his experiences as a signals officer with the 3rd French Army during the offensive carried out in the spring of 1917. He helps one

to realize the difficulties experienced by the signal service from constant changes in the area allotted to the army, with the British on one flank and the 10th French Army on the other. Months of strenuous work were put in before the offensive took place, and when the advance did take place, it was over ground completely wrecked by the enemy, and the sappers of the signal service were kept working at full pressure day and night. Two plans show the telegraph system of the 3rd Army.

3. *Avec les sapeurs de la 1/3 de Dinant à la Marne.*

Captain Simon has written an account of the work done by the 1/3 Company of the 3rd Regiment of Engineers between the outbreak of the war and the battle of the Marne.

The Company left Arras on the 7th August, 1914, and was attached to the 1st Army Corps. The first encounter with the enemy took place at Dinant on the 15th August. The 1st Corps was holding the passages of the Meuse against Von Hausen's III. Army advancing from the east; the 3rd and 10th Corps were holding the line of the Sambre against the II. Army (Bülow) from the north.

The first important job allotted to the 1/3 Company was the preparation for demolition and, subsequently, the demolition of four bridges over the Meuse, viz., the road bridges at Hastière, Dinant, and Bouvignes, and the railway bridge at Anseremme. The arrangements were to be completed by 20 hours on the 17th. The 18th, 19th, 20th and 21st passed uneventfully. On the 22nd the enemy tried to secure the bridges, and these were blown up by the detachments allotted to each.

In the case of the Hastière and Anseremme bridges the destruction was not as complete as it should have been, and the Saxon corps was able to put up a light foot-bridge over the broken girders, on which the infantry, but not the guns, crossed. The Bouvignes bridge was a modern one of reinforced concrete. Each rib was cut across in two places, so as to leave a clean cut in the bridge, 30 m. wide. In the case of the Dinant bridge, the enemy occupied the town before orders were received to blow up the bridge. The captain of the company waited as long as possible for orders and finally blew up the bridge on his own responsibility. It afterwards transpired that three messengers carrying orders for the demolition of the bridge had failed to reach him.

The next important piece of work was the erection, during the retreat, of a boat and trestle bridge across the Marne at Reuil, at the end of a very strenuous march. Fortunately the company commander was able to obtain transport for the carriage of his men, who were utterly exhausted, and the work was completed in the time required.

After the battle of the Marne, the armies settled down to trench warfare, and the 1/3 was employed on a number of different classes of work, and it took part in all the offensives.

4. *Exercice sur la carte (Sapeurs-Mineurs). Emploi du génie à l'échelon armée.*

A tactical exercise, accompanied by a map, on the work to be done by the engineers in a retirement (such as might have occurred in the early stages of the war). The first position was west of Paris, along the line of the Seine, where all bridges were to be prepared for demolition. The other two positions were south of this. The exercise is worked out in detail.

A.S.H.

REVUE MILITAIRE SUISSE.

(*April*, 1934.)—1. *A propos de fortifications permanentes.*

Colonel Lecomte gives us a first instalment of an article on permanent fortification in Switzerland. Forty years ago the subject received a good deal of attention. France had begun to reorganize her permanent defences: the system had been disorganized by the war of 1870–71. The Swiss felt that some action on their part was necessary.

The completion of the St. Gothard tunnel, in 1889, changed the aspect of the defensive problem. The St. Gothard *massif* commanded four main roads and railways that might serve as main lines of operation for an army campaigning in Switzerland. Under the terms of the Triple Alliance co-operation between Germany and Italy against France could only be effectually maintained by the occupation of the St. Gothard. Hence the importance, from the Swiss point of view, of fortifying the St. Gothard.

The general principles, accepted by the Swiss Government and people about forty years ago, were :—

(1) A foreign army must be prevented from crossing the Alps by permanent fortifications on the St. Gothard and at St. Maurice.

(2) The crossing of the Swiss plateau must be prevented by the field army, resting partly on these works but, above all, on provisional works, to be erected on the outbreak of war.

Coming to modern times, the writer considers that the crossing of the Alps can be left out of the question. The Swiss Army is capable of making such good use of the ground as to prevent any of its neighbours crossing them.

An invasion of the Swiss plateau is another matter. It is here that fortification might play a part. Permanent fortification must comply with two essential objects, viz., to cover mobilization and facilitate manœuvre. The first object can be attained by strong fortresses commanding the main routes of invasion, near the frontier; the second by fortresses that ensure the possession of points of strategic importance, either as manœuvring pivots, or as bases of operations.

2. *Les exigences et les disciplines actuelles du haut enseignement militaire.*

General Duffour continues and concludes his lecture to the Swiss Society of Officers in this article. He touches on a variety of subjects to show the necessity for keeping up to date in one's ideas.

The first doctrine is that adopted in Great Britain for mechanizing an important portion of her home army for warfare. This has been done very thoroughly, advantage having been taken of the experience gained in nine years of experimenting.

A second doctrine is that propounded by the Italian General Douhet, *i.e.*, merely to resist on land and at sea, while making a mass offensive in the air. His first work, *The Mastery of the Air*, appeared in 1921, but the principle was not taken up by the Fascist Government till 1927. It has received support in America, Great Britain and France, and it is only in keeping with the German character that it should have found favour in that country.

A third doctrine is that propounded by General von Seekt, the organizer of the *Reichswehr*, combining, to a certain extent, the British and the Italian ideas. The system consists of three parts: (1) an air force of the greatest possible strength; (2) a professional army of at least 200,000 men, capable of taking the field at a moment's notice; (3) a large popular army of men trained from their early youth, and a thorough industrial organization for war.

General Duffour dwells on the importance of learning from history, not blindly, but with a thought of the changed conditions under which modern warfare is conducted.

To end up with, he explains the system of training French officers for the higher commands, firstly in the " École de Guerre " for those between 28 and 38, and, secondly, in the " Centre des hautes Études militaires " for lieut.-colonels and colonels between 47 and 52.

(*May*, 1934.)—1. *Défense nationale et réorganisation de l'armée.*

Major Masson asks whether the present militia system in Switzerland is suitable for maintaining the integrity of the country. He thinks it is, subject to certain modifications. There are certain times of the year when there is not a single man with the colours. He suggests that, in peace-time, there should be some permanent

units of *chasseurs*, who would, on the outbreak of war, occupy some of the "nerve centres" and the obligatory points at which the frontier could be crossed, pending the completion of the mobilization of the army.

There are other problems, such as the organization of industries, the evacuation of civilians, the protection of rear areas of the field army, and that of inhabitants against gas, etc., that all require careful study in peace-time.

2. *La couverture des frontières.*

Colonel Léderrey discusses the question of the defence of Switzerland, with special reference to a covering force for guarding the frontier.

Dealing with the question of fortification, he is averse to a heavy expenditure on permanent fortresses, whereas no invader would allow time for semi-permanent works to be erected, which would delay him on the frontier. He suggests that a scheme should be worked out in peace-time for a series of embryonic works, in which certain portions, such as machine-gun emplacements, should be constructed and covered up with earth until required.

Next, dealing with demolitions, the writer quotes from a work by General Normand, who considers that the Belgians could have held up the German advance in 1914 more effectually by a thorough system of demolition than by their forts, and that they might have compelled the Germans to make a direct attack on France. In any case, demolitions should be carried out with brutal thoroughness, and the methods adopted by the Germans in their strategic retreat of March, 1917, and their final retreat in 1918 are held up as examples of the most effective way of delaying an enemy.

A short reference is made to industrial demolitions (*e.g.*, destruction of mines, steel-works, power stations, etc.) and to the evacuation of the civil population. The last part of the article is devoted to "covering troops." The latter should be composed of all kinds, *i.e.*, *élite*, *landwehr*, *landsturm*, etc., but they should be organized separately from the divisions of the field army, and they should be called out for a very brief period of training every year.

3. *A propos des fortifications permanentes.*

Colonel Lecomte continues and concludes his article in this number. He admits that he has no exaggerated enthusiasm for permanent fortification, but he is prepared to discuss the question impartially in the light of modern requirements. When the World War broke out, Switzerland was quite unprepared to keep out any invader. In present circumstances she is not much better off.

The writer considers that there are three districts in which it is necessary to have proper forts with heavy artillery and complimentary equipment. These are the regions north of Schaffhausen, that south of Bâle, and that north-east of Geneva. In each place he would establish a group of two to four modern forts with permanent garrisons. This would necessitate the creation of a permanent force of nearly 2,000 men, a new departure from the established militia army.

In addition, he would provide blockhouses with machine-guns or light cannon on all the frontier bridges over the Rhine, and in the Jura defiles. These would be garrisoned in peace-time by frontier guards.

(*June*, 1934.)—1. *La mitrailleuse moderne.* By General Rouquerol.

New instructions issued for machine-gun units call attention to the history of this infantry weapon since its first introduction, and to its future.

The original weapon, used for the first time in the war of 1870, was allotted to the artillery. In course of time, the reduction in the weight of the weapon caused its transfer to the infantry.

The Germans were the first to push their machine-guns into the front line, and this gave them a considerable advantage early in the war. The French worked out machine-gun tactics slowly, and by the end of the war they were fully a match for the enemy.

The long range attained by the machine-gun has made its fire as technical a

business as that of artillery, and its personnel should be highly trained and should specialize in its use. The main difference between the firing of a field-gun and of a machine-gun is that in one case the firer can see where his shots go, and can rectify his error, whilst in the other case he cannot, as a rule, test the accuracy of his shooting.

The automatic rifle comes under a different category, and is an infantryman's weapon pure and simple.

2. *La défense de l'armée.* By A. Schenk.

This article explains the attitude of various political and non-political bodies in Switzerland towards the army. The writer considers three main classes:—(a) the extremists of the left, a small but prejudiced party whose attitude will always be opposed to the army; (b) the majority of the people, who are in favour of the army, but are, on the whole, indifferent to military matters; (c) the lovers of compromise, who are fairly numerous, who are prepared to tolerate the existence of an army, but are desirous to curtail expenditure on it to the lowest possible figure.

A number of national associations are mentioned, in connection with whom the writer fears that anti-militarist propaganda is sometimes being spread. He speaks with praise of the various military and semi-military associations, but thinks they are over-prudent about interfering in public affairs.

3. *La guerre chimique en campagne.* By S. de Stackelberg.

This is the first instalment of an article on chemical warfare. The writer points out the various advantages that it offers, both in attack and in defence, and then goes on to describe the various kinds of gases in use, both heavy and light. In gas-shells it has become the general rule to adopt a mixture of a light volatile gas with a heavy gas.

It is always possible to neutralize gases and harmful substances in general. The equilibrium that exists in nature enables us to find an antidote to every poison.

The writer next goes on to describe the gas wave. This usually consists of chlorine or a mixture of chlorine and phosgene—both heavier than air—which forms a layer about 3 m. deep. The use of such a wave is dictated by tactical considerations. In an attack it is necessary to spread the gas cloud over a far wider front than that to be attacked, *e.g.*, for 1 km. of front to be attacked gas should be spread over a 5-km. front. Atmospheric conditions must be watched the whole time: a change in the direction of the wind may mean disaster to one's own side. It must be borne in mind that ground favourable for discharging gas is always unfavourable to an attack.

The last portion of the article is devoted to chemical bombardment by artillery. Chemical bombardment has become necessary owing to the powerlessness of artillery against field works that have attained the strength of permanent fortification.

A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*April*, 1934.)—*The Gas-attack with Projectors at Flitsch, 24th October*, 1917. Major Heydendorff gives credit for the first gas-attack by means of projectors to the British, near Arras, on the 24th April, 1917. The simultaneous discharge of a large number of gas-drums, obtained by this method, flooded the trenches with gas to such an extent that respirators failed to keep it out, and the German losses in this and in the succeeding attacks were heavy. German headquarters at once decided to adopt the projector method, and the 18-cm. gas projector was soon produced. It consisted of a smooth tube with hemispherical end, without a mounting, for burying in the ground. The charge was fired electrically, and threw a gas-drum containing 12 to 15 litres of phosgene, or Green-Cross, a distance of 1,600 metres; or ordinary bombs could be used instead of the gas-drums.

An opportunity for the first trial of this new weapon was afforded in the autumn of the same year in the great Austro-German offensive, which resulted in the Italian

disaster at Caporetto. The 35th Pioneer Battalion of the German Army, trained in gas-projector work, was allotted to the forces selected for the attack, the 14th Army under General von Below. The area chosen for gas bombardment lay south of Flitsch and embraced deep ravines with steep sides, which had served the Italians well as covered positions for reserves. Of 1,000 projectors arranged for, 894 arrived and were dug in.

At 2 a.m. on the 24th October the artillery started gas-shell bombardment, and five minutes later the whole of the projectors were fired, except that 47 failed. There were also 29 prematures. The latter, by gassing the firing-positions, spoilt to a great extent the rest of the programme. It had been intended that each projector should fire one gas-drum and then one ordinary bomb. Actually, by nearly 9 a.m., it had only been possible to fire a second time with 269 of the projectors.

At 9 a.m. the infantry went over the top, 63 German battalions and 72 Austro-Hungarian battalions advancing on a front of 30 km. Three deep breaches were made, at Flitsch, at Karfreit (Caporetto) and at Tolmein.

Major Heydendorff says that the whole Italian garrison of the ravines, between 500 and 600 men, were found to have been killed by gas, and that the gas-projector bombardment, by thus eliminating all flanking fire from the ravines against the Austrians advancing on Flitsch, had doubtless considerable influence upon the events of the day.

The Giving of Orders in the Fight. Major Hegedüs has compiled several pages of typical orders, suited to varying situations in the field, and such as would be issued verbally by company or section commanders. His introduction to these examples consists of considerations of a more general nature upon the giving of orders, and here he says much that is valuable in or out of the fight, *e.g.*, on the necessity of clearness and on the necessity of decision. The author rises to eloquence when he treats of calmness. "Calmness is the first requirement of every leader. This is a calmness which has nothing to do with lethargy. On the contrary, it has in the leader to be associated with a quick grasp and the power of rapid thought. It consists rather in a composed state of mind arising from internal discipline and confidence in one's own powers. This peace of mind must be radiated downwards from the leader so that it comes to pervade the troops. Only when this is the case can one be sure of purposeful action quickly adapting itself to changing circumstances."

The Replacement in War of Demolished Railway Viaducts, by Major Janick. After the Russian Revolution in March, 1917, the fighting strength of the Russian armies noticeably weakened, and Kerensky's brave gesture of a renewed offensive in E. Galicia soon petered out. Almost immediately followed the counter-stroke, eleven German divisions taking the offensive near Zalosce on July 19th, with such success that they penetrated on the first day to a depth of 15 km. on a 20-km. front. By the 3rd August the whole of the territory of E. Galicia and of the Bukovina, which had been occupied by the Russians, was again in Austrian hands. The advancing troops found nearly everything on the railways, but especially all bridges of 20-metre span and upwards, destroyed with a thoroughness indicating the abandonment of any idea of re-conquest. This was specially the case with respect to the three single-track railways radiating from Stanislau, and an enormous amount of work was thrown upon the engineers in the deep-cut valleys of the Pruth, the Dniester and the Sereth. The work of restoration had to be put in hand at once, and the first object of attention was the main (single) line from Stanislau *via* Kolomea to Czernowitz, which at that time was the only line of supply of the 3rd and 7th Armies. Next in importance was the railway which, following the course of the R. Pruth, eventually crosses the Carpathians, and at Korosmezo enters what at that time was Hungary, thus connecting the Galician railway network with the supplies of the Hungarian plain.

The writer, then commanding the 1st Railway Coy., gives here an account of what was done to make good the demolition of two adjacent viaducts. Each of these

consisted of a main arch flanked on both sides by a series of smaller arches, the whole built in faultless ashlar. Especially the larger of them was a difficult object and famous for its length, 183 metres, its great span 72·4 metres, and for its bold design. It crossed the R. Pruth, having here the nature of a mountain stream, in a very oblique direction with six 12-metre-long secondary arches on one bank, then the main arch over the water-course at a height of 28 metres above the bottom of the valley, and ended with a single 12-metre arch on the other bank. The bridge lies in a rise of 11 per 1,000, and is in plan a slight S-curve, with a straight portion 104 metres long connecting two arcs of 275 metres radius, which are carried to the last arch before the centre span.

The smaller viaduct was of the same design, but only 120 metres long, with main arch span of 53·7 metres.

The Russians' method of demolition had been the same in each case, viz., charges at the crown of the main arch and built in at the foot of one of the main piers. The result was completely successful, main arch and one pier subsiding into the river-bed, leaving gaps of 86 and 65·5 metres respectively, or from centre to centre of the first sound piers of 89·5 and 69 metres. There remained suspended in each gap, as a grotesque communication from bank to bank and a proof of good construction, a catenary of rails and sleepers.

For rapid field service repair, considering the great spans and the height above the river-bed, only one type came into consideration, viz., the newly-standardized iron war-bridging material of the Roth-Waagner system, and sufficient of this material was ordered up from stock at the Railway Store Depot at Korneuburg for spans of 81 metres and 60 metres. The destroyed pier at Jaremcze (the larger crossing) was replaced by a pier also made of Roth-Waagner material, but at Jamna, where weight and height were less, the corresponding replacement was made by means of a wooden crib. The lattice-girders were built out from both sides of the gap in the larger bridge, but at Jamna building out had to be done from one side only, owing to the line running into the Jamna tunnel within 15 metres of the gap. The line on this side was also useless for supplies owing to the next tunnel having been blown in.

Both bridges were completed, passed their tests and were handed over to the railway management 47 days after the work was started. The skilled personnel employed, which included one Bavarian Railway Construction Coy. and two sections of a Prussian R.C. Coy., amounted to 19 officers and 502 O.R. There were also to assist 282 prisoners of war.

Economic Mobilization, by Director of Supplies Iwanski. This form of preparation was almost entirely lacking among the nations which entered the Great War. Amongst the many reasons that have been given for such neglect are, that nobody believed that a long war was possible; that no nation wished to arouse suspicion of hostile intent by undertaking in peace-time economic measures impossible of concealment and likely to be misconstrued; that war ministries had no adequate staffs, either in numbers or training, for dealing with industrial questions.

The first nation to take up the question after the war was the United States, and in 1920 Congress passed the United States National Defence Law, which provides for the whole personnel and material strength of the country being made available for national defence in war. Such a process is now everywhere recognized under the term "industrial mobilization."

The writer of this article now warns us that, alongside the military mobilization, the industrial mobilization, or utilizing of all personnel and material strength of a country for war, as arranged for by the U.S.A., is sufficient only in the case of a rich and self-supporting country like the United States. Other countries in proportion to their weakness must mobilize their whole economics, *i.e.*, they must arrange for their trade to continue in war, and for a continuous supply of their necessary imports of lacking war material. For such countries "industrial" mobilization, like financial mobilization, though an important part, is still only a

part of a greater "economic" mobilization. The writer treats the latter under twelve heads:—personnel; finance; raw materials; motor-spirit; transport; industrial measures; food sources; trade and communications; social measures; intelligence; propaganda; and statistics. He suggests for the sub-heads of item six in the foregoing list, *i.e.*, for "industrial" mobilization:—distribution of raw materials and motor-spirit; machinery; munitions and ordnance; chemistry (explosives, medicines and manures); leather; clothing; food; building materials. As evidence of the importance now attributed to this subject, attention is drawn to the founding of the Army Industrial College in the United States in 1924 and of the Imperial Defence College in England, both of which are highly commended.

(*May* 1934.)—*The Role of the Tagliamento Defences*, 1915–17. These defences, which consisted of a fortified perimeter in the hilly country east of Gemona, and two smaller fortified bridge-heads in the Venetian plain, one at Codroipo and the other at Latisana, started building in 1910, and by August, 1914, were for the greater part complete and armed. Their object was to secure for the Italian Army, mobilizing behind the Piave, an area for deployment between the rivers Piave and Tagliamento.

Between August, 1914, and Italy's entry into the Great War in May, 1915, the Tagliamento defences were completed as regards armament, stores and subsidiary works. Italy's army took the field with only 66 batteries of siege and heavy field artillery, a lack of heavy guns which led to General Cadorna's decision to strip the Tagliamento defences in favour of the field army. In the autumn of 1915 accordingly a disarmament took place, which was complete except in the case of two works, the barrier fort at the mouth of the Fella valley and the fort in front of it at Chiusa, which closes the Raccolana valley. These two forts alone retained their armament, as they lay on the direct line of approach, from Austria *via* Tarvis in Carinthia, of the only outflanking movement threatening the Isonzo position.

Cadorna, arraigned before the Italian Commission appointed to enquire into the causes of the disaster of Caporetto, pleaded, in addition to the reason for disarmament of the Tagliamento defences given above, that the works themselves with their weak-armoured cupolas would have been useless against the Austrian 12-in. mortars. The Commission found that General Cadorna, filled only with the idea of advancing at all costs, had never entertained the possibility of the enemy driving the Italians back as far as the Tagliamento.

The writer, Major Heydendorff, while admitting the impossibility of the Tagliamento defences standing up to a siege, believes that they would, in spite of their weakness, have provided just that amount of resistance to the advancing Germans and Austrians necessary for the Italians to make an orderly withdrawal over the river. He makes out his case by analysing the events and movements between the 24th and the 31st October, and by estimating the delays which might reasonably have occurred, had the admittedly weak Tagliamento defences only been able to put up some sort of a show.

The Commission of Enquiry's finding was that in view of the state of the retreating Italian army, the presence of permanent fortifications along the Tagliamento "would hardly have influenced the course of events."

Major Heydendorff cannot agree with this finding, and consequently is obliged to blame the Commander-in-Chief for not re-arming the Tagliamento defences, in other words, for not returning the guns lent to the field army when they were no longer needed. They could certainly have been spared in 1917, when the number of heavy batteries on the Italian front had risen from 66 to 950.

The Russo-Polish War of 1919–20. Colonel von Wittich continues his remarks, critical and uncritical, and deals in this instalment with the first larger-scale fights in the north, and the retreat of the Poles in the Ukraine. In the first phase, viz., up to May, 1920, Poland's star was in the ascendant, the occupation of Kiev marking its zenith (*v. R.E. Journal*, September, 1933, pp. 537–8). The second phase lasted from the middle of May until the end of June, and falls easily into two parts, viz.,

what happened north, and what happened south, of the marshes of Pinsk. Taking these in turn, on the upper Beresina, half-way between Vilna and Smolensk, two Russian and two Polish armies faced each other. Both sides were full of fight and decided to attack. The reason given by the Russian account for their own decision is worth preserving: "During the assembly of our main forces in the north the Poles had been victorious in the south. Their success at Kiev had an effect also upon the northern front, as evidenced by their pressing forward. There was every indication that we were on the eve of a Polish offensive along the whole line. In order, therefore, to avoid a disturbance of our own intended large-scale offensive, we found ourselves compelled to go over to the attack, and our offensive of the 14th May arose from this cause. It began before our troops had completely assembled, and those divisions which had not yet arrived were to be looked upon as reserves." After reading this last sentence, officers, trained in the school of trench warfare with its minute preparations, will place their own notes of exclamation.

In their offensive preparations each side chose its own right wing for the blow, and thus, when the Russians struck first, they found the Polish reserves away on the other flank. The Polish left was driven back nearly 100 km. in 13 days, and Pilsudski, deciding that the situation called for a powerful counterstroke, sent up a fresh (reserve) army in support. The two Polish armies now on the left attacked with determination, attempting the tongs effect. This, however, the retiring Russians managed to evade, and the operation turned into a frontal thrust all along the line. By the time the Beresina was reached, half the lost ground had been recovered, and the effort was called off. The troops then dug in, honours being easy.

The course of events on the south side of the marshes of Pinsk ran otherwise. There also two armies opposed two armies, but the Russians had a preponderance in cavalry of nearly six divisions to two, which played an important part.

The Poles, after the capture of Kiev (end of first phase) spread themselves over a 400-km. front, facing S.E. and stretching from the Dniester to the Pripet, a tributary of the Dnieper. There seems very little to be said for this imitation by the Poles of the position warfare and continuous fronts of the Great War. Possible factors leading to its adoption may have been that the Polish troops, being of the nature of militia, were unsuitable for manœuvring, and also it may have been desired to close the occupied territory against raids and propaganda. Unless the enemy should adopt a similar distribution of his forces, there could be no guarantee for a defence opening up any prospect of success.

The Russians attacked at the end of May. Their plan was a general advance and the pinching-out of Kiev by means of their northern army and a group formed for the purpose in the centre. One day later, Buddenyi's 27 regiments of Cossacks, which had arrived from the lower reaches of the Don on the 27th May, having marched 1,100 km. in 32 days, were to be put through in the centre, then to swing north and complete the encirclement of the Polish northern army.

Partly this plan was not carried out at all (*e.g.*, the Russian southern army appears not to have attacked anywhere on the first day) and partly the plan was to some extent carried out, only late.

Although the Poles were driven back Fortune was very kind to them; for Buddenyi, ex-Serjeant of Caucasian Dragoons and now commanding an army of cavalry, a character both headlong and headstrong, and spoilt by independence so that he obeyed only the orders that suited him, elected to turn S.W. on an errand of his own devising, instead of N.W. as ordered. The result was that the Polish northern army, escaping encirclement, was able to withdraw, counter-attacking heavily whenever necessary, but always unbroken, to fresh positions. They had lost Kiev, and in a month of fighting a strip of Russia varying from 50 to 300 km. in breadth.

This failure of the Poles cannot be attributed in any way to their being less good fighters than the Russians. They failed chiefly because their leadership had, in its measures for holding the Ukraine, sinned against the formula approved by experience,

that a strategic defence which does not merely aim at gaining time, but at more positive successes, must not confine itself to passive defence, but in its method of defence, must include the counter-attack aiming at a decision.—(*To be concluded.*)

France's Safety. This is a compilation from various sources, especially from articles dealing with the French frontier defences which have appeared in *L'Illustration*, the *Revue d'Infanterie*, the *Kolnische Illustrierte Zeitung*, and the *Neue Freie Presse*. Among these periodicals the second-named alone can be regarded seriously from the point of view of military scientific accuracy. The remainder, like the rest of the popular Press, cater for the taste of a public, either really sensation-loving, or which they believe to be so. It is unlikely that they have discovered, or disclose, anything which the French War Office desires to conceal, but they draw freely upon the imagination. The *Revue d'Infanterie* in this fantasia provides a substratum of fact, but it undoubtedly betrays no secrets. The application of a diagrammatic drawing to an actual photograph of a wooded hill shows a nest of pill-boxes, galleries and shelters, and is certainly interesting. It is claimed that this picture shows "a modern French group of fortifications on the German frontier." The map of the fortified frontier leaves much to be desired. It bristles with unexplained symbols, and it makes the French defences between Lille and Maubeuge face the wrong way. *Ex pede Herculem.*

The Meaning of the Belgian Defence Measures. This is an historical retrospect of all projects for the defence of Belgium which have been considered by the Belgian Government since the Franco-Belgian Agreement of 1920, and of the measures undertaken to that end. The account gains in interest owing to the sidelight thrown by the *résumé* of an essay on the possible tasks of the French Army, by an anonymous writer in the *Temps* of 9th January, 1934. This essay followed a lengthy series of articles in the same paper, dealing with the teachings of war generally, and with the consequent demands upon France as regards organization. The writer, a Bavarian, Colonel von Xylander, answers his own question by saying that the present measures for the defence of Belgium show two things :—(1) that France has learnt that for the efficient defence of a country preparation must be extended to include even improbable eventualities. France has no intention of following the example of the German Empire and the Austro-Hungarian Monarchy, which to their detriment stood in 1914 without any strategic agreement before a situation breaking upon them as a surprise. (2) Such extensive co-operative work with Belgium (as has already taken place and as is contemplated) gives France an increase of strength, which will not be taken into account when armaments come to be reduced, but which is practically the same as an increase of France's own strength.

The Search for New Weapons, and their Development for the Purposes of Surprise—a Task of the General Staff. Colonel Blümner, starting from the story of the opportunity lost when Lieut. Burstyn, of the Austro-Hungarian Army, invented a tank in 1911, which was turned down by the experts (*v. Waffen und Wehr*, January, 1933, and *The R.E. Journal*, June, 1933, p. 365), loses no time in lamenting, but investigates what happened with that and other inventions for the purpose of discovering what system is to be adopted, and what arrangements are to be made, to avoid similar misfortunes in future. He points out that the testing of a quite new invention by a Proving Commission in the first instance is a mistake, since the commission will always judge from the standpoint of the existing and familiar. Thus, Burstyn's tank, perhaps unfortunately labelled as a motor-gun, was judged from the technical standpoint only as a new form of an existing weapon; and as such was condemned. It never got as far as being seen by the General Staff, *i.e.*, being considered from a tactical point of view. It should have been regarded as an entirely new form of weapon, of a tactical nature, in fact a special means of overcoming machine-gun fire; when its development as such could have been put in hand.

It has been said that technics strides ahead of tactics, *i.e.*, that new weapons are invented to which the forms that the fight takes have to conform: but it would be

better if technics and tactics went hand-in-hand, and that those responsible for the conduct of war and of the fight should point out military requirements for inventors to devise new weapons. The French general Herr, in his *Artillery, Past, Present and Future*, quotes from a committee report: "Important as is the study of war in the past, the art of war is ever developing, and the army must maintain the closest touch with science and with industry. The art of destruction, like that of construction, can progress only with a full recognition of scientific and industrial possibilities, which are continually growing. Between the technical departments of the army and the commander-in-chief there must be the closest touch. During the war this touch was gained to a certain extent: in peace it must be maintained, and made closer still." Colonel Blümner goes one step farther than this, for he says it must be one of the duties of the General Staff to point out to technical experts what war's requirements are, and he specially commends the British C.-in-C. in 1915, Sir Douglas Haig, for having asked for tanks, albeit General Swinton's idea, an account of which had been laid before him, had found favour neither at the W.O. nor at Armstrong's.

Colonel Blümner demands that the General Staff contain a special department consisting of G.S. officers with technical training and military-minded engineers, whose business it would be to keep abreast of scientific advance, and to point out army requirements with a view to the creation of new weapons. This department would watch all new patents, at home and abroad, to seize upon any idea for trial which promises either improvements in existing, or the creation of new, weapons.

The Italians have already a Scientific Intelligence Service, whose business it is to supply information of this nature to the Research Council at Rome.

War Literature, 1933. Professor von Frauenholz fulfils his promise of keeping up to date by means of a yearly addendum his bibliography of publications in all countries having a bearing on the Great War (*v. R.E. Journal*, December, 1932, p. 739, and March, 1933, p. 184 and p. 189). Among nearly one hundred new works and articles, he mentions specially *The Age of Imperialism*, being the title of Vol. X of the Propyläen History of the World. In this volume are to be found in less than 80 pages General Count von Montgelas' "Military and Political History of the World War," and E. Brandenburg's "The Decades before the World War," and "Europe after the World War." Two volumes by Herman Oncken called *The German Empire and the Previous History of the World War*, deal with events, causes and effects since 1871. It stops in July, 1914.

Both Austrian and German Official Histories continue to appear. The former with Vol. IV has reached the middle of 1916, while the latter reaches the end of 1915 with Vol. IX.

Amongst biographies and memoirs the following are praised:—General von Einem's (Prussian War Minister, 1903–09) *Reminiscences of a Soldier*; von Lettow-Vorbeck's *What the English have told me about East Africa* (both published by K. F. Koehler, Leipzig); Poincaré's *Victoire et Armistice* (Librairie Plon, Paris); and the memoirs of Lloyd George and Harold Nicolson.

(*June*, 1934.)—This again is a Memorial Number, issued on the occasion of the unveiling of a war memorial to, and in honour of, those officers of the General Staff who fell in the Great War. It should perhaps be mentioned, in explanation of how such a memorial came to be erected, that officers of the General Staff in the old Austrian Army formed a separate corps, which officers entered once for all as senior subalterns, after having passed the Staff College. Whatever may be said for or against such a system—and the article quotes much abuse, from "hated caste" to "wandering encyclopædias"—it was finally adopted in 1875.

The Under-Secretary for National Defence, General Fürst Schönburg, writes introductory words of appreciation, and mentions incidentally one of the reasons which, it may safely be presumed, led the *M.M.* to devote a whole number to the

subject, viz., that since the Treaty of St. Germain was made, and under the provisions of that treaty, the Austrian Army possesses no General Staff at all. A second reason, both probable and adequate, but not here disclosed, is that Austria looks forward to the time when she shall again possess a General Staff. For these two reasons, even if there were no others, it seems a good plan to make propaganda by showing Austrian readers what a General Staff is for, what it did when it existed, and what will be expected of officers in the future.

The headings under which the subject is treated are:—the history of the G.S.; the Staff College; the place of the G.S. in the armed organism; the relationship between the Chief of the General Staff and the highest military functionaries (the A.G., the Q.M.G. and the commanders); the various G.S. branches: (1) operations, (2) direction and instruction (*i.e.*, A Branch and E Branch as regards G.S. personnel only), (3) lines of communication, (4) survey, (5) railways, (6) signals, (7) intelligence; the General Staff in the war and land defence ministries; the G.S. in the formations. Finally, the relationship between the commander and his G.S.O. is clearly laid down: "This relationship is correct, when the former, before he expresses a determination, calls for the views and proposals of the latter. When these have been propounded, it is for the commander to say whether he agrees or not, openly and freely to adopt what he thinks good. Only by his acceptance does an idea become a purpose. It then becomes the task of the G.S.O. to work out into the smallest detail the orders in accordance with the commander's determination. It is here that his responsibility lies."

An Example of the Difficulties of a War of Coalition, by Lieut.-Colonel Klumpner. The reference is to the armies of the Entente in the Balkans in 1916, and the writer, whose authorities are *La grande guerre dans les Balkans* (Larcher) and *L'Armée d'Orient* (Deygas), has chosen an illustrative example of the difficulties that may arise amongst allied nations in the carrying out by their troops of concerted action. The difficulties were mostly political in origin, but the lack of a leader, able to inspire the troops of five nations, brought about a state of affairs where "everybody complained; the Serbians against the French for letting them bear the burden of the fight, and for waiting for Serbian successes before committing themselves; the French against the British for taking their feigned attacks too literally; the Russians, because they were being sacrificed in other people's interests. Even nations which were related showed little understanding of each other. The Serbs quarrelled with other Slavs in the volunteer formations, the Russians indignantly rejected the Serbian suggestion that they should be placed under Serbian orders."

There were also many limitations and conditions to be observed in using the troops of the different nationalities, *e.g.*, the Italians granted to the French C.-in-C. the right of laying down tasks, objects and areas, but reserved to themselves to decide the manner in which an attack was to be carried out.

The account here given makes one heartily sorry for General Sarrail, and inclines one to agree with the unknown writer's definition: "A war of coalition is the continuation with other means of the multiform politics of the allies; its course and its result are determined accordingly."

Credit for the capture of Monastir the writer gives to the Serbs, and to the Serbs alone.

The Loss of Monte Maggiore by the Italians in the Offensive of October, 1917, by Major-General Schemfil. The Italian Commission charged with investigating the causes of the catastrophe of Caporetto, "the greatest defeat, reckoning by numbers lost, in the world's military history," found that, after the original break-through, three phases were of decisive significance. The first of these was the loss by the Italians of the Monte Maggiore, which determined the withdrawal of their front behind the Tagliamento. Monte Maggiore, 5,300 ft. high, lies in the centre of a range 20 miles long, stretching with only one gap, the valley of the Torre, from the Isonzo to the Tagliamento. As the range runs due east and west its retention by the

Italians became of vital importance, since Monte Maggiore became the key to their whole position as soon as the Austrians, on October 24th, had broken through at Flitsch on the north side of the mountains. Cadorna, during the first day of the battle, gave the 2nd Army commander three different lines of resistance, all of which started in the north at the Monte Maggiore.

The Commission of Investigation published the result of their labours in a three-volume work called *Dall' Isonzo al Piave.* In it they find that the group of two battalions of Alpini, and five machine-gun companies, to whom the defence was entrusted, withdrew from the Monte Maggiore between noon and 1 p.m. on the 26th October, fighting in two directions and under threat of encirclement.

The writer of this article, who took part in the operations as a captain, brings a wealth of evidence to show that the retirement was premature, since at that time there was neither attack nor threat. He finds much to praise in the Commission's account of what happened, only their findings were based on one side's evidence, and they made insufficient allowance for lack of morale.

The Truth about Verdun. To combat a statement in Vol. XIII of the German State Archive's series, *Battles of the World War*, that "Verdun was a German defeat of terribly far-reaching significance," H. Z. Beringer has written a book in praise of Falkenhayn, and to show that Verdun was really a German victory, because it was mainly instrumental in bringing about the subsequent mutiny in the French Army. Colonel Kiszling, the reviewer, while praising the book otherwise, dissociates himself from this view and holds to the opinion of the State Archive.

F.A.I.

WEHR UND WAFFEN.

(*April*, 1934.)—*The Bending of Sound Rays under the influence of Temperature, and the Necessary Allowance to be Made in Sound-ranging.* During trials with Goerz's sound-rangers it was noticed that the angle in the vertical plane was less than the optical angle of elevation. The explanation of this phenomenon is the curvature in the travel of the sound ray caused by difference of temperature in the medium traversed. Lord Rayleigh, Commerell and Mathieson, according to the assumptions made, found the curves to be catenaries, cycloids or parabolas. Dr. Raaber, on the assumption that the higher layers of the atmosphere are colder than the lower ones and that the fall of temperature is constant, here publishes his working out of the curve, the results of which Goerz's have already taken into account, so that in their latest instruments the discrepancy between optical and acoustic direction can be continuously eliminated. Temperature inversion, or the case, which sometimes occurs, of temperature rising with height, *i.e.*, the acoustic angle being greater than the optical, can equally be compensated for.

The New Artillery Training Regulations. Major Schlieper here runs over the chief changes introduced by three manuals issued by the German W.O. last January. They deal with field artillery drill, mountain-gun drill and fire-training in the battery respectively, and are issued as sub-numbers 2, 2a and 3 of the general number for *Artillery Training Regulations*, H.Dv. 200.

The Importance of Mobility for Heavy Artillery. The burden of this plea is that it is not the tanks, but the heavy artillery which, in the war of the future is going to break down the enemy's resistance when he goes to earth, or when he occupies every village and every wood that offers him a holding-point. For this the mobility of the heavy artillery must be greatly increased. The horses of the German heavy artillery of the field army in 1914 were sufficient to keep up with the infantry, and so enabled the heavy artillery to break down the enemy's resistance in the great German drive. But even at the beginning of September, when the German 6th and 7th Armies in Lorraine came up hard against the advanced positions of Epinal and Toul, although 67 heavy batteries were assembled before the Position de Nancy, the heavy artillery

failed, because, moving by means of railways and scratch teams of horses, its lack of mobility had given the French time to make themselves secure. This failure was followed almost immediately by another, when their deficiency in heavy artillery and the lack of mobility in the heavy artillery which they had were the probable reasons why the Germans lost " the race to the sea."

Here a kind fate has presented us with motor transport. Horse draught for heavy artillery must in future be only an exception, and used only in cases of emergency. At a time when the pace of all movements of armies and of all movements of troops has been already, and is being still, speeded up, the heavy artillery cannot remain sticking to horse-draught, for motor-draught multiplies its value and gives it a mobility hitherto possessed only by field artillery.

The gun-constructor, instead of as hitherto grudging every pound of weight, will in future be able to place weapon effect in the foreground. He will be able to increase range and calibre. The supply question is also solved. Motorization makes it for the first time possible for heavy artillery to be put in in masses and with the full effect of surprise, even in mobile warfare. It has at last thrown a bridge over the gap which has hitherto separated weapon effect and mobility.

Motorization is, of course, to be applied to heavy artillery in no narrow sense, as if it was a question of moving the gun alone, but in its entirety to all that serves the gun.

The International Automobile and Motor-cycle Exhibition, Berlin, 1934. Although these notes appeared after the Exhibition had taken place (March 8th to 18th), they are of so general a nature as hardly to indicate that fact. They deal with :—

(*a*) The automobile industry as a key industry.

(*b*) The Chancellor's new road scheme. As the automobile industry cannot help the unemployment question directly, the vast majority of the unemployed being unsuitable for its ranks, the Chancellor has decided on the construction of special automobile roads throughout Germany. The opening of these roads as encouraging traffic, trade and touring, is bound to have a stimulating effect upon the automobile industry, and through it upon other industries.

(*c*) The motorization of Germany, or cars for all.

(*d*) The conditions necessary to bring about (*c*), viz., cheap cars ; mass-production and improved methods to reduce cost of production : cars cheap to run ; no tax on new private cars or motor-cycles ; cars reliable ; improvements in carburettors, auxiliaries, air and oil-filters, extended use of light metals ; cars comfortable ; increase of length, the engine farther forward or right aft, broader chassis, the wheels being built in.

(*e*) The State Postal Department and the State Railways represented by exhibits at this exhibition for the first time.

(*f*) The co-operation of railways with a lorry service facilitated by the use of goods-containers, movable between truck and lorry by means of a crane.—(*To be continued.*)

Recent Results in the Treatment of Wounds by Artificially-produced Ultra-violet Rays. The Mercury-vapour lamp, which was produced by a German firm over 25 years ago, emitted ultra-violet rays of a concentration 50 to 100 times greater than those of the sun. It scored its first successes in the treatment of children with rickets, but its possibilities as a wound-healer were soon recognized, and the Quarz-lamp, or artificial sunlight, was used for this purpose in the German Army during the war. Apart from its healing powers and the sterilizing action of the rays, there is the further advantage that treatment takes place through the bandages, so that the latter do not have to be removed to the patient's discomfort and the undoing of Nature's efforts at repair. The latest improvements are embodied in the Quarz-lamp " Jubilee " model.

The German Earth Oil Question (continued). Capt. Bornemann, having treated of earth oil found in Germany, now deals with the subject generally: the nature of petroleum; three methods of gaining petrol from petroleum:—

(1) Direct distillation, which is uneconomic, producing after topping only 36% of petrol, on the average, with American oils.

(2) Process of cracking, in which the heavy hydrocarbons' residue after (1) are treated further at higher temperatures, and under certain circumstances at higher pressures, whereby it is broken up further into petrol, coke and menthane, a saturated cymol, $C_{10}H_{20}$, which, structurally considered, may be regarded as the source of the terpenes and camphor. The yield of petrol is thus increased to as much as 60%.

(3) The hydrification process. This process of increasing the hydrogen content of petroleum, *i.e.*, of converting the heavy earth oils into low-boiling hydrocarbons is similar to the process by which Dr. Bergius obtains petrol from coal. It is carried out at a pressure of 200 atmospheres, and a temperature between 400° and 500°C. The reaction takes place only in the presence of the right catalizators, and the yield of petrol depends chiefly on their suitability. It is possible to increase it to well over 90%.

Capt. Bornemann next produces figures to show the increases which have taken place in the motorization of transport and of industry, and also in the number of ships oil-fired or with Diesel engines. He argues from these increased demand in future. Before dealing with the subject of synthetic petrol as a possible means of satisfying Germany's annual requirement of motor spirit, the author gives some useful short notes on the world's economic oil situation, and the inter-relationships of the Standard Oil Co., the Shell Group, the Anglo-Persian Oil Co. and the Soviet Russian Naphtha Group.—(*To be concluded.*)

(*May*, 1934.)—*Organization and Circumstances of Command of the Artillery in the Attack*, by Major Schneider. Modern artillery tactics, as laid down in artillery training manuals (Austrian and German), rests upon experiences of over four years of war, which was out of all proportion position warfare. The Great War never showed whether and to what extent these proved principles of leadership were applicable to mobile warfare. But mobile warfare must be reckoned with in future, even in its purest form, the encounter battle. Hence leaders, and especially artillery leaders, must enter the fight with clear ideas about what in such cases is necessary and possible, and must not allow themselves to be led away by artificialities, which from the start disadvantageously affect the course of the fight. Typical of position warfare were great artillery concentrations, plans carefully worked out beforehand, and centralized command.

In mobile warfare there will be no time for allotments of reserve artillery; each formation will have at its disposal its own artillery and no more. The decision will be brought about not by the absolute artillery strength but by its relative superiority at the moment and at the decisive point. This superiority can and must be obtained by getting a lead in development, by moving up faster and by the best methods of artillery leading. The artillery leader must not, in such situations, make his decisions dependent upon reconnaissance which causes a further loss of time. He will often have to order into the unknown, and may be sure that the enemy also will not yet be ready for action. In the encounter battle, rapidity in artillery measures is the first object of attainment. Usually, with the sending in of the main infantry attack, where the decision is to be sought, the further activity of the artillery will be given. As long as the attack runs according to plan, there is no scope for independence on the part of subordinate artillery leaders; but at the moment when of necessity the conduct of the fight slips out of the hands of the higher commander into the hands of the leaders of the fighting troops, the fact of artillery fighting groups being still under central leadership can only have a crippling effect upon the further progress of the whole operation. Artillery staffs at this moment

no longer have their place at the back, they now belong to the attacking infantry. Only the closest co-operation with the local infantry leaders, and their own insight into what is going on, can in this situation guarantee that conformity of the measures of the two chief arms which is indispensable for success.

Considerations about the New Artillery Training Manuals. Lieut.-General Marx here takes exception to several of the changes introduced in the two new F.A. training manuals. His remarks are much to the point, obviously carry the weight of experience, are constructive and spiced with humour.

Air-attacks on the Fleet at the British Autumn Manœuvres, 1933. To his account of the course of events the writer adds his opinion: "Let there be no misunderstanding that these manœuvres have publicly proved the excellence of the air material and the splendid performances of the airmen. Weapon effect, according to all information, is not at the same level. This will certainly be improved. . . . The question whether air attack with torpedo is better than attack with bomb is still open." The writer fully agrees with the Admiralty statement arguing against the claim of decisive success on the part of the air forces.

Technics and War, by Major-General Becker. This article, reprinted from the *Journal of the Union of German Engineers,* contains an historic review of instances in war in which one of the combatants has obtained a military advantage by utilizing technical superiority, especially when combined with surprise. The writer, who is also a doctor and a professor, plumps heavily for technics. A quotation from Franke, "That through military science the understanding of the connection between military and technical questions may be awakened already in the youth of Germany is a necessity, the denial of which is tantamount to national suicide," leads up to General Becker's own moral: "Let us see to it that our splendid manhood, which certainly will not fail in self-sacrifice and heroism, does not, through military technical mistakes and omissions, through underestimating the value of military technics and through the artificial creation of a gap between fighting troops and technical troops, suffer a fate similar to that of the dervishes at Omdurman."

The International Automobile and Motor-cycle Exhibition, Berlin, 1934 (continued). Even without cutting the cackle, one gets to the 'osses in time, in this case to short notes about the exhibits. Taking lorries first, and only the more important exhibitors, Büssing showed no less than fifteen chassis, also a wide range of models of spark and compression ignition engines. A 3·5-tonner with three axles and an eight-cylinder V-engine deserves special notice. It has both rear axles driven, and spiral springs built horizontally into crank-arms, a method of springing which should give it good cross-country powers. Daimler showed seven engines, four-, six- and twelve-cylinder, from 35 to 330 H.P. A working model of one of these was shown in section. All engines were Diesels, except in their G_3, a cross-country army type, which has a six-cylinder petrol engine. Hanomag's are the first German firm to follow in light lorry construction the American idea of building the engine in horizontally, suspended under and about the centre of the frame, so that its whole space above the frame is saved. One of the most interesting vehicles in the whole exhibition of lorries is one on these lines, a five-tonner with four wheels steered and four wheels driven. It has a turning-circle of only 13 metres' radius. When its present 55-H.P. Diesel engine is replaced by one twice as powerful, it should do well across most difficult country. Hanomag's have gone very far as regards standardizing parts. Henschel, of Kassel, showed a 5-tonner with two axles, with an Imbert charcoal-gas generator (photograph). They were the first firm to show the Trilok gears, a form of power-transmission which, without stages, adapts speed to road conditions by means of a gas-lever, thus putting up a German rival to the Leyland gear. Junkers showed their different types of double-piston two-stroke engines, 60, 90 and 120 H.P., but the greatest attention was accorded to their Jumo 5—"*Que diable allait-il faire dans cette galère?*"—540-H.P. six-cylinder aeroplane engine. Their Jumo 4 was noticed in *The R.E. Journal,* March, 1934, p. 180.

Krupps showed a number of interesting products, especially their air-cooled engines which, starting with their 50-H P. petrol and Diesel engines exhibited last year, have developed into a 65-H.P. gas-engine and a 70-H.P. Diesel engine of quite new construction. All Krupp engines are equipped with oil-pumps of a type newly put on the market by Deckel, of Munich. Their cross-country six-wheeler has the same remarkable method of springing as the Büssing 3·5-ton lorry already mentioned. The Augsburg factory strikes a new line in an extended use of sweating, both in engine and chassis, thus achieving improved appearance and a fair amount of weight saved.

Amongst wood-gas and charcoal-gas generators, besides the well-known constructions of Imbert and of the Deutz factory, is shown the charcoal-gas generator of the Wisco Company, which uses a wet method of cleaning. A sketch shows this, and other sketches show a section of the Phänomen engine and its pressure lubrication arrangements.—{*To be continued.*}

The German Earth Oil Question. Discusses sources newly opened up in Germany, at Wietze, Oberg and Nienhagen. These oils vary in asphalt content. Experts look forward to a total yield of as much as 2 million tons a year—note, the present yearly import is 3½ million tons—but owing to the shortage of refineries, production has already had to be throttled. The most important establishments for treating earth oil are the Leuna works in Thüringen, and those at Mioburg, near Hanover. Capt. Bornemann thinks that it would pay to put up refineries capable of handling up to 300,000 tons a year. This would be sound, whether the oil was found in the homeland or imported.

{*June*, 1934.}—*Testing Telescopes for Picture Quality.* Professor von Hofe tabulates here the seven common faults of a telescope, five of which are prejudicial to the sharpness of the picture. These faults are nearly all capable of being measured objectively, but distortion, which is due to the non-homogeneity of the lens material, does not lend itself to instrumental measurement. It can be simply tested for by observation of a fixed star, a perfect object for this purpose as it is a point at practically infinite distance. A fixed star in a good telescope should be seen as an undistorted point even when slightly out of focus either way. This is a condition which astronomic telescopes have to fulfil, but it would form an exaggerated demand upon an ordinary telescope, and a trial of this nature should be regarded as no more than a severe test of picture quality.

Aids to Gunnery and Fire Conduct in Mobile Warfare. It is upon the methods worked out and results obtained in over four years of warfare, which was predominantly position warfare, that our present ideas of artillery co-operation with infantry are based. It is by the results obtained in position warfare that the achievements of the artillery in the mobile warfare of the future are going to be judged. Major Zuber has accordingly worked out, and here explains with diagrams, methods for which he claims that, even in a comparatively short time, the whole necessary service of observation and of fire conduct in mobile warfare can be brought up to a standard similar to that reached in position warfare.

The International Automobile and Motor-cycle Exhibition, Berlin, 1934 {*continued*}. This month's instalment deals with cars. The tax on private cars having been abolished, conditions were favourable for a boom. At the head of the new constructions marches not the two-seater but the four-seater, of at least about 20 H.P. This is entirely appropriate to the forthcoming programme of a network of motor roads throughout Germany, projected by Herr Hitler to reduce unemployment.

Chief features of the exhibition are springing, which in almost all the new cars has changed its methods almost fundamentally, and streamline construction.

Adler, of Frankfort, amongst 28 exhibits, showed a Trumpf Junior, which has its 25-H.P. water-cooled 1-litre engine with gears and final drive built up as an aggregate, the whole carried on rubber pads. Zochopauer showed for the first time a four-cylinder 26-H.P. car with the swinging axle, hitherto used only for the rear axle, used also in

front. It has also a peculiarity in that the superstructure is built as a self-contained structure. A photograph shows 40 workmen carried on a chassis-less superstructure, resting only on two trestles. Bavaria Motor Works showed a 1·5-litre, six-cylinder engine, of 40 H.P. and 4,200 revs., which has three carburettors, each feeding two cylinders. General Motors, of Detroit, showed their types of Cadillac, Buick, Pontiac and Chevrolet. Chrysler's showed a Plymouth model streamline car with the engine a half-metre farther forward than last year's model, immediately over the front axle and supported " floating." Daimler's showed among 24 exhibits their " 130 " model with engine aft and rear axle drive. This position of the engine has yet to be sufficiently tried out; it has the drawback that cooling does not take place in the natural flow of air. Hanomag's, who in 1924 put the first real " baby " on the market, have entirely given up the smallest types of car, but Hansa-Lloyd-Goliath, of Bremen, are still active in this line and showed two small cars (one of them a three-wheeler) with air-cooled engines, in both cases placed aft. Maybach's, of Friedrichshafen, had one of the chief centres of attraction. They showed amongst five models the two most expensive cars in the Exhibition, priced at 38,000 and 42,000 marks respectively.

Equally interesting, though just as much out of place among the cars as the Jumo 5 engine was among the lorries, were their engines displayed separately, a 410-H.P. 12-cylinder Diesel of 1,400 revs., weighing two tons, and extensively used in motor-boats, and lighter types with the same number of revs., 210 H.P. and 150 H.P. This series has been in late years extended downwards to include lorry engines with six, four and three cylinders and 2,000 revs.—(*To be continued.*)

12th Introductory Course in Photogrammetry. This course, which is run by the Zeiss Aerotopographic Co., takes place this year from the 24th to 30th September. The lecturers are Professor von Gruber and Professor Hugershoff, and all appropriate instruments will be demonstrated in use. The subjects which will be dealt with are: the photogrammetric picture; aeroplane photography; stereoscopic vision and measurement; terrestrial survey; apparatus and procedure; mutual and absolute orientation of picture pairs; the geodetic principles of photogrammetric measurement, radial and stereotriangulation; geodetic instruments; the different uses of photogrammetry; discussion of photogrammetric problems. Visits will be made to the Zeiss General Exhibition and to the Planetarium, while Sunday has been reserved for a trip to Weimar. The fee for the course is only 20 marks; assembly, 10 a.m., 24th September, at 2, Ernst Abbéstrasse, Jena; particulars of accommodation from Verkehrsverein, Markt, Jena.

1st International Congress on Ray Research. Under the patronage of the Duce and the presidency of Senator Marconi, this Congress will take place in the Doge's Palace, Venice, from September 10th to 15th. The papers will be mostly on the physical side, but the biological side will also be dealt with. The members include E. D. Adrian (Cambridge), d'Arsonval and the Duc de Broglie (Paris), R. A. Millican, of the Millican Ray, and Sir C. B. Raman, of the Raman Effect. Particulars from Dr. G. Protti, 173, S. Gregorio, Grand Canal, Venice.

The Pioneer's Quarterly, No. 2, May, 1934. This journal intended for the field engineers of the German Army, and for all commanding officers, made its first appearance in February, 1934. It appears in demy quarto with a striking cover in scarlet and buff. The following titles give an idea of its contents:—" Engineers and Infantry in Mobile Warfare," " Orders or Instructions? " " A.A. Protection of River-crossings," " Field Engineer Company Training," " Bridge Demolitions in War," " Explosives," " Demolitions in the Retirement of the 9th Army, 1914," " Railway Destruction by Raid," " A.T. Defence by Mines."

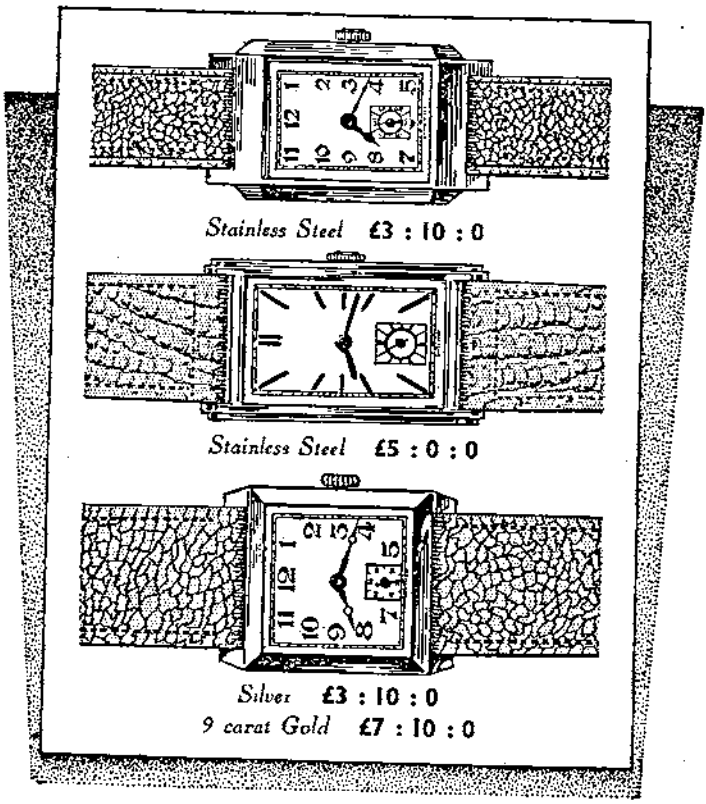
The magazine is edited by Major Zimmerman, and published by " Offene Worte," Berlin, W.35. Price abroad, 3 marks per copy, postage included.

Welcome to a comrade journal! F.A.I.

(*It is hoped to publish reviews of this magazine*—ED.)

By Appointment

WATCHES FOR MEN



Stainless Steel **£3 : 10 : 0**

Stainless Steel **£5 : 0 : 0**

Silver **£3 : 10 : 0**

9 carat Gold **£7 : 10 : 0**

Watches for men from The Goldsmiths & Silversmiths Company are of proved time-keeping reliability, and offer the best in quality, workmanship and value. There is a two years' guarantee given with every watch purchased.

Illustrated Catalogue will gladly 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)