The Royal Engineers Journal.

VOL. L. SEPTEMBER, 1936.

CHATHAM:

THE INSTITUTION OF ROYAL ENGINEERS,

TELEPHONE: CHATHAM, 2669.

AGENTS AND PRINTERS: MACKAYS LTD.

LONDON:

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

THE ARTHUR FFOLLIOTT GARRETT PRIZE.

THE Arthur ffolliott Garrett Prize is awarded for the best article received and published in *The Royal Engineers Journal* in any year, which deals with any of the following subjects:—

1. Irrigation and Water Supply. 2. Railways. 3. Survey.

The Prize is confined to officers on the Active List not above the rank of substantive Major, either singly or in syndicates, and its value is about £7.

THE MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £14, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. The Prize is confined to Officers on the Active List not above the rank of substantive Major, either singly or in syndicates.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions:—

(*a*) Descriptions of works actually carried out in peace or war. (*b*) Invention. (*c*) Design (excluding works of defence). (*d*) Labour organization on work. (*e*) Scientific investigations generally. (*f*) Accounts of exploration work and surveys.

THE INSTITUTION OF ROYAL ENGINEERS.

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

CONTENTS.

All communications for the Institution should be addressed to:—

The Secretary, The Institution of Royal Engineers, Chatham.

COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

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

Patron:—H.M. THE KING

President.

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

Vice-Presidents.

Maj.-Gen. R. N. Harvey, C.B., C.M.G., D.S.O., *Col. Comdt. R.E.*............1935

Maj.-Gen. D. S. Collins, D.S.O. (*D.F.W.*). 1936

Elected.

Brigdr. C. A. Bird, D.S.O., *p.s.c.* 1934

Col. W. Garforth, D.S.O., M.C. 1934

Brig. H. N. North, D.S.O., *A.D.C.* 1934

Lt.-Col. B. K. Young, M.C. 1934

Lt.-Col. W. H. Oxley, M.C., *p.s.c.* 1934

Capt. B. C. Davey 1935

Major H. P. W. Hutson, D.S.O., O.B.E., M.C. ... 1935

Col. G. B. O. Taylor, C.B.E. 1935

Lt.-Col. C. A. West, D.S.O., M.C., *p.s.c.* 1935

Col. R. G. P. Hunter, O.B.E. 1935

Major R. L. Brown 1936

Brig.-Gen. *Sir* James E. Edmonds, *Kt.*, C.B., C.M.G., *p.s.c.* 1936

Lieut. M. C. A. Henniker, M.C. 1936

Lt.-Col. W. A. FitzG. Kerrich, D.S.O., M.C. ... 1936

Col. J. C. Wickham, D.S.O., *p.s.c.*, R.S. 1936

Ex-Officio.

Maj.-Gen. L. V. Bond, *p.s.c.* (*Cdt. S.M.E. & Inspr. R.E.*)

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. F. J. C. Wyatt, O.B.E., M.C. (*R.E. Board*).

Col. G. N. Macready, C.M.G., D.S.O., O.B.E., M.C. (*G.S.*).

Major W. D. M. Christie (*C.I.C.*).

Major J. R. T. Aldous, 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. T. R. Williams, C.M.G., D.S.O. (Australian Staff Corps)............ 28 1 30

Major C. R. S. Stein, *p.s.c.* (R.C.E.)............ 24 10 33

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

2,150—1.9.36.

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

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

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

THE EFFECT OF THE QUETTA EARTHQUAKE ON VARIOUS TYPES OF CONSTRUCTION.

By CAPTAIN H. L. LENDRUM, R.E.

THE object of this article is to give a description of the damage caused to various types of buildings in Quetta. The writer was detailed to make an engineering survey and had the opportunity of examining a large number of buildings, both civil and military, in most cases before the effects of the earthquake were altered or entirely removed by salvage work.

Similar buildings exist elsewhere in India and it is hoped that it may be of value to R.E. officers who are, or may be, stationed within the earthquake zone.

CAUSE, INTENSITY AND DIRECTION OF THE EARTHQUAKE.

Before discussing the effect on buildings it is necessary to go briefly into the cause, intensity and direction of the earthquake.

(1) *General.*

The earthquake took place at 3.03 a.m. on Friday, 31st May, 1935. It lasted less than a minute and, if judged by the numbers killed, it ranks as the most severe earthquake in India and the third most disastrous in the world. In Quetta alone, it is estimated that about 18,000 perished, although it is still impossible to give accurate figures.

Baluchistan has always been subject to earthquakes.* Minor

* *Memoirs of the Geological Survey of India*, Vol. LXVII, Part I, by W. D. West, M.A., and *Punjab P.W.D. Paper*, No. 84, "Earthquake-Resisting Design," by A. R. Astbury, C.S.I., C.I.E., M.I.C.E.

shocks have been of frequent occurrence, the more severe earthquakes occurring in 1892, 1909 and 1931. It is interesting to note that each shock appears to have been more severe than its predecessor, culminating in the 1935 disaster.

Mr. West, the Government of India geologist who visited Baluchistan in connection with both the 1931 and the 1935 earthquakes, considers that another severe earthquake in *exactly* the same place is unlikely for a considerable period of time, but that, as India is passing through an era of marked seismic activity, it is more than possible that severe earthquakes will occur with their origins elsewhere.

*(ii) Cause of the earthquake.**

The hills of Baluchistan are of geologically recent origin. They are bordered by the older and more stable masses of Central Asia on one side and the plains of India on the other, and it is thought that the cause of the Baluchistan earthquakes (and of the whole Himalayan earthquake zone) is pressure from these two sides, which causes the young and comparatively weak rocks to slide, at intervals of time, over each other, generally along a fault plane.

The slipping and fracturing of the rocks, and the subsequent movement, release a large amount of energy and cause intense vibrations in the surrounding rocks.

The wave motion thus set up consists of "long" waves which travel at about two miles a second, with a periodicity of 1 to $1\frac{1}{2}$ seconds, the amplitude normally not exceeding two or three inches. In soft soil the passage of these waves induces subsidiary surface waves, the wave length and periodicity of which vary with the nature of the ground. The resultant ground motion is therefore complex.

In Quetta, the main shock was definitely felt to be in a south-north direction (the epicentre being south of Quetta), but there was also a subsidiary motion, approximately at right-angles to the main shock. This was confirmed by an examination of the damage to buildings.

It may be mentioned that the theory of slipping and fracture described above is not uniformly accepted. Dr. Najubi Nasu believes that earthquakes are caused by sudden chemical changes under the earth's surface which alter the bulk, and not by fracturing as a result of the gradual accumulation of stresses.

*(iii) After-shocks.**

Any severe earthquake is always followed by "after-shocks." The fracturing of the main rock mass sets up subsidiary stresses in the surrounding rocks which gradually relieve themselves. This

* *Preliminary Geological Report on the Baluchistan Earthquake of May 31st, 1935*, by W. D. West, M.A., Geological Survey of India.

relief of stresses produces minor shocks, which vary in frequency and intensity but gradually diminish.

The most severe of the after-shocks occurred on the afternoon of June 2nd; this by itself would have been considered a severe earthquake. Photo No. 1 was taken during this after-shock. In the centre three Indians are throwing themselves on the ground. In the distance large quantities of dust can be seen rising from the hills, due to displaced boulders; this was responsible for the unfounded rumour that the earthquake was volcanic in origin.

(*iv*) *Epicentre and area affected.**

The focus (or origin of slipping) is estimated to be a plane extending roughly from Baleli (10 miles N.W. of Quetta) in a S.S.W. direction to Mandi Haji, the area of the epicentral zone being about 68 miles long and 16 miles wide. This zone just included the west and south parts of Quetta.

The effect of the earthquake was unexpectedly localized. It seems to have been perceptible only over an area of about 105,000 square miles compared with 1,900,000 in the 1934 Bihar earthquake and with 370,000 in the much less severe 1931 Mach earthquake; this leads to the conclusion that the focus must have been shallow (probably less than 5 miles below the surface), whereas in Bihar it was unusually deep.

(*v*) *Earth Movement.*

It appears that movement of the earth in Quetta itself was confined to the surface or very close to it, probably not extending to a depth of more than 2 or 3 feet. There are no surface cracks, foundations are sound, and sump pits, wells and underground magazines are almost undamaged. A few lead joints in cast-iron water-pipes were damaged at a depth of 5 to 6 feet, but it is probable that this was due to weak joints affected by vibration rather than to any movement of the pipes, which were not displaced. No trees or poles were overturned except in the few cases where they had been struck by falling buildings.

Outside Quetta, however, appreciable earth movement has taken place, mainly in the vicinity of streams and nullahs. Sections of roads and approaches to bridges dropped 2 or 3 feet, small fissures appeared in the ground and a few mud volcanoes were formed; but the earth movement was not extensive.

(*vi*) *Intensity.*

Perhaps the most surprising fact about the earthquake is the very rapid decrease of damage away from the epicentre. In Quetta

* *Preliminary Geological Report on the Baluchistan Earthquake of May 31st, 1935*, by W. D. West, M.A., Geological Survey of India.

itself most buildings in the low-lying areas to the south-west (the city, civil area and R.A.F. lines) were completely destroyed, but similar buildings in the north-east were only slightly damaged. The slightness of the shock at the Staff College in the extreme N.E. corner, only 3 miles from the completely ruined city, may perhaps best be illustrated by mentioning that, on the morning of the earthquake, a class of Staff College students arrived, as arranged, at the R.A.F. lines to witness a demonstration by the R.A.F.

Mr. West estimates that the shock within the epicentral zone just reached an intensity of (x) on the Rossi-Foral scale, which is the maximum of the scale ("Shock of extreme intensity. General catastrophe. Buildings ruined").

The Rossi-Foral scale, which, in the absence of suitable seismographs in the area concerned, is generally taken to be the accepted standard, is based on the degree of damage caused to structures and, for the lower range of the scale, on human observation. It is not, however, entirely reliable for India, as the scale was devised for buildings of European standards and complete ruination may occur (and would in the average Indian village) at an intensity well below (x).

It seems doubtful whether the intensity exceeded (ix) because, although a few well-constructed buildings collapsed (for which there was generally an explanation), a considerable number survived with very little damage. Earth disturbances were rare and localized, and it does not seem correct to place the Quetta earthquake, as regards intensity of shock, in quite the same category as the earthquakes of Bihar (1934), Tokyo (1923), Messina (1908), San Francisco (1906) and the Kangra Valley (1905).

In Quetta, the intensity appeared to vary from about (ix) in the S.W. corner to about (vi) in the extreme N.E.

(*vii*) *Acceleration.*

The main damage to buildings is caused by the horizontal component of the wave motion, which is generally taken to be proportional to the rate of acceleration imparted to the ground.

It is therefore important to know the acceleration of major earthquakes. Unfortunately this is usually very difficult to determine, and the Quetta earthquake was no exception.

Calculations based on the overturning of a square pillar, using the most common formula, gave an acceleration of 13·8 feet per second per second, but it is almost certain that this is too high. This formula itself takes no account of the cumulative effect of successive vibrations and assumes the wave motion to be of simple harmonic form, which it certainly was not. From an application of the Ormori-Mercalli scales it appears to lie between 3·28 and 6·52. The new railway quarters in Quetta were designed, with normal factors of safety, to

1.—Severe after-shock on June 2nd (dust rising from the hills).

2.—St. John's Road.

3.—Junction of Bruce and Circular Roads.

The effect of the Quetta earthquake 1-3

4.—Bruce Road.

5.—Mastung (Kalat State).

6.—Quetta Club.

The effect of the Quetta earthquake 4-6

withstand an acceleration of $\frac{1}{10}$ g feet per second per second and were undamaged, although furniture was thrown about the rooms and the occupants were unable to stand.

In the Tokyo earthquake, calculations based on actual seismograph readings gave an acceleration of $\frac{1}{5}$g feet per second per second in the lower and most severely damaged parts of the city, and, as Mr. West states that this was an earthquake of very great intensity which is never likely to be exceeded in Baluchistan, it can perhaps be safely assumed that the acceleration in Quetta did not exceed 6 feet per second per second.

A design factor of $\frac{1}{8}$g, which is being adopted for new construction in Quetta, should, therefore, in conjunction with normal factors of safety, be amply safe.

Effect on Buildings.

It is well known that the general standard of construction in India, both in specification and workmanship, is much lower than in Europe. For this reason any severe earthquake causes a vast amount of damage.

In Darjeeling after the 1934 Bihar earthquake, Mr. D. G. Blomfield, Chief Engineer P.W.D. Bengal, and Mr. J. Chambers, Executive Engineer, Darjeeling, found that the damage to buildings of sound construction was trifling, and they came to the conclusion that had all the buildings been of substantial construction, embodying sound engineering design, it is unlikely that they would have been seriously damaged.*

This applies with equal truth to Quetta in 1935, and, until construction in India approaches the level of Western countries, it is certain that any severe earthquake in India will cause immense damage.

Quetta City, like most Indian cities, was mainly a congested area of narrow streets and badly-constructed buildings. The population had been increasing and instead of spreading outwards, the increased population had merely been accommodated by constructing an extra story or so on top of the existing weak buildings.

Mr. West remarked in his 1931 report that, should an earthquake of the severity of the 1905 Kangra Valley earthquake, or even one considerably less severe, visit Quetta, it would lay in ruins the greater number of buildings, so poorly were they built. The event proved that he was more than justified. With the exception of one or two well-constructed buildings the entire city collapsed, burying the bulk of its inhabitants; even those who were able to get into the narrow streets were seldom able to escape from them in time.

Photos Nos. 2, 3 and 4 illustrate the type of damage in the city.

* *Darjeeling Earthquake of January*, 1934, by John Chambers, M.C., Vol. 8, No. 10. *Indian Concrete Journal* of October, 1934, and subsequent discussion with Mr. D. G. Blomfield.

Photo No. 5 shows the damage in Mastung, a town situated in the centre of the epicentral zone.

In the cantonment and civil area, the majority of the older buildings had very thick mud walls and frequently no foundations. Large rooms were provided and extensive verandahs. Such buildings were cool, but they were far from being earthquake-proof, and the majority, in the more severely affected areas, collapsed.

At a later date, burnt bricks were more generally employed and the thickness of walls decreased. Lime, at that time of very good quality, was frequently used as the mortar in superior buildings, but subsequently, presumably for reasons of economy, mud mortar was extensively employed, particularly for interior work. Most of the buildings in good quality lime mortar have been comparatively little damaged, but those in poor quality lime and in mud mortar suffered severely.

With the improved quality and reduced price of Indian manufactured cement, the modern tendency has been to use a weak cement mortar, and such buildings have generally survived well.

Apart from the general question of design, the principal reasons why such widespread damage occurred in Quetta were, firstly, the use of inferior mortar and, secondly, the unsatisfactory bonding of cross-walls.

Owing to absence of earth displacement, foundations, plinths and floors were practically intact. In numerous cases, well-braced light roofs, adequately tied to the walls, held up walls which otherwise would have collapsed, and it was observed that buildings with hipped roofs were much less damaged than those with gable ends. Verandahs, also, were a source of strength to many buildings.

Ceilings of mud plaster on wire netting frequently fell, and proved to be a most dangerous form of construction ; but boarded ceilings, on the other hand, rarely came down.

The direction of the shock greatly influenced the type of damage. In Quetta the main shock came from the south and it was very noticeable that long, unsupported sections, such as boundary walls, or inherently weak constructions, such as gables and arches, were much more damaged when at right-angles to the line of the main shock than when parallel.

Modern earthquake-resistant buildings, except of small size, normally consist of a structural frame of steel, reinforced concrete or timber, with brick, masonry or concrete panel walls, generally reinforced in horizontal courses. In Quetta, a certain number of steel-framed buildings have recently been erected, and these were practically undamaged. There were also a few timber-framed buildings of small sizes and these, too, were intact.

There were *no* reinforced-concrete buildings but, judging from the behaviour of concrete work generally, there is no reason to suppose that they would not have been equally satisfactory. The main weakness of framed buildings is the junction of the panels with the frame and in this, concrete, being homogeneous, has a distinct advantage.

The only buildings in Quetta designed specifically to be earthquake-resistant were the new railway bungalows. These were erected after the 1931 earthquake to a seismic factor of $\frac{1}{10}$. They consisted of a close framework of steel rails (both vertical and horizontal members) with thin panels of burnt bricks in P.C. mortar. A light roof and ceiling were provided and all ornamentation, such as cornices, parapets and chimney-stacks, was omitted. Chimney-flues were light concrete pipes. The appearance of the bungalows was not very attractive and they were cold in winter but, although situated in the worst area, they were not appreciably damaged.

Details of the damage to different types of buildings are given in Appendix I. The standard of construction generally adopted in India is so different from home practice that these are possibly only of interest to those stationed in India. It may here be mentioned that nothing in this article is intended to be a reflection on those responsible for the building of Quetta in the past. The rather poor specifications are common throughout India and are due to a stringent financial policy, from which India, of necessity, has always had to suffer. Such buildings have served their purpose. They were comfortable, cool and cheap to construct, and it is only in the last year or two that India has become " earthquake-conscious." The disasters of Bihar in 1934 and Baluchistan last year are bound to produce a re-orientation of policy for construction in areas subject to earthquakes.

Principles of Earthquake-Resistant Design.

Seismic factor. The first step that has to be taken in the design of earthquake-resistant structures is to decide the magnitude of the force to be resisted. This is of necessity an arbitrary figure based on past experience in the area concerned and its seismic liability.

The most usual seismic factor in areas liable to severe earthquakes is $\frac{1}{10}$ ($\frac{1}{10}g$ feet per second per second). The seismic factor is a fraction of the total weight of the building above any plane, considered as a force applied horizontally from any direction at that plane. The horizontal component of the earthquake force is thus assumed to be constant in magnitude, whereas in fact it is continually varying, but some approximation has necessarily to be made.

The effect of the vertical component of the earthquake force is normally neglected in design as its magnitude is considerably less than that of the horizontal component and it is, in any case, guarded against by normal design to resist static loads.

Periodicity. It is very desirable that the natural periodicity of buildings should not coincide with that of the earthquake.

The main factors which affect the natural vibration period of a building are its shape and its rigidity. A tall, large, unbraced building is liable to have a periodicity near that of a severe earthquake shock (usually between the limits of 1 to $1\frac{1}{2}$ seconds). It seems possible that this was the cause of the collapse of so well-constructed a building as the Railway Institute. This was a large, tall building with very thick brick walls set in hard lime mortar, and it is difficult to account for its complete collapse otherwise.

The determination of the natural period of a building is extremely complicated, but the important fact is that increase of rigidity decreases the natural period of vibration. Well-constructed framed buildings of several stories normally have a period of less than one foot per second. The rigidity of unframed buildings is proportional to the strength of the mortar and the degree of bracing from floors, cross-walls and roofs, and it is accepted that any single-story building of normal size, soundly constructed of strong materials, will have a natural periodicity well below that of a destructive earthquake.

At the other end of the scale are the very light flexible buildings whose periodicity is above that of the earthquake. The bamboo huts of Burma, although they get badly shaken, withstand earthquakes quite well.

Homogeneity. As far as possible a building should be homogeneous so that it moves as a whole during an earthquake. If a building consists of widely different materials, unbraced and untied, these parts will oscillate with different periods, and become torn apart. The subsequent jolting and battering causes the collapse of the building. This was very apparent in most of the buildings in Quetta.

Centre of gravity. The centre of gravity should be kept as low as possible to reduce the bending moments induced in the structure. This is particularly important in the case of main walls, which may have to resist as much as 95% of the total earthquake stresses transmitted to the building.

Shape. Symmetry of plan and elevation is most important. The ideal plan is circular, but, as this is normally impracticable, the most suitable plan is a square or rectangle. It was noticed that long irregular buildings with projecting wings suffered more damage than others. Low square buildings were generally little damaged, however poorly constructed.

It was apparent that the degree of damage was also greatly influenced by the height. The period of oscillation at the top of a tall weak wall is frequently several times greater than at the bottom and it behaves like an elastic string vibrating with its own period irrespective of the period of oscillation of the ground. In the case of a rigid wall it is constant, but, when the ground motion has a very short period, it may behave like an inverted pendulum with increased amplitude of the top.*

Eccentric loads. Eccentric loads such as large water-cisterns, heavy chimneys, corbels and parapets upset the balance of a building and are always a source of danger. Large architectural features, such as towers, will vibrate with an entirely different period from the main building and most authorities recommend their complete separation (sufficiently far to avoid hammering). Where this is impossible, they should be rigidly inter-connected.

Conclusion.

Earthquake-proof design is now engaging the attention of the Government of India and the rebuilding of Quetta and Chaman is to commence shortly. The new buildings will be earthquake-resistant, but for the benefit of those in other stations in India it can reasonably be anticipated that any ordinary single-story building, situated on solid ground, designed on sound lines and constructed with good materials and workmanship, will withstand the majority of earthquake shocks likely to be experienced, although not necessarily without material damage.

In conclusion I should like to thank Mr. W. D. West, Geological Survey of India, Mr. H. W. Oddin-Taylor, Superintending Engineer P.W.D., Quetta, Mr. P. W. Wilton-Davies, Executive Engineer N.W.R., Quetta, Mr. D. G. Blomfield, Chief Engineer, Bengal, and numerous R.E. officers for the assistance I have received in the collection of data and the preparation of this article.

APPENDIX I.

Details of Damage.

The following remarks are based on examination of buildings in areas of approximately equal intensity of shock, and they apply to the more severely affected areas. In the north and east of the cantonment, where

* Vol. 8, No. 10, *Indian Concrete Journal.* Summary of experiments in Japan.

the shock was relatively slight, there has been little damage to any type of building. Heavy chimney-stacks have come down. In mud-brick buildings, the top courses of brickwork have usually loosened due to movement of the roof, and diagonal cracks, with occasional bulging, have appeared in the walls. After-shocks, of which Quetta has had a considerable number, have caused these cracks to widen.

Foundations. In Quetta, there has been no appreciable movement of foundations. There were very few cracks in P.C. floors and plinths were undamaged. The few foundations that have been opened up were sound. A number of old mud bungalows had no foundations, but they were not appreciably more damaged than adjacent buildings with foundations, possibly because they were able to rock freely upon the ground.

Owing to the absence of earth displacement, shallow foundations have proved adequate. It cannot, however, be forecast that future shocks will behave similarly, and earthquake-resistant design generally incorporates deep well-braced foundations or a concrete raft.

Plinths, damp-proof courses and floors. Buildings with well-constructed plinths, carried well above ground level, were considerably less damaged than those without. The most satisfactory plinths have been thick burnt brick in good P.C. mortar, stone plinths being generally of rather inferior workmanship.

P.C.C. damp-proof courses acted as an effective brace at plinth level and increased the rigidity of buildings. Asphalt, bitumen and similar damp-proof courses were not so satisfactory, owing to the lack of homogeneity with the adjacent masonry. With P.C.C. it is an advantage if the superimposed masonry is laid while the damp-proof course is still "green."

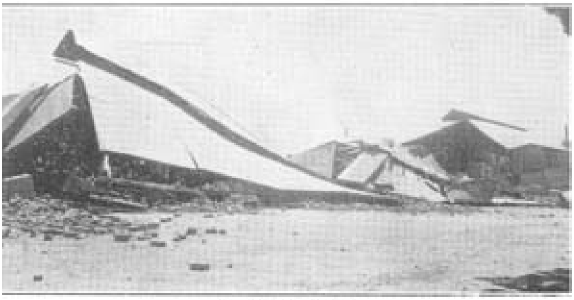
Floors of any description escaped with very little damage. A lightly reinforced-concrete floor, laid in conjunction with the damp-proof course, probably provides sufficient rigidity at floor-level for all ordinary buildings.

Superstructure. It can safely be stated that the majority of buildings collapsed because of inferior superstructure. Walls were too weak to withstand the heavy stresses transmitted to them.

To a very considerable extent the degree of damage to unframed buildings varied with the quality of the walls. A typical example is in the Residency area. The Clerks' Office of good burnt brick in hard lime mortar was practically undamaged, the Library of burnt brick in mud mortar was badly cracked and the gables fell out, while the Finance Office of sun-dried brick in mud mortar collapsed completely. All three buildings had main walls of 18 inches' thickness, they were within a few yards of each other and of similar orientation (long walls east—west).

Photo No. 6 shows the Quetta Club. The older part in sun-dried brick in mud has completely collapsed, but the main building, seen on the right, of burnt brick in weak P.C. mortar, although containing considerably larger rooms, was not greatly damaged.

Mud mortar. The failure of mud mortar has been apparent everywhere and it is evident that it should be rigidly excluded from any building in an earthquake area. With sun-dried brick, complete



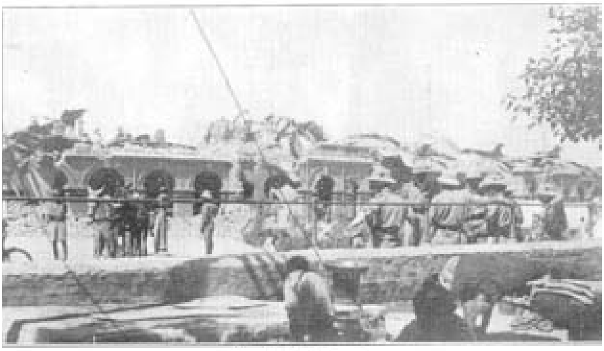
7.—R.A.F. Lines.

8.—Civil Gaol.

9.—24, Queen's Road (north end).

The effect of the Quetta earthquake 7-9

13.—Residency.



14.—Civil Courts.

15.—King Edward Memorial Serai.

The effect of the Quetta earthquake 13-15

collapse generally occurred in the more severely affected areas, but, with burnt brick, bad cracking was more frequent, together with the collapse of the gables.

Photos Nos. 7, 8 and 9 illustrate three cases of mud mortar buildings. No. 7 was taken in the R.A.F. Lines. No. 8 shows the complete collapse of the civil gaol (in the worst area) and No. 9 damage to an officer's quarter, which is typical of buildings just outside the worst area.

Lime mortar. The lime mortar used 30 to 40 years ago is tough and adherent and quite as strong as weak cement mortar.

Modern lime is inferior. It is a fat lime, prepared from stone limestone, made hydraulic by the addition of *surki*. Much of it is badly slaked and insufficiently ground, and it possesses little tenacity. The worst is no better than mud mortar and such buildings have been equally badly damaged. Where better quality lime has been used, the buildings have stood reasonably well, particularly when the walls were thick.

Cement mortar. Buildings in 1.2 or 1.3 P.C. mortar were practically undamaged and the extra cost of a strong mortar clearly justified itself.

Many buildings have been erected in 1.6 P.C. mortar. Small buildings suffered comparatively little damage but, for large buildings with long unsupported lengths of wall, this mortar proved to be too weak. Even in the case of small buildings, the line of fracture of diagonal cracks, radiating from the corners of door and window openings, invariably ran through the mortar joints. With strong mortar, they ran straight through the brickwork.

A constructional detail which adds considerable strength to a building is to run one or two bands of concrete, or even stone in strong P.C. mortar, right round the building, the most effective being at lintel and roof levels.

Thickness of walls. Other things being equal, buildings with thick walls were much less damaged than those with thin walls. The only exception to this was with sun-dried brickwork, when the thickness appeared to have little or no influence on the degree of damage.

Plane of weakness. One of the disadvantages of an unframed building is the danger of a weak course of masonry, which may cause the complete collapse of the wall above. Even with the best supervision it is difficult, at any rate in India, to ensure that every course is well laid with its proper amount of mortar. Two good examples are St. Mary's Church and the new unroofed Railway Hospital. Both were very well constructed buildings except for one weak course of brickwork. The heavy north main wall of the church, of good quality lime mortar, has moved bodily outwards, about four inches at the centre, on a course in which the mortar was almost entirely sand. Buttresses and support from the roof and end walls have prevented collapse. In the hospital, a long west wall of reinforced brickwork in good 1.4 P.C. mortar has completely collapsed, there being practically no mortar at the plane of overturning.

Bonding. A further point of weakness frequently observed was the inferior bonding of cross-walls and additions. Where the bonding was poor, cross-walls pulled away and their bracing effect was lost.

Arches. There was marked difference in the behaviour of arches. Those running north and south were usually little damaged, but there were many cases of failure of arches in an east and west direction. Arches carried on a wall and a column were less affected than those carried on two walls.

Although many arches survived, it was frequently not without damage (the first stage usually being the loosening of the keystone) and their use, if they are to be employed at all, should be rigidly restricted to unimportant parts of future structures.

Buttresses. Where properly proportioned and spaced, buttresses and pillars have been very effective. Bonding has sometimes been weak and buttresses have tended to separate, resulting in the cracking of the walls, but there was only one case of the complete collapse of a buttressed building.

Columns. Columns have been very highly stressed but, with the exception of brick pillars, they have carried their loads well. Concrete, steel and timber columns were normally intact; stone columns were inclined to fracture or "spall" at the base, but only two cases of failure were seen.

Bed stones and lintels. It is the normal practice to provide a bed-stone for every beam and a lintel for every opening, however small.

In the case of bedstones, the P.C.C. blocks invariably loosened or pulled away from inferior walls. When, however, the bearing consisted of a steel plate with long bolts direct into the masonry, there was considerably less displacement as the homogeneity of the wall was not disturbed.

With heavy trusses necessitating bedstones, a suitable type is that employed in one of the R.A.F. hangars. Here the block was well keyed into the adjacent brickwork, headers being omitted in alternate courses. Apparently the concrete was poured after the brickwork had been built up, and it is certainly more satisfactory than using pre-cast blocks.

Lintels behaved well; but for small openings they appear quite unnecessary. Reinforced brickwork stayed well, while there were several examples of ordinary unreinforced brickwork in P.C. mortar (unarched) which were undamaged, the span in one case being six feet.

Fireplaces. A very common source of damage and injury has been the collapse of fireplaces and chimney-breasts, particularly those in sun-dried brickwork.

Light flues are of particular importance. The light concrete pipes employed in the new railway quarters or the sheet-iron flues provided in one or two officers' quarters, although unattractive in appearance, were very effective.

Heavy chimney-stacks fell badly and should be rigidly excluded in future construction in any earthquake zone. The substitution of light circular metal chimneys for brick chimneys will appreciably increase the safety of existing buildings.

In a cold climate like Quetta, it has been customary to add from time to time an extra fireplace or two to existing buildings. This proved to be an unsatisfactory procedure as there was little adhesion between the new work and the old.

Plaster. P.C. plaster has been very satisfactory, but even in areas of quite moderate intensity of shock, mud plaster has cracked and frequently fallen away, although the walls were intact. It is very liable to fall away from concrete, especially from the under-side of lintels.

The provision of good plaster is important from the psychological point of view. Cracked plaster destroys confidence in the safety of a building.

Doors and windows. It was assumed that a small number of door and window openings was a source of strength to a building. Actually, walls with a considerable number of doors and windows have been less damaged than those without. This is presumably due to the bracing given by frames, sills and lintels to weak walls. It would probably not hold true for walls of superior specification.

Walls with door and window lintels on one level (particularly if a continuous lintel has been used) have been little damaged and this form of construction appears desirable for the future. It is probable that the building seen in Photo No. 4 owes its escape to its strong lintels.

For safety, doors should open outwards. Numerous cases occurred of doors jamming, the occupants being unable to escape quickly.

Glass. It is remarkable how very little glass has been broken, even when the building has been considerably damaged. The glass in dormer windows and greenhouses, which have been subjected to severe shaking, has seldom cracked.

Roofs. Owing to the heavy winter snowfall, nearly all buildings in Quetta have pent roofs, the covering being either Naini Tal pattern sheeting or, more recently, C.G.I. sheeting, which appears to " weather " better. In one or two cases, tiles have been used and these have been unexpectedly satisfactory, hardly a tile being displaced.

There were very few flat roofs. The one or two concrete roofs have stood well. Heavy jack arch roofs have loosened slightly but have not collapsed.

Buildings with hipped roofs have stood much better than those without. The additional bracing of the hip rafters adds rigidity, and gables are always a source of weakness.

Where trusses have been employed at gable ends, the roof has generally been undamaged (see Photo No. 10). Where end trusses have been omitted, and rafters supported direct on the wall, the roof has almost always been badly distorted, owing to the partial collapse of the gable.

In many old buildings, purlins were carried direct on partition walls, a most inferior form of construction which usually proved disastrous.

Trusses with a strong horizontal tie beam, such as steel Fink trusses or timber King Post trusses, suffered very little distortion except where complete collapse occurred, but it is evident that considerable reversal of stress has taken place. Thin ties, such as flats, have buckled slightly and the struts of King Post trusses have, in some cases, pulled away.

Ceilings. The most common type of ceiling was mud plaster on wire-netting. Had the intention been to design the ceiling most likely to ensure the death of the occupants in the event of an earthquake, nothing could have been more effective. The wire-netting entangles them and the mud tends to suffocate them.

Boarded and composition ceilings, such as Celatex and asbestos-cement, were much more satisfactory, especially when provided with a close framework of well-jointed ceiling joists.

Ceiling fans should be very rigidly fixed as they are a great potential source of danger in an earthquake occurring at night.

Gables. Unsupported gables have very frequently fallen, especially those on the north and south sides. This is clearly illustrated in Photo No. 10. Both north and south gables collapsed but the east gable carrying the post office clock (which incidentally can just be seen stopped at three minutes past three) was undamaged.

In several cases, support from an internal partition wall of good-quality mortar reduced the amount of damage, and it was unfortunate that in a number of buildings where an internal wall existed, it was stopped just short of the gable to form an " electrician's " passage.

Raised centres. Some long buildings have had a raised central portion, such as the high entrance hall to the railway station. These have almost always collapsed and should be avoided (see Photos Nos. 11 and 15).

Change of level. Long buildings on sloping ground have been stepped, and damage has frequently occurred at the change of level, principally to the cross-wall, gable and parapet, and possibly also to the foundations, which must have been unequally stressed. It would be better to reduce the length of buildings to avoid stepped foundations in such cases.

Porches and bays. Heavy porches have collapsed rather badly. Unless they are very well tied into the main wall they pull away, especially when in the line of the shock. At Sandeman Hall, a large, square, symmetrical building carrying five heavy domes, all four porches (brick arches on stone pillars) have collapsed (see Photo No. 12). The remainder of the building, although badly cracked, has not fallen, and it is interesting to note that the domes (burnt brick-in-lime mortar, cement plastered), presumably owing to their spherical shape, appear to be quite undamaged.

Bay windows, on the other hand, survived well and as they form an architectural feature in what may otherwise be a rather dull building, their use is recommended.

Verandahs. Verandahs have been a source of strength in many buildings. Without their support, collapse would have been much more severe.

To be effective, verandahs must be well anchored to the wall, preferably by a wall plate. There is a tendency for the wall to crack a course or two above the junction, but this can probably be overcome by reinforcing these courses.

Heavy verandah roofs should be avoided. The heavy verandahs at the Residency, inadequately tied to the main building, collapsed badly (see Photo No. 13).

Boundary Walls.

Much destruction of brick walls took place, the greatest damage occurring when walls ran approximately east and west. There were few cases of partial damage. Long walls either collapsed completely or not at all.

Although brick walls collapsed so badly, light concrete pre-cast fencing (R.C.C. posts and rails with one-inch thick P.C.C. panels) stood very well, and, as it is comparatively cheap, its use is recommended.

Framed Buildings.

Steel-framed. There was an appreciable number of steel-framed buildings. The more modern buildings designed on sound lines such as the new railway quarters, the heavy repair shop and the instrument repair shop in the Arsenal, remained almost intact. The steel frames and R.C.C. floors were undamaged in any way, the only failure being the brickwork. Large panels of 4½-inch brickwork in 1.6 P.C. mortar are not strong enough. They pull away at the junction with the stanchion and are not thick enough to resist the overturning moment.

Sheds. Large sheds with light steel trusses on steel stanchions withstood the shock very well. They were considerably less damaged than similar buildings with trusses carried on brick pillar and panel walls.

In the case of sheds of very light construction, the main damage has been caused by the collapse of the walls. When these (usually mud) have been placed inside the stanchions, they have, in falling, taken the columns with them and caused the collapse of the whole shed. Owing to the presence of cross-walls, the tendency is for main walls to collapse outwards.

Timber-framed. Timber-framed buildings are all of relatively small size, but so far as could be ascertained they were quite undamaged, however weakly constructed.

Timber-framed glazed verandahs and conservatories, of which there were many examples in Quetta, seldom had even a pane of glass broken.

Timber-framed subordinates' quarters at the power station, with small 4½-inch brick-in-lime mortar panels, remained practically intact. On account of the fire risk, which is always present immediately after an earthquake, especially where oil lamps are used, timber-framed buildings are not recommended for sleeping accommodation.

Multi-Storied Buildings.

The upper stories of double-storied buildings have generally been badly damaged, with the ground floor almost intact. This was partly due to the increased amplitude of the oscillations, but mainly because the ground floor was well constructed with thick walls in good mortar, well braced by the upper floor, whereas the upper story was generally of light construction, usually in mud mortar.

An example of this is seen in Photo No. 14. When the upper story was as strongly constructed as the ground floor, it was far less seriously damaged (see Photo No. 15).

Most multi-storied buildings in the city were weakly constructed throughout and complete collapse occurred. Even so important a building as the Town Hall was built almost entirely in mud mortar. This was a large double-story building ; Photo No. 16 shows all that now remains of it.

The three-storied instrument repair shop, a steel-framed building, has stood well, slight damage only occurring to the brickwork ($13\frac{1}{2}$-inch burnt brick in weak P.C. mortar) which, had it been reinforced, would probably not have taken place.

Tall earthquake-resistant buildings, several stories high, are common in the U.S.A. and Japan, and there seems no reason why they should not be used in India, if properly designed. They are, however, more expensive, and the usual justification for multi-storied buildings, limited ground space, does not apply in the normal Indian cantonment.

ROADS, DRAINS AND WATER-SUPPLY.

Roads and drains. In Quetta itself no damage occurred to roads and drains. Outside Quetta, damage, which was not of a serious nature, took place due to earth movement : it was confined to sections near river- or nullah-banks.

Water-supply. The main water-supply from Urak to the reservoirs, and the reservoirs themselves, were unaffected, but the intensity of shock in that area was relatively small. In the distribution system, cast-iron pipes with spigot and socket lead joints were used. The pipes were buried to a depth of four to six feet and were little affected. The few joints which broke were in a length of pipe that had previously given trouble at the joints.

High water-towers are particularly liable to damage. Photo No. 17 shows an elevated 10,000-gallon water-tank at Mastung Road station. The twisted steelwork testifies to the force exerted. Even in shocks of minor intensity the pipework is severely strained, and flexible couplings are desirable.

Bridges. Owing to their superior specification, good foundations and limited height, bridges are not normally susceptible to earthquake shocks unless accompanied by earth movement. All bridges and culverts in Quetta itself were undamaged.

In the surrounding country where earth movement took place, several bridges were damaged. Both masonry abutments of the Baleli Bridge (eight miles towards Chaman) dropped and were badly damaged, while at the Murree Brewery Bridge over the Lora (two miles S.W. of Quetta), the west abutment of brick-in-lime mortar fell into the stream, dropping that end of the bridge several feet (see Photo No. 18). The east abutment was renewed after the 1931 earthquake and is carried on vibro-concrete piles. It was quite undamaged and from this limited data it appears that deep pile foundations are much more earthquake-resistant than relatively shallow solid masonry ; particularly in the case of abutments, which are not normally designed to withstand the increased

16.—Town Hall.

17.—Water Tower, Mastung Road Station.

18.—Bridge over the Lora on Brewery Road.

The effect of the Quetta earthquake 16-18

16.—Town Hall.

17.—Water Tower, Mastung Road Station.

18.—Bridge over the Lora on Brewery Road.

The effect of the Quetta earthquake 16-18

pressure due to the displacement of the earth behind them. The piers of the Baleli Bridge in the nullah-bed were not damaged although it appears that they have sunk a little. In both bridges, the R.C.C. floor slab was undamaged.

Nature of the Ground.

It is generally accepted that earthquake shocks are not transmitted so readily through rock as in soft soil. In both the 1931 and 1935 earthquakes the area affected was mainly alluvium, and places situated on solid rock were not appreciably damaged. One particular danger-spot, however, is the junction of rock and alluvium. Villages situated along the side of the valley at the junction of the *pat* and the hills were much more severely affected than those nearer the centre of the valley. The probable explanation is that the rock and the alluvium vibrate, during an earthquake, with different periods.

Dry ground transmits shocks less readily than water-logged ground, owing to the damping effect of the air pores in dry soil. To this fact is attributed the very considerable difference in the degree of damage in Quetta itself. The whole of Quetta is situated on alluvium, but the southern and western areas are low-lying and water-bearing, whereas the northern and eastern areas are dry.

Another danger zone is the vicinity of streams. An earthquake tends to level out surface inequalities and it is well known that the banks of rivers and nullahs tend to collapse inwards. This was clearly illustrated along the Lora, which flows on the western side of Quetta.

Summarizing, the best site appears to be solid rock, dry soil is preferable to wet, and the particular danger-spots which should be avoided are the junction of hard and soft soils and the immediate proximity of rivers and streams.

THE PREPARATION OF ENGINEER EXERCISES WITHOUT TROOPS.

To many—possibly to most—officers the preparation of a winter's course of tactical exercises without troops presents a severe test of the imagination: and, if this is so, the preparation of a series of engineer exercises, calculated to arouse interest and enthusiasm, is an even more formidable undertaking. Themes are apt to be few and hackneyed: but, even so, the framing of the official solution is apt to lead the senior officer into realms of detail and of technical calculations which he would prefer to avoid. In tactical exercises such details can be avoided: there are always, as we know, three solutions to every tactical problem, and the fourth or official solution is "neither the only nor necessarily the best solution." This permits of a pleasant vagueness both in the setting of tactical exercises and in the criticism of the solutions. No such vagueness is permissible, however, in the normal engineer exercise: we cannot rebuild a broken bridge with principles. We have to supply the detailed conditions of the problem and to criticize in detail: and any officer who has had to set and correct (f) projects knows how difficult it is to set a problem which is not only "water-tight" but which the setter himself can answer.

The setting of engineer exercises, in the usual sense of the term—that is, of technical problems—involves indeed a great deal of imagination and a great deal of time: and in these busy days which of us has time to spare? This is, no doubt, one reason why, in any winter training programme for R.E. officers, Regular, S.R. or T.A., it will be found that the days allotted to tactical exercises (T.E.W.T's) greatly exceed those given to engineer exercises (E.E.W.T's).

Another reason is that it is so easy to attach officers to units of the other arms for tactical training: the time of the C.R.E. is saved and co-operation (blessed word!) is promoted.

Finally—and this is perhaps the principal reason—the examination value of the T.E.W.T. is vastly greater than that of the E.E.W.T.

But how lamentable this is will be realized when we remember that in war the engineer is judged only very rarely by his solution of a tactical problem. For the ordinary run of engineer officers war presents a continuous series not of tactical but of engineer problems, and, as a corps, we stand or fall on our solution of engineer problems, using the term in the widest sense—problems, that is to say, in the handling of engineer troops as engineers, not as infantry.

The engineer problem, in the sense defined above, should therefore be the principal and not a secondary subject of our individual training. We ought—and we must—prepare ourselves intensively for our special duties. We must ensure that our officers—few of whom have now any experience of war—shall enter upon the next war fully experienced, as far as peace training can make them, in the day-to-day handling of an engineer unit in the field and accustomed to foresee and to solve the problems of all kinds with which they may be faced.

What is the difficulty? Lack of time—we have not the time to prepare exercises and our officers with all their other duties cannot spare those days in the country which frequent E.E.W.T's entail. Lack of imagination—the possible subjects for E.E.W.T's seem so few and it is so difficult to avoid a sameness leading to monotony and boredom. Who ever heard, indeed, of the enthusiast for engineer exercises? But may this, again, not be the result of our taking too narrow a view of what constitutes an engineer exercise?

We propose in this paper to suggest a method by which not only—it is hoped—will a vast number of engineer exercises leap to the mind without any strain on the imagination, but by which those exercises will obviously be such as we may expect to meet in war. They should have the stamp and therefore the interest of reality. Moreover, the method will allow of our sub-allotting the preparation of the individual problems and solutions to our subordinates in such a way that we are certain that the resulting problem will be a practical problem, without the need of any detailed explanation or guidance, to the benefit of the setter and to the relief of his superior officer.

The method is simple: it is merely this:

> to set all the problems of one training season—or indeed to base the whole training for the year—on one major operation, an operation taken preferably from history, but which may be adapted from some suitable Command or War Office exercise.

Let us test the claim by an example; but before we do so let us give the "K.O." to a couple of objections. The first objection is this: that officers have not the time to do many such exercises during the winter training season. The fallacy here is that E.E.W.T's must necessarily be long: in the example which we give below will be found suggestions for "situations" which can be tackled in a few minutes, either on the ground or in the lecture-room or in private study. Here our proposed "method" helps since the fact that the "general idea" is continuous, unchanging and known to everyone, should save a vast deal of time both to the instructor and his victim. But the essential idea that we must grasp is that engineer exercises are the *primary* training of the engineer officer. When we accept this whole-heartedly there should be no difficulty in finding the frequent, even daily, hour and occasional morning for such instruction. Nor need this form of instruction be confined to the winter months.

A second objection is this: that it is all very well to base our study on, for example, the Marne campaign of 1914, but we cannot go over to France every day to study on the ground the portion of history on which our exercises are based: that we have not any ground, or river, or bridge near our station resembling the ground, river or bridge on the map; and, anyway, the map is so bad that we cannot make out exactly what the ground is like. The answer to this is: first, that the actual shape of the ground does not matter, we are not, or hope we are not, likely to fight over the same ground again: and second, that by a simple device we can transfer the ground to our own neighbourhood. For example, the Marne is a river 270–300 ft. wide where we crossed it in September, 1914. But the technical problems of a river crossing depend mainly on the breadth of the river, the cross-section and current, and the nature of the banks and approaches. Of these, the technical difficulties due to the breadth of the river must in such an exercise in any case be imagined, and it is, therefore, not unreal to say:

"The Marne and its banks from X to Y exactly resemble the M stream (or N canal) between A and B except that—instead of being 20 ft. wide and 2 ft. deep—the Marne is 270–300 ft. wide with muddy bottom 8 ft. deep within 6 ft. of the banks and has a current of 2 m.p.h."

We can even use a railway cutting or hollow road for this purpose.

We shall find occasion to use this device frequently in the example below.

EXAMPLE.

(*Ref. Extract from France* 1/80,000, *sheet* 49*).

OPENING NARRATIVE (outline only).

It is September, 1914. The B.E.F. of the same strength as in 1914, but with modern establishments, is advancing after its retreat as it did in the second week of September, 1914. Its enemy (Northland) is organized on the same lines as are now assumed for the B.E.F. (The last is necessary, since in the first place we must not assume any particular enemy and in the second we shall require to transfer ourselves to the enemy side for certain types of operation, as, for example, employment of engineers in withdrawal, defence, demolitions, etc.)

* This sheet forms part of the MARNE BATTLE AREA sheets issued with the War Office pamphlet, *Battle of the Marne 8th–10th September, 1914* (*Tour of the Battlefield*). Copies of it can be obtained from the War Office through the usual channels.

Narrative 1.

The time is the evening of 7th September. 1 Div. after a march of from 7 to 10 miles in hot weather, without making appreciable contact with the enemy, has gone into close billets in Beauchien (6923)—Montigny (7022)—Jouy (6822) with outposts Champ Martin cross-roads (7225)—Pinebard (7025)—Breuil (6824) in touch with 2 Div. on our left. (Whether these locations are according to history does not matter. They are sufficient for the engineer problems which we wish to study.)

The R.E. of 1 Div. are billeted as under :—

23 Fd. Coy. Beauchien in 2 Inf. Bde. area.
12 Fd. Coy. Montigny in 1 Gds. Bde. area.
H.Q. Div. R.E. }
6 Fd. Pk. Coy. } Jouy in 3 Inf. Bde. & Div. H.Q. area.
26 Fd. Coy. }

Forward limit of 1 Corps Engineers responsibility from midnight 7/8 Sep. :—

the line of the Grand Morin, inclusive to Corps (*i.e.*, Div. is responsible on 8 Sep. for all engineer work north of the Grand Morin, until the Corps line is moved forward, *e.g.*, to the Petit Morin).

Problem 1. *Billeting arrangements and routine.*

On 7 Sep. 1 Div. marched in one column covered by 1 Mob. Div.

Adv. Gd.	—	2 Inf. Bde. and attached tps.		
Main body	—	1 Gds. Bde. ,,	,,	,,
		3 Inf. Bde. ,,	,,	,,

by the road passing through the G of La Ferté-Gaucher (7020).

3 Inf. Bde. and Div. H.Q. have just completed a long halt with head on the south edge of the map (703200) during which orders to billet in Jouy were received and billeting parties were ordered forward under staff capt. 3 Inf. Bde.

(*a*) (Indoors, on the map.)

(*i*) Composition of R.E. billeting party ? Any equipment with the party ?

(*ii*). You are the officer in charge of the R.E. billeting party which consists of........................

You have forgotten to bring with you any books of reference. You turn over in your mind and jot down what you remember of :

The principle of allotment of billets.
The method of calculating accommodation.
The duties of billeting officer.
The duties of billeting N.C.O's.

Give the notes which you make.

(*b*) (On the ground.)

Jouy is (by a curious coincidence) exactly like the village of *e.g.*, Odiham, the road by which 3 Inf. Bde. and attached tps. arrive being the same as that entering Odiham from Aldershot.

You are the billeting officer for R.E. 1 Div. (less 12 and 23 Fd. Coys.). You have with you a D.R. and one sapper N.C.O. and one driver N.C.O. from each of 26 Fd. Coy. and 6 Fd. Park Coy. (H.Q. R.E. 1 Div. lives and billets with Div. H.Q.). The staff capt. 3 Inf. Bde. who is arranging the billets brings you to a certain point and says :—

"The Sappers will have the village west of this point, and your vehicles will park in that field. You must make your own water-supply arrangements. The village sanitary and water arrangements are working but the E.L. supply is destroyed. Div. H.Q. will probably be at......................... and 3 Inf. Bde. H.Q. at..................................."

(*i*) What is your plan of action ?

(*ii*) Give your (verbal) instructions to your billeting N.C.O's.

(*iii*) You and your billeting N.C.O's will now proceed to allot billets and make other arrangements. You and they will make rough sketches showing the allotment of billets and will each mark two billets (on the footpath, *not* on the door).

(*iv*) Give your final instructions to your billeting N.C.O's (after completion of recce.).

(*v*) You decide to go yourself to meet the units, and you find the O.C. 26 Fd. Coy. and O.C. 6 Fd. Pk. Coy. together at the head of 26 Fd. Coy.

Give verbally the information which you would give them.

(*c*) (On the ground or on the map, in continuation of (*b*).)

You are O.C. 26 Fd. Coy. When you get to................ the billeting officer meets you and gives you the sketch showing the billets, etc., in Jouy (= Odiham).

(*i*) Describe your procedure.

(*ii*) Give your verbal orders prior to entering the billeting area.

(*d*) (On the map.) Minor problems, connected with the above billeting scheme, dealing with :—

Routine of rifle, foot, M.T., etc., inspection.

Guard and duties.

Cooking and issuing food.

Receipt of rations.

Reporting sick.

Disposal of sick.

Action in case of accident to vehicles.
Replacement of lost equipment.
Returns.
Disposal of defaulters.
Disposal of enemy prisoners captured in billets.
Action in case of complaint by inhabitants.
Standing orders.
Duties of clerk.
Duties of C.S.M. and C.Q.M.S.
Duties of R.S.M. at H.Q. Div. R.E., etc., etc.

(On the ground.)

Water points.
Wiring of Div. H.Q. office billet (represented by an officer's Qr.).
Gas-proofing of office billet (represented by an officer's Qr.).
Selection and preparation of decontaminating station.
Organization of gas watching and decontaminating service in billeting area.
Corduroying exit from muddy field.
Provision of movable barrier at exit of village., etc., etc.

It would be possible to go on in this way *ad infinitum*. Enough has been said, however, to indicate the method—and perhaps to convince the reader that there is something yet to learn of this very ordinary operation. It may be objected that this is not an engineer exercise ; yet it is so in so far as it deals with engineer establishments, engineer equipment and engineer transport. Let us, however, look at some more definitely engineer problems.

Problem 2.

(*a*) Orders for a march (on the map).

(*i*) At 2100 hrs. a warning order had been issued by H.Q. 1 Div. (Jouy) for Div. to be ready to march at 0400 hrs. 8 Sep.

Reqd.—Write the warning order issued by C.R.E. 1 Div.

(*ii*) At 2300 hrs. Corps orders arrived directing 1 Div. to continue the pursuit on 8 Sep. crossing the 24 East and West grid line at 0600 hrs.

Roads for 1 Div. both incl. Montigny-Bellot (7229)—Sablonnieres, and Breuil—Gd. Champcormolin (6926)—Gd. Marché (6828)—Sablonnieres, thence Hondevilliers—Nogent l'Artaud where bridges were to be occupied and a bridgehead established.

It was estimated that only Northland's 9 Mob. Div. (whose composition may be taken to be the same as that of British Mob. Div.) would oppose the Corps and it was expected that bridges over Petit Morin would *not* be broken but that enemy would destroy the Marne bridges.

Corps Pontoon Bridge Park would reach St. Remy at 0900 hrs. where it would receive further orders.

The G.S.O.2 1 Div. read a copy of this order to Staff Capt., C.R.A. and C.R.E., while G.S.O.1 1 Div. was closeted with the Div. Comdr.

Reqd.—As C.R.E. be prepared to give your engineer appreciation to G.S.O.1. Since your own companies destroyed the bridges at La Ferté you know that the Marne is at least 250 ft. wide and possibly wider, and that the Petit Morin at La Ferté was about 20-30 ft. wide and fairly fast.

(*iii*) The Div. plan for the march included :—

Adv. Gd. 1 Gds. Bde. with 12 Fd. Coy. under command.

Route La Frévillard (7223)—Bellot—Sablonnieres, etc.

Main bodies—3 Inf. Bde. to follow 1 Gds. Bde.—head to pass east exit of Jouy at 0530 hrs. 2 Inf. Bde. to be assembled at Gd. Champcormolin at 0630 hrs. ready to march by Gd. Marché on Sablonnieres whence it would follow 3 Inf. Bde.

Reqd.—Assuming that G.S.O.1 accepts your recommendations for employment of R.E. which includes carriage of 23 Fd. Coy. in C.R.E.'s M.T. pool and bringing of 23 and 26 Fd. Coys. under C.R.E. control:

Draft R.E. para. for 1 Div. operation orders.

Write 1 Div. R.E. operation orders for the march.

How would the latter be issued? What routine method would C.R.E. have for issues of orders?

(*b*) (On the ground).

As before, Jouy is represented by Odiham—billeting details are as in solution to Problem 1 above.

As O.C. 6 Fd. Pk. Coy.
O.C. 26 Fd. Coy. } issue your orders for the march.

As O.C. 23 Fd. Coy. which may be assumed to be billeted as for 26 Fd. Coy., Odiham now representing the village of Beauchien, give your orders for the march including arrangements for embussing.

As above—orders issued by section and sub-section commanders, C.S.M., C.Q.M.S.

There are evidently plenty of problems both indoor and outdoor to be got out of the preliminaries for the march. An examination of these will show that many of them are more or less stereotyped especially as to the routine and the orders to sub-units. It is suggested that this is in some ways an advantage and that we might well have a standard exercise worked out in great detail on which N.C.O's could be practised, *as a drill.* The same is true of the billeting exercise outlined above.

And so it goes on.

Do we require a reconnaissance problem? Here are a couple among the many which must spring to the mind.

Problem 3. Reconnaissance.

(*a*) As a *Subaltern* / *Serjt.* / *Corporal* of 6 Fd. Pk. Coy. reconnoitre the best covered line of approach for the bridging vehicles of the coy. from Gd. Champcormolin to Sablonnieres avoiding the road as far as possible. For this exercise Gd. Champcormolin is represented by W village, the Petit Morin by the X—Y road and Sablonnieres bridge by the crossroads at Z.

(*b*) Reconnoitre the bridges at Bellot and Sablonnieres represented by the bridges at X and Y over the Z canal and report

(*i*) carrying capacity,

(*ii*) details of bridge, demolition details, possibilities for diversion, using report form in *Engineer Training, Appendix II*.

Here is a small bridging problem with the minor administrative problems arising out of it.

Problem 4. Bridging.

(*a*) (On the ground.) The bridge at Sablonnieres, represented by bridge H over the river G, is reported by Adv. Gd. Fd. Coy. (*i.e.*, 12 Fd. Coy.) to be suitable for one-way traffic only.

As a subaltern of 23 Fd. Coy. at Gd. Champcormolin (*i.e.*, village of X) you receive orders to take your section at once to bridge H, where two S.B.G's* from the 6 Fd. Pk. Coy. will arrive about ½ hr. after you; you will build a heavy bridge with them to be replaced later, on a second alignment, by a heavy semi-permanent bridge. You are to ensure that neither of the roads leading to the bridge is blocked by your transport or operations.

(*i*) Reconnoitre the site and make a plan.

(*ii*) Issue orders (at the bridge site) to your section pending arrival of S.B.G's.

(*b*) (Indoors.) What arrangements will be made at the Sablonnieres S.B.G. bridge for bridge maintenance and signboarding?

(*c*) (Indoors.) When the bridging vehicles for the Sablonnieres bridge rejoined 6 Fd. Pk. Coy., the O.C. Coy. drew your attention, as Adjt. R.E. 1 Div., to the fact that he now only had the launching apparatus, four sections and some decking

* Small Box Girder.

of the divisional S.B.G's and that it would be some time before the remainder would be retrieved.

What arrangements do you suggest for completing wholly or in part the divisional equipment?

A minor problem in improvised bridging can be presented by supposing that the bridge at Bellot is destroyed and that the corps require a heavy bridge to be built from local materials. 6 Fd. Pk. Coy. is to do this.

As regards major bridging problems, the crossing of the Marne (assuming the bridges to be broken) presents unlimited problems; for although in all probability only one F.B.E.* and one heavy pontoon bridge will be constructed on the divisional front, any number of different sites can be found locally to represent those selected from the map, providing a variety of problems. It is, perhaps, hardly necessary to point out that such problems are only of practical value if worked out in complete detail. It is easy to describe generally where and how a bridge may be built. It is only when as O.C. Bridge we have to issue verbal orders to our subordinates that we are made to realize all the details which require decisions, *e.g.*, the arrangements for the reception, parking, traffic control and receipt at the bridge site of the Pontoon Bridge Park vehicles—the order and rate of delivery of stores—the arrangements for protection of the bridge site—the detailed arrangements for the improvement of approaches—the provision of maintenance parties, and their standing orders—progress and completion reports, etc., etc.

The above are only a few of the practical details to be considered, details with which all officers should, if they are to be fully trained, be familiar from experience which can only be provided in such engineer exercises.

Do we require a "blocking" exercise—an operation with which we should all be familiar since its execution may fall equally to divisional or corps engineer units? A little ingenuity will produce one. For example, at an early stage of the operation on 8 Sep. we may suppose a gap between ourselves and the French Fifth Army. 1 Div. has to send a mech. fd. coy. to block the line of the Petit Morin for 5 miles upstream of Bellot (represented by the river X from A to B) against the threat of Northland 5 Mob. Div. Or, at a later stage of the day's advance, we may well have to block the right flank of the division on the line Viels Maisons—Essises—Chézy (not included on extract from the full sheet 49).

For a demolition exercise we must transfer ourselves to the side of Northland, replacing Von Kluck's First Army by the B.E.F. Starting from the arrangements made by a far-sighted if pessimistic engineer control at G.H.Q. on 3 Sep. and the following days, we

* Folding Boat Equipment.

can then produce any situation from the reconnaissances, assembly of engineer resources for and preparation of a large co-ordinated and deliberate demolition scheme—of which the Marne downstream from (incl.) Château-Thierry forms the "*primary belt*"—down to the hurried preparation and execution of a secondary belt on the Petit Morin or (as problems for N.C.O's), to the preparation of tree blocks or craters on the roads through the steep and wooded banks of the Petit Morin and Marne or to the issue of orders to demolition parties.

That great trainer, the late General Sir David Campbell, used to say that he could train a cavalry regiment to the highest pitch of efficiency in a square mile of ground provided that it contained one wood, one hill and one village. How much more easily should we be able to train ourselves, if we will, on one such operation as we have now been contemplating, with its infinite range of engineer problems great and small; provided, and provided only, that we insist on going down to practical details, that is to say, for the commander whether senior or junior, to the actual issue of orders.

We must, however, make one exception to this, in regard to an important branch of R.E. duties in war which do not come within the limit of such an operation as that which we have been considering. We refer to duties on the base and L. of C.—duties which will fall, in great wars, to the S.R. A.Tps.Coys. allotted for that purpose but which in small wars may fall to the lot of ordinary fd. coys. Here we can hardly hope to work on an historical example but the method of having one standard operation on which to base all our exercises is peculiarly suitable. It is, indeed, only when we come to deal in detail with execution of work at the base, *e.g.*, the preparation of an hotel as a general hospital, the construction of base depots, ammunition depots, etc., etc., that we realize the thousand and one technical problems which arise and the large responsibilities which will have to be delegated to even the most junior commanders. And we can only deal in such detail if we have a base lay-out fully worked out. The ideal is, therefore, to have such a standard base scheme near each R.E. station or alternatively to have a paper scheme, items of which can be transferred as required, by the method already suggested, to the vicinity of our training centre.

"Idealistic," no doubt the reader will say, "and, in the time available, impossible." We only ask that commanding officers will make a trial of this method to produce an outline of subjects for engineer exercises. We believe that, if their minds are susceptible to its stimulus, they will be appalled at the variety and extent of the subjects which suggest themselves and which must be brought within the experience of officers and N.C.O's before they can be regarded as fully trained in the engineer sense, and at the extent of our failure to provide that training and experience.

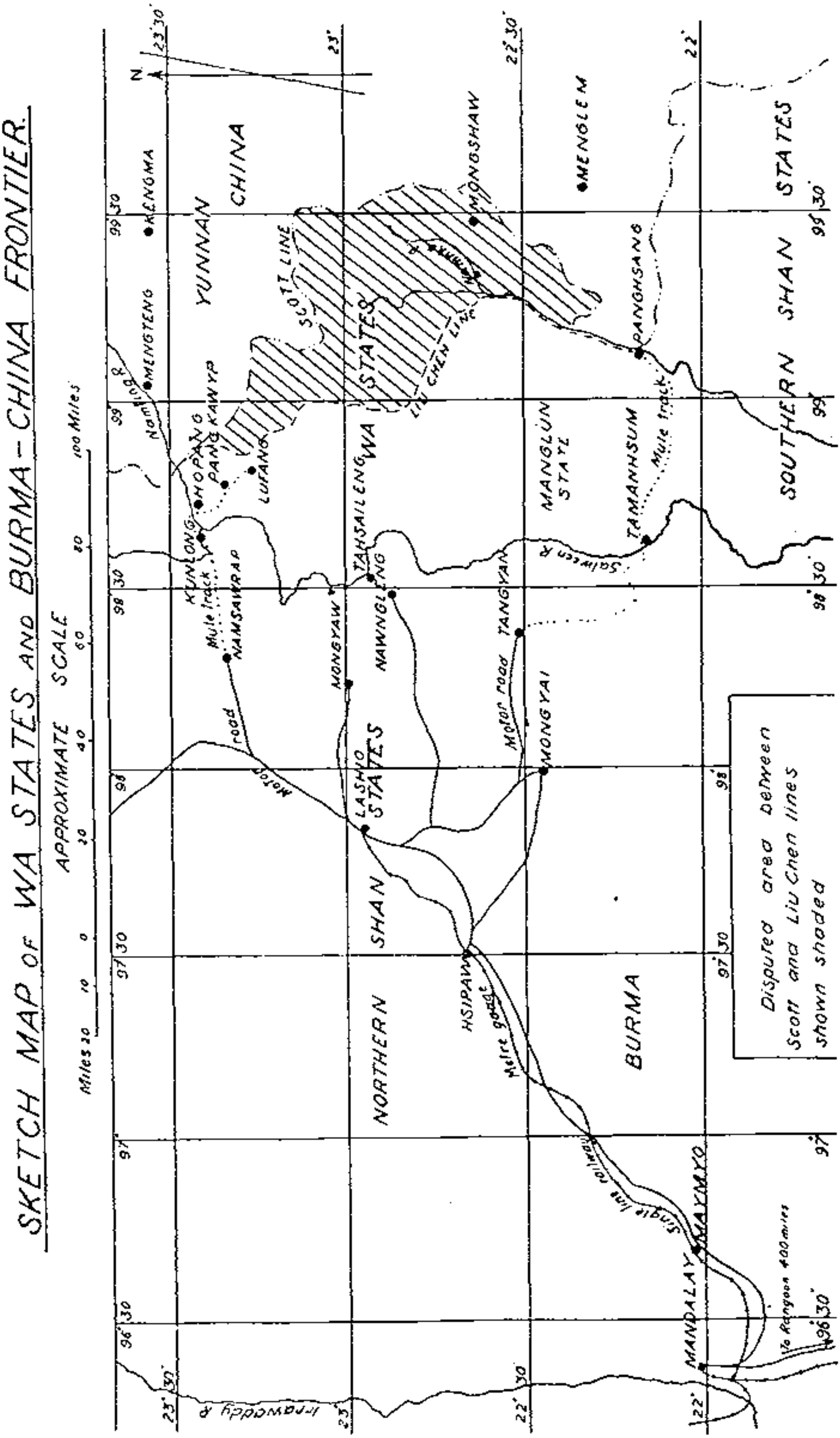
SOME NOTES ON THE WA STATES.

By CAPTAIN A. D. B. COCKS, R.E.

WHILE many books have been written about the North-West Frontier of the Indian Empire, the same cannot be said about the North-East Frontier. The latter has come into more prominence recently, however, owing to the Sino-Burmese Boundary Commission which is at present at work. This article is intended to describe some of the conditions and difficulties which are to be contended with in this part of the world, and the work done by Sappers here in the last two years. The area dealt with is that on the boundary of China and Burma between latitudes 22° and 23° 30′ north, as shown on the sketch map. West of the river Salween the country is fully administered, but east of it British Administration is either very loose or non-existent. This latter part is generally known as the Wa States, although a variety of other tribes and races also live there.

The Was are generally classified by us as Tame Was (Las) or Wild Was (Was). They are the descendants of an ancient race which once covered a large area in this part of the world, and who, owing to their savagery and the extremely difficult nature of their country, have resisted all attempts at intrusion for thousands of years. The population of the Wa States is said to be nearly 150,000. The Wa is short, stocky and dark, and looks less of the Mongolian type than his neighbours on either side. The Tame Wa is a hard-working cultivator and lives in self-contained village communities; he now dresses as a Shan. The Wild Wa wears little clothing and in the hot weather none at all. He crops his hair short. The Wild Wa villages are usually sited high on a hillside or on a crest, and are strongly defended. They consist of a muddled collection of houses surrounded by a rampart of earth or stones up to 8 feet in height, covered with thorn or cactus bushes. Outside this is a deep ditch in which are placed *panjies*. These consist of a large number of sharpened and sometimes fire-hardened bamboo stakes stuck in the ground, forming a most formidable obstacle.

The Was also defend their villages by stockading the paths leading to them. Their stockade is a strongly built and loopholed wall of logs and earth. In 1934, a Burma Military Police (B.M.P.) column in the Wa States found that the loopholes were very narrow and were all sited with the single object of hitting a man in the chest as he



SKETCH MAP OF WA STATES AND BURMA-CHINA FRONTIER.

advanced up the path. It was possible to reach the stockade quite unharmed by simply crawling up to it or by making a slight detour to one side. From this column the Was evidently learnt a lesson, as the present Boundary Commission have found that, in all the stockades they have examined, new loopholes have recently been made to cover all angles at any height. The Wa is famous because of his head-hunting inclinations, but many of the stories about this habit are exaggerated. It seems that the Wa hunts heads only as a religious custom, and there is a definite season, of about three months' duration starting in March each year, during which he indulges in this activity. He firmly believes that the acquisition of a new head each year is essential for the success of his crops and the protection of his village. It certainly happens that the villages with the most heads are the largest and strongest. On the other hand, he is not wholesale in the collection of heads, and one village that has been lucky in obtaining as many as it requires for the year will sell the surplus to its neighbours whose raiding parties may have come back empty-handed. These heads have a definite value according to their variety, Chinese being highly priced, followed by Shans and then the more primitive tribes.

All Was are extremely superstitious and no event takes place without previous consultation with the spirits or *Nats*. They normally carry a bag containing charms which they consult before taking any course of action. On the average each household is said to possess one gun, but these are almost invariably of the most primitive type. Each man always carries a *dah* with him; fire-hardened bamboo spears, cross-bows and ordinary bows also are common.

Before the advent of the British, with their low-down fighting tricks, such as surprise attacks, flank attacks and the use of rifle grenades, war used to be a gentlemanly affair in the Wa States. When village A wished to attack village B, to avenge the taking of a head or for any other reason, the procedure was somewhat as follows:—A would send B a message to state that they would shortly be attacked and that women and children need have no fear. The warriors of A would then consult the chicken bones with much ceremony, and, when these showed that the *Nats* were favourable, they would march out and encamp opposite village B. It was the custom to camp so as to inform the enemy when and whence to expect the attack. It was an unwritten law that an attack should only be delivered the morning after such a camp and from the direction of the camp. Any surprise or other form of attack would be quite contrary to their code of warfare.

An Anglo-Chinese convention of 1894, modified by an agreement of 1897, detailed the boundary for the Burma-Yunnan Frontier. In 1899, a Sino-Burmese Boundary Commission, of which Sir George

Scott was the Chief British Commissioner, went out to demarcate this boundary. This Commission soon came to grief as no agreement could be reached between the British and the Chinese, the latter simply walking off home. Sir George Scott then continued on his own and surveyed a boundary known as the "Scott Line," in accordance with the text of the agreement. He encountered much opposition during this work from the Was and was eventually compelled to return along the route by which he went into the country, instead of completing a circular tour as planned. Two British officers, who rashly went into a village bazaar unprotected, lost their heads, using the full meaning of the phrase. These two heads are still the most potent of all charms amongst the head-hunting Was. They are passed from village to village and whichever one possesses them is temporarily stronger and more prosperous than its neighbours.

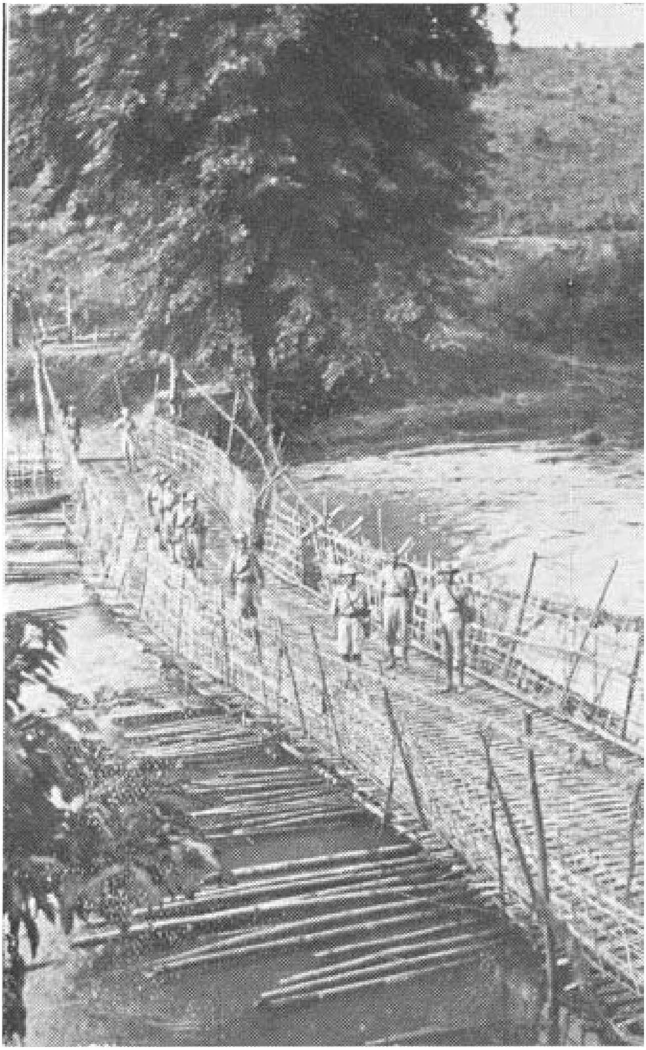
In 1935, at Tamanhsum village the oldest inhabitant proudly pointed out to a reconnaissance party of the present Boundary Commission the site where the "Red-coats" had camped, and showed the remains of two trenches where, he said, they had practised firing. Since that time until two years ago the country has not been visited by white men, except for a very occasional adventurer or missionary and one or two B.M.P. Columns confined to small areas. The Chinese have since claimed the boundary along a line much farther west than the "Scott Line," known as the "Liu Chen Line." Their claim appears to be based on confusions caused by the similarity of place-names and the constantly changing positions of villages. Their line has never been explored or surveyed.

Early in 1934, a B.M.P. Column, east of the Salween, encountered considerable opposition from the Was, and soon afterwards the posts of Hopang and Lufang which this Column established were threatened by Chinese forces. The situation became so tense that in June two Companies of the Burma Rifles and No. 10 Field Company, Q.V.O. Madras Sappers and Miners, were moved up to Lashio, while a section of the 10th Mountain Battery, R.A., went right out to Lufang. Either this threat or the arrival of the worst of the monsoon discouraged the Chinese, who retired. The Yunnanese Government at once classified these raiding parties as bandits. It is said that they were sent out demi-officially on the understanding that, if they achieved a success against the British, they would be rewarded and called soldiers, but if they failed they would be denounced as outlaws.

The Sapper Company spent a fortnight in tents in typical monsoon weather on Lashio Golf Course before moving into the B.M.P. barracks, until they returned to Mandalay at the end of a month. During this time one or two detachments went forward and repaired bridges on the line of communication to Lufang, but most of the time was spent in practising jungle warfare and in the conversion of all loads to 60 lb. This included the construction of new light boxes, as the G.S. pattern box for 80-lb. loads weighs as much as 30 lb. empty. Experiments were also carried out in carrying wire rope on men's shoulders, like a snake, along jungle paths with a view to getting this rope up to form a flying ferry across the River Salween. The best result obtained with 3" S.W.R. was to carry it doubled, and to have thirty men per 120 fathoms. The only two outstanding features of this month in Lashio were first the formation of an extremely amateur "Wa Wanderers" football team, it being probably the first time that eleven British officers have ever been stationed there together, and secondly, the complete disintegration, amongst other items, of the O.C. Field Company's best slippers by white ants during the first night in camp.

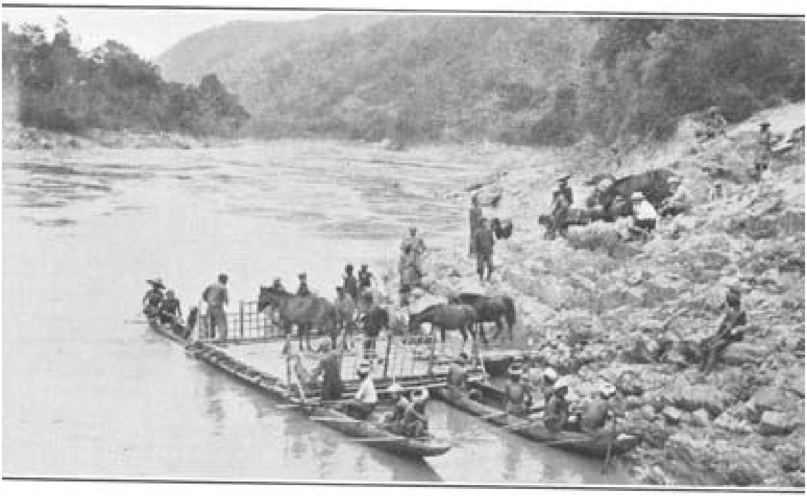
During the month two R.E. officers went forward on reconnaissances. One reported the mule-track as quite impossible for a military line of communication, and we heard that the Gunner Section going to Lufang had over 60 of their big mules down in the space of two miles. The other reported the rivers Salween and Namting in full spate and requiring much work to make their crossings feasible as part of a line of communication. The return of this officer is typical of the conditions encountered. We left Lashio to go and meet him by lorry on a fine day, and reached motor head, mile 55½, in less than four hours. There we met the reconnaissance officer resplendent in a Shan hat (a flat circular straw 3 ft. in diameter) with S. and M. and R.E. badges and flash complete. "Wet weather jungle marching order," he called it, and this liberty was excusable as both his *topees* had become so sodden with rain as to be completely useless. After a night of pouring rain in a leaky tent we took 8½ hours to do the return trip, encountering a tree fallen across the road and a landslide, and getting bogged twice. The trip would have been impossible without axes, shovels, blocks, tackles and *dahs* which we took with us, and yet after two days of sun the road would again be quite a fair motor-road. It poured with rain throughout the day and our miseries were completed by the presence of a nest of large red ants at the foot of the fallen tree. As much time was spent in removing these pests, whose nip is not to be despised, as in clearing away the tree. At one time both British officers had simultaneously torn their shorts off to remove ants from the more inaccessible places. We considered that we had earned our rum punch that night.

After the withdrawal of the Chinese raiders it was decided to explore all the crossings of the River Salween thoroughly. Three reconnaissance parties were sent out, each with an R.E. officer, and all the ferry sites and possible crossings in this area were visited. These reconnaissances were all carried out in the monsoon, when this jungle is notoriously unhealthy. Of the six R.E. officers who carried out reconnaissances, lasting from a fortnight to a month each in 1934



Some notes on the Wa States - Bamboo bridge

Village Types.



River Salween—Tamanhsum Ferry.

Some notes on the Wa States - River Salween - Tamanhsum ferry

and 1935, one got enteric, one dengue, and one malaria, and this despite taking every reasonable precaution. These do not constitute abnormal casualties as the officers of other arms who went out suffered equally, if not more heavily, from sickness. The present Boundary Commission has had surprisingly little sickness to date, but they are out only in the dry season and they would probably find it a very different matter once the monsoon started.

One of these reconnaissances, looking for a route to the Tahsaileng ferry, came across the frame, some 40 ft. high, of a gold dredger on a tributary eight miles west of the River Salween. They did not have time to investigate this thoroughly before having to return to put in their report. A second reconnaissance was therefore sent out to find out how this mass of machinery was sent out through a country in which carts or any vehicles with wheels are never seen. It appeared that, thirty years before, an enterprising firm took this machinery out on bullock carts, along a 45-mile track graded and cut out solely for the one convoy of carts. The track is now completely overgrown and in places almost impossible to trace. The present mule-path goes straight between villages regardless of gradients, whereas the cart track had to make several detours and do much traversing in order to avoid the hills. Even then, there were some very formidable gradients and on one hill alone the local inhabitants stated that seventy bullocks died of exhaustion in getting the convoy up the slope. To drop down the final hill to the gold-bearing stream, a slipway some 300 yards long was cut out of the hillside and the machinery was let down this on ropes.

Despite all these exertions only a few *viss* of gold were obtained in a couple of years, as it was only found to be present in small quantities. The British firm then sold out to some Chinamen. Even they could make no profit, and after a short time they tried to get the machinery back to civilization in order to sell it. The engine was retrieved and is still working in a pumping station in Lower Burma, but the dredger proved too difficult to move. Parts of it are still on the hillsides, abandoned on their way out, but the main framework remains on the site where it proved to be of such little use.

All the reconnaissances in 1934 received definite orders not to cross the River Salween, as the Was on the far side were more unfriendly than usual at that time. The presence of parties of Chinese bandits and much Chinese intrigue did nothing to improve matters. By 1935 the situation had quietened down and both British and Chinese Governments had agreed to the formation of another Boundary Commission. This was to decide whether the "Scott," the "Liu Chen" or a compromise between these two lines should be taken as the boundary. The League of Nations was asked to appoint a neutral chairman for this commission, and a

Swiss Engineer, Colonel Iselin, who had been chairman of the Syria-Iraq Boundary Commission, was sent out.

The plan for the British half of the Commission was that they should start at the northern end of the line, because a B.M.P. line of communication already existed up to their post at Lufang. The Chairman and Chinese Commissioners were to be met near Pangkawp, where a military advanced base was to be formed. It was hoped to survey and determine the boundary and return via Panghsang, where a second advanced base was to be established. From the latter base the Commission and its escort were to be sustained over the last half of a circular route. The Commission met as planned in November, 1935, and it was hoped to complete the work by May, 1936, as it is impossible for such large bodies of men to be out during the monsoon, which breaks in May and continues until October.

As the southern line to Panghsang had not previously been visited, except by Sir George Scott's original Commission and a B.M.P. column in the open season of 1920-21, a reconnaissance was considered necessary. The military officers for this reconnaissance were escorted by a platoon of B.M.P., it still being a rule that no movement in the Wa States is to take place unescorted. The B.M.P. are unsurpassed at this type of jungle work and this platoon showed themselves to be efficient in camp discipline and excellent marchers. Instead of normal equipment they carry bandoliers and rucksacks, and are armed with the service rifle with a short bayonet. According to their caste every man carries in addition either a *dah* or a *kukri* for jungle cutting. Government mules are taken for Lewis guns, but ammunition and all other stores are carried on Chinese mules.

On this reconnaissance the Sawbwa of Manglün, the ruler of the largest state east of the Salween, who governs an area of about 2,800 square miles, was officially visited in his *Haw* (palace), the construction of which had been subsidized by Government. This state is loosely administered by the Burma Government which imposes a light taxation. According to local custom gifts were exchanged, the Sawbwa ending up by presenting a deer and a young bear to the civil officer.

No trouble was expected, but there was a slight thrill the day Panghsang was reached, when a spy brought the news that 600 Chinese bandits were planning to attack a village, twelve miles away, that night. About 30 of the local villagers produced a variety of curious weapons and dashed off to help their neighbours. Meanwhile there was intense excitement in the camp when unusual lights were seen moving on a neighbouring hillside. The camp "stood-to," a patrol was sent out to investigate and the officers even went so far as to buckle on loaded revolvers and to walk about with their torches held at arm's length from their bodies. The owners of the lights were not discovered and the rumour of an attack turned out to be false. The patrol was guided by one of the local inhabitants who presented a most formidable appearance. He was only about 5 ft. in height and was armed with a Belgian breech-loading gun nearly as long as himself. To supply this gun he carried an ordinary bandolier over his shoulder in addition to a cartridge belt round his waist, both quite full, to say nothing of an enormous *dah*. Any fearsome or warlike nickname suited him, but he was from then on known as "Battleship." Having, as he considered, saved the party that night, he accompanied them for four marches on their return trip to make sure that they would not be molested.

In the dry season, 1935-36, the discussions between the rival Commissioners were more protracted than was anticipated and the Boundary Commission will have to go out again. It is due to start in November, 1936, and should complete the work before the 1937 rains. In November, 1935, the Chinese Commissioners made extravagant claims, and it took two months with conferences almost daily before the Commission moved from its original meeting-place. The military forces employed last season, either to escort the Commission or on lines of communication, consisted of two platoons and one M.G. Section of British Infantry, three Companies of Indian Infantry, one Section of a Mountain Battery and auxiliary troops. The Sappers were represented by the survey officer and his party from the Indian Survey and one section, under an Indian officer, of No. 10 Field Company, Q.V.O. Madras Sappers and Miners.

The Wa country in general consists of a confused jumble of hills running from heights of over 8,000 feet to valleys as low as 1,000 feet. The hillsides have sharp ridges and are very steep and thickly covered with bamboo or small tree jungle, which can only be penetrated by cutting. In the valleys run rivers and streams which, though generally fordable in the dry season, present very serious obstacles during the rains. The crossing of the River Salween is always a major problem and is often impossible after heavy rains. The river varies in width from 300 to 1,200 feet and in speed from 4 to 10 m.p.h. according to the place and the season of the year; it mostly flows in a deep and very steep valley, which makes the approaches to it exceedingly difficult.

The boats at the ferries consist of hollowed out tree-trunks and the villagers propel them with bamboo paddles, while the ropes for warping or mooring them are made from creepers. For transporting animals a raft is formed by joining two of these dug-outs with a bamboo platform, the decking being of *waggat*. This consists of giant, or elephant, bamboos as they are called, split with a *dah*, opened up, laid flat and interlaced like basketwork to form a mat. All the hill tribes are wonderful workers with a *dah*, and, given some bamboo, they are capable of making anything from a house down to a knitting needle.

Over the smaller streams temporary bridges are often made to last during the dry season, but are swept away when the floods start in the rains. One of the photographs shows such a bridge built over a river 120 feet wide and flowing at 5 m.p.h. This bridge took 46 villagers a month to build and, except for the anchorages, nothing besides bamboo was used in its construction. The *waggat* decking rested on bamboo road-bearers, placed touching each other, which were supported on nine large bundles of bamboos acting as floating piers. The bridge was anchored to five ropes made of plaited bamboo fibre stretched across the gap, two of them over ten inches in circumference. The construction of these ropes took most of the time and a large proportion of the bamboos used. This bridge could just take a continuous line of loaded mules in single file. As many as 2,713 large bamboos were used in its construction. A prominent feature of any native work of art such as this, is the number of bamboo streamers and baskets of offerings to the *Nats*, which are placed on or near the work.

The only communication in this country is by footpaths between villages. These are sometimes only a couple of feet in width and are cut through the jungle, which often overhangs the track completely. The track normally runs along the tops of ridges, but is sometimes perched precariously on the edge of a hillside and is liable to be swept away by landslides after rain. The gradients have to be seen to be believed, and ascents and descents of 2,000 feet or more are common. On a normal march they often average 1/10, with long stretches at 1/5 and occasional slopes at 1/3 or worse. The favourite exhortation amongst the British officers on one reconnaissance was "Laugh that one off," gasped out by the man with the most breath left after topping such a rise and finding the hillside still leading, as it seemed, vertically upward to heaven in front of them. In dry weather the track surface, which is generally of red laterite, is easy to march on, but after rain it becomes very slippery and, on the steep slopes, men sink ankle deep and mules flounder hock deep in the clay. This makes even a march of 8 miles or so very exhausting, although after a couple of days' sun there is again an ideal surface for walking.

The only form of transport used is that of small local-bred mules with Chinese saddles. A saddle is shown in one of the photographs; it consists of two wooden boards shaped to the mule's back and separated from it only by two flaps of stuffed canvas, which very seldom exceed 1/2" in thickness. On to the saddle fits a four-legged wooden frame to which the loads are strapped by means of cowhide thongs. These thongs are very precious to the muleteers and ferocious arguments ensue when the Chinese, yelling Yunnanese, accuse one's bearers, roaring Tamil, of cutting or damaging their thongs. In these cases an interpreter rarely achieves anything, and the best way to settle the matter is for the officer to shout loudly in English at both parties impartially. These thongs are 30 feet in length. The Chinese muleteer has his own peculiar method of strapping on the loads. He strongly resents anyone trying to help him and will at once untie and retie any load fastened by an outsider, however well it may have been done. The loads are strapped on to the frame when the latter is on the ground. When each side has been tied, the muleteer lifts the frame by the centre of the arch to ensure that the whole balances. The balance of the loads is adjusted by moving them higher or lower on the frame, and the fine adjustment consists of a piece of stick or a stone added to the lighter side. This tying of loads is a distinct art and, while an experienced muleteer will nearly always get the balance right first time, a learner may spend a quarter of an hour or so fiddling with one frame. When the frame balances it is ready for loading, and this is done by two men lifting it over the mule's head to fit it snugly into the saddle.

These mules seem tiny on first acquaintance as they average only about 12 hands, but they are most entertaining and well-trained animals. They carry only 120 lb. of load and it is a strict rule that the weight of any one box or bundle should not exceed 60 lb. They are not by any means over-burdened with kindness and this perhaps may partly be accounted for by the fact that each muleteer is responsible for five mules. At first sight their saddle and crupper sores make anyone accustomed to military animal management feel quite sick. These sores are deliberately kept open throughout the march and any scabs that may form are picked off daily. The raw patches are only given a chance to heal properly at the end of the march, if the mule can then be spared from work and given a well-earned rest. The mules are roughly cold-shod in the field and are generally shod in front only. The shoes are of local production, but properly manufactured nails are used.

A day in the life of a mule on column is a hard one. It starts at dawn when he is with the remainder of the herd resting or feeding loose in the jungle. He is roused by wild shrieks from the muleteers, half of whom go out to find and round up the mules, while the others are strapping the loads on to the frames. Reluctantly he obeys the summons and wanders back into camp, where he gets a handful of paddy, his only ration for the day. The muleteer then spits on his hand, casually smooths down the mule's back once only, however dirty or wet it may be, and slips on the saddle. He then puts on a muzzle to stop the mule grazing along the wayside, and with the spare end of it ties him up to his own loaded frame. The saddle has no girth and is kept in place only by primitive crupper and breast straps. This is done so that, if the mule falls, the saddle and loads come off and the mule can get up by himself.

When all the mules are saddled and duly tied to their frames the column is ready. To start the march the loads are first put on the "leader" mules. These are better trained than the others and are distinguished by coloured head collars and a string of bells round their shoulders. They walk quietly off following the guide who beats a small gong the whole time the column is on the move. As quickly as possible the other mules are then loaded, and, with a smack on the rump, they are off after the leaders. The mules wander along with no man to lead them and encouraged only by occasional yells and cat-calls from the muleteers, who space themselves out about every fifth mule along the column. It is obvious that any halt is inadvisable as the mules would then get bunched up and start wandering off into the jungle. For this reason, whenever it is tactically possible, the mule convoys go straight through from camp to camp without any halt. They do not move fast and are slowed down considerably if steep slopes are encountered; 2 m.p.h. is a fair average for their rate of march. Military columns average only about 10 miles per day, but Chinese merchandise convoys are accustomed to do nearly twice this distance.

At the destination confusion almost invariably ensues. As the mules arrive they are shooed off as much as possible to the area of the camp where their loads will be required. Here they are unloaded, unsaddled and unmuzzled as quickly as possible before they stray away with their loads. The ensuing jumble is straightened out after the whole convoy has been unsaddled. As soon as he is free each mule has a thoroughly good roll in the nearest open space. He then makes off into the jungle where he spends the rest of the day and the night roaming, eating and resting until roused again for the next day's march.

In hostile country, when there is a danger of the mules being stolen, they have to be collected at dusk and tethered inside the perimeter. This method makes for ease in getting away for an early start next day, but has the great disadvantage that the mules do not then have time to feed themselves upon the jungle, and paddy or some form of grain has to be carried for them. It is their ability to feed on the jungle that makes the Chinese mule the only means of transport in this country, where columns have to be away from their base for long periods. Besides the fact that the usual large army mule is not as tractable or as sure-footed on these jungle paths as his Chinese prototype, a simple illustration will show the disadvantage of using him. On a ten days' column one Chinese mule will carry 120 lb. The army mule will carry 160 lb., but at the same time a second mule is necessary to carry the forage for the two of them, assuming an 8 lb. a day feed. This increase in the number of mules gets worse and worse the longer the column has to stay out.

The Chinese mules are wonderfully sure-footed and will face practically anything. They will scramble down a very steep and rocky river-bank, jump on to a frail-looking bamboo platform between two dug-outs, and then stand still all the way across the river, even though there are no handrails on the raft. Many of the bridges over minor streams consist only of two logs side by side with their tops planed off, but the mules never hesitate to cross over these, even if there is a deep drop below the logs. They are very obedient and many of them respond readily just to verbal commands.

On one reconnaissance the two "leader" mules were the pride of the local *myosa* (headman). These were two light duns and they wore the usual elaborate-coloured cloth head-collars with sets of bells. They would come to their muleteer's call as readily as a well-trained dog, and gave a clever performance every day on arriving at the new camp site. As soon as their loads were taken off, instead of dismissing at once like the other mules, they would solemnly parade round the camp perimeter in single file proudly tossing their heads. They would continue this until all the mules, answering the call of their bells, had come up, been unloaded and had wandered off again. Not until then would the muleteer call them into the middle of the camp, where they would stand stock-still side by side. The removal of their head-collars was their signal of dismissal and they would immediately trot off, roll and go and join their companions.

The muleteers are nearly always Chinese. They are a most cheerful crowd and are prepared to laugh or smile at any time, but it is a heart-breaking task trying to instil any discipline into them. It was found that to have any reasonable prospect of getting on the march by 7 a.m. they had to be roused promptly by 3 a.m. Even so, on the first really wet morning of one column, everybody was waiting to start at 7 a.m. except the Chinamen who, despite their early rise and a constant stream of encouragement and abuse from all ranks, were not ready until 9 a.m. They then solemnly pronounced that they had had no breakfast and that they were not going to move until they had eaten. No amount of threats, even of violence, would move them and the column had to wait with ever-growing anger until 10 a.m., when the muleteers consented to start. In the end they were probably the losers over this insubordination, as the reply was to allot them no hut or tent on rainy nights so that they were sufficiently miserable in the morning to want to move early. This could not really have affected them greatly as they are all confirmed opium-smokers and are more or less unconscious from dusk to dawn. It was soon obvious that all orders had to be given before dark, because any order given once the smoking had begun passed into oblivion with their other dreams. Beyond the

Salween the ban on opium-growing is not yet enforced and opium could be bought there for just one hundredth of its Rangoon price; a great temptation to law-abiding officers who should be above cheating the customs!

From these random notes it should be clear that the conditions in this part of the world require to be dealt with in their own peculiar manner. A student of military text-books would be very shocked at the way a force moves and fights in these jungles, until he learnt that their methods are condoned in a small unofficial publication entitled *Jungle Warfare*. This book is produced by the B.M.P., who from long experience of columns in this type of country have become the recognized experts. It details the methods of movement and fighting which have been proved to be the most satisfactory. Owing to differences in establishment, equipment and training, this book may not apply to the army in all its minor details, but its main principles have been adopted by all forces and are in daily use by the escort now out with the Boundary Commission.

SOME PRINCIPLES OF PROTECTION IN AIR RAIDS.

By Colonel W. Garforth, D.S.O., M.C.
(*Air Raid Precautions Department, Home Office.*)

1.—The Air Raid Precautions Department.

The Air Raid Precautions Department is a civil department and is part of the Home Office. For many years the problems connected with the protection of the civil population against gas were considered by sub-committees of the Committee of Imperial Defence: but the whole matter was treated as secret. In May, 1935, the Air Raid Precautions Department was formed and took its place as part of the Home Office.

The activities of the Department extend in many directions and these include the passive protection of the entire civil population.

An air raid precautions organization is being built up by local authorities. The Department is also in touch with factories throughout the country, and the managements of these organizations and of large business premises are being asked to prepare their own air raid precautions schemes so far as they are able. For this purpose lectures on the principles of protection in air raids are being given to factories, business organizations and chambers of commerce.

2.—Air Bombardment of the Future.

The air bombardment of the future would be very different from anything of a similar nature which took place in the last war. To illustrate this, it may be mentioned that the speed of modern bombing aeroplanes varies from 180 to 300 miles an hour. Also the weight of bombs which could be dropped in this country in one day in the next war might bear little relation to the amounts dropped in the last war.

Great advances have been made in the design of aeroplanes, instruments and the technique of bombing, and all these considerations make it imperative that attention should be paid to the question of protection against air raids.

3.—Bombs and Protection.

Before going into details of what a modern air bombardment will be like, one or two remarks regarding bombs may be of interest.

Bombs do not strike the ground at right angles. In other words, the angle of arrival is inclined to the vertical. This inclination in the case of bombs dropped from, say, 16,000 ft. is 16° and from 2,000 ft. is 38°. The height at which bombs can be released may vary, from 20,000 ft. and over, down to 1,000 ft. and under.

In an air bombardment three kinds of bombs can be used—the incendiary bomb, the gas bomb, and the high-explosive bomb. Each will be dealt with in turn.

The Incendiary Bomb.

The incendiary bomb may vary in weight from 1 kilo (*i.e.*, 2 lb. 3 oz.) up to 60 lb. It is expected that the light kilo bomb will be more freely used than those of greater weight.

Experiments to determine the penetrative powers of the kilo bomb are now being undertaken, but it is known that this bomb will penetrate all forms of light roof, such as tiles, corrugated iron, slate, fibrous-cement sheeting, glass, ruberoid, etc. Its penetration will, however, probably be arrested by the top floor of the building. Here the bomb would continue to burn for about ten minutes and would set on fire any inflammable materials in the vicinity, such as furniture, bedding, curtains, etc. A reinforced-concrete roof, 4 in. to 6 in. thick, would probably, however, resist penetration by the kilo bomb, in which case the bomb would ignite on the surface of the concrete and then burn itself out.

As the bomb generates its own oxygen, it is not easily extinguished and experiments are now being carried out to determine the best way of dealing with it. The cheapest and most readily available form of protection is to clear the attic or upper rooms of all inflammable material and to cover the floor with fine dry earth about 2 in. thick. A greater quantity of material affords even more adequate protection, but it should be borne in mind that attic floors might not be strong enough to carry more than 2 in. of this material. Similarly sheet-iron (about 18 gauge) or $\frac{3}{8}$-in. asbestos boarding (free from cement) can be used in place of the dry earth.

Although an incendiary bomb cannot be actually extinguished by sand, something may be done to control it by applying about 30 lb. of this material with a long-handled shovel. By this action the glare is reduced and the spread of the fire will be limited. Flames, however, will come out of the top of the sand. Chemical extinguishers, water, etc., can be used to limit the spread of fire. The water or chemical extinguisher should not be applied to the bomb itself but should be used to keep the surrounding woodwork wet. If the bomb has been partially controlled with earth, it can be picked up with a shovel and put in a bucket or other suitable container which already contains 2 in. or 3 in. of dry earth or sand. Further earth or sand should then be poured in the bucket before removing it from the building. In order to enable a person to approach the burning bomb, non-inflammable dark glasses are essential.

Gas Bombs or Spray.

The weight of a gas bomb will vary from a few pounds up to 250 lb. and even more. The container weighs less than half of the total weight of the bomb.

Air Raid Precautions Handbook No. 1 (*Personal Protection Against Gas*), which can shortly be obtained from H.M. Stationery Office, contains much information regarding gases which will be used in war. It is not necessary here to do more than mention that there are two main types of poison gas which might be used, namely :

(1) Persistent ;
(2) Non-persistent.

Persistent gases usually consist of liquids (*e.g.*, mustard gas) which contaminate the area on which they are released and may continue to give off vapour for hours, days or even weeks if not neutralized.

Non-persistent gases, when released, rapidly mix with the atmosphere and disperse quickly.

As regards respirators there are three types : the Service respirator, the Civilian Duty respirator and the General Civilian respirator.

The Service respirator, which is the type used by the Defence Services, will be used by those who must enter and remain in heavy concentrations of gas, such as policemen, firemen and members of decontamination squads.

The Civilian Duty respirator is intended to afford protection to persons who have to carry on their normal duties in the presence of poison gas, but who are not likely to be exposed to such high concentrations as the Defence Services, police, etc.

The General Civilian respirator is intended for use by members of the general public.

All the above respirators are designed to protect the wearer's eyes, face and lungs from any known poison gas which may be used in warfare.

High-explosive Bombs.

High-explosive bombs carried by aircraft weigh anything up to 3,000 lb. each. A bombing aeroplane can carry from two to three tons of bombs. Owing to the great expense of the heavier type of bombs, such as those weighing 1,000 lb. and over, it is unlikely that these will be used except against special targets such as arsenals, dockyards, railways, etc. Those weighing under 1,000 lb. will, however, be quite common and the effect of these bombs may be classified under two heads, namely, fragmentation and blast.

Fragmentation is the breaking up of the shell of the bomb into small pieces, which inflict damage to material and personnel in the vicinity.

Blast is the sudden creation of high air pressure designed to shatter buildings, machinery, etc., which may be exposed to it. The effect of blast dissipates rapidly, but in the case of heavy high-explosive bombs bursting, say, less than 50 ft. away from a building, the effects of blast may be considerable. Most buildings would probably suffer severely.

High-explosive bombs may be of two kinds :—(i) those intended to explode on contact with a hard surface, in which case they are fitted with percussion fuses, and (ii) those intended to penetrate deeply into the ground or into a building, in which case the bomb is specially strengthened and fitted with a semi-armour-piercing nose.

A 500-lb. bomb fitted with a percussion fuse, when falling on a large, multi-storied building, would detonate on the roof, or certainly on the top floor, bringing down a considerable part of the building with it. Medium and heavy bombs fitted with a semi-armour-piercing nose would penetrate right through such a building down to the basement before detonating, when a great deal of damage would be done.

Protection from high-explosive bombs fitted with percussion fuses would be afforded by highly-reinforced concrete about 5 ft. in thickness, but the semi-armour-piercing bomb must also be considered.

Protection from 500-lb. high-explosive bombs fitted with semi-armour-piercing noses can only be secured by constructing shelters at considerable depths below ground level, say, 50 ft. to 70 ft., or by protecting the shelter or basement by an independent mass of concrete, highly reinforced, from 12 ft. to 15 ft. thick. As both these forms of protection are very costly, it will, as a rule, not be possible to provide protection against direct hits of medium and heavy semi-armour-piercing high-explosive bombs. In exceptional cases, however, such as vaults for banks or other special buildings, such protection may not be out of the question.

Efficient protection can, nevertheless, be provided against the effects of blast and splinters from the explosion of high-explosive bombs. Good protection can be afforded in cellars or basements or specially constructed underground shelters. In the absence of this form of protection, shelter can be obtained on any floor of a building provided the shelter is made gas-tight. And, in the case of ground floors, sandbag walls (or sand or earth between shuttering) across the window and door openings can be provided to prevent the ingress of splinters.

Thickness of Materials to Resist Penetration.

The following thicknesses of various materials will resist penetration by splinters from a 500-lb. bomb exploded at a distance not nearer than 50 ft. away from the materials named :—mild steel plate—1½ in. (special steels may give increased resistance) ; stock bricks in cement mortar—13½ in. solid and 15½ in. hollow (with 2-in.

cavity) ; ordinary concrete not weaker than 6 : 1 mixture—1 ft. 3 in. ; reinforced concrete—12 in. (normal structural reinforcement) ; reinforced concrete—10 in. (specially reinforced to resist the punching shear effect of the splinters) ; sand or earth—2 ft. 6 in. ; shingle or ballast—2 ft. ; shingle contained between steel plates, front plate $\frac{1}{4}$-in. thick, back plate $\frac{1}{2}$-in. thick—10 in. ; coal (lump or dust)—2 ft. 6 in. ; brickbats—2 ft.

Trenches.

If suitable protection for personnel cannot be found in a building, excellent protection can be obtained in shelter trenches 7 ft. deep with passageways 2 ft. wide. Recesses suitable for the accommodation of, say, ten men seated, are cut off these passageways. The trenches should, of course, be revetted. Various forms of revetment can be used, such as boarding, corrugated iron, or other suitable materials. The trench can be made gas-proof by covering it with 2 ft. of earth supported on corrugated iron. If rubble is available, a layer of 9 in. of this material should be placed on top of the earth. Where revetment is used, the excavated width of the passageway should be 2 ft. 10 in.

An air lock should be provided in the passageway at each entrance. This may take the form of two gas curtains, 4 ft. apart, with a shelf at the side of the trench on which the curtains are placed when not in use.

A diagram of a trench system for accommodating several hundred people, together with notes on the construction of the trenches, can be obtained from the Air Raid Precautions Department.

Similarly, notes on the construction of mined galleries are supplied by the Department.

Shelters and Gas-tight Rooms.

Information regarding the making of a room gas-tight is given in the *Handbook for Factories* which will shortly be on sale at H.M. Stationery Office.

The same principles apply to making large basements, etc., gas-tight.

As regards shelters in general, certain points should be borne in mind. These include a supply of water independent of the normal water-supply mains which may, of course, be damaged ; an independent lighting system, sanitary arrangements, a supply of food and self-contained wireless.

Further notes on this subject can be obtained by application to the Department.

As regards the selection of cellars or basements as shelters, it is most important to bear in mind the possibility of flooding. In the case of cities where high-pressure mains (which may be damaged by high-explosive bombs) exist close to cellars or basements, this danger of flooding is very real, and unless it is quite certain that there is no possibility of flooding in this way, cellars or basements should be avoided as shelters. This is a point which may easily be overlooked and which demands special attention.

In the case of newly-constructed shelters, the ceiling should be designed to carry the weight of debris resulting from the demolition by high-explosive bombs of, say, part of the building above it. For this purpose it is estimated that the floor should be strong enough to carry a superincumbent weight of 4 cwt. per foot super. The unsupported span of floors over the shelter (which form the roof of the shelter) should not exceed 15 ft. to 20 ft.

Windows.

The blast effect on windows of bombs exploding about 100 ft. away from a building is considerable. Ordinary glass panes will be broken into pieces which will be projected with high velocity into the building. This may cause serious damage to personnel. If, however, the following precautions are taken this danger can be prevented. The existing glass panes should have cellophane (as used for wrapping packets of cigarettes, etc.) or celluloid, 1/64 in. thick, cemented (by a cement varnish such as Necol varnish) to their inner surfaces. Glass treated in this way will be blown into the building but will not break up into pieces. If the panes of glass are in addition closely supported by ½-in. wire-netting (the smaller the mesh the better) or other suitable foundation on the inside, they will not be blown into the building. This netting must be securely fixed to the frame of the window. Glass reinforced internally with wire-netting offers considerable resistance to the effects of blast, although small fragments of glass may be projected from it which under certain conditions might be dangerous.

Vitreo-Colloid or other similar material offers considerable advantages as compared with glass in resistance of blast pressure. If a window to resist blast is required, Vitreo-Colloid in place of the glass, closely supported by wire-netting or other suitable foundation, should be used. Such window panes will probably remain in position intact.

If Vitreo-Colloid is used, as suggested above, it is essential to ensure that the window frame is rigidly supported as it will have to withstand considerable pressure from the blast.

Steel or wooden shutters fixed to the outside of the window serve no purpose, as the pressure pulse due to blast passes through such shutters and will break ordinary glass window panes as described above.

With ordinary glass panes, a steel shutter 3/16 in. thick fixed on the inner side of a window frame would stand up to blast and prevent glass splinters being thrown about the room. A wooden shutter to serve the same purpose would have to be 4 in. to 6 in. in thickness. Neither steel nor wooden shutters are, however, recommended for this purpose.

In view of the above, therefore, windows should be treated in one of the following ways:

(*a*) Vitreo-Colloid closely supported by wire-netting in place of the ordinary glass panes.

(*b*) Existing glass panes with cellophane or celluloid (1/64 in. thick) cemented on the inside should be closely supported with wire-netting firmly fixed to the window frame.

(*c*) The panes of glass should be internally reinforced, that is, glass made with wire-netting inside it.

The above are in order of merit.

Dispersion.

In cases where it is not possible to find protection in buildings or specially-designed shelters, and where open ground is not available for trenches, the operatives of large factories and business premises may be dispersed to their homes. This, however, must be done within the warning period.

4.—Warning of Raid.

The country has been divided into areas and when the raiders reach a certain distance from any particular area, that area is warned. With the great speed at which modern aircraft travel it will be unwise to count on receiving more than 7 to 10 minutes' warning.

5.—Protection of Material.

Buildings such as power-houses, first-aid posts, hospitals, telephone exchanges, and other buildings of vital importance, will require special protection. This may be given in the form of sandbag walling across doors and windows and, in some cases, along the walls, etc.

In the case of large factory buildings, the question of protection of machinery has been considered. Sandbag traverses or traverses consisting of other materials such as bricks, shingle, etc., can be constructed for this purpose. Steel netting has even been suggested as a means of protection against splinters, but experiments have shown that this method of protection is unsatisfactory and is also very costly.

6.—Lighting Arrangements.

All buildings should be provided with means of preventing lights being seen from the outside. This may be effected, of course, by means of carefully fitting blinds.

7.—CAMOUFLAGE.

The object of camouflage is to conceal from the enemy air-observer, certain buildings, gasometers, oil tanks, railway stations, etc., the approximate or actual locality of which may already be known to him from information collected by agents, aerial photographs or other means.

In order to make it difficult for the pilot to recognize and select his particular objective it may be necessary to camouflage other objects in its close proximity.

If possible, it is worth while flying over the object at the minimum height at which the enemy is expected, in order to make a special note of the features which betray its position both as regards outline and colour, its proximity to any obvious landmarks and the tone and nature of its surroundings. At the same time, it is most important that an air photograph of the object and its surroundings should be taken, before the camoufleur has done his work. From the data thus obtained, certain problems will present themselves. They will vary with each object. It may be that a smooth surface must be eliminated (such as the top of a gasometer) or a long shadow concealed, or a smoking chimney or railway station hidden, or any combination of such problems. A comparison of air photographs, taken after camouflage has been erected, with those taken previously will show whether the work has been effective.

The camoufleur will have recourse to certain stratagems to attain his ends. Seasons of the year are very important as affecting colour, and should be noted. It is vital to make the camouflage appear natural, and this can be tested by criticisms from airmen after the camoufleur has completed his work. It may here be mentioned that camouflage should only be carried out by experts. It is not work which amateurs can, with success, execute.

Disruptive painting is often used to break the surface outline of an object. The basic idea in this type of painting is to treat the outer edges of an object with the paint which approximates in colour and tone to its surroundings, while coating the central surface with paints of contrasting colour in fantastic designs. Generally speaking, the colours used should be those found in the neighbourhood of the object, and usually three, or four at the most, different colours should suffice. The pattern selected should be large and simple rather than small and complicated, since from the air a number of small patterns will all fuse into one neutral tone. The colour suitable for painting an object in one area may differ considerably for another object in a different area.

If a large smooth surface has to be treated, efficacy of paint alone may confer inadequate camouflage. It may well be necessary to render the surface uneven by dummy erections of wood and painted canvas. If a flat-roofed building is situated within a grass park or near one, it might be worth considering the actual sowing of grass on top of the roof.

As vertical surfaces are often in the shade, they would require to be painted in a lighter colour than horizontal surfaces which reflect light. The elimination of shadow is a particularly difficult problem to deal with, increasing in difficulty with the size of the shadow. It can sometimes be obliterated by erecting a lean-to surface from the top of the object which casts the shadow to the ground, so that the angle which this lean-to surface makes with the horizontal is less than that made by the sun's rays and the horizontal at its lowest declination. The movement of the shadow must, of course, be taken into account.

General Remarks.

Conspicuous roof coverings should be avoided. Dark green asbestos slates are very suitable for roofs and, if the area is not large, it may be possible in some cases to erect over small tanks pitched roofs, covered with roofing material similar to that of the surrounding buildings.

Everything should be done to avoid contrasts of colour (except in disruptive painting) and, if possible, buildings should be toned-in with the landscape and the ground.

By judicious planting of trees it may be possible to break up shadows, etc., but the objection to this is, of course, that trees would take some time to grow.

Oil Tanks and Gasometers.

As oil tanks and gasometers are particularly difficult to conceal, a few special suggestions regarding these may be of interest.

The camoufleur must decide *either* so to paint the oil tank that by exactly copying and continuing local features and colours on the tank itself it ceases to be recognizable as a separate feature in the landscape, *or* to accept the fact that it cannot (owing to its surroundings) be made to disappear, and to paint it in disruptive patterns so that although it can still be recognized as a separate feature, yet it will not be recognized as an oil tank.

If streets and roads run right up to the oil tank, and it is surrounded by houses, probably the first method will be effective ; but if the tank is isolated in its surroundings, disruptive pattern painting will probably be more efficacious.

In the first method, the lines of the roads in the immediate vicinity are continued, in the same direction and in an exactly similar coloured paint, over the sides and roof of the tank, and the rest of the tank painted in colours and shapes exactly similar to those of the surrounding houses.

In the second method, the three or four predominating colours of the neighbourhood are used and applied to the roof and sides of the tank in large fantastic designs with the object of breaking the outline of the tank; a black line of demarcation some six inches wide applied along the junction of two colours sometimes increases the disruptive effect of the pattern.

Special Cases.

When it becomes impossible to conceal a certain object which is in itself a give-away, such as a prominent smoking chimney, the only alternative may be the erection of several dummy, but similar, objects in its neighbourhood, so as to deceive the enemy as to the location of the real object.

Large Areas.

In the Great War, the Germans resorted to overhead coverings constructed of steel or wooden uprights with wooden roofing, which in some cases extended over many acres. These coverings were erected over military sidings, dumps, etc. On the roofing were painted fields, roads, railways, trees, etc., so that an area of great activity could be completely concealed. This type of camouflage is described in Solomon J. Solomon's book *Strategic Camouflage*, and it may be worth consideration in very special cases, although its application would, of course, be costly.

8.—SMOKE.

The question of smoke is receiving careful consideration by the Department. If a smoke cloud is formed to conceal a target, it should cover roughly nine times the area of the target in question.

Although smoke clouds to cover targets of any considerable area are, therefore, costly to maintain, the matter is receiving careful investigation as it is considered that, in certain cases, smoke will be useful in making it more difficult for the enemy to recognize and pick out his target.

9.—BOOKS BEING PREPARED BY THE AIR RAID PRECAUTIONS DEPARTMENT.

Books and memoranda on the subject of Air Raid Precautions have been, or are being, prepared by the Department.

A.R.P. Handbook No. 1 (*Personal Protection against Gas*) and *Handbook No.* 2 (*First Aid for Air Raid Casualties*) can be obtained from H.M. Stationery Office.

A.R.P. Handbook No. 6 (*Factories*) will be available shortly from H.M. Stationery Office. This book explains how the managers of factories and large business premises can prepare their own air raid precaution schemes.

A very important book, namely *Handbook No.* 5 (*Structural Precautions against Bombs and Gas*) is now under preparation. This book will be of a technical nature and will afford detailed guidance to architects, engineers, local authorities and others on certain of the matters referred to in these notes, *e.g.*, the construction and adaptation of shelters and the protection of buildings of different kinds.

Such structural precautions may include a concrete roof to keep out light incendiary bombs, the use of fire-resisting materials in building, the roofs of shelters to be strong enough to take the weight of falling debris, *i.e.*, calculated to stand a weight of 4 cwt. per foot super, framed structures (steel or reinforced concrete) preferable to the old solid type of structure and the use of non-absorbent building materials where there is danger of contamination by liquid gas.

10.—The Preparation of Air Raid Precautions Schemes.

All managers of factories and business premises employing over, say, 100 operatives, are urged to prepare their own air raid precautions schemes.

Notes giving the suggested headings for such schemes are obtainable from the Department.

Beyond the preparation of a carefully thought-out paper scheme, which can be readily put into operation without delay should an emergency arise, no further action is now suggested. Arrangements should, however, be made for the supply, without delay, of the necessary materials, tools, sandbags, earth, etc., if and when required.

While it is hoped that the necessity for putting such a scheme into operation will never occur, it is incumbent on all in authority to prepare one.

The preparation of an air raid precaution scheme does not mean the inevitability of an air raid, any more than the taking out of a fire insurance means the inevitability of a fire.

Furthermore, it is hoped that architects will give the question of structural precautions their careful thought and consideration, as the safety of many thousands of their countrymen may depend on their labours in this direction.

11.—Assistance of the Air Raid Precautions Department.

Finally, it may be stated that the Air Raid Precautions Department is always at the disposal of anybody who may require its advice and assistance.

RAILWAY SURVEY IN TANGANYIKA TERRITORY.

By CAPTAIN C. E. M. HERBERT, R.E.

THERE was an inclination to disguise this article and call it " Kupima Majanini ; an African Interest " or something like that which might sound worth reading. But half of it is technical and honesty has rightly won with a more prosaic title. The other is disappointing in English and means " Surveying in the Grass " ; all the same, it is an accurate description of the work in many parts of the Territory.

A number of excellent articles on surveys of different kinds in tropical Africa have appeared in *The R.E. Journal* from time to time recently ; the main purpose in giving this account is to describe some features of the method employed by Tanganyika Railways on their preliminary surveys. Regarding that portion which deals with the use of tacheometry, there is probably little that is novel to those accustomed to this method ; but it may be of interest to anyone who has not had the opportunity to appreciate fully the merits of this way of working—principally speed and flexibility to suit the class of survey and degree of accuracy required.

It is felt too that a brief record might be made of the employment together of three Sapper officers under Tanganyika Railways, and it is next to impossible to keep out some rather random references to various experiences and impressions during a very fascinating time.

The party consisted at first of Captain D. M. J. Murray, R.E., Lieutenant C. G. B. Greaves, R.E., and Lieutenant C. E. M. Herbert, R.E. The party leader, Major L. E. Silcox, D.S.O., was unable to join until about six months after the work had begun, until which time the Sappers carried on quite successfully and found plenty of interest in having to tackle their problems. But it must here be said that the value of the job to the Sappers was immensely increased by having Major Silcox, a railway engineer with wide experience in different parts of the world, as leader. Railway location is equally an art and a science, and practice is the one way to learn it properly. His experience later became essential and his presence enabled the work to be finished much more quickly than it otherwise could have been done.

Herbert arrived in Dar-es-Salaam in August, 1930, after a short visit to South Africa and having already learnt a bit about African roads and mud in Portuguese East.

At this time a Commission in the Territory was deciding on future railway construction policy, following on a report by Brigadier-General Hammond, and the General Manager, Chief Engineer and other senior officials were away from the capital.

Instructions arrived shortly for equipment and stores for a tacheometric survey party to be collected and the next few days were quite full. Invaluable help was received from a Scots District Engineer just back from leave and waiting a few days in Dar-es-Salaam before returning to work. Food and so on was bought and servants engaged. Meanwhile, the General Manager, Colonel G. A. P. Maxwell, C.M.G., D.S.O., M.V.O., M.C., and Mr. Gillman, the Chief Engineer, had returned, and an extremely kind interest was shown by both in the forthcoming welfare of the party. One felt most fortunate in having a Sapper, taking a personal interest, as G.M.; and an evening was spent by Mr. Gillman in explaining the way in which the work was to be conducted. An outline of the method adopted by him is described later in this article and is an outcome of many years on survey in East Africa.

He had arranged that a start should be made by surveying an area near Dodoma, about 300 miles inland on the Central line. Dodoma is a small township, complete with railway district engineer, and this little beginning enabled the party to get accustomed to conditions, learn some Swahili (of a sort) and generally feel at home before starting in more remote parts on the principal job for which it had come out.

Herbert left for Dodoma about a fortnight after arrival in the Territory and he found collected around him almost immediately, firstly, Ali Mahomed, an Arab-Swahili Permanent Way Inspector with a knowledge of about 50 words each of most languages in the globe, and an amazing verbosity; next, 80 Wanyamwezi, very excellent natives recruited from a district (Tabora) 250 miles farther inland, to act as survey boys, bush-cutters and, later, carriers, lastly, Fowlds, the only other European to be with the party and who stayed throughout nearly the whole of the work, was engaged locally to act as lorry-driver and general non-technical assistant.

The work consisted simply of the mapping of a catchment area of several square miles feeding a normally dry watercourse which had recently become badly silted as a result of soil erosion. On account of this silting there had been wash-aways on the railway. This soil erosion in native-inhabited areas is a common evil in many parts of East Africa and is due to the effects of the weather on ground which has been over-grazed (the goat being probably the worst offender) and carelessly cultivated. The useful surface soil gets carried away, leaving the ground unsuitable for man or beast, with the result that the natives, who are thereby chiefly affected, leave this ground and move on to other land, which, in turn, becomes destroyed in the same way. Space does not permit to enlarge on the various consequences of this improvidence; even the war on tsetse is indirectly concerned.

The only problem in the job to be done was to locate the divide, by no means pronounced, in country which was covered with close thorn scrub, except where patches had been cleared for cultivation. This meant quite a lot of walking about ahead of the surveyed area to select new traverse lines to cut, until by great good fortune a lift in a Survey Department aëroplane became available. The pilot had been taking air photographs of Dodoma township and as soon as his presence was known, he was asked to provide a fly-round. In a few minutes as much was seen as would have resulted from several days of walking.

Murray and Greaves arrived a month after work had started and the camp began to look more impressive.

The first local event of any importance occurred a day or so later. A remark had been made that the natives in that part, Wagogo by name, seemed a pretty poor lot. This was shortly challenged. Circumcision and initiation ceremonies for the youths had been proceeding and the finale provided an excuse for the rest of the village to have a big non-teetotal party and dance. It started one afternoon and continued without a break until the morning of the second day afterwards. A few got a little tired and rested, but most seemed anxious not to miss a moment.

There is little more to be recorded of happenings at Dodoma other than some few first experiences, and the work was quite quickly finished. At the beginning things went a bit slowly, as the quickest way of getting a staff boy to put his staff where wanted was to go there with him, but under such conditions and with a dictionary in the pocket, it is surprising how soon enough words are picked up. It is pleasant to work in a country where delays from landowners are almost non-existent, but even at Dodoma one was encountered early on in the form of a very fine old Arab who owned a large vegetable garden surrounded by a spiky hedge of giant spurge. He was fearfully suspicious of the goings-on and hung around with his son to see that no attempt was made on the probably impossible task of cutting through the hedge. However, a lot of smiles and honest-looking expressions appeared eventually to resolve his misgivings.

Near his *shamba* (plantation) was the only water-supply, rich in colour and consistency. One cared for the look of it as little as apparently had a number of large frogs which were floating dead on the surface. Happily other arrangements were quite easily made, by getting engines to supply water from their tenders into cement drums placed alongside the line. Probably the water was no worse than what was often drunk later after the inevitable boiling and filtering, but it looked rather beastly to a novice at bush life.

The first event of excitement and one which made the whole party feel quite "African," was sitting up for and getting a lioness (the less valiant lion made off) one Sunday night only a week after the arrival of the second two officers.

Mention may here be made of the allocation of odd jobs which was decided upon at Dodoma. The temporary party leader ran the Imprest. On big pay-days this involved the counting out of some thousands of shillings, paper money being distrusted. This was always troublesome, but the first pay-day was ludicrous. When pay was complete all the boys started returning with their handfuls of shillings, bar one or two extracted, so that their money might be placed in safe custody.

Another member became official correspondent and party doctor and proved so popular in the latter capacity that at first about twenty per cent. of the strength would attend evening sick parade. Later on, after some pretty use of Epsom Salts and iodine, the attendance became more normal, but cough mixture and permanganate gargle always continued to be strong favourites. Very little surgery was solicited.

The third combination of jobs was mess secretary and quartermaster which included provision of the boys' rations, consisting of mealie meal or rice, beans and salt, with meat as opportunity offered, *i.e.*, by purchase or shooting. This job made for about as intimate contact with the boys as anything could have done, and various important reasons were produced as to why the Government ration should be increased. On one occasion a headman sadly said that men were falling from hunger on the work, but the most casual glance at their girths did not support this statement.

At the beginning of October the camp at Dodoma was broken up. Herbert accompanied by Fowlds returned to Dar-es-Salaam for three days to collect a Ford 1-ton lorry and some more stores, while Murray and Greaves went to Kilosa with all the boys and equipment, and started walking. This was the beginning of the main job which occupied the rest of the party's time in the Territory.

Kilosa is under 200 miles inland on the Central line and the aforementioned Commission had decided that the next new line should run south from here to a place called Ifakara, on the Kilombero River. The rival line considered, and which had already been surveyed, was from Dodoma southwards to Iringa. Various projects contemplate future extensions to the Rhodesian border or Lake Nyasa, but the immediate decision was between these two lengths. The Dodoma-Iringa work was naturally favoured by the few European settlers at Iringa, but was not thought to be justified. The area through which the Kilombero runs and the country adjacent is almost unbelievably fertile. It is also below 1,000 feet in altitude and quite unsuitable for permanent European settlement, but the purpose of the proposed Kilosa-Ifakara railway was to serve this natural granary and encourage development of it by the natives. At this time road transport charges made Kilombero rice more expensive in Dar-es-Salaam than consignments from the Far East.

The survey was to be started from a point 60 miles from Kilosa and continued south, as the reconnaissance of the northern section had not yet been done.

The party re-assembled itself, complete with lorry, on the way to the starting-point. A lorry on East African survey work is possibly a luxury, as roads are either non-existent or can only be called roads at the end of the dry season. But the Ford provided was an extremely useful luxury and later performed great things through water and liquid mud. When the work was away from the one road, the lorry travelled along the traverse lines where scrub and trees had been cleared; occasional patches of corduroy were necessary. Its great merit was that it enabled the party to be independent of additional porters for moving camp, as several lorry trips were made instead. Also, except for some months during the rains, it provided a rapid way of getting supplies from Kilosa.

The first survey camp was made in an ideal spot on the bank of a large river. From the tents hippo could be watched in the evenings, and a large herd of elephant bathing on the far bank was once seen.

Full and serious working days now started, and the place seems appropriate to describe the survey methods and give some details of other technical matters, covering the whole period of the party's work.

GENERAL.

The complete railway survey process performed by Tanganyika Railways before the construction of a line follows the normal scientific method of present-day practice and consists of :—

(i) General Reconnaissance.
(ii) Preliminary Survey (Tacheometric).
(iii) Final location of the line.

The result of (i) is the production of a map, usually to a scale 1/100,000, of the area through which the railway will run and showing the general direction of the proposed route, with possible alternatives. Sufficient information is obtained to enable rough provisional estimates to be produced and to weigh the economic potentialities of the line.

(ii) is the subject of this article. The survey follows the general line determined by the reconnaissance and the result is a detailed map of a strip of country drawn to a scale of 1/5,000, with the contours usually at 1 metre V.I. In places of special importance, such as large river-crossings and restricted defiles, 1/1,000 plans may be necessary. The plans must indicate the type of soil (whether it is solid rock or black cotton will make an appreciable difference in the Estimates !) and vegetation.

Drilling to determine sub-soil or depth of rock at approximate sites for bridge piers and abutments may also be done as a part of the preliminary survey.

The object of this survey is to produce plans on which the paper location of the railway can be performed at leisure, and all local alternatives carefully studied. When the paper location is complete, detailed estimates for the cost of the whole line are worked out.

(iii) takes place when the decision to start building the line has been made and immediately precedes the construction. The trace indicated by the paper location is followed and, together with the actual location of the line on the ground, the immediate topography is mapped to disclose small local features and accidents of the ground which may have been omitted by the preliminary survey and which will necessitate adjustment of the paper location alignment.

Width of Survey.

The width of the strip mapped by the preliminary survey varies greatly. At times a width of 10 kilometres may be necessary. When the ground is gently undulating, and especially in close country, it is impossible even for a location genius to select a narrow strip in which he can be certain that the best line will lie.

On the Kilosa-Ifakara survey it was never found necessary to exceed a width of 3 km. and over a fair distance as little as 300 metres was ample. This was along certain lengths closely following the foot of the first great escarpment 200 miles inland from the coast. The location here was obvious within narrow limits as heavy black cotton land, marshy in the rains, lay almost immediately below the slopes.

It is not attempted to make the direction of the main traverse coincide very closely with the probable final located position of the line. When this is done it is only too often found later that an insufficient width of topography has been taken in many places, and, unless a party sets out again to remedy this, the engineer doing the paper location may have to plot an indifferent line on the limited strip in front of him.

Traversing and Pegs.

Plate 1, Diagram 1, shows the standard system of traverses employed. Naturally this system is modified to suit conditions; often, for instance, three parallel traverses connected at intervals may be suitably used; subsidiary traverses in difficult country may be run all over the place (see Plate 2; many of the smaller ones are omitted), but the diagram will enable the method to be explained.

The main traverse is first done, the tacheometer being set up over each peg and readings taken to the next pegs back and forward, the elevation of each peg being thus obtained. Every portion of the main traverse is checked by returning over it in the same manner.

The surveyor may take important adjacent detail at the same time as doing the main traverse or subsequently.

Side traverses, cut at equal distances apart and roughly at right-angles to the main traverse, are surveyed by proceeding systematically along them to and fro, a check being provided each time the main traverse is reached. For example, starting from peg 107, the route is A—B—109—C—D—111—E and so on.

Pegs, cut on site, are driven on both main and side traverses usually every 150 metres, which is three lengths of the chain used. This is done beforehand by selected intelligent but unskilled natives. These pegs are a convenience as they show staff boys where to go without being told and provide a check against gross error in distance on the part of the surveyor. The tacheometer readings are the ones booked. No other chaining is done. Pegs are, of course, necessary in any case on the main traverse, but on zig-zag side traverses they are often dispensed with.

Plate 1, Diagram 2, shows the drill for working side-traverses with pegs driven. Six staff boys are a good average number with which to work; four for the pegs and two for intermediate shots on changes of slope, streams, etc., and for side shots. If many side shots are possible or desirable, more staff boys will be used.

X marks the change pegs where the boy reverses his staff when the instrument is moved forward; the letters show the progressive positions of the staff boys. It does not matter what the exact staff drill is, but some sort of routine movement of staffs is desirable.

With pegs 150 metres apart, the longest shot on traverse lines is seen to be 300 metres.

TRAVERSES AND RESULTS OF THE SYSTEM.

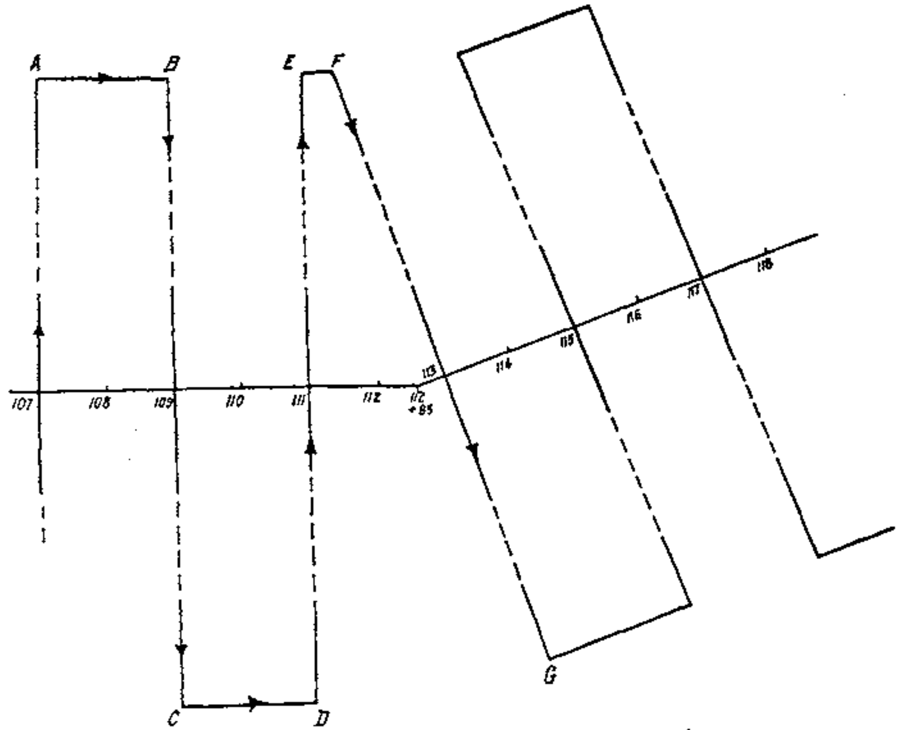
The distance apart of side traverses depends on the country. In easy or ordinary rolling ground 300 metres is sufficiently near together and a 150-metre interval should provide sufficient information in really difficult country. Except in thick grass and the most dense bush, it is nearly always possible to get some useful side shots if the staff is moved until a portion of it is visible.

For standard working, the side traverses, as stated above, are at right-angles to the general direction of the main traverse.

It is sometimes advisable that they should be set out by a surveyor; otherwise the job may be done by anyone who can use a compass or by even more elementary means. Once a good headman is given two banderoles in line, he will cut on a dead straight line for miles.

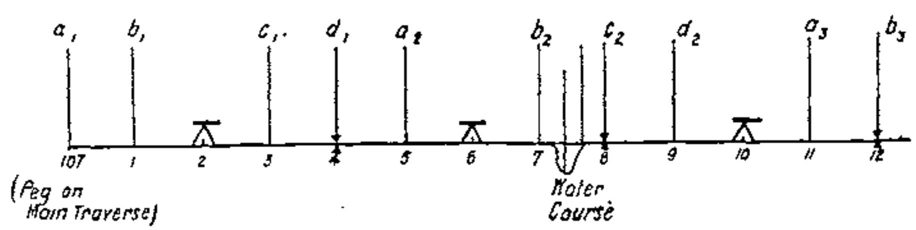
PLATE I.

DIAGRAM 1.



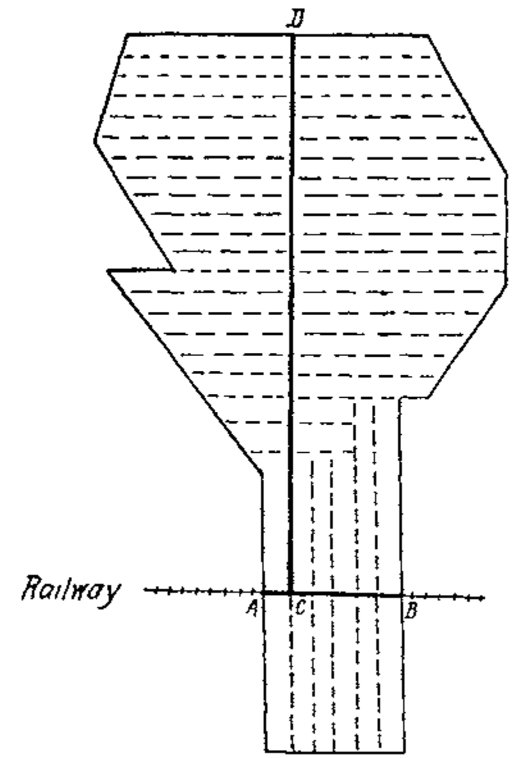
In close country an additional traverse may be needed in the area between 111-D and 113-G.

DIAGRAM 2.



If 12 is at A (ref: Diagram 1) the next move of the instrument is to B

DIAGRAM 3.



A-B and C-D are main traverses. The perimeter of the diagram is the boundary of subsidiary traverses, the directions of which are shown by broken lines.

There is not much to be gained by having very long straights of main traverse.

The result of the traversing methods which have been explained is to obtain an evenly distributed set of spot-heights covering the whole area, and consequently bold but accurate contours can be plotted.

Streams and other features will have been located where they cross traverses and side shots will have fixed stream junctions and other detail wanted.

The advantage of the method, the whole of which can be said to be in the nature of a drill, may now be appreciated. It will be seen also that no special skill on the part of the man with the instrument is necessary. The method obviates the natural tendency of the not very skilled surveyor, given a main traverse but otherwise left to his own devices, to produce a host of rather useless spot-heights close at hand, but not to cover his task evenly.

Survey of Areas.

It seems worth considering whether this way of working might not be more extensively used for the mapping of areas, as has been recorded of Dodoma ; its use need not be associated only with thick country through which rides must be cut.

Take, for example, the case of a Base Ammunition Depot. With a good party of surveyors an officer would need only to indicate on a small-scale map, or by sketch, a main traverse line and the depth to which side traverses must be extended, and might then feel satisfied that the survey would be adequately and rapidly performed.

Plate 1, Diagram 3, is a memory sketch to show the framework only of traverses at Dodoma. The area was, of course, much larger than that contemplated above.

Tacheometry.

The use of the tacheometer in traversing has been clearly outlined in *The R.E. Journal*, June, 1933, and repetition would be unnecessary. This paragraph merely amplifies what was then published. A comparison of the articles will show that rather larger closing errors were allowed in Tanganyika. Probably longer shots (up to 300 m.) were normally taken on traverses and the 5-metre staves used were boldly marked. In open country and on rare occasions, side shots up to 700 and 800 metres were got ; but this entails rather guesswork on the staff.

It is remarked that the field book contained 9 columns, against 14 shown in the specimen in the previous article.

Five-inch Watt's vernier stadia theodolites were the instruments most commonly used. Some surveyors prefer a direct reading instrument or another of the modern types now on the market. It is largely a matter for the individual's taste.

The Watt's product is cheap and sturdy as well as being light: there was no instance of damage to any of the instruments used.

Permissible error on main traverse is ·05 m.; on subsidiary traverses ·15 m. These limits apply whatever the length of traverse surveyed and there were hardly any occasions when work had to be repeated.

Testing and adjustment for vertical collimation was done daily by reading on a staff very steadily held and about 300 m. distant.

A compass fixed to the instrument was relied on for direction. If there is no local attraction a sensitive compass gives quite sufficiently accurate results and in any case direction is third in importance after elevation and distance. Traverses were usually found to close within 10 or 15 metres for position.

The top plate is clamped with the index at zero while the compass is set, and thereafter all the directions booked are magnetic bearings. To save this setting, instruments are also provided with a circular graduated compass fixed centrally over the horizontal plates and bearings are read through a magnifier to the nearest 20′. The booking of magnetic bearings makes plotting by protractor much quicker and avoids cumulative errors.

It is essential to make a sketch on the right-hand page of the field book. Positions of spot heights are marked and rough form lines drawn to show the shape of the ground. It is always best if the surveyor at least draws his own contours on the plan. With a little practice a good memory for country can be developed, but the form lines are a useful aid if some time elapses before plotting is done.

The field book may be reduced at "sundowner" time. Six hours of actual surveying entails not more than half an hour on the complete book reduction, when the surveyor is used to doing it. A quick way is for one man to read out from Jordan's Tables, while the other writes down the differences in elevation and corrected horizontal distances.

On the Kilosa-Ifakara survey the party did its most rapid work at the end, when the country was fairly easy from a surveyor's point of view. A distance of 70 km. and total area of 155 sq. km., was completed in six weeks. Plotting was kept practically up to date and Sundays were non-working days. Three instruments were in use, while the party leader selected traverses ahead.

Different methods of obtaining topography have uses and conditions to which they are most specially adapted, but it is believed that anyone with much experience of it would favour tacheometry whenever it could reasonably be employed. It is at its best when, standing on high ground with a dozen staffs out, the surrounding country can be mapped without leaving the instrument.

Major Silcox, with all his experience, had not previously used it, but he became converted before the job was over. The non-technical assistant after some instruction once went out on his own and did some slow but quite useful work.

The composition of a party with one instrument, in addition to the surveyor, will be described (see Photo 1). A head boy to shout at staff men till they are in position and be rude to them at intervals. He will probably soon pick up how to place and roughly level an instrument, which he can do while the surveyor sees where he wants the staves and makes his sketch. Next, a man to hold the umbrella and carry things. Another with a bush knife is very useful for lopping the odd bough or clump of grass that is in the way. There remain only the staff men; the stupidest may be as good as any once he realizes that crooked holding is sinful.

Difficult Country; Grades and Curvature.

One short portion of the survey, only 17 km. long, is worth particular mention. The route roughly followed the gorge of a minor river, the Ruhembe. This river flows from the great escarpment and then runs parallel through the gorge which lies between the escarpment and an outlying mountainous block. The only definite fact in a lot of jumbled and steep country was that the railway had to rise 150 metres in 12 km. as the crow flies. Little local development without extensive tunnelling and great viaducts was possible, and loss of elevation once gained or much running at grades easier than the ruling gradient could not be afforded.

The ruling gradient for the remainder of the railway was 1 in 100 (compensated) and the sharpest curves were 300 m. radius. The Ruhembe gorge had to have its own ruling grade and curvature; trains would be assisted by banking engines or double heading. At first sight 1 in 80 might be thought to do the trick comfortably. Two routes were eventually located on paper; one 1 in 60 and another 1 in 80; maximum curvature 250 metres. Estimates for this section were heavy in any case and rather prohibitive for the easier grade.

Plate 2 is a reproduction from part of a 1/20,000 key plan for the sheets. It shows a portion of the Ruhembe gorge with the 1 in 80 dotted and the 1 in 60 as a continuous line. For clearness the reproduction omits rivers and streams excepting the Ruhembe and one tributary. Contours are at 25 metres V.I. Owing to the steepness of the slopes and general confusion of the ground, it was possible to plot 5 m. contours only on the 1/5,000 plans of this area.

The preliminary survey here followed closely on the tail of the reconnaissance and the results of the latter were not at first available. Work was not held up because the railway had to lie within the limits of the gorge area. Plate 2 is provided with this article to illustrate an argument.

In such difficult and irregular country as that shown, it is held that it is an impossibility for the reconnaissance to indicate a route except within wide limits. To do so would necessitate the production of plans to a scale much larger than that normally produced at this stage.

Therefore, whether the general policy is for the preliminary survey to map a wide strip, or a narrow strip relying on the locating genius of the engineer, it is maintained that in very difficult country of this nature the topography of a wide area *must* be taken (with contours at 5 or 10 metres V.I.) before the best location can possibly be decided upon. Of course, time must not be wasted by making accurate maps of the hill-tops.

In this case of the Ruhembe gorge the preliminary survey produced its usual 1/5,000 plans, but it may be considered an instance of where the P.S. itself is in the nature of a detailed addition to the reconnaissance. A fourth stage intermediate between preliminary and normal location survey would here be necessary—the survey, possibly to a scale 1/1,000, of a narrow belt following the alignment selected on the P.S. sheets. Although the whole survey process sounds heavy, it cannot be too strongly stressed that both time and cost will be saved many times over when construction takes place.

Photograph 2 shows a typical ride in the gorge area. Ten weeks was spent by the party working in the area for 17 km. of railway. Plotting was kept right up to date and provisional paper location was done. The work would have been quicker but for a lot of time lost through various ailments, ranging from fever to a poisoned knee and toothache. Silcox alone remained staunchly immune.

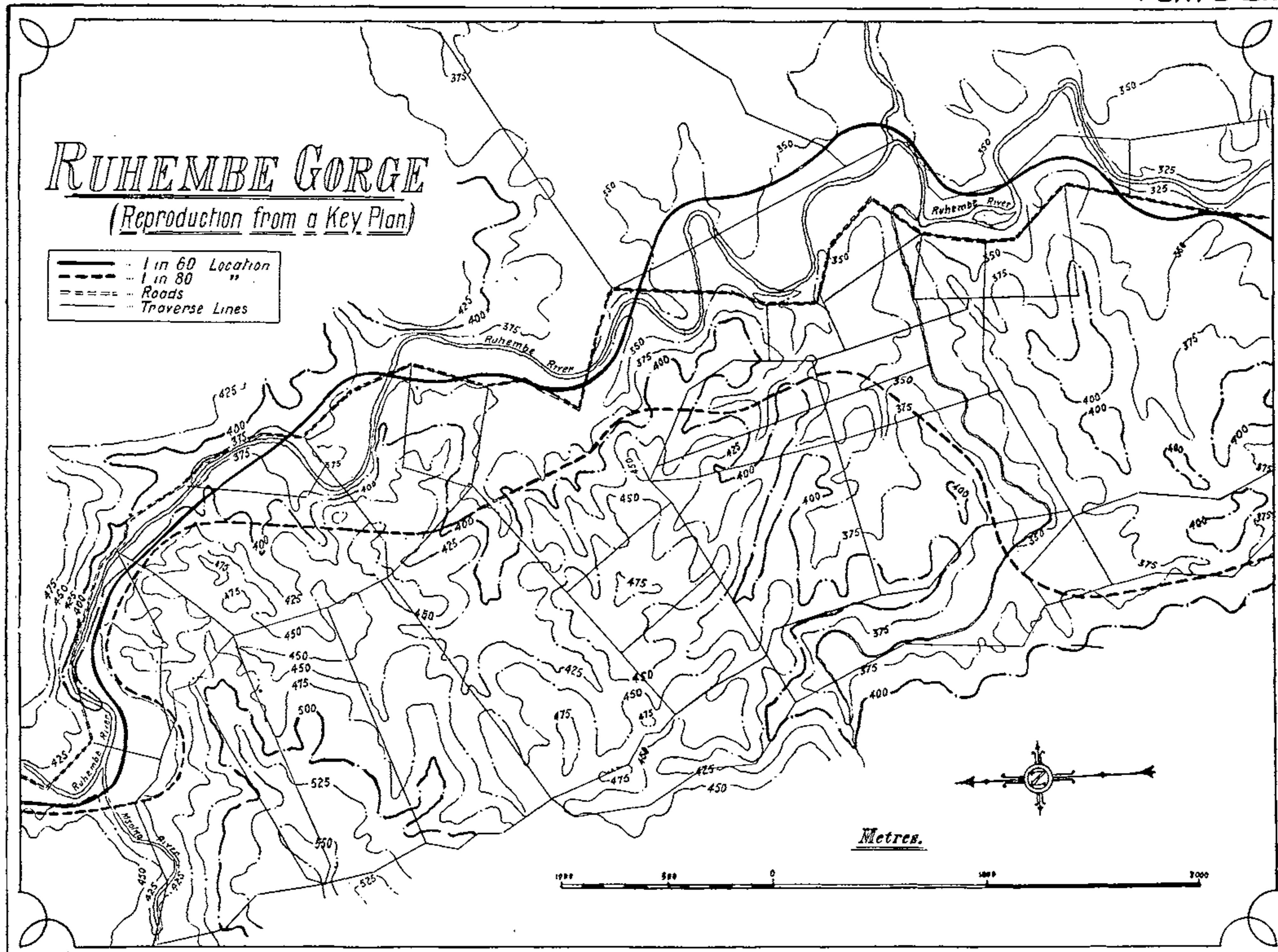
CONSTRUCTION ESTIMATES.

This subject was outside the original scope of the article, but some figures seem worth recording in tabular form. These are shown in an Appendix.

The estimated all-in cost per kilometre for the whole line was a little under £6,500. It is interesting to note that the corresponding cost for the preliminary survey was £40. This included time spent on estimates.

The last few pages have had bunched into them as much as need be said about the technical side. The sequence broke off at a point where bush life was just beginning to be experienced, but without some of its inconveniences.

Tents were either 14′ x 12′ or 10′ x 10′ with bathroom and verandah added and the complete camp gave an impression of fairly sound


RUHEMBE GORGE
(Reproduction from a Key Plan)
1 in 60 Location
1 in 80 "
Roads
Traverse Lines
Ruhembe River
Msolwa River
Metres.
1000
500
0
1000
2000

comfort. So much so, in fact, that a K.A.R. officer returning from some duty farther south and persuaded to spend the night, said that he had only seen one better. This had belonged to an American doing an expensive shooting *safari*. Later, things were judged to be fairly even when an inspection of the place sited in accordance with M.F.W. down-wind of the camp showed orchids flowering inside.

Photo 3 is of a camp towards the end of the dry season.

In January, 1931, field work had to be stopped for a while during the worst of the rains and, after building some weather-resisting huts of grass and mud, most of the first lot of boys were paid off and went home. All promised to return, but the possession of enough money to obtain an extra wife or for other good purposes proved too strong an attraction for most of them.

This semi-permanent camp was built at a one-man post, Kiberege by name, and was kindly considered by the District Officer to be an improvement on the usual wet-weather social amenities, when he had only the villagers to talk to for several months.

The huts were well built and had concrete floors ; cement in drums had been found, apparently discarded, and was brought in by the lorry. Photo 4 shows this camp and the appearance is quite nice, but the time spent here cannot be looked back on, even after some years, with any happy memories.

Rain was terrific and after the grass had got growing, exercise, in the form of a walk, was poor fun. Also, although plotting had hardly been touched before the rains, there was not enough work to keep the party occupied.

The fertility of the ground in this part has been mentioned already. After the rains started grass went ahead by two inches per day ; a blade laid flat on the ground measured 16′ 6″. This was not elephant grass nor was it taken from an exceptional clump. Some packets of Sutton's seeds were planted at Kiberege by boys sent ahead before the camp was occupied. Fresh vegetables were looked forward to, but with one notable exception they were a failure, most of the seeds having been eaten by insects. " Hardy Suburban " cucumbers were planted and grew to be six inches in diameter and rich yellow in colour. It was natural to suspect unusual behaviour in Africa and a liaison with the marrows next door, but their insides proved their suburban integrity.

In place of vegetables, it was for a while possible to collect limes from two deserted German rubber plantations ; they had been grown for use in closing up places, where rubber had been tapped, by the effect of their acid.

Another rainy season recollection is a trip to Kilosa, which had been planned for between the short and long rains. This break had not fallen true to time, but various supplies had to be fetched, so the quartermaster, lorry-driver and six boys set off in the lorry. The journey was under 100 miles each way, but took five days there and back. Fowlds showed an unnatural patience in lifting the differential out of the mud sometimes five yards only beyond the last effort. At one place outside Kilosa on the return everything was washed away above an Armco culvert, leaving a gap 14′ wide and 7′ deep. On either side of the road the ground was complete bog, so a bridge was built for lorry plus load of one ton. Seven small trees provided stringers, smaller ones the decking and the whole was lashed with bark. Sapper instinct compelled the making of calculations which showed that the bridge was half the necessary strength, so the trees were assumed to be double strength. The weak point was one end of the gap which was very soft, but the bridge was finished in one and a quarter hours and the lorry was driven over. The rear axle reached the far side just in time, as the whole contraption fell in as the bankseat subsided. *Ahsante Muungu* or "thanks to Providence," was said by all and the journey continued.

Field work was recommenced before March was over; rain was still heavy, but the alternative was complete idleness; so about seven miles on each side of Kiberege were done, using locally engaged boys. In a few weeks the whole look of the country had been changed with the growth of new grass and the roughness and smaller valleys were lost in a rolling sea of green. Survey was almost entirely restricted to the cut rides. A curiosity of this country was the formation of silt fans by streams flowing from the escarpment. Some were a good half-mile wide but not very noticeable on the ground. The streams persisted in flowing along the top in a most unnatural manner so that contours met rivers in the wrong direction. This trickiness had been detected before the days of the big grass, or an air of suspicion might have rested on everything.

A new batch of 110 Wanyamwezi joined in time for the move from Kiberege back into tents and the routine of survey and moving camp continued till field work was over, which is the excuse for writing about things not connected with the rather monotonous history of events.

These Wanyamwezi are sound fellows—clean, fairly truthful, intelligent, fond of exercise and with many other excellent qualities including self-respect. The tribe provides good material for the K.A.R. as it did for the Germans in former days (some of the survey boys were ex-German *askaris*), and they would make first-class pioneers.

It would be thought that a day's work on bush-cutting in a temperature of over 100° demanded enough energy, but when a football was first presented, the boys took to the game with gusto and for a while it became a regular evening amusement. There were few rules to spoil things until the first and only fixtures were played on Boxing Day against the pick of Kiberege. The warmth of discussion between opponents then called forth the District Officer to take over the whistle in the middle of the game.

Most of them spoke sufficient Swahili for everyday use, but their own language, like that of nearly all East African tribes, is distinct. Between Kilosa and Ifakara alone there were natives of four tribes, each with their own words, which differed as much as French and English. If the old Arab traders did no other good for Africa, at least they were the means of spreading a common language over a good slice of the continent. Swahili is said to be one of the twelve major languages of the world; in addition to East Africa it is useful over much of the Congo and the odd native who speaks it can be found as far south as the Victoria Falls.

This would fail in giving a general picture of survey life in the country unless something is said about game and pests. The first provided one of the biggest outside interests and the second one of the few banes of existence.

South of Kilosa there was game of almost every description and plenty of it, but the country was usually so close that on occasions one might be a few yards away without knowing. It may be fancied that the game would know better and keep clear, but in these parts very little shooting had been done and often a buck would get up just in front and vanish in the grass. One morning after the usual shouting had been going on for some time, a lone buffalo quietly walked out from the side of a ride and crossed between the surveyor and the boy following with the instrument.

Another time a party on bush-cutting returned to camp where plotting was in progress, and said they had knocked off as they had cut as far as a lion and lioness eating a buffalo. Plotting was suspended in favour of investigation, but by the time the site was reached, the lions had temporarily adjourned. A headman gravely indicated the relative positions where the encounter took place with the point of his umbrella, and it was interesting to trace out from marks and tracks how the buffalo had been brought down. An ambush had been prepared by one of the animals, presumably the lion, while the lioness had chivvied the meal into it. It seemed the more extraordinary as the buffalo was almost full grown, yet its neck had been broken with one blow, the mark of which was seen behind the head. The pair were seen later that day and sat up for but without success.

One camp alongside a river and near Ifakara took the prize for assortment of night noises. There is no "silence of the jungle" about the low-lying bush! From different directions one evening came the appropriate sounds from an elephant, two lions, some hippo and a hyena, and on top of all that were hoots from birds, the incessant buzz of crickets, and frogs making a noise like a dozen carpenters with saws.

The sight of a herd of *impala* or the fresh pug marks of a lion never failed to thrill when seen early in the morning on the way out to work, while it still felt like the beginning of a grand summer day. Even the most *blasé* surveyor could hardly fail to show interest on discovering that what he had mistaken through the telescope to be staves carried at the slope were really the necks of giraffe in the distance.

The insects that afflict internally, externally and under the skin are too well known to need description, but added to them there was locally a vegetable horror in the form of a rather pretty vetch called *pupu* or "buffalo bean." The pods of this fiendish plant, when dry, give off a cloud of tiny invisible hairs, which itch like nothing on earth and go on itching for hours. Scratching only makes it worse and sometimes even the boys were practically in tears. *Pupu* country is not the place for shorts.

Tsetse were everywhere on the main job, but they are not nearly as irritating as ordinary flies in cattle country. They seem hardy insects; it was found they would preen their wings with their back legs for half an hour after the removal of their heads.

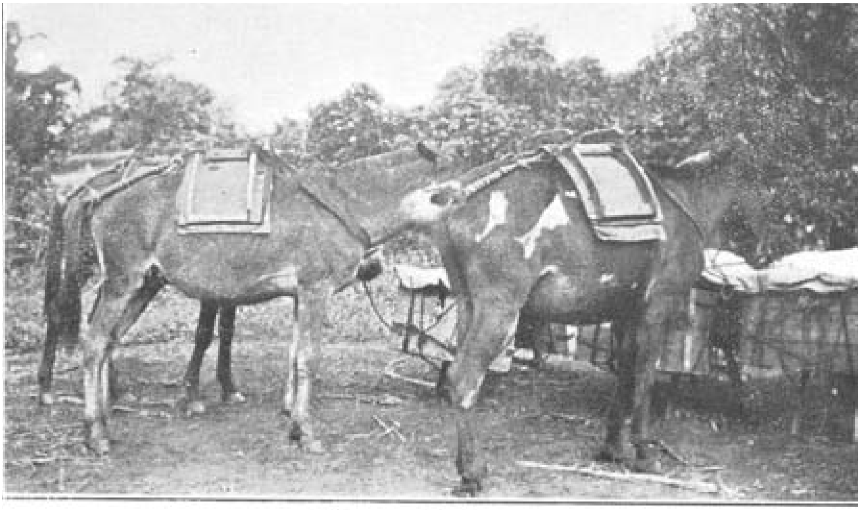
CONCLUSION.

Field work was finished by November, 1931, and the party packed up, leaving behind only the concrete blocks at each kilometre on the main traverse.

Quarters were taken up in some unoccupied buildings at what had once been a station of some importance at the highest point on the railway. Office work lasted till February, 1932, by which time the "crisis" and retrenchment meant that everyone had to go home. Feelings varied but it was largely with great regret that the departure took place.

The married members of the party selected a direct boat via the Cape; of the others, one went by boat northwards but making a short detour into Kenya *en route*, and the other via the Congo, Rhodesia and South Africa, and thence from Durban.

A love of the African bush is easily developed and with it a feeling that it's a pity to spoil things with railways! But Africa is still big enough to stand a good many thousands of miles of new railway, and it is to be hoped that when conditions are really better and development goes on, there will be many more opportunities for experiences similar to the one which has been described.



Chinese Mule Saddles.

Unloading.

Some notes on the Wa States - Unloading

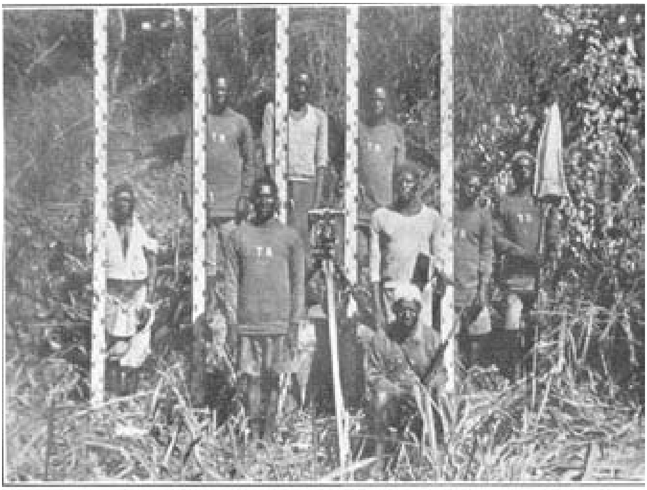


Photo 1.—Party of men for work with one instrument.

Photo 2.—Survey ride in Ruhembe Gorge area.

Railway survey in Tanganyika Territory - Photo 1& 2

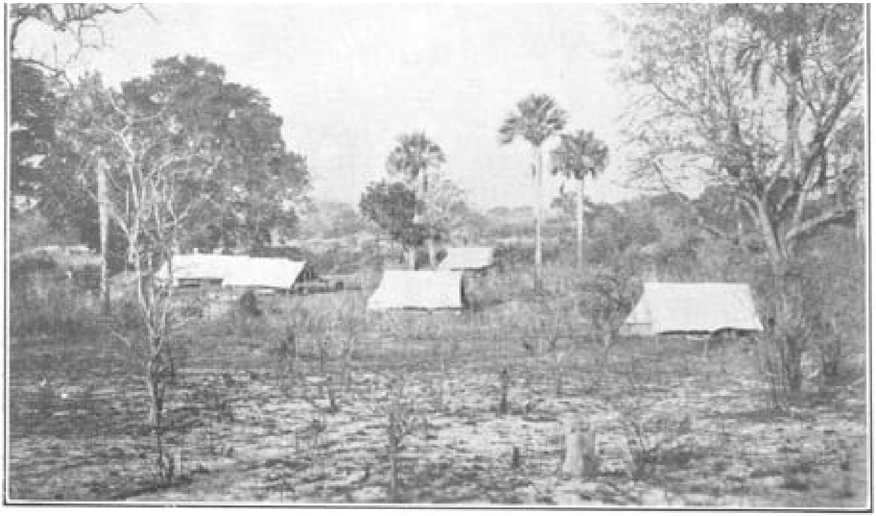


Photo 3.—Typical camp. End of dry season.

Photo 4.—Rainy season camp at Kiberege.

Railway survey in Tanganyika Territory - Photo 3& 4

APPENDIX.

Construction Estimates.

Percentage of cost of various items in the four different portions of the line.

Items	Undulating and easy	Ruhembe Gorge (see text)	Scarp foot	Outlying features beyond scarp; marshy re-entrants	Whole line
Land purchase, location survey, level crossings, signals, workshops	1·64	2·36	1·83	1·74	1·96
Formation	13·50	23·36	15·69	27·61	19·04
Bridges and culverts	17·66	53·51	36·50	28·31	33·63
Permanent way (rails 55 lb.)	50·91	17·58	34·82	33·75	35·06
Stations and quarters, water supply	3·80	—	6·34	4·74	3·91
Special works (chiefly river training)	7·10	0·77	0·87	—	2·40
Administration (including charges for rolling stock used during construction)	5·39	2·42	3·95	3·85	4·00

THE PROGRESSING OF PRODUCTION IN NEW AND REPAIR WORK.

By LIEUTENANT A. E. M. WALTER, R.E.

Introduction.—Whether the Unit to be made is a radio set or a locomotive, the principles of scheduling or progressing production remain the same. It is only in the application of these principles (to suit the particular Unit being manufactured) that there is any variation. Briefly, the principle is this. Fix the date on which it is decided to make the Unit, call this zero day. Now every item which goes to make up the whole Unit takes a certain time to manufacture or assemble. Some of these items take longer than others; one item must take the longest time, say X days. Then start to make this item X days before zero day. Order the material to make this item and get it delivered in time to start manufacture of the item X days before zero day. This involves ordering the material X + Y days before zero day. Similarly with all the other items which go to make up the whole Unit. Then on zero day, all the items will have been made and assembled and all will be ready for the assembly of the Unit.

The application of these principles is now described, firstly in New Work (the manufacture of the Standard Motor Car), and secondly in Repair Work (the repair of locomotives in the Darlington Shops of the L.N.E.R.). It will be seen that, in these two cases, although the class of work is different, the machining and fitting standards are different, the workshop lay-outs are different and the supply of material is different, yet the same principles run through both systems.

2. *New Work.*—Before considering the question of scheduling or progressing work, it is of interest to see how the Executive is organized in this typical example of a specialized or mass production factory. The whole output is the result of the efforts of the following departments:—

1. The Managing Director, who has under him
2. The Design Dept.
3. The Sales Dept.
4. The Purchase Dept.
5. The Planning Dept.
6. The Production Dept.

7. The Material Control.

8. The Inspection Dept.

9. And the following departments whose work is outside the scope of this article, Statistics, Cost Analysis, Serviceing and the Secretariat (expenditure).

Before anything is made there must be a demand for it. This demand is gauged and fostered by the Sales Dept. The Design Dept. try to design the Unit which is best suited to the demand. The procedure for production then follows roughly the following lines. Although the example is taken from the manufacture of a motor-car, since the principles and procedure are applicable to the manufacture of any article, we shall consider the manufacture of things called Units (which can be anything from a shell to a locomotive).

At a definite date before zero day (the day on which the first Unit will be assembled) a meeting is held and, as a consequence of the estimated demand, it is decided to manufacture, say 1,000 Type A Units, 5,000 Type B Units, and 10,000 Type C Units.

As a result of this decision, the Purchase Dept. are given a Sanction to place orders for material for the manufacture of a certain portion of the total number of Units which it has been decided to make. For example, say that Sanction 1 permits the purchase of all the material which will be required to make 200 Type A Units, 800 Type B Units and 2,000 Type C Units. Since the total number of Units are to be made in one year the Units covered by Sanction 1 will have to be made in a certain proportion of the year. From this stage we will now consider how each department functions in order that the Units of Sanction 1 shall be made by that definite period of the year.

3. *Purchase Department.* On the authority of Sanction 1, this department places its orders for material, sufficient to make up all the Units covered by this Sanction. It is not possible, nor is it at all desirable, that all this material should be delivered at the same time. The Planning Dept., who know the capacity of the factory to deal with material, is therefore called in at this stage and the two departments decide how much of Sanction 1, and how many Units of each type shall be made during each month of the period covered by Sanction 1. This information is then passed on to the Material Control. In actual practice this decision is arrived at by the close co-operation of the Purchase, Planning and the Material Control Departments, the reasons for which will be better understood later.

4. *Material Control.* (M.C.) The Purchase Dept. is only responsible for the placing of orders for material, and not for its delivery. The rate of delivery and the date of delivery is the responsibility of the Material Control. It is the job of this department to have close contact with all the sources of supply of material. That is

why they are called in when the decision as to the rate of manufacture per month is made (see Para. 3). Since it is the job of the M.C. to see that supplies of material arrive to date, and since they know the rate at which they can get their various supplies from the different sources, it is no use deciding to manufacture Units at a rate faster than that at which the M.C. says that it can obtain the requisite materials. But once the decision as to the rate of manufacture has been reached (as described above), then it is up to the M.C. to see that material arrives to date and to check the flow of material both externally to the factory and internally through the factory. In the case of the Standard Car Co., three inspectors are kept whose sole duties are to watch the external flow of material to the factory. They go from factory to factory chasing the suppliers and, due to their knowledge of the uses to which the material is to be put, helping the supplier to speed up his production. As far as possible, the M.C. aims at avoiding stocks of material and tries to reach a state of constant flow of material from supplier to factory and then through the factory.

The M.C. checks the flow of material as follows. As will be seen later, at the beginning of each month, the Planning Dept. issues a Schedule (applicable to the month ahead) which shows the numbers of each Type of Unit which it is proposed to make during each week of that month ahead. The material has already been ordered (by the Purchase Dept.) and thus the M.C. has now got six weeks in which to see that the material is being prepared in the suppliers' factories according to contract rate, and to chase it to see that it arrives to date. A check on the quantity and flow is kept on a form (Form 1, see Appendix 1), a relevant duplicate of which is sent to every supplier. The numbers required each week show the rate at which the supplier has to produce his materials. The quantity actually supplied each week is entered up by the supplier and also by the M.C. on his copy. The check between these two copies is used to settle questions as to how much has actually been supplied. Most material is checked only as to quantity when received in the Stores. In a few cases, such as radiators, material is checked as to quality as well as quantity on arrival at the factory. Quantity inspections are carried out by the Stores Section of the M.C.; quantity and quality inspections are carried out by an inspector belonging to the Inspection Dept. The question of material rejected as unfit is dealt with under inspection later.

5. *The Planning Department.* (P.D.) In the case of the Standard Motor Co., the P.D. tends to combine the functions normally divided between the P.D. and the Production Dept. In America, the P.D. is called the Plant Dept., which gives a better idea of its functions, *i.e.*, the designing and installation of plant and the lay-out and erection

of buildings to give the desired rate of production at the greatest efficiency and lowest costs. The Production Dept. on the other hand schedules the rate of work, progresses the flow of work, fixes rates, etc. I have not yet been to a factory in this country where these two departments are truly subdivided. In all factories that I have been through, these two departments have been more or less combined, and in most cases the difficulty is got over by calling the combined department the Progress Dept., whose duties include the designing and installation of plant, the design and making of jigs and tools, designing the most suitable lay-out, fixing rates, supplying drawings, processing and progressing work, etc. The working of such a department is now described.

The Progressing of Work. It must be remembered that there are really two separate phases in the production of a Unit :—

First Phase. The manufacture or assembly of the Details which go to make the whole Unit.

Second Phase. The assembly of the Unit.

6. *Phase* 1. Every Unit, almost, however small, is made up of a certain definite number of parts or Details (the word most often used). Also one complete Set of Details makes up one Unit. Now as stated above (Para. 2), Sanction 1, for example, was the authority for the manufacture of a definite number of Units of each Type. This necessitates the same number of Sets of Details. Now the first thing to do is to manufacture the correct number of Sets of Details sufficiently ahead of zero day to enable assembly of the Unit to start on zero day. The manufacture of Details entails the Processing of them, so that they shall be made in the quickest and cheapest way to conform to design, and also entails the Progressing of them so that they shall be manufactured and delivered ready for assembly into the Unit on zero day. The method of Processing and Progressing is as follows. (I may add that I have studied quite a few systems in various factories, but I have never met one so entirely satisfactory as the one described below.)

Processing of Work. The Design Drawing Office issue two complete drawings for each Detail of each Set. For example, a Set may consist of 150 separate Details. Then 300 drawings will be issued for that Set (one Set when assembled makes up one Unit). One copy of each Detail drawing goes to the Processing and Rate Fixing Section and the other copy goes to the Shop Drawing Store. The Processer studies the drawing and, from his knowledge of the machining operations required to make the Detail and from his knowledge of the machines and tools at his disposal in the shops, he breaks down the making of the Detail into a number of Operations or Processes.

In addition, he either knows the rate at which each of these operations can be performed on certain machines, or else he times these operations on the machines on which they are going to be performed and from this information he fixes a price or rate for doing the job. Once the rate is fixed by agreement between the rate fixer and the Shop Steward (who represents the men), it is an important point of policy to stand by the decision, right or wrong. This does more for industrial harmony than anything else. Having decided the number of operations and the price for each operation, the rate-fixer issues a card (see Form 2, Appendix 1) to the Progress Section who base all their progressing on this information. In addition, the Process Section hand a copy of Form 2 to the Jig and Tool Drawing Office, who prepare drawings for the jigs and tools required for each operation shown on Form 2. In addition, since the Process Section receive one copy of each Detail drawing, their duties include the recording of all alterations to drawings in their possession, seeing that all the shop foremen, using that particular drawing that has been altered, are notified of the alteration, and that the copy in the Shop Drawing Store is altered. All alterations to drawings are recorded on a card made out as shown on Form 3, Appendix 1. It will be noted that the shop foreman who has been shown the alteration is made to initial the card so as to tie him down later, if required!

Progressing of Work.—About the time that the duplicate copies of the Detail drawings are sent out from the Design Drawing Office, a book of forms such as Form 4, Appendix 1, is sent from the Design Drawing Office to the Progressing Section. Every single Detail which goes to make up one Set of parts (which make one Unit) is listed on Form 4.

From Form 4, the Sanction Cards are made out (see Form 5, Appendix 1). One card (Form 5) is made out for each operation shown on Form 2, and in addition a top card is made out as shown which covers all the operations which go to make up the particular Detail. The large number on this top card shows the total time that it will take to perform all the operations (shown on the cards below) and get the Detail through the shops. These cards are then filed in a card file, with a "flag" on which is the Detail number.

With the aid of Forms 2, 4 and 5, the Production Tally is next made out (see Form 6, Appendix 1). The complete Tally for a Starter Jaw is shown. The Tally is used as follows. The Machine Shop Manager first decides to put the starter jaws into production during a certain week. As a consequence of this decision, the Production Tally is made out for a batch of starter jaws. The Tally is sent by the Progress Section to the Shop Foreman in whose bay the starter jaws will be made. The Shop Foreman immediately takes the Tally to the Stores and gives it to the Storekeeper. The

Storekeeper, provided he has the required material in his bins, tears off the pink slip in the Tally Card and issues the material, at the same time stamping the card with the date the material was issued (shown in blue on the card). The date (shown in red) is stamped on the card by the Progress Section before issuing the card. This date (red) is that much in advance of the date (shown in black ink) on which the Tally Card was issued as the time which will be taken to perform all the operations shown on the white slips. The difference of time in weeks between the date (black) and the date (red) corresponds to the large red number shown on Form 5.

The Storekeeper, when he issues the material, puts it into a bin or tray and leaves the Tally Card on top. Now operation No. 1 is to be done on the Bar Automatic (see top white slip). The workman in charge of the Bar Automatic then takes the material and the Production Tally to his machine and performs Operation No. 1. On completion of Operation 1, the work is inspected by the Examiner. When passed, the top white slip is filled up as shown in ink by the workman, the whole slip is torn off and placed in a box at the end of his bay. It will be noticed that 49 pieces of material were passed after operation and that one has been put down as "workman's scrap." This means that the workman damaged one piece during the operation. He will therefore only be paid for 49 pieces as shown later.

Payment of Wages. At frequent intervals during the day, all the white slips around the shop are collected and brought to the Progressing Section. In the Progress Section, the card of Form 5 for Operation No. 1 is looked out and, as soon as the card has been filled up as shown, the white slip or payment voucher is torn down the perforations, the right half is filed for sending to the Wages Section and the left half is returned to the workman. If a workman complains that he has not received back a Voucher for a job which he alleges that he has done, reference to the card in Form 5 immediately shows whether it really has been done or not.

The advantages of this system are as follows :—

1. *Progressing.* (A) STORES. On going to the stores, examination of the Production Tallies there immediately shows

(*a*) How much work is being held up due to machines not being available in the shops, and

(*b*) What work is being held up due to lack of material in the stores.

(B) SHOPS. On picking up a Production Card anywhere round the shops the following information is immediately available.

(*a*) The date by which all the operations to make the Detail should be completed (red date).

(*b*) If there has been any hold up due to lack of material in the stores. The blue date should be the same as the black date, if there has been no hold up.

(*c*) The date by which all the operations will be completed if there has been a hold up of material. By adding the difference of time between the black date and the red date to the blue date, the date on which the whole job will be completed is known.

(*d*) By counting the number of white slips left, the number of operations left before the job will be completed is immediately known.

2. *Payment of Wages.* Due to the fact that the Payment Vouchers are not returned until the information thereon has been entered on the appropriate card in Form 5, there is an immediate check on whether the operation has been done or not. This avoids disputes.

7. *Phase 2. The Assembly of the Unit.*

It was shown in Para. 3, how, as a result of the co-operation of the Purchase, Planning and Material Control Depts., a Schedule was got out showing the proposed monthly rate of production for each Type of Unit. This Schedule is issued by the P.D. and the form it takes is shown in Form 7, Appendix 1. Instead of A 9 we should read Type A and so on. It will be noticed from the date at the head of this Monthly Schedule that the specimen in question was issued late. It should have been issued on the 1st October, 1935.

From the Monthly Schedule (showing the total numbers of each Type of Unit to be made during the month), a Weekly Schedule is made out (see Form 8, Appendix 1). This shows how many Units of each Type it is proposed to make during *each day of the week*. It is from this Weekly Schedule that Form 1 was got out by the M.C.

From the Daily Schedule shown on the Weekly Schedule (Form 8), the Production Control Sheet (Form 9) is got out. This sheet shows the HOURLY RATE OF FLOW through the factory and is really the result of all the efforts of all the departments and all the progressing done in PHASE 1.

As a result of PHASE 1, all the Details which go to make up ONE UNIT are ready for assembly on zero day. The next stage is the assembly of certain collections of Details into Sub-Assemblies. One of these Sub-Assemblies will take longer to assemble than the others. It must be remembered here that Sub-Assemblies for Types

A, B, and C are all being put together at the same time, and that, as stated above, one process of Sub-Assembly for each Type of Unit is going to take longer than all the other Sub-Assembly processes. All assemblies naturally take place on an Assembly Line or Belt. The belts for the assembly of the different Sub-Assemblies which take the longest time to make are all grouped together in one shop. In this shop, coming down the belts are the Sub-Assemblies for the three different Types of Unit we are manufacturing. Since one Type involves more work than another, coming off the end of these three Sub-Assembly belts, we might for example get Sub-Assemblies of the following Types of Unit in the following order :

1 Sub-Assembly of Type C
1 ,, ,, ,, B
1 ,, ,, ,, C
1 ,, ,, ,, A

Now the Planning Control watches the ends of these three belts and, in the case of the Standard Motor Co., when 30 Sub-Assemblies have come off in a definite order (dependent on the rate at which the Sub-Assemblies of each Type are put together), hurries away and gets out the Planning Control Sheet. This Control Sheet shows the order in which all the other Sub-Assemblies (of each Type) must come together on the Main Assembly Line. Then since this order is based on the order in which the Sub-Assemblies which took the longest time to put together came off their belts, the correct Sub-Assemblies to make up one Unit of each Type will come together on the Main Assembly Line, and whole Units of each Type will be rapidly put together.

The Standard Motor Co. is the only company of any size which puts Sub-Assemblies of different Types of Units down the same Main Assembly Line. Ford and Morris have separate Assembly Lines for each Type of Unit owing to their larger outputs. Shells would have to be done on separate assembly lines also. The Standard System obviously demands far greater organization, but results in far lower costs of production, since only one main assembly line is needed, and therefore is of particular interest.

It will be seen how the Principles of Progressing Production have been followed throughout. For example, in the manufacture of the Standard Car, some of the Details take six weeks in which to complete all the operations necessary in their manufacture. Therefore, at the start of manufacture of the Units covered by Sanction 1, batches of these Details are first started on their course through the shops. These Details are then followed by those which take 5 weeks to get through the shops and so down to those which only take a few hours. In the same way in the assembly of Sub-Assemblies.

Welding together the panels of the body and completing the panel assembly, followed by painting the body (less wings and wheels), followed by body trimming, are all regarded as a Sub-Assembly process which takes about $2\frac{1}{2}$ days to perform. The Planning Control watches the order in which the different types of bodies come off the panel assembly line on their way to the paint shop. The Control Sheet is made out in this order and a copy is sent to everyone concerned, from those inspecting Details down to those actually loading the Main Assembly Line. Then, as in the case of engines, since it takes $1\frac{1}{2}$ days to assemble, run-in and test an engine, one day after the issue of the Planning Control Sheet engines will be passing down the engine assembly line in the order given in the Control Sheet. Finally, chassis parts or Details will be loaded on to the Main Assembly Line only a few minutes before they will actually be used in the order shown in the Control Sheet. Thus all Sub-Assemblies and all Details which go to make up the Unit meet at the correct time on the Main Assembly Line and so become a Unit.

8. *Inspection Department.*—The whole basis of specialized production is accurate and rapid inspection, which alone ensures that all Details are of the same dimensions to within very fine limits. There will then be no delay on the Main Assembly Line; all parts will go together perfectly. This necessitates the careful designing of jigs, templates and gauges so that, though the inspection covers very fine limits, time spent on inspection is reduced to a minimum. Some idea of the limits worked to in the inspection of the Standard Car is given by the following.

Diameters of all bearings and journals of the crankshaft are accurate to 2/10 of 1/1000".

All flywheels are statically balanced to within 2 grams' weight.

All involutes on gear wheels are accurate to $\frac{1}{2}$ of 1/1000".

All pistons are matched for weight to within 2 drams' weight.

All cylinders are bored accurate to 2/10 of 1/1000".

And yet the inspection to these limits does not take long, due to the careful design of suitable jigs, templates and gauges.

THE PROGRESSING OF PRODUCTION IN REPAIR WORK.

1. INTRODUCTION.

The progressing of production in repair work is based on the method employed in the Darlington shops of the L.N.E.R. The scheme was first introduced there in 1930 for the repair of locomotives and, in the light of more modern methods, *e.g.*, the locomotive repair belt at the Crewe shops of the L.M.S., is open to improvements which doubtless have taken place.

2. Organization.

The organization of the shops is briefly as follows. The shops chiefly concerned in the repair of a locomotive are the

Erecting Shop. Has its own foreman.

Machine and Fitting Shops. One foreman with two assistants. Each section of these shops, whether machining or fitting operations are being done, has its own charge-hand, *e.g.*, the following sections are under charge-hands:—wheels, piston heads and rods, connecting and side rods, link motion, etc.

The Forge. Under its own foreman.

The Iron and Brass Foundries. Each with its own foreman.

The Brake Repairs. Under a charge-hand.

3. The Process of Repair.

1. The locomotive is completely stripped over the stripping pits which are in a bay of the erecting shop.

2. Every detail, after passing through the cleansing tanks, is delivered to the appropriate shop or section of shop. The boilers go to the boiler shop, the wheels, cranks, con. rods, pistons, etc., go to the correct sections of the machine shop, valve gear to the valve gear inspector and so on.

3. Within a fixed time of the locomotive being stripped, reports on the condition of, and the repairs required to every detail, have to be sent in to the progress manager. These reports, of course, come from all the various sections to which details have been sent for inspection.

4. The progress manager (P.M.) now has before him complete information as to how long the various details are going to take to repair and also how long the detail which is going to be slowest to repair is going to take to repair. Actually, the boiler is invariably the slowest, but, in order not to hold up all the other details while waiting for the boiler, a similar and repaired boiler is almost invariably substituted for the original boiler to save time. As a consequence of this information, the P.M. fixes a date at which all details must be back at the erecting pits completely repaired. This is called the "Gear at Erectors" date.

5. Having fixed the Gear at Erectors date, the P.M. issues tickets to each shop foreman concerned in the repairs. These tickets show the shop foreman the date at which the details must be back at the erecting pits, *i.e.*, the Gear at Erectors date. (See Form 1, Appendix 2.)

6. Each foreman, on receipt of his ticket, issues a similar ticket to the various charge-hands concerned (see Form 2, Appendix 2).

7. The charge-hand, on receipt of his ticket, issues a similar job ticket or card to the men or man who will do the job. (See Form 3, Appendix 2.)

Now the whole scheme at this stage works on a thing called a "Table of Times" which is worked out for each shop. The Table of Times for the machine shop is shown below (p. 406). This table is used as follows:

(*a*) Under the heading "Basis for Chargeman's Tickets" it will be seen that axle-boxes, for example, only have operations performed on them in the machine shop (this including pouring brasses) and they go to no other shops in the course of repair. It also shows that any axle-boxes requiring repair *must* reach the machine shop 8 *days* before the Gear at Erectors date.

(*b*) Under the heading "Basis for Workman's Tickets" it will be seen that the operations required to repair an axle-box take 4 *days* to get the box through the shop. Hence, since the axle-box is delivered to the machine shop 8 *days* before it is required for erection in the locomotive and it takes 4 *days* actually to repair it in the shop, it will be seen that, allowing for all contingencies, the axle-box will be ready on the date required. These contingency margins are based on the practical working of the shops in question and are not merely "healthy" allowances to save the shop foreman.

The advantages of this system are:—

1. Once the Gear at Erectors date for any particular locomotive has been issued by the progress manager, every detail has to move to a schedule, the Table of Times, and a definite date on which the locomotive will be finished can be given. This is of great assistance to the traffic department in assessing the amount of loco. power available at any given time.

2. If a detail is held up, the cause can be located immediately. For example, take the case of a new connecting rod required (see Table of Times). The blank material must reach the forge 20 days before Gear at Erectors date. It is then allowed 9 days in the forge. The next stage is the machine shop. If it arrives late at the machine shop, the delay may be due to two instantly traced causes, firstly, late arrival of the blank at the forge, secondly, operations slowed up during the passage of the rod through the forge. When the rod reaches the machine shop, the card (Form 3, Appendix II) immediately shows whether the forge received the material late or whether the delay took place in the forge itself.

CONCLUSION.

An example showing how this system is used is shown on page 405 to make it quite clear.

Although the system is taken from a locomotive repair shop the method is applicable to the repair of any machinery. It will be seen how the principles of progressing production cited earlier are adhered to. The time taken to repair the detail which takes the longest time to repair is first found (as a result of inspection of the worn detail in this case) and on that time, zero day or Gear at Erectors date is based. All details then "flow" through the shops starting in sufficient time to link up once more on the assembly line or erecting pits on zero day.

Example of Progress Card System.

1. Assume that the progress manager has fixed Gear at Erectors date for Engine No. 1960 as the 31st July, 1931.

2. Brake gear is being progressed through repair; see Table of Times below (p. 406).

3. The Table of Times shows that all the operations required to repair brake gear take 18 days to get through the shops. Remembering also that all details are scheduled to be ready for assembly FOUR days before Gear at Erectors date to give a margin for hitches during repair, then the brake gear must reach

(A) *The Forge.* 18 working days before Gear Day, *i.e.*, by the 7th July. After the forging operations, the brake gear must be at the

(B) *Electric Welders.* 12 working days before Gear Day, *i.e.*, by the 14th July.
Hence time allotted for repair in the forge = 7th to 14th
= 6 *days*.

The brake gear must be at

(C) *The Machine Shop.* 9 working days before Gear Day, *i.e.*, by the 17th July.
Hence time allotted for repair in the electric welders
= 14th to 17th
= 3 *days*.

The brake gear must be completed in the machine shop by the 27th July.

Hence time allotted for repair in the machine shop
= 17th to 27th
= 9 *days*.

Hence total number of working days spent in repair of the brake gear in going through the various shops = 6+3+9 days = 18 days.

This is in accordance with the Table of Times.

Unlike new work, with rigid inspection and work done to fine limits with new material, in repair work the Detail must be scheduled for completion at least four days before zero day, or Gear at Erectors day, in order to allow for the inevitable snags which crop up in repair work, snags which cannot be foreseen even by rigid inspection since they only show up during the repair operations.

TABLE OF TIMES.

ITEM.	BASIS FOR CHARGEMAN'S TICKETS. All materials for Repair or orders for new materials to be sent from examination bench or fitting dept. the following number of working days in advance of "Gear" date.			BASIS FOR WORKMAN'S TICKETS. All cards issued to workmen to be dated the following number of days in advance of "Gear" date.		
	SMITHY AND FORGE.	MACHINE SHOP.	TO ELECTRIC WELDERS.	SMITHY AND FORGE.	MACHINE SHOP.	ELECTRIC WELDERS.
Axle-boxes	—	8	—	—	4	4
" W.I. (new)	23	18	—	18	—	4
Brake Gear.........	18	9	12	9	4	9
Con. Rods (new)	20	11	—	17	5	—
Side Rods (new)...	18	8	—	14	2	3
Motions (new) ...	22	8, new 20	—	20	4	3
Pistons	—	6	—	6	3	2
Valve Gear (new)	24	20	—	20	10	—

NOTE.—Tubes, boiler mountings and regulators to be delivered to the boiler 7 working days in advance of finished boiler date.

All internal pipes to be fitted and ready for boiler mountings 7 working days in advance of finished boiler date.

CALENDAR FOR JULY, 1931.

Working Days—Monday to Saturday.

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
			1	2	3	4
5	6	7	8	9	10	11
12	13/	14	15	16/	17	18
19	20	21	22	23	24	25
26	27/	28	29	30	31	

APPENDIX I.

FORM 1.

(USED BY THE MATERIAL CONTROL.)

1 ITEM	2 Nos. Reqd. for week ending				3 Quantity supplied during week ending 2 Nov.					
	2 Nov.	9 Nov.	16 Nov.	23 Nov	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.

NOTE.—One copy is sent to the supplier and one copy is retained by the M.C. Column 3 is repeated on this same form for each week of the month. Thus every day of the month is shown on this form. Space does not permit the whole form being shown on this page.

FORM 2.

(Card 8" × 7".)

(USED BY THE PROCESSING SECTION.)

DETAIL NO.	NAME OF COMPONENT.		Sheet No.
27104	*Starter Jaw.*		
Operation No.	**Description of Operation.**	**Rate.**	**Unit Type or Series.**
1.	*Turn outside and drill hole, etc.*	*4d. each*	*Type A*
2.	*Mill jaws*	*5d. each*	,,
3.	*File up—Fitters*	*1d. each*	,,
4.	*Carbonize, etc.*	*10d./doz.*	,,
5.	*Bore and tap BSF hole, etc.*	*3d./doz.*	,,
6.	*Harden*	*4d./doz.*	,,

NOTE.—The prices shown above are purely fictitious. There are actually nine operations to complete a starter jaw, but only sufficient are shown above to show how processing is done.

FORM 3.

(Card 5" × 3".)

(USED BY THE PROCESSING SECTION.)

NAME OF DETAIL.	RECEIVED.	SERIES.	DETAIL.	
Starter Jaw	*26/10/35*	*Type A*	*27104*	
Description of alteration.		Department.	Sig.	Date.
Ext. Dia. increased $\frac{1}{8}$"		*Rate Fixing*	*X.Y.Z.*	*25/12/35*
		Noted A.B.C. (Foreman).		

FORM 4.

(USED BY THE PROGRESSING SECTION.)

Detail No.	Drg. No.	Description of Detail	No. off per Unit	Material	Form of Material	Source of Supply	Remarks
123456	*2240*	*Cylinder Head Nuts*	*13*	*Mild steel*	*$\frac{3}{4}$" Hex Bar*	*Machine Shop*	
16721	*3428*	*Starter Motor*	*1*	—	—	*Bought out*	*J. Lucas & Co.*

FORM 5.

TOP CARD.

THE STANDARD MOTOR CO., LTD.,
COVENTRY.

SANCTION CARD.

Part .... *STARTER JAW* ....

....

Series ......(*or type*)...... *A 10* ....

Drg. No....*12345*......... Detail No....*27104*...

Component ....

Operation Sheet No................... **2** ......

Operation .... (*red*)

Section............*Machine Shop* ... .

Machine Tool No....................................

RATE.

2—4	4—8	8—F
Date	Date	Date

Batch	*1*	*2*	
Quantity	*50*	*50*	
TOTAL			

Workman's Name	Check No.	Quantity Issued	Quantity Passed	Insp'tion Note

(*Front of card*)

Workman's Name	Check No.	Quantity Issued	Quantity Passed	Insp'tion Note

S.M. CO. FORM 316

(*Back of card*)

OPERATION No. 1

CONTINUATION CARD

Workman's Name	Check No.	Quantity Issued	Quantity Passed	Insp'tion Note
A. B. Smith	*137*	*50*		*X.*
		1	*49*	*Jones*

H.A.S S.M. CO. FORM 733. 96278

(Front of card)

CONTINUATION CARD

Workman's Name	Check No.	Quantity Issued	Quantity Passed	Insp'tion Note

H.A.S. S.M. CO. FORM 733. 96278

(Back of card)

FORM 6

(Cover sheet)

LEFT PAGE

THIS TALLY MUST ACCOMPANY THE WORK THROUGH EVERY OPERATION.

INSPECTION AND STORES DEPARTMENTS MUST NOT ACCEPT WORK WITHOUT THIS TALLY.

WORKMEN MUST SEE THAT QUANTITIES SENT FOR INSPECTION OR RECEIVED AFTER INSPECTION ARE CORRECTLY INDICATED ON THIS TALLY AND CORRESPOND WITH INSPECTION NOTE UPON WHICH PAYMENT IS MADE.

RIGHT PAGE

S.M. CO. Form 536 F.

20 (red) Tally No....*20 (red)*

THE STANDARD MOTOR CO., LTD.,
COVENTRY.

PRODUCTION TALLY

Part...........*Starter Jaw*................................

....

Series..............*A 10* ....

Detail No. .... *27104* ....

Drawing No. ....

Quantity...

Batch .... *2* ....

Component ....

Material issued by ....

Date........... *26/10/35 (black)*.....................

Quantity passed to Stores ....

6 Nov. 35 (red)

Passed by ....

Date ....

Received in Stores by ....

Date ....

Remarks ....

.... *5 Nov. 35 (blue)* ....

....

....

(One side of folded card as above, reverse blank)

FORM 6.

(Inner sheets consisting of slips of paper of various colours)

(Pink slip) REQUISITION

CASH'S LANE Tally No.........*20*.....

To Stores.

Please Supply ....*Starter Jaw* ....

....

Detail..............*27104*	Quantity ....
Series......*A 10*..................................	....
Batch No. ....*2*..............................	....
....	....
....	....
S.M. CO. FORM 721	

(Top white slip).

P 74417	**P** 74417
VOUCHER FOR PAYMENT.	**Voucher for Payment**
Operation No...............*1*...... Tally No.......*20*	Tally No. ......*20*...........
Operation......*Turn outside and drill hole, etc.*...............	Detail No. ...*27104*........
Series.........*A 10*......................*Bar Auto*...........	Oper. No. ...... *1*...........
Detail No.......*27104*........... Component..............	Price ...*4d. each* (*red*) ......
Description ....*STARTER JAW*......................	Wages...*16/3* (*red*) ....
Batch..*2*...Workman's Scrap...*2* (*red*)...Maker's Scrap...	Qty. Passed ......*49*........
Workman's Name...*A. B. Smith*....... Check No....*137*...	Name...*A. B. Smith* ......
Examiner's Sig....*X. Jones*...... Week ending..*9 Nov. 35*	Check No. *137*.............
Qty. for Payment... *49* (*red*)... Price *4d. each* (*red*)...	
Wages...*16/3* (*red*)	Exam. Sig....*X. Jones* ...
S.M. CO. FORM 537	

(White slip)

P 74418	**P** 74418
VOUCHER FOR PAYMENT.	**Voucher for Payment**
Operation No...............*2*...... Tally No.......*20*	Tally No. ......*20*...........
Operation......*Mill Jaws. HORIZ. HILL*	Detail No. ...*27104*........
Series.........*A 10*	Oper. No. ...... *2*...........
Detail No.......*27104*........... Component..............	Price ....
Description ....*STARTER JAW*......................	Wages ....
Batch...*2*... Workman's Scrap ...... Maker's Scrap.......	Qty. Passed ....
Workman's Name........................Check No.	Name..........................
Examiner's Sig. .... Week ending	Check No. ....
Qty. for Payment......... Price ....Wages	Exam. Sig. ....
S.M. CO. FORM 537	

(White slip)

P 74419	**P** 74419
VOUCHER FOR PAYMENT.	**Voucher for Payment**
Operation No...............*3*...... Tally No.......*20*	Tally No. ......*20*...........
Operation......*File up Fitters. G*	Detail No. ...*27104*........
Series......... *A 10*	Oper. No. ...... *3*...........
Detail No.......*27104*........... Component..............	Price ....
Description ....*STARTER JAW*......................	Wages ....
Batch...*2*...... Workman's Scrap ...... Maker's Scrap.....	Qty. Passed ....
Workman's Name ....Check No........	Name ....
Examiner's Sig. .... Week ending.........	Check No. ....
Qty. for Payment......... Price..............Wages.........	Exam. Sig. ....
S.M. CO. FORM 537	

FORM 7.

PRODUCTION CONTROL DEPARTMENT. OCTOBER 28TH, 1935

PRODUCTION SCHEDULE FOR NOVEMBER.

TYPE	*Weeks Ending* 2nd	9th	16th	23rd	30th	TOTALS

FORM 8.

WEEKLY SCHEDULE.

Delivery to Sales, Week ending...193

Issued to...

Issued from Planning Dept...

Batch No.	Type	Colour	Trim. Comb.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTALS
TOTALS		Nine S.W.B.								
		Nine S.W.B. Chassis...								
		Nine L.W.B.								
		Nine L.W.B. Chassis...								
		Ten								
		Ten Chassis								
		Light Twelve								
		Light Twelve Chassis								
		Twelve								
		Twelve Chassis								
		Sixteen								
		Sixteen Chassis ...								
		Light Twenty								
		Light Twenty Chassis								
		A. Twelve S.								
		A. Sixteen S.								
		S.S. Chassis								
		Twenty								
		GRAND TOTALS ...								

S.M. CO. FORM 726

FORM 9.

PRODUCTION CONTROL SHEET. Date Issued.............. Sheet No............

BATCH	TYPE	EQPMT.	BODY COLOUR	TRIM	WINGS	WHEELS	BODY NO.

(These headings will be adapted to suit the actual Unit being manufactured.)

APPENDIX II.

Form 1.

CARD ISSUED TO SHOP FOREMEN. WHITE CARD.

Engine No. ....
Gear at Erectors Date ....
Work ....
Signed ....

Form 2.

CARD ISSUED TO SHOP CHARGEMEN. BLUE CARD.

Engine No. ....
Gear at Erectors Date ....
Work ....
Signed ....

Note.—Since a charge-hand knows (from the Table of Times) how long he has got for the job, on receiving his ticket and seeing the "Gear at Erectors" date, if time is getting short, he goes off in search of the job and so automatically helps to keep work on the move and up to date.

Form 3.

(CARD ISSUED TO WORKMAN.)

(Various colours, according to the shop in which the work originated, are used. Each shop has its own colour for a job which originates in it.)

(A) (CARD USED WHEN MORE THAN ONE SHOP IS INVOLVED.)

Engine No. ....
Date Work Received ....
Date Passed to.................... Shop ....
Work ....
Signed ....

Date Work Received.....................................
Date Passed to...................... Shop ....
Signed ....

Date Work Received.....................................
Gear at Erectors Date..................................
Signed ....

(B) (CARD USED WHEN ONLY ONE SHOP IS INVOLVED.)

Engine No. ....
Gear at Erectors Date ....
Work ....
Signed ....

THE LAST DAYS OF AN OLD TURKISH BRIDGE IN PALESTINE.

By LIEUTENANT E. C. W. MYERS, R.E.

THE British-built standard-gauge railway line from Egypt runs from the Suez Canal Ferry at Kantara to Haifa. From Gaza to Tulkarm, an Arab town forty-six miles south of Haifa, it runs over the old Turkish alignment, but the part from Tulkarm to Haifa is new. From Haifa the standard-gauge goes no farther, but a narrow-gauge line joins this port with Affule.

Affule lies on the still intact Turkish 3 ft. 6 in. line which comes up from Tulkarm and goes on across the Jordan, to the Hedjaz railway at Deraa. The part of the little old Turkish line, about which this story is centred, is that which starts at Tulkarm and which winds its way into the Samarian Mountains to Massoudie. From Massoudie the old main line turns northwards through the Dothan Pass to Affule, while a branch continues eastwards ten miles farther into the hills and ends at Nablus. For reasons of economy the stretch between Massoudie and Affule has been closed, but, were it not for the Strike, a daily train would still be running between Tulkarm, Massoudie and Nablus.

From the junction at Tulkarm, the narrow-gauge line has a third rail alongside to take both small and standard-gauge trains for three miles to some stone quarries which are worked by convicts from a large settlement alongside. For some fifteen miles after this, the small railway and the road to Nablus share the twisting deep valley into the wild and rocky mountains of Samaria. The road up this valley is important because it is still the only one, except that via Jerusalem, which connects Jaffa with the north.

On May 21st, the 42nd Field Company, at only twelve hours' preliminary notice, had been ordered to Palestine to protect and if necessary maintain, the operation of the Palestine Railways.

At this time, the Arabs, in their attempts to stop all communications throughout the country, were continually making attacks on both the road and the railway from Tulkarm to Nablus. Traffic was being sniped at ; road convoys ambushed ; culverts destroyed ; huge boulders rolled down from the steep rocky hills in attempts to hit passing cars ; the road blocked ; telephone wires cut and posts uprooted ; and in many instances attempts at demolition by means of explosives stolen from local quarries were being made on the railway bridges which span the *wadi* beds of the innumerable subsidiary valleys.

Ten miles up from Tulkarm the railway crosses—or rather used to cross—a dry *wadi* bed and the main road alongside by means of a single old Turkish masonry bridge of two arches. (See Photos Nos. 1 and 2.) Towards the end of May an attempt at demolishing this bridge by the Arabs resulted in a few stones only being blown from the centre pier.

As a result of the persistent attacks by Arab marauders and because there was not a sufficient military force then to guard the railway, at the end of May it was decided to stop running trains to Nablus. As road transport, owing to the strike, was at a standstill, the closing of the railway line soon made the local inhabitants of Nablus run short of food, because, living in the centre of a hilly and barren area, they are far from self-supporting. In return for a large exporting industry of soap they import the majority of their foodstuffs. Huge stocks of their flour began to accumulate at Tulkarm and to become an embarrassment to the " Railways."

The Arabs began to realize that their attacks on the railway were cutting their own throats. Local sabotage decreased; and when it was learnt that the soap manufacturers in Nablus were furtively carrying on their work behind shuttered houses in spite of the orders of the Arab Strike Committee, the railway authorities, in order to encourage the non-striking community, asked for military co-operation and permission to run a train of provisions through to Nablus, in return for a load of soap. After much argument and delay, the local military area commander agreed, and on June 2nd an armed train of some half a dozen trucks, with Sappers on the footplate and in the brake-van, supported by the Air Force and armoured cars to prevent interference by Arab marauders from the hills, puffed its way up the line to Nablus, over the old Turkish bridge and over many other mouse-eaten culverts, results of Arab attempts at demolition.

While the train was unloading and reloading in the middle of the day at Nablus, some Arabs must have crept out and had another quick nibble at the bridge already mentioned, for, when the road convoy arrived back there slightly in advance of the returning train the bridge was found to be in an even weaker state than in the morning. A soldier was sent up the line, at the double, to warn the oncoming train. But it was just too late. The train could not be pulled up in time. With all brakes on and wheels skidding the engine passed over the bridge and did not pull up until a hundred yards on the far side. Miraculously the pier had held up. The watching convoy breathed again. And that was how the last train passed over this old Turkish bridge. (Photo No. 2.)

However, when Force Headquarters heard of this " party," they disapproved of the Area Commander's action on the grounds that Nablus contained a really " bad lot," and the supply of provisions—

even in exchange for soap—was considered to help the enemy camp. "No further trains were to be run." The reply from Area to Force H.Q. was duly sent, "No further trains *could* be run, because of the state of the Turkish bridge."

This set the Arabs off again, nibbling the railway elsewhere, sometimes in their attempts blowing themselves up, but slowly gaining knowledge in the use of explosives. It was feared that a final nibble at the double-arched bridge would bring the whole affair down just at a time most inconvenient to us, when an important troop move might be in progress. Consequently the military authorities, upon Engineer (42nd Field Company) advice, applied for permission to demolish this bridge.

After a discussion between Force Headquarters at Jerusalem and the railway authorities at Haifa, it transpired that the "Railways" had a scheme several months old for replacing the masonry bridge by a girder one to allow for widening of the road. So it was not long before permission was obtained to blow the bridge up, on the condition that the abutments were left unharmed in order to take the girders of the new bridge when constructed.

On the evening of the 11th June, orders were received for the demolition to take place on the 13th. A detachment of the Seaforths from the battalion stationed in the old Turkish fort at Nablus would picket the heights to prevent Arab interference; a party of the 42nd Field Company would blow up the bridge; and a gang of convicts from Tulkarm prison would come along to clear up the mess and re-open the road. All was to be done between 9 a.m. and 1 p.m. in order not to interfere with the convoy timings; for at this period of the strike the only means of road communication for non-striking civilians was by military protected convoys, timed to connect with each other at fixed points throughout the country.

A reconnaissance of the bridge on the 12th June, revealed that the Arabs had removed yet a few more stones from the centre pier, and that some young bird, judging by the squawks which were emitted, had its home in a long weephole situated above the centre pier. The dimensions of the bridge were as follows:—

(Both arches similar.)

Span of each arch	18 ft.
Height of each arch	13 ft.
Thickness of arch ring	1 ft. 6 in.
Width of centre pier	13 ft.
Thickness of centre pier	5 ft.
Thickness of centre pier where most nibbled by Arabs	3 ft.

The Field Company possessed large stocks of locally commandeered dynamite. It was decided to make use of the Arab nibbles into the

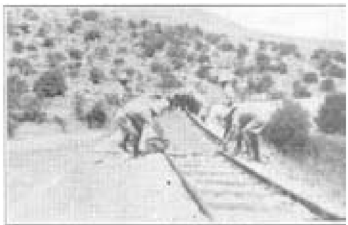
1.—A general view of the bridge.

2.—The last train.

3 —The centre pier on June 13th.

4.—Revetting for the charge.

5.—Revetting for the charge.



6.—Sliding a section of rail from off the bridge.

The last days of an old Turkish bridge in Palestine 1-6

7.—A view of the demolition from the firing point.

8.—Immediately after demolition.

9.—Natives clearing the roadway.

The last days of an old Turkish bridge in Palestine 7-9

centre pier, as they made a good " chase " for a continuous charge. From the formula $\frac{3}{4}BT^2$, 90 lb. of dynamite would do the work. It was desired to break up the bridge thoroughly in order to facilitate removal of debris. It was not wise to put a charge in the haunches for fear of damaging the abutments. It was found that two layers, each of eleven 5-lb. boxes of dynamite (in boxes 5 in. x 9 in. x 3 in.), laid end to end and tamped at both ends of the chase, fitted conveniently. Therefore 110 lb. of dynamite were to be used, the charge being detonated at four points equal distances apart—by commercial electric detonators, with four " No. 8's " each with separate but equal lengths of safety fuse as an alternative method. (There was a scarcity of " F.I.D." at that time.) A corrugated iron wall, revetted by angle iron pickets, was to be built alongside the pier ; a sandbag base to be prepared for the charge, which was to be tamped by earth and a layer of sandbags on top. (Photos Nos. 4 and 5.)

A detachment of an officer, N.C.O., and 10 men of the 42nd Field Company arrived at the bridge soon after 9 a.m. on the 13th, after a 60-mile motor journey from its headquarters, then at Sarafand. The picketing parties of the Seaforths arrived a few moments after them, and at 9.15 a.m. work commenced.

After half an hour's work, a very agitated native railway official arrived on foot—probably having walked the ten miles from Tulkarm—and asked the R.E. officer if he would be kind enough to pick off the nice facing stones from the entire bridge, as they were wanted to be saved by the railway authorities. It was regretted there was not time—it would have taken two busy days with masons' tools—to chisel them out. It was pointed out that he would be able to sort out his facing stones after the demolition of the bridge (?) ; but it was a sadder and dubious official who walked off back to Tulkarm.

Although progress was slow owing to the tricky revetting (see Photos Nos. 3, 4, 5 and 6), all was ready to fire soon after 10.30 a.m. and at 10.45 a.m. a Mk. V exploder at the end of three hundred yards of double cable, from a good vantage point on the hillside, two hundred feet above the level of the bridge, did its work at the first attempt. (See Photos Nos. 7 and 8.)

Few large pieces of bridge flew about, and after the explosion the road on both sides of the bridge was still absolutely clean. Only one or two bits succeeded in going any distance, and those went vertically skywards. The general effect of the explosion seemed to be to lift the whole centre portion of the bridge a couple of feet, before the entire outfit collapsed like a pack of cards. Apart from two large pieces of the haunches of the centre pier—about four feet cube—everything broke up into tiny pieces and was easily removed by the native convicts. (Photo No. 9.)

The work of clearing up the road had hardly started when a squawking was heard coming from beneath the debris; and from out of the shattered remains was excavated a complete and very much alive young hawk—undoubtedly the same bird that had been heard the day before during a reconnaissance with a long stick into its weephole home. The bird must have been blown up inside the weephole, which temporarily must have remained intact.

It was possible with the trained convict quarrymen to pare off the loose and shaken haunches from the still firm abutments. By 12.15 p.m. the road was re-opened to traffic; and by 12.45 p.m. the job of clearing up was completed. As the detachment of the Field Company left, the convicts were climbing back into their cars, and it was noticed that a cheery rogue was taking to prison with him the young hawk. Let us hope one day it will escape to tell its tale, for there must be few hawks who can boast of having been blown up by a hundred pounds of dynamite.

Disorder, sabotage and violence in Palestine at the moment still continue, and as a result there is much interesting work for the Sappers. Since this article was originally completed, the 42nd Company have been called upon to drive armed patrol trains at night and have been called out on punitive expeditions to blow up Arab houses; and the 2nd and 42nd Field Companies between them have blown up no small part of Jaffa. It is hoped that someone better qualified than this writer will later find time to give details of the vastly interesting work—almost a Sapper's dream come true—of the large-scale demolitions in the Old City of Jaffa.

ARTILLERY SURVEY.

By CAPTAIN A. S. WILSON, Australian Staff Corps.

THE authors of "Skew Guns and Survey" and its sequel, which appeared in the December, 1934, and September, 1935, issues of *The R.E. Journal*, have provided an excellent summary and criticism of official artillery survey methods. Few gunners will disagree with the criticism of O's R. and B. especially in relation to the temporary grid, as defined by them. The alternative solution offered by the authors does not, however, carry the same conviction as the criticism; their solution is to substitute a large-scale map and simple map-reading for "the six hours of survey." All gunners will agree that map-reading from a large-scale map (supported by "shooting in for line") is easier, quicker and more reliable in small operations than a rushed survey; but obviously the first requirement, in the simple plan proposed, is the large-scale map itself. The authors of "Skew Guns and Survey" have not shown that such maps will always be available. In fact, it is up to O's R. and B. to inform the gunners how many hours before zero it will take to provide these; for instance, in defence, say (1) at Darwin (where no trig. control exists), and (2) at Sydney (where a close control is available). It would also be interesting to have times for large-scale mapping during an advance, for attacks, and for rearguard operations, under the various possible conditions.

A glance at page 393* will show that the production of a topographical map is a long process even when a triangulation exists in the theatre of operations, or has kept pace with the advance. If the control has to be carried from any distance the production of maps will take not hours but days, unless the R.E. initiate a survey in the area concerned and adopt a set of co-ordinates on a temporary grid, unrelated to the distant triangulation or its co-ordinates. (There is, of course, no need to call this grid "temporary"—if the word offends—for it will probably be used throughout the war. A more dignified name would be, say, "No. 5 (A) Zone Grid," indicating that the continuity of the grid in No. 5 Zone had been broken.)

Referring to the points raised by O's R. and B.

(1) Page 390, para. 3. It is agreed that the Corps Field Survey Coy. is seldom referred to in T.E.W.T's, but this is not the fault of the Artillery. There appears to be only one solution, and that is for those who appreciate the value and necessity of maps (on both large

* *The R.E. Journal*, September, 1935.

and small scales) to spread the gospel, so that the next war will not find us without a proper mapping policy, as occurred in 1914.

(2) Page 390, para. 3. The complaint that no official publication on "Survey in War" is available is very timely, and should stir both sappers and gunners to face their responsibilities. The matter is one which calls for co-operation between the two arms, but the initiative surely should lie with the sapper.*

(3) Page 391, para. 1. The objects of artillery survey are stated on page 391 as "surprise and effect." It would be more correct to say that these are the advantages which the gunners hope to reap from survey. The objects of artillery survey are :—

(*a*) The co-ordination of guns and targets so that the artillery methods of predicted fire, as developed in the Great War, may be retained. Such methods in their highest form include the use of both large-scale maps and survey.

(*b*) To form the basis for co-ordinating all counter-battery work, which embraces every form of target location, such as air observers, air photos, flash-spotting and sound-ranging, and other ground observers.

(*c*) Together with air photos and other means of target location to supply a temporary expedient or substitute for large-scale maps in the early stages of an operation.

(*d*) To assist observed shooting.

When these requirements are satisfied, surprise and effect (given observation, or calibration and meteor, *i.e.*, *a weather telegram*), on any given target, follow automatically.

It is advisable to keep these larger aspects of survey in mind and, as O's R. and B. suggest, to refrain from thinking of survey only in relation to the quick-fire plans of small advanced-guard schemes.

It may be logically contended that, if survey is to be used seriously only in larger operations (say for a division or corps), it is best done by Sappers, and should form part of their survey programme. It is unlikely, however, that the R.E. will be prepared to furnish personnel for sound-ranging and flash-spotting groups in peace or war, and in any case it has already been agreed these shall be under the R.A. A Survey Coy., R.A., of two groups, supported by surveyors, thus appears inevitable, whether large-scale maps are available or not.

The question of co-operation between Survey Coys., R.E., and R.A., which is raised in para. 3, page 391, is not so difficult as O's R. and B. think, if particular cases are considered. A generalization relating to unstated conditions must be vague and unconvincing. The trouble lies in the lack of any official doctrine, and, to meet this in Australia, we have developed a tactical teaching to ensure co-op-

* Since writing this it has been learnt that a publication entitled *Surveys in War* is available in India.

eration between an Artillery Survey Coy. and the *Survey Corps* (the Australian equivalent of Survey Coys., R.E.).*

(4) Page 396, para. 2. O's R. and B. raise the question of when a brigade survey should commence. If the brigade is acting as advanced guard to a division, survey should commence as soon as the vanguard meets serious opposition. The survey so commenced is not for use in the vanguard fight, but is to ensure that no time has been lost, should the brigade or divisional artillery be deployed. To this end the brigade survey party and a reconnaissance party from the Survey Section† should march in rear of the vanguard. The function of the brigade survey party is to commence the survey for co-ordinating the whole brigade, in the event of it being deployed.

The function of the reconnaissance party is to assist in tying on to the existing triangulation (if any), or in co-ordinating the surveys by leading brigades on parallel roads, so that all surveys shall be on the same grid (the permanent, or zone grid, if possible) from the outset.

With O's R. and B. we will endeavour to avoid temporary grids, especially among brigades, for the very same reasons as tabulated by them. The term "temporary grid," as defined on page 396, *et seq.*, calls, however, for some comment. The original meaning of the term was that it signified a co-ordinated *survey* based on an assumed origin, and perhaps an assumed azimuth. This procedure is, of course, necessary in any survey when a trig. control is not available, or cannot be utilized in the time available. The co-ordinates of such a survey would be as close an approximation as possible to the map, since the co-ordinates of an initial station would be read off the one-inch map. Bearings would be based on an astronomical determination whenever possible.

The next stage in the development of artillery methods was to use guns as survey instruments, to deduce the co-ordinates of targets. This is a perfectly legitimate occupation for a gunner, provided he has the time, and a knowledge of the various necessary correcting factors. The process, however, is not surveying, but is an interesting

* To avoid confusion between the terms Survey Coy. and *Survey Corps*, the latter is shown throughout in italics.

† The Australian organization for a Survey Group is as follows :—

- Survey Group.
  - Group H.Q.
  - No. 1 Section.
  - No. 2 Section.
    - Sec. H.Q.
      - Reconnaissance Party
      - Computing Party
    - "A" Sub-Section.
      - 2 Traverse Parties, each of 4 men.
    - "B" Sub-Section.
      - 2 Traverse Parties.

Traverse Parties are organized for traversing but can be broken down for triangulation.

and valuable exercise in pure gunnery, and is called "deducing co-ordinates from shooting." The process will be carried out by gunners (not by brigade surveyors in their primary role) no matter what grid is in use, and so need not be considered as a peculiarity or weakness of the temporary grid.

The real weaknesses of a temporary grid are :—

(i) lack of co-ordination if brigades are on different grids, and the resulting difficulties when co-ordination is eventually ordered ;

(ii) the existence of different sets of co-ordinate values (Engineer, *Survey Corps*, or temporary artillery grids) in the one area.

(*In war it is likely that the anticipated worries regarding grids will not be serious, unless the whole war consists of perpetual movement.*)

Temporary Grids by leading brigades. The question of temporary grids has caused much discussion and thought to those interested in artillery surveying. The problem ultimately reduces to the following questions :—

(*a*) whether, in an endeavour to save time, a temporary grid, or grids, should be officially initiated ;

(*b*) whether leading brigade surveys should be placed under higher control immediately, so as to ensure co-ordination from the outset.

The guiding factor in making a decision is the strength of the opposition, for the stronger the opposition the greater the time required for preparing the attack, and consequently the more time there will be for survey. In many T.E.W.T's the finding of the enemy and the gauging of his strength is left completely to the advanced guard commander, whereas in war, air and cavalry reconnaissance, both distant and close, will give ample warning and information to the commander of the force, and thus prevent the advanced guard suddenly striking the enemy *in strength.* If this contention is admitted, the variety of difficulties which can be raised regarding grids during an advance are seen to be unreal, for given warning of the presence or strength of the enemy, time will be available to arrange proper co-ordination. In triangulated or mapped country this should always be on the permanent grid ; in untriangulated country the co-ordination should consist of one grid based on the best information available, and initiated by the highest artillery commander in the area.

(5) Page 401, para. 2. O's R. and B. conclude by stating that artillery surveys on the permanent grid, and large-scale maps, supply the remedy for all the gunner's survey problems. To a great extent this is true, but survey data is necessary for accurately laying out the initial, or "original," line of fire of a battery. Survey data is also essential for use by flash-spotting and sound-ranging groups.

These ideal conditions should always be found in prolonged operations, but in the early stages of a campaign and in new theatres, there is a strong chance that no trigonometrical control, let alone large-scale maps, will be available at the outset, or that the control will not be sufficiently dense for immediate use by batteries. The accepted function of artillery survey under these conditions is to supply the artillery with survey data as an immediate substitute for large-scale maps, and if necessary for the permanent grid. Meanwhile arrangements for the production of large-scale maps are, we hope, in hand.

The technique of artillery survey necessary to achieve its object depends on ground and air surveys, and will finally exhibit its results as *fighting maps* for battery, brigade, divisional, corps and counter-battery use. In other words a map, on the permanent grid if humanly possible, resembling in all details the map proposed by O's R. and B., except that it will be in one colour and lack the finish of the office-drawn article—but it will be plottably accurate. This work, except the reproduction, is within the capabilities of a Survey Coy., R.A., but no difficulty is expected in arranging reproduction within a corps—in fact it may well be done by the R.E. Lithographic Section of the R.E. Survey Coy. or *Survey Corps*.

Let us now consider the relation between the Survey Coy., R.A., and the brigade survey parties. These parties were introduced to speed up survey—before the advent of deducing co-ordinates by shooting—for it was found that the Survey Coy., R.A., could not be relied upon to produce data in the scheme-time of small operations. A new school therefore arose which initiated the idea of brigade surveys under brigade arrangements. This scheme was to ensure that the survey for a brigade was not delayed, as had occurred when brigades were entirely dependent on the Survey Coy., R.A. Brigade surveys now became the fashion, temporary grids for each brigade were accepted as normal, and methods for swinging and converting grids were treated as respectable survey processes. Meanwhile the Survey Coy., R.A., was almost ignored, or treated as something which would probably be useful in the event of trench-warfare. Occasionally a voice would cry in the wilderness and draw attention to the weaknesses of temporary grids and the need for a co-ordinating control on the permanent grid, but the answer was that such considerations were purely academic and only of theoretical importance, and that "commonsense, practical methods" were required in the field.

Where differences of opinion exist, there is only one way of reaching agreement as to the truth, and that is to investigate the whole subject in all its departments and build up a co-ordinated and logical synthesis, avoiding all innovations of the *ad hoc* variety to bolster up preconceived ideas. Such an investigation has been completed in this country; a summary of the general technical conclusions reached, and their tactical application, is given in the following paragraphs :—

TECHNICAL CONCLUSIONS.

A Summary.

1. The need for continuous liaison and co-operation with the *Survey Corps*, so that if possible all artillery surveys will be on the permanent or zone grid from the outset, and so that artillery and topographical surveyors will work with the greatest speed, economy and co-ordination towards the same end.

This liaison has been commenced in peace and its first results are a better understanding between topographical and artillery surveyors. In addition the *Survey Corps* are including the following in their work of 1-inch map-making :—

(*a*) The inclusion of as many trig. points as possible on 1-inch maps ;

(*b*) The issue of a trig. list with each map sheet. This list gives the class or order, the description and location, co-ordinates, and reference bearings. The trig. points are classified as 1st, 2nd, 3rd and 4th class stations ; the 4th class include resected points additional to those necessary in the construction of the map.

The increased number of trig. points will facilitate the accurate fixation of O.P's, pivot guns and targets by gunners or by brigade surveyors in rapid surveys for those small operations, which are the subject of criticism by O's R. and B. In addition they will be of great use to surveyors and artillery in the brigade areas of a divisional or a corps operation.

(*c*) The inclusion on the map of convergence and time corrections at every minute of longitude for use with Daily Time Azimuth Tables. (These Tables give the true azimuth of the sun and a selected star at every 4 minutes of L.M.T.)

2. The early commencement of survey in all operations. So that the advantages of an early start shall not be sacrificed by unnecessary changes of grid, reconnaissance parties from the Survey Coy., R.A., and *Survey Corps* will accompany the leading brigades of a division or corps. These parties will assist leading B.S.O's to initiate brigade surveys on the correct grid, thus facilitating the co-ordination of all classes of survey.

3. Continuous contact between artillery survey units and artillery commanders to ensure early knowledge of artillery plans ; thus the Survey Coy. Commander becomes the survey advisor, or staff officer for survey, at Corps Artillery H.Q., and the Survey Section Com-

mander becomes the advisor or staff officer at Divisional Artillery H.Q. In each case the next senior survey officer carries out the actual technical duties for the necessary surveys.

4. The use of the following technique, when a dense control is not available :—

(a) *Triangulation* is used by the Survey Group only as a *control* (over the divisional or corps area) for the detailed surveys in the brigade areas. It will consist of a few triangles, if possible on a common base, for this reduces reconnaissance (that time-consuming factor), with its intervisibility problems, to a minimum.

(b) *Traversing* is used by the Survey Group and Brigade Surveyors for the *detailed survey* of points such as O.P's and pivot guns in brigade areas, except where resection or other trigonometrical devices are possible. The advantages of traversing are (*inter alia*)* that work can be commenced almost without reconnaissance, for traverse routes can be decided from the map. Triangulation is a geometrical process dependent on the ground, whereas traversing can conform to the tactical requirements and be taken direct to the areas required by the artillery.

(c) Target fixing is carried out as follows :—

Targets visible from O.P's	Targets invisible from O.P's
1. By O.P. personnel (range finder and director)	1. By Bde. and Survey Sec. Surveyors from air photos, using intersected points as a control.
2. By Bde. or Survey Sec. surveyors (by intersection, and, in defence, by direct means).	2. By shooting with air observation.
3. By differential measurements from a 1-inch map.	3. By differential measurements from the map.
4. By shooting and ground observation.	
5. From air photos.	

* Other advantages are :—

(a) Unlike triangulation, the rate of traversing can be accurately calculated and so the time for a survey can be determined. Conversely, the amount of survey which can be done in a given time can be quoted ;

(b) Traversing can be carried out by night, or thick weather, and so is a certain instrument in war.

These advantages are only claimed for traverses which are carried out by the Australian method, which differs radically from that of the R.E.

(*d*) The use of astronomical methods whenever possible (1) as a means of ensuring a correct and common orientation among brigades, (2) as a means of eliminating errors and discovering mistakes in bearings, and (3) to facilitate computation.

SOME TACTICAL CONCLUSIONS.*

A Summary.

The division of responsibility between the Survey Group (or Sections) and the brigade survey parties is as follows :—

A. CENTRALIZED CONTROL, *e.g.*, when time is available thoroughly to organize and carry out a survey—say, for defence before the enemy has made contact.

The C.C.R.A. (or C.R.A.) will inform the Survey Coy. (or Section) Commander on (*inter alia*) the following matters, as may be relevant :—

(1) The proposed deployment of the artillery brigades ;
(2) Time by which survey data must be available in brigade areas ;
(3) Requirements for counter-battery work ;
(4) Policy regarding sound-ranging and flash-spotting.

The Group, or Section, Commander, knowing the existing survey situation, will then carry out a reconnaissance accompanied, if necessary, by the commanders of the flash-spotting and sound-ranging groups and a representative of the *Survey Corps*.

A detailed and co-ordinated plan under centralized control will then be drawn up for the survey of the position, which will include :—

(1) A close control, on the permanent grid if possible, with an eye to extension front and rear ;
(2) Fixation of points in brigade areas, or other facilities for the brigade survey parties, who will be required to fix O.P's, pivot guns and selected targets ;
(3) Air photo requirements for the preparation of a large-scale fighting map of the area, unless the *Survey Corps* can guarantee a large-scale map in the time available ;
(4) Co-operation with brigade survey parties, and with the *Survey Corps* ;
(5) Allotment and time-table of tasks.

B. DECENTRALIZED CONTROL. For instance, for an attack under divisional control, preceded by advanced guard operations.

* Space does not permit of a complete thesis on the tactical employment of a Survey Group, or Section, in all classes of operations.

The Advance.

Surveys for leading brigades. When the vanguard meets serious opposition the B.S.O. will commence a survey to meet requirements of the leading brigade, in case it should be deployed. So that this survey may be initiated on the permanent grid, the B.S.O. is accompanied by a Reconnaissance Officer (R.O.) and party from the Survey Section, who will assist the B.S.O. as follows :—

(*a*) By tying the survey to the existing triangulation, if any ;
(*b*) By co-ordinating the survey with that of other leading brigades, if necessary.

The leading B.S.O. is also accompanied by a *Survey Corps* representative, whose functions are to assist in placing brigade surveys on the permanent grid from the outset. He will, if possible, be a surveyor who has worked in the area in peace. His duties will include :—

(*a*) Identification of permanent trigs. visible from the line of advance ;
(*b*) When a triangulation is brought up from the rear, but is some distance from artillery surveyors, the *Survey Corps* representative may arrange co-operation. This may be effected by (1) the *Survey Corps* observing long rays to a beacon or beacons specially sited by their representative in the forward area, or (2) the Survey Coy. observing to the rearward points and employing precise methods of observation and computation. The fixation of these points need not necessarily await contact with the enemy, but may be fixed at intervals when conditions are suitable. Points so fixed may be subject later to small additive or subtractive corrections. Such corrections should not affect co-ordinates used by the artillery. At times it will be advantageous to observe long rays by night, and for this purpose long-range Lucas lamps have proved useful.

The Attack under Divisional Control.

The survey carried out by the leading brigade or brigades will form the basis for co-ordinating the whole of the divisional artillery, and to this end the Reconnaissance Officer must inform the Section Commander (who is with the C.R.A.) of the present survey situation.

The Section Commander will then obtain information from the C.R.A. on the following points :—

(*a*) The artillery dispositions ;
(*b*) The outline plan as affected by survey ;

(*c*) The time by which survey data is required by brigades. (The commander of a large force will, without doubt, consider the time required by surveyors as a factor in deciding the zero hour, for survey data will often be as important as ammunition or any other battle requirement);

(*d*) The nature of the grid. This will be ordered by the C.R.A. after consultation with the Section Commander.

The survey solution in this case differs from one in which time is available for centralized control of all survey resources. Here there may not be time for detailed arrangements for the co-operation between the Survey Section and the survey parties of incoming brigades. The Section will extend the leading brigade survey, probably by traverses, into the areas to be occupied by incoming brigades. Section officers will establish touch with B.S.O's through Divisional Artillery and Brigade H.Q's, so as to supply the brigade survey parties with starting-points or means of co-ordination.

If necessary, a portion of the Survey Section will superimpose a control over the divisional area while the detailed work is being performed. In addition the following tasks will be carried out:—

(*a*) Intersection of points for controlling the plotting from air photos of target areas invisible for O.P's;

(*b*) Preparation of a divisional fighting map;

(*c*) Reconnaissances and preparations for extending the survey forward and rearwards to meet future eventualities;

(*d*) Co-operation with the *Survey Corps.*

* * * * *

It is hoped that the points discussed in this paper will answer the questions raised by O's R. and B. and help to further co-operation between those who consider the question of survey and maps as vital in war.

A TRIP TO KABUL.

By CAPTAIN C. T. EDWARDS, R.E., *p.s.c.*

THE writer was fortunate enough, in June, 1933, to be one of a party of three officers who obtained permission to travel from Quetta, via Chaman and Kandahar, to Kabul. It is thought that a short account of the trip will prove of interest to officers who have served in Northern India.

The party consisted of five, a gunner, a 2/11th Sikh, the author, a bearer, and a small garage proprietor from Quetta. The last was an unusual character. He had served in the Navy, in the Persian Gulf, had travelled extensively, and had a smattering of many tongues. He was then taken to act in the dual capacities of interpreter—both Persian and Pushtu—(Persian is largely spoken in the Kandahar province of Afghanistan), and mechanic, so that Master might not be too much troubled with the sordid business of punctures. In this, however, he proved a broken reed, with the result that the B.O's of the party rapidly acquired an unusual dexterity in this respect.

Two cars were taken, W-A's new Hillman twenty saloon, and the writer's 24-h.p. Ford, which already had some 4½ years' Indian service, and 28,000 miles, to its credit. Equipment taken included bedding rolls and kit, three days' food and drink, petrol for three hundred miles, a spare spring per car, and a selection of tools and spares. Both cars had the equivalent of five persons on board, which made them somewhat heavy on their springs. The Hillman gave a little trouble; when it got hot the diaphragm of its petrol pump refused to function, and caused delay on several occasions. In addition, its rear petrol tank hit a rock crossing an irrigation cut beyond Chaman, and sprang a leak: this was patched with soap, which proved quite satisfactory. The Ford gave no trouble at all, but both it and the Hillman suffered badly from punctures caused by *chapli* nails.*

The party left Quetta at 6 a.m. on May 25th, 1933, with the object of doing the 76 miles to Chaman before a nine-o'clock breakfast. The Hillman passed out on the Khojak Pass, however, and we did not arrive at Chaman till half-past ten, and so could not leave on the 66 miles lap to Kandahar till eleven-thirty.

The journey between Kandahar and Chaman is made frequently during the summer by numbers of lorries bringing fruit from the

*Heavy Sandals

Kandahar area to railhead at Chaman. These lorries use the old direct caravan route via Mel Manda and Dabrai, which, except for the first twenty miles out of Kandahar, is merely a camel track. Leaving Chaman we soon arrived at Spin Baldock, or Kila Jadid as it has been named since the 1919 war, where we had to wait for half an hour while our passports were scrutinized by the easy-going commandant of the Fort. As soon as we continued our journey, we found ourselves on the sandy *patt* of the Spin Baldock Plain. Though passable to occasional M.T. in fine weather, this *patt* breaks up at once under continuous traffic. For the next fifteen miles, therefore, the track was several hundred yards wide, caused by successive lorries easing off to either side in order to find better going, and consisted of deep ruts full of dust ; a weary stretch, most of which had to be traversed in bottom gear. Nearing Dabrai the plain sloped gently upwards to the Bidarzai Kotal, which leads through the low range of hills between Dabrai and Mel Manda. Though rough and stony, this stretch was much preferable to the sandy *patt*. Beyond Mel Manda the Ghlo Pass had to be traversed before the Kandahar plain was reached. The last twenty miles into Kandahar lay along a graded formation, devoid of foundations or surfacing, but which was provided with rough bridges over occasional water-channels. Most of the country between Chaman and Kandahar is arid and desolate in the extreme, and singularly devoid of water ; to the west of the route lies a considerable desert. This can be seen, from time to time, an endless expanse of ridges of reddish sand. The Kandahar plain itself, however, is very fertile, drawing, as it does, large supplies of water from the Tarnak river. On passing through the Ghlo Pass one comes first of all on poor-looking stretches of crops. Approaching Kandahar these improve, until, on topping the last rise some six miles from the city, one can see that the area immediately surrounding the city is very green, and contains large numbers of orchards and gardens.

We reached Kandahar about an hour before dark, and made our way to the British Consulate, where we were hospitably received by the Consul, a very helpful Indian of good family from the Punjab. The consulate consists of an old Persian house, surrounding a courtyard, and is quite well built. A feature of the house is the underground rooms, to which the household retreat as a protection from the summer heat, which in June and July is considerable. The city proper is surrounded by a wall, no longer continuous, in which are a number of gates, and which is of considerable extent. So far as we could judge it was roughly in the shape of a square, each side rather more than half a mile long. Outside the walls the city is extended in all directions by the suburbs, a succession of villages, orchards and gardens, which appear to extend for some ten miles in each direction. We unfortunately did not have time to visit the many places of

The Bidarzai Kotal, 20 miles beyond Chaman.

Kandahar, the Bazaar centre.

Kandahar, the N.W. Suburb, looking towards the Baba Kotal Wali. Girishk road in foreground.

A trip to Kabul 1-3

Kandahar, the Argandab River, showing new ferry under construction, and lorries waiting on the far bank.

Kelat-i-Ghilzai, the fort from the south. Note the road, with its side drains, and telegraph pole

Ghazni, a south view taken rather more than a mile away. Note the road on the left.

interest around Kandahar, as time was very short, but we managed to get as far as the Arghandab river, some ten miles out on the Giriskh road. This river drains an extensive area for some 250 miles to the north-east; it is a perennial stream, and, during the spring and early summer, while the snows are melting, it is, at Kandahar, a rapidly flowing river some hundred yards wide. Vehicles using the Kandahar-Giriskh road cross the river by means of a rickety ferry. A feature of the Kandahar province is the beehive huts. Wood is very scarce in this area, and accordingly the roofs of all except the largest houses consist of a dome-shaped structure of mud bricks.

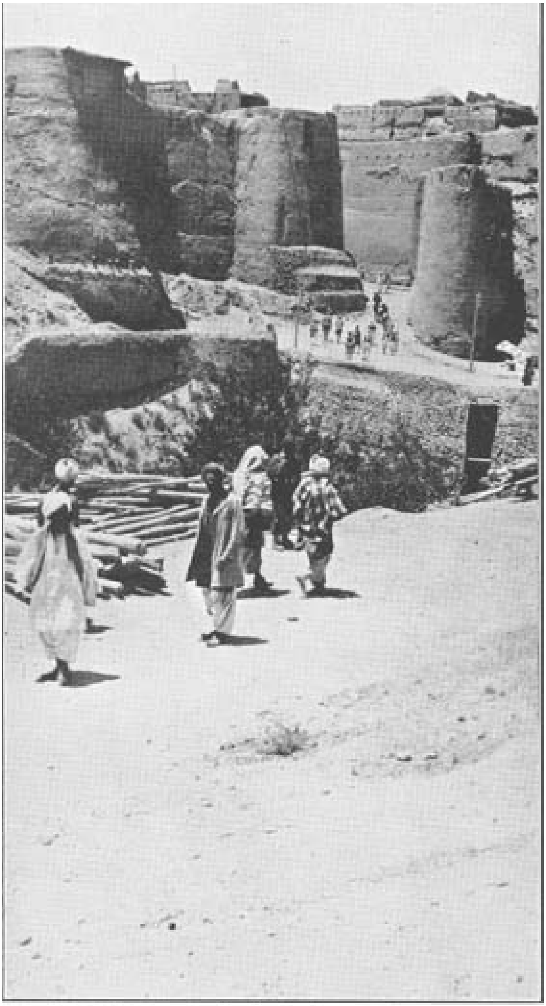
There is an existing road all the 317 miles from Kandahar to Kabul, consisting of a well-graded formation with no foundation or surfacing. This road was obviously laid out by a competent engineer, but is rapidly deteriorating owing to lack of maintenance and drainage. At the time of its construction it was bridged for all its length. South of Ghazni, these bridges are made of sun-dried bricks, built in proper arch formation, with, in some cases, a number of intermediate piers. The waterways allowed for, however, were in almost every case inadequate, with the result that few of these bridges were, in 1933, fit for traffic. No attempt had been made to repair them, but in every case rough deviations existed, ramping down to the nullah beds. North of Ghazni, the bridges consist of continuous timber road-bearers of a span of some 15 ft. to 18 ft. covered with about 6 in. of earth. Intermediate piers, where these exist, are made of sun-dried bricks and stones. The majority of these bridges were, in 1933, still standing, though a number of them had holes in the roadway. All existing bridges were in use by lorries, overloaded according to the usual practice of our Aryan brother, and equivalent to laden 30-cwt. lorries. Only four of the river-beds crossed carried perennial streams, all of them being north of Ghazni.

The route from Kandahar to Kabul is, on the whole, an easy one from the road-making point of view, and would present little difficulty to the railway engineer. Having traversed the route, one could understand why, in all the British wars with Afghanistan, advances from Kandahar to Kabul and *vice versa* have never presented great difficulties. From Kandahar the road gradually ascends, for some 220 miles, the valleys of the Tarnak and Ghazni rivers, rising from some 3,500 ft. at Kandahar, to nearly 9,000 ft. just beyond Ghazni. This valley is somewhat similar to the Zhob valley between Hindubagh and Gwal Haiderzai or the Khan Metarzai pass between Khanai and Khanozai. It is bounded on both sides by hills of no great height, whose lower slopes have easy rounded contours. The width varies between two and ten miles, though in a few places it becomes rather broader. The Tarnak river contains a certain amount of water, but there is not much stream except in spring and early summer. The flats on both banks of the river are cultivated, but the higher ground is all covered with camel thorn. Beyond occasional patches of shrubs there are no trees. Except in the few places where the road descends to the river flats, there are few patches of sandy *patt*, the soil, for the most part, consisting of fine gritty conglomerate, quite suitable for standing up to all except heavy continuous traffic. The valley floor on the whole is flat and regular, except that deep, steep-sided nullahs make their way to the river-bed at intervals.

Some 16 miles beyond Ghazni the road traverses the Shashgao Pass at just under 9,000 ft. This, though in no sense a defile, possesses some possibilities as regards defence, though it presents no difficulties to the road engineer. Beyond the pass the road descends for some 25 miles to Shaikhabad on the Wardak river, whence it follows the valley of this river for some three miles. From here, for the 46 miles to the Kabul plain, the route is rather more hilly and enclosed; the road traverses several low passes, and the hills tend to close in on either side. This section contains several stretches of easy mountain road. The higher portions of the route around Ghazni are usually closed by snow for about eight weeks in January and February.

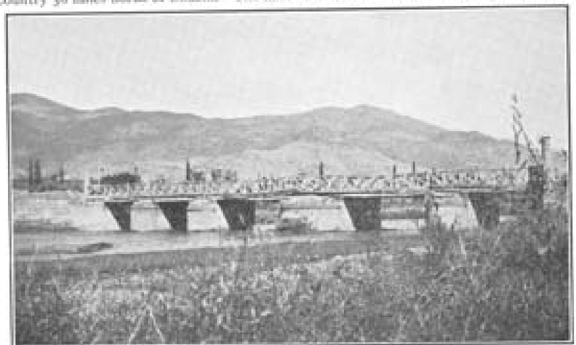
We left Kandahar early on the morning of the 26th, having filled our tanks from the "Shell" pump in the city. The first twenty miles lay through the Kandahar plain, after which the road began to ascend the slopes of the Tarnak valley. There is a caravan stage about every fifteen miles, around which there was usually a small village, the intervening country showing little sign of habitation. At mile 84 we came to Kalat-i-Ghilzai, where the old fort, perched on a hill, brings the famous siege to memory, and a fair-sized bazaar. Beyond Kalat-i-Ghilzai we were going through Ghilzai country, and met a number of these people, some of them recently returned from their cold weather stay in India. Being somewhat delayed by punctures, we did not reach Mukhar till dusk. Here we put up at the rest house built by Ammanullah some years previously. This place, which was tolerably well furnished, had its *khansamah*, long baths, and water-borne sewage. Away to the north-west of Mukhar lies the Hazara country, from which came the recruits for the Hazara Pioneers, recently disbanded. We met at Mukhar one or two men who had been recently discharged owing to the disbandment, and who were considerably disgruntled thereby.

Leaving Mukhar early on the 27th we made good time to Ghazni, which is in the middle of an open upland plain, apparently very fertile. Ghazni is ninety-one miles from Kabul, and is the most important centre on the road from thence to Kandahar, controlling as it does the exit from the Shashgao Pass, and being the focus of Ghilzai territory. It appears to have undergone little change since it played an important part in the Afghan Wars of 1839 and 1878-80.



Ghazni, the Kabul Gate. On the far side of the pile of logs there is a deep moat. The actual gate is behind the central bastion.


Country 30 miles north of Ghazni. The man in uniform is one of the road gendarmerie.


Bridge over the Kabul River, 30 miles south of Kabul. This is typical of the bridges north of Ghazni.


Kabul, the bazaar centre. Note the traffic control post.

As may be appreciated from the photographs, the Fort, perched on a hill, and surrounded with massive walls, must have been of considerable strength before the days of effective artillery. The inside of the Fort is a regular rabbit-warren full of winding narrow streets and bazaars, the latter containing a few articles of European and Japanese manufacture. The local "Wall's ice-cream man" was very much in evidence, the ices being made from snow collected during the winter, and stored in underground cellars. We visited the tomb of Mahmud of Ghazni, just outside the fort, and wandered through New Ghazni, a modern bazaar built in the plain below the fort. The photograph of the Kabul Gate of the fort is interesting, as it tallies closely with the descriptions of the gate which are given in the contemporary accounts of the storming of Ghazni in 1839. The actual gate is behind the central tower (with three deep steps in front of it) in the photograph, and cannot be seen until one is within a few yards of it. It will be remembered that, after its capture in 1839, Ghazni Fort was occupied by a small British force for some time, and that, towards the end of the war, a number of British officers were held prisoner there. The actual fort played no active part in the war of 1878–80, though the town was occupied by General Stewart's force for a few days after the latter had defeated the Ghilzais at Ahmed Khel, a few miles to the south. The Ghazni plain was a not unattractive part of the world, being green, with a number of orchards, and being surrounded by a ring of high peaks; one snow-capped peak, some distance to the west, could be seen at intervals all the way from south of Mukhar to the top of the Shashgao Pass, a distance of some eighty miles.

North of Ghazni some attempt has been made in places to "surface" the road formation, but, as no foundations have been provided, the effect is disastrous, the road being worse than the most pot-holed French *pavé*.

Leaving Ghazni after an early lunch we made good time to Kabul, where we had no difficulty in finding our way to the British Residency. North of the Shashgao Pass the country changes its character. To the south it gives the impression of rainlessness, the ground being covered in most places by camel thorn, with no cultivation existing (except round Ghazni) away from the river-bed. To the north of the Pass there is evidence of more rainfall, the camel thorn decreases, and there is a considerable amount of cultivation. The Kabul valley itself is very fertile, and possesses an abundant water supply from the Kabul river and its tributaries. The British Residency is by far the most prepossessing building in Kabul: it is all white, and stands in the centre of a large walled compound, which also contains the secretariat offices and the bungalows of the Residency staff. The interior of the Residency resembles an English country house, and has been most tastefully furnished and fitted out by

Maple's. Sitting in the billiard-room, and listening to the wireless, it was hard to realize that one was in the middle of Afghanistan.

It is an interesting fact that the Residency remained completely untouched during the lawless periods between the abdication of Ammanullah and the accession of Nadir Shah. The building was abandoned hurriedly early in 1929, and remained empty until re-occupied some time after Nadir Shah's accession in 1930. In the meantime it was looked after by an old *chowkidar*, but nothing in the building was touched.

We stayed four days in Kabul, the guests of the Military Attaché. During this time we had ample opportunity for exploring the city and its environs. We were very anxious for a trip on the newly constructed road over the Hindu Kush to Mazar-i-Sherif, but time did not permit. Kabul is set in picturesque surroundings, though the city itself is as squalid as are most eastern cities. To the south and east lie the mountains of the Safed Koh range, away to the north are the snow-capped Hindu Kush, while twenty miles to the west is the Paghman Range, the lower slopes of which are well wooded. Paghman itself, the hill station of Kabul, lies fifteen miles from the city at a height of some 8,000 ft. (Kabul is at 6,500 ft.), and is most attractive. It contains a variety of English trees and plants, and is watered by a number of mountain streams; it boasts a small racecourse, badly kept, with impossible corners, but complete with grandstand. The architecture of the place, however, is not up to the high standards set by Nature; the notables of Kabul have built themselves a number of terrible cheap-looking villas, mostly painted a horrible yellow.

One of the features of the Afghan rulers has been their lack of sense of proportion. Ammanullah built Dar-ul-Aman, an ambitious lay-out, just outside Kabul, constructed on the lines of New Delhi, which contains a vast King's Palace and a huge Parliament House. These now stand unfinished and desolate, with the essentials of the plumbers' fittings lying about waiting to be installed. In the same way Nadir Shah built a large sanatorium for consumptives, fitted up with long baths, and h. & c. for each patient. He also started a model farm with pasteurizing apparatus. These modern buildings are in striking contrast to the squalid hovels in which most of the inhabitants of Kabul live.

There is a small European community living in Kabul, consisting of a number of schoolmasters, engineers and military instructors. These latter were nearly all Germans, as are also the majority of the engineers. There is a certain amount of social life among the Europeans; each nationality takes it in turn to throw a party, and we attended a meet of the Kabul Valley Paperchase Club, which was, of course, run by the British element. One also meets a few of the Afghan governing and official classes, most of whom seem to speak

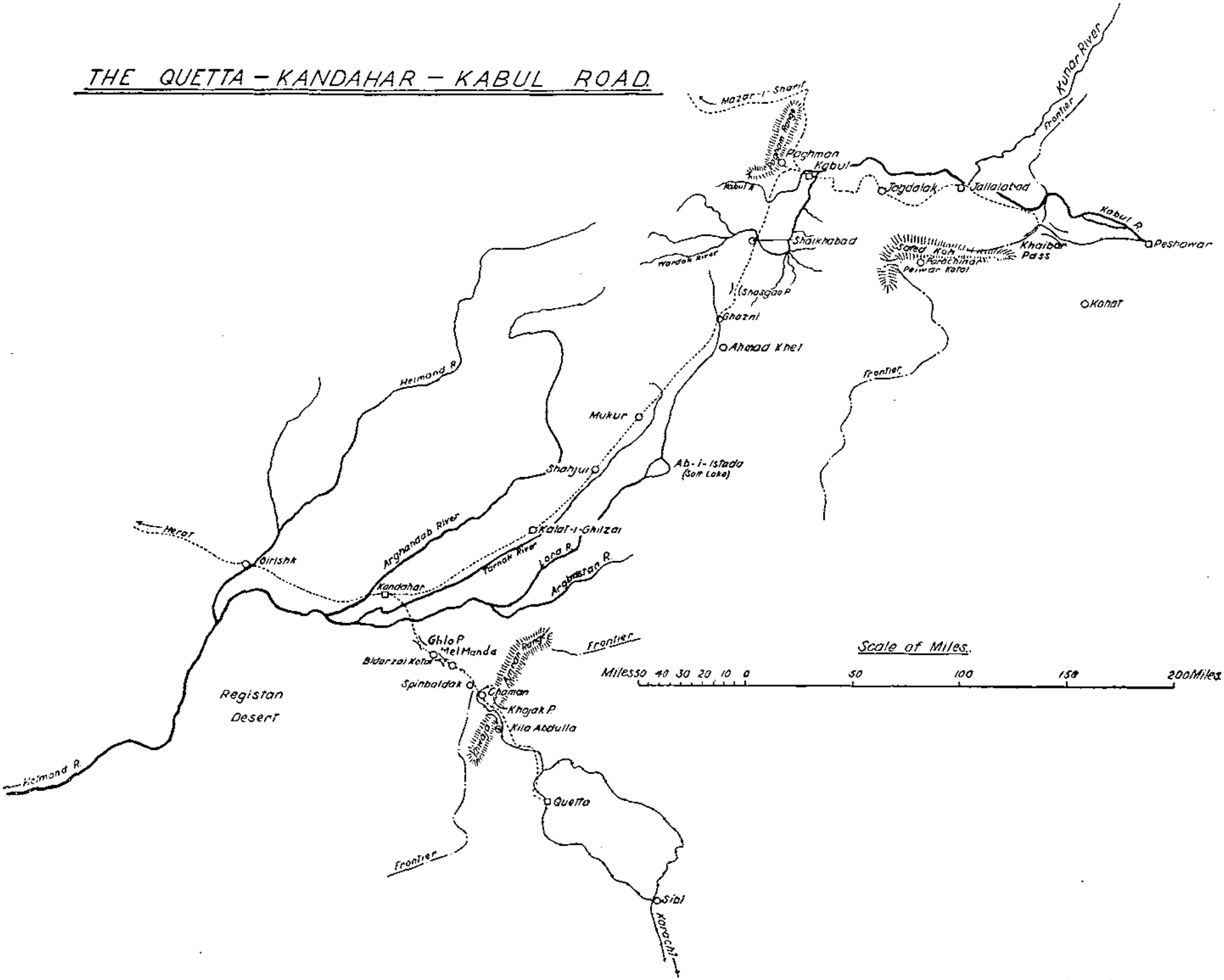
French, and show traces of Western influence. We played contract with a young relative of Ammanullah, who knew far more about the game than we did.

At the time of our visit, the country was showing definite signs of the good administration of Nadir Shah and his brothers, who were slowly but surely introducing a measure of law and order into the main valleys. We could see evidence of this on our journey, though it was apparent that the measure of control decreased with the distance from Kabul. An organization of gendarmerie now keeps the main routes open to unmolested travel, and detachments of the Afghan regular army are located at the chief centres to back up the representatives of Kabul. The main strength of Afghanistan, however, now, as always, lies with the tribes, and on the King's capacity to control the tribes depends his ability to remain firm in the saddle. At the time of writing it seems that the good work begun by Nadir Shah is being carried on by his brothers, who appear to be loyally standing by the present king, Nadir Shah's son. This one judges by the absence of any news of internal trouble in Afghanistan, and by the fact that foreign travellers appear to come and go as they please. We caught occasional glimpses of the Afghan Army both in Kabul and elsewhere. From what one could judge, their lack of good organization would always prevent them from being such a formidable fighting body as the irregular tribes, who are, in their own country, little dependent on any organization at all. Around Kabul, however, the Regulars appeared to be smart and well disciplined. It does not appear that Afghanistan will ever travel very far on the road to progress, though the advent of the motor-car will do something to help in this respect. Progress is mainly dependent on good communications, and Afghanistan is too poor and sparsely populated ever to provide good roads or railways out of her own resources. Political reasons will always prevent her from obtaining these resources from either of her powerful neighbours. During our visit we met frequent evidence of the fact that the British are in favour in Afghanistan at the moment ; all the worthies who were encountered on the way were pleased to see us, and interested in the fact that we came from Quetta.

We left Kabul early on June 1st, and made good time back to Quetta, returning by the same route. We had originally hoped to complete the round trip via the Khaiber, but time, and the state of our tyres, did not permit of this. Quetta was reached soon after *tiffin* on June 3rd, an early start from Kandahar having been made that day.

It is interesting to reflect on the effect which motor transport and improved weapons have had on any possible future campaign beyond the Frontier. Contrary to what might at first be expected, these developments have increased the difficulties of such a campaign. The armies of 1839–40, and 1878–80, were not very dependent on a continuous L. of C.; their requirements of ammunition were not very great, and they could carry with them enough for a considerable period. Most of the supplies required for their personnel and transport were obtained by local purchase, and they did not require much in the way of a road. The modern army, however, requires a continuous supply column to satisfy its many wants, and all the motive power for its M.T. must come from the base. Dust on the roads will be a considerable problem, and will call loudly for a properly treated road surface. In short, in spite of our improved means of transport, we are to-day much less mobile beyond the Frontier than we were fifty years ago. But there is a remedy. The main valleys of Afghanistan are quite suitable for the light tank, to which, as yet, the Afghan has no answer. A force organized around a Light Tank Corps could be both hard-hitting and light moving, rendering much easier the problems of supply.

THE QUETTA – KANDAHAR – KABUL ROAD



THE ROYAL ENGINEERS AND ANTI-GAS DEFENCE.

By CAPTAIN G. L. WATKINSON, R.E.

The Army Council have decided that, in order to further the development of anti-gas training in the Army, the Royal Engineers shall in future be the "parent arm" for all anti-gas measures, and shall be charged with making a special study of the application of modern developments in defence against gas. As a natural corollary to this decision, R.E. Commanders will in future become the technical advisers in this subject to the Commanders under whom they are serving.

The care of yet one more baby has been added to the already wide responsibilities of the R.E. officer, and there is yet another subject for the young officer to master during his course at Chatham. But, lest the additional burden should be over-estimated, certain aspects of the matter may usefully be made clear.

Firstly, the *Army Council Instruction* above quoted does not introduce anything completely new, but rather resuscitates in part that which was in being during the Great War, when the Corps of Royal Engineers was not only responsible for offensive chemical warfare, but also provided anti-gas advisers and developed anti-gas measures. General Foulkes has written a clear account of the activities of the Royal Engineers in connection with gas during the Great War in a book entitled *Gas*, which, it is suggested, should be read by all Royal Engineer officers. It must be emphasized here that, in the present case, offensive chemical warfare is not under consideration; for that would be entirely at variance with the British policy of respect for the Geneva Protocol of 1925, by which the majority of States renounced resort to chemical warfare.

Unfortunately it has recently been made only too clear, that not all other countries hold the same view, and that some of them will almost certainly resort to chemical warfare, if national interests are at stake and it is considered that a military advantage will accrue from its use. For this reason it has become essential that anti-gas training and research in the British Army should be intensified.

Secondly, the additional work involved for the Royal Engineers is not so great as might at first appear. All arms will continue to be responsible for training and practice in the protection and decontamination of the individual and of small areas, just as they are for the erection of field defences, Royal Engineer advice and assistance being sought if necessary. Protection and decontamination of large and special areas only will be a particular Royal Engineer responsibility, together with the construction of L.-of-C. installations for the decontamination of personnel and material by the R.A.M.C. and R.A.O.C. respectively. For instance, if a machine-gun post is contaminated by a persistent gas shell, it will be the duty of the unit concerned to take the necessary action: but, where a headquarters or signal dugout has to be constructed, the Royal Engineers who make it must see that it is gas-proof as well as bomb- and shell-proof; and, where a bridge approach has been contaminated, the Royal Engineers will be responsible for taking the necessary measures to surmount the obstacle.

It is important to realize that from now on other arms will look to the Royal Engineers for expert knowledge. The Corps must therefore make itself thoroughly "anti-gas minded." The responsibility is a heavy one; for, if training and protective measures are good, gas becomes little more than a delaying agent: whereas, if they are not, there will be heavy casualties from it and the effect on morale will be great. For this reason the subject must be treated with the respect and seriousness which it deserves.

For those who have not yet completed the Young Officers' Course at Chatham, it is the intention to introduce the more general part of the necessary instruction into the existing courses, in order to emphasize the anti-gas aspect of the various problems already dealt with; it may be necessary also to lengthen the fieldworks course slightly in order to deal with the more specialized aspects of the matter. For officers who have already passed through the S.M.E. a series of special courses, each of a fortnight's duration, will be held each winter at Chatham, starting in October next. By these means the Corps will in a short time be in a position to undertake effectively its new responsibilities. Clearly many officers will be unable to attend these courses for some little time, wherefore the more need for them to make a special study of that excellent little manual *Defence Against Gas*, 1935, and to pick the brains of their more fortunate brethren when they return from Chatham.

Lastly, it may afford some relief to the minds of R.E. officers to know that anti-gas research from the purely chemical point of view is not one of the Corps aspects of the new baby. This is still a task for the chemist pure and simple, but it will be the responsibility of the Corps to make use of the results of that research in their technical and tactical applications.

MOTORIZATION AND BLOCKING OPERATIONS.

Translated from an article entitled, "Motorisierung und Sperrungen" by COLONEL DENNERLEIN in *Vierteljahreshefte für Pioniere*, February, 1936.

Note. "The engineer battalion in the German army consists of headquarters, bridging column, engineer park, engineer column and three engineer companies.

Each company consists of headquarters and three platoons: each platoon consists of headquarters and three sections and is roughly equivalent to a section of a British field company."

ALL armies with up-to-date equipment endeavour by the use of machinery to procure for themselves advantages and a preponderance over the enemy. This endeavour embraces the most widely-differing activities from the forwarding of war stores to the carrying out of reconnaissance in touch with the enemy. Already in the Great War the uses of the motor were manifold in the air and on the ground, for supplies, for the transfer of reserves, the moving of heavy artillery, for tanks, aircraft, and many other purposes. As a further stage in the development of the motor there has lately been added to these, the systematic formation of motorized troops, especially of armoured formations, light divisions, motorized reconnaissance detachments and similar bodies.

Following upon an enforced inactivity in these matters lasting for years, the German Army is now again able to put theoretical considerations about the employment of and defence against such formations into practical development.

In this article only defence against motorized formations will be dealt with—and that only as far as such defence is carried out by the engineers, either wholly or in part.

The main idea of defence against a motorized enemy is to rob him of his strength, especially of the speed and mobility of the motor vehicle. This object is attained when the roads and the country over which his motor vehicles have to operate are blocked. Blocks can also be brought about by the effect of fire-arms. It is only necessary to recall to mind the barrages of the last war. But to the same extent as motorized troops secure themselves against fire effect by armouring, so the significance rises of those same weapons, which are intended principally for use against the armoured vehicle itself. Practical experiences of the last few years have shown that the engineer is capable with his own weapons—the means of blocking—of co-operating in this task, and that he will be called upon to do so to an essential degree. These means will be used in order to lay blocks—including the demolition of buildings—to carry out the blocking of ways, or country, in accordance with the wishes of the commander. The most valuable is naturally a block which not only stops the vehicle, but destroys it, thus at the same time affecting its crew. It is only necessary to mention here that the progress of technics has given us this possibility.

The best means of blocking and the most effective obstacles are, however, only of use when the engineer applies them at the right place and at the right time. For its provision against a motorized enemy it is necessary that, besides having a sufficient equipment of the appropriate means of blocking, the engineer units allotted to the task should in their own motorization equal the enemy in speed and mobility, or at any rate nearly so.

Beyond this, however, is necessary a wider organization of the defence and of the units allotted to it. Engineer units, as at present organized and equipped, must in the very great majority of cases be supplemented by other arms, in order to be fully equal to the task of defence, *i.e.*, of blocking against motorized opponents. The following are necessary:—Reconnaissance troops, to obtain the intelligence which shall determine the provision of a block and its nature; also machine-guns and anti-tank weapons, so as to strengthen the defence, especially in a *terrain* which is less suited for defence by engineer weapons. Many situations, *e.g.*, when the warding off of the enemy a.f.v's partakes more of the nature of defence against attack, demand also that artillery be added. Thus there come into existence mixed formations—blocking formations or detachments—for which, in addition to the central body of motorized engineers, motor-cyclist rifles, motorized machine-gun units, motorized anti-tank companies and tank-reconnaissance units are suitable. The number of units and the proportion of the various arms may differ according to task and *terrain*. It is in accordance with the nature of a task of blocking to choose for its solution a *terrain* which, by an extended use of obstacles, effects a saving in the means of defence, and thus throws upon the engineers and their weapons the chief burden. It follows, therefore, that in most cases it is best to entrust the leadership of a blocking detachment of the various arms to an engineer officer with staff and ample means of signal communication.

The tasks of blocking detachments of this nature may be:—The closing of a gap in a broad front, the extension of a front for the protection of a wing, protection of the flank of troops either on the march or engaged, protection against pursuit, concealment, and in every case, it must be remembered, against a motorized enemy. It stands to reason that a blocking detachment will also resist as well as it can an enemy, whether dismounted or mounted, whenever such resistance lies within the framework of its task. But such manner of fighting is not peculiar to the blocking formation, the object of which is ever to be kept in mind, viz., effect against a motorized enemy.

From the most recent experience a special task is holding up the break-through of tanks in the depth of a position. For this purpose the engineers, with an ample supply of means of blocking capable of rapid application, can put a barrier in front of the hostile thrust. The task is a difficult one, and the possibilities of its solution, by means of special equipment and special methods of application, have not yet been exhausted. It will therefore not be dealt with further in this article.

The blocking detachment must generally be regarded as an independent fighting unit, since the absence of other troops is almost always the cause of its formation and employment.

Hence the principles for the employment and method of procedure of a blocking detachment must partly differ from those of the engineers, when engaged in blocking within a fighting front, *e.g.*, in the rearguard action of an infantry division. Thus, for example, the demand for great depth in a block, *i.e.*, the blocking of a whole area, loses greatly in significance, as it is mostly to be provided only in the second line. On the other hand, the attaining of as great a breadth as possible, *i.e.*, the provision of a blocked line, gains in importance, since a motorized enemy will always strive to circumvent the blocked sector; which he is able to do. Other differences arise from the fact that, especially at the commencement of blocking operations against motorized reconnaissance parties, it is often a matter of holding up motor vehicles which are principally bound to roads. The blocking party must therefore—as already stated above—seek out an area in which motor vehicles cannot move off the roads, or can do so only at certain places, which the party must then also block. Sectors which can be completely blocked against infantry and cavalry by a single blocking party with the strength and means at its disposal will seldom be found. On the other hand, it is very important that blocks against motor vehicles should be without a gap. The enemy must be forced at one or more spots to leave his vehicles, to defeat the block, and then to remove it. The longer he takes over this, the better the blocking party has performed its task. In many situations it will also be demanded that blocks can be quickly removed in order to permit the advance of one's own troops. Further, immediately upon the arrival of the blocking troops at the site to be blocked, the first task to be undertaken is to provide a complete line of obstacle, so as to gain a certain degree of security from the first, since hostile a.f.v's generally come as a surprise. The special principles for blocking formations here laid down affect the behaviour of the individual blocking party in the choice of the means of blocking and in the method selected for armed resistance at the block. First, however, we must consider the application of the blocking formation as a whole.

The question arises first :—Where should the block be made? Does the commander, who orders the blocking detachment to operate, order this, or does the commander of the detachment receive a task, such as the protection of a wing, in which it is left to him to decide upon where to block, and in what breadth, etc.? For various reasons the higher command will not be able to allow the Blocking Detachment commander this freedom. The higher command alone knows the tactical and also the strategic demands of the situation, and their urgency. It is also not a matter of sending the blocking detachment against the enemy with the task of holding the latter up as far as possible ahead, since it would have to be a very favourable chance for the encounter with the enemy to take place exactly at a blockable sector. The commander of the troops must order which of the sectors, that offer themselves, is to be blocked. When this cannot be decided from the map, a reconnaissance to be carried out quickly by armoured cars or aeroplanes is necessary. If no blockable sector is available, *i.e.*, if the country is such that cars can travel also off the roads, then blocking will have only a slight success, no matter where it is ordered.

The necessary strength of the blocking detachment to be formed, or, when such is laid down, the possible breadth which can be blocked, may be arrived at approximately. When, as is generally the case, the main strength of a blocking detachment lies in its engineers, the strength of the detachment (or the breadth of sector blockable) is determined by the engineers' powers of performance. In most cases it will be correct for each bridge, road or path to reckon one engineer section. To this must be added the machine-guns necessary for ensuring the safety of the engineers, and for armed resistance at the block. The proportion of one motor-cycle rifle company, motorized machine-gun company, or motorized infantry approximating in strength to these, to two engineer companies appears suitable as a general rule. This proportion alters when portions of the whole sector are either not, or are little, suitable for blocking by engineer means, and when, consequently, the defence has principally to rely upon machine-guns and anti-tank guns. The latter are required in such numbers that each of the most important blocked places can be provided with one gun.

The point should here be introduced that, as long as there are no specific blocking formations with anti-tank weapons as part of their equipment, it is an unconditional necessity for motorized engineer units to have anti-tank guns included in their fixed establishment. The cases, in which motorized engineer companies or reconnoitring parties must be set in motion against the enemy before the arrival of the anti-tank weapons allotted to them, will be the rule. Then, however, the engineer unit concerned needs an anti-tank weapon in order to ward off hostile tanks without loss of time, and thus be able to get on with its work.

It is important that the blocking detachment be put into operation at the right time. The provision of every kind of block takes time. This time will vary according to circumstances. With rapid blocks by means prepared beforehand, well-trained engineers can indeed provide blocks to hold up a.f.v's in a few minutes, and also threaten them with destruction, should their drivers attempt overrunning. However, these rapid blocks alone are insufficient, as they are generally capable of removal by the enemy, if he has succeeded in driving the defenders away. They form a first line of security, as stated above, behind which the blocks proper, which are difficult to remove, will be erected. For the construction of the latter generally several hours will be required, because in this case it is a question of the destruction of a bridge, the creation of an abattis, barricades, etc., or the building of mines under a road-surface. If this time is not at one's disposal before the enemy arrives at the block, and is able to render work on the block impossible by means of his fire, then there is no likelihood of success. The principle laid down in the French Army appears to be correct, viz., that invariably, when in the front a gap begins to open, or a wing begins to become uncovered, the necessary steps for blocking must immediately be put in hand.

Here arises the question :—Where does the blocking detachment come from when required ? According to war establishments there are at present in no army any troops designated as blocking formations. The best way would be to allot to the divisional motorized field engineers and other engineer battalions the necessary complementary troops. As only motorized units are concerned it may be accepted that the assembly of a blocking detachment would generally be possible in a few hours. It would be more difficult to assemble it and would cause greater loss of time, when the units are already engaged elsewhere and have to be released. When this happens the assembly of a blocking detachment in time becomes questionable. If an army is amply provided with motorized engineer battalions, motorized machine-gun units, motor-cyclist rifle units, and motorized anti-tank units, the danger will be diminished, especially if there has been a far-seeing disposition of these units. But even if one accepts that the assembly of a blocking detachment at the required moment is always successful, there remains as a disadvantage of this system of provision that performance, and hence success, will always be less with a formation which has not been trained together, than with one that has been so exercised.

The idea of permanent organized blocking formations, which include the chief weapons in a proportion to be fixed by experience, consequently suggests itself; the arguments in its favour being a co-operation which has been thoroughly learnt, mutual personal knowledge, and a leadership which has got accustomed to working with the various component parts of the formation.

The general training of engineers, of motor-cyclist rifle units and of anti-tank companies is insufficient, since, as shown above, the principles and procedure of a blocking detachment are not general, but special. This is a special case, with the requirements of which leader and troops must be familiar. Only thus can the rapid and appropriate co-operation of the arms and the technical means of the blocking unit be attained. Through practising blocking units against a motorized enemy the necessary training can be obtained, and at the same time the recognition of special requirements, the most suitable methods, and most effective means, be further extended. This is the more necessary because examples, from the history of war, of real experiences hardly exist. Hence the views here set forth for the behaviour of blocking detachments need constant further development and practical testing, especially by the armoured forces which will have to reckon with blocking detachments as opponents.

The commander of a blocking detachment will generally have to give his orders for its employment at the place of assembly. Whether he can base them upon the results of a reconnaissance, or must rely upon the map, depends upon the situation. Both cases are possible.

Whenever it is in any way possible, the time necessary for assembling the blocking detachment must be utilized for a reconnaissance (rapid) in a car, or better still, in a plane. No details can be dealt with. These must be reconnoitred by the company, platoon or section commander (individual reconnaissance). It does not appear advisable to delay putting in the blocking detachment to gain time for reconnaissance. This would oppose the principle of striving to get ahead of the enemy at the sector to be blocked.

Also, for the advance from the place of assembly to the blocking sector, every effort must be made to arrive as early as possible, but certainly before the enemy: and to arrive there on a broad front. Hence it is not to be recommended that the advance march be made in one column to a position of preparedness, from which the parties are distributed to their respective tasks. The demand for speed is better served by advancing on the road network fanwise, and broken up into mixed marching groups. How far this breaking-up may be carried depends upon the road network, and also upon the number of a.t. weapons at one's disposal, since the latter must take upon themselves the security of the march. This also is an argument for the equipping, already advocated, of the motorized engineers with such weapons. The execution of the march in shorter columns has the advantage that the speed of motor vehicles can be better utilized, and leads to the formation of small mixed groups, as they are finally required for work or for defence at the various places to be blocked.

Upon arrival in the sector to be blocked the most urgent task is to provide a preliminary barrier which must be continuous and at least strong enough to cause the enemy to quit his motor vehicles for its removal, and to attack on foot. The chief purpose of this first barrier is the safety of the blocking detachment itself, since the further activity of the latter becomes questionable if the enemy succeeds in breaking through the obstacle even at a single spot. What happens then can be likened to what takes place after water has made its first small breach in a dam. Hence subordinate leaders, platoon and section commanders, must before all reconnoitre by the quickest means whether places exist where the enemy can slip through. From the map such spots are often not recognizable, *e.g.*, fords, newly-built bridges, wood-cutters' roads, etc. It is essential for success that such should be discovered as early as possible, and blocked.

Of what now does the first barrier consist? At a place which cannot certainly be avoided the road or way will be closed by the engineers with rapid obstacles (mines, rolls of wire, iron rope), machine-guns or infantry take position where they can prevent the enemy from removing the obstacle. Since it is always to be reckoned with that, at the head of a motorized enemy column there will be found armoured vehicles capable of holding down effectively the fire of the infantry defending the block, it will be necessary also to provide the defence with an armour-piercing weapon. The whole must be pushed forward so far in front of the block proper that work on the latter cannot be hindered by the enemy's fire. Pushing these screens too far forward is, however, a mistake, since they are easy to circumvent, and, if without the possibility of timely support, can be rendered ineffective by the enemy. Only by close co-operation between the various arms can these tasks be fulfilled.

Both the correct application of a blocking detachment and the nature of its work demand therefore unified control by means of a responsible leader. Since a company will often be responsible for a broad front in a *terrain* poor in roads, the platoon and company commanders will at first be able only gradually to intervene and set things in order. The method is therefore recommended of placing all other arms in the blocking area immediately under the engineer commanders. Above all other arguments for this course is the fact that training in blocking is most extensively practised among the engineers, and hence it is among them that there is the prospect of finding the greatest number of experts. A really satisfactory state of affairs is, however, not reached before all the arms taking part are not only trained in blocking, but also through frequent practising together have learnt to co-operate. Then only will appear the necessary purposeful co-operation of the different arms and technical means under skilled leaders.

Secured by the first barrier, the engineers erect the block proper, which is to afford the greatest resistance possible. The point which is here specially to be observed may be just mentioned, viz., that, in situations in which a blocking formation is generally employed, the work of blocking must from the first be so organized that even if the enemy suddenly appears, success against him is still probable. Thus, for example, in the case of bridge demolition, it is best to place in position hasty charges in bulk ready for firing, and then to carry out the demolition, if time allows, by means of carefully worked-out charges laid systematically.

Specially important for success is the fighting at the blocks. Its object is to gain time, *i.e.*, to postpone as much as possible the moment at which the enemy can start clearing away the block. As a rule the blocking detachment will fight a delaying action at the blocked sector, but the situation may call for a more resolute defence. The method of fighting from first contact to withdrawal will be in accordance with the general rules and principles for such cases, but there are still several things to be regarded as peculiar to the conduct of the fight by a blocking detachment.

The relationship between the breadth of front and the weapons at one's disposal generally forbids the provision of more than one line of resistance. The necessity of the rapid completion of an obstacle without a gap can generally be met only by concentrating all personnel on the front line. Great breadths of front require in any case comparatively large numbers of personnel for reconnoitring and carrying messages. If, nevertheless, it is possible to spare personnel it might be better to hold them back as a mobile reserve in order to put them in where the enemy attacks the line. This arrangement, however, promises success only when reconnaissance, observation and signals function perfectly, and the reserve—thanks to good communications—can in the shortest time be thrown in at any threatened spot. If where the enemy intends to break through can be foreseen without any doubt, it will be possible also to draw reinforcements from portions of the front that are not threatened. Initiative and power of decision on the part of the subordinate leaders in being determined to support each other powerfully and at the right moment are of great importance.

As a good, but often little known, aid in the fight at the block, for keeping an obstacle under observation, and for driving off surprise attacks in the darkness, the small searchlight deserves increased attention.

As an aid to judging the effect of blocks upon a motorized enemy, certain figures, which have been gained by experience, are at our disposal. They are, however, to be used with care, since circumstances differ in every situation. For example, the restoration of a bridge or the construction of a new one, even over a small river, 20 to 30 metres broad, takes several hours. For the removal of a tree obstacle, consisting of 25 felled trees, without concealed charges or other complications, an engineer section having ample tools took 45 minutes. The searching for mines and rendering them harmless is more difficult, and takes more time. Such clearances and especially the restoration of bridges, in any useful time, can be done only by engineers, as the other arms lack the necessary tools. In motorized formations, at any rate for the present, there are not likely to be many engineers. Consequently the removal of obstacles alone will as a rule take several hours, in many cases several days. The gain in time through armed resistance at the block has also to be added. Accordingly one may reckon, to be quite on the safe side, that a motorized formation which comes up against a blocked sector will lose again the greater part of the advantage conferred by its speed. And it will certainly meet such, if a proper use has been made of the means of blocking. The best protection against hostile a.f.v's will thus be the engineer.

Finally, a statement of opinion about the function of blocking, which appeared in the article, " Thoughts on the Further Development of the Engineers," in the first February number of the *Deutsche Pionier-Zeitung*, must be countered. It is not correct to say that the service of blocking, the use of the engineer weapon, the block, is " a poor man's help in need, arising from Germany's recent military restrictions." It is much more a means at the leader's command, which has gained its present position of importance, as a countermeasure to the development of armoured troops and the motorization of armies. This significance is fully appreciated in those armies, which unlike our own have not been under restrictions for many years.

Blocking is also not to be considered only as an auxiliary to the defender. The German Western Army in 1914 went into the battle of the Marne as the aggressor, and sorely needed blocking formations to block the gap between the 1st and 2nd Armies, even against an enemy who was not motorized in the modern sense. The German Eastern Army won, as attacker, the victory of Tannenberg, and would for screening and defence against Rennenkampf's Army have received from blocking formations a valuable increase of strength.

The service of blocking will not lose in value in future, nor will it lose in importance compared with the other activities of the engineers. One can say rather that its significance and development will keep pace with the motorization of armies, and especially with that of the fighting motorized troops.

MEMOIR.

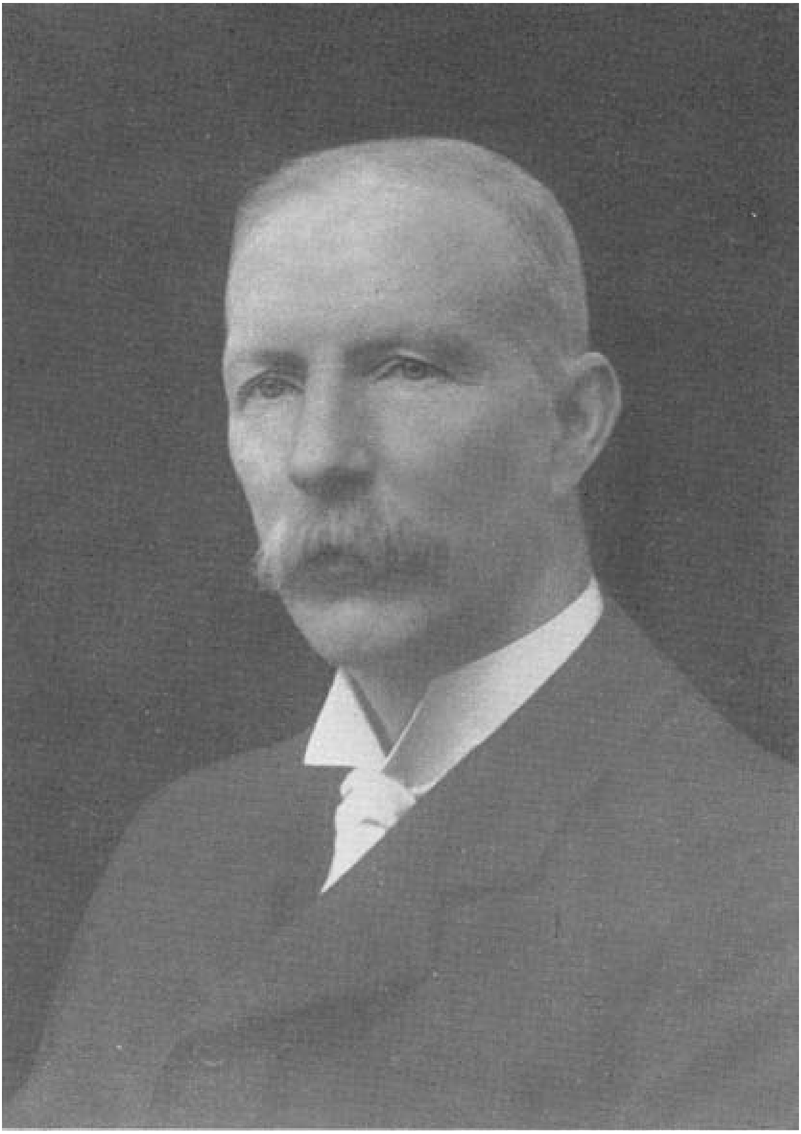
MAJOR SIR MAURICE ALEXANDER CAMERON, K.C.M.G.

MAJOR SIR MAURICE ALEXANDER CAMERON, K.C.M.G., died on 16th May, and a brief outline of his career was published in the July *Supplement.* A more detailed account may be of interest.

His grandfather, John of Auchnasaul, who was instrumental in raising the 79th Cameron Highlanders, was one of the Glen Nevis Camerons, who trace their descent from an early Lochiel. His father, Lieutenant-Colonel Alexander Cameron, C.B., 42nd Royal Highlanders (The Black Watch), was stationed at Stirling when Maurice Cameron, the youngest of four children, was born in the castle on 30th November, 1855. Cameron had no recollection of his father, who commanded the regiment during the Indian Mutiny and died of wounds received at Bareilly on 9th August, 1858. Since then all members of the family have gone into one of the fighting services.

Cameron's first school was that of Mr. Downes, at Brighton, where he developed the passion for sailing which endured all his life. After Easter, 1869, he went to Wellington, then under Dr. E. W. Benson, who later became Archbishop of Canterbury. Here he did well; a faded scrap among his papers shows that during his four years at the college he won no fewer than 25 prizes, the majority for mathematics and geometrical drawing, and also the Modern Exhibition. At Christmas, 1873, he passed first into Woolwich, and joined the following March. Here he maintained his record, passing out first and being awarded both the Sword of Honour and the Pollock Medal. A member of his batch was the Prince Imperial, with whom Cameron became friends; he used to visit the Empress Eugenie and her ill-fated son at week-ends at Chislehurst. He looked back with unmixed pleasure on his two years at Woolwich, where Sir Lintorn Simmons had recently carried out a number of reforms. In April, 1875, he was commissioned and joined at Chatham, where he went through the usual courses, among which were a construction tour which extended as far north as Sheffield and Bradford, and a geological tour in the north of Ireland. He found much to interest him in these, but their attractions palled before those of submarine mining, in which he took a long course in the summer of 1877.

While at Chatham all his spare time was devoted to sailing and



Maj Sir Maurice Alexander Cameron KCMG.

music, his real interests apart from his work. The R.E. Yacht Club owned, among others, the 13-ton schooner *Violet*, in which he made long cruises across the Channel when leave permitted, and the 9-ton yawl *Nelly*, used for racing and occasional cruising. By the time he left he had gained considerable experience in sailing under varied conditions. Early in 1878, being then at Pembroke Dock with his section of the 33rd Submarine Mining Company, he bought his first vessel, the *Toggle*. In this boat, a 4-ton yawl, he did a great deal of cruising to Tenby, Ilfracombe and other places, generally single-handed. Here it may be noticed that in 1879 he passed the Board of Trade examination for his certificate as Master Mariner.

In the autumn of 1878, he was ordered to London to edit the new War Office *Manual of Submarine Mining*. Most of this he wrote up from notes and papers; he also designed and drew many of the plates, a responsible task for a young officer of only four years' service, and proof of the opinion held of him by seniors.

As for his other dominant interest—music—as a subaltern at Chatham he would go to a concert in the afternoon and then directly on to an opera at Covent Garden. When he came to London, he had more opportunity to gratify his love of music, went to all concerts of note, and particularly enjoyed quartets at the houses of musical friends. He had taught himself the piano and later took singing lessons, but never had time to reach the standards he set himself.

Work on the *Submarine Mining Manual* completed, he was kept on at the War Office as " odd job " man. Among missions entrusted to him in this capacity was a visit to Portsmouth to take charge of the then new arc searchlights, with which experiments were being made in connection with submarine mining. Another was to Antwerp with a naval officer to see an early form of torpedo on which the two were unable to make a good report.

He was still at the War Office in the summer of 1880, when the 33rd Submarine Mining Company, to which he nominally belonged, was ordered to Malta, and his application to go with it succeeded. Appointed Adjutant R.E. on arrival, his work on submarine mining came to an end for the time being. He enjoyed the outdoor part of the adjutant's business more than the office. Bathing and music were his principal enjoyments at Malta. He wanted a boat and, cash being short, he resorted to the expedient of building a canoe himself, the building yard being the flat roof of the house shared with other R.E. subalterns. The vessel was not completed when he was ordered to Ceylon, and a projected voyage in her to Sicily was perforce abandoned.

After two months' leave spent in Ireland, he sailed for the East, and was posted to Trincomalee. Here, with five Europeans, he carried on submarine mining, his force strengthened as required by natives, who proved apt pupils. When his immediate Chief left in

1882, he remained in charge of the district in addition to his submarine mining work. He had brought the unfinished canoe with him, and, having now completed it, made many excursions both by sea and river, eventually contracting fever by exposure in creeks and swamps where mosquitoes swarmed.

After some eighteen months of peaceful and enjoyable work at Trincomalee, he was ordered to Singapore where he arrived in May, 1883. Singapore offered advantages over the station he had left, not the least of these being the larger and more varied society. He was also on his own, there being no other Sapper officer nearer than Hongkong. He could thus carry on as seemed good to him. The submarine-mining practice over, he was sent on a tour of sites where it was proposed to build forts, an occupation which lasted till the end of the year. He then accepted the post of Deputy Colonial Engineer and Surveyor-General in Penang, whither he went in December to enter upon a new phase of life. Works of various kinds were in progress—hospitals, police stations and rest-houses, scattered all over Penang Island and Province Wellesley. He also had charge of all the roads, other than municipal, in both territories, and there were important Government buildings in Georgetown to be designed. It was a strenuous time. For the first six months he toiled night and day, Sundays included ; then he began to feel his feet.

The several tasks before him were greatly to his taste, and what he appreciated was the independence of his position. There were no Regulations, no returns, and none of the formalities which are necessary in the Service. He found this freedom a very agreeable change. The most important work done at Penang was the reclamation of the sea-front of the town. This involved the erection of about a mile of sea-wall, which had to be built on precarious mud foundations. The foundations could be laid only at low spring tides, a circumstance which compelled unceasing vigilance at unseasonable hours, and was a lasting source of anxiety. The undertaking which Cameron found most enjoyable was the construction of a hill road round the south of the island—interesting work from the engineer's point of view, and through very beautiful scenery.

His congenial work at Penang was abruptly though temporarily checked by a summons to Singapore to assume charge of the submarine defences in view of the Russian war scare arising out of the Penjdeh incident. The crisis passed, and in April, 1888, he took three months' leave to pay a visit to Australia. Returning to Singapore, he remained there as Colonial Engineer, and was chiefly engaged on the construction of forts for the defence of the port. As Colonial Engineer, he was *ex officio* a member of the Executive and Legislative Councils, whereby work of very different nature fell to him. From time to time he went up to Penang in connection with the building on reclaimed land of a large block of Government offices. The nature of the site compelled exceptional care in laying the foundations, and entailed more thought and anxiety than any work for which he was responsible during his service.

In January, 1888, he left Singapore for home on twelve months' leave, much of which he spent cruising in the chartered 14-ton yawl *Dione*. In March, 1889, he was back in Penang, where, apart from the erection of a new Governor's House on Penang Hill, there was no construction work of much interest to him. That house was a novelty in the Straits, being built of granite, quarried locally as being cheaper than brick carried up from the low country.

In 1890, he was struck off P.W.D. duty, his services being required as chairman of a Commission to investigate the conditions of imported Chinese and Indian labour. This involved travel through the Malay States, visiting numerous properties, a task which he found interesting and instructive. The Commission's Report completed, he took leave and went to Japan, which he thoroughly enjoyed; then back to Penang and more road-making, this time through country even more lovely than that opened up by the hill road before mentioned.

In 1891, money was running short and much building and other work was suspended, and Cameron, disinclined to stay for mere maintenance work, applied to go Home, and left in February, 1892, when his successor arrived. He always looked back on his nine years in the Straits with unqualified pleasure. After shaking off the fever contracted at Trincomalee, he was always well; life was interesting, often amusing; he made lasting friendships, and if his appetite for music was not satisfied, he found a refuge in poker at night, and in golf by day.

In April, 1892, he was appointed Division Officer for Dover Castle and Canterbury, also having charge of the District north of the former station. Exploration of the *penetralia* of the old castle interested him, but on the whole he did not greatly care for the work after the active and responsible business he had done in the Straits. In 1894, he was promoted major and the following year he was ordered to join the Designs Branch of the War Office. His stay there was brief; within a few months he was offered, and accepted, the post of Third Crown Agent for the Colonies, an appointment for which his abilities and experience peculiarly fitted him; moreover, in the Crown Agents' office he enjoyed the freedom from red tape which had done so much to commend his work in Penang. The establishment was one of growing importance; when he joined the staff consisted of 44 men; when he retired as First Crown Agent, in 1920, it numbered about 630.

At this time he seized every opportunity of cruising. He kept his yacht, first the *Doris*, a yawl of about 23 tons, then the *Peggotty*, a 50-ton schooner, at Tollesbury in Essex, and in the latter vessel made longer sea trips than of yore, visiting the Shetlands, the Dutch coast, Kiel and Castletownshend, a haunt of his early days on the Cork coast. Some of his trips were a source of anxiety to his friends, as, for example, when returning from Holland, the *Doris* lay hove-to for 48 hours in a gale, unduly delaying his arrival home. He was elected a member of the Royal Cruising Club in 1913, and ten years later became Hon. Treasurer, retaining that office until he resigned in 1933, when he was made an honorary member of the club in recognition of his many services.

Cameron was a man to whom idleness was irksome, almost impossible, and when his term of office as Crown Agent drew near its close, he cast about him for other spheres of work. He found one in the Professional Classes Aid Council, joining the Case and Executive Committees, on which his advice and sound judgment were of the greatest value, ultimately succeeding Major Leonard Darwin as President. While health lasted he was a regular attendant at Committee meetings, both while resident in London and after his move to Liss in Hampshire.

He also found scope for his activities in the work of the Royal National Lifeboat Institution which made natural appeal to one of his tastes. Lt.-Colonel C. R. Satterthwaite, the Secretary, sends the following :

> "Sir Maurice Cameron joined the Committee of Management in 1921, and was elected a Vice-President in 1933. He came to the Lifeboat Service with a wide experience as a yachtsman, and his engineering knowledge was of the greatest value in the many problems with which the Institution is faced from time to time ; but, beyond all his technical qualifications, he brought good humour, sympathy and understanding. He was an ideal Committee member, and much of the organization of the Institution to-day is built up on lines suggested by him. All who worked with him feel that in his passing they have lost a very dear old friend."

Cameron married in 1894, Miss Ethel Ancrum, the sister of his greatest friend, Arthur R. Ancrum, who joined the Sappers with him and died in the Afghan Campaign of 1879. They settled in Brunswick Gardens, and there his three sons were born : in 1895, Ewen Arthur, who joined the Royal Field Artillery and was killed in Flanders just before Christmas, 1915 ; in 1898, Alexander Maurice, and in 1903, John Ancrum, both of whom have followed in the footsteps of their father and two uncles, and entered the Royal Engineers. Mrs. Cameron died in 1903. Seventeen years later, Cameron married Miss Francis Perkins, like himself an ardent lover of music. They then lived in Bedford Gardens, but a few years later moved to Forest Brow at Liss. There he died at the age of 80 on 16th May, after illness following an operation.

He received the C.M.G. in 1900, and was promoted to Knight-Commander of the Order in 1914.

Physically as well as mentally Cameron was richly endowed. Six feet two inches in height and perfectly proportioned, he was handsome in age as he had been in the fullness of his manhood. Of his abilities and mental gifts, his career is the best witness. To his friends—and it was his enviable faculty to make a friend of anyone who was brought in contact with him—the quality that impressed was his frank enjoyment of life, due to that happy nature which sees the best in men and things. Of none can it be more truly said, in the words of Savage Landor, that " he warmed both hands before the fire of life."

E.W.D.C

CORRESPONDENCE.

ENGINEER ORDERS.

Ministry of Defence,
Baghdad, Iraq.
3rd July, 1936.

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

SIR,

The article entitled " Engineer Orders," in *The R.E. Journal* of June, 1936, has made me realize, as never before, the value of peace-time training, as, if we all follow the principles advocated in it, we shall all be so busy writing, during the next war, that none of us will have any time to fight. This will be a good thing.

I fear, however, that the article is not altogether in accordance with the teaching of higher authority, for *F.S.R.* Vol. II, 1935, Sec. 15, although it says in para 1 that orders " will, whenever possible, be issued, or confirmed in writing," yet in para 3 quite clearly advocates, as the normal system, the issue of orders verbally.

During the last war I once remarked to my very efficient C.R.E. that he did not seem to carry much office about with him and he replied, showing me a pencil and a wad of a certain thin paper, " I have all that is essential." This was, of course, not intended to be taken very seriously, but the lesson was a sound one.

In the course of some years as a Field Company Commander on active service, I cannot remember ever either issuing a written operation order, or feeling any need for one. One's orders were issued verbally and noted down by the hearers in their notebooks: the unit war diary provided a written record of them.

Take the example given in "Engineer Orders" on page 206. What section commander is able to carry out his task more efficiently through receiving this mass of paper? I do not know how long it took Major Treblea to draft it, and then to make 6 copies of it, but I am sure his time would have been better spent in further reconnaissance, or in thought, or even in having a drink and a rest.

Yours faithfully,

M. EVERETT, *Colonel.*

THE ORIGINAL HOME OF THE AIR ARM.

Culworth, Bideford,
August 6th, 1936.

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

SIR,

What place has the best claim to be considered the birthplace of military ballooning in England, and consequently of the R.A.F., which claims descent from the Balloon Equipment Store, through the Balloon Section, Balloon Company, Air Battalion, R.E., and the Royal Flying Corps, to its present size and dignity?

In Vol. II of the *History of the Corps*, we read that experimental balloon ascents for reconnaissance purposes were carried out at Aldershot and Woolwich in 1863, and that at a subsequent date, not given in the History, a staff of balloonists was established in the Corps and located at Chatham.

If the claims of the abovementioned three places were investigated and right of priority granted to one of them, it would seem appropriate to mark the spot with some memorial, not necessarily large or expensive, as the original home of the Air Arm.

Yours faithfully,

F. C. MOLESWORTH, *Colonel, late R.E.*

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

BOOKS.

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

HAIG.

By Duff Cooper.

Vol. II.

(Faber & Faber. Price 25s.)

The first volume of Sir Douglas Haig's Diary carried the story down to the close of the Battle of the Somme. The new volume opens with the supersession of Joffre by Nivelle, the fall of Asquith, and the plans for 1917. The advent of Lloyd George as Prime Minister must have caused misgivings in Haig's mind; but, loyal as ever, he set out to do his utmost to support the new leader. On several occasions the two met at Haig's headquarters, and Haig always recorded any promising improvement in their relationship. As a vigorous organizer, Lloyd George wanted to know more about the military plans than Robertson or Haig were inclined to disclose, but this has always been the source of suspicion between soldiers and politicians; and both Robertson and Haig were alive to the extreme dangers of premature discussion of plans. The Nivelle failure will serve for all time as a classic example of the disasters resulting from too early an unfolding of plans by a Commander-in-Chief.

Haig welcomed the appointment of General Nivelle as successor to Joffre, as he knew him to be a man of energy, but he came later on to doubt his sincerity, when he had to resist his inclination to order the British Army about.

The operations for 1917 had already been outlined at the Allied Conference at Chantilly in November, 1916. Haig's own plans now remained substantially the same. The urgent need of driving the Germans off the Belgian coast in order to relieve the submarine danger was now more than ever present in Haig's mind, and while he undertook to carry out certain attacks in the southern part of the British front to co-operate with Nivelle's main attack, he always intended that the main British attack for 1917 should be in the north.

The first step for 1917 was to relieve some of the French line down to the Amiens–Villers-Bretonneux road; and this Haig agreed to do by the middle of February. He hoped to do more if he received more divisions from home.

Nivelle held the most optimistic hopes for his big attack on the Aisne. He wanted Haig to attack between Bapaume and the Scarpe, but Haig insisted that he must go farther north and include the Vimy Ridge. How sound this was was proved by the striking success of April, 1917, when the Ridge was carried with brilliant dash. Haig could never have left that strong position in German hands while he pushed into the salient at Monchy-le-Preux. The fact that the German withdrawal in the previous month had stopped short of Vimy Ridge showed the importance the enemy attached to it.

Haig, in his Diaries, gives his full reasons for his plans, and one cannot but be impressed by the clarity of his views. Though he was not a good exponent in the council chamber, he was a cool, methodical thinker in his study, and while the Prime

Minister's restless mind flew from pillar to post, Haig worked patiently and steadfastly towards the victory which he knew would come if only patience and steadfastness were maintained. The eloquent Nivelle captured the imagination of the Lloyd George mind, which was always readier to accept the opinion of foreign generals than of British.

But Lloyd George had strategic ideas of his own. He had given up urging the importance of Salonika, and was now intent upon reinforcing Italy to attack Austria. In spite of a very strong numerical superiority all through, the Italians had not succeeded in making headway against the Austrians, and the main front in France was to be denuded of men and guns in order to stage a new campaign in the distant Carinthian theatre. Mr. Duff Cooper pointedly remarks " when the great disaster " of Caporetto ensued in the same year, Lloyd George was one of the first to attribute " it to the insufficiency of the Italian High Command, to that very Command, in " fact, to which he had been so anxious a few months earlier to hand over the conduct " of a vast inter-allied operation for which he would have endangered the solidarity " of the Western Front " (p. 22).

Nivelle did not attach much importance to Haig's projected offensive in the north. It was a purely British affair, and he argued that it would be unnecessary if his own attack was successful. All the way through the book there is abundant evidence of Haig's anxiety to help the French. Indeed, his loyalty to our Allies is one of the outstanding characteristics of his Command. All the French commanders-in-chief valued his staunchness.

The sorry story of the Calais Conference on the 26th February, 1917, is given at length in the Diaries. Haig describes the " ambush " into which he and Sir William Robertson were so nearly led by the politicians ; an ambush, which, had it succeeded, would have aroused a storm of indignation through the country. The Conference, so far as Haig and Robertson knew, was called for the purpose of discussing the urgent transportation problem.

" I sat next to L.G. at lunch. He agreed to see Geddes and me for a quarter of " an hour before the Conference on the matter of the railway transport question. " As soon as he had finished lunch, however, he hurried off to see M. Briand in order, " he said, to settle the programme of the meeting. He was closeted with Briand " for over half an hour, and then sent word to say that he would go to the Conference " straight away without any preliminary talk with me and Geddes. No doubt, at " the meeting with Briand, the procedure which was followed at the Conference " was decided upon. . . . After a few general words from L.G. and Briand, Geddes " was asked to give the several points in dispute. He explained our requirements " in tonnage and in trains. General Ragueneau and M. Claveille replied and the " discussion then started upon points of technical detail. L.G. thereupon broke in " and said he thought it would be better if the railway specialists withdrew and " settled their differences together, whilst the more important question of ' plans ' " was dealt with at once. For me this was quite a new and unexpected development. " But doubtless this had all been planned by L.G. with Briand beforehand " (p. 43).

A secret conference followed, at which Nivelle outlined his plans. Haig had agreed to these with the one exception, referred to above, regarding the exclusion of the Vimy Ridge. " Lloyd George said he did not understand about strategy and tactics, " he would like it clearly stated what the respective responsibilities were. He " therefore asked the French to draw up their proposals for a system of command " *before dinner*, so that he, Robertson and I could discuss it after dinner, and a " subsequent Conference with the French Govt. would then be held to-morrow " morning to decide finally " (pp. 45, 46).

In this short space of time, the French produced a typewritten paper which Lloyd George gave to Robertson to examine. It was made to appear that this document could have been drawn up then and there. It was obviously the result of some discussion which must have taken place much more deliberately elsewhere. It contained French proposals for the control of the British Armies in France, and virtually relegated the British Commander-in-Chief to the position of administering discipline only and looking after reinforcements.

"Robertson and I then went into L.G.'s room. The latter now told us that the "War Cabinet had decided last week that, since this was likely to be the last effort "of the French and they had the larger numbers engaged, in fact it was their battle, "the British Army would be placed under the French Commander-in-Chief's orders" (p. 46).

"He asked me my views. I said that in my opinion it would be madness to place "the British forces under the French, and that I did not believe that our troops "would fight under French leadership. . . . He agreed that the French demands "were excessive, but insisted on Robertson and myself considering a scheme for "giving effect to the War Cabinet's decision" . . .(p. 46). "Colonel Hankey "(Secretary, War Cabinet) further added to our dissatisfaction by saying that L.G. "had not received full authority from the War Cabinet for acting as he was doing." . . . "We agreed we would rather be tried by Court-Martial than betray the Army "by agreeing to its being placed under the French. Robertson agreed that we must "resign rather than be partners in this transaction. And so we went to bed, "thoroughly disgusted with our Government and the politicians" (p. 47).

Before the Conference next morning, General Lyautey, the French War Minister, and General Nivelle both spoke of "the insult offered to me and the British Army "by the paper which Briand had produced. They assured me that they had not "seen the document *until recently*. Indeed, as regards Lyautey, he had not seen or "heard of it until he entered the train at Paris to come to Calais to-day. I under- "stood that the paper was drawn up in Paris with Lloyd George's approval, and, of "course, that of Briand."

Haig put in writing his conclusions on this drastic proposal and handed them to Sir William Robertson for laying before Lloyd George. These are given in full on p. 48.

Fortunately, the protestations of Haig and Robertson prevented the disastrous step. But what are we to think of the method by which Mr. Lloyd George introduced the subject; of the want of confidence in the Commander-in-Chief which he showed; of the opinion he held of the British Army?

The War Cabinet itself was by no means all in favour of the plan. Lord Derby was horrified when he learned the truth.

Mr. Duff Cooper tells us "on the Saturday before the Conference, Robertson had "been informed that, contrary to the general usage, his presence at the meeting of "the War Cabinet would not be required, the assumption naturally being that "military matters were not down for discussion; and yet at this meeting the tremen- "dous military decision was taken to place the whole of the British Army under the "command of a French officer, who was junior to the British Commander-in-Chief "and had not hitherto conducted any operation on the vast scale that was now in "contemplation. Having persuaded his colleagues to take such a military decision "without consulting one of their military advisers, the Prime Minister deliberately "concealed it from his Chief of the Imperial General Staff, whom, together with his "Commander-in-Chief, he lured to an inter-Allied Conference, without any knowledge "of the matter they were to discuss, or the proposals that were to be made, although, "behind their backs, he had previously arrived at a secret agreement with the French "authorities. It has been shown how, although Haig's first impressions of Lloyd "George had not been favourable, he had nevertheless made every effort to co-operate "with him loyally. A fatal blow at such co-operation was struck at Calais. There "can be little successful co-operation where there is no confidence" (p. 51).

Mr. Lloyd George's attacks on Haig have been so bitter and so baseless, that this account of the Calais Conference cannot be too widely read. The effect of such intrigue on men like Haig and Robertson must have been staggering. Nothing can be more damaging to the morale of an army than loss of confidence in its leader. Fortunately for the nation, the troops never lost confidence in Haig; indeed, through all the bitter struggles of 1917 to the victorious campaign of 1918 they had complete trust in the Commander-in-Chief, one of the straightest men who ever served his country. "All would be so easy if I had only to deal with Germans," wrote Haig in his diary at this time (p. 60).

In view of all that followed, can it be doubted for a moment that Haig's resistance to placing the British Army in French hands was the only course the nation would have sanctioned? Mr. Lloyd George's retention of the Premiership would have continued only to the Nivelle disaster, had his plan been successful.

The Diaries show how Haig did his best to get on with Nivelle; indeed, the relations between Haig and all the French Commanders-in-Chief throughout were friendly and cordial.

The British part of the Nivelle programme was faithfully carried out. The Third Army attacked at Arras and the Vimy Ridge with brilliant success; but owing to the War Cabinet's decision in January that the British front must be extended farther south, Haig had insufficient reserves to exploit his success. In the south, the great French offensive was hanging fire, and the British had to continue attacking on the Arras front. Too much time elapsed between Haig's attack and Nivelle's. The Germans were able to obtain breathing space. Not that the French attack would have had any better chances of success—there had been too much leakage of plans—but it would have increased the German difficulties if the French attack had been more simultaneous.

The failure on the Aisne made it necessary to reconsider the whole programme for 1917. Nivelle was replaced by Pétain; but the serious mutinies which broke out in the French Armies put out of the question any further effort on the French side for a long time to come. Haig knew the state of affairs, but he loyally kept his knowledge to himself. To have communicated it, or even to have hinted at it, might have led to too dangerous a dissemination; if the Germans had known, can we doubt what would have happened?

But it was this knowledge of Haig's which induced him to insist on the necessity of keeping up the pressure on the Germans. The task, he saw, must fall on the British Army alone. He urged the fulfilment of his plans; and in order to do so he was bound to oppose all attempts to denude his forces to launch new offensives in other distant theatres.

Haig has been criticized for holding too strongly that the Western Front was the only theatre where victory should be sought. Lloyd George—and those who hitched their wagons to his star—pressed for the "way round," no matter how distant the détour. Apparently sound arguments were adduced for half a dozen different theatres in which the props should be knocked away. No one will deny that sound strategy does include the "way round," but it must be a way round within reach; a way which does not involve a whole new expedition, absorbing much-needed guns, ammunition, shipping, trained staffs, new G.H.Q's, long lines of communication. All of the Lloyd Georgian schemes were to reduce the main front in France, and what would the Germans welcome more than that? A defeat of Austria in Carinthia, or of the Turks in Palestine, would not have saved the main British and French armies in France from being overthrown, as they certainly would have been if they had been weakened as the amateurs proposed. To enable Germany to win, she must beat the British and French in France. Conversely, to beat Germany, the victory must be won over the German armies in France. All the other theatres would crumble if the German front in France was smashed; as indeed they did.

The submarine menace had by now become acute. On April 28th, Robertson informed Haig that "the situation at sea is very serious indeed . . . Jellicoe almost "daily announces it to be hopeless. There may soon be a serious shortage of food "in this country, and this has to be taken into consideration in regard to all theatres

" of war. For us to stop fighting now would seem to be a confession of failure, and " would allow the enemy to do as he likes " (p. 101). Haig entirely agreed, and considered it time to carry on with his main plan for a British attack in the north.

Another Allied Conference was held in Paris on May 4th to decide on future action. Lloyd George came out for once in strong support of his military advisers. Haig wrote : " Mr. Lloyd George made two excellent speeches, in which he stated that he " had no pretensions to be a strategist, that he left that to his military advisers ; " that I, as Commander-in-Chief of the British Forces in France, had full power to " attack where and when I thought best. He (L.G.) did not wish to know the plan, " or where any attack would take place. Briefly, he wished the French Government " to treat their Commanders on the same lines. His speeches were quite excellent " (p. 106). . . . " The Conference passed off in the most friendly spirit, and all stated " that they were united in the determination to attack vigorously and carry on the " war *jusqu'au bout* " (p. 107). How different from the Mr. Lloyd George of to-day.

It must be remembered that these are Haig's words written at the time the events took place. They were not the result of knowledge after the event, nor were they put down in support of a publicity campaign to attack anyone. Yet what do we find in Lloyd George's Memoirs, written some seventeen years later ? A bitter attack on Haig for his Passchendaele campaign, which Lloyd George said had been planned without his knowledge.

The Battle of Messines, on June 7th, opened Haig's new campaign with a success, which astonished the Allies and staggered the Germans. Had the weather continued fair, the next stage—the offensive by the Second and Fifth Armies in the Ypres Salient—might have been equally successful. Its aim was to get the Passchendaele Ridge and eventually, in combination with a force landing on the Belgian shores, to clear the Germans from the coast. Admiral Jellicoe had told Haig that " if the " Army can't get the Belgian coast ports, the Navy can't hold the Channel, and the " war is lost." The shipping situation was becoming desperately serious.

" It was with this knowledge in his mind, based on the opinion of so distinguished " a sailor, that Haig persisted for so long in his fierce, obstinate struggle for the " Belgian Coast " (Duff Cooper, p. 123). But this was the time when Lloyd George wished to transfer British effort to the Italian front. " We can only be thankful," writes Mr. Duff Cooper, " that Lloyd George, whose faith in foreign commanders " appeared unshaken by the failure of Nivelle, did not succeed in his endeavour to " send British troops under the command of Cadorna to fight against so formidable a " foe " (Austrians reinforced by Germans).

All through the book, the Diaries contain Haig's reasons for his strategy, plainly and reasonably stated, in the form of memoranda for the War Cabinet, letters to his French colleagues, or comments in his diary. These opinions are the more valuable in that they have not been touched up or revised in the light of subsequent events.

Lloyd George not only attacks Haig for his strategy, but charges him with wasting men's lives by persisting in the Passchendaele attack. No more terrible charge than this can be brought against a commander of armies. How unjust and baseless the accusation is may be judged from Haig's own diaries, and from the continued loyalty of the troops Haig led. Writing in 1927, Haig said " . . . it is impossible for Winston " (Churchill) to know how the possibility of the French Army breaking up in 1917 " compelled me to go on attacking. It was impossible to change sooner from the " Ypres front to Cambrai without Pétain coming to press me not to leave the Germans " alone for a week, on account of the awful state of the French troops " (p. 134).

The drain on the German man-power by the battles of July–October, 1917, is emphasized by Mr. Duff Cooper from German sources, notably von Kuhl and the Crown Prince Rupprecht.

After Passchendaele came Cambrai. The French again pressed for more line to be taken over by the British. Haig was asked to extend his right to a point S.W. of St. Cobain—a front of six divisions. These demands for greater extension of the

British line appeared reasonable to the French, but they were not based on sound argument. The French line was still considerably longer than the British, but its density varied very greatly. The bulk of the German divisions were opposite the British, and Haig was doing more towards winning the war than he would have done by thinning out his line. But he did agree to taking over a four-division front.

Amidst all his distractions at the front and behind him, Haig was also disturbed by the political demand for an Inter-Allied War Council, a body which, he foresaw, could not solve the military problems, and which certainly could not function as a Command. War councils and war committees were beloved by Lloyd George, but they have never yet proved to be anything but a danger in war. Moreover, the Government appointed Sir Henry Wilson as Chief British military representative at Versailles, and Sir Henry was busy ingratiating himself with Lloyd George. Mr. Duff Cooper writes: "Faced with the problem of how to be loyal to Lloyd George "and Haig at the same time, he solved it by being loyal to neither" (p. 328). On May 11th Wilson wrote in his diary: "On the whole, I advised Haig's being brought "home" (*Wilson*, Vol. II, p. 99).

These personal intrigues had no effect upon Haig, except in so far as they made it more difficult for him to concentrate upon the supreme task of winning the war; but they accentuate the great difference in character between the different personalities.

As the winter of 1917 passed, Haig's chief anxiety was for more reinforcements. He repeatedly urged the Government to send him more men. He was well aware that the Germans meant to launch a tremendous offensive before the Americans could take part in strength; and he was convinced that the blow would be mainly directed against the British. There were plenty of men left at home, kept there by the bogey of a German invasion.

Haig has been charged with leaving the Fifth Army sector weak, in spite of the warnings of his Intelligence Staff that that was the sector most likely to be attacked. But he had only eight divisions left at his disposal, and he knew that any French reserves which might be sent could more readily reach the Amiens sector than a sector farther north.

On the subject of the appointment of the Generalissimo, the Diary shows us that it was Haig who first pressed for the appointment of Foch. On March 25th, 1918, he wired to the C.I.G.S. asking him and Lord Milner to come to France to urge that Foch "or some other determined General who would fight, should be given supreme "control of the operations in France" (p. 254). He had a great respect for Pétain, but he did not believe he was the right man to co-ordinate the Allied Armies. The Germans were striking at the junction between the British and French Armies, and it was vital to prevent them breaking it. Haig urged the largest possible concentration north of the Somme near Amiens. Pétain feared a big attack on the French line in Champagne. There was no one to decide on combined action.

"Haig had refused to detach divisions that he could not spare to form part of a "General Reserve under the command of a Committee, but he was willing and eager "at this crisis to place himself and all his forces under the command of a fighting "general. 'I can deal with a man,' he said, 'but not with a Committee'" (p. 258).

The appointment of Foch in the midst of the March crisis did what was required. Throughout the anxious days of March and April reserves were moved where they were most needed, and Haig and Foch worked in harmony together. The failure of the Germans to do what they had hoped to do gave Haig further confidence in his belief that an Allied victory was possible in 1918. The American Army was still unformed, lacking in equipment of all kinds; and General Pershing himself admitted, in October, 1918, that it would be "next autumn before it could be organized and "sufficiently trained to play an important part" (p. 399). Therefore it would have to be the British Army which would bear the brunt and bring about the victory, if victory was to be won that year.

Haig's cool judgment remained the same all through the months of victory as well as of crisis. His Diary betrays no undue elation, but steadfast faith in the troops, and satisfaction when he receives congratulations on their achievements.

The modesty which he showed when, at the end of the war, he refused honours for himself until he was assured "that adequate provision had been made for the men "and officers who had served under him" was in keeping with the whole of his life. He desired nothing better than to be allowed to live the rest of his days in peace and quiet with his family, but to the end he held it to be his duty to do his utmost to look after the interests of the soldiers who had been so loyal to him. The closing chapter of the book shows how deeply he felt the tragedy of the war; and how he devoted himself without stint to the British Legion. Can this be the man to whom Lloyd George imputes indifference to their lives?

The Diaries of Haig are the diaries of one of the most upright, loyal, true and fearless men this country has produced. No one can read them without pride and satisfaction. They are not doctored words; they are not carefully marshalled diatribes; they are the honest expressions of the Commander-in-Chief at the very moment of thought. They contain opinions but not onslaughts. Haig never took part in any vendetta. If he expressed an unfavourable opinion of anyone in his diary, it was in his diary only; he did not seek sensational publication. Indeed, he would have wished no publication at all so far as he himself was concerned. But silence in the face of Mr. Lloyd George's attacks could be maintained no longer, and the Trustees of Lord Haig's papers have done well to release them now, and to entrust to Mr. Duff Cooper the duty of giving to the public the real truth about him.

But the book is more than a vindication of Haig. It gives us an insight into the reasons for Haig's success. It shows us the stupendous burden that rests upon a modern Commander-in-Chief.

His was not the electric personality which would arouse cheers wherever he appeared; but he was the kind of man whom anxious men wanted.

W.H.K.

NAVAL WARFARE.

By Commander J. Creswell, R.N.

(Sampson Low, Marston & Co., Ltd. Price 10s.)

It is probable that this book would not be much read by army officers unless especially brought to their notice. It is, nevertheless, well worth a study if it were only for the inclusion in it of Chapter VIII on Overseas Expeditions, or what are more usually called in our regulations combined operations.

It is regrettable, however, to see, in this chapter, a revival of the heresy that ships can attack forts. On page 212 are the following words:—

> "But to conclude from this that it is always unsound for ships to engage forts is another matter. All these disadvantages can be overcome if a sufficient preponderance of force can be brought to bear, and such may well be the case, for a large body of ships can be concentrated where you will, but forts are immovable."

This may be true to a certain extent of a fortified port abutting on a comparatively open sea, but in a narrow strait it would be impossible. All harbours have entrances, and reserve defences in rear of the entrance should forbid the place to ships, or render it untenable by them if they have managed to enter.

With this trifling criticism the book can be recommended to all readers, with the remark that all British army officers should know something about naval warfare. It would hardly be an exaggeration to state that every Englishman should know something about naval warfare, as it is the results of naval warfare rather than of land warfare that will affect his fate.

If the above statement is considered too wide, it may be reduced to the following more moderate assertion. It is the duty of the majority of R.E. officers to know something about combined operations, it being their duty to help the fighting forces to get ashore, and, when ashore, to provide them with piers, water supply, and so forth, under peculiar conditions; points on which it is difficult to find satisfactory information in any regulations that we have.

H.E.G.C.

SANCTIONS BEGONE!

By H. Rowan-Robinson.

(William Clowes. Price 7s. 6d.)

Readers should not be misled by the somewhat rhetorical title of this book, which is a serious study of League of Nations problems. It was written early this year, but was not received for review till the June number of *The R.E. Journal* had gone to press; but events since its composition may well have confirmed the author in his views. It comprises firstly a history of the efforts of the League to preserve peace and records its successes and its rather more prominent failures, and the reasons for both. The author deduces that, with its present Covenant, the League is not only useless, but dangerous to peace; and he advocates its drastic reform. He considers that the League can never be effective till all the Great Powers, at least, are members; and that those outside it will never come in until sanctions in their present form are removed from the Covenant. When this is done, he hopes that the moral authority of a universal league will be so great as to deter any aggression, while such a League would also be able to remove the root causes of war by solving financial and economic difficulties. He would then leave it to the individual decision of member states whether they would take part in sanctions, their sole obligation being to refuse to supply belligerents with war material or more than the normal amount of other commodities. This he would reinforce with regional pacts between powers of the regions concerned or those whose own national interests are so intimately involved that popular support in any action taken against an aggressor is reasonably certain.

While there must be many different opinions on these proposals, few will disagree with the author's emphasis in laying down that no power should enter into any international agreement which it may be unwilling or unable to implement. That most of the signatories of the League Covenant have done so is painfully apparent.

E.V.B.

JOURNEY TO THE WESTERN FRONT TWENTY YEARS AFTER

By R. H. Mottram.

(G. Bell and Sons, Ltd. Price, 7s. 6d.)

The author of this book takes us lightly over the ground which was occupied for so long by the British Expeditionary Force in France, 1914–1918. In doing so he adopts the happy plan of dealing with it by the "Army Areas" of those days, thus bringing in that friendly feeling which goes with a localized interest.

His war experience seems to have been varied and wide, and he has eliminated the prejudiced and parochial from his outlook. He also has a delightful knack of linking up localities with historic scenes of former times. He should, however, take more care to avoid the close repetition of certain succulent sentences which have evidently appealed to him; and there are even occasions when it is necessary to re-read a paragraph to get the intended sense.

To the post-war generation this book should have appeal as an easily read summary of the course of the war on the Western Front; but to the man who served in France it has another appeal. Such a man will find himself recognizing this or that place, the old familiar scenes will gradually float back into his memory, and long-forgotten faces will re-appear. As he reads on, a subconscious but poignant longing will steal over him to recapture those times with their comradeship, cheerfulness, and the worth-whileness of everything. A little later he will probably be found fingering his son's *School Atlas*, or the *Michelin Guide*, and wondering if he can fix up a tour " over there " with old So-and-so.

In fact it is well worth reading this book, in which the author conjures visions from the past in such a simple and pleasant style. E.N.E.

AN OUTLINE OF BRITISH MILITARY HISTORY.

By Major R. H. Cole, M.B.E., M.A., LITT.D., and Major E. C. Priestley, M.A.

(Sifton Praed. 12s. 6d.)

The authors have set themselves the extremely difficult task of writing a history of the development of the British Army, combined with history of British campaigns, in a work of some four hundred pages. The declared object of this book is to provide " a clear outline for the use of Students who want such a sketch as a preliminary to the more detailed study of individual campaigns."

The learned student of Military History may cavil, particularly at the bibliography on which the book is obviously based: the works cited are those of the more popularly known variety. The literary reader may criticize the style in which simplicity often descends to *naïveté*, yet the authors have definitely succeeded in their object. For the first time a simple but comprehensive story is produced of the campaigns of the British Army. The account provides a good beginning for the student, a definite background on which to build from their study and a straightforward simple story for all young officers in the Army.

A word must also be said for the publishers. The clear maps, folding out clear of the letterpress—an essential found only too seldom in military books—do a great deal to enhance the value of the book, which should be of real value to any military student wanting a sound and clear introduction to the history of the British Army.

MILITARY ORGANIZATION AND ADMINISTRATION.

By Brigadier W. G. Lindsell, D.S.O., O.B.E., M.C., *p.s.c.*, R.A.

16th Edition. (Gale and Polden, Ltd. Price 7s. 6d.)

This most useful book needs no new recommendation unless it be that this the 16th Edition, dated March, 1936, brings the work right up to date. The new edition embodies the many important changes which are to be made in the organization of the army, and the consequent alterations in the maintenance machinery of a modern expeditionary force. The mechanization of unit first line transport and consequent modifications in the supply system have been included.

AN ELEMENTARY STUDY OF APPRECIATIONS, ORDERS AND MESSAGES.

By Major W. K. M. Leader, M.C., *p.s.c.*, Duke of Cornwall's Light Infantry.

(Sifton Praed. 1936. Price 7s. 6d.)

In the review on this book, which appeared in the last number of this *Journal*, it was stated that " the book did not appear to be quite in line with *F.S.R.*, Vol. II, " 1935, on the subject of what should go in an appendix to an operation order, and what in an operation instruction."

Shortly after the review had gone to press, Amendments (No. 1) to *F.S.R.*, Vol. II, 1935, were received, including an amendment to Sec. 13. As a result of this amendment, the statement quoted above no longer holds good, and Major Leader's book is now in line with *F.S.R.*, Vol. II, 1935, on the subject referred to above.

E.K.S.

HINTS TO TRAVELLERS.

(*Eleventh Edition.*)

VOLUME I.

SURVEY AND FIELD ASTRONOMY.

By E. A. REEVES AND OTHERS.

(Published by the Royal Geographical Society. 1935. Price 16s.)

The eleventh edition of this well-known book, with the traditional but inadequate name, should have been published in 1933, but owing to the ill-health of the author this was impossible. Then alterations in the *Nautical Almanac* for 1935 upset all the astronomical computation forms. However, the edition, now it has appeared, is good and is printed in a very legible type.

The companion volume which concerns equipment, transport, health, etc., is in future to be published separately, which seems only sensible, as the two volumes are quite distinct in character and need revision at different intervals.

As heretofore, the book deals with exploratory survey and field astronomy and all the necessary instruments. Exploratory surveys are few and far between nowadays. In the past, officers of the Corps have distinguished themselves on many occasions. It is interesting to record that a young officer of the Corps is shortly setting out on one of these surveys to Baffin Land with the British Canadian Arctic Expedition, and will be away about three years and no doubt will find this book useful.

R.E.F.

A KEY TO MAPS.

By BRIGADIER H. ST. J. L. WINTERBOTHAM, C.B., C.M.G., D.S.O., sometime Director-General of the Ordnance Survey.

208 *pages and* 9 *plates.*

(Published by Blackie & Sons, Ltd. Price 5s.)

The book is written to form one of Blackie's " Key " Series and to be a companion to such books as *A Key to the Stars*, *To the Countryside*, etc.

As such it would appear to be primarily meant for the man and woman in the street and not for those whose job it is to deal with maps and map-making in their daily life. The author says in his preface that the book is an endeavour to make the use of the map easier, and it has catered throughout for those whose knowledge of maps is probably slight. Without in any way being an alternative to *The Manual of Map Reading*, 1929, the book could well be used as an adjunct to that textbook by those in the Army. As a criticism one might say that the book perhaps contains too much " meat."

What is meant by this is that the ordinary map user—the motorist, the cyclist and the hiker—is not concerned with plans, charts, sheet lines, covers, folds or the actual printing of the map. If a motorist, he likes his 10-mile, ¼-in. or ½-in. map, and with it and the A.A. or R.A.C. *Handbook*, he has all he wants. Other map users, working on the 1-in. map for their more peaceful rambles, will probably find the chapter on hills the most useful.

The book, as the author frankly admits, is entirely preoccupied with Ordnance Survey publications and processes, but, of course, many other good maps are sold in England. All, however, are based on the work of the Ordnance Survey. For those interested in the deeper aspects of map-making, the chapter on projections is excellent, and the chapter on locating a point is controversial. This chapter introduces the 5,000-yd. grid on the 1-in. map, and now printed on the Ordnance Survey 5th Relief Edition of that map, but with which we in the Army are unfamiliar. I have not yet met the civilian who cares to meet you at 12345 67890 (to the nearest

100 yards) instead of the "Leather Bottle" in Cobham. If he must use a reference, he seems to me to prefer the square A.7 method.

The index is good. The illustrations are adequately reproduced. That on page 76 gives an idea of the amount of gear necessary for map-making, while that on page 92 seems to portray the Navy in a very serious mood with three officers watching another work—an unknown survey principle!

The book is written with the enthusiasm, humour and compelling style so well known to members of the Corps who have come in contact with the author. As a mine of information on maps it cannot be beaten. The scale of "parasangs" suggests the query, "How did old commanders move?" Xenophon and his 10,000 Greeks, though they had no maps, managed to get home without them. But how much of interest they must have missed on the way! This, we think, suggests the main object of the author, though, of course, he is not writing for military purposes.

R.E.F.

ELECTRICITY.

By W. L. Bragg, sc.d., f.r.s.

(G. Bell & Sons, Ltd. Price 8s. 6d. net.)

Professor W. L. Bragg's book originates from a recent series of Royal Institution Christmas lectures to a juvenile audience, following the tradition established by Faraday a century ago, and since then continued by a long succession of our most brilliant exponents of science.

In this book the author has presented the fundamental principles of electricity in a simple and interesting way, and his ideas are illustrated in electrical appliances well known to all. No mathematical formulæ have been given; on the other hand, the magnitude of units in which electrical quantities are measured is indicated by quoting figures for familiar examples.

The first three chapters deal with the behaviour of electrical charges, electrical currents, magnets, and with such fundamental apparatus as cells, motors, and dynamos. In the remaining chapters the author deals in some detail with the electrical apparatus used in everyday life, including power stations, the "grid," telegraphs and telephones, oscillating circuits, and "wireless."

The book is admirably illustrated with photographs and diagrams, and while interesting to the expert is a valuable mine of information to the general reader.

F.G.D.

DETERIORATION OF STRUCTURES OF TIMBER, METAL, AND CONCRETE EXPOSED TO THE ACTION OF SEA-WATER.

(Fifteenth Report of the Committee of the Institution of Civil Engineers.)

Edited by S. M. Dixon, m.a., b.a.i., m.inst.c.e. and H. J. Grose, m.c., b.sc.

(H.M. Stationery Office. Price 12s. 6d.)

This book is a summary of the experimental work carried out from 1920 to 1935 on behalf of the Committee of The Institution of Civil Engineers, in order to examine the effect of sea-water on structures of timber, metal and concrete. The conclusions arrived at are of great value, though the subject may be said to be still in its infancy and research work is consequently being continued.

The book is divided into three main sections, each dealing with one group of materials.

The first section deals with the effect of sea-water on timber, in so far as marine borers are involved. Of marine borers the most common and troublesome is the "teredo" or "shipworm"—a bivalve mollusc. Other borers are the minute "limnoria" and "chelura," which, though popularly called "worms," are actually crustaceans.

The experiments consisted of exposing test pieces of timber (usually Baltic, Russian and Canadian softwoods), some untreated, others treated with various preservatives and poisons, to the action of sea-water in home and tropical waters. Before making the actual tests it was necessary to test the effects of various poisons on marine borers in the laboratory. It was difficult to remove the teredo from his burrow without killing him, and the method employed most successfully was to expose the living teredines by immersing blocks containing living specimens in sea-water and counting the number of extruding siphons. The blocks were next immersed for a few days in poisoned sea-water. The siphons were immediately retracted. The blocks were then returned to normal sea-water when the siphons of the surviving specimens again extruded and were counted—a simple and effective method of observing the mortality! Resulting from these experiments a number of effective poisons were used in the actual tests.

Creosoting was also known to be a deterrent to the borer, and consequently most of the actual experiments were carried out on pieces of timber which had been treated with creosote, poison, or both.

For the actual tests small blocks of timber usually 12 in. x 8 in. x 2½ in. were used: those which had been treated were covered with thin slabs of untreated timber to act as an "appetizer" to the teredo and other pests. Borers will pass from one piece of timber to another as long as the surfaces of each abut closely. The first tests were carried out at Lowestoft, but both there and at Plymouth, where other tests were carried out, it was found that, owing to rough weather and other causes, the action of the teredo was irregular and the results of the tests inconclusive. Other blocks were consequently sent for exposure to Colombo, Singapore and other tropical and sub-tropical places, where the action of borers was far greater and the results of the tests were illuminating.

In general it was found that creosoting of timber by the Bethell process was the best method, being definitely effective against teredo but less effective against chelura. Against limnoria it was of little use. The creosoting of soft woods presented some difficulty as the effectiveness of the treatment depended on the penetration of the creosote: penetration was assisted by making shallow incisions in the timber immediately before creosoting. Painting the surface of the timber with creosote was useless. The poison most deadly to the teredo was found to be chloro-dihydrophenarsazine, commonly known as "D.M." Adding D.M. to creosote did not improve the preservative effect, but crude mineral oil (in itself useless against teredo) was found to be of use when 5% of D.M. had been dissolved in it.

A preservative against limnoria, fortunately a less common pest, has yet to be discovered.

The second section of the book deals, firstly, with the corrosion of various ferreous substances, carried out at Auckland, N.Z., Colombo, Halifax, N.S., and Plymouth. The test specimens were bars 24 in. x 3 in. x ½ in., and were exposed at each station in 3 groups—(1)aerial, or above the level of high water (2) half-tide, between the levels of high and low water, and (3) completely immersed.

The materials used for the bars were six types of carbon steels, two mild steels to which copper (0·6% and 2·2%) had been added, "stainless" steel (13·5% of chromium), two nickel steels (one low in nickel and the second containing 36% of nickel), three wrought-irons (ingot, Low Moor, and Swedish charcoal), two cast-irons (hot blast and cold blast), and a number of special soft-grade chromium steels.

A number of additional tests were made at Plymouth to examine the behaviour of the above metals when exposed to fresh water.

The results of the tests appear to show that for half-tide or complete immersion all the substances tested are fairly ineffective, with the exception of the steel containing 36·6% of nickel, which resisted all forms of corrosion well and showed comparative freedom from pitting. Wrought-iron was superior to the carbon steels when placed in salt water, though inferior when exposed to fresh water or air. The chromium (stainless) steel suffered severe corrosion both in half-tide conditions and when fully immersed in salt water, while resisting atmospheric and fresh water corrosion satisfactorily. Cast-iron proved quite as effective.

The protection of steel and iron from salt water by means of paints and other preservatives is discussed next. The results, while definite, are not surprising, and they may be briefly summarized as follows :—

Plates which were already corroded had to be sand-blasted before painting or treating to produce effective results. Multiple coats were more effective than single coats. For complete immersion tests, iron oxide paints were found to be superior to red and white lead paints, though inferior for half-tide or aerial tests. Coal tar was found superior to both iron oxide and lead paints, while bitumen was found to be excellent for underwater work. Copper and zinc oxide anti-fouling paint was inferior to iron oxide, but lead chromate paint was promising.

To conclude the summary of this second section of the book, it should be added that the results of all the tests on metalwork varied somewhat according to the locality, and showed that materials best for one station were not necessarily best for another.

The third section of the book is of great interest to the sapper officer, dealing with the deterioration of reinforced concrete under the action of sea-water. Some years ago the theory generally accepted was that deterioration was due to corrosion of the reinforcement. Later, the trend of opinion tended towards doubts as to the resistance of normal types of cement against sea-water. It was thought that pozzolanic substances, either natural or artificial, when added to the cement, would give better results. Oddly enough, the conclusions now arrived at show a tendency to swing back to the older theory.

The tests were carried out with small R.C. piles 5 ft. long and 5 in. square, some of which were exposed to sea-water at Sheerness and on the Gold Coast. Others were exposed to artificial concentrated sea-water at the Building Research Station, Watford.

Four types of cements were used—Portland, rapid-hardening Portland, aluminous, and Portland blast furnace cement. Three mixtures were used, " rich," " medium " and " lean," the rich mixture being 1 part cement to 2·6 parts aggregate. To some of the mixtures artificial pozzolana was added and to others, trass (a natural pozzolana). The specimens were prepared under laboratory conditions, and both dry (½-inch slump) and normal (2-inch slump) mixtures were tested.

These tests have been in progress for five years only and it will be necessary to issue a more definite report at the end of a further five years.

The results of the tests so far obtained appear to show that the cracking and failure of the pile occurs after rust has appeared on the surface. This seems to suggest that failure is due to the corrosion of the reinforcement caused by the permeability of the concrete. The corrosion in its turn sets up internal stresses which disintegrate the concrete. The answer appears to be that all reinforcing bars should be covered with at least 2 in. of concrete, which in turn should be as dense as possible. A rich dry mix with a trowelled surface appears to be fairly impermeable.

The most surprising conclusion so far arrived at is that artificial pozzolana is apparently of no value, but that trass added to a lean mixture is advantageous.

It might be of assistance to explain that the former is a substance which, while not necessarily cementitious in itself, possesses constituents which, in the presence of moisture, will combine with hydrated lime at ordinary temperatures to form stable, insoluble compounds of cementitious value. " Trass," which is a rock of volcanic origin found in Germany, is one of a number of naturally occurring materials which possess pozzolanic properties.

The final report on this section, due in 1940, will undoubtedly throw further light on this still obscure subject.

L.R.E.F.

THE RESISTANCE OF PILES TO PENETRATION.

By RUSSELL V. ALLIN, M.Inst.C.E.

(E. and F. N. Spon, Ltd. Price 10s. 6d.)

This book consists chiefly of tables, based on the Hiley formula, showing the ultimate resistance to penetration of various types of piles under various conditions. It deals mainly with much larger piles than an R.E. officer would normally expect to have to drive, but should be of great value to anyone concerned with pile-driving operations on a large scale. The author deduces two important lessons from his tables (*a*) the advantages gained by the use of a heavier hammer with a smaller drop and (*b*) the small and sometimes insignificant increase of ultimate resistance achieved by substantial reductions of the final set in heavy driving.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(*April*, 1936.)—1. *L'emploi des troupes du génie lors des inondations de la Plaine du Rhône.*

Colonel Schaffner, commanding the Engineers of the 1st Division, describes the work done by the Engineers in the first few days of July, 1935, during the floods in the Rhone Valley in the cantons of Valais and Vaud.

Heavy falls of snow, followed by very high temperatures in June, caused a sudden rise in the level of the Rhone, followed by a breach of the river-dyke. On the 1st July, the flow of the river was estimated at 1,000 cubic metres per second, of which 200 cubic metres were discharged outside the river-bed.

The Engineers were called upon to drive a line of steel sheet piling above and below the breach, and construct a pile bridge across the gap to carry 10 tons per metre run. On the 2nd July, a reinforced concrete bridge over the Grand Canal was carried away. A boat ferry service was established to take its place, but this was almost immediately replaced by a pontoon bridge to carry 3½-ton loads. Thousands of sandbags were put down to prevent the flood from spreading.

On the 4th July, it was decided to replace the pontoon bridge by a suspension bridge. This was taken in hand on the 7th and completed on the night of the 11th/12th. In addition, a pile-bridge to carry 8-ton loads was built between the 8th and the 11th.

A series of photographs illustrates the extent of the floods, and the various bridges constructed.

2. *Le cerveau du régiment.*

General Clément-Grandcourt continues his study of regimental command posts. In this article he describes the allocation and distribution of work in a regimental headquarters.

3. *La bataille des yeux.* By Captain Zimmermann.

The campaign in Italy of 1859 was the last war in which the two opposing forces were in full view of one another. The introduction of the rifled breech-loader increased the distance between them, while the invention of smokeless powder and the Maxim gun made the battlefield a desert. Bright uniforms disappeared, troops dug themselves in underground, the entrenching tool became the infantryman's second weapon. In 1914, the machine-gun controlled the field of battle.

In modern warfare the soldier sees practically nothing; if he has a target to fire at, it is most minute. Moreover, he is left to himself, and depends upon his own initiative.

The commander, too, sees nothing, or next to nothing, of the enemy. To enable him to carry out his duties, he requires (1) a system of powerful optical instruments and a specialized personnel, (2) a system of communication by which he can obtain information, (3) light machine-guns and tanks, (4) artillery of accompaniment. Gas shells are ideal for neutralizing the enemy's fire.

The writer concludes with the axiom: "He who sees will gain the victory."

(*May*, 1936.)—1. *Matériel du génie.* By Colonel Lecomte.

Referring to an article in the April number, on the employment of Engineers during the floods in the Rhone Valley, the writer criticizes the present strength and equipment of the Engineers in the Swiss army. The floods carried away the bridge over the Grand Canal on the 2nd July, and it took ten days to re-establish communication for mechanical transport. If the 1st Division had been engaged in active operations of war at the time, such a delay might well have proved fatal.

The present strength of engineers in each Swiss division of 30,000 men consists of a battalion of 4 weak companies of sappers and one still weaker company of pontoon men.

After discussing where the work would have been retarded, and how it could have been speeded up in war-time, the writer makes definite recommendations for improving the state of affairs.

The only bridging material in the equipment of a battalion of sappers is a light pile-driver, mounted on a carriage. The battalion is mainly instructed and equipped for the construction of extemporised bridges suitable for horse-drawn wagons or light vans. The company of divisional pontoon troops also has a light pile-driver and equipment for 40 metres of light bridge. With this material it can construct either a ferry, or a foot-bridge of 60 m., or, at a pinch, 20 metres of heavy bridge, for 6–8-ton loads.

The standard equipment is designed for 3-ton loads. The loads can be increased to 6–8 tons by rather doubtful methods of strengthening.

In carrying out the work, the engineer commander of the first division was compelled to ask for the loan of the pontoon company of the 2nd division, as well as of a heavy pile-driver belonging to the army bridging equipment. In war-time it might not be possible to count upon such extra assistance.

Taking all favourable circumstances into account, the first division might, in war-time, have been able to re-establish communication for 6- to 8-ton lorries, after a delay of 6 days. Such a delay is not permissible.

Colonel Lecomte concludes by giving a detail of what a division should include in future, *i.e.*:

A company of pontoon troops, with material for 30 to 40 metres of heavy bridge, capable also of being used for light bridges, foot-bridges, or ferries. The material should include a heavy pile-driver.

A battalion of sappers, with two or three companies, provided with equipment for floating foot-bridges and metal material for light bridges. The sapper battalion will not require a heavy pile-driver, but it will be useful for each company to have a light pile-driver.

Another point raised is that sappers are not only insufficiently equipped for bridging, but for every class of work. All work is still done by hand, as in the days of Julius Cæsar. Sappers should be provided with mechanical means for drilling holes in wood, stone, or iron, for lifting heavy loads, working saws, etc.

2. *Le cerveau du regiment.*

General Clément-Grandcourt concludes his article in this number. The points dealt with are the tactical dispositions for the defence of the command-post, concealment from view, defence against aircraft and other forms of attack, and, finally, the arrangements for moving the post to another site when necessary.

3. *Transmissions.*

Lieut.-Colonel du Pasquier discusses the organization of the Signal system in the

Swiss army. He lays down, as a general principle, that an infantry regiment should have a signal section. The artillery group supporting the regiment should also have one. The two signal sections should be interchangeable.

In dealing with the signal service of the supreme command, the writer quotes the failure of the mission of Lieut.-Colonel Hentsch of the German G.H.Q. in September, 1914, before the battle of the Marne. He clears Colonel Hentsch of blame. The failure of the Schlieffen plan was due to unsatisfactory signalling communication. The blame is due to those, who, at the most critical moment of the war, entrusted the decision to Hentsch.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

The Technical Supplement (*March*, 1936) contains articles on the following subjects:

1. Recent research in air resistance to projectiles.
2. Practical diagram for calculating bridges with continuous girders.
3. Mechanical problems in gun-carriages.
4. Notes on extemporised bridges across water-channels between 6 and 8 metres wide.
5. A graph for the approximate calculation of ranges.
6. Effect of lattice-work on the resistance of iron piers in No. 1 road-bridge.
7. Stability to the action of heat in nitro-glycerine powders of varying composition.

(*April*, 1936.) 1. *I capisaldi dell' impiego dell' artiglieria nelle nuove " norme per il combattimento della divisione."*

Colonel Marras discusses the limitations in the employment of artillery in the new regulations for the division in battle.

2. *Orientamenti per la guerra di movimento.*

Brigadier-General Fautilli comments on the opinions expressed in an article that appeared under the same title in the *Rivista di Fanteria* on the subject of artillery in mobile warfare.

3. *I collegamenti di una divisione di fanteria nell' azione difensiva.*

Major Cappuccini illustrates the working of a system of signalling communications in an infantry division. He has assumed a special situation and a given area of operations. The working out of the scheme is explained by maps and photographs. The whole system is under the officer commanding divisional engineers, and includes a telephone system, a photo-telegraphic system, radio communications, carrier-pigeons and searchlights.

4. *Il materiale da 75/18 per batterie someggiabili e per batterie a cavallo e autotrainate.* By S.T.A.M.

In this article the writer describes the character istics required of modern divisiona artillery material. He refers to the new long 75/18 howitzer, a typically Italian gun for pack, horse-drawn and motor-drawn batteries. He considers this howitzer entirely suited to its purpose.

5. *Impressioni di guerra sul fronte somalo.*

Major Petroni gives a first instalment of his impressions of the war on the Somali front. The description of the country in Italian Somaliland will be of special interest to those who took part in the campaigns against the Mad Mullah over 30 years ago. The main difference in the conduct of the present campaign is the use of mechanical transport in the place of camel transport. Without efficient mechanical transport it would have been quite impossible to conduct operations on a large scale more than a short distance from the coast.

The supply of water and food formed the main problem in a country where the former is scarce and the latter practically non-existent. Pumps and water-tanks were used extensively; water was carried in motor water-carts, and considerable trouble was taken with the sterilization and filtering of impure water. The medical services come in for high praise. There appears to have been little sickness amongst the troops. The writer was agreeably surprised at the healthiness of the climate, the scarcity of lions and snakes, and the ability of the Italian troops to stand extremes of heat and cold. No mention is made of scurvy, which was one of the curses of British campaigns of the old days, and cases of malaria were comparatively rare.

The rations, both of European and native troops, were liberal.

The writer makes comments on the use of expanding bullets by the Abyssinians, and gives a sketch of cartridges. Some of these were evidently intended for big game, in others the lead bullets had been cut with a knife.

6. *Possibilità del telefono automatico nel campo militare.*

2nd Lieut. Contini discusses various systems of automatic telephones, *e.g.*, the Siemens-Strowger, the Ericsson and the Western systems, and the possibility of utilizing them for military purposes.

7. *Nota sull' industria del petrolio.*

In this note Lieut.-Colonel Varvaro gives a brief outline of the development of the oil industry, and the alternative methods of refining oil, *i.e.*, the normal method, and the "cracking" process. The "hydrogenation" process has been developed slowly on account of the great initial expense. It is specially suitable for crude oils with a high proportion of sulphur, that cannot be refined satisfactorily by other means.

The writer concludes by describing the oil industry in Italy. The amount of crude oil produced in the country is negligible, but the Italian government has secured control of an important Rumanian company and of the Albanian oilfields, and has acquired a large interest in the Mosul oilfields. Refineries have bnee built at Naples, Spezia, and Porto Marghera; and encouragement has been given to the production of substitutes for petrol, such as alcohol. The country is determined to secure an adequate supply of fuel for its fighting services, in spite of all outside attempts to cut it off.

(*May*, 1936.)—1. *Considerazioni sull' impiego dell' artiglieria celere.* By Major-General Camerra.

The writer here discusses the duties of the artillery of a mobile division. The main object to be attained is the immediate intervention on the field of battle. Fire would ordinarily be directed against automatic arms, anti-tank guns and tanks. Counter-battery work would be the exception.

2. *Il traino meccanico delle artiglierie.*

Major Cavalli deals with the problem of mechanical traction in the artillery. In army artillery there is no question of radical innovations, it is rather one of improving and perfecting methods already in use. For corps and divisional artillery there are numerous problems. Should guns be hauled by tractors, or self-propelled? Should a system be adopted with an all-wheel drive, or with caterpillar tracks? These questions are discussed at length.

3. *Sorgenti luminose per apparati fototelegrafici campali.*

Lieut. Puglisi compares the different sources of light available for photo-telegraphic work in the field. These are (1) acetylene light, (2) oxy-acetylene light, (3) aero-acetylene light, (4) electric incandescent light (4-watt lamp). The same question was discussed in the *Rivista di Art. e Genio* for August-September, 1935.

4. *Il rifornimento delle munizioni sul campo di battaglia.* By Colonel Frondoni.

A scheme in which details are worked out for maintaining the supply of ammunition to a force consisting of two divisions and a proportion of corps artillery for a two days' battle.

5. *Sviluppo ed aspetti del cinema applicato nel campo addestrativo scolastico e militare.* Lieut.-Colonel Gabrielli.

The educational film has been found to be of considerable value for instructional purposes, but it has the drawback, as far as schools are concerned, of providing instruction without calling for a mental effort. The writer endeavours to show the value of the cinema in barracks and its possibilities in the training and education of the soldier. He goes on to describe the development of the military cinema abroad (Belgium has made great progress in this direction) and concludes with an account of what has been done in Italy.

6. *Impressioni di guerra sul fronte somalo.*

Major Petroni concludes his article on his impressions of the Somali front. He eulogises the native troops: Somalis, Arabs and Eritreans, as well as the Somali camel and the mule (both the Italian and the native variety). Some of the difficulties of keeping up mechanical transport are mentioned. Observation, even from aeroplanes, is everywhere difficult. Wire telegraphy is not easy to maintain on account of damage done by transport animals and the ravages of white ants. On the other hand, radio has proved a success, the range of instruments being about $2\frac{1}{2}$ times that in Italy. The writer concludes with a dissertation on bush fighting, and the tactics to be adopted in the campaign.

7. *Memoria su di un dispositivo per facilitare lo studio ed il montaggio delle teleferiche campali.* By Lieut.-Colonel Borelli.

The following operations are necessary for working out a scheme for an aerial ropeway:—

(1) A preliminary selection of the trace.

(2) A profile of the ground.

(3) A study of the configuration of equilibrium in the cable, the determination of the number, position and height of the supports, the position of the terminal stations.

In this article the writer endeavours to show how the necessary details can be worked out without any theoretical calculations or specialist knowledge.

The tension T in kilogrammes in a ropeway is given by the formula:

$$T = py,$$

where p is the weight of the cable in kg. per metre of length, and y the ordinate of the catenary in metres.

The two terminal stations are fixed. In the intervening space all cables will have the same configuration of equilibrium if they pass through points where

$$\frac{T}{p} = y = \text{a constant.}$$

The method suggested is the construction of a model, on a small scale, of the ropeway, of fine steel wire. A tension T is applied at one end (usually the lower end), having the same proportion to the weight, per unit of length, of the wire, as the tension of the main cable to its weight, for a given dip p. The tension can be applied by means of small weights or of a spring dynamometer.

The approximate trace having been selected, and the terminal stations fixed, the model cable is stretched with a tension T',

$$T' = \frac{p'}{p} = T.$$

Where the wire touches, or nearly touches, the ground, it is raised by sticks or light trestles. The angles of deviation of the rope on the supports are then noted. These angles must lie between a fixed minimum to ensure the stability of the wire on the supports and a maximum for the resistance of the trestle and the regularity of the line.

The supports are then shifted, until, after a few attempts, the necessary conditions are obtained. The profile so obtained represents, on a small scale, the exact alignment of the carrying rope as it will be constructed.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*January-February*, 1936.)—1. *Les matériels de ponts anglais.* By Captain Beauvais.

This is a detailed review of two articles that appeared in *The R.E. Journal*, viz. "Military Bridging Equipment," by Colonel A. P. Sayer, D.S.O., R.E. (September, 1934), accompanied by 16 photographs, and "Simplicity and Flexibility for our Service Pontoon Equipment," by J.A.C. (September, 1935).

The writer points out that not a single article of bridging equipment that was "regulation" at the time of the war, has survived in actual use.

2. *Étude sur les téléfériques.*

Captain Leygue continues and concludes his article on ropeways in this number.

Circumstances may require the construction of a ropeway at very short notice in the field, and a rapid survey presents considerable difficulties. The terminal stations will usually be definitely fixed, and there is no question of preparing a series of alternative surveys for the alignment in order to select the best one. Two operations are now required, viz. (1) the laying out of the line on the ground, (2) the preparation of a longitudinal section.

A topographical survey can be carried if the position of the stations on the ground is known. If the line (assumed to be AB) runs up the slope of a hill, and a point M can be found, not too distant, on the opposite slope of the valley, so that the points A, B, and M are in the same vertical plane, the line AB can be staked out in a very short time.

For a long line several working parties should be employed, working simultaneously; the number depending upon the length of the line and the difficulties of the ground. Each working party will be provided with a portable radio set, a tacheometer, survey-chains, a megaphone, bill-hooks, and, if necessary, explosives. These working parties will start from the terminal stations, working towards each other, and from intermediate points, under the orders of the officer in charge. The latter will have determined the general alignment from a study of the map. The observations made by each party will be transmitted by radio to a central station. The central station will correct any errors made by the working party in the alignment. As soon as the line has been fixed, it will be cleared of trees and bushes for a width of 6 metres.

The next stage will be to check, and, if necessary, straighten out the alignment, reducing the number of angles to a minimum. The working parties will not decide at what points pylons are to be erected. This will be decided by the central drawing-office, who will plot the information received from the working parties on a scale of 1/1,000.

All the salient points plotted in the longitudinal section are considered suitable for standards, but need not necessarily be used for such. If, at a particular point, the acute angle formed by the straight lines connecting it with the adjacent points is less than a given angle "a," the point will be suitable, if not, the standards at the adjacent points must be raised. The height of the standards will also depend upon the sag in the rope, and the distance of the latter from the ground.

A map on a scale larger than 1/25,000 may be found useful for selecting an alignment, but it cannot be relied upon for levels. An aerial survey can be used, but if a large-scale survey map exists, the latter is preferable. A survey can be carried out rapidly by increasing the number of working parties, giving them all available instruments and centralizing the information collected. Having determined the general alignment, each party will be given a definite magnetic bearing to work on. The levelling will be done by taking as long shots as possible.

In certain circumstances a ropeway can be put up without a preliminary survey, the only instruments used being a tacheometer and chain or even field-glasses and range-finder. But in such a case it is advisable to use standards whose height can be easily adjusted. A survey can, however, only be omitted when there is a clear view along the whole line.

Ropeways are used very extensively in industry, not only in mountainous country, but on the level. Individual loads exceeding 10 tons in weight can be carried, though a ropeway of this type is necessarily costly.

As regards a standard type of ropeway for service purposes, the writer points out that conditions vary to a much greater extent than in the case of a boat-bridge or a road or railway bridge.

A comparison is made between mono-cable and bi-cable ropeways, to arrive at the most suitable type for military purposes. If the gradient is not steep, the carrying rope of the bi-cable has only to carry the loads, while the hauling rope transmits the motor effort for moving the loads. In the case of steep gradients, however, the carrying rope is subjected to considerable transverse stresses. In a mono-cable the single rope is subjected to both kinds of stresses. But if a ropeway is not erected with the greatest possible care, a contingency only too likely with a ropeway constructed in the field, there will be transverse stresses along the whole line, and the wear and tear of the rope will be as great in a bi-cable as in a mono-cable.

The designers of modern ropeways can cope with gradients of 100% and even in excess of this amount.

In a bi-cable the weight of a carrier can be distributed by using a series of pulley wheels; in a mono-cable the load is concentrated at one point. An exception is made in the case of long loads, which are suspended from two separate carriers. In a mono-cable the pressure on the standards must not exceed 1,500 kg. Where individual loads are small, *i.e.*, less than 500 kg., the total weight of ropes is less in the mono-cable than in the bi-cable. But if these loads are exceeded, the bi-cable becomes more economical. The maximum practical diameter of rope for a mono-cable is 27 mm.; a rope of greater thickness than this is not pliable enough for a military ropeway.

It is generally accepted that in the lay-out of a bi-cable ropeway, a slight deviation from the straight is permissible, say as much as 50 metres in a length of 1 km. A mono-cable must be laid out in an absolutely straight line. In both cases, lines should be laid out with the greatest care, but an error of alignment matters less if the spans are large than if they are small.

If spans are large, higher standards will be required in the case of a mono-cable than a bi-cable. Also, if the distance between loads is considerable, a bi-cable will prove the more economical proposition.

With regard to the erection of cables, little progress has been made in the past forty years. The practice has been to roll the cable in a series of coils, each weighing from 30 to 50 kg., with intermediate connecting lengths of 2 metres. One or two men are told off to each coil, and, at a given signal, the whole is hoisted on to their shoulders, and the procession wends its way up the mountain. If the paths are good, mules can be substituted for human carriers, and the weight of the loads increased in proportion. As a mono-cable has fewer ropes, it is more suitable in the case of a rapid installation.

An occasional inspection of the cables is very necessary, and a moving rope can naturally be examined more carefully as it rounds the terminal stations than a fixed carrying rope.

The lubrication of the different parts is a matter requiring attention. The tension of the cables must be kept constant; they will occasionally have to be shortened. In a mono-cable the cutting and splicing of the wire rope will put the installation out of action for a time.

There is little difference in the motor power required to work a mono-cable and bi-cable of the same capacity.

The working speed of a well-built bi-cable is higher than that of a mono-cable, but in the field, where the work is, more or less, rough, there is little to choose between the two systems in the matter of speed. The average speed is between 1·50 and 2 metres per second.

In practice, the length of a line is limited to about 2,000 metres. If a greater length than this is required for a bi-cable, the line must be divided up into sections, each with its own tension gear. A single motor and hauling rope can work such a system. But, on the score of simplicity, a mono-cable is preferable to a bi-cable in long lines.

In conclusion, the normal type of field ropeway is the mono-cable. But, for extra heavy loads in single-load systems and in rapid installations, bi-cables are preferable.

3. *Le train de bétonnage de la "Société Parisienne."* By Lieut.-Colonel Metz.

A description, with photographs, of a special train, constructed by the "Société Parisienne," for transporting a concrete-mixing plant, and all the ingredients for making concrete, to any portion of a railway line at which concrete work may be in progress.

The train is made up in the following order :—

A water-tank wagon containing 18 cubic metres of water.

A central electric wagon, containing a 220-volt generator actuated by a 100-h.p. Diesel engine, supplying power to the whole installation, and light for work at night.

Two hopper wagons for sand and gravel, with belt conveyers running along their whole length.

Concrete-mixing wagons with a compartment at each end for storing cement, places for the discharge of the belt conveyers, and two concrete-mixers in the centre.

Two more hopper wagons as above.

(*March–April*, 1936.)—1. *Les travaux de piste à la cluse de Tassent.* By Captain Tajan.

This is a description of road construction work carried out in the Grand Atlas in 1933 by two companies of Engineers, one company of Sappers and Pioneers of the Foreign Legion, 5 battalions of Infantry and 500 civil labourers.

At the end of the operations of 1932, a motor-cycle road had been constructed as far as Tassent (altitude 1,950 m.), at the end of a valley separated from the Plateau of the Lakes by a high barrier (mean altitude 2,700 m.). This barrier is divided in two by a deep and narrow gorge through which the spill water from the lakes flows. It was through this gorge that the new track was constructed.

The work involved a large quantity of rock-cutting and blasting. "Spiros" compressors were used. In places the rock surface was sheer, and sappers had to work suspended by ropes. The work took exactly a month to complete.

2. *Quelques ingénieurs militaires au XVIIe siècle.*

Colonel Lazard, the author of the life of Vauban, here gives an account of the life of some of Vauban's assistants and subordinates.

These are: the brothers Decombe, who were raised to the nobility by the king, and one of whom became Director of Engineers; Pierre de Lalande, who received the same distinction, but never became a director; Lapara, who officiated for Vauban when the latter was on tour.

3. *Méthode pratique pour le calcul des chutes de tension, etc.*

Chef de bataillon Allard explains a practical method of working out the drop in tension in the unbalanced arteries of a three-phase, low-tension lighting system.

The arteries of a three-phase lighting system supplying current to the lamps of any military building are, inevitably, thrown out of equilibrium throughout the greater part of their alignment, even if in the neighbourhood of the transforming station the phases are charged equally.

This article explains a method of finding the drop in tension and of calculating the most economical sections of conductors, and the application of the methods in certain concrete cases.

A.S.H.

REVUE MILITAIRE FRANÇAISE.

(*March*, 1936.)—*L'Armée Rawlinson dans la Bataille du 8 Août* 1918, by Lieut.-Colonel Gallini, is a long article of some sixty pages on the great attack which opened the final Allied offensive on the Western Front. It is a study from the British point of view.

The author pays tribute to the strict secrecy preserved by the British in the preparations for this battle, and to the refusal of prisoners captured just before the attack to divulge any information of it to the enemy.

The account is clearly written and the author gives a list of the authorities he has consulted.

L'Artillerie dans la lutte contre les engins motorisés, by Lieut.-Colonel De Mazenod. Of Artillery interest only.

Le Colonel Lawrence et la Guerre Moderne, by Lieut.-Colonel Mayer. A review of two recent books by Captain B. H. Liddell-Hart, *Colonel Lawrence* and *Modern War*. The author thinks that Liddell-Hart has used Lawrence as a means of airing his own conceptions of war. Lawrence certainly had unorthodox ways, and scorned the routine methods of the ordinary trained soldier, but even the ordinary trained soldier would have been unlikely to carry routine methods about with him when leading Arabs. The veil of mystery which wrapped itself round Lawrence was chiefly due to his self-effacement after the war. In his dealings with the Arabs and in his personal exploits with small parties he was following the methods of others before him, Lord Kitchener, for example. Because he blew up bridges under the eyes of sleepy Turks and harassed the communications with unfailing energy, there is no ground for proclaiming him the equal of Marlborough or Napoleon.

The article reviews Liddell-Hart's *Modern War* in a favourable light, and recommends its study as a preparation for the future, but adds that war does not follow blindly the laws of logic.

(*April*, 1936.)—*Guerre d'hier et de demain. Organisation générale de la manœuvre motorisée*, is another of General Pichon's carefully studied articles on modern war as it is affected, or is likely to be affected, by modern motorization. This time he treats of the question of organizing information of the movements of the enemy's motor columns; and, in general, of the organization of the areas behind the troops against motor raids by the enemy.

Motorisation et Manœuvre, by Lieut.-Colonel Lançon. An article forecasting the general characteristics of a future war with mechanized armaments.

Les Grandes Voies Commerciales du Proche Orient, by Captain Tézé. A short article, with sketch map, describing the railways, motor routes and air routes to the Near East.

Since 1923 Turkey has constructed more than 3,000 kilometres of new railway in what used to be Asia Minor; and further railway construction is in progress in Syria.

Un livre d'actualité : L'Angleterre dans la Monde is an anonymous review of a book by Johannes Stoye recently published. It describes the foreigner's view of the British Empire, the vital problems confronting it, the dangers looming ahead; but it winds up with the belief that though we might lose India and Australia, we shall create yet another Commonwealth of Nations out of the remainder of our possessions.

(*May*, 1936.)—*La Bataille des Frontières* (22 *Août* 1914) *à la* 42*e Division*, by General Boichut, who at that time was the commander of the divisional artillery. The article describes the encounter-battle which was the 42nd Division's first serious engagement. The account is not very clear; and it is difficult to follow the times of the various stages of the battle.

La Défense des Coupures, by Lieut.-Colonel Mainié. The modern equipment of tanks, which can approach the older forms of defence (machine-guns, wire, trenches) with more or less impunity, now makes it necessary to seek defensive positions behind natural obstacles to tank progress, such as rocky escarpments, unfordable rivers, woods and close villages. The author has chosen the defence of rivers for his study. The points he brings out have been frequently discussed, and he does not claim any new theories, but the article forms a good general summary of the features to be looked for in a good defensive position behind a river, over which the points of passage can be kept continuously under fire.

Three examples are shown on maps, illustrating three typical rivers, with defensive positions behind them.

A useful study for those who have to draw up tactical schemes.

Le Comte Schlieffen, organisateur et stratège, by Commandant Courbis. This is the first instalment of an account of von Schlieffen's work on the German General Staff, and the development of his great plans for the strategic operations on two fronts. Much of the information given is from hitherto unpublished documents.

The development of the plans is clearly traced and small sketch maps illustrate the article.

(*June*, 1936.)—*Protection contre les Engins Blindés, au cours de la marche d'approche*, by Colonel Ricard. A tactical discussion on the protection of main bodies in the event of the enemy's tanks getting in behind the advanced guards.

Le Comte Schlieffen, organisateur et stratège is continued in this number. The progressive modifications in the German plans of 1898–1899, 1899–1900 and 1902–1904 are discussed. All these changes had their counterparts on the French side; but most of them were due to the improvements in the Russian organization. The article brings the account down to 1905.

Concentration du Groupe d'opérations des confins dans l'Anti-Atlas, 1934, by Captain van Belle. A study of the "Q" work of the campaign of 1934 in the Anti-Atlas region of Morocco. Several articles on this campaign have recently appeared in the *Revue Militaire Française*. The present one goes more fully into details and describes the organization of the campaign. The necessity for a strict regulation of the convoy traffic seems to have been the chief lesson, from the author's point of view.

Les Stratagèmes de Polyen, by General De Bude, gives a few extracts from a new translation which the author has just prepared from the Greek. Purely of historical interest.

W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*May*, 1936.)—1. *Les opérations militaires à la frontière est de la province orientale pendant la campagne*, 1914–1918. (*I*). By Lieut. Bayot.

This is part of the second chapter in a series of articles dealing with the Anglo-Belgian operations against the German forces in East Africa in 1915. Chapter I (published in the June–July, 1934, number of the *B.B.S.M.*) dealt with the defensive period between August and December, 1914. We now come to the preparation for the offensive between the 1st February and the 27th May, 1915.

On the 20th January, the principle of co-operation between the British and Belgian forces had been agreed upon between the two Governments, and an offensive was planned to take place in April. The general ideas of this offensive were :—

(1) An action by Anglo-Belgian forces starting from Rhodesia and having Bismarcksburg as its objective.

(2) An offensive by Belgian troops in Ruanda and Urundi.

(3) The organized defensive of Tanganyika and Ruzizi between the two zones of attack.

The writer gives a copy of some correspondence that passed between Major-General Wapshare, his representative, Brig.-General Malleson, and Commissary-General Henry.

He also offers some remarks on General Malleson's proposed plan of campaign, and on the objections made to it by the Belgian Command. He maintains that the Belgian plan was more methodical and less risky than the British plan, and that a more cautious attitude was justified until the Allies found themselves in a much stronger position in 1916.

In March, 1915, the direction of the Belgian operations was made over by General Henry to General Tombeur.

Two sketch maps illustrate the plan of campaign.

2. *Instruction par le diorama.*

Serjt.-Major Dombrecht explains a system of practical instruction by means of the diorama, making use of a series of interchangeable foregrounds and backgrounds.

3. *Tirs d'arrêt.*

Lieut.-Colonel Smedts makes some suggestions for infantry when asking for an artillery barrage, and for artillery when called upon to provide one.

4. *Quelques réflexions sur l'esprit d'initiative.*

Lieut.-Colonel Frankignoul concludes his article on the spirit of initiative begun in the April number.

The necessary conditions in a mission entrusted to a subordinate are :—

that the orders should be expressed clearly and concisely,
that they should inspire the subordinate with confidence,
that they should be complete.

5. *Nouvelle note sur la défense contre les chars et exemple d'étude du terrain.* By Major Wanty and Lieut. Willemart.

In this article Major Wanty describes the general principles of anti-tank defence. The 47-mm. gun is the weapon in ordinary use for anti-tank work, but, for purely passive work, mines are the most effective method, and they are more economical than a heavy expenditure of shells.

Lieut. Willemart works out a defence scheme with a map showing the disposition of 47-mm. guns to ward off a tank attack.

6. *Un tournant de la stratégie et de la tactique.*

Major Colsoulle has written a brief study on the effect that motorization and mechanization will have on the strategy and tactics of the future. Whereas it is probable that all armies will be completely motorized, financial reasons will prevent them from being entirely mechanized.

Heavier duties will devolve upon the advance guard of an attacking force. In the system of defence, anti-tank guns will take the place of machine-guns, and anti-tank obstacles that of barbed wire entanglements. Speed in the march of armies is increased tenfold, and the stopping power of the rifle has been overcome.

(*June*, 1936.)—1. *Les opérations militaires à la frontière est de la province orientale pendant la campagne*, 1914–1918. (*II*).

In this instalment Lieut. Bayot describes the preparation for the offensive against the German forces in East Africa in the early months of 1915. The object of the Belgian offensive was the conquest of Ruanda and Urundi, with the idea of an advance as far as Lake Victoria. In June, 1915, the British Government had temporarily abandoned the idea of a general offensive against German East Africa.

Various minor engagements that took place between Belgian and German detachments are described, with explanatory sketches.

2. *Le 18 juin 1815, à Wavre.*

Major Branders describes some incidents in connection with the Prussian occupation of Wavre, and Grouchy's delay in realizing the situation on the 18th June, 1815.

3. *Le tir des mitrailleuses contre avions volant bas.* By Captain Levecque.

Some hints for finding the range of low-flying aeroplanes.

4. *La protection du charroi des grandes unités contre les enterprises terrestres de l'ennemi.*

Captain Danneels describes the way the transport of the 1st German army was handled during von Kluck's flank march between the 6th and 13th September, 1914. Most of the transport was horse-drawn. In spite of the most careful co-ordination, the position of the transport was a most precarious one on the 9th and 10th.

In the second part of his article, the writer gives his views on the protection of the transport of an army corps, acting on the exposed flank of an army, against raids by motorized units. In September, 1914, the 1st German army had time to protect the greater part of its transport by improvised measures. The high speed of modern vehicles will make such a resource impossible nowadays.

5. *Le tir réduit sur silhouettes.*

Major Gilbert gives some hints about miniature rifle practice at silhouette targets.

6. *Le War Office.* By Captain Commdt. Vandaele.

A résumé of a publication entitled *The War Office* by Hampden Gordon, Assistant Secretary at the War Office, giving an account of its history and organization.

A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*April*, 1936.)—*Prince Eugene.* This number, to mark the 200th anniversary of the death of Austria's greatest soldier, leads off with the reproduction of a photograph of his equestrian statue in Vienna, and a notice of his services. The remaining articles, none of which is of special engineer interest, are :—*Air-spaces and their Influence on the Defence Situation of Nations*, by Major-General von Pitreich; *Economic Strategy*, by Lieut. P. Handel-Mazzetti, late Austro-Hungarian Navy; *French Ideas about Aerial Warfare*, a review of Pierre Faure's *L'avion tuera la guerre* (Gallimard, Paris, 10 francs); *Tactical Exerci e No.* 3 (continued); *The Most Important Manœuvres in* 1935, by Lieut. Field-Marshal Schäfer; *The War in East Africa* (up to 15th March); *The Summer of the War Year* 1917, under which title Colonel von Dragoni reviews the second double number of Vol. VI of *Oesterreich-Ungarn's letzter Krieg*; and the *Polish Policy of the Central Powers*, 1914–18, a review of Major-General Schubert's book of the same title.

(*May*, 1936.)—This number contains *Twenty Years Ago, a Strategic Study of the War against Serbia*, 1914–15, by Colonel von Wittich; *Economic Strategy* (concluded); *Tactical Exercise No.* 3 (continued); *The London Fleet Conference*; *On the Methods of External Ballistics*, by Major-General Nowakowski; and *The Literature of the Great War*, in which Dr. Frauenholz continues his previous notes on this subject, by dealing with the publications of 1935. Of the latter the most important is Vol. X of the German Official History, which deals with the events of 1916, chiefly the struggle for Verdun, up to the end of Falkenhayn's tenure in August. The flood of memoirs and biographies has noticeably abated.

(*June*, 1936.)—*Field-Marshal Archduke Friedrich*, on his 80th birthday; *Twenty Years Ago, a Strategic Study* (continued); the prize essay, by Major Zuber, *Co-operation of Infantry and Artillery in Modern Mobile Warfare*; *Tactical Exerci e No.* 3 (concluded); *Count Stephan Tisza*, a review of G. Erényi's book about this statesman, who was Hungarian premier from 1913 until after the death of the Emperor Francis Joseph. Erényi repudiates the widespread opinion as to Tisza's responsibility for the ultimatum to Serbia; *The Czecho-Slovakian Law of National Defence*; *The War in E. Africa* (up to 15th May); and *Experiences of Colonial Warfare*, in which Major von Frauenholz writes of what he saw with the Spanish in Morocco in 1912.

F.A.I.

VIERTELJAHRESHEFTE FUER PIONIERE.

(*May*, 1936.)—*Considerations on the Employment of Pioneers, and on how Orders should be given to Them*, by Major von Ahlfen. Four instructive examples, with hand sketches, are given here, which may be taken as applying to a field company forming part of a strengthened infantry brigade. The cases chosen are respectively: advance in mobile warfare to push the enemy back and occupy ground; to make a river-crossing and keep it open for the division on the following day; failure in pursuit, owing to the engineers receiving their orders too late; and blocking against tanks in retirement. The object of the article is to show mistakes due to the engineers not being put in at all or not early enough, and thus to induce commanders to foresee the possibilities of their employment. The moral is that, in these days when in the presence of the enemy, one should expect to be blocked anywhere, or equally, be prepared to block, the commander can no longer afford not to take heed of these facts, but must, before any operation, get his orders out early to the engineers, just as he does already to the artillery, and for the same reason, that they must have time for preparation.

The Training of Pioneers (Anglice, Divisional Engineers) to Work in the Dark. The necessity for such training for modern warfare needs no emphasis. In carrying it out, the most important factor of success is to awaken the man's interest in night operations, by showing him that under cover of darkness he can gain success otherwise impossible (*cf.* the 7th Field Coy. and the Canadians at Paardeberg). Nightwork should not be done on such strictly military lines as to take all pleasure out of it. Other good tips are :—Mistakes may be avoided and less time wasted if the difficulties of working at night are pointed out to the men beforehand. Only what can be done perfectly by daylight should be attempted in darkness; otherwise there will only be a mess. Daylight must be used for preparing everything, and also for practising working without noise. Progress must be systematic; therefore start by working in the dusk, then on moonlit nights, and finally without a moon. The spirit of the whole thing must be observed, no shouting of orders permitted and no flashing of officers' torches. Do not overdo the sparing of the man by overmuch rest on the following day. It does no harm to officer or man to go a little short of sleep once in a way; and it is good for the men to see their officers at work bright and early the next morning. Finally, the soldier will not only be useless, but a positive danger for nightwork, as long as he has got the " how easy is a bush supposed a bear " feeling; in fact, he must become panic-proof. The chief aids to this end are being thoroughly used to working in the dark, and being imbued with the necessity of not getting rattled.

As regards the work to be done, in addition to the erection of obstacles, the clearing of obstacles should be practised, but not of mines. Blocking at night should be practised frequently in the framework of a scheme so as to bring home to each individual that his work is part of an operation of service to the other arms. River-crossings of all sorts should be practised in the dark, and here also it is important to have the enemy actually represented by listeners.

Troops that have been trained to use their ears as well as their eyes at night, and to work noiselessly, will be of considerably enhanced value for war. Further, it has been noticed that the standard of their work by daylight will be found to have improved distinctly through such training.

Inundation as an Effective Obstacle, by Dr. Kraus. The object of this article is to show how the water engineer by appropriate measures utilizes the different natural conditions for the creation of artificial inundations. Dr. Kraus classifies the cases of the holding-up of water as either hydrostatic or hydraulic, according to whether all flow ceases and a flat horizontal water surface is produced, or whether, the flow continuing, the water surface is inclined and curved. Both of these types are found in nature, above ground as lakes, and underground as accumulations of ground water. The possibilities of treatment by the water engineer are six, without counting combinations of them which will often prove the best.

(1) In a river-bed of sufficient breadth the water is held up, even with the river at its lowest, to give the depth requisite for military purposes.

(2) The water is dammed high enough for the river to overflow its banks and flood the valley, the spill finding its way back into the bed farther down.
(3) By a valley being completely dammed at a suitable spot the water forms a lake.
(4) Water is led from neighbouring valleys or existing reservoirs to the area of inundation.
(5) Ground water is opened up by dredging.
(6) Low-lying land is flooded by means of the sea at high-tide, the water being held up on the ebb.

The writer discusses these cases in turn, illustrating his remarks with a number of hand sketches, plans and sections. He mentions then successful examples of inundation obstacles from the Great War, *e.g.*, the use of the Somme Canal, north of St. Quentin, in front of the Siegfried ("Hindenburg") Line; the use of the Oise–Sambre Canal, near La Fère; also good work done between Lille and Douai by opening the dams of the Deule Canal. He awards the palm, however, to the Belgians for their inundations in 1914 at Nieuport, when by the skilful manipulation of six sluices they put the whole area between the canalized Yser and the Nieuport–Dixmude railway embankment one metre under water, and turned a German advance in full swing into a retreat. Starting with the twelfth century, this was the ninth occasion on which inundations had been used at Nieuport for war purposes.

The result of the experience gained of the utility of artificial inundations in war is that field and fortress engineer alike must concern themselves with this type of obstacle.

Experiences in Mountain Warfare, by Lieut.-Colonel Winkelmann. This article deals with the engineering side of mountain warfare in a practical manner, the writer having been in the Great War, first as O.C. a Pioneer battalion in the Carpathians (heights up to 6,600 ft.), and serving later with a division in the Austrian Alps. He discusses here, with sketches, the siting of a line of blockhouses, design of a blockhouse, liable, and not liable, to come under artillery fire, fire trenches on forward slopes, observation post, shelter on a reverse slope, and the siting of dugouts on a forward slope, which he places on switches 40 to 60 metres behind the heavily-traversed front line. Lieut.-Colonel Winkelmann says the tactical principle for mountain warfare is that all ranks must be filled with the idea that for the attacker there is no insuperable obstacle. The word "impassable" must be used with great care, since the degree of passability changes with every change in the weather. It is only occasionally true that any mountain hazard is impassable. Every height can be taken, every gun can be got into position, given only the necessary will, time and exertion. This dictum, of course, works both ways, being also true of the enemy.

In mountain warfare the independence and the personal influence of the subordinate leader are the key to successful enterprises, and nowhere does the worth of the individual stand out so clearly.

Field Engineering for All Arms. A new manual (HDv. 315) appeared at the end of 1935, replacing HDv. 315 of 1924. The latter, although it embodied the experience of the Great War, did not go much beyond the somewhat prescribed limits of the regimental pioneer, *i.e.*, bivouacs, camps, demolitions, roadmaking; and the advent of tanks and motorization was hardly taken into account. All this has now been changed. The fact that in future wars new tasks must fall to the engineers, other than those they had to perform before and during the Great War, forces us of necessity to increased engineering demands on all arms. To-day, far more than formerly, and in future, it must be demanded that the engineers remain a weapon in the leader's hand to be put in as complete and independent units. Only under quite definite conditions there will remain as a possible exception the employment of engineers to assist the other arms, and especially their becoming split up among the lower formations. Hence arises as a necessary consequence a far-reaching rendering of the other arms free from needing the co-operation of the engineers, at any rate as far as concerns their special battle tasks; and that means that there must be a wider and more intensive training of the other arms in field engineering. The other arms, without engineer assistance, must be able to carry out minor demolitions and blocking operations on a small scale, crossings by extemporized means, the building of foot-bridges, and of short bridges, up to 4 tons, with extemporized material, the negotiating of swamps and craters, the improvement of roads, arrangements for the defence of localities, and field fortification up to shelters and O.P's.

It is on these lines that the new manual runs.

The remaining articles in this number are:—*The Uniforms and Weapons of the Prussian Pioneers since* 1715, which is remarkable for a handsome double-page coloured plate. *The Removal of Tree-blocks*, in which Captain Schaette tells how his company was called upon last July, near Regensburg, to clear away 137 trees, which had been overthrown by a tornado. They had their company tools and six power-saws. Two sections, working one on each side of a road-block, 125 metres long, cleared the road of 102 trees (8 in. to 18 in. in diameter) for traffic in three hours. Good practice was also got in manhandling the logs on to lorries for removal. *The German Coast Fortresses in* 1914, in which Major Dinter gives an account of what existed, type of fortress and detail of armament, starting at Pillau in the Baltic and finishing at Wilhelmshaven. He says that not a single round was fired at the enemy during the course of the war by any German coast or island fortress, and that it may therefore be said of them (as already in the case of the land fortresses) that by their very presence they fulfilled their purpose. *The Summer Training of the* 315*th Pioneer Regiment, United States Army*, consists of extracts from an article in *The Military Engineer*, Washington. *Engineer and Pioneer Officers who have been Awarded the Order " Pour le Mérite "*; and a bibliography of the Great War in the Alps, with short remarks about some of the books.

There is also a note on portable carpentry machine tools which are recommended for use by pioneers. The Mafell Factory Co., Ltd., Aistaig bei Oberndorf, has produced an electromotor-driven borer, weighing 32 lb. and making holes up to 18 in. deep and 2¼ in. in diameter. Holes are usually bored vertically, but can also be made inclined. This borer made a hole 1¾ in. in diameter and 14 in. deep in about 30 seconds, cut a worm in it, and screwed in a hollow steel liner in another half-minute. The same firm has produced a mortice-making machine, which is also recommended to pioneers for accuracy as well as speed. An endless cutting chain is driven by a tooth-wheel on the shaft of a powerful electromotor. Mortices can be made of any length and in four breadths, from 3 cm. to 6 cm. The mortice-cutter weighs nearly 70 lb., but is said to be easily pushed along a beam.

F.A.I.

WEHRTECHNISCHE MONATSHEFTE.

(Formerly *Wehr und Waffen.*)

(*April*, 1936.)—This number contains Lieut.-Colonel Justrow's *Verdun and the Heavy Artillery*; *Machine-pistol or Automatic Rifle?*; two mathematical articles on *The Penetration of Projectiles into Solid Bodies*, by Dr. Vieser, and on *Motion and Air Resistance*, by A. Reuther; *The Importance of the Craftsman for the Military Utilization of Colonial Populations in a War of the Mother-country*, by Dr. Ruprecht; *Guerrilla Warfare*, a comprehensive study by K. Metzel; and *Shooting at the Olympic Meeting*, 1936.

(*May*, 1936.)—The articles are:—*Leadership and Technics in the Battle of Skagerrack*, written by Admiral Hansen to mark the 20th anniversary of the Jutland battle; *Temperature Conditions inside the Tank*; *War without Money*, an economic and political study; *The Further Development of the Tank*, by G. Burstyn, who as a subaltern in an Austrian railway regiment, in 1911, designed a self-propelled armoured gun-carriage; *Calculating the Drift of Projectiles*; *The Officer-Engineer*, in which W. Brandt attacks the system of sending young engineer officers for 4½ years to a university on full pay and at government expense. He would substitute for it two years at a Technical College. He also recommends the obtaining of first-class officer-engineers for the army by offering a bonus to cover the cost of their studies, and ante-dating of seniority, to ex-officers who served at the front in the Great War, subsequently took their diplomas and have been employed as engineers ever since; *The Russian Railways*, which shows that the Russian network is still inadequate both economically and for war; and a note taken from *Die Umschau* on Buna, the synthetic rubber, which says that after thirty years of research, experiments and trials, German chemists have succeeded in solving the problem of producing synthetic rubber out of materials of German origin, viz., coal and lime. "In spite of the superiority of Buna products over natural rubber owing to their insensitiveness to oil, benzole and petrol, which causes Buna tyres to last half as long again as ordinary rubber tyres, it must be admitted that they cost four times as much."

F.A.I.

THE INDIAN FORESTER.

(*February*, 1936.)—An article on the "slash pine," a native of Central and the southern part of North America, deserves attention. This tree, *Pinus Caribæa* as its botanical name is, has been successfully grown in India. It resembles the *chir* but can stand a wider range of temperature; it is a fairly rapid grower and produces useful structural timber. It is likely, therefore, that we shall hear more of it within the next few decades.

Of the other constituents of this number, "A Tour in the Naga Hills," by N. L. Bor, describes the manners and customs, including some very unpleasant ones such as head-hunting, of the primitive tribes living there. "The Cleaning and Care of Guns"—an excerpt from a Canadian paper—is also worth reading.

(*March*, 1936.)—A writer with the pseudonym "S" has discovered a gem in the "Friend in Pocket"; in an article entitled "Great Snakes" he comments on this most illuminating brochure on the snakes of India, about which we have apparently much to learn. For instance, when a *kul nashak*, Latin name unknown, bites a twig, "not only will the twig burn to ashes, but also the bush or tree from which it came. Similarly, if it bites a man, he will die and his relatives will meet the same fate."

There is an article on giant trees; the tallest tree known at the present time is a redwood in California, 364 ft. high. India possesses none approaching this height, but there are deodars 240 ft. high in the Sutlej valley.

"Damage by Frost" emphasizes what engineers as well as foresters ought to know, viz., that ground frosts often occur while the official thermometer, 4 ft. above ground, is recording temperatures well above 32° Fahrenheit. The Forest Research Institute at Dehra Dun has been taking comparison readings, from which it appears that the difference may be as much as 10 degrees between the temperature at ground level and that recorded by an official instrument.

(*April*, 1936.)—We are informed that excellent cricket bats are now made from willows in Kashmir, the best tree for the purpose being one which is thought to be a hybrid between two imported trees.

"Three Years in Garo Hills," by Mr. De, of the Indian Forest Service, is an interesting article describing the manners and customs of a race still almost untouched by civilization. The Garo Hills lie about 200 miles N.N.E. of Calcutta, where the Brahmaputra makes its great bend to the south.

(*May*, 1936.)—In this number there is nothing of special interest to us, unless it be an article, "Martesia: A Marine Borer," which might with advantage be studied by those who have to fix piles and other timbers in tropical waters. The Martesia family is distinct from the *teredo* and other more commonly-known shipworms, and the prevention and cure of attack are different.

(*June*, 1936.)—Erosion from the Siwaliks, in which term is included the whole range of Himalayan foothills from the Indus to the Brahmaputra, forms the subject of two articles; in both particular attention is directed to the Hoshiarpur Siwaliks between the Beas and the Sutlej. One article, an extract from the *Himalayan Journal*, describes how the felling of forest on these hills, and subsequent indiscriminate browsing by goats, have led to the almost complete desiccation of the area, the detritus from which has been brought down by intermittent and perennial streams called *chos*, to form immense fan-shaped areas of sand, of very low fertility, over previously cultivable land in the plains. The total area thus destroyed or damaged, exclusive of the deforested tracts in the hills, is estimated at nearly 150,000 acres.

At the same time, the average annual rainfall has decreased from 36·70 to 26·61 inches, though it cannot be stated definitely that this diminution is an effect of the deforestation.

In the other article, " The Hoshiarpur Siwaliks from the Air," Mr. Glover describes an aeroplane journey over the area. He took with him a 16 miles to the inch as well as a 2 miles to the inch map, but states that he found the latter useless on account of the pace of the machine, the absence of conspicuous landmarks, and of his own inexperience as an observer. It is interesting to compare this with the flights of another forest officer recorded in the December number of *The Indian Forester* (see *The R.E. Journal* for March, 1936), who carried out successful observations, from a forestry point of view, with 1-inch maps. Circumstances were, however, somewhat different.

The article is illustrated by photos taken from the air, which show the benefits being derived from the closing of the areas to grazing, and from the reclamation of the sandy tracts.

The Government of India have recently created a " Timber Development Section " at the Forest Research Institute at Dehra Dun. The qualifications and duties of the officer in charge are described as follows. He " has expert knowledge of modern engineering practices, timber mechanics and wood preservation. He has also at his disposal the resources and expert knowledge of other officers of the F.R.I. He will prepare and disseminate short but instructive pamphlets on timber problems to forest officers, engineers, engineering institutions, Government departments, and the public, and he will tour India continually in an effort to bring to the notice of those concerned the economy and efficiency of properly designed and properly constructed and treated wood structures."

Another article describes in brief the successful planting of areas at the Malakand Agency and Cherat with *chir*, a near relative of the Scots pine. On account of the scanty rainfall at these places, as well as to the poor nature of the soil, direct sowing proved useless, and consequently the seeds were first germinated in tin tubes, and not planted out until they were a year old and six inches high. The tallest plants, three-year-olds, are now thirty inches high.

F.C.M.