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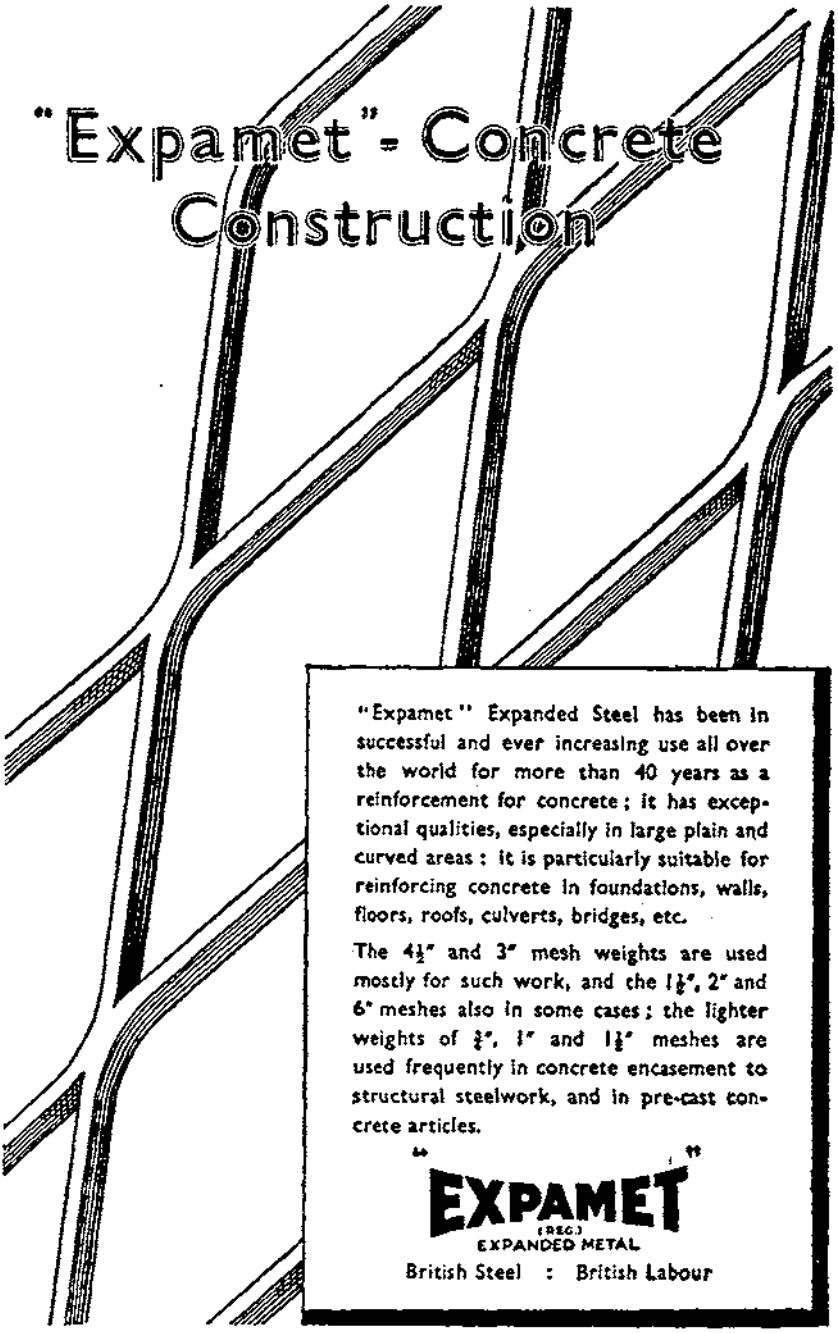

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THE INSTITUTION OF ROYAL ENGINEERS.

IT IS ANNOUNCED THAT HIS MAJESTY KING EDWARD VIII HAS BEEN GRACIOUSLY PLEASED TO BECOME PATRON OF THE INSTITUTION OF ROYAL ENGINEERS.

THE following letter was received by General Sir Bindon Blood, G.C.B., G.C.V.O., Senior Colonel Commandant Royal Engineers, from the Keeper of the Privy Purse :—

" Privy Purse Office,
Buckingham Palace.
30th March, 1936.

DEAR SIR,

I am commanded by The King to inform you that His Majesty has been graciously pleased to grant his Patronage to The Institution of Royal Engineers.

Yours truly,
(Signed) WIGRAM,
Keeper of the Privy Purse."

Sir Bindon Blood replied as follows :—

" DEAR SIR,

I have the honour to acknowledge your letter of 30th March, 1936, in which you inform me that His Majesty has been graciously

pleased to grant his Patronage to the Institution of Royal Engineers. I also have the honour to request that you will convey to His Majesty, on behalf of the Institution and all ranks of the Royal Engineers, our humble duty and sincere thanks for the honour which he has done to our Institution.

Yours truly,
(Signed) BINDON BLOOD."

His Late Majesty King George V was Patron of the Institution of Royal Engineers, from the granting of the Royal Charter in 1923 until his death.

THE AIR MAPPING OF THE NORTH-WEST FRONTIER.

By CAPTAIN D. R. CRONE, R.E.

GENERAL.

THE article "Air Survey," by Lieut. Salt, in the *R.E. Journal* for March, 1935, gives an excellent account of the theory on which graphical methods of mapping from air photographs on the medium topographical scales are based. This article is an attempt to deal with some of the practical difficulties of the work by describing the air mapping which has been carried out on the North-West Frontier of India.

DESCRIPTION OF THE COUNTRY.

The North-West Frontier of India is burdened with two boundaries, the International Indo-Afghan Boundary or Durand Line and the Administrative Border. The Administrative Border is the line up to which land revenue is collected and the country fully administered. It follows approximately the boundary of the Sikh Kingdom which was taken over after the Second Sikh War of 1849 (see the sketch map on p. 173). The Durand Line was laid down by a treaty with Afghanistan in 1893 as the southern and eastern limit of the sphere of influence of the Amir of Afghanistan. Along the North-West Frontier it runs north-east, at an average distance of 40 miles roughly parallel to the Administrative Border, for 300 miles from the Gomal River in the south to Hindu Raj range in the north. From this point it makes a loop to the northwards to include the states of Dir, Swat and Chitral and the Gilgit agency and joins the Indo-Chinese boundary.

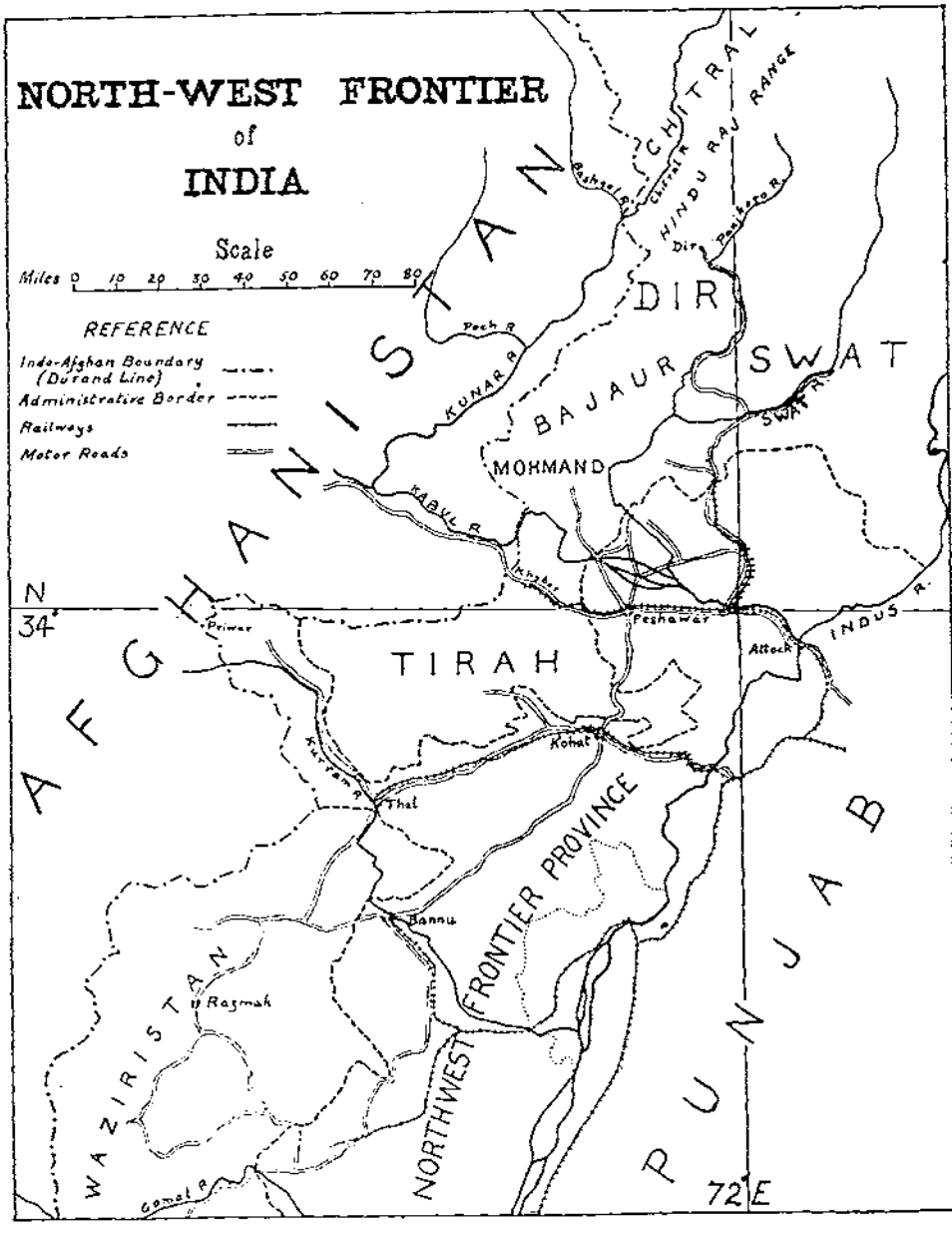
The country between the Durand Line and the Administrative Border from the Gomal River to the Hindu Raj range is a jumbled mass of high mountains, inhabited by numerous tribes and clans always ready to fight desperately to prevent any invasion of their sanctuary or to exploit by raiding across the border any weakness or preoccupation of the Indian Government. The result of this is that no organized mapping of the area has been possible and the topographical maps are based on the fragmentary surveys carried out during military operations which have been undertaken from time to time in the area. At the same time good topographical maps are necessary because such an area forms a serious danger.

RAPID AIR MAPPING 1923-33.

The maps which existed of this area of tribal territory in 1920 were reconnaissance surveys, mostly carried out in the closing years of the last century during the demarcation of certain portions of the Durand Line and the many expeditions which marked that period. A very fascinating account of the making of these maps is given in *The Indian Borderland*, by Colonel Sir Thomas H. Holdich, K.C.M.G., K.C.I.E., C.B., late R.E. The surveys were principally on the half-inch scale with considerable gaps which were filled from native reports and, moreover, the hills were indicated by the good old caterpillar symbol with little or no indication of height.

In 1922, the decision to establish a permanent military occupation of Waziristan, which forms nearly half the area we are considering, created an urgent demand for accurate maps at a time when the art of mapping from air photographs born of the war seemed to be the answer to the surveyor's dream. Air surveying with vertical photographs was in fact the only method of making a complete survey of the whole country in any reasonable time or at a reasonable cost, and a section started on the job in 1923.

All the experience in air mapping had been in very different country, in which the preparation of mosaics of the air photographs was all that was required to establish the material for compilation into maps by normal processes. Nature, in Waziristan, still had some cards to play. The ceiling of the aircraft carrying the photographic equipment was very little higher than the mountain tops, so that the amount of photography to be done was enormous. The tops of the highest mountains were not actually completely photographed until four or five years later, when newer equipment was available. Over certain parts of the ground during weather suitable for photography a high wind prevailed, which on several occasions entirely prevented aircraft from reaching the area intended for photography before the fuel supply was exhausted. The out-turn of photography was further reduced as all available aircraft were generally required for army co-operation. Even when the photographs had been obtained the preparation of mosaics of any extensive area in this mountainous country was generally impossible. The routine method finally evolved consisted of the preparation of mosaics of the photographs of one strip, or portions of a strip, which could be satisfactorily laid down ; the drawing of the map detail on these strips ; the photographic reduction of these drawings to the 1½-inch scale. This last step required considerable ingenuity. Starting from a strip over fairly reliable ground survey from which the reduction could be calculated, each strip in succession was reduced so that the scale along the strip edges matched. A little knowledge of the ways of photographs in mountainous country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will show that this method does not remove all the distortions, and the residual distortion was removed in a rather arbitrary manner by cutting up the reductions and pasting the pieces down on a sheet with their edges either slightly apart or slightly overlapping, so that the whole assemblage filled the space between two areas of reliable ground survey.

The map of the detail thus obtained was completed to show the hill features, which were sketched on the detail by form-lines from an examination of the vertical photographs in a stereoscope and also from oblique photographs. An attempt was made to keep some sort of constant vertical interval, but this was not often possible. The difficulty in these maps, as in the previous reconnaissance maps, was that there were no spot heights to indicate the absolute height of the mountains. Captain (now Major) Heaney attempted to fill this gap by flying over the mountain tops with an artillery range-finder set across the aircraft and pointing downwards, so that the height of the aircraft above the mountain could be measured. The height of the aircraft was determined by flying over a triangulated point and taking similar observations. Theoretically, the out-turn should have been a large number of fairly accurate spot heights. In practice, the difficulties of using a range-finder in a cockpit to look downwards, while travelling at a high speed, prevented the method from becoming a standard method of survey, although the theory is worth remembering.

The Waziristan survey was nearing its end when in 1926 the Shi'a-Sunni dispute in the Tirah flared up and attracted military attention to this part of tribal territory. This coincided with the development of the radial line method of plotting vertical photographs by the War Office, and the first maps of Tirah made from air photographs adopted this method. The radial line method, which is the graphical method described in Lieut. Salt's paper, requires a considerable number of points fixed on the ground for its accurate application, and it was fortunate that the column which moved into the Shi'a salient to observe events in the interests of the Government were able to escort Khan Sahib Muhamad Hasan, an Indian survey officer with many years of experience in air survey work, to various points of vantage from which he was able to fix numerous points for subsequent use with the radial line method. One of his instruments was the Wild photo-theodolite, with which photographs can be taken at each end of a carefully measured base. The theodolite enables angles to be measured to fix the position of one end of the base and the bearing of the base and also, by measuring the angles to an "invar" subtense bar, to measure the length of the base. The photographs at one end of the base were taken in exactly parallel directions to those at the other. The photographic plates taken in this instrument are sent to Messrs. Wild in Switzerland, and

Fig. 1(b). Wild Stereo Plot

Sheet 38 M/NW & SW Scale ½ inch to 1 mile

Grid I (4 mile squares)

Season 1932. Afghānistān.

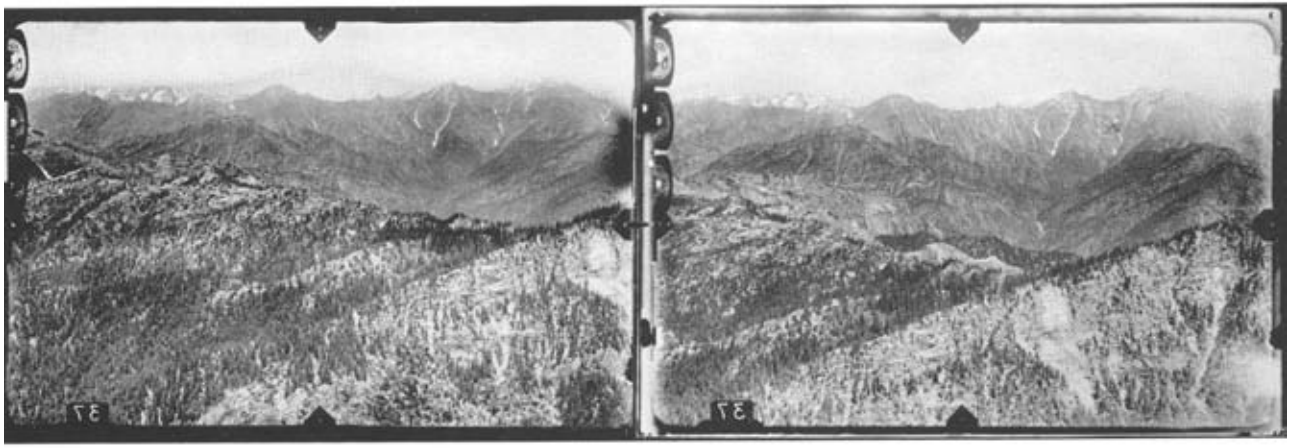


Fig. 1(a).—Photographs taken with Wild Photo-theodolite (about 2/3 actual size). Right-hand stereo-pair of the set used for the plotting, illustrated.

Air mapping of North West frontier Fig 1(a)

from the length of the base and the measured bearings of the pairs of photographs they are set up in the Wild Autograph in the relative positions which they occupied in the field. In this instrument, the plates are viewed stereoscopically and the country appears to stand out in perspective as on the ground. A floating mark appears in the field of view, and three wheels (two hand and one foot) on the machine enable the mark to be moved left and right, up and down, and backwards and forwards. These enable the mark to be brought to any point on the ground desired. If the mark is brought on to a path, for instance, and the wheels so moved that it moves along the path, then the pencil on the drawing-board at the right of the machine draws a map of the path on the scale for which the machine has been set. If the wheel that represents the up-and-down movement is locked and the wheels moved so that the mark moves along the surface of the ground, then the pencil draws a map of the contour of the height at which the height wheel has been locked.

The Wild photo-theodolite was first used on the Frontier in the latter stages of the Waziristan mapping, and has since been of very considerable help in the subsequent mapping of the remainder of tribal territory. Fig. 1 shows one pair of photographs and a portion of the plotting carried out from a single photo-theodolite base. (AB.)

The unrest in Tirah increased and became more general, until, in 1930, nearly all the tribes in this part were prepared to take full advantage of what was reported to them as the incipient abdication of the British Government, by raiding and looting the principal towns. Air operations and the ground operations of the cold weather of 1930-1931 demanded topographical maps of the greater part of Tirah, and these were produced hurriedly by the radial line method. By this method the map detail can accumulate little error even if fixed ground points are very few and far between. The one-inch map of Tirah was compiled as a whole bridging a gap between points of nearly forty miles. The compilations in the centre of this gap agreed in position to within 100 yards, and the scale differed by a little over one per cent. Hill features had still to be shown by form lines as there were insufficient spot heights to enable heighted contours to be drawn, but the Wild photo-theodolite had provided sufficient scattered bits of accurately plotted contours around the edges to give the form lines interpolated between them considerable value as contours. In several artillery shoots with air observation at targets invisible from ground observation posts, the opening salvos with line, range and angle of sight taken from the one-inch air survey map, were substantially accurate.

The trouble in Tirah had also spread to the tribal territory to the north, the Mohmand country. The existing maps of this part were of a much higher standard than elsewhere, as they had been surveyed as lately as 1908 with the hill features shown by contours with a fair

number of clinometer spot heights. No rapid air survey maps were therefore required for the brief air operations in 1932. Rapid air survey maps similar to those produced in Tirah were compiled during 1933 in case the ground operations in Mohmand country were to be extended farther afield into Bajaur, where the existing maps were from the old half-inch reconnaissance surveys.

This brief historical summary shows that up-to-date one-inch maps of the whole of the inaccessible tribal territory on the Afghan border of the North-West Frontier Province have been produced from air photographs in the decade from 1923 to 1933.

At the same time, the remaining territory from Bajaur northwards along the Afghan boundary almost to the tri-junction with China which, during this period, became accessible to ground surveyors, has been accurately surveyed on the ground on various scales suitable to the type of country. This ground survey is outside the scope of this article, but tribute must be paid to this notable achievement, the full account of which, when published, should make an admirable sequel to Holdich's *Indian Borderland*.

THE REGULAR AIR SURVEY PROGRAMME.

The air survey maps of Tirah, Mohmand country and Bajaur mentioned as having been compiled between 1930-33, have not been published as part of the regular series, so that any map user concerned with these parts will have to use the old reconnaissance surveys unless there is an emergency which demands the publication of the new rapid surveys. The reason for this is that in 1930 it was accepted that for the normal peace-time programme of the air survey party, which was the preparation of standard one-inch sheets, the out-turn was to consist of fully contoured sheets of the accuracy of normal one-inch ground survey. At that time and in the circumstances governing Frontier mapping, this was a very high aim. It was justifiable, however, provided that up-to-date maps could always be made available at short notice for military operations. This, as we have seen, was the first task and was carried out concurrently with the research on methods to achieve the higher aim. The setting of the highest standard had the advantages that it would induce research, that it would ensure that surveyors under training were thoroughly grounded in sound methods and that the job once done would not require revision in the very near future as would be the case in Waziristan. It is believed that the methods now being used for the regular air mapping of the trans-border sheets fully achieve the aim and these methods are described in what follows.

We will first summarize the principal difficulties of this air mapping of the Frontier.

The total area is about 10,000 square miles, which can only be entered along a few roads (see map). The greater part of the area is inaccessible and cannot be overlooked from any accessible points. The greatest distance of any point from accessible ground is thirty-five miles as the crow flies.

There is no regular secondary triangulation. There are a few isolated areas of rapid triangulation carried out with military columns, but the density of fixed points falls to one or two intersected points per 100 square miles over a great part of the area, and it must be remembered that as these points have in many cases no check, they may be wrong.

There is no net of spot heights apart from the triangulated intersected points.

Previous ground surveys are of no assistance, except as checks on gross error and for names, since they were rapidly carried out on a smaller scale often in advance or in the absence of adequate triangulation.

The ground is mountainous, varying from 2,000 to 10,000 feet above ground level, and air conditions above the mountains are not particularly stable.

On the North-West Frontier, therefore, we have none of the data required for the method of mapping from air photographs outlined in Lieut. Salt's paper. The variation of ground height is more nearly 50 than 10 per cent. of the altitudes attainable by the aircraft. There is no secondary triangulation from which the scale and position of the plotted strips can be determined. And there is no series of spot heights from which contours can be drawn on the photographic overlaps. As the general method must be preserved, each of these gaps requires to be filled before the routine standard method can be employed.

The first consideration is the relief of the ground. Nothing can be done to increase the height of the aircraft and so reduce the percentage of the ground relief, as oxygen apparatus is not employed in India and the ruling factor is the altitude at which the crew can work in comfort for a considerable time. Under the conditions of flying in India the maximum error due to ground relief of 10 per cent. of the altitude of the aircraft, can be taken as an error of position of map detail of fifteen yards. This occurs only when the point of maximum relief falls at the corner of a photograph which is tilted to the maximum amount. This occurrence will be extremely rare, and it may be assumed that even with the height relief on the Frontier the errors on the one-inch scale will not be any greater than the errors of distortion of the paper on which the final map is printed. The method of obtaining the relative positions of the photographs in a strip by preparing *a minor control* plot by graphical triangulation,

is, therefore, the same as already described in Lieut. Salt's paper. Owing, however, to the scarcity of fixed points in many parts, few, if any, *minor control* plots can have their scale determined, so that it is impossible to prepare a *master grid* on some definite scale. The principle of the master grid was, in fact, first introduced in India in order to get over the fact that in some areas no strips could be scaled. In this case a block of strips is selected and a *minor control* plot on one side of the centre one is brought to the same scale as the centre one, by enlarging or reducing it graphically to obtain equality in distances between a pair of points in the common lateral overlap (the area covered by both the centre strip and one side one) (see Fig. 2).

All the *minor control* plots in the block are thus brought to the scale of the centre one, and they can be correctly placed relatively to one another by superimposing the points in the common overlap. If two fixed points appear in the block, the true scale and position of the block can be determined. If fixed points are still not available, the relative scales of the blocks can be determined by comparison of their edges.

With very rapid mapping the accurate identification of points inadequately described is not always possible, and it was for this reason that, in the hasty mapping of Tirah mentioned above, scale was carried inwards from the edges near the administrative border and was found to agree to about 1 per cent. This agreement may be fortuitous, but it indicates that even in extreme conditions the method is capable of giving accurate results.

The final and most serious gap in the data is the lack of a series of spot heights from which the contouring may be carried out. To produce a contoured one-inch map from vertical photographs, two or three spot heights per square mile are required, and what is more important they must be well distributed in height; that is, they are required in the bottoms of the valleys as well as the tops of the mountains. Any ground method of fixing these heights is quite out of the question on the Frontier, so that they must be fixed from the air or not at all. Major Heaney's attempt to fix heights by means of a range finder carried in aircraft has already been mentioned. The fixing of heights in the valleys by this method would have presented even greater difficulties. Several attempts were made to fix the required heights from vertical air photographs, by methods of various degrees of complexity. These methods could be made to produce results sensibly in accord with the truth when the data could be selected to conform with rigid rules, as in tests over accessible territory, but in their applications to inaccessible areas the several methods gave discrepant and, in some cases, obviously absurd results. Investigation on these lines occupied three years before it was finally decided that useful results could

not be easily obtained from vertical photographs by any simple method.

The other approaches to the problem which seemed to offer solutions were the use of a plotting machine, such as the Wild Autograph mentioned on p. 175 or the Zeiss Stereoplanigraph illustrated in

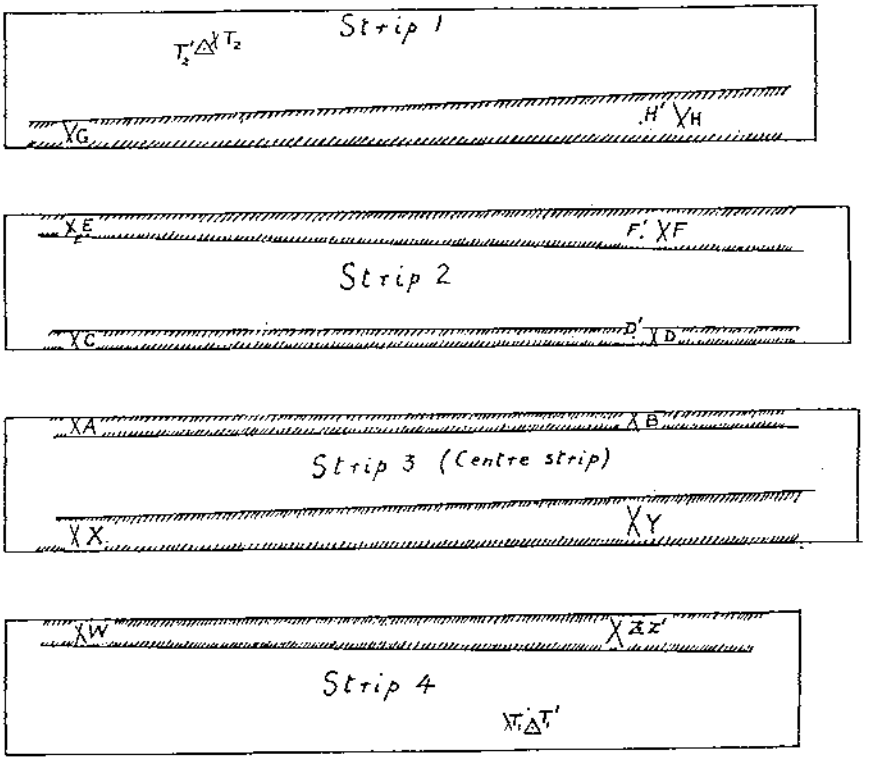


FIGURE 2.—Combination of Minor Control Strips.

Lateral overlaps

Points A, B, E, F, X and Y are the same objects as C, D, G, H, W and Z respectively.
In strip 2 the figure CDEF is reduced to CD'E'F' so that CD' is equal to AB.
In strip 1 the figure GHT_2 is reduced to GH'T'$_2$ so that GH' is equal to E'F'.
In strip 4 the figure WZT_1 is enlarged to WZ'T'$_1$ so that WZ' is equal to XY.
When CD' is superimposed on AB, GH' on E'F' and WZ' on XY the scale of this combination can be obtained from the fixed points, T'$_2$ and T'$_1$.

Lieut. Salt's paper, or the development of a method dealing with high oblique photographs.

The use of a plotting machine would have meant that photography would have to be carried out with the camera specially made for the machine, and would not therefore form a normal training task for the Royal Air Force on the Frontier.

Its use would also mean that one machine operator, or at most three, would be engaged on the whole work and the training of a war cadre for the Field Survey Companies could not be effected on the most suitable area available. Although the use of a plotting machine was ruled out by other considerations, a test of the accuracy obtainable by this method was considered desirable and was carried out. As a result of this test, it is proposed to use a plotting machine as an auxiliary instrument for work in peace-time as indicated later.

In 1931 a method of plotting from high oblique air photographs had been produced for the purpose of completing a considerable gap in Tirah. A high oblique photograph is one which includes the horizon. The method is described in *The R.E. Journal* for September, 1933. This method required a fairly well-defined horizon and frequent fixed points. When it came to be considered for the purpose of supplying fixed heights for contouring it was necessary to do without the well-defined horizon and if possible to reduce the number of fixed points required. The method adopted is briefly as follows. An approximate horizon is used with the calibration data to obtain a projection in the horizontal plane. This affords a fairly accurate fixing of the plan position of the air station. With this plan position fixed, a true horizontal can be found from the projection of the photograph in the vertical plane if three known heights appear in the photograph. As the high oblique photograph embraces a large area of country, some photographs can usually be found in a strip in which three points appear, and the true horizon found from these can be transferred to the adjacent photographs in the strip. With the horizon accurately fixed the heights of any points of which the plan positions are known can be determined. A typical pair of high oblique air photographs is illustrated in Fig. 3.

This method afforded an excellent way of providing the spot heights required for contouring. The plan of the map detail prepared from the vertical photographs enabled the plan position of the air station of the oblique photograph to be fixed accurately, and also gave the distances required for the determinations of the spot heights. All that was required was that the oblique photographs should be arranged to be taken from such a line, at such a height and such an obliquity that the horizon appeared near the top of the picture and sufficient points in the bottoms of valleys appeared for the purpose of contouring the vertical photographs. In practice, it has been found that photography from lines about ten miles apart with four fixed heights per 100 square miles, will provide spot heights for contouring to the accuracy attainable by a ground surveyor with an Indian clinometer in similar country (that is, spot heights with a probable error of about twenty feet). This method only involves additional photography of about 10 per cent. of the

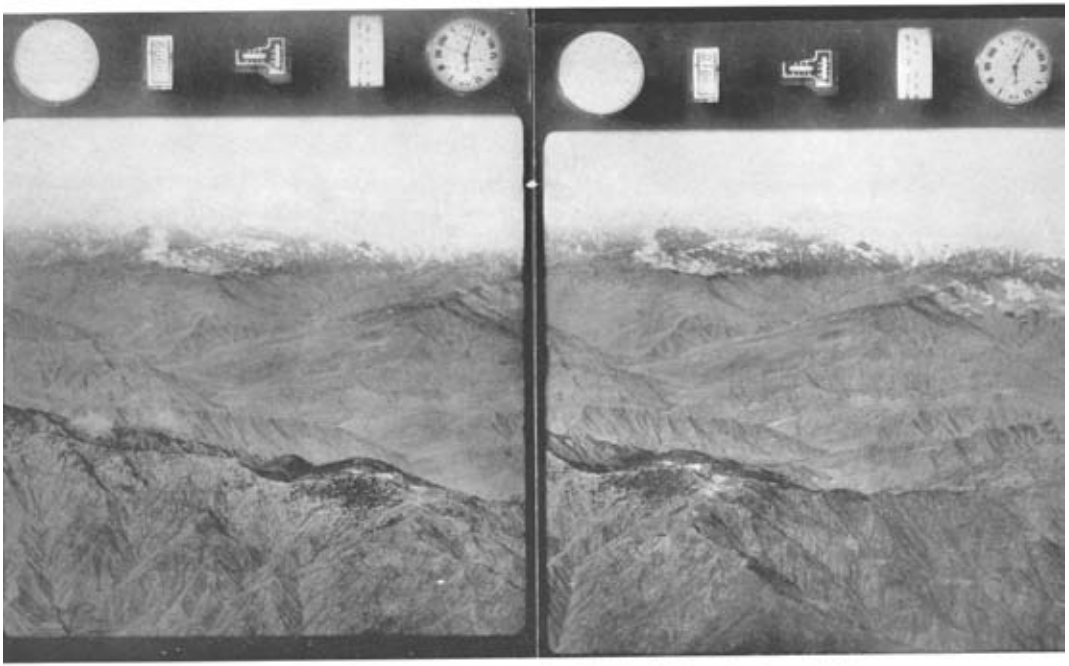


Fig. 3.—Stereo-pair of high oblique air photographs taken with Service F-8 Camera (about 1.3 actual size).

Air mapping of North West frontier Fig 3

vertical photography and successfully fills the gap in the greater part of the area.

There are still, unfortunately, areas in which there are not sufficient fixed heights, and it is in these remaining areas that it is proposed to employ the plotting machine to provide the necessary fixed points. The tests of the Wild Autograph with vertical photographs taken with the Wild air camera showed that single strips could be plotted and contoured with the accuracy required for one-inch mapping up to a distance of sixteen miles from accessible ground. In this way a gap of thirty-two miles between two areas of accessible ground could be bridged, and by careful arrangement of the strips the contours and spot heights plotted from these in the Wild Autograph could be made to supply the spot height control still lacking for the setting of the high oblique photographs.

This completes the solution for the normal peace-time mapping for producing a one-inch map of the same standard as from ground surveys. For the most difficult area the whole sequence is :

(i) the routine vertical photography by the R.A.F. with the F/8 camera.

(ii) the plotting of the detail map of the area and the layout of the strips to be photographed with the Wild air camera ;

(iii) the vertical photography with the Wild air camera ;

(iv) the fixing of four points in the terminal overlaps of the Wild photographic strips, which fall in accessible ground ;

(v) the plotting of the Wild strips which is carried out by the firm in Switzerland ;

(vi) the layout and photography of the high oblique strips by the R.A.F. with the F/8 camera simultaneously with (v) above ;

(vii) the plotting of the oblique photographs and the fixing of numerous spot heights from them ;

(viii) the contouring of the vertical photographs and the compilation of the contours on the detail map ;

(ix) the examination and testing of the survey and the final fair mapping.

Air Mapping During a Campaign.

It remains to consider the application of this peace-time routine to the demands of a campaign. Owing to the fact that any campaign in which the Indian Army is likely to be involved will probably be in country of rather sparse detail, where the troops will be concerned with very large areas and where the artillery or machine-guns will

seldom require to engage targets from a map, the standard map scale for war is laid down as 1/50,000. Maps on this scale will be required of the whole war zone and, over and above this, certain small areas will require to be mapped on the 1/25,000 or larger scale as occasion demands. It is desirable that the 1/50,000 maps, and essential that the 1/25,000 or larger-scale maps, be accurately contoured. For many fairly obvious reasons it is not, at present, proposed to utilize a plotting machine for mapping with an army in the field in India.

The system, envisaged by the author as a suitable one, is as follows:

(i) the first survey task of the air contingent will be the vertical photography of the area of immediate concern at the smallest possible scale, which is at present about 1/28,000.

(ii) on completion of the vertical photography, the survey task of the air contingent will be the oblique photography of the area from lines at an average spacing of ten miles.

(iii) the primary task of the field survey sections (topo sections), which will be assisted by the survey oblique photograph, will be the provision of points fixed by triangulation for the purpose of:

  (*a*) the *control* of the detail map from the vertical photographs.

  (*b*) the control of the plotting of the oblique photographs.

(iv) the primary task of the air survey section will be the production of the 1/50,000 map. This will, according to the time available, be:

  (*a*) a very hasty map from mosaics.

  (*b*) a hasty map accurate in detail with hill features sketched in with form lines as carefully as time permits, similar to the maps of Tirah mentioned above. This will be a normal type at times of rapid movement.

  (*c*) a deliberately prepared map accurate in detail and accurately contoured from spot heights provided by the plotting of the oblique photographs. This would be similar to the standard peace-time maps now being prepared. The fixed points would require to be obtained by reconnaissances in force if necessary, to eliminate the use of the plotting machine.

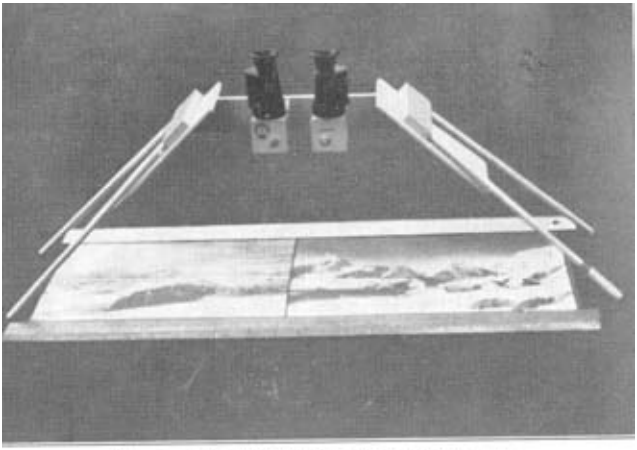


Fig. 4a.—Zeiss Topographical Mirror Stereoscope.

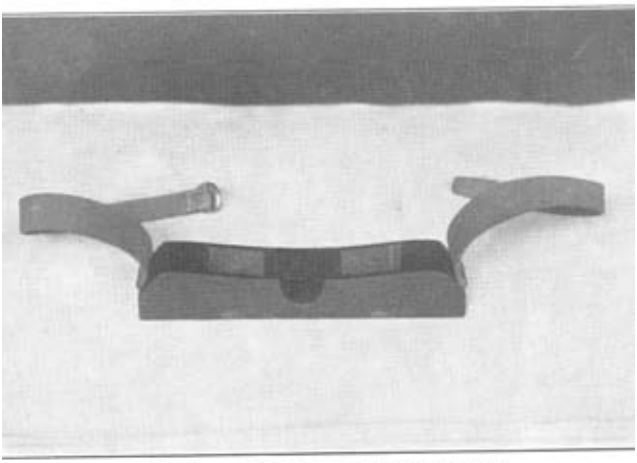


Fig. 4b.—Indian Pattern Head Stereoscope

Air mapping of North West frontier Fig 4 & 4b

In the event of a map on the 1/25,000 scale being required the routine would be :

(v) the air contingent would be required to provide prints of photographs on the scale of the map or larger.
This may require :
(*a*) no further action if the original photography was on a scale larger than 1/25,000,
(*b*) the enlargement of the original negatives to provide prints on approximately the 1/25,000 scale, or
(*c*) the re-photography of the area on the 1/25,000 scale. This course will generally be desirable in any case for intelligence purposes.

(vi) the air contingent would be required to supplement the oblique photography, if this is required by the nature of the original oblique photography or the ground.

(vii) the field survey sections would be required to supplement the points already fixed, by triangulation, either instrumentally or graphically.

(viii) the air survey sections would prepare an accurate, contoured map on the 1/25,000 scale by the radial line and Indian oblique methods.

The only special instruments required for the air mapping are the two stereoscopes shown in Fig. 4.

The out-turn to be expected from the methods outlined depends on a great many factors which it is not possible to summarize easily, but the figures found by experience on the Frontier for this type of country may serve as some sort of indication.

As a result of observations made during the training of British officers it is estimated that a 1/50,000 map of 100 square miles can be produced by the mosaic method (iv) (*a*) above in 12 hours.

A skeleton exercise which was carried out in February, 1935, to test the methods given at (iv) (*b*) and (viii) above provides the most up-to-date information of the out-turn by these methods. Very bad weather conditions prevented the fixing of adequate points by the field survey section working on the ground, but fairly accurate maps were produced in spite of this.

The following is a brief summary of the exercise :

133 square miles of hilly country on the north slopes of Cherat hills in Peshawar district were photographed by Hart aircraft with the F/8 camera (7-inch lens) at a mean scale of 1/25,000. The ground relief was about 15 per cent. of the height of the aircraft above the ground. The detail was compiled by the radial line method and

heights were determined by the Indian oblique method from high oblique photographs taken from a height of 6,000 feet with the F/8 camera (10-inch lens). Form lining and contouring were carried out from the vertical photographs.

The fixed ground points were provided by triangulation by a field survey section (Indian Establishment).

The 1/50,000 map of 133 square miles was compiled by four surveyors in 105 hours. A 1/25,000 map of 33 square miles was compiled by four surveyors in 36 hours.

It is concluded that an air survey section (Indian Establishment) could produce :

(i) a 1/50,000 form-lined map in two colours of 270 square miles ready for distribution in 120 hours (5 days) from the commencement of photography, or

(ii) a similar 1/50,000 map with contours in place of form lines, method (iv) (*c*), in 170 hours or one week, or

(iii) a contoured 1/25,000 map in two colours of 50 square miles in 42 hours from the time of commencement of the 1/25,000 vertical photography,

and that the 1/25,000 map would be of sufficient accuracy to enable pack or field guns to engage targets indicated on it.

EXPLORATIONS AND EXCAVATIONS IN PALESTINE.

With Special Reference to the Work of the Palestine Exploration Fund.

By Colonel Sir Charles Close, K.B.E., C.B., C.M.G., SC.D., F.R.S.,
Chairman of the Fund.

In the year 1864 the Baroness Burdett-Coutts determined to take steps to improve the water supply of Jerusalem, and she was advised that, towards that end, what was first required was a plan of the Holy City and of the surrounding country. She gave £500 for this purpose and the work was placed under the supervision of Sir Henry James, the Director General of the Ordnance Survey. Captain C. W. Wilson, R.E., was selected to carry out the task, and he and a small party of R.E. left for Palestine in June, 1864, and completed the survey in May, 1865. Wilson's excellent survey was the occasion of the first contact of the Corps with the exploration of Palestine, and since that date officers of the Corps have been, almost continuously, engaged in one way or another in improving and adding to our knowledge of the topography and archæology of this most interesting of all lands.

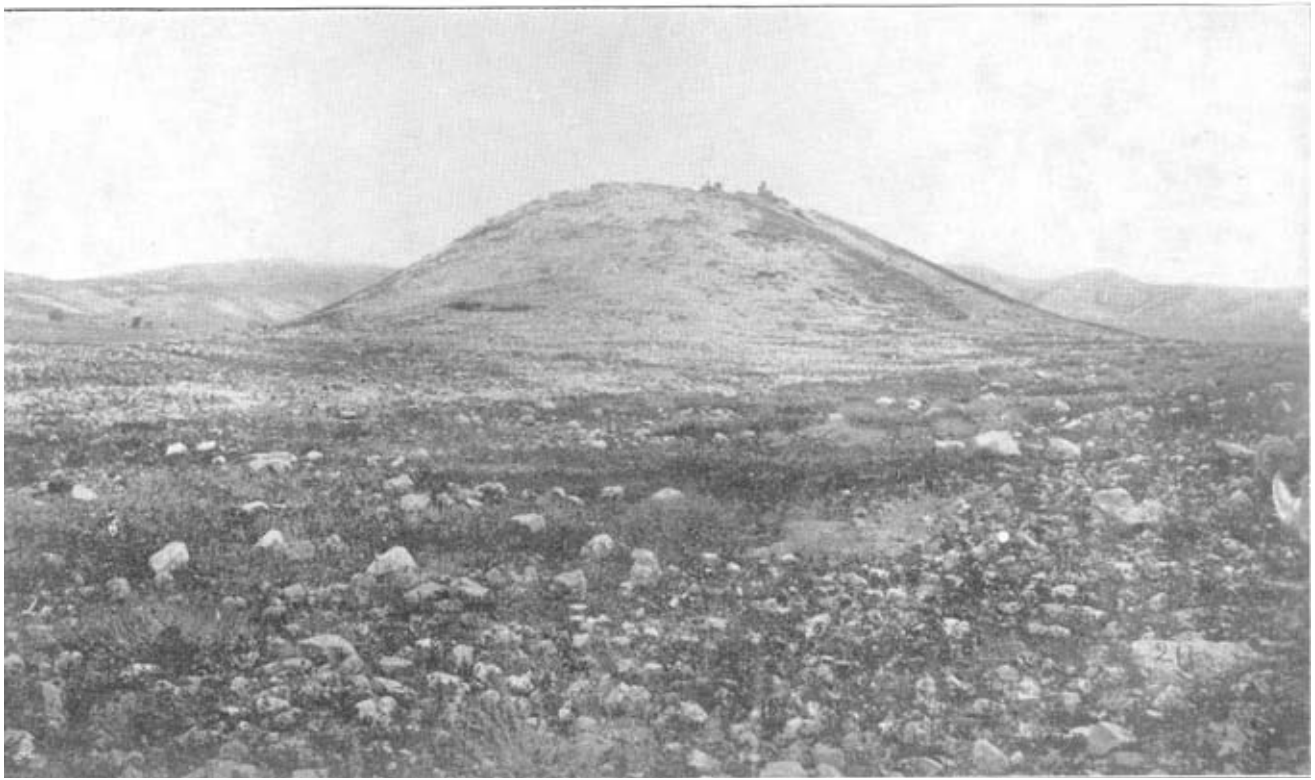
The birth of the Palestine Exploration Fund took place, very appropriately, in the Jerusalem Chamber at Westminster. A meeting was held there on May 12th, 1865, which was presided over by the Archbishop of York and was attended by Sir Roderick Murchison, the President of the Royal Geographical Society, by Dean Stanley and others, and at this meeting it was resolved " That an Association be formed, under the title of the Palestine Exploration Fund, for the purpose of investigating the Archæology, Geography, Geology and Natural History of Palestine." The Society was formally constituted on June 22nd, 1865, and on this occasion the Archbishop laid down some exceedingly sensible rules for the guidance of the new society. These rules were: (1) That whatever was undertaken should be carried out on scientific principles. (2) That the Society should, as a body, abstain from controversy. (3) That it should not be started, nor should it be conducted, as a religious society.

These rules have been consistently observed during the seventy years of the Fund's existence. The late Sir Charles Watson, writing

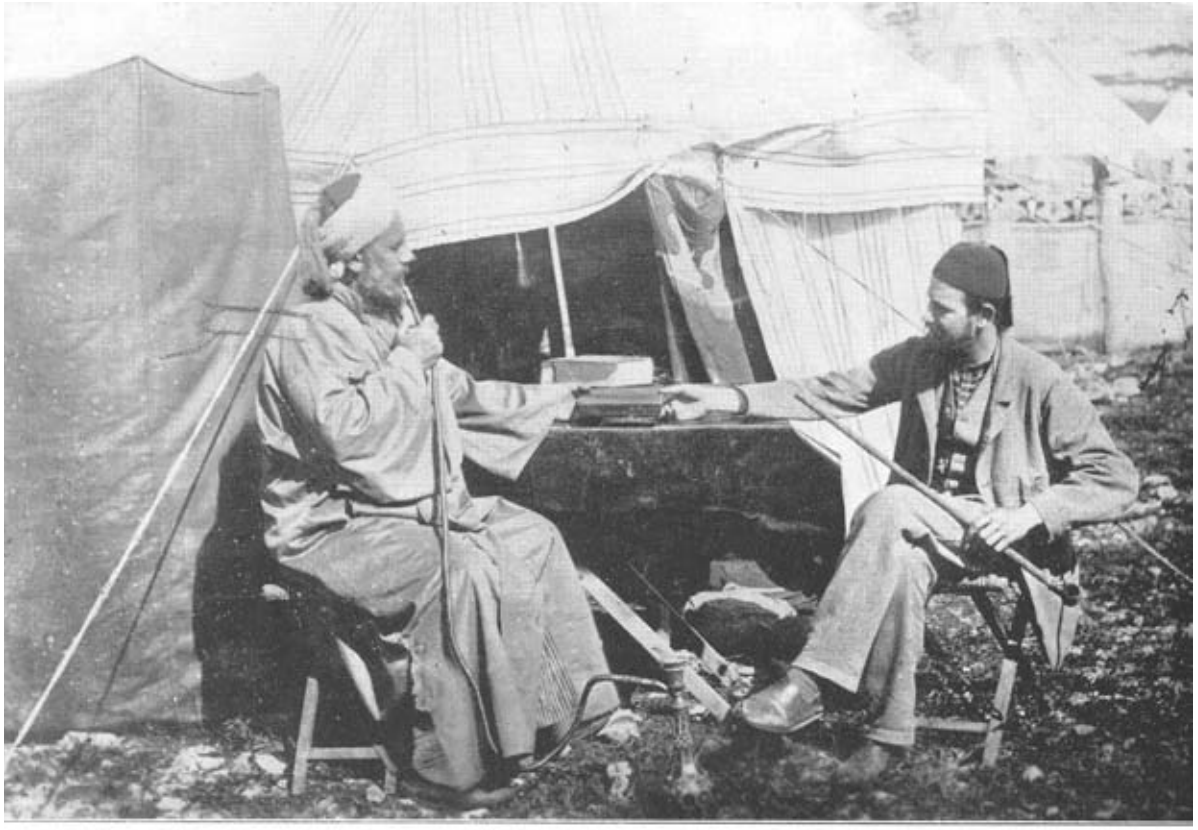
twenty years ago, described the spirit of the first of these rules in the following words: "The object of the first principle was to ensure . . . that the work should be faced in the same spirit of fearless investigation into the truth as obtains in scientific research. The conduct of a large part of the work by officers of the Royal Engineers, and of the rest by scientific explorers, has ensured the due observance of this fundamental principle. No dispute has arisen . . . concerning the truth and accuracy of the reports furnished by the representatives of the Society."

Captain Wilson returned to England, after the completion of the map of Jerusalem, shortly after the founding of the Fund, and the War Office approved of the continued loan of the services of this officer to the Fund. He and Lieut. Anderson and Corporal Phillips landed at Beirut in November, 1865, and the work of the Palestine Exploration Fund may be said to have then commenced. Wilson's instructions were "to make such a preliminary survey as would enable the Committee to fix on suitable places for future exploration, and also to acquire such special information as would throw light upon the different points referred to in the original prospectus." These points are very numerous and include such matters as the discovery of the Tombs of the Kings, the Palace of Herod, the Pool of Bethesda, the water-tunnel of Hezekiah, the investigation of the sites of Shechem, the Roman cities along the coast, Gilgal, Jericho, Bethshan and many another site famous in history. The outline of work also included the fixing of the topography by means of the determination of the positions of "principal points throughout the country." Then there was to be a geological investigation of the valley of the Jordan and the Dead Sea; and reports on botany, zoology, and meteorology.

Well, it is clear that Wilson and his two companions had their work cut out for them, but we must look upon their expedition as being intended to serve the purpose of a kind of rapid preliminary reconnaissance. They were in the Holy Land from November, 1865, to April, 1866, less than five months. They were a very busy five months and the little party did succeed in carrying out some really useful investigations and observations, which comprised the determination of time and latitude at 49 points, with a line of azimuths from the north of the country to Jerusalem. They made fifty plans of churches, synagogues, mosques, etc., and copied many inscriptions. They even found time to do a little excavation. Sir Charles Watson says that the Turkish authorities were most helpful and the Arab population usually well disposed. "Whatever success was achieved in this, the first expedition of the Palestine Exploration Fund, was due mainly to the energy, accuracy and intelligence of Captain Wilson." It was a glorious scamper.



Exploration & excavations in Palestine - Mound at Ain es Sul



Exploration & excavations in Palestine - Lieut Warren

Stimulated and guided by Wilson's admirable preliminary expedition the Committee of the Fund rightly decided to carry out work of a more permanent character. They had in view, in particular, the execution of a topographical survey of the whole of Palestine, and the detailed examination of the sites of ancient Jerusalem. Lieut. Charles Warren, R.E., was selected to carry out the work, and he with a party of R.E. arrived in Palestine early in 1867 and continued at work for three years. Their main task was the investigation of the neighbourhood of the Haram enclosure at Jerusalem and of the spur of Ophel running southward from the enclosure. One of the main difficulties was the enormous accumulation of rubbish over the original sites, rubbish which resulted, not only from the natural debris of more than three thousand years of occupation, but also from the successive destructions which Jerusalem had suffered. Warren had to sink shafts through the debris, in some cases nearly a hundred feet deep. In these cases his training as a Sapper stood him in good stead, for the *shafting* was carried through dangerously loose rubbish, and the work completed without any fatal accident.

Warren's investigations settled some disputed points and brought some new facts to light. He proved that the Temple was probably on the site now occupied by the Dome of the Rock; he made a thorough exploration of the huge rock-cut cisterns, underground, within the Haram enclosure, the largest of which has a capacity of two million gallons; he traced the eastern wall of the City of David for 700 feet; he discovered the shaft, of prehistoric date, up which Joab climbed when David captured the City from the Jebusites, and much else.

It was now Captain Wilson's turn, and he, with Captain Palmer, R.E., Professor Palmer the Oriental scholar, Mr. Wyatt, and four non-commissioned officers, carried out a survey of the southern part of the Sinai Peninsula, between October, 1868, and the following April. They reconnoitred an area of some 4,000 square miles and took many observations for latitude. Their work is still, I believe, the basis of our geographical knowledge of southern Sinai. As is well known, Professor Palmer, Captain Gill, R.E., and Lieut. Charrington, R.N., were murdered in the Sinai desert fourteen years afterwards, during the time of the Egyptian Expedition of 1882.

And now we come to what is perhaps the most important of all the undertakings for which the Fund has been responsible, namely, the Survey of Western Palestine. The original party consisted of Captain R. W. Stewart, R.E., Serjt. Black and Corpl. Armstrong, with Mr. Tyrwhitt Drake as Arabic scholar and archæologist. Stewart got ill soon after his arrival and was ordered home, and Mr.

Drake took charge for a time. Then, in July, 1872, Lieut. Claude Conder, R.E., arrived to take charge—a most happy selection.

In 1894 Conder gave a lecture at the S.M.E. describing his work in Palestine, and as this lecture is now more than forty years old, and the printed account of it is not very likely to have been studied by this generation, I will venture to quote from it. Conder said: "I was sent out in command from the S.M.E. in 1872, a few months after the work was started. . . . I maintained my connection with the work till the outbreak of the Egyptian War in 1882, and I spent six of these years in the field in Palestine, and four in the publication of the map and memoirs of the survey in England. The whole of Palestine from Dan to Beersheba was completed during this time on the scale of an inch to the mile, the survey being based on a regular triangulation depending on two measured bases. In 1881, and the early part of 1882, I was in command of a party which commenced the survey of Eastern Palestine on the same principles. West of the River Jordan we had surveyed 6,000 square miles. East of the Jordan we measured a base and connected it by triangulation with our former stations on the Judean watershed, and carried out the survey and thorough examination of part of Moab and Gilead, amounting to an area of 500 square miles, before we were finally stopped by order of the Sultan. We also had experience in levelling, since we ran a line 30 miles long from the Mediterranean to the Sea of Galilee, the level of which (682 feet below the Mediterranean) was formerly uncertain within 300 feet."

Conder says that they had in the party two, and sometimes three, non-commissioned officers of the Corps, chosen from the Ordnance Survey. He adds: "My latest comrade, Captain Mantell, who accompanied me east of Jordan, is so well known to you that you will easily believe how much of our success, under the very difficult political circumstances in which the survey beyond Jordan was carried on, was due to his exertions—and I may add, his courage."

This is merely a bare outline of an exceedingly interesting piece of exploration, not merely topographical, but embracing valuable investigations and discoveries in the field of archæology. Conder wrote an admirable, popular account of this survey in two volumes, entitled *Tent Work in Palestine*. This work is still well worth reading; it is by no means a dry-as-dust account of his work and travels and adventures, and it can still be recommended to any one who is thinking of a journey in the Holy Land. Of course the archæology is not up to date, for the time had not yet come for any systematic classification of pottery. But much was done in the way of identification of ancient sites, and Conder said that, "The object was not only to study the ancient topography and geography of the country . . . but also to secure a thorough examination of the whole

area, since the surveyor must of necessity visit the whole of the ground. Something like 150 places mentioned in the Bible were thus discovered which were quite unknown before, to say nothing of the ancient sites mentioned by classic writers, in the Talmud, and in the early Christian and Moslem accounts of the country." And he points out that even by 1894 some of the relics of antiquity had disappeared: "Some of our drawings and accounts of ancient remains are now all the evidence that remains of their existence, since they have of late been destroyed by greedy speculators, or by monks and others, who have erected modern buildings on the ancient sites." If his ghost were to visit Palestine now, more than forty years after that sentence was written, he would find much of the same kind of obliteration going on, only in present times it is due to the remarkable economic development of the country under the Mandate.

Conder came home on leave in May, 1874, and whilst he was away Mr. Drake died at Jerusalem, no doubt as the result of the many attacks of fever from which he had suffered. Drake's place on the survey was taken by Lieut. H. H. Kitchener, who joined the party in November. In July, 1875, the party was attacked by the people of Safed, a town in the hills above the sea of Galilee, and the two officers were somewhat seriously injured. The work was stopped until the offenders had been tried and punished, and the party came home. Kitchener returned with the party to Palestine in March, 1877, and the Survey of Western Palestine was brought to a successful completion by him in September of that year. We may agree with Watson when he says that this was the most important work on the Holy Land ever given to the world. In addition to the one-inch map, the literary account consisted of seven volumes which included the Memoirs, Name Lists, Special Papers, the Jerusalem volume, and an account of the flora and fauna of Palestine. All this is still an indispensable foundation for the proper study of Palestine.

The map remained the standard map of the country until the opening of Allenby's brilliant campaign, when it was gradually supplemented by large-scale air photographs and special war-time surveys. After the acceptance, by this country, of the Mandate, a proper Survey Department was formed under the direction of Major C. H. Ley, R.E., and, on his retirement, the direction passed to Lieut.-Colonel F. J. Salmon, who may be claimed as an R.E. and who is now Commissioner for Lands and Surveys. So that we may say that the geography and topography of the Holy Land have been the especial care and privilege of the Corps for the past seventy years.

But there is an intermediate piece of work of this nature, of considerable importance, which should now be touched upon. The surveys of Conder and his companions stopped short of the Negeb, or Wilderness of Zin, that somewhat inhospitable country to the south

of Beersheba and between that town and the Egyptian frontier. The Palestine Exploration Fund had long been desirous of obtaining accurate information about this region, and in 1913 an opportunity occurred for the execution of a topographical and archæological survey of this area of about 4,500 square miles. Captain S. F. Newcombe was put in charge, with Lieut. J. P. S. Greig to assist him with the topography. C. L. Woolley and T. E. Lawrence, who were at the time exploring the Hittite city of Carchemish on the Euphrates, joined the expedition in order to report upon the archæology. The topographical work began at Gaza in December, 1913. Newcombe tied on his triangulation to the points in Sinai which were connected with the triangulation of Egypt. The survey was carried out on the reconnaissance scale of 1/125,000, and it was executed with the utmost rapidity. It was a fine piece of work, reflecting the greatest credit on Captain Newcombe's skill, powers of organization, and energy, for it was completed in five months. The map, published on half the above scale, became available to the Fund and the public after the war.

The above account may perhaps serve as a brief sketch of the exploration of Palestine during the last two generations, so far as concerns the topography and the identification of historical sites; but there remains what is even more interesting, namely, the detailed archæological investigation of these sites, in such a way as to throw light upon their literary history and to give us a clearer idea of the development of the culture of their inhabitants.

Excavation and archæological exploration in Palestine differ from such work in Egypt, in that the visible, material remains of antiquity are far fewer in the former country. Successive conquests and destructions have often left little or nothing to be seen above the surface of the ground. How many times has Jerusalem been captured and destroyed? How little remains, above ground, of ancient Samaria! But there is another side to the picture. The country is rich in *tells*, ancient mounds, dating in some cases as far back as the fourth or even fifth millennium B.C.; mounds which are composed of the ruins of city after city, inhabited by race after race, each leaving some trace of their occupation, but unable to make for themselves a continuing city.

What, it may be asked, is the special interest of Palestine as a field for the investigation of antiquity? Its interest, of course, is mainly centred in the Bible. It is by means of this wonderful literature that we can penetrate more deeply into the past, and see more clearly into the actions and motives of the men and women of those distant ages, than we can by any other means. We are by this means in possession of true history. Saul and David and Solomon; Omri and Ahab and Mesha, King of Moab; Hezekiah, Isaiah and

Jeremiah, and many another, come before us as living, individual human beings, and not as ceremonialized abstractions. We are in touch with a vitally important stage in human progress, and anything which makes clearer to us the careers of the saints and sinners of the Holy Land, which helps us to realize their characters, their struggles, successes and failures, their daily lives and the general circumstances and the atmosphere in which they lived, is well worth our attention.

Now this is just what archæological study can do. It can make vivid such stories as that of the anointing of Solomon at the well Gihon; how he rode down there from the City of David, on David's own mule. We know where that city was; we know the path that the young king rode along and the place of the well Gihon. In the same way the exploit of the valiant men of Jabesh-Gilead, who took down the bodies of Saul and of his sons from the wall of Beth-shan, is more real to us when we know the site of that ancient fortress and can travel over the country crossed by the valiant men. And the threshing floor at the Gate of Samaria, where the two kings sat on a fateful day; and the narrow cell where Micaiah was shut up until Ahab was to come again in peace; and the stronghold before which the Assyrian army was encamped, before the capture of Jerusalem, two thousand and five hundred years ago; and many another site; each and all illustrate vividly the events of ancient history, the real history of the past.

But it is not merely that archæology serves, as it undoubtedly does, as a criterion of history and an illustration of it. It has a still higher function, in that it gives us a sure background for our knowledge of the birth and development of ideas of the greatest importance to us in our everyday lives. It is chiefly from Palestine that we derive our heritage of ideas which even now govern our actions; our thoughts of mercy, justice and kindness, which we owe, not to Greece or to Rome, but to the prophets of Israel. We must look back to the Holy Land for the beginnings of the best elements of our civilization. There is, then, ample reason for our interest in the labours of archæologists in Palestine; labours which are gradually opening to us clearer views of a past which so much concerns our present.

The Palestine Exploration Fund has been very fortunate in obtaining the services of eminent archæologists to carry out the work of excavating the historical sites. And chief among these, in the early days of the Fund, was M. Clermont Ganneau, a distinguished Semitic scholar, who had a large share in rescuing the Moabite stone and in interpreting it. He also identified the site of Gezer, and discovered the Greek tablet which had been set up in Herod's temple, prohibiting the entry of Gentiles into the Inner Court. He carried out much important work for the Fund. All this in the 'seventies.

The first deliberate excavation of a *tell* was that of Tell-el-Hesy, a mound some 15 miles to the north-east of Gaza. This tell had a height of 100 feet above the valley, and more than 60 feet of this was debris. The Fund was fortunate enough to obtain the services of Professor Flinders Petrie for this excavation, and he worked at the tell during 1890, and then handed over to Mr. Bliss. Professor Petrie here, for the first time, classified the pottery by periods, and so far as Palestine is concerned laid the foundations of systematic archæology. The excavation continued until December, 1892. It appears that the place was founded about the seventeenth century B.C. It was, at first, identified with Lachish; but this identification is now given up. Archæologists now take Tell Duweir to be Lachish.

We must pass by some excavations which were undertaken by the Fund at three mounds some fifteen miles or so to the south of Ramleh, namely, Tell es Safi, Tell Zakariya and Tell Sandahannah, in the years 1898 to 1900, and must describe, in brief, the very important excavation of Gezer, which took place between 1902 and 1909.

Gezer.

Gezer is one of those sites, of which there are at least six in Palestine, where we find a narrow, isolated hill with a fortified area on the top and inside the fortifications a shaft, or passage, leading to a secret, internal supply of water from a spring. Jerusalem, that is the ancient Jebusite City, is another example of the same kind.

Gezer is also one of the many cases in which the modern name is identical, or nearly so, with the ancient name, for the modern name is Tell el Jezari. The site was not only identified by the name, but Clermont Ganneau had found, thirty years before, cut on the rock some inscriptions in Hebrew and Greek which marked the boundary of the ancient city and contained the name Gezer. The first mention of Gezer in written history is to be found in the Tell el Amarna tablets of the middle fourteenth century B.C. It is mentioned in the book of Joshua that Horam, King of Gezer, came up to help Lachish; and Joshua smote him and his people until he had left him none remaining. And in the middle of the tenth century, in Solomon's reign, "Pharaoh king of Egypt had gone up, and taken Gezer, and burnt it with fire, and slain the Canaanites that dwelt in the city, and given it for a portion unto his daughter, Solomon's wife." Considering how near Gezer is to Jerusalem, this is a curious commentary on the state of Palestine in David's reign.

The work of excavating this important site was entrusted by the Fund to Mr. R. A. S. Macalister who began his task in June, 1902. He soon found the ancient city wall, 14 feet in thickness, and "inside it were the remains of towns built, as in the case of Tell el Hesy, one

Gezer. Prehistoric water-tunnel, excavated by the P.E.F. in 1907.

Gezer. "High Place," excavated by the P.E.F. in 1902.

Exploration & excavations in Palestine - Gezer

SINAI EXPEDITION, 1883–84.

Mr. G. Armstrong. Professor E. Hull, Mr. H. C. Hart, M.A., Capt. H. H. Kitchener, R.E., Mr. R. Laurence.

Exploration & excavations in Palestine - Sinai expedition

over the other." The place had been occupied since neolithic days. Macalister " observed some curious stones projecting from the debris in the central valley, and dug a trench in order to examine them. This led to the discovery of a remarkable 'high place,' the most important that has been found in Western Palestine, consisting of a row of eight monoliths standing in a north and south line, and varying in height from 5 feet 6 inches to 10 feet 6 inches." Close to this row of monoliths he found what is probably the socket for the sacred pole, or " asherah."

But perhaps the most interesting of all Macalister's discoveries was that of the great water-tunnel, descending from the top of the hill, down an incline, cut in the solid rock. The tunnel was 23 feet high and 13 feet wide, with a flight of eighty steps leading to an underground spring. It must have been cut in very early days, say in the Early Bronze Age, or before 2000 B.C., and it enabled the inhabitants to get their water under cover, within the defences. They were better off, in this respect, than were our Early Iron Age ancestors, whose forts were not as a rule provided with any water supply. But in other respects the conditions were not unlike; each " king " had his fortified city, and apparently ruled an area round this up to a line about half-way to the next " king's " city. We know that in Palestine the kings made alliances with each other, and that from early in the fifteenth century until some time in the middle of the twelfth, they were under the general domination of Egypt, a domination which varied in effectiveness with the character of the reigning Pharaoh. It is one of the puzzles of archæology why there is no mention of Egypt in the books of Joshua and the Judges, for that the kings existed and were in correspondence with the Pharaoh we know from the Tell el Amarna letters.

The next excavation undertaken by the Fund was that of Ain Shems, otherwise Beth Shemesh, the City of the Sun, between the Judean highlands and the plain of Philistia, a site of much interest, although it did not yield as much increase to our knowledge of the past as did Gezer. This excavation was finished at the end of 1912, and was the last to be undertaken before the outbreak of war.

Great Britain, having accepted the Mandate for Palestine, has also accepted in a special degree the charge of the antiquities of that country, for which we have a direct national responsibility. That responsibility includes the duties of cataloguing and preserving the ancient sites and monuments, and of exploring and assisting others to explore them. In so far as Great Britain is concerned these first two duties are being carried out by the Department of Antiquities in Palestine, and in the matter of the excavation of the sites and the publication of the results, by two British societies, namely, the

Palestine Exploration Fund and the British School of Archæology in Jerusalem.

But it would convey quite a false impression to leave that statement as it is, for some of the most important of the excavations and discoveries that have been made since the war have been made by American societies and institutions, notably by the Universities of Pennsylvania, Harvard and Yale, by the American School of Oriental Research, and by the Oriental Institute of the University of Chicago, which has recently suffered such a severe loss by the death of its Director, J. H. Breasted, one of the most distinguished archæologists of our time.

Then we must not omit to mention some most important excavations which are being carried out at private cost, namely, the excavation of Jericho, which has been proceeding for some years under the direction of Professor Garstang, the funds being furnished by Sir Charles Marston; and the excavation of Tell Duweir (Lachish), which is under the direction of Mr. Starkey, the cost being defrayed by Sir Henry Welcome, Sir Charles Marston and Sir Robert Mond. Then we have also the Danish excavations at Shiloh; more American excavations at Mizpah and at Kiriath-sepher; excavations by the French *École Biblique* at Ain Duq; and those of Tell Ajjul, near Gaza, and Tell-el-Fara and Tell Jemmeh, by Sir Flinders Petrie. A glance at the *Map of the Principal Excavated Sites*, published by the Palestine Exploration Fund, will show the really immense amount of excavation which has been carried out, especially since the war.

These various excavations have added greatly to our accurate knowledge of the past. From Jericho we obtain knowledge of the size of the city captured by Joshua, some six acres; and from that we can calculate that the number of inhabitants who were killed off was about 1,500. From Megiddo we find the precise arrangements made by Solomon for stabling 250 horses. From Beth-shan we can determine the design of a succession of temples from the fifteenth century B.C. to the twelfth century; we have much information as to the Egyptian domination of Palestine in those centuries; and we have the name and the picture of the Baal of Beth-shan. At Lachish (Tell Duweir) Mr. Starkey has found contemporary letters, written on potsherds, dating from 597 B.C., dealing with the military situation a few years before the destruction of Jerusalem by Nebuchadnezzar. And we have two specimens of alphabetic writing of a very early date, sometime about 1270 B.C. Each of these excavations deserves at least a paper to itself.

Askalon.

The first excavation to be undertaken in Palestine after the war was that of Askalon, by the Palestine Exploration Fund. The Fund,

in fact, tried to discover something of the culture of the Philistines and something of their manner of life in the streets of Askalon. The site is a large one, about 200 acres in area. It is now a semi-circle, enclosed on the land side by earthen ramparts, crowned by the remains of Byzantine and mediæval walls, about a mile and a quarter long; the ramparts abut, at their north and south ends, on the sea. It is thought that the earth ramparts may belong to the age of the Philistines. Inside this enclosure the space is parcelled out into fields, and nearly every field contains Roman material.

Professor Garstang had charge of the work and commenced operations in August, 1920. Now archæology is, in a way, a kind of sport. You never know what is going to turn up, if anything. What did turn up at Askalon were Roman remains of the time of Herod: statues, a pool, a theatre, colonnades and a cloister. But on this site we are not much interested in Roman remains; what we want to find are traces of the Philistines, a cultured people who seem, eventually, to have become amalgamated with the Hebrews, though they were not very good friends about the year 1000 B.C. But we did not find out much of value about this race, whose origins and history still remain rather obscure. The difficult character of the site, its large size, and the expense of working in the cultivated fields, did not enable any very thorough examination to be carried out.

It was reported that Arabs and Crusaders had added to the confusion caused by the deep digging of the Romans when they laid their foundations. But some sections were cut which enabled a sequence of pottery specimens to be established. It appears that we must place the date of the foundation of Askalon at about 1800 B.C., and the immigration of the Philistines at about 1200 B.C. In the Tell el Amarna correspondence of the fourteenth century there is a letter from the King of Askalon, Yitia, to the Pharaoh, his master: "He kisses his feet; he bows himself seven times and seven times to the ground; he is sending tribute; he is providing the food necessary for Pharaoh's army." But the King of Jerusalem, in another letter, accuses Yitia of having conspired with Gezer and Lachish to assist the Khabiru invaders.

Jerusalem.

To the south of the existing wall of Jerusalem there extend two spurs; the spur on the west, short, broad and high; and that on the east, long, lower and narrow. For ages the western hill has been called Mount Zion, or the City of David. But more than sixty years ago Rev. W. F. Birch attacked this traditional view. Dr. Masterman, the Honorary Secretary of the Palestine Exploration Fund, remarks that "Mount Zion had been so long applied to the southern

end of the western hill, and the traditional 'Tomb of David,' outside the Zion Gate, had been so long venerated by Moslems, Jews and Christians, that it must have needed some mental detachment to maintain an entirely different view."

Archæologists are to-day agreed that Birch was right, for the following reasons: The only perennial spring, in or near Jerusalem, is that known as the Virgin's Fountain, or in the Old Testament, "Gihon." Now it is certain that the primitive people who first occupied ground near Jerusalem would have camped near a spring; and it is also certain that those who first, perhaps in the Early Bronze Age, fortified the hill, were careful to include their water supply in the fortress. The spring above-mentioned rises on the eastern slope of the eastern hill. In connection with this spring there are various tunnels and shafts leading to the centre of the primitive fortress, notably Warren's Shaft. There are several other examples of this kind in Palestine, especially at Gezer. The primitive site was, therefore, the eastern spur. Moreover, the long, narrow ridge of this spur is very favourable for defence, whereas the western hill is not. And excavations on the eastern hill have fully confirmed the antiquity of settlement here; whilst on the other hill the earliest remains are Hebrew.

The Biblical evidence strengthens this view. Joab captured the city by climbing up "the Gutter," that is along the water-tunnel and up the shaft. And we read in the second book of the Chronicles that "This same Hezekiah also stopped the upper water-course of Gihon and brought it straight down to the west side of the City of David." And Manasseh built "an outer wall to the City of David on the west side of Gihon in the valley." All this fits in very well with the supposition that the Jebusite City was on the eastern hill, and not at all with the other theory. This was generally accepted in 1923, when an opportunity occurred of excavating the hill, which we may now call the hill of Ophel.

In 1922 the Government of Palestine, through the Department of Antiquities, invited archæologists of all nations to co-operate in the excavation of the hill of Ophel. It was stipulated that at least £5,000 must be available for the work, and there were certain requirements to prevent slipshod excavation. Thanks to the generosity of Sir Charles Marston, of Lord Burnham, of the British Academy, with some funds raised directly by the Palestine Exploration Fund, it was found possible to start this important excavation under the direction of Professor Macalister.

Work began in October, 1923, after some heart-breaking negotiations with speculators who had bought up the fields in order to be bought out at a high figure. The field selected was 200 yards south of the Haram. Professor Macalister, assisted by Mr. Garrow Duncan,

began the excavation, and in 1924 Mr. Duncan took sole charge. The work was closed down in the spring of 1925. In some respects the results were disappointing; no inscriptions, and no objects of a movable kind of any considerable importance were found. But the excavators did find extensive remains of the ancient fortifications of the Jebusite and Israelite periods.

Some fine stretches of ancient walls were found on the outer eastern edge of the crest of the hill. In particular a sloping revetment or ramp, some forty feet long at the top, composed of blocks of stone, "carefully placed, and ending in a sloping, stair-like surface of 23 steps," the steps being about a foot high. This feature used to be considered as of Jebusite date, and it was an attractive speculation that it might have formed part of the very walls from which the Jebusites taunted David. But some authorities do not date it so early, and Dr. Albright remarks that, "The sloping revetment of the Israelite period on the eastern slope of the hill is the most impressive monument of Israelite fortification which we possess."

Another fine stretch of wall, forming a projecting tower, fifty-five feet long, is attributed to the time of Solomon, no doubt correctly, for the masonry is similar to that of the same period at Megiddo and Gezer. It is a fine piece of masonry, and here we may be fairly sure that we are looking upon the work of the early kings.

These excavations, which proved to be very barren of small objects of archæological interest, have helped to confirm the supposition that the City of David was on the eastern spur. This supposition was further strengthened by excavations on the western side of the Hill of Ophel which were carried out for the Palestine Exploration Fund a few years later.

Early in 1927 Sir Charles Marston generously gave to the Fund sufficient money to carry out excavations on the western side of the hill, and the work was begun by Mr. J. W. Crowfoot and Mr. G. M. Fitzgerald in May of that year. The excavation involved the digging down from the level of the rock surface, on the ridge, to the bottom of the old Tyropoeon Valley, the greatest depth through the debris of centuries, was 50 feet. The Tyropoeon Valley, "originally a ravine, was gradually filled up with the remains of its own buildings at various epochs, and with the rubbish that has been cast into it when deserted; it has so often been the dust-heap of Jerusalem." So wrote the late Dr. H. R. Hall. The most important discovery was that of an ancient gate, built at a low level on the western side of the Ophel ridge, that is, on the east side of the Tyropoeon. Père Vincent, than whom there is no higher authority on all that concerns ancient Jerusalem, thought that this gate with its massive side towers, and the wall in which it stood, were maintained "long after it had ceased to be the external wall of the city, as a second line of

defence to give additional protection to the oldest quarter of the city. It was in this quarter that David and many of the kings were buried, and that palaces were built down to the time of Titus." The walls round Ophel would be an exact parallel to the wall round the " City " of London.

On either side of the gateway are two towers of massive construction; the width of the roadway is nearly twelve feet. The excavators give the following as a probable history of the structure: " The gate was built in the Bronze Age, or at latest in the Early Iron Age; it was in regular use throughout the time of the Hebrew monarchy; it was still in use after the return from the Captivity, and was restored at least once in the time of the Maccabees; it was destroyed by Titus, and a foundation wall was built across it later."

It should be noted that the early Canaanite walls on both sides of the spur attain a width of 26 feet. " When the invader had forced his way through the gateway, he found himself confronted by a cliff, and, whether he turned to the right or the left, he was exposed to the attack of the defenders above him." We have now, thanks to these two excavations and to the work of M. Weill, to the south, a fairly complete idea of the old fortress.

Samaria.

Omri bought the hill of Samaria of Shemer, for two talents of silver; and he fortified the hill, and called the name of the city which he built after the name of Shemer, the owner of the hill, Samaria.

The site is a fine one, and has even been preferred to that of Jerusalem. The hill rises three or four hundred feet above the valley, and the summit is 1,400 feet above the Mediterranean. In a straight line it is only about 35 miles from Jerusalem, and about 45 miles by road—so small is the country! It is almost exactly half-way between the Jordan and the sea.

The date of the foundation of Samaria was about 880 B.C.; and the date of its capture by the Assyrians was 721 B.C. This latter date is fixed from Assyrian sources, and is the only fixed point in the history of the monarchy. Between these dates we have an interval of 159 years, and this is the most interesting period in the history of the city. It is said that from 721 to 331, when it was occupied by Alexander the Great, little or nothing is known of Samaria.

The short and moving history of the city, during its century and a half of independence, is written in the books of the Kings and the Chronicles. There are few stories more dramatic than the account of how Ahab, " King of Israel and Jehosaphat the King of Judah, sat each on his throne, arrayed in their robes, and they sat on a threshing floor at the entrance of the gate of Samaria, and all the

prophets prophesied before them. And they bade the Kings go up against the Syrians to Ramoth-Gilead. Save only Micaiah." Excavations have discovered what may be the cell in which Micaiah was shut up, to be fed on the bread of affliction and the water of affliction; and the pool where they washed Ahab's chariot; and the remains of the ivory house that he built; and some of the carved ivories.

In the years 1908–09 excavations at Samaria were undertaken by Harvard University, under the immediate direction of Professor Reisner. The excavators were able to uncover remains of the early Israelite period, probably of the time of Omri and Ahab, though much of the masonry had been removed in past times to build the village of Sabastya. Mr. Jack remarks that the excavations "give us a picture of the grandeur of Samaria" in the time of Ahab, "with its strong walls, its palaces, its private houses built with hewn stone, its perfect organization, its riches and its power." No buildings were found earlier than the time of Omri, and it is thought that the site was not inhabited before Omri bought it from Shemer. The only vestiges of occupation before the Iron Age belong to the neolithic period.

Ahab's palace had a great court 100 yards long, enclosed by a heavy retaining wall, and around this was a series of small rooms serving as domestic offices, chariot houses and stables. Mr. J. W. Jack, whose book on Samaria gives the best accessible account of the pre-war excavations, describes how a small cemented pool was found to the north of Ahab's palace. This may have served for watering horses and cleaning chariots. "We cannot help recalling the historic scene when Ahab, after being mortally wounded at the attack on Ramoth-Gilead, bled to death in his chariot, and his servants washed it along with his armour in 'the pool of Samaria.'"

During the same excavations 63 ostraka, or potsherds on which was Hebrew writing, were discovered. They are early specimens of Hebrew writing, the date being about 862 B.C. They consist of accounts of oil and wine received at the palace; they are, in fact, way bills. These accounts mention 21 place-names, many of which have been identified.

So much for the pre-war excavations. In 1930 excavation of this site was resumed, this time by collaboration between Harvard University, the Palestine Exploration Fund, the British School of Archæology and the Hebrew University, and work only came to an end in 1935.

In the first year a stretch of the Israelite city wall was discovered, three courses above the foundations; in 1931 some more slight remains of the Israelite palace; many Roman constructions were found in most of the fields, though it was not possible to reconstruct the plan of the temple of Augustus.

By far the most interesting finds in 1932 were the ivory fragments. Many of the fragments were blackened by fire, but not by any means all. Most of the ivory reliefs came from narrow bands of decoration; some may have been used to decorate a bed; some may be from the arms of a throne, or may have decorated a room. Mr. Crowfoot states that in style the whole group of ivories is closely related to a series of ivories which were discovered by a French expedition, near Carchemish, in 1928. Several of these came from the decoration of a bed, and an inscription proved that this bed had belonged originally to a king of Damascus of the ninth century. Egyptian influence is rather more prominent in the Samaria examples.

There are traces of gold foil and blue inlay on some of the Samaria ivories. "The stratum in which these were discovered is full of Israelite potsherds of the eighth and ninth centuries B.C." In the Book of Amos, which was written about 760 B.C., we find various denunciations of the luxury of Samaria:

> "Woe to them that are secure in the mountain of Samaria,
> . . . Who lie upon couches of ivory,
> And stretch themselves out upon their beds."

and:

> "The houses of ivory shall perish
> And the great houses shall have an end,
> Saith Yahweh."

ENGINEER ORDERS.

By CAPTAIN T. H. B. FOOTT, *Australian Staff Corps.*

"THE C.R.E's of divisions should not allow themselves to be overloaded with office work." So runs the most delightful passage in *Engineer Training*, Vol. II. Nevertheless, "to bring about a desired course of action with the full co-operation of units," they will have to issue operation orders. Possibly C.R.E's would need to spend less time in their offices writing their orders, if more guidance in the matter of preparation of these were included in the engineer manuals. Work Tables, Working Party Tables, and Working Party Demands are all fully explained and illustrated, but of orders, on which all the foregoing depend, there is no mention. This is very different from the case in other arms, where in some instances mnemonics are used to ensure a uniform form of order. Engineer orders can never be expected to attain this degree of standardization, but the pattern in every case will be generally similar. The outline of this pattern should be understood by all the engineer officers of a division, and each of these should be able to add the details as they concern him. By this means only can the various tables be correlated, and a unity compounded from the miscellany.

2.—THE FIELD ENGINEERING PLAN.

(*F.S.R.*, II, 14, *2*. *E.T.*, II, 52, *2*. *E.T.*, II, 41, *1* & *2*. *M.E.*, III, 57, *1*.)

The divisional commander will decide what work is to be executed by the different parts of the division. The regular R.E. officer possibly finds no difficulty in understanding the whole picture; the average non-regular officer probably fails to envisage more than a part. It was to enable some junior officers of the Australian Engineers to see more than the part that the exercise which follows was worked out. Each unit, including the engineers, will be given a distinct task to carry out. The programme of work which details the order of priority is called the *Field Engineering Plan*. The C.R.E. is the divisional commander's technical adviser on all engineering matters, and, as such, it is his duty to assist the staff with advice in the execution of these duties, *i.e.*, control of the field engineering plan, and of the supply of engineer stores. He is responsible for the general direction and control of all work carried out by engineers, and can inspect, and advise on, all engineering work carried out by

other units. He must have a knowledge of the tactical situation, from which he can forecast the scope of the work that can be contemplated, taking into consideration the time available. He must also keep himself informed, both by personal reconnaissance and by reports from his subordinates, of the topography and resources of the area and of any special features that will require consideration. His appreciation will form the basis of the advice he gives the divisional commander, who then decides on the field engineering plan. The C.R.E. will prepare a schedule showing both the estimated and the actual progress towards completion of the various jobs, either in the form given in *M.E.*, III, Table T, or else graphically.

3.—Analogy of Fire and Engineering Plans.

(*F.S.R.*, II, 133, *1*. *F.S.R.*, II, 133, *7*.)

The object of an operation order is to bring about a desired course of action with a full co-operation of all arms and units. This is achieved by formulating a series of plans—the fire plan, the administrative plan, the intercommunication plan, for example—in which are outlined the parts units are to play. Operation orders are normally divided into the main parts: Information, Method, Administrative Arrangements and Intercommunication. The method paragraph contains a statement of the tasks allotted to units in sufficient detail to ensure co-operation. It gives the action to be taken by the bulk of the divisional units, and it is here that we expect to find details of both the fire and the field engineering plans. The method paragraphs of some orders will contain a fire plan and little else; of others a field engineering plan and little else. Many orders on the other hand will contain both a fire plan and a field engineering plan.

4.—Form of Method Paragraph.

A logical sequence should be followed in allotting tasks in the method paragraph. Units should be dealt with in order of the importance of their tasks; thus the fire plan of a division in defence may be shown under the sub-heads artillery and infantry brigades and other sources of fire power. Similarly, the corresponding field engineering plan would probably be dealt with under the sub-heads engineers, infantry and other sources of labour.

Where the method paragraph contains both the fire plan and the field engineering plan, the more important would come first, and all the units involved therein would be dealt with in logical sequence. The two plans are expected to fit together in their operation, and no difficulty should be experienced similarly in dovetailing them in the method paragraph.

5.—Example of Field Engineering Plan in Method Paragraph.

Consider the case of an infantry division halting after retirement. Orders are issued for the halt and occupation of a defensive position when the main body has crossed a river under the protection of a brigade between the river and the enemy. In the divisional order we should expect first the protection plan, then the tasks of units contributing to the fire plan of the main defence, followed by the roles of the units in the field engineering plan. Where any unit is placed under the command of anyone other than his normal commander, this point of abnormal control, as well as that of tasks, must be made clear in the order. Part of the divisional order for the above-mentioned operation might read as follows :—

Method.

9. *Protective Detachment.* Comdr. : Brig. AMONTILLADO, 4 Inf. Bde.
Tps. : 4 Fd. Bde., 4 Fd. Coy., 4 Inf. Bde., etc. } from 1400 hrs., 8 Aug., 35.

10. *Arty.*
11. *Inf.*
12. *Tanks.*
13. *Reserve.* 15 Inf. Bde. (less working party) } Main defensive position.

14. *Eng.* Eng. 3 Div., less 4 Fd. Coy., will prepare all bridges across R. YARRA between both incl. KOOYONG and RICHMOND for complete demolition. Preparations to be completed by 1700 hrs., 9 Aug. No interference with traffic is permitted. Two waterpoints will be provided in both 10 and 15 Inf. Bde. areas.

15. *Inf. Working Parties.* 15 Inf. Bde. will provide C.R.E. with 100 O.R. continuously till 1600 hrs., 9 Aug.

6.—Divisional Engineer Orders.

Just as each infantry brigade issues its own orders based on the divisional order, so does the C.R.E. issue an order to divisional engineers. This is an operation order and follows the form laid down in *F.S.R.*, II, 133. An interesting example of a divisional engineer operation order is quoted in full in *R.E.J.*, March, 1935, page 38. The C.R.E.'s order based on the divisional order quoted in paragraph 5 above would take a similar form ; the method paragraph would read :—

Method.

4. *Control.* 4 Fd. Coy. is placed under command of 4 Inf. Bde. from 1400 hrs., 8 Aug.

5. *Tasks.* 10 Fd. Coy. will prepare following bridges for complete demolition by 1700 hrs., 9 Aug. :—
   KOOYONG Railway Bridge.
   GRANGE ROAD Bridge.
   CHURCH ST. Bridge.
   RICHMOND Railway Bridge.
   No interference with traffic is permissible.
   Two Secs. 15 Fd. Coy. will each provide and operate two waterpoints in 10 and 15 Inf. Bde. areas.
   18 Fd. Park Coy. will continue present location and tasks.
   15 Fd. Coy. (less two secs.) reserve at 15 mins. call vicinity WHEATSHEAF HOTEL.
6. *Tools and Materials.* 2,000 lb. ammonal held by 18 Fd. Park Coy. available for demolitions. Coys. will submit requirements explosives by 2000 hrs. to-night.
7. *Working Parties.* 100 inf. 15 Inf. Bde. available Eng. 3 Div. continuously till 1600 hrs. to-morrow. Report inf. labour requirements by 1500 hrs. to-day.

Then follow the administrative and intercommunication paragraphs. The former would detail the arrangements for picking up the extra explosive, and the latter would contain instructions regarding liaison with infantry brigades, and times at which progress was to be reported.

7.—FIELD COMPANY PLANS.

As the Battalion, so the Field Company. The tasks have been assigned by the superior commander, and the subordinate commanders must put these into effect. To do this, they must make their reconnaissances, form their plans and issue their own orders. Assuming that they got their C.R.E.'s orders by 1400 hrs., 8th August, they would direct their companies to *rendezvous* and themselves proceed direct to the tasks, where they would make their detailed reconnaissances, appreciations and plans. Their men would probably arrive on the job by, say, 1600 hrs.

Major Treblea, commanding 10th Field Company, inspects his four bridges and decides on the following plan :—

Bridge.	*Type of Charge.*	*A.E.*	*Inf.*	*Explosive.*	*Time to Complete.*
Kooyong ...	Cutting	One Sec.	*Nil*	300 lb. G.C.	18 hrs.
Grange Rd. ...	Mining south abutment	,, ,,	30	700 lb. ammonal	22 hrs.
Church St. ...	,,	,, ,,	30	700 lb. ammonal	22 hrs.
Richmond ...	Cutting	,, ,,	*Nil*	300 lb. G.C.	18 hrs.

His immediate problem is to get his own men and the infantry working parties on to the job as soon as possible. Of these, the

infantry will probably take the longer, as they are not under his direct command. His first step, therefore, is directed to getting these on the move as soon as possible. He sends a message to the C.R.E. with the following text :—

> Require two inf. parties each 30 O.R. continuously for excavation mined charges GRANGE ROAD and CHURCH ST. Bridges AAA Sprs. PICK and RULE will meet reliefs at TOORAK HOTEL and CAPITOL BAKERY respectively at 1700 hrs. and four-hourly intervals thereafter AAA No tools required AAA 2 and 3 Secs. respectively should complete tasks by 1600 hrs. to-morrow.

8.—Working Party Demands.

(*M.F.W.*, 1925. App. 1.)

The C.R.E. on receipt of the messages requesting the supply of additional labour, compiles a *Working Party Demand* for transmission to 15th Infantry Brigade.

TO 15 Inf. Bde.
FROM Eng. 3 Div.

Please supply working parties as under :—

Serial.	*Unit.*	*Party.*		*Rendezvous.*			*Guide.*	*Tools.*	*Task.*	*Officer i/c Work.*	*Remarks.*
		Off.	*O.R.*	*Date*	*Time.*	*Place.*					
1			30	8	1700 hrs.	TOORAK HOTEL	Spr. Pick	*Nil.*	Excavation, GRANGE RD. Bridge.	Lieut. DEWAR, 10 Fd. Coy., A.E.	Time work 4 hours
2			30	8	1700 hrs.	CAPITOL BAKERY	Spr. Rule	*Nil.*	Excavation, CHURCH ST. Bridge.	Lieut. O'COURT, 10 Fd. Coy., A.E.	Ditto.
3			30	8	2100 hrs.		As for Serial 1.				
4			30	8	2100 hrs.		As for Serial 2.				
5			30	9	0100 hrs.		As for Serial 1.				
6			30	9	0100		As for Serial 2.				
							etc.				

Distribution—

Copy No. 1 15 Inf. Bde.
2 10 Fd. Coy.
3–4 War Diary.
5 File.

J. Walker, *Capt., A.E.*
Adjt. Eng. 3 Div.

The specimens given in *M.F.W.*, 1925, Apps. I and II of Working Party Demands and Instructions respectively, differ only in the most unimportant details. It is therefore suggested that an exactly similar *pro forma* should be used for both, and that the *pro forma* on page 205, which is that contained in *M.F.W.*, 1925, App. I, meets all requirements.

9.—INSTRUCTIONS TO UNIT PROVIDING WORKING PARTY.

On receipt of this demand, the infantry brigade issues orders to the battalions providing the working parties. These are normal operation orders in which the method paragraphs give the details of the parties, and to which are attached *instructions to the unit providing the working parties*. These instructions are made out on the same *pro forma* as used in the previous paragraph, but only one serial is dealt with in each instruction. Two copies, marked " A " and " B " respectively, of each instruction are made out by brigade, the former of which goes through battalions to the officer in charge of the working party, and the latter through C.R.E., Field Company Commander, and officer in charge of the work to the guide for the working party. Both copies are taken by the ultimate recipients to the *rendezvous*, where they are exchanged. This ensures that parties are met by the correct guides.

10.—FIELD COMPANY ORDERS.

Now to return to the commander of the 10th Field Company, who, when last mentioned, had just sent off his message asking for additional labour. He has now to write his company orders and they will probably take the following form :—

SECRET
COPY No. 1.
8 Aug., 35.

10 FD. COY. OPERATION ORDER No. 53.

REFERENCE MAP: RINGWOOD, 1 in. to 1 mile. (References on Australian graticule not shown.)

INFORMATION.

1. Reliable air reports up to 1500 hrs. show no enemy south of CRAIGIEBURN by 1300 hrs. to-day.
2. (*a*) 3 Div. is halting for night 8/9 Aug. south of R. YARRA, and taking up a defensive position between both incl. KOOYONG and RICHMOND covered by 4 Inf. Bde. north of R. YARRA.
   (*b*) 4 Fd. Coy. is under command of 4 Inf. Bde.; 15 Fd. Coy. is erecting 2 waterpoints in each 10 and 15 Inf. Bde. areas, with the bulk of the coy. in reserve near WHEATSHEAF HOTEL; 18 Fd. Park Coy. is continuing present location and task.

INTENTION.

3. 10 Fd. Coy. will prepare bridges over R. YARRA for complete demolition.

METHOD.

4. *Working Table.* App. I.
5. *Guides.* From 2 and 3 Secs. App. II.
6. *Interference with traffic* is not permitted.

ADMINISTRATIVE ARRANGEMENTS.

7. *Transport.* 2 and 3 Secs. will each provide one empty L.G.S. wagon to draw ammonal as shown in App. I, R.V. WINDSOR, R.S., midnight 8/9 Aug.; report there to 2 i/c.
8. *Explosives.* (*a*) 2 i/c will draw 1,400 lb. ammonal from 18 Fd. Park Coy. by 0100 hrs., 9 Aug.
   (*b*) 2 and 3 Secs. will each hand over to 1 and 4 Secs. respectively 140 lb. G.C. by 2300 hrs. to-night.

INTERCOMMUNICATION.

9. Coy. H.Q. remains TOORAK CAFE.
10. Progress reports will be forwarded from Secs. at 1800 hrs., 8 Aug., and at even clock hrs. till completion.

Issued to Sec. orderlies at 1500 hrs.
Distribution—
Copy No. 1—1 Sec.
2—2 Sec.
3—3 Sec.
4—4 Sec.
5—2 i/c.
6—File.

A. A. A. TREBLEA,
Major, A.E.
Comdg. 10 *Fd. Coy.*

SECRET
COPY No. 1.

APPENDIX I to 10 FD. COY. OPERATION ORDER No. 35, DATED 8 AUG., 35.

WORKING TABLE.

Unit.	*Location.*	*Task.*	*Extra Men.*	*Extra Explosive.*
1 Sec.	KOOYONG Rly. Bridge	Cutting booms	*Nil.*	140 lb. G.C. from 2 Sec.
2 Sec.	GRANGE RD. Bridge	Mining south Abutment	30 Inf. Continuous	700 lb. ammonal
3 Sec.	CHURCH ST. Bridge	Ditto	Ditto	Ditto
4 Sec.	RICHMOND Rly. Bridge	Cutting booms	*Nil*	140 lb. G.C. from 3 Sec.

All tasks to be completed by 1700 hrs., 9 Aug.
Distribution as for original order.

SECRET
COPY No. 1.

APPENDIX II TO 10 FD. COY. OPERATION ORDER No. 53, DATED 8 AUG. 35.

2 and 3 Secs. will provide Guides as follows :—

Serial.	*Unit to provide*	*Rendezvous.*			*Guide to be called.*	*To report on return*	
		Date.	*Time.*	*Place.*		*at*	*to*
1	2 Sec.	8	1700 hrs.	TOORAK HOTEL	Spr. PICK	GRANGE ROAD Bridge.	Lieut. DEWAR
2	3 Sec.	8	1700 hrs.	CAPITOL BAKERY	Spr. RULE	CHURCH STREET Bridge.	Lieut. O'COURT
3	2 Sec.	8	2100 hrs.	As	for Serial	1.	
4	3 Sec.	8	2100 hrs.	As	for Serial	2.	
5	2 Sec.	9	0100 hrs.	As	for Serial etc.	1.	

" B " copies of instructions to working parties with serial numbers corresponding with above attached hereto.
Distribution—
Copy No. 1—2 Sec.
2—3 Sec.
3—File.

11.—SECTION PLANS.

While a section subaltern can scarcely be expected in this case to write out a normal operation order, he must decide on a plan and should commit it to paper in order that it may be gone on with in case he becomes a casualty. Also his company commander will want to know what he intends doing, and to see whether the plan is reasonable, and whether any additional assistance should be given.

12.—ENGINEER APPRECIATIONS.

Lieut. Dewar, commanding 2 Section, gets his orders at 1520 hrs. He details an intelligent Sapper to act as guide, gives him his pseudonym and " B " copy of the instructions to the working party, and tells him to meet the infantry at the Toorak Hotel and to bring them back to the Grange Road Bridge. Then leaving the section to be brought along to the bridge, he rides off with a cyclist and makes a

reconnaissance of the job. This is followed by an appreciation which might take the following form :—

My *object* is to have this bridge prepared for complete demolition by 1700 hrs. to-morrow.

Time factor. Time now 1600 hrs. Expect 2 Sec. here by 1615 hrs. and inf. here by 1730 hrs.

Man-power. 40 working members in Sec. I may require all of them to-morrow, so will work small eng. reliefs to-night to direct inf. working parties in 4-hour shifts.

Type of work. Not possible to employ more than 6–8 men on excavation in ½-hour shifts.

Quantity of explosive appears right (calculation).

Earthwork. 700 lb. ammonal will require excavation, say 80 cu. ft. in chamber and 160 in drive. 15 cu. ft. per hr. is utmost that can be expected, so at least 16 hrs. excavation required.

Placing of explosive. Delivery should be complete by 0300 hrs. Placing should take 2 hrs. after completion of digging. Exploder, etc., should be tested while charge is being placed.

Tamping. 300 sandbags will have to be filled and placed, say 2 hrs. for this and 2 hrs. for remaining fill.

My plan will be as shown in the attached *Work Table.*

(In these notes consideration of courses open to both sides is not necessary.)

"Every appreciation should finish with an outline plan, which contains enough detail for orders to be written from it." An engineer appreciation is no exception to this, and the outline plan is contained in the work table. The latter is not intended to be a detailed working-party table, but is an analysis of the work. In making it out the sequence of work will be considered, so that any piece of work, the completion of which is essential before other work can be started, can be seen and put in hand and not delayed by less essential jobs. Amendments may be necessary from time to time, but there should be no need for them in a small clear-cut job such as this.

13.—Work Table.

(*M.E.* III, 57, 5.)

Item.	*Serial.*	*Quantity.*	*Men.*	*Hrs.*	*M.-H.*	*Hours after Z. Z time = 1630 hrs., 8 Aug., 35.* 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	*Remarks.*
Reconnaissance and setting out	A		6	1	6	6	Eng.
Guides for Inf.	B		1	5	5	1 1 1 1	Eng.
Supervision of Inf. digging	C		3	16	48	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	Eng.
Inf. digging	D	240 cu. ft.	30	16	480	30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30	Inf.
Drawing explosive	E	700 lb.	3	4	12	3 3 3 3	Eng.
Placing charge	F	700 lb.	6	2	12	6 6	Eng.
Filling sandbags	G	300	30	2	60	30 30	Inf.
Preparing leads and testing	H	400 yd.	6	2	12	6 6	Eng.
Placing sandbags	I	300	30	2	60	30 30	Inf.
Continuous testing	K		4	4	16	4 4 4 4	Eng.
Placing remaining tamping	L	90 cu. ft.	5	2	10	5 5	Eng.
		TOTALS			121	7 3 3 3 4 3 6 6 7 6 3 3 4 3 3 3 4 12 12 4 4 9 9 –	Eng.
					600	30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 – – –	Inf.

14.—Working-Party Tables.

(*M.E.* III, 57, *16.*)

Orders to sections are frequently, possibly generally, issued in the form of *working-party tables*, based on the work table, which apportion men to tasks by shifts. Having completed his work table and dispatched a copy to his company commander, Lieut. Dewar would make out a rough working-party table and dictate the substance of it to his N.C.O's at a conference at 1615 hrs. The notes for his working-party table might read like this:—

Date.	*Shift.*	*Time.*	*A.E.*		*Inf.*		*Serial.*	*Details.*
			N.C.O.	*O.R.*	*Off.*	*O.R.*		
8 Aug.	1	1630–1730 hrs.	3	3	–	–	A	Reconnaissance and setting out.
		1630–1730 hrs.	–	1	–	–	B1	Guide for Inf.
		1730–2030 hrs.	Sgt. RICH	2	–	–	C1	Supervision Inf.
		1730–2130 hrs.	–	–	1	30	D1	Digging.
	2	2030–2130 hrs.	–	1	–	–	B2	Guide for Inf.
8/9 „		2030–0030 hrs.	Cpl. THIN	2	–	–	C2	Supervision Inf.
		2130–0130 hrs.	–	–	1	30	D2	Digging.
			etc.					

15.—Chain of Command.

At this stage, with the Sappers preparing the bridge for demolition, it may be as well to conclude with a summary of the chain of command:—

(i) The Divisional Commander, after consultation with his C.R.E., decides on the Field Engineering Plan (paragraph 2).

(ii) The method paragraph in divisional orders apportions tasks in Field Engineering Plan to units both engineers and infantry (paragraphs 3–5).

(iii) Divisional Engineer orders allot tasks to Field Companies (paragraph 6).

(iv) Field Company Commanders make plans (paragraph 7), ask for working parties (paragraphs 8 and 9), and issue Field Company orders detailing sections to jobs (paragraph 10).

(v) Section Commanders make their appreciations and plans in the form of work tables (paragraphs 11–13). They then prepare detailed working-party tables (paragraph 14), which get the men on the job, and the field engineering plan is carried out.

THE COLLECTIVE TRAINING OF MOBILE A.A. SEARCHLIGHT UNITS.

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

I.—INTRODUCTION.

"The principles of war must be given full consideration in determining the action of a unit on the battlefield."*

TRAINING is preparation for the battlefield and must be conducted in accordance with these principles.

The *object* of searchlights is to find and illuminate hostile aircraft. They will stand or fall, in war, by their ability to do this. Obviously, then, anti-aircraft work must have absolute priority in their training. Other subjects, such as military engineering and trade training, are very important but must take second place if this object is to be attained.

Experience shows that, if the necessary standard of skill is to be reached, a minimum of 40 nights' training a year is essential. Allowing for all nights on which flying is impossible this will absorb four months of the training season.

Deducting a month for furlough we are left with seven months for other subjects which may be conveniently divided as follows :—

Military engineering	2 months.
Drill and weapon training	1½ ,,
Trade training	3½ ,,

As over 40 per cent. of the personnel of A.A. Searchlight Companies must be trained and exercised in both rifle and Lewis gun, weapon training takes longer than with most Sapper units.

To avoid staleness the anti-aircraft training must be broken up into periods not exceeding six weeks but, to avoid loss of skill, occasional practices should be carried out during periods allotted to other subjects.

A convenient division of the year is as follows. (Note.—This does not include Air Defence Brigade exercises or manœuvres.)

* *F.S.R. II.*

SUBJECT.	PERIOD.				TOTAL TIME.
A.A.	April to mid-May.	Mid-June to end July	Mid-Aug. to mid-Sept.		
Months	1½	1½	1		4
M.E.	Mid-May to Mid-June.		Mid-Sept. to Mid-Oct.		
Months	1		1		2
TRADE.			Mid-Oct. to Mid-Dec.	Jan. to Mid-Feb.	
Months			2	1½	3½
MIL. TRAINING AND W.T.				Mid-Feb. to end March.	
Months				1½	1½
LEAVE.		First half Aug.	Last half Dec.		
Months		½	½		1

The following remarks deal solely with anti-aircraft work since the training on other subjects differs in quantity alone from that in other units.

Individual and detachment training have been dealt with elsewhere.* The remarks which follow assume that detachments possess a reasonable standard of efficiency. But, it may be said, if detachments are efficient the target will be picked up and followed. What need, then, for collective training? This line of reasoning might have some justification in the case of large fixed defences. It has none when applied to mobile units.

In considering the defence of any area, the first point which we are bound to take into account is the extent of the area to be illuminated. This depends on the speed and height of the attacking aircraft. A determination of these factors is very difficult since the performance of aircraft is constantly improving. Assume, however, a speed of 240 miles an hour and a ceiling of 20,000 feet, which is not an overestimate even for existing types.

Assume also a vulnerable area of two miles' radius such as a base. The line of bomb release will then be about two miles outside the

* See Article on "The Individual Training of A.A. Units" (*R.E. Journal*, March, 1936).

edge of the vulnerable area. Now the gunners require 105 seconds (or, at this speed, seven miles) of illumination to hit the target.

Hence the line on which the target must be illuminated is 11 miles from the centre of the vulnerable area.

The areas which can be covered by units are approximately as follows :—

1 company	..	An area of radius	4 miles.
2 companies	..	,, ,, ,, ,,	6 ,,
3 ,,	..	,, ,, ,, ,,	8 ,,
4 ,,	..	,, ,, ,, ,,	10 ,,

So it is apparent that at least one four-company group is required to protect one vulnerable area.

2.—THE PRINCIPLE OF CONCENTRATION.

Now a searchlight group is an extremely large unit consisting, in war, of 1,379 men and 278 vehicles, excluding trailers.

It is unlikely that we shall have many of them. On the other hand, it is probable that there will be innumerable points which require protection. What are we to do? The temptation to divide our available resources between the points to be protected is very great, on the principle that half a loaf is better than no bread.

But, when lights are co-operating with guns, half a loaf is considerably worse than no bread. A layout of insufficient size will merely indicate the objective to the attacking aircraft without enabling the gunners to fire a single effective round. The reason is as follows. The gunners can only make the necessary predictions if the aeroplane flies on a straight course at a constant height for a certain time. Luckily this is exactly what the aeroplane must do in order to use the bomb sights; but immediately the bombs are dropped the pilot has perfect liberty of action and can dive and jink as he likes.

After that the chance of hitting him is remote. If, then, the necessary time of illumination of the target cannot be provided, it is better to have no lights at all. This does not apply when lights are co-operating with fighters since the latter can chase the target, whatever its manœuvres. All they require is an intersection of beams near the target.

At this point the reader may ask why night air defence is not left entirely to fighters. These, however, are only effective if they are in the air in sufficient numbers, at approximately the right height, at the time of a raid. To achieve this result either a prohibitive number of fighters must be locked up in defence, or sufficient warning of a raid must be obtained to enable them to take off and gain the height necessary to meet it. This condition demands a widespread observer system which is only possible in large fixed defences.

Hence, in the field, guns must generally be employed in preference to fighters.

From the above it will be seen why dissipation of force must be avoided and why concentration of the necessary number of lights at the vital point and time is essential. It is for the commander of the force to decide which *are* the vital points at the moment.

But how, it may again be asked, does all this affect the collective training of a searchlight group? The answer is that it is far more difficult and takes much longer to reconnoitre and occupy a large layout than a small one. Consequently it requires a great deal of practice which can only be carried out during the collective training season. Unfortunately, in peace, all sites must usually be reconnoitred long beforehand as agreements must be concluded with the landowners.

In these circumstances the occupation of a layout bears only the slightest resemblance to an operation of war. Realistic conditions, however, can be obtained when the Manœuvre Act is in force.

3.—The Principle of Economy of Force.

Anti-aircraft establishments contain only one relief, and men may have to work day and night with only the shortest periods of rest. Everything possible should therefore be done to economize their energy.

It is true that each searchlight detachment can cook for itself and, within limits, deal with its own administration. But if, when the situation permits, sections or companies can be concentrated, then guards, cooks and other administrative personnel will be saved, overhaul and repair of equipment will be facilitated, officers and dispatch riders will be spared many wearisome journeys, and the men will get more rest. During movement, on the other hand, long columns spell fatigue. So we get back to the old adage: Disperse to move. Concentrate to live.

Needless to say this alternation between dispersion and concentration demands great experience which, again, can only be acquired by constant practice during the collective training season. Without this experience, energy instead of being conserved is almost certain to be wasted.

4.—The Principle of Mobility.

It has been indicated above that lights must be concentrated for the defence of points which are of vital importance. But an area which is important to-day may be quite unimportant to-morrow. Searchlight units, in consequence, must be prepared to move from one area to another frequently and rapidly. Their inherent mobility

is, of course, very great. Given clear roads they can easily move 100 miles a day, while they carry enough petrol for three days' normal work. On the other hand, it is not always easy to exploit this mobility owing to congestion of the roads when movement is most required.

Take the situation of Amiens in March, 1918, as a case in point. This place was a bottle-neck through which the majority of reinforcements had to pass on their way to bolster up the line threatened by the German advance. Consequently, it was bombed day and night by the enemy. Under modern conditions such a place would quickly become impassable unless adequately defended. It would become a vital point to which air defence units would be compelled to move at a time when all roads were filled with other troops and traffic.

From this we see the necessity for training searchlight units to move rapidly on congested roads. This can only be effected by movement in small bodies which, experience shows, should not exceed a section in strength. Such bodies can worm their way through almost any traffic provided that they move at sufficient intervals, either laterally, or in depth, or both. The danger, in such circumstances, is loss of control.

Pre-arranged bounds must therefore be laid down on which control may be re-established.

A group, moving in this manner, consists of 20 columns, excluding group headquarters. These comprise :—

4 company headquarters, each of :—

1 four-seater car.
4 two-seater cars.
4 motor-cycles.
4 light lorries.
2 spare searchlight lorries.
1 workshop lorry.
1 stores lorry.

16 Sections, each of :—

2 two-seater cars.
3 motor-cycles.
1 light lorry.
6 searchlight lorries.

At first sight a company headquarters seems unwieldy. Actually the mechanists, in their 4 two-seater cars, with the workshop and store lorries, may be away with breakdowns, in which case the remainder of the columns will approximate in size to a section.

If true mobility depends, as it does, on control, the necessity for rapid and accurate transmission of information and orders is obvious. This, in turn, depends on the efficient organization and training of dispatch riders during the collective season, under conditions resembling, as closely as possible, those of war.

5.—The Principle of Co-operation.

The business of searchlight detachments is to illuminate the target, but there is some danger that they may forget for whose benefit they are working. Thus it is quite possible that a light, in its anxiety to pick up a target, may mask the only section of guns which can hit it.

Similarly, while three lights making a good intersection near, but not actually on, the target, may be quite sufficient indication for our fighters, a large number of lights, all searching for the target and making many different intersections, may be actually misleading.

Take, again, the question of plotting and height finding.

The Air Force require only rough indications but want them very early. The gunners want accurate heights, but only after the target has been illuminated. Here are two entirely different problems requiring, possibly, two different systems. Most of the collective training season, therefore, should be spent in actually co-operating with guns or fighters. Unfortunately a great part of it may be spent, through unavoidable circumstances, in co-operation with neither.

6.—The Principle of Security.

Every A.A. searchlight officer and N.C.O. should possess a copy of *Shockheaded Peter* and should read and re-read the story of Little Johnny Head-in-Air, who was so preoccupied with the sky that he walked into a river and was drowned. Searchlight units are often very like him. While posting sentries to watch the air, they may never give a thought to hostile armoured cars, rifle thieves, or ill-disposed persons generally who may be lurking on the ground. Nevertheless, every body of troops is responsible for its own protection, and the fact that it is an anti-aircraft unit does not excuse a company, section or detachment from making all possible provision for its own ground security.

The problem of security is very difficult when at rest, but not so difficult when on the move.

In the latter case a section can employ an advance guard and rearguard in the normal manner. A light six-wheeler and a motor-cyclist, for instance, form a very useful advance guard. Then again, each section has six Lewis guns, in addition to its rifles, and can easily carry up to 100 anti-tank mines, while each lorry should always

carry one or two coils of concertina wire. Hence, the establishment of road blocks, in case of attack, is an easy matter, provided that the men know what to do and are constantly practised in doing it. Generally speaking, sections are taught that, in case of attack, the advance guard lorry will be slewed across the road while its crew scatter on both sides and open fire. On the alarm being given, remaining lorries are drawn up to block the road while the crews act in the same way as the advance guard, leaving, however, one detachment to block and watch the road in rear. At least one detachment tries to work round with mines or wire to block the road behind the enemy. The whole operation is offensive in character. Men require constant practice in this form of action, but can be brought up to a very high degree of skill. The rapid scattering is the great point, since a scattered section presents a very poor target to the machine-guns of an A.F.V. while, on the other hand, the A.F.V. serves as an excellent target for the converging fire of the section.

It is quite realized that this fire may not be able to put the A.F.V. out of action, but it will be quite sufficient to make matters extremely unpleasant. It is probable that the lorries and equipment will suffer, but in war these are more easily replaced than trained personnel.

Moving fast and in small packets, a searchlight unit does not offer a very obvious or, indeed, a very attractive, target to low-flying attack. Moreover, with its large number of anti-aircraft Lewis guns—26 per company—the unit can hit back vigorously. Mountings for the guns on the lorries and look-out men are, therefore, all that are required.

At rest, the picture is different. In this case the unit may be spread over the country in small detachments at intervals of two miles, while each detachment in action is itself spread over an area of some 300 yards by 100 yards. In these conditions it is intensely vulnerable and is impossible to protect without an escort of prohibitive size.

The only remedy would seem to lie in concentration and concealment. Sections should not, therefore, remain dispersed when they are not actually required to use their lights. During the hours of daylight they should concentrate in *rendezvous*, preferably well off the main roads and, whenever possible, in woods. Here they will be inconspicuous both from the ground and the air. Being concentrated, they will be far more defensible and will also be in a position to conserve their energy as shown above when discussing economy of force. Detachments should leave the *rendezvous* and proceed to their positions as short a time as possible before dark. By doing this they will make it difficult for any ill-disposed persons to reconnoitre their positions by daylight in preparation for a night raid. While in position they should do everything possible by way of trip wires, alarms and snares to provide for their own protection.

Cunning detachment commanders can effect a very great deal in this direction.

No amount of talking or lecturing will ever teach protection. Only experience can do this. During training, a body of ill-disposed persons equipped with "mock-up" A.F.V's should always be provided to keep companies "on their toes." A certain amount of levity may be introduced in the general and special ideas dealing with their activities, which, if light-heartedly organized, can not only produce extremely useful results but also add considerably to the gaiety of training.

During 1935 these methods were largely introduced into company work. As the identity of the ill-disposed persons was always uncertain everyone lived and worked in an atmosphere of suspicion which would have been worthy of Venice in its worst days. But the result on the men was surprising. It was almost impossible to get near a detachment without falling into wire, tripping over strings or being hit with a lump of firewood thrown from a spring gun. In fact the business of conducting distinguished visitors round the lights became most hazardous. The situation in one case was complicated by the fact that the company had been given a "Princess" to guard. An "ill-disposed person" actually got himself posted as a sentry over this lady, but so heavily was she chained to a tent pole, that he could only kidnap her hand. This was duly served up to the C.O. with suitably insulting messages, at his early morning tea. Subsequently the Princess was whisked from detachment to detachment in an effort to conceal her whereabouts, and the shocked inhabitants of a South Coast watering-place beheld a company commander, at 10 o'clock at night, driving an Austin Seven through the town while clasping a rakish-looking lady round the waist. The local padre must also have feared the worst when, on paying a visit to a neighbouring detachment, he was firmly repelled from a tent within which he most clearly discerned the flutter of feminine draperies. But the fairy tale of "F" Company, the Princess, and the ill-disposed persons, if written at all, must be written elsewhere.

7.—The Principles of Surprise and Offensive Action.

Since anti-aircraft searchlights are essentially defensive in character, it would not appear that these principles could find any place in their work; but they do. It must be remembered that the crews of hostile aircraft dislike being shot at as much as most of us. Consequently they will try by all means in their power to avoid detection. They may attempt many kinds of manœuvre.

One method is for several planes to enter the illuminated area on the same course at comparatively short intervals in the hope that there will not be sufficient lights within range of that particular

course to engage them all. Again an attack may be made by a formation of several machines staggered in height, so that the lower machines may attract the attention of listeners while those above slip through unseen.

Probably the favourite method is an attack by gliding. But in this the aircraft may be on the horns of a dilemma. If he starts to glide too late he will be picked up and followed by the sound locators. If he starts too soon he may find that he has lost too much height by the time he gets over the lights, since he must expect to drop about 1,000 feet per mile.

It must be remembered that even gliding aircraft make some noise, but it is often so faint that it may pass unnoticed unless the presence of a target is suspected.

The danger of being heard before the glide commences may be avoided by employing another machine to fly up and down on full throttle just beyond the range of the lights. The gliding attack is then launched through, and under cover of, its noise, and this may create a very difficult situation for the lights.

All this, however, assumes that the enemy knows the exact position of the lighted area.

Bearing in mind the principles under discussion, the lights should see that he knows *no* such thing. In fact the lights, like everyone else, must try to mystify and mislead the enemy. Here is one way of doing this. Given a four-company lay-out, thin the inner lights until one section per company can be taken into reserve. Use these sections to expand and contract the outer edge of the lay-out. Suppose, for instance, that on the first night they are placed in front of the outer edge which is thereby pushed out for four miles or more. Aircraft will determine to start gliding, say, about four miles or more before reaching this edge. On the second night these sections are brought in and used to stiffen up the original outer edge, leaving, possibly, a few lights out to act as sentries and to confuse the enemy, who may then start gliding some eight miles from the outer edge and may have dropped 8,000 feet before reaching it. On the next night all four sections may be employed on one side of a lay-out and on the next night somewhere else, and so on.

The whole point is that the enemy, not knowing when he may encounter the defences, cannot calculate where to begin his glide. He will probably start too soon or too late and in either case will be easy meat.

The whole attitude of the defences must thus be offensive and surprise must be exploited to the utmost. A spider in its web should be the crest of the Anti-Aircraft Searchlight Companies.

It follows that all air defence work is a battle of wits between the defenders and the attacking squadrons. But wits are best sharpened by experience. Hence, in training, the actual conditions of war must

be reproduced on both sides to the greatest possible extent. In the early stages of training, or with new types of aircraft, fixed and predetermined courses for co-operating machines, flying between fixed and limited hours, is valuable, but real training consists in fixing a vulnerable point and in giving co-operating squadrons a completely free hand to attack it in any way and at any time of the night they choose. If the R.A.F. can be persuaded to place a camera obscura near the vulnerable point, and if the attacking machines fire a light to indicate bomb release, the results can be calculated and interest and value will be added to the work of both sides

8.—Conclusions.

We thus come to the following conclusions about the anti-aircraft collective training of mobile Searchlight Units :—

(*a*) *Duration.*—Four months—or 40 nights' work—should be allotted to this subject every year, divided into periods of not more than six weeks' duration. Occasional periods of work, either against aircraft or indoors on individual training appliances, are necessary at other times to keep detachments in training.

(*b*) *Type.*—Practice in peace must approximate as closely as possible to war conditions as regards the size of lay-outs, the conditions under which they are occupied, the performance of the target aircraft and methods of attack.

(*c*) *Co-operation with other Arms.*—The training of Searchlight Units should be carried out in co-operation with the guns and fighters with which they may have to co-operate in war. This is necessary to enable the Searchlight personnel to acquire a thorough knowledge of the differing requirements of each. But further, air defence, including searchlights, should be included in all big tactical exercises or manœuvres, to enable commanders and staffs to practise making decisions as regards the areas to be defended and to enable them to acquire practical experience as to the time required to give effect to their decisions and as to the possible difficulties which may be encountered.

(*d*) *Movement.*—Searchlight Units have great natural mobility which must be practised as much as possible, in order that effect may be given without delay to the decision of the commanders as regards points which are vital at the moment. These points may vary from day to day. Hence the areas in which training is taking place must also be varied as constantly as possible, and movement from area

to area must be made under war conditions. As an example a Group carried out training in the one year in the Aldershot area, Somerset, Essex, Kent, East Sussex, West Sussex and Hampshire. To provide for mobility and security against attack by A.F.V's and low-flying aircraft, movement must be practised as follows:—Small bodies, moving widely separated, either in interval or distance or both, by controlled bounds, from concealed *rendezvous* to concealed *rendezvous*. Wherever possible this movement should be made when roads are congested either with troops or civilian traffic. A move round the outskirts of London on Sunday or Bank Holiday is excellent practice.

(*e*) *Security.*—Searchlight Units are naturally vulnerable and, therefore, the greatest attention should be paid to training in security. Constant raids, gas attacks, alarms and excursions should be made on companies under training in order to accustom them to worse-than-war conditions. Experience shows that such training even improves the searchlight work of detachments.

(*f*) *Surprise.*—Training should seldom be of a stereotyped nature. Squadrons providing target machines should be encouraged to do everything they can to outwit the lights and every effort, on the other hand, should be made to outwit the aircraft. War, after all, is nearly always a matter of brain *versus* brain and this applies to anti-aircraft searchlights as much as to any other part of the fighting forces.

(*g*) *General.*—The great point in the training of Searchlight Units is to keep the personnel constantly on the alert. If no one knows when he is going to be raided, or gassed, or attacked from the air, or ordered to move 50 miles at short notice, and yet if everyone is prepared for all or any of these emergencies, then there is a fair chance that a reasonable degree of efficiency will have been attained. Nevertheless, let us end as we began by remembering that the object of Anti-Aircraft Units is to illuminate hostile aircraft.

THE KINCARDINE-ON-FORTH ROAD BRIDGE.

By CAPTAIN S. A. STEWART, R.E.

Consulting Engineers—Sir Alexander Gibb and Partners.
Contractors—The Cleveland Bridge and Engineering Co., Ltd.
Estimated cost—Bridge and approaches, £280,000.

INTRODUCTION.

As the major part of a construction course the writer has been lucky enough to be spending about 18 months acting as an assistant engineer on the staff of Sir Alexander Gibb and Partners, at the construction of the new road bridge across the River Forth at Kincardine.

He would like here to thank the firm very much for the way in which they have afforded him full facilities at the job, and especially for allowing him to take an executive part in carrying it out.

The work is part of the unemployment relief scheme of the counties of Fife, Stirling and Clackmannan, who provide 25% of the cost, the remainder being provided by the Road Fund. Contractors have to guarantee to employ at least 75% local labour.

Work started in January, 1934, and should have been completed by December, 1935. Owing to various difficulties, however, which will be described in due course, it is unlikely that it will actually be completed before August, 1936.

SELECTION OF KINCARDINE.

A sketch map showing the position of Kincardine relative to neighbouring towns is shown in Fig. 1 overleaf.

It will be seen that it is situated at the first relatively narrow neck west of the present Forth Bridge, the river between the two sites having an average width of 2—3 miles. The ideal site for a road bridge from the traffic point of view is of course near the Forth Bridge, but the cost of such an undertaking would be at least £4,000,000. Although the gap is only 1¼ miles wide, the depth of the channel (60 fathoms) would necessitate the use of very large spans, with consequent high cost. It is even said that the main channel under the Forth Bridge is the deepest part of the North Sea.

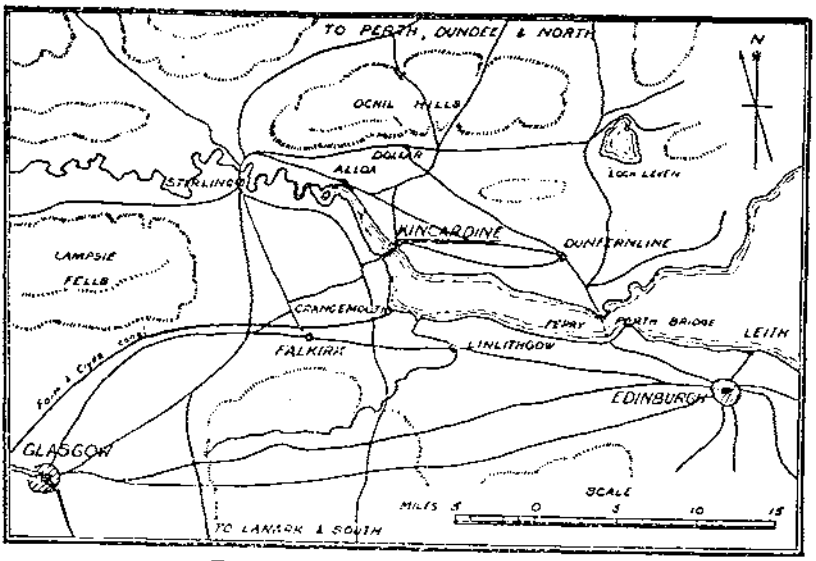


FIG. 1.—The Forth, showing roads.

The Kincardine site is the most easterly available consistent with keeping the cost below £300,000. It will be seen that it reduces the distance between Edinburgh and Dunfermline from 57 to 37 miles, and also provides an outlet to the north for Glasgow which avoids the bad traffic bottle-neck of Stirling.

There is a vehicle ferry alongside the Forth Bridge, but this gives a somewhat expensive half-hourly service, and even to-day people drive round by Stirling to avoid it. The Kincardine bridge will cut some 20 miles off this loop.

It now seems possible that the question of constructing a bridge in the vicinity of the Forth Bridge is to be re-opened, in which case the Kincardine bridge will lose a considerable proportion of its present value. It will, however, have given work for over two years to some 160 local unemployed, and it is well known that one cannot have too many bridges.

Until recent years the Kincardine site has been regarded as impracticable for bridging, owing to the difficulty of obtaining a good foundation on the south side.

THE SITE.

General.

The Firth of Forth at Kincardine is 1,800 ft. wide at ordinary high tides, but on the south side there are a further 1,200 ft. of saltings which are covered at extreme springs. The depth of water in the centre is 35 ft. at high tide.

The line of bridge on the north side is opposite the middle of Kincardine village, and the L.N.E.R. has to be crossed at Kincardine

Station. The effect of this is to raise the north end of the bridge to give the required headroom, and a high embankment has to be made to carry the north approach road.

On the south side the country is flat, and a few scattered farms provide the only inhabitants.

The site is the same as that chosen for Forth crossing of the electricity grid line, which is carried by two 360-ft. towers and under which the bridge actually passes.

Tides.

The tides are somewhat violent in character. Normal spring rise and fall is 19 ft., but 24 ft. has been known on occasions. The current reaches five knots both in and out, and the water rises an inch a minute at half-tide. There are also dangerous cross-currents caused by sandbanks, and latterly increased by the stagings and coffer-dams of the bridge.

River Traffic.

There is little traffic on this part of the Forth. About six tramp steamers pass in a week, going to and from the port of Alloa, and occasionally to Stirling. The largest of these is about 1,300 tons.

Owing to the above-mentioned tidal conditions, however, it has been necessary to construct in the bridge a very large swing span. The total length of the girder is 364 ft. and when in the open position will provide two 150-ft. clear channels. It will be one of the largest swing spans in the world.

The river traffic, small as it is, hinders the construction of the bridge a good deal. The temporary staging cannot completely cross the river, a gap of 150 ft. having to be left permanently clear. The swing span also has to be erected in the open position.

A mishap even occurred during the construction of the staging when the gap was fully 250 ft. wide. At about 4 a.m. on 10.2.35 the S.S. *Bovey Tracey* (612 tons, London to Alloa) missed the gap, which was fully lighted, and crashed into the staging. A crane was half brought down, timber piles were snapped off in all directions, and innumerable stores, among them a pile-driving hammer, went to the bottom.

The ship suffered little damage, but work on the staging was set back about two months; luckily no permanent work was affected.

Geology of the Site.

For some of the foundations sandstone rock is available at depths of −20 to −35 O.D. The rock runs at this level from the north side to the middle of the river, at which point a "fault" occurs; here it drops steeply away to a depth of some hundreds of feet, and is covered by soft muddy clay, with belts of gravel and boulder clay. Thus the southern half of the bridge has to be founded on piles.

This information was obtained from a series of boreholes, put down before the bridge was designed.

Approaches.

The roadwork in connection with the scheme consists of the following :—

(*a*) A new north approach road 1,600 ft. long through Kincardine village, involving certain demolitions, but keeping as far as possible to gardens.

(*b*) A new road 2,000 ft. long by-passing the village and connecting with the north approach road.

(*c*) A new road 6,500 ft. long connecting the south end of the bridge with the main road running east and west from Stirling to Grangemouth and Edinburgh.

The cost of this roadwork is, approximately, £35,000.

General Description of Bridge.

Design.

A drawing showing most of the salient features of the work appears at the end of this article.

The bridge, which is one of the longest road bridges in this country, may be described as a multi-span structure, of overall length 2,696 ft., the main portion consisting of fourteen 100-ft. steel spans supported on concrete piers. At the centre is a swing span 364 ft. long which swings about a central pivot, and consists of a " through " Warren type girder, the bottom chord of which is 30 ft. above high water. There are seven 100-ft. spans on either side of this swing span.

On the north side there are in addition three 62 ft. 6 in. steel approach spans which cross the L.N.E.R. and sidings at Kincardine Station.

On the south side there are nine 50-ft. reinforced-concrete approach spans and a 260-ft. piled viaduct (concrete) which cross the saltings.

The roadway is 30 ft. wide with two 5-ft. footpaths.

A large permanent timber dolphin 420 ft. by 50 ft. extends up and down stream from the centre pier to protect the swing span when in the open position, and to form a landing stage for small vessels.

Loads.

In common with modern highway practice, the bridge is designed for the new Ministry of Transport standard loading which now replaces the " standard train." This has been worked out in the form of a uniformly distributed dead load, depending on the span, plus a concentrated load applied at the worst point—a form which saves many calculations.

In this case the loading is 208 lb./sq. ft. for the 100-ft. spans, plus a concentrated load of 2,700 lb./ft. applied across the bridge at the worst point.

These figures are roughly twice as large as those caused by the heavy (unrestricted) class of military loading.

Foundations and Piers.

Design of 100-ft. Span Piers.

A pier consists of two reinforced-concrete columns at 29-ft. centres, joined by a reinforced-concrete portal beam. The underwater parts of the columns are cylindrical, 14 ft. 6 in. diam., and the upper parts taper to 8 ft. diam. at the tops.

The portal beam is arched, 4 ft. 6 in. wide, 6 ft. deep at the centre and is heavily reinforced. The sole reinforcement in the columns is a circle of vertical $\frac{3}{4}$-in. diam. bars near the outside, spaced by horizontal rings at intervals.

Concrete in the portal beams and cylindrical bases is $1\frac{1}{2} : 2 : 4$. In the tapering parts of the columns, the outside 9 in. containing the steel is 1 : 1 : 2, and the centre is mass concrete 1 : 3 : 6.

The whole pier is cast in welded steel shuttering, which has the advantage of cheapness, lightness, rigidity, and absence of laps and rivet heads to interfere with the concrete face. In fact welding appears to be the ideal form of construction for shuttering, especially in cases such as this, where there is considerable repetition of curved and tapering work, notoriously difficult to do neatly in timber.

Piers are of two kinds :—

(*a*) Those founded on rock on the north side.

(*b*) Those founded on groups of piles on the south side.

Methods of placing Pier Foundations on Rock.

(*a*) *In open steel wells.* The original intention was that a 14 ft. 6 in. diam. steel cylinder should be sunk in the ground, and the water pumped out of it. Excavation was then to proceed inside it until rock was reached. In practice, however, it was found that the ground overlying the rock was of insufficient density to prevent the cylinder from "blowing," *i.e.*, water entering with a rush from underneath.

Three pier foundations were actually placed in this manner, but as the depth increased, the "blows" increased in frequency and violence, and the method was finally abandoned.

(*b*) *Under compressed air.* The remaining piers on the north side were successfully sunk to rock under compressed air, the existing cylinders being adapted for the purpose.

A cone-shaped plate was fitted across the cylinder near the bottom, forming a working chamber, and an access shaft was bolted to it. Working in this chamber under air pressure, men were able to sink

the cylinder to rock, the spoil being passed out through the air lock. When excavation was complete, four feet of concrete were placed on the bottom and allowed to set under air pressure. This formed an effective seal so that the air, etc., could be taken off and the remaining concrete placed in the open. The full sequence of operations is shown in Fig. 2.

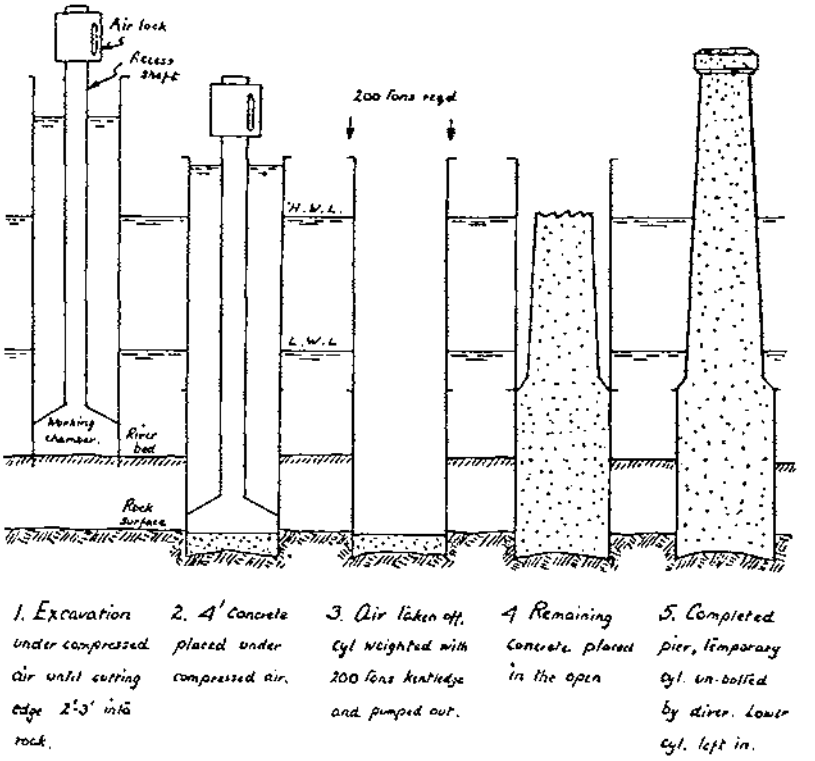


FIG. 2.

The chief disadvantage of this method is that large quantities of kentledge are required to sink the caisson. In stages 1—2 most of this can be provided by filling the space between air shaft and cylinder with water. In stage 3, however, some means has to be provided for applying about 200 tons to the top edge of the cylinder. This was actually carried out by weighting with large cylinders of sand, bundles of rails, etc., but the process was very laborious.

The method was later improved upon for the swing span foundations.

A difficulty that occurred on one occasion was caused by a large boulder (about 2 cu. yds.) which was found to be under the cutting edge when a cylinder was lowered. This kept it some four feet from the ground, and no men could stand in the working chamber owing to the depth of water. Men standing on a short ladder were, how-

ever, able to drill a hole in it and place a gelignite charge. The cylinder was then floated up a few feet and the charge fired. On lowering again no obstruction was felt, and it was found that the boulder had been split in half, one half being trapped inside the chamber—a most successful demolition. It was left as a large " plum " in the base concrete.

Method of placing Pier Foundations on Piles.

As a result of driving test piles in various positions, it was decided to use 18 in. by 18 in. reinforced-concrete piles to support the 100-ft. span piers on the south side. The standard length of these was 55 ft., but some 65 ft. long were cast for use in soft places. The specified " set " was 1 in. for six blows of a 5-ton hammer falling 3 ft. 9 in. (4 ft. 3 in. for a 65-ft. pile).

The 100-ft. span piers were each placed upon nine of these piles, arranged as four verticals and five rakers at 12/1, to give additional stability. The bottom of the solid portion of the pier was designed to be 10 ft. below ground level.

The sequence of sinking a foundation is shown in Fig. 3.

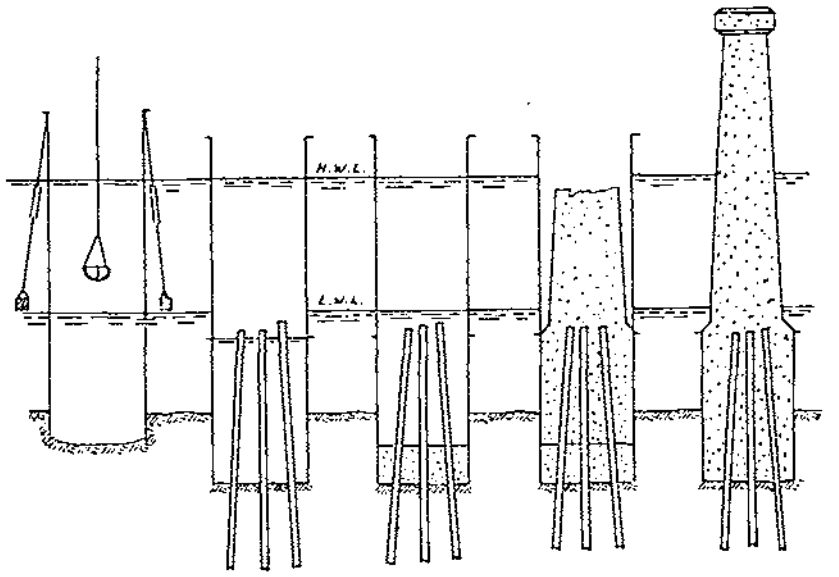


FIG. 3.

When watching a pile being driven for the first time it seemed difficult to believe that a set would ever be obtained. The pile first

sank about 12 ft. under its own weight, and then a further 6 ft. when the hammer was lowered on to it. For the next 20 ft. it drove at 6 in. to 1 ft. per blow. At about 40 ft. penetration it began to pull up, and suddenly, when the point entered the bed of gravel, it began to drive quite hard. In practically every case the specified set, or better, was obtained; in some cases it was as low as $\frac{3}{8}$ in. for six blows.

The under-water concrete was deposited from bottom-opening skips, which open themselves on reaching the ground. A point to note, however, in using concrete placed through water in muddy situations, is that a good proportion of it becomes soft "slurry," and never sets at all. In this case about 30% of each plug had to be shovelled out again when the cylinder was pumped out, being quite useless as concrete. Luckily enough of it had set to enable the cylinder to be pumped dry with safety. Without this plug the cylinder would only stand a head of about 10 ft. without blowing. This was just enough to enable the piles which went lowest to be driven at low water.

SWING SPAN PIERS.

Main Centre Pivot Pier.

The weight to be carried by the foundations of this pier was about 5,000 tons (1,600 tons swing span and 3,400 tons weight of pier itself). Fortunately rock was available and the pier was originally designed to have a solid base 46 ft. diam. founded on it. The intention was to drive a coffer-dam and carry out the excavation and concreting in the open. Unfortunately, whenever an attempt was made to pump out the dam, a blow occurred. All the usual "aids" were tried, but were of no avail.

The reason for this was subsequently discovered when the dam was withdrawn. The sheet piles had been driven too hard against the rock and the last few feet had buckled and twisted in all directions. These piles should have been of thicker section.

The design of the pier was therefore altered to enable it to be founded under compressed air. It was made to stand on six "legs," each leg consisting of a 14 ft. 6 in. diam. cylinder (similar to the 100-ft. span pier bases), filled with concrete. The tops of the legs were joined together at a level of -12 ft. O.D. by a solid concrete base 4 ft. thick, from which sprang the main wall of the pier. The coffer-dam could just be pumped down to this level with safety.

The legs were sunk to rock under compressed air inside the coffer-dam, in a somewhat similar manner to the 100-ft. span piers already described, but in order to avoid the 200 tons of kentledge already mentioned, a slight alteration was made. The cylinders were filled solid with concrete except for the access shaft and working chamber, and were lowered to the bottom on jacks. Thus they had enough

weight to sink themselves and very little concrete had to be added once the foundation level was reached.

The pier itself consisted of a hollow concrete cylinder 42 ft. diam., with walls 5 ft. thick. The top was roofed over with a concrete slab, supported on concrete beams, but this roof only serves to support the main pintle. The actual weight of the swing span is carried by the roller path, which is directly over the circular wall of the pier.

The roller path (36 ft. 9⅝ in. diam.) was carried on a circular grillage joist set in the concrete. This latter was set level to within 1/16 in., and the roller path was levelled finally upon this by 48 pairs of folding wedges. This accurate levelling was done with a Watts precise level, set up at the centre and reading on a steel rule graduated in 64ths. The level was placed very low down and only about 2 in. of rule were utilized as the staff. In this way the roller path was finally levelled to within ·01 in. A further test was applied as follows :—

A wall of putty was laid round the outer (and lower) edge of the roller path, and water was placed upon the sloping face until it just reached the scribed centre line. It was, however, difficult to determine where the water line actually was, owing to surface tension, etc., and it was considered finally that this method was no more accurate than the other.

The correct cross-fall was obtained with an accurate engineer's spirit level reading in thousandths, laid upon a piece of metal cut to the correct slope. This cross-fall was finally corrected to within ·002 in. The roller path was centred and made truly circular with a specially made pair of trammel dividers (18 ft. 4$\frac{13}{16}$ in. radius) from a centre mark on the pier.

The track itself was composed of 16 sections of steel casting, made by Sir William Arrol and Co., who machined it on a special vertical lathe.

End Piers for Swing Span.

These piers form a bearing for the ends of the main girder when in the closed position, and also incorporate large ornamental concrete pylons and an archway over the road containing the safety gates. They also house the wedging and locking gear.

The north end pier is founded on rock on two 21-ft. diam. "legs" sunk under compressed air in a similar manner to those for the centre pier. The two legs join below low water to form an apparently solid pier (actually hollow, with 5-ft. walls). This was carried out as before, in a partially de-watered coffer-dam.

The south end pier, although outwardly identical with the north, is founded on 76 reinforced concrete piles 40 ft. long, driven to rock, which at this point is some 30 ft. deeper than before. The nature

of the ground overlying the rock makes a coffer-dam possible, but it has been decided not to risk pumping it completely dry. The intention is to form the base of the pier on similar lines to the other south side piers, *i.e.*, excavate with grab, drive piles, and place 4 ft. of concrete through water. Then it is to be hoped that the dam can be safely pumped out and the remaining concrete placed in the dry. At the time of writing, however, this pier has not got farther than the pile-driving stage.

Each pier involves some 4,000 tons of concrete, which is poured in welded steel shuttering.

STEEL SPANS.

Design.

Each 100-ft. steel span consists of six built-up I-section girders. These girders are 9 ft. deep at the piers, and reduce to 5 ft. deep at the centres of spans.

Alternate spans are continuous over two piers, the bays between them consisting of girders "suspended" from the cantilever ends, as in Fig. 4.

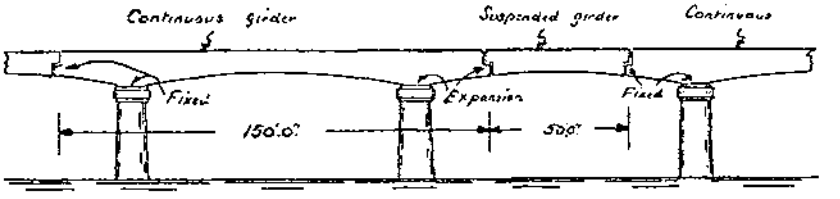


FIG. 4.

The advantages of this arrangement are as follows:—

(*a*) Maximum bending moment reduced, saving weight.
(*b*) Increased headroom provided for small fishing boats.
(*c*) Construction of expansion joints facilitated.
(*d*) Improved appearance.

The girders are braced together by angles, and rest on cast-iron bearing plates grouted into recesses in the tops of the piers. A $\frac{3}{8}$-in. phosphor-bronze plate forms the actual bearing surface, and four holding-down bolts concreted into the pier pass through bearing plate and girder flange. For fixed joints, holes are provided in the girder, and for expansion joints, slots. These slots allow $\frac{3}{4}$-in. movement in either direction.

The suspended girders rest on cast-steel rocker bearings, those at one end incorporating an expansion joint which allows $1\frac{1}{2}$-in. movement in either direction.

It is interesting to note that the change in length in the whole bridge is approx. 11 in. for 50 degrees change of temperature. This amount is distributed between 18 expansion joints. The actual

joint in the road surface is formed by two toothed steel castings running across the road, which slide in and out of mesh with each other.

The concrete deck (8 in. thick at centre) is supported on steel buckle plates, riveted to the upper flanges of the girders.

Method of Erection.

For convenience of transport and erection, each continuous girder arrived (by rail) in three 50-ft. lengths. The weight of the heaviest (pier) portion was 9 tons, which enabled it to be handled by two 5-ton loco. cranes. The trucks could be run out on the staging on the north side, and the girders lifted off them direct on to the piers. The girders for the south side had to be ferried across the river on pontoons.

The loco. cranes, however, could do no more than place girders on to one end of the piers. Those farthest away were therefore hoisted up first, and rolled across to their final positions on steel balls running on a special roller track.

The method adopted was to hoist the two pier portions of a girder up and support their ends temporarily on trestles. The centre portion was then hoisted between them, and the construction joints bolted up. Two girders were assembled side by side in this way and braced together; this formed a rigid member weighing about 55 tons, which was easily rolled over to its correct position by a man with a " Sylvester " jack, working on each pier.

On reaching their final position, the girders were raised by hydraulic jacks for the roller path to be withdrawn, and then lowered on to the bed-plates. To the relief of those responsible for the setting out, all girders have so far fitted the pier spacing well—the expansion joints being central at normal temperature.

When the girders were at their correct level and position, the construction bolts were replaced by rivets, and the bed-plates were grouted up.

Before dispatch from the contractors' works at Darlington, all the steelwork had been assembled and marked, and so far there has been no difficulty in assembling it on the site.

50-ft. Reinforced-Concrete Spans.

Design.

Each bay of the 50-ft. spans consisted of five main arched beams, cast integrally with a 10-in. road slab. These beams were 6 ft. 6 in. deep at the haunches and 4 ft. 6 in. at centres of spans.

The expansion joints are arranged every three bays. Three spans are cast in one piece, and one end is rigidly secured to a pier by reinforcing splice bars. On the next three piers this continuous 150-ft. beam rests on a sliding bearing, the third pier at the same time

being rigidly attached to the next three spans. Thus an expansion joint is formed over every third pier.

The piers for these spans are a smaller edition of those for the 100-ft. spans, each pier leg being supported on six 16 in. x 16 in. x 55 ft. reinforced-concrete piles. In some cases where a soft patch was encountered and the specified set difficult to obtain, two extra piles were driven in the foundation. All piers were above neap tide high water mark, and presented little difficulty in construction, other than that caused by the deep and unpleasant mud of the saltings.

A minor difficulty was that this mud was of a very shifting nature, and even 6-ft. pegs driven into it would not stay where they were put. The staging varied in level as much as four inches when cranes moved on it, and it did not remain in the same identical position for long. Thus all setting out had to be done only just before it was required, using as far as possible the permanent concrete of the bridge as a basis.

Shuttering.

The beams were formed of 1 : 2 : 4 concrete poured in welded steel shuttering. Originally it was intended to cast beams and slab in one piece, but this method was abandoned owing to the difficulty of stripping the beam shutters. Each shutter weighed over four tons, and became more or less inaccessible once the slab was in place.

The method therefore adopted was to cast the beams first and strip the shutters. The slab shuttering (timber) was then supported on timber runners bolted to the sides of the beams, through holes left for the purpose in the concrete.

PILED VIADUCT.

Design.

The piled viaduct was constructed on bents of three 18 in. x 18 in. x 65 ft. piles, spacing of bents being 10 ft. A reinforced-concrete beam was placed across the tops of the three piles and was cast integrally with the 10 in. deep road slab.

A double bent of piles was driven every 52 ft., carrying a beam of double width, which embodied an expansion joint. Half of this beam was rigidly attached to one bay of deck, while the other half formed a shelf upon which the next bay could slide. The sliding surfaces were separated by bitumen solution.

All beam and deck concrete was 1 : 2 : 4.

Construction.

The piles were cast on the site in timber moulds. They were made of 1 : 1 : 2 concrete, using rapid-hardening cement, and weighed nearly 11 tons each. Minimum time before driving was 10 days, but this was usually greatly exceeded.

Air lock at top of compressed air caisson. North side piers.

Assembling steel pier shuttering.

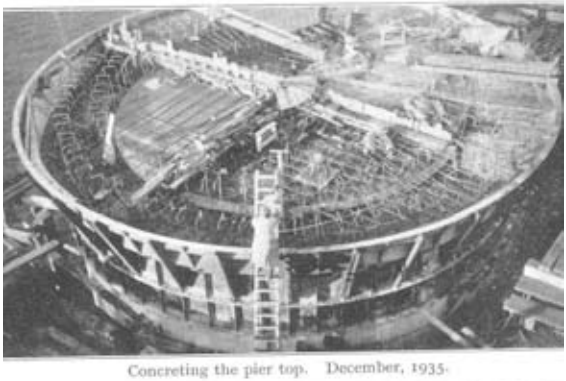
The first pair of girders (55 tons) ready for rolling into position on piers.

Kincardine-on-Forth road bridge - Air lock at top of compres

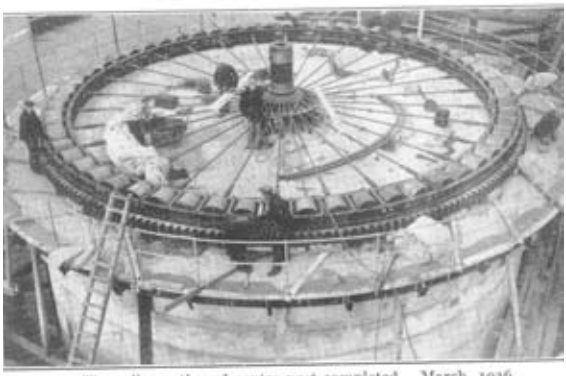
The 364-ft. swing span erected in the contractors' yard at Darlington.

Kincardine-on-Forth road bridge - The 364 - ft swing span

The centre pier from the south end pier. December, 1935.



Concreting the pier top. December, 1935.



The roller path and centre post completed. March, 1936.

Kincardine-on-Forth road bridge - The roller path and centre

Most of them reached the specified set (1 in. for six 21 ft./ton blows) in a bed of gravel at about –45 ft. O.D. One or two drove through this and had to be lengthened *in situ*: they then reached a set at about –68 ft. O.D. This is the greatest depth that has been reached by any part of the bridge.

The whole of the shuttering for the piled viaduct was of timber, and calls for little comment.

The Swing Span.

Although at the time of writing (March, 1936) there is little of the swing span erected above the roller path, some details of its construction may be mentioned. The dimensions of the girder are: Length 364 ft., width 44 ft., height 54 ft., and weight 1,600 tons.

It consists of two Warren type girders with the roadway passing between them. It is swung about a central pivot, and leaves two 150-ft. clear channels when open. It is carried by 60 cast-steel rollers each weighing 15 cwt., and is operated electrically by two 2 ft. diam. pinions running round a rack. The shafts transmitting the final drive to these pinions are 9½ in. diam.

The sequence of opening the bridge is as follows:—

(*a*) Put signals at danger, ring warning gongs, and close safety gates.
(*b*) Withdraw wedges (hydraulic operated), thus freeing ends of girder.
(*c*) Withdraw locking bolts (also hydraulic).
(*d*) Swing bridge.

All the operations are electrically interlocked, and the whole sequence will take two minutes.

For closing the bridge the operations are reversed. Limit switches are provided to prevent overshooting, and a photo-electric cell is placed at the end of the bridge. When a ray of light from the end pier strikes the centre of this, a green light shows in the operator's cabin, and the locking bolt may be inserted. If this ray does not fall centrally on the cell, a yellow light shows, indicating that the bridge is nearly central, and that the bolt will lead into its slot. If the bridge is too far off centre, a red light shows, indicating that the bolt will not enter.

Each operation is carried out by a separate motor, all A.C. except the two 50-h.p. swinging motors, which are direct reversing D.C. A Ward-Leonard set converts A.C. to D.C. for this purpose. The bolts and wedges are worked by hydraulic rams (Tangye Ltd.), pressure for which is provided by electrically-driven oil pumps. It is not yet known what the sag in the girder will be, but it has been decided that the power required to take it all out when the bridge

is closed will be prohibitive. According to calculation it should be in the region of 4 in., of which about 2 in. will be taken out by the wedges.

All the machinery is situated below the roadway in the centre of the girder. The operator's cabin is also in the centre, but raised 28 ft. above the roadway.

A diesel set (Brush Engineering Co.) is provided in case of electrical failure.

Cables, water supply, telephone line, etc., are all laid along the river-bed from the end pier, and pass up to a complicated brush gear through the central pivot. The cables, etc., will be laid in a trench excavated (by grab, explosive, etc.) 4 ft. deep in the bed of the river.

The girder itself, which is shown assembled in the contractors' yard in one of the photographs, will be erected in the open position upon trestles placed on the protective dolphin.

MISCELLANEOUS NOTES.

Work under Compressed Air.

Probably the majority of officers have not had the experience of going into compressed air, so that the following notes may be of interest.

Before going under pressure for the first time, it is advisable to be examined by a doctor to see that one's heart and blood pressure are in order, and that one's ears are clear. It is alleged that compressed air will find out the slightest ailment from which one may be suffering.

As regards dress, an overall or mackintosh of some kind is required and gum-boots, though not essential, are desirable. Although there is little water about, there is usually mud, and everything one touches is dripping with wet rust.

The top chamber of the caisson contains a passenger lock and a bucket lock. The passenger lock can accommodate a maximum of four people at one time; inlet and outlet of air is controlled by the occupants. As pressure is being applied, one's chief sensation is a "woolliness" in one's ears, which it is essential to relieve by swallowing every 10 seconds or so. An alternative method is to hold one's nose and attempt to blow through it. If neither of these methods produces a "click" in the ears, considerable pain will soon be felt, and it is advisable to stop compressing or the ear drum may be ruptured. Normally one experiences no discomfort unless one has a cold.

The pressure in lb./sq. in. above atmosphere is 0·44 of the depth of the cutting edge below water. In these foundations the deepest has been −38 ft. O.D. At high water the depth below water was

about 48 ft., giving a pressure of about 21 lb./sq. in. above atmosphere. Compressing to this pressure takes about 5–6 minutes in the lock. It does not matter how fast one compresses, the limiting factor being pains and discomfort in the ears.

The greatest pressure in which it is possible to work is about 45–50 lb./sq. in. above atmosphere, representing a depth of 100–115 ft. In this pressure work is very exhausting, and is only possible for $\frac{1}{2}$–$\frac{3}{4}$ hour at a time. Compressing takes about 20 minutes and decompressing one hour.

When the pressure in the lock becomes equal to that inside, the door opens automatically, and one enters the top chamber. Here one is immediately conscious of the continuous rattle of the non-return valve through which air is being supplied by the compressor, which almost drowns conversation. This top chamber is about 7 ft. diam. and 7 ft. high. It contains in the roof one side of the bucket lock, and a panel of electric signals to the crane driver is attached to the wall. In the floor are two shafts, one about 4 ft. diam. for the bucket and one about 2 ft. diam for passengers. Fortunately for some passengers, the ladder is between the two shafts and can be used from either, if the bucket is not actually being hoisted. After climbing about 60 ft. down this ladder one reaches the bottom.

Arriving here, one finds oneself in the conical working chamber in which the excavation is being carried out. Normally there has been about 15 ft. of excavation in mud, gravel, clay, etc., before the rock (sandstone) is reached, and excavation is continued for 2–3 ft. into the rock to get a good hard surface and form a key. As excavation proceeds, the caisson sinks under its own weight. The procedure is to excavate all round the cutting edge and leave the middle standing high; this gives a dry platform to work from and confines the water to the edge. While in clay or gravel, however, there is little water visible, the surface consisting of comparatively dry material.

Once the rock is reached, pneumatic concrete-breakers are employed, and the discomfort caused by their reverberations in the steel cylinder is considerable. Normal excavation is carried out by pick and shovel.

When one is in compressed air one would not know that it was not normal atmosphere, except that it is very difficult to whistle. The compressor supplies far more air than is needed, the surplus blowing out under the cutting edge. Normally this happens continuously, but occasionally a sort of "*hunting*" occurs, the pressure building up and then blowing out with a rush. Every time a blow occurs, a dense fog immediately forms inside, which clears again before the next blow. To the uninitiated a blow makes a somewhat alarming roar; some visitors on one occasion were considerably shaken when their arrival on the bottom coincided with one, together

with the sudden extinction of all the lights, due to some minor fault.

Having finished one's visit, one is faced with a 60-ft. climb up the vertical ladder. It is advisable to stop and have a rest half-way up, as under air pressure this causes considerable exhaustion. It is also better to have a short rest at the top before de-compressing.

De-compressing in the lock from 20 lb. pressure should take 11 minutes, and is far more dangerous than compressing. One has no feeling of discomfort, and one's ears seem to "click" automatically, so the tendency is to hurry the process. One has to learn the correct speed by the sound made by the air escaping, rather than by one's physical sensations, as there are no pressure gauges visible from inside the lock. Generally speaking, if fog forms in the lock one is going too fast, but this may happen anyway on a damp day.

The effects of de-compressing too fast may be :—

(*a*) Bleeding at the nose or ears.
(*b*) Headaches, giddiness or fainting.
(*c*) Pains in the stomach and/or joints, caused by bubbles of nitrogen absorbed by the blood.
(*d*) Loss of consciousness, resembling drunkenness.

However (*c*) and (*d*) are not likely to occur below pressures of 25 lb./sq. in. There have been practically no casualties among the men working on the job. The commonest complaint is catching cold on coming out, as the climate inside is very warm and damp.

Men working in compressed air do 12-hour shifts with 1½ hours off for meals. They receive an extra 3d. per hour. The shift consists of a ganger and five men at the face, and two lock keepers (inside and out) controlling the bucket which removes the spoil. Work was carried on continuously day and night, two shifts being employed.

SETTING OUT THE BRIDGE.

Setting out for line. The first task on arrival at the site was to set out the centre line of bridge, which had been fixed by the preliminary survey. A wooden target set in a concrete block formed the north mark, and the south mark consisted of a 6-in. diam. stake about 12 ft. long, driven almost flush into the saltings. The distance between these two marks was calculated by triangulation from a measured base. In practice it was found more convenient to use two marks offset 14 ft. 6 in. from this centre line, *i.e.*, on the centre line of one row of pier cylinders. The temporary staging was then driven to this line.

The position of the base cylinders for the piers was given by nails driven into the staging, the nails having been aligned between the targets by theodolite. These cylinders did not always finish either

exactly in the correct position or exactly vertical, and it was necessary, once the parallel base of the pier was concreted, to set the tapering shutters accurately upon them. This was done by string-lines and plumb bob from fresh sets of nails on the staging, as it was almost invariably found that the original ones had moved owing to the passage of loco. cranes, etc.

The two pier legs were set square to the line of bridge by setting the theodolite on a temporary platform over one of them and turning through 90 degrees. The shutters being steel and well made, it was only necessary to level the tops to ensure their being vertical.

Measurement of distance. This was carried out by a 500-ft. steel ribbon, calibrated in feet. Tension of 10 lb. was applied by spring balance, the ribbon being continuously supported along the staging, and a temperature correction was necessary at each reading.

While concrete work was in progress on the south side, it was considered sufficiently accurate to measure from the calculated position of the south target. When the piers for the steel spans had to be set out, however, it became necessary to make an accurate measurement across the (then) 300-ft. gap between the two stagings.

Experiments were carried out on dry land with the ribbon suspended on trestles at various distances, and a correction curve for sag was plotted. The measurement across the gap was then made on a calm day with the ribbon freely suspended, and from this the calculated distance between surveyed marks was found to be 1¼ in. too great.

Levels. An Ordnance bench mark on the north side was decided upon as the bench mark for the bridge. Another O.B.M. on the south side could not be made to agree with this, having apparently sunk 1½ in., in common with everything else on this side. Finally, when the gap between the stagings was reduced to about 250 ft. accurate runs of levels between bench marks became possible and new values were fixed for those on the south side. No part of the bridge had at this time reached its final level, so that no harm was done.

First attempts to establish levels on the south side were made using the water level at slack water. It was, however, almost impossible to obtain calm enough conditions to get an accurate result. Level sights were taken at targets on the opposite bank, the length of sights between the two ferry piers at low water being about 1,500 ft. For some time it was not realized that the curvature of the earth would cause a ·05-ft. correction on this length of sight. To those whose survey was rusty, the fact that curvature produces an error of 8 in. in a mile seemed astonishing.

Instruments and limits of accuracy. The instruments with which the major part of the setting out was done were a Cooke, Troughton and Simms 3½-in. Tavistock theodolite, and a Watts precise level.

With these accuracy to within $\frac{1}{8}$ in. in any direction should be possible. Actually the greatest inaccuracy that has occurred anywhere is about $\frac{3}{8}$ in.

A word should be put in here in praise of the Tavistock theodolite, which quite spoils one for any other. This instrument never seems to get out of adjustment, and one never bothers to take the mean of two readings on opposite faces or swings, as one knows that they will be identical—a bad habit to get into.

For less important work, a Watts 5-in. micrometer theodolite, a Stanley vernier theodolite, and a Cookes reversible level are sometimes used.

PLANT.

The following are the chief items of plant in use :—

Staging. Bridge is constructed from temporary timber staging carried upon 12 in. x 12 in. timber piles.

Cranes. Derrick cranes (Morgan Bros.), 15-, 12-, 5-, 3-ton. Loco. cranes (Thos. Smith), 7-, 5-, 3-ton. All steam driven.

Coffer dams. Sheet piling (Larssen) No. 2, lengths 45 ft. and 60 ft. Pumps (Gwynne), electrically driven, 2,000 g.p.m.

Caisson work. Compressor (Sentinel), D.A. steam, 150 cu. ft./min. Jacks for lowering cylinders, Tangye 100-ton hydraulic.

Pile driving. Timber and sheet piles, McKiernan Terry, D.A. steam hammers Nos. 5, 6 and 7. Reinforced-concrete piles, B.S.P. single-acting steam hammers Nos. 7 (3-ton) and 9c (5-ton).

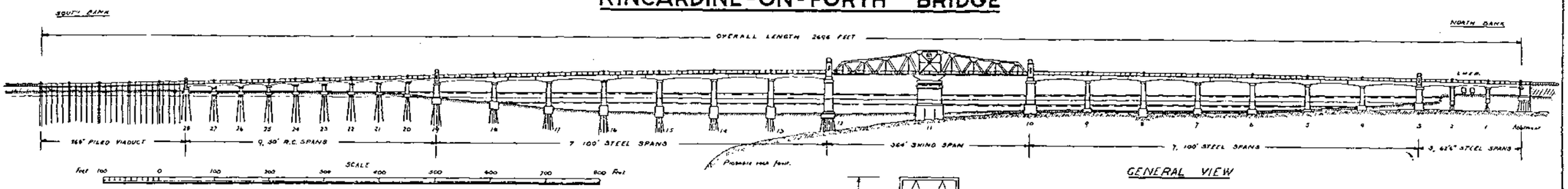
Concrete mixing. Ransom and Rapier max. size $\frac{1}{2}$ cu. yd.

SUB-CONTRACTORS.

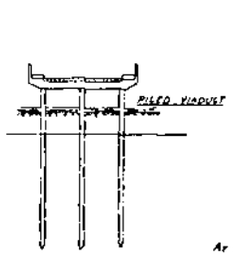
All the work was carried out by the Cleveland Bridge Co., with the exception of the following :—

Rollers and roller path—Sir Wm. Arrol and Co., Glasgow.
Rack and gearing—Henderson and Co., Aberdeen.
Electric motors—Laurence Scott Electromotors.
Interlocking and switch gear—G.E.C.
Standby diesel engine—Brush Engineering Co.
Wedges and locking bolt gear—Tangye Ltd.

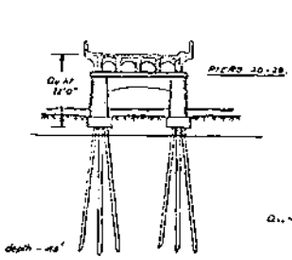
KINCARDINE-ON-FORTH BRIDGE



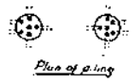
GENERAL VIEW



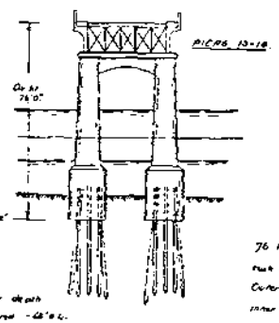
Each bent consists of 3 18"×18"×65' R.C. piles.



Each leg on 6 18"×18"×63' R.C. piles (1 vertical and 5 raked)



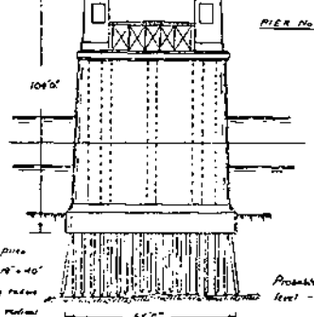
Plan of piling



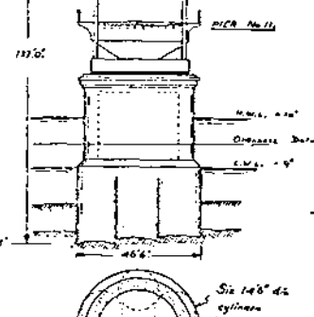
Greater depth penetrated - 62' below L.

Each leg on 9 R.C. piles 16"×16" ×55' (4 vertical and 5 raked)

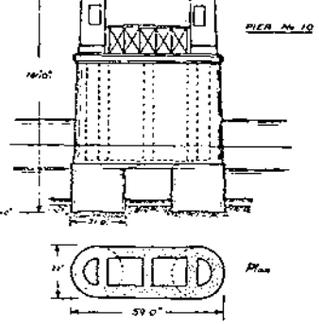
Plan of piling

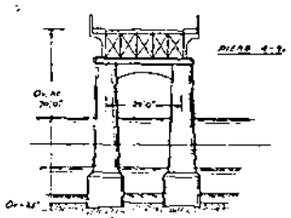


Plan of piling



Plan of piers





Note:- All piers on North side up to (incl) No 11 are founded on rock.

DETAILS OF PIERS

SCALE
Feet 10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 Feet.

By permission of Resident Engineer, Kincardine-on-Forth Bridge. S.A.S. Dec. 1936.

"C.I.R.E.S."

By MAJOR C. M. SIMPSON, M.C., R.E.

THE Royal Engineer Stores Inspection Department, Royal Dockyard, Woolwich, of which the head is the Chief Inspector of R.E. Stores (C.I.R.E.S.), is a link in the organization for the provision and maintenance of matériel. The function and duties of this Department, which we will hereafter call "C.I.R.E.S.," by which name it is more generally known, are a closed book to many officers of the R.E. and R.C.S. The object of this article is to throw some light on what C.I.R.E.S. has to do, and how he does it.

In the first place, the C.I.R.E.S. is *not* a storeholder. The only stores he holds are his own equipment required for inspection purposes, and sealed patterns or samples of Vote IX stores. The latter are as far as possible of the latest approved design, and are for the purpose of guiding manufacture.

The C.I.R.E.S. is responsible for :—

(*a*) The inspection of all new Vote IX stores—*i.e.*, articles of technical equipment of the R.E. or R.C.S.—during the progress of manufacture and on completion.

(*b*) The inspection of part-worn Vote IX stores, as ordered, *i.e.*, articles which have been passed into the service after manufacture. Such stores may be either on charge of a unit, or have been returned after use to Ordnance or have been held in Ordnance stores.

(*c*) The preparation of specifications, with drawings, to cover manufacture of Vote IX stores.

(*d*) The preparation of draft paragraphs of *List of Changes of War Material* to cover modifications in design of stores in use in the Service.

(*e*) The inspection of Vote X stores, *i.e.*, a wide range of building components and materials, electrical and mechanical plants, electric lamps, electric installation wiring stores and fittings, etc., for the Director of Fortifications and Works for Works Services.

ORGANIZATION.

To compete with the above range of duties the Department is organized in three main divisions :—

Division I—responsible for duties in connection with stores required for R.C.S. and for fixed electrical communications.

Division II—responsible for duties in connection with stores required for R.E.

Division X—responsible for duties in connection with stores required for works services.

Each of these divisions is further sub-divided into sections as follows :—

Division I—Section 1—Wireless Stores.

Section 3—Telegraph and Line Stores, etc.

Division II—Section 2—Electrical Stores.

Section 4—Mechanical Stores, including Survey equipment.

Division X—Works Section—Stores for Works Services other than electrical and mechanical items.

Departmental Repair Workshops.

For convenience there is a certain amount of overlapping between the divisions : for instance, all cables and leather goods are inspected by Division I, and electric instruments and portable secondary batteries for wireless sets are inspected by Division II. The primary consideration in such cases is that stores of a similar nature or characteristic should be concentrated under one inspection-responsibility group so that knowledge and experience gained can be readily collated and used, the choice of group being dependent on factors such as the quantity of different items of the same nature already falling under the obvious divisions of R.E. and R.C.S. stores, and the location and distribution of testing equipment.

Divisions I and II are each in charge of a Major, who is designated an Inspector (I.O.1 and I.O.2). Division X is in charge of a Captain, designated an Assistant Inspector (A.I.X). Sections 1 to 4 are each in charge of a Captain (or equivalent Civilian Officer) and any Section may under exceptional circumstances have one or more additional officers. There are one Captain (I.R.E.M.) and two Lieutenants (I.R.E.M.) in Division X, each of whom is responsible for duties in connection with specific categories of Vote X

stores (*e.g.*, E. & M. Plants, Running Contracts Stores, Vote X Electrical Stores). The senior I.R.E.M. is also in charge of the Departmental Workshops. Each I.R.E.M. in Division X is administratively responsible for a group of examiners in this Division. All Captains and Subalterns are designated Assistant Inspectors (*e.g.*, A.I's 1—9).

Generally speaking, the stores inspected by Sections 1 to 4 are inspected at Woolwich Dockyard, where special mechanical, electrical (including wireless) and optical testing equipment is installed for the purpose. The revision, renewal and modernization of this testing equipment is one of the most important duties of the officers of the Department. The examiners of these sections normally work at Woolwich, but they are often sent to inspect components or special parts of stores at firm's works; and in the case of special contracts, examiners from these sections may be detached and posted to the firm's works to carry out the whole inspection until the contract is completed.

The Works Section comprises all "outside" examiners, that is, the examiners resident in the industrial areas—London (4), Birmingham (4), Manchester (2), Sheffield (2), Newcastle-upon-Tyne (2), and Glasgow (1). These examiners are responsible in their respective areas for inspecting :—

(*a*) Orders placed on running contracts.
(*b*) Stores orders of all kinds placed by C.R.E's.
(*c*) Materials for all contracts, as required by Sections 1 to 4.

In addition sub-groups of Works Section may be formed for special contracts, and then become responsible for the whole inspection of such contracts at the firm's works. These temporary sub-groups are only formed for such stores as generating sets or other combined plants when ordered in large quantities.

Division X also comprises the Departmental Workshops, which function as a Branch Ordnance Workshop, carrying out repairs to searchlight equipment, electrical instruments, generating sets and switchboards, and the mechanical features of wireless equipment, etc. The Departmental Workshop also furnishes a nucleus of experienced examiners for the testing of E. and M. plants and for the examination of part-worn stores; it provides in certain cases a practical medium for trial and final decisions on details for *List of Changes* when modifications of existing service equipment have been decided upon.

In general, each Section is in charge of a Foreman Examiner, and special sub-sections or sub-groups of Sections are in charge of Assistant Foremen Examiners (*e.g.*, Survey Instruments sub-section of Section 4, London District group of Works Section, etc.).

PERSONNEL.

The personnel, apart from officers, of the Department consists of an office staff of clerks and stenographers who are Civil Servants, under an officer known as the Establishment Officer, and of examiners who are termed the Industrial Staff. The examiners consist of a large proportion of ex-Service men—particularly ex-R.E. Mechanists, ex-W.O's and N.C.O's of R.C.S., and ex-Engine-room and Electrical Artificers of the Royal Navy, all of whom possess generally the technical qualifications required—and of civilians, who are either taken on young and trained up to the required standards, or appointed direct at any age if they possess the necessary qualifications.

Examiners are divided into four grades, of whom it may be said that a 1st Grade examiner can undertake the inspection of any store in his own particular line (*i.e.*, either electrical or mechanical), a 2nd Grade is specially qualified for one type of store (*e.g.*, electrical instruments, compressors, secondary batteries, electric lamps, etc.), a 3rd Grade probably a learner, and a 4th Grade either a very young learner or a superior labourer qualified to handle delicate stores and assist in tests. About 90 per cent. of the examiners are 1st or 2nd Grade. "Outside" examiners must have 1st Grade qualifications, and are promoted to 1st Grade as soon as they prove themselves so qualified. "Outside" examiners are the only direct link between the C.I.R.E.S. and manufacturers for a large number of small orders, particularly Works Services C.R.E.'s orders, and have accordingly a position of trust and responsibility calling for qualities of tact, character, and technical efficiency of a high order. They are therefore specially chosen.

DUTIES.

So much for organization—what does inspection really involve? Briefly it can be divided into three stages, always assuming that provision is governed by the principles of open tender, *i.e.*, the cheapest that will fulfil the purpose required coupled with serviceable standards of workmanship. If every article purchased were the best of its kind, and therefore probably the most expensive, the requirements for inspection would be reduced to a negligible quantity, but the cost of stores would be at least doubled, whereas the cost of inspection does not exceed 5 per cent. of the cost of stores purchased on the tender principle. The three stages are :—

(1) Pre-contract action.
(2) Inspection during progress of the contract.
(3) Final inspection of the finished article.

(1) *Pre-Contract Action.*

In the case of Vote X stores for Works Services the appropriate stages of pre-contract action described below are carried out by the Director of Fortifications and Works branch of the War Office, or by Chief Engineers, or C.R.E's according to the value or nature of the store. Where necessary, C.I.R.E.S. is asked to give an opinion or recommendation on specifications or tenders; and sometimes, for running contracts, to furnish particulars of values of orders actually placed on preceding contracts. Generally speaking, Works Service orders are for commercial designs complying as regards quality and performance with specifications issued by the Director of Fortifications and Works.

For Vote IX stores, *i.e.*, the technical equipment of R.E. and R.C.S., pre-contract action is carried out in the following main stages :—

(*a*) Design
(*b*) Field trial } for new types of equipment.
(*c*) Modification of design as a result of field trial, or for "ease of production," or for other reasons. This may apply to current patterns of equipment.
(*d*) Preparation of specification and drawings to govern manufacture or repair.
(*e*) Preparation of tender form.
(*f*) Consideration of tenders.
(*g*) Placing of contract.

(*a*) and (*b*) are the province of the R.E. Board on behalf of and in conjunction with the War Office (M.G.O.11). C.I.R.E.S. is an associate member of the R.E. Board, and keeps generally in touch, but is not directly concerned, with these stages. Stage (*c*) may be done by the R.E. Board (in the experimental establishment concerned) or by special contract by a manufacturer to bring the design details into line with modern production methods; or, for modifications for existing stores, by C.I.R.E.S. under the orders of the War Office (M.G.O.11) in conjunction with the R.E. Board.

C.I.R.E.S. is responsible for stage (*d*), and for preparing, when instructed by War Office (M.G.O.11) to do so, paragraphs (in draft form) for *List of Changes* either introducing the store or modifying it in accordance with the final design decisions arrived at in stage (*c*). The specifications (which term includes the drawings) have to be prepared for actual production by the commercial world, and must be as foolproof as possible. The technical requirements and preliminary drawings for these specifications are normally supplied to the C.I.R.E.S. by the R.E. Board. Full use is made of

all British Standard Specifications, and Government Departmental Specifications to cover materials, construction, workmanship and performance. Great care is required in the preparation of specifications, as the legal right to reject an unsatisfactory delivery is dependent on the specification.

In addition, current specifications have to be amended continually to incorporate improvements in design, construction or performance, which are found to be essential or desirable as a result of experience during manufacture or practical use in the Service. A necessarily somewhat elaborate organization exists in the Headquarters' Office of C.I.R.E.S. for this work, which entails the co-ordination of the knowledge of those responsible for drawing, inspection, drafting and the maintenance and issue of specifications.

The specifications are widely issued, including copies to all the Dominions and India. Care has to be taken that no confusion can arise through the use of out-of-date copies of the specification, so that all normal users have to know when a specification is superseded by an amended copy.

C.I.R.E.S. is concerned with stage (*e*) in the preparation of contract demands which form the basis for the issue of the tender. This includes the description of the store, with brief details, usually much the same as in the *Vocabulary of Army Ordnance Stores:* the reference to specifications and drawings: and the insertion of relevant requirements for delivery, inspection, issue of components for manufacture from Ordnance (if any), packing, special information required from tenderers, and any special conditions of contract.

As regards stage (*f*) C.I.R.E.S. is usually consulted and reports to M.G.O.11.

(2) *Inspection during Progress of the Contract.*

This comprises :—

(*a*) Inspection of parts or components placed to sub-contract by the main contractor.

(*b*) Inspection tests of materials.

(*c*) Inspection of parts or components actually made at the main contractor's works.

(*a*) is carried out, as far as is possible, with the staff available, to avoid the delay due to dispatch and subsequent return for correction of defective parts to the main contractor. Sub-orders are obtained in triplicate, and examined for agreement with specification requirements. Except for important components, sub-orders are inspected by resident " outside " examiners.

The Section Officer responsible for the final inspection farms out

the inspection of sub-orders to the Section Officer who normally inspects that type of article or material—*e.g.*, the inspection of castings for searchlight projectors will be carried out at the foundry by Section 4: A.I.4 may either arrange for this to be done by an examiner of his own section or by the appropriate "outside" examiner for the area where the castings are being made. When the A.I. is satisfied with reports from the examiners (or foremen-examiners) on sub-orders, a release note is issued to the sub-contracting firm, with a copy to the main contractor. This is the authority for dispatch of the part or component to the main contractor's works for incorporation in the final assembly.

For (*b*) test certificates for mechanical tests on materials (and sometimes for performance tests of apparatus) are accepted from reliable contractors, when necessary. If possible the execution of these tests is witnessed by the examiner, who then initials the certificates. In most cases sample test pieces are forwarded to C.I.R.E.S. for inspection and mechanical testing. A special routine procedure is carried out for electric welding involving (i) mechanical tests of the deposited electrode metal to comply with specified or guaranteed figures; (ii) mechanical tests of sample joints and welded test pieces for compliance with specification and to prove the skill of the welding operator; (iii) visual inspection and proof tests of the finished article. Records are kept of welding current and voltage, electrode deposition, etc., for the tests and finished work: welding of the main store is only permitted by operators who pass the tests at (ii). The detail of welding inspection technique is improved continuously as experience is gained and data collected.

(*c*) is dealt with in the same way as (*a*) or (*b*), whichever applies, but in certain contracts is carried out by examiners specially posted to main contractor's works to do the whole inspection.

(3) *Final Inspection.*

This really amounts to the testing for performance as required by the specification, and the checking that all details as ordered have been made and supplied. The final performance tests may vary from a simple mechanical or electrical operation to the complete testing over a continuous period of 24 hours or more of a generating plant, with auxiliaries, in a specially-constructed tropical temperature room. The more elaborate tests may be followed by dismantling and inspection of all working parts: this is again followed by reassembly, final check running and painting. In some cases packing for shipment must be inspected.

The necessity for specifying clearly, before the contract is entered into, what final tests and examination will be required is obvious, as testing, dismantling, re-erection, etc., are all costly and it is only

under much persuasion, and after much delay, that contractors can be induced to carry out tests not clearly specified. In fact, the whole work of inspection can only run smoothly when specifications are clear and comprehensive. A little extra work on specifications will usually save or prevent an enormous amount of delay and difficulty in the process of getting what is wanted.

ADVISORY DUTIES.

One usefulness of the Department lies in the close touch which is continually maintained with commercial manufacturers of a large range of engineering and signal equipment, and the experience gained in the repeated examination of identical or similar stores over a long period of years. This induces a thorough acquaintance with manufacturing methods and with all types of specifications governing production, and so with standards of quality and performance; and also an ability to sum up the relative value and reliability of different manufacturers. Like everything else, inspection efficiency requires training and experience. The Inspection Department can, as a result of their experience, give an ordering authority helpful advice on all aspects of commercial production, names of suitable firms, manufacturing capacity, etc., and the reasonable certainty that what is being paid for will be obtained.

The C.I.R.E.S. is ready to help any ordering officer at any time by supplying suitable type specifications and names of firms: or by examining proposed specifications for stores which he will ultimately be required to inspect.

CO-OPERATION.

It will be observed from the above that C.I.R.E.S. has to practise a large measure of co-operation. Briefly the Department in all its activities has to consider and co-operate with :—

(*a*) Two branches of the War Office, M.G.O. (Director of Mechanization) and Q.M.G. (Director of Fortifications and Works).

(*b*) The R.E. Board and its Experimental Establishments, also the S.M.E., Chatham.

(*c*) Deputy-Director of Ordnance Services, Woolwich Arsenal (for Provision).

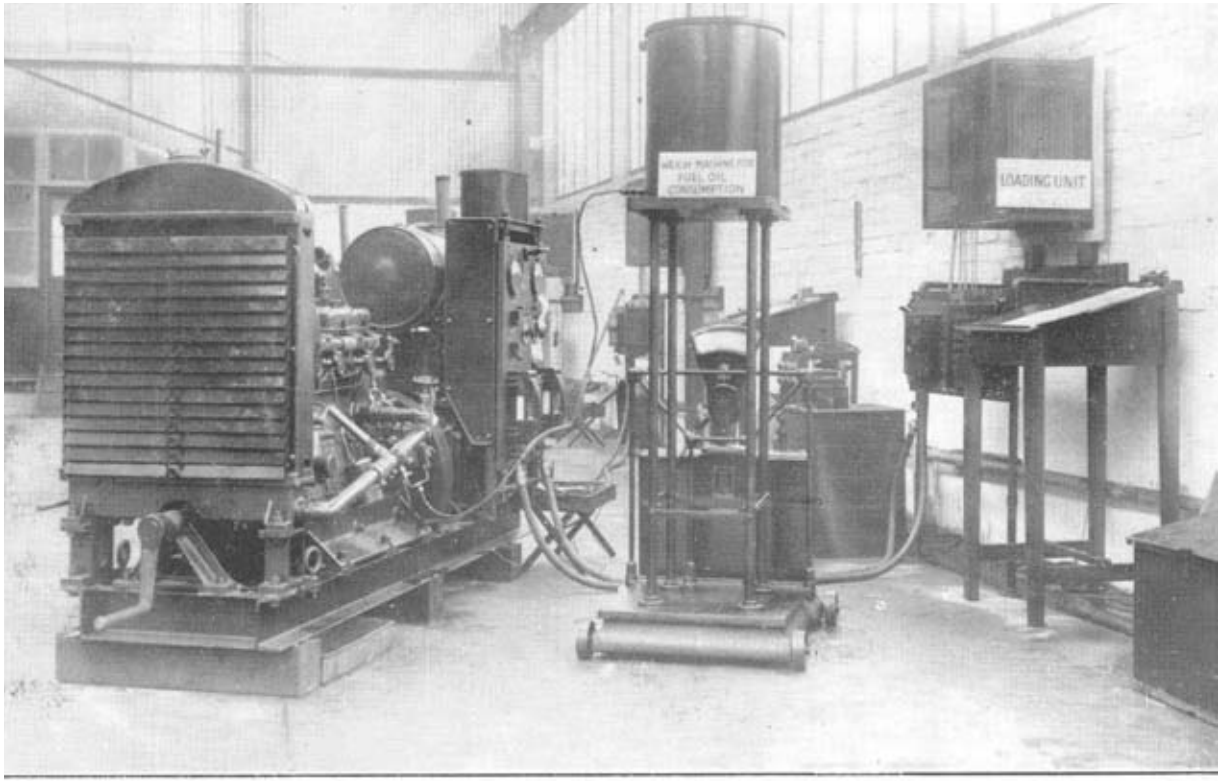
(*d*) Director of Army Contracts.

(*e*) Manufacturers throughout the United Kingdom.

(*f*) Departments of Woolwich Arsenal, such as Superintendent of Design, and War Department Chemist.

st Shop Lay-out. Note each unit complete and self-contained, and (at rear under clock) office for examining staff of C.I.R.E.S

C.I.R.E.S.' - Lay out for Inspection Works Test 1.



Lay-out for Inspection Works Test for "Generating Set, 22 KW." Note fine-controlled load resistance, desk, fuel weighing machine and fuel tank combined, portable tray for check electrical instruments (all provided by contractor under C.I.R.E.S. direction).

C.I.R.E.S.' - Lay out for Inspection Works Test.

APPENDIX.

I.—Testing Apparatus.

In addition to the more usual equipment necessary for electrical, mechanical and radio testing, special testing equipment of a varied character is installed at Woolwich such as the following :—

A cathode ray oscillograph and allied equipment to test the efficiency of wireless receivers.

Apparatus to determine the electrical efficiency of microphone and telephone receivers.

Collimators to check the accuracy of theodolites reading to one second of arc.

Standard compasses to fix the magnetic meridian within two minutes of arc.

A machine to measure accurately the tensile strength of rubber.

Standard potentiometer and Wheatstone bridge apparatus to calibrate sub-standard electrical instruments.

Photo-electric cell equipment to measure the total lumens of electric lamps and for searchlight photometry.

Sensitive photometers to measure the brightness of luminous paint on compasses and watch dials.

A tensometer to record the mechanical properties of metals using miniature test pieces.

Standard slip gauges correct to one hundred-thousandth of an inch to test wear on gauges.

II.—Technical Information and Experimental Investigations.

The large range of articles and the many processes involved in modern manufacture necessitate close investigation in a variety of subjects, and in some cases owing to the lack of experimental establishments specially adapted for the purpose, C.I.R.E.S. is called upon to carry out such investigation and even to design. Some of the subjects so dealt with in recent years are :—

1. Annual testing of General Service electric lamps, involving photometry methods with photo-electric cells, and leading to investigations on these.
2. Trials of new types of primary and secondary cells for compliance with inventor's claims.
3. Accelerated tropical ageing of rubber for cables, bicycle tyres, hoses, and other articles.
4. Design details of prismatic compasses, including the complete design of liquid compass. This has involved details such as types of liquid and metals and their interaction with each other and with finishing materials, such as lacquers : sealing compositions : design of jewels and mounts : luminosity and ageing of radio-active compounds and methods of preparation of luminous paint : photo-engraving of mother-of-pearl : construction for rapid production under modern methods : behaviour of the finished product under tropical conditions.

5. Simple photo-electric methods for determining luminous output and efficiency of searchlight lamps and reflectors.
6. Methods of manufacture, grading and properties of micas and ebonites.
7. Methods of re-proofing canvas.
8. Supply and preparation of " Kapok " for floats.
9. Measurement of strain in glass.
10. Properties of chlorinated rubber as a lacquer.
11. Fastness of dyes in signalling flags.
12. Methods of manufacture of synthetic sapphires.
13. Mechanical properties of cadmium-bronze wire.
14. Lay-out of complete up-to-date testing equipment for wireless sets and components.
15. Inspection technique of welding.
16. Manufacture and heat treatment of high tensile and alloy steels.
17. Manufacture of non-ferrous alloy metal castings.

III.—STATISTICS.

During 1934–1935, C.I.R.E.S. dealt with the following approximate total values of new and old stores :—

New stores, £600,000 at an inspection cost of 4 per cent., and part-worn stores £400,000, at an inspection cost of 1½ per cent.

The number of original orders and contracts dealt with during 1934–1935 was approximately 50,000. In some of these the number of sub-orders was very large, reaching in exceptional cases as many as 150–200. The number of actual orders dealt with, therefore, probably approached a quarter of a million.

SKEW GUNS AND SURVEY—AN ANSWER.

By " STERNO."

Is it possible that Gunner officers, as a body, so far handicap themselves as not to read *The R.E. Journal?* If otherwise, how could O's R. and B. have been made to wait a year or more for an answer to their pregnant questions in the December, 1934, number? One can think of at least half a dozen exponents of artillery survey who would lower their heads with a bellow if and when that article, and the succeeding one in September, 1935, should come to their notice. It is to be hoped that one of these will have got in his charge before this less effective assault can reach its target.

Still, rather than risk a perpetuation of the erroneous idea that Gunners can offer no excuse for artillery survey, let it go home, hit or miss. First, it must be admitted that the September, 1935, article is a shrewd dig at artillery survey. Published in 1927, it would have been difficult to answer, but the situation has changed a good deal since then. The " several people in the know " who were consulted by O's R. and B. do not seem to have been aware of these changes, while the Gunner officer, whose depressing demand for six hours' delay for survey preparation originally galvanized O's R. and B. into protest, was evidently an archery exponent without the courage of his convictions.

A good starting-point will be the question which is asked in both the December, 1934, and September, 1935, articles :—

" Will not 75 per cent. of the value of any survey be wasted if large-scale maps of the battle area are not available? "

This question (expecting the answer " yes ") represents the point of view of the French, who are training for a European war, fought on a 1/25,000 map, and only use survey to put themselves on to such a map. Presumably they feel that artillery survey would not be at home in Morocco or Jebel Drusa and are prepared to leave it in France when warring in those parts. They may be right, but we are optimistic enough to regard it as a cult to be practised where no large-scale maps exist. We hope to build up our own 1/25,000 map on the artillery board.

This leads one to consider the birth, infancy, childhood and adolescence of artillery survey, still a rather callow youth, but sound at heart. It will be years before anyone thinks it worth while to write up his full biography.

I. PRE-NATAL.

Before the war the possibility of a battery shooting at something not visible from its O.P. had not been considered. It was bad enough (so some Majors thought) to be asked to shoot at something that could not be seen from the guns themselves. In the early part of the war, batteries, working within these limits, were unable to shoot at many targets which deserved shooting at. By the end of the war the Gunners were deeply involved in shooting without observation, by means of the large-scale map, combined with very good and frequent meteorological reports.

II. ARRIVAL OF THE LITTLE STRANGER.

Those of us who were entered to gunnery in the last year of the war were brought up in this atmosphere of large-scale maps, and it was quite a shock to be told, about 1920, that those conditions would never recur, and that in the open warfare of the future all shooting would be by observation.

Followed three years' calm. It was in 1923 that the doctor was called in. In that year a certain Gunner Major, afterwards an I.G., returning from a Battery Commanders' course at the School of Artillery, summoned his officers and announced the birth, adding with simple honesty, "I can't make head or tail of it, but I do know that Difference Easting over Range equals sine bearing and that ought to carry us through Practice Camp."

III. INFANCY.

The next few years were frightful. There must have been people who knew what we were trying to get at, but one seemed to meet only survey maniacs, lost to all sense of proportion, or angry obstructionists who saw only the more displeasing characteristics of the child, and never bothered to try and understand it.

All the trenchant *R.E. Journal* criticisms would at that period have been fully deserved. At the cost of hours of delay we presumed ourselves to achieve the surprise and effect of putting down concentrations of fire without previous registration. Practice Camp results showed the effect to be dubious, the surprise often misdirected. This was sometimes due to unskilful arithmetic, sometimes to careless use of instruments; which incidentally were not designed for the degree of accuracy now expected of them. A tendency arose to insist on a quick check by shooting before putting down the concentrations, obviously a weak compromise, as pointed out by O's R. and B. In any case the delay was irreducible under the system then existing, which was as described in the September, 1935, article.

Brigade survey officers could take no steps at all until the Corps Survey Company, R.A., had extended the R.E. trig. control down to their brigade areas. Similarly, batteries had to await in patience the ministrations of the brigade survey officer.

IV. Childhood.

It must have been about 1928/1930 that the child underwent an operation which probably prevented it growing into a village idiot.

The surgeons were a clear-sighted few who could feel about artillery survey as the American did about Christian Science: "They've gotten a good gun; maybe they don't hold it straight, but I'll say they've gotten a good gun."

The really big change was in the primary object towards which artillery survey was directed. Instead of the unconvincing "surprise and effect by unregistered concentrations," the idea was evolved of using rather similar methods in order to apply, to any target registered by one gun, the fire of an artillery brigade or even a divisional artillery. Here was a definite attempt to make good the feeble weight of artillery fire in the division, far below what the war showed to be necessary.

Arising out of that came two more reforms. Firstly, the recognition of the gun as the only sensible survey instrument for fixing points in the enemy's area. This may mean a loss of surprise, but many consider that the fall of a few shells, all fired from one gun, will not tell the enemy where and when you propose to concentrate your divisional artillery, and you can always make it more difficult by arranging "dummy registrations." Secondly, the principle that artillery survey starts from the bottom, and not from the top, and therefore can begin right away as soon as the first Gunner appears on the scene, whether the Gun Position Officer of an advanced-guard battery, or the brigade survey officer of the leading brigade. Furthermore, that individual batteries, unless restrained for some special reason, will start shooting merrily at what their O.P's can see without waiting for the reaping of the survey harvest. Against slight opposition with which an advanced guard can deal unassisted, one can imagine that harvest never being reaped at all, but the seeds will always be sown nevertheless. One thing the surgeons ought to have cut out ruthlessly, but didn't, is the name "survey." That which in the year 1935 goes by the name of "artillery survey" is about as closely related to the science of survey as bone-setting by the captain of a tramp steamer is to the work of a surgical specialist. For artillery in open warfare it serves well, but it is really rather an insult to genuine survey (including R.E. survey) to preserve the misnomer. It is not a matter of accuracy altogether. The object in artillery survey is to acquire quickly some data likely

to be wanted early, and to build on that foundation as time permits and circumstances require. The fact that the foundation may later have to be quite considerably shifted divorces the process straight away from real survey, where infinite pains are taken to make the original foundation immovable and immutable.

Perhaps the trouble is the Survey Company R.A. Their work is sufficiently like real survey to entitle them to a seat (quite a low one) at the annual surveyors' banquet.

V. ADOLESCENCE.

The progress following this change of outlook has been quite remarkable.

On the one hand the " old sweat " has been somewhat mollified by finding that the honest-to-God registration of targets by shooting, which he was brought up on, is a normal and necessary part of the new cult. On the other hand, a new generation has grown up who can look a log. or a tan. in the face without nausea.

What it is now hoped to achieve with artillery survey (reward offered for a better name) is perhaps best shown by a hypothetical example.

A force advancing gains contact with the enemy. The advanced guard, one battalion, is supported by a field brigade, of which H.Q. and two batteries are well forward, two farther back. On contact the two leading batteries at once come into action, and start shooting by observation (no six hours' delay).

The brigade survey officer, either working on his own or in conjunction with the reconnaissance group of the R.A. Survey Section, fixes the pivot gun position, and bearing of the zero line, of one of these batteries, and makes this the starting-point of the brigade grid. If by any chance the Brigade Survey Officer is not on the spot (but in nearly every case he will be), the Gun Position Officers each make the best shot they can at it from the map and the compass on the No. 6 director ; the brigade survey officer afterwards accepts one of their fixings as his starting-point, or adjusts them to conform with his more accurate answer.

Two batteries proving insufficient, the remainder of the brigade is then deployed. The brigade survey officer is meanwhile fixing one or more bearing pickets from which the other G.P.O's can fix their positions. All batteries then " talk the same language."

As targets are shot at, their switch from zero, range and angle of sight are recorded, and from this data (reduced to normal meteorological conditions if possible) their co-ordinates are plotted by the G.P.O. concerned on his 1/25,000 board, at present a blank large-scale map. The information is ultimately passed to the brigade survey officer, who compiles and keeps up a brigade fighting map.

The longer the brigade is in action the more targets it can concentrate its fire on to. In practice there are snags, of course, which may bring disappointment. The chief one is the third dimension introduced by the angle of sight. If wrongly estimated, the registering battery, though it hits the target, will make a false deduction as to its range, and therefore its co-ordinates, which may cause the other batteries to miss it handsomely.

The brigade survey now fixes the O.P's on the same grid, and, that done, can get the co-ordinates of those targets which for any reason must not be registered by shooting. He receives from three O.P's reports as to their bearing and angle of sight. The snag there is obvious. Three bearings, each taken by a different (intelligent) N.C.O. from a different O.P., are apt to produce a triangle of error of alarming size. Better, if the tactical situation allows, to let a gun find the co-ordinates.

The temporary grid, then, far from being a temporary expedient for use in a temporary emergency, is the normal, and is accurate within the limitations of our workmen and tools. It may, of course, be fairly far removed from astronomical realities. In the early days of its existence this was considered so unimportant that the following rather striking picture was painted at a lecture on the subject.

A Corps Commander has selected his battlefield. His C.C.R.A. sidles up to the lance-bearer, and snatching his lance plants it firmly in the ground. Then, without reference to map, book, or table announces in a clear voice, " The co-ordinates of this lance are Easting 10,000, Northing 10,000, height 500, and the bearing of that umbrella-shaped tree is 100 degrees." From that lance survey was to spread all through the artillery of the Corps, on a grid having no connection at all with reality.

The inherent weakness of this conception is that air-calls for the artillery will contain references to the map in use, with which therefore the temporary grid must be reasonably in agreement. For that reason it is enjoined on G.P.O's or brigade survey officers who initiate a temporary grid to make their basic data as near to the truth as possible.

When the rest of the divisional artillery comes into action, the task of putting them on the same grid should fall to the Survey Company R.A., though a brigade survey officer of an incoming brigade might himself (in some cases) have to tie his brigade on to the grid of a brigade in action. The Survey Company can either extend the existing brigade grid to the whole of the divisional artillery, or can initiate a new grid, based on accurate data obtained from the R.E. survey. If time allows, the latter is preferable, since the original discrepancy when the grid was initiated can be alarmingly magnified when extended over several thousand yards. But

it means that the first brigade in action, which has probably registered all the divisional artillery tasks, is temporarily put out of its stride while target records are being amended. This delays the broadcasting of co-ordinates to incoming brigades.

As regards the conversion of co-ordinates and bearings of zero lines from temporary to permanent, the methods recommended by the *Manual of Artillery Survey* are (in order of merit) computation, tracing-paper and a graph. It seems probable that the tracing-paper method would be the most practical in the field, checked by computation as time permits. In these days G.P.O's have some form of shelter to work in.

Obviously the difficulties of these G.P.O's will vary as the extent of the original error in fixing the starting-point of the first brigade's grid. An error in co-ordinates is a very small matter, involving only simple addition or subtraction to correct the fixings of targets. An error in bearing involves a " slew " of the whole system of recorded points. It is obviously more profitable to study methods of avoiding the necessity for this " slew " (" skew " or what you will) than to study the means of correcting it afterwards. By keeping the reconnaissance group of the R.A. Survey Section in the forefront of the battle, where it can take a hand in the fixing of the original starting-point, it is hoped that " slew " will rarely be necessary.

Qualifying the statement above that " the gun is the only sensible survey instrument for fixing points in the enemy's area," it should be said that when the Survey Company R.A. gets going it will put in plenty of useful work fixing conspicuous points across the way as control points for rectifying air photos, datum points for calibration, or for testing rangefinders. But all this presupposes some stabilization. The point to be made is that the artillery is going to try and be effective long before that sets in.

The application of artillery survey (1935) to situations other than the above is easily visualized. There is certainly no finality about it yet, nor perfect agreement. But it does seem to be on the road to full manhood.

DOWSING.

By MAJOR A. J. EDNEY, R.E.

MUCH has been written in the daily Press during the past few years on the subject of water divining. Since this art covers more than the search for water only, the term now generally accepted to cover the whole field is "dowsing." Until recent times methods of dowsing have been a jealously-guarded secret, mainly because most of the possessors of knowledge on the subject have made their living thereby. Nowadays, however, there are a number of books available on dowsing and many societies exist to probe into its possibilities.

HISTORY.

The Biblical account of Moses striking the rock in order to produce water for the Israelites has been explained by some as due to the fact that Moses must have been a dowser. The use of a dowsing rod in his hands would undoubtedly have given the appearance of striking the rock. This, however, can only be a matter of conjecture. It is known that the monks in England in early times were well acquainted with methods of dowsing. Many old monasteries still standing in remote country districts draw their water supplies from a good underground flow and often the wells are sited where two underground springs meet. Dowsers were brought over from the Continent in mediæval times to locate tin lodes in the Cornish mines.

Naturally, dowsing in those times was regarded as a form of witchcraft and as such was roundly denounced by Luther. There is no record, however, of a dowser having been burnt at the stake. In America, that land of apt phraseology, the term "water witch" is still in common use. An old print shows a representation of the devil dancing over a stream with a dowsing rod in his hands!

In 1578, in France, the Baron de Beausoleil attracted notice by dowsing for metals and, after a somewhat chequered career, was appointed by the King to be Commissary-General for Mines in Hungary.

On 5th July, 1692, an incident happened in the south of France which was carefully recorded. A man and his wife were murdered at Lyons. Jacques Aymar, a peasant, claimed that he could

discover the murderer by means of his dowsing rod. He first got his rod to react over the dead bodies and then set forth on his search. After a short distance, he entered a garden and his rod turned over a child who was playing there. She told him that three villainous-looking men had called at the house for wine. Thereupon the City Fathers of Lyons took heart and provided Aymar with an escort of five archers. The chase began. The rod reacted over glasses at various inns. Finally, Aymar arrived at Beaucaire and went straight to the prison. Here his rod turned over a prisoner who had recently been arrested for theft. The latter swore he was innocent of the murder, but the archers took him back to Lyons the way they had come. Their prisoner was recognized at all the inns *en route*, and finally confessed. He was tried and executed.

An Englishman, Linden, wrote a book on dowsing for minerals, in 1750. It is interesting to note that he advocated holding a piece of zinc in the hand together with the mineral being sought, thereby setting up a very small electrical field. This was before the days of Galvani and Volta, who developed the theory of the electric cell.

Gerboin, in 1798, discovered that more exact results could be obtained by observing the behaviour of a pendulum oscillating over given samples. The time-honoured instrument until then had been the rod.

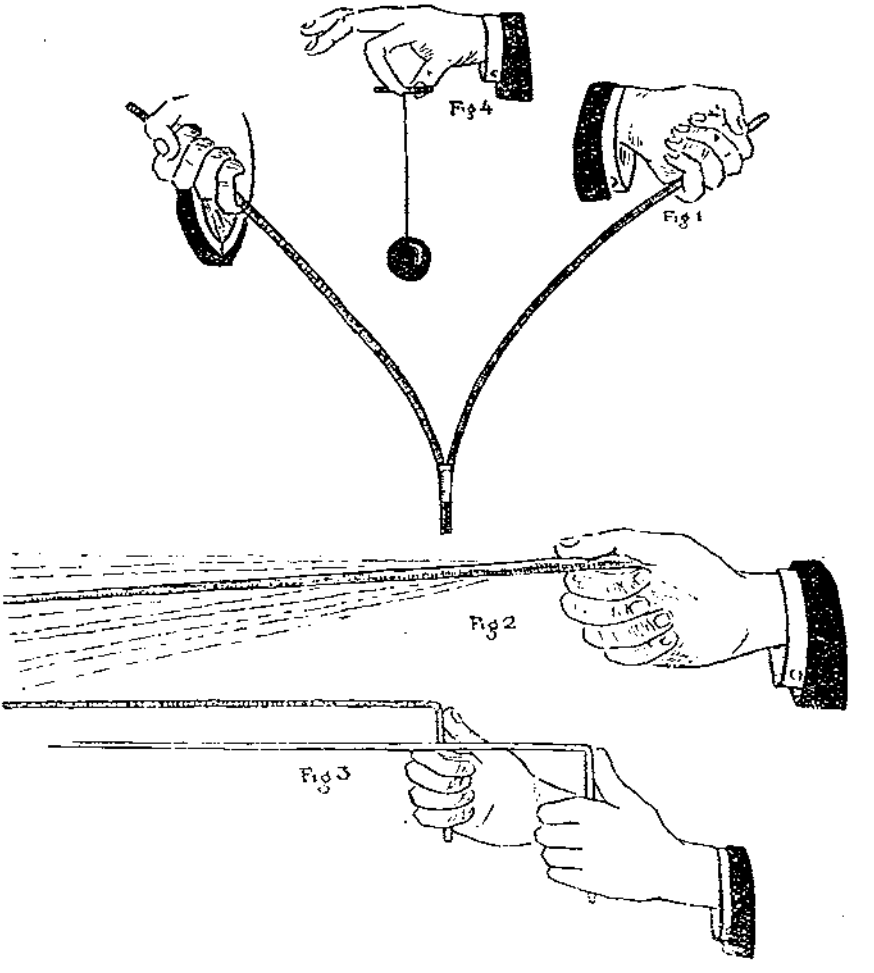
About 1850, various dowsing machines appeared on the market and their inventors claimed that the presence of underground water and other substances would be detected by their use. Machines are still available, but the experiences of the users of many of them have not been very satisfactory.

In 1913, a conference on dowsing was held in France by M. Mager. That, together with the work of the late Sir William Barrett and Theodore Besterman, represented the first co-ordinated attempt to put the investigation of the phenomenon on a proper scientific footing. At the present time, societies for the study of dowsing exist in all European countries. In England the work is carried out by the British Society of Dowsers. In Paris recently the degree of Doctor of Veterinary Medicine was conferred on a veterinary surgeon in recognition of a thesis on diagnosis of animal disease by dowsing. He also carried out a practical demonstration by successfully pointing out cows in a herd that were infected by tuberculosis. In 1933 the first Congress was held in England under the auspices of the British Society of Dowsers.

THE ACTION OF THE ROD AND PENDULUM.

Firstly, it must be stated that a very large proportion of the population could be made to feel some reaction when holding a

dowsing rod over running water. Subjects must be prepared to believe that they are able to dowse and must carry out an honest test. Having obtained a reaction, it is possible for a person, by practice and training, to develop the power.



THE ROD.

The rod of history is the fork-shaped piece of hazel, the wood being about the thickness of the little finger and the branches of the fork about 12 inches long.

A more convenient rod may be made by taking two pieces of black whalebone, each 14 inches long and 7 mm. x 2 mm. cross-section. These should be bound together at one end by a piece of black adhesive tape. To try this instrument, hold it as shown in Fig. 1 and stand

over running water—for instance, a garden hose with the tap turned on. The rod will then lift or dip, the movement varying for different persons. The rod should be held firmly in each hand but the muscles of the forearm must be allowed to relax. Whalebone rods already cut to size may be obtained from Devine & Co., Ltd., St. Stephens Road, Old Ford, London, for 1s. 6d. per pair. If no reaction can be obtained over running water, then ask someone who is known to be a dowser to hold your wrists, and try again. Reaction is increased if an open safety-pin, points outwards, is held between the thumb and first finger while holding the rod.

A single rod about three feet long and ¼-inch diameter is used by some dowsers. Hold the rod in the right hand (Fig. 2) and approach running water, at the same time giving the far end of the rod an up-and-down movement. On passing over the water, the movement of the end of the rod passes from oscillation to rotation.

A further method is to use the hands only. Extend the arms in front of the body with the fists closed and the backs of the hands uppermost. Approach running water, quickly moving the fists together and six inches apart again continuously. In this case, on passing over the water, one hand will be drawn slightly in front of the other.

An indicator which seems to act readily with people who are only slightly sensitive is shown in Fig. 3. The rods can be of 10 gauge iron or copper wire, the long arm being about 18 in. in length and the short arm 6 in. To use these rods, hold them out to the front and parallel as seen in the diagram. On traversing underground water both rods will swing inwards and cross.

THE PENDULUM.

First procure a black solid rubber ball about 1½ in. diameter, a yard of black thread, a small stick, 4 in. long and ¼-in. diameter, and a match. Bore a hole ½-in. deep in the ball and, using a piece of the match as a plug, fix one end of the thread into the ball. Tie the other end of the thread to the centre of the small stick and wind the thread thereon. Now stand over water running in a hose pipe, hold the thread of the pendulum between the thumb and forefinger of the right hand stretching out the remaining fingers (Fig. 4). Give the pendulum an oscillating movement, at the same time slowly allow the thread to unwind. When the pendulum is a certain length the movement will change from oscillation to gyration. Carry out this test several times and the length of pendulum required for the detection of water is then known. This length is not necessarily the same for everybody. The main difficulty in working with a pendulum is to prevent movement by auto-suggestion.

Dowsing for Water.

When searching for underground water, it is desirable that, having located a supply, the depth, quantity and quality should be known.

Location.

It may here be pointed out that a knowledge of geology is invaluable to the dowser since in many cases it narrows the field of search. Again, there are many facts of everyday life which give clues as to the existence of underground water. A large solitary tree standing in the middle of a seemingly waterless plain will be found to have its roots in hidden water. Ancient buildings away from villages and towns usually depend on some local underground water supply. Moles must drink once a day or they die. Fields with molehills should therefore attract the attention of the dowser. A cursory glance at the ground's configuration, on the other hand, may often lead one astray.

Personally, I once discovered that, while a 60-foot bore in a likely looking valley yielded nothing, water was disclosed by the rod at the top of a neighbouring hill at a depth of six feet.

It would be well to consider here the manner in which water flows underground. One hears much loose talk of underground streams and rivers. Such things do undoubtedly exist, but it is unusual to come across a rushing underground torrent. Normally, the source of supply consists of a stratum of saturated soil through which the water slowly moves. Through a fissure in chalk or rock the movement may be rapid; through gravel, noticeable; but through fine sand, almost imperceptible. In the latter case, extraction calls for special strainers and some skill on the part of the well-borer.

To survey completely an area for subterranean water by dowsing is tiring and usually unnecessary.

Assuming that water is required in a certain area, then one should proceed as follows: Go to the centre of the area and hold the rod in the position of readiness (Fig. 1). Slowly turn the body clockwise. If the operator is reasonably sensitive and water exists, the rod will lift or dip when it is pointing towards a supply and at right angles to the direction of flow. Move off in this direction grasping the rod firmly. Sooner or later, the rod will react smartly. Mark this place with the heel and continue in the same direction for about 50 yards. Now turn about and go back towards your heel mark still holding the rod. Another reaction will be registered. Mark this place. Half-way between the two marks is usually above the centre of the water. The line of flow is at right angles to the line between the two marks. Test yourself by repeating the operation several

times. The pendulum can be used to confirm the direction of water given by the rod. Set the pendulum to the required length for detecting water. Hold it in the right hand and cause it to oscillate. Point with the left arm. When pointing in the direction of water, the pendulum passes from oscillation to gyration.

DEPTH.

I have found that a light hold on the rod will give a reaction over water which is near the surface. The deeper the water the more strongly must one grasp the rod to obtain a reaction. By operating over water of known depth, it is possible to standardize one's grip. This appears to be a clumsy and inaccurate method, but it works —with practice.

Another system is to lay out a 100-foot metallic tape at right angles to the direction of flow, with one end of the tape above the centre of the stream. Stand at the end of the tape which is over the water and face the other end of the tape. Hold the rod in the normal manner and walk in the direction you are facing. After proceeding two or three yards a reaction is felt on the rod. Ignore this, and continue walking. When a second reaction is felt, stop and note the distance on the tape. This measurement is equal to the depth of the water. This should be checked two or three times on both sides of the flow.

A third means for gauging depth is as follows. Stand over the place where you have located water. Raise the rod to the level of the top of the head. If a reaction is obtained with the rod in this position the water is very near the surface. The deeper the water the more the rod must be lowered to obtain a reaction. I have found that when the rod has to be brought down to waist level then the water is about 300 feet deep.

It must be pointed out that results vary with different people and therefore some form of personal calibration is necessary.

Several methods exist for the determination of quantity and quality of water, but successful results can only be obtained after much practice. The methods employed can be read in many of the standard books on dowsing.

PERSONAL EXPERIENCES.

My first experiences in dowsing happened purely by coincidence. With another officer in the Corps, I went down to Dorset some years ago to prepare a water-supply scheme for manœuvre camps. A calculation of supplies available from the local river showed us that sufficient water was unobtainable from that source. It so happened

that an article on dowsing appeared in *The Daily Telegraph* on that day and that a supply of rods was to hand in a near hazel hedge. We each tried our luck at dowsing and my rod reacted very strongly after going a few yards. The War Office called in a professional dowser who confirmed the result of my experiment.

The next phase began in India. A well-boring engineer happened to tell me in the club that he had sunk a number of bores in a tea estate and obtained no water. He was working on the "No water, no pay" principle and was losing money. I mentioned that I had been able to dowse for water in England, with the result that I obtained leave to accompany him to the tea gardens. In all, five sites were selected where I considered water would be found. The first bore was made but only yielded 1,500 gallons an hour. The company was sufficiently encouraged to try a second site. This yielded 30,000 gallons an hour and no further bores were required.

Soon after this, trouble was being experienced on a Government Experimental Farm in an Indian Province. Much money had been spent in sinking a tube well for irrigation purposes but no water had been obtained. I selected a site for a fresh bore within fifty yards of the original bore and gave the probable depth of the water as 120 feet. The water-bearing stratum was struck at 119 feet! I would have felt quite satisfied if the water had been anywhere between 90 and 160 feet.

The yield here was 8,000 gallons an hour. I later received a letter saying that the supply had seriously diminished, but there was a bad crack in the pump casing and that might have something to do with it! Some leave was sacrificed for this task and a benevolent Government allowed the bare fare for travelling and deducted eight annas because Civil Allowance rules only allowed taxi fares from the station to Government House and not to one's quarters.

On a new railway alignment in East Bengal, boring operations had been carried out without success over the previous twenty years at a site selected for engine-sheds. A point to drill was indicated by dowsing where 4,000 gallons an hour were obtained within 20 yards of a previous bore.

An interesting experience was gained in Ganjam District, where a reconnaissance was made to discover water for a camp site. The point selected was a short distance from the sea-shore in sandy soil. Good drinking water was obtained by sinking a Norton tube well to a depth of 12 feet. This was below high-water mark.

Similarly, a copious supply of water was obtained in the Andaman Islands from a bore sunk to a depth of 60 feet on the sea-shore below high-water mark. This water was free from sea salt but contained a fair supply of other salts which gave it the flavour of Vichy water.

In response to a request from one of the Provincial Governments

in India, I agreed to devote sixty days' leave to making a dowsing survey in part of the province.

The formulated task, when it reached me, consisted in travelling 900 miles across country and visiting 66 towns and villages! Needless to say, only a small portion of this work was carried out in the time available.

Altogether bores were made on about fifty different sites that were indicated by dowsing.

As far as I know, none of them failed completely to produce water. In a few cases, the supply was rather meagre but better than nothing.

In England, the problem is rather different from India, as one is often operating where many underground supplies exist. Dowsing for water is often made difficult by the fact that the area being prospected is in a town, where personal reactions are upset by the proximity of steel-framed buildings, piped-water supplies, drains and electric power lines.

In 1934, my first real failure happened. This was at Porton where the existing supplies were drying up. As far as I know, a bore sunk on a new site indicated yielded little result. I suspect the near proximity of existing piped-water supplies had something to do with the lack of success.

The only other practical work undertaken in that year was selection of two places to bore near London, one at a nursery ground near Staines and the other near Watford, where 120,000 gallons per hour were obtained.

The work on both these occasions was commented on by an independent observer in the *Journal of the British Society of Dowsers* (No. 7). As his remarks are of interest, I quote his words :—

> " One diviner I met with claimed that he could approximately tell the depth by the height he held the twig above the ground. Thus, if he obtained the greatest pull when holding the rod (a whalebone one, by the way) above his head, then the stream was near the surface, the lower he held the twig the greater the depth to the stream. There certainly appears to be something in this, for he was correct in the three cases in which I tested him out.
>
> " In one case a bore-hole had been drilled in a nursery ground to the West of London. This bore had been carried to 600 feet and was practically bone dry. This particular diviner selected another spot some 250 yards away claiming that some 4,000–5,000 gallons an hour could be obtained at a depth of about 250 feet.
>
> " A second bore-hole was subsequently drilled at the spot selected, to a depth of 600 feet, and water was met with in a thick bed of sand which was penetrated between 243 feet and 287 feet below the surface.

"This particular bore-hole has not yet been fully tested; it is quite certain that a yield of over 1,000 gallons an hour will be obtained.

"It is worth while noting that this site was also selected by another diviner, who also claimed that water would be met with at the same depth.

"It has always been a mystery to me how a diviner can compute the depth merely by the way he grips the rod, but judging from results obtained, one diviner I know certainly gets good results on the whole, so far as indicating the depth is concerned.

"I am inclined to think that the velocity of the flow of the underground water may have a considerable effect upon the strength of the pull on the rod and that it is quite possible that a small quantity of water travelling at a comparatively high velocity may have an effect out of all proportion to the quantity.

"This theory seems to have been borne out in a case of water-divining not long ago. A shallow underground stream was located in a gravel bed. The quantity of water was computed by a water diviner and given as being about 25,000 gallons per hour. When the necessary excavations had been made and the pumps inserted, a prodigious quantity of water was met with. In fact, it was nothing less than a broad, slowly moving underground stream, not a fissure. The yield obtained was no less than 120,000 gallons per hour and this quantity was pumped continuously day and night for three months. Had this water been flowing through a fissure I am inclined to think the diviner would have estimated a much larger yield."

The Causes of the Reactions of Dowsing.

Many theories have been advanced from time to time as to the explanation of the reactions of dowsing. The question was taken up by the R.E. Board some time ago and the following is an extract from the correspondence that ensued :—

"Mr. ——, M.A., of the Cambridge Physiological Department, who has conducted extensive research work into the Magnetism and Electricity of the human body, states that he sees no difficulty in testing such mediums to ascertain what, if any, connection the divining power has with the physical property of the individual's body. For complete tests, however, the medium would have to be prepared to be punctured with needles."

A willing medium for a "complete" test was not found.

The main argument as to the phenomena of dowsing centres mainly round the discussion as to whether it is psychic, physiological or physical.

Sir William Barrett, who spent many years studying the question, came to the conclusion that dowsing is a physical reaction, pure and simple.

An eminent German scientist thinks that the process of dowsing is the physical stimulus of the nervous system of the operator.

Again, the proved results obtained by some dowsers, such as prospection off a map, can only be grouped as what is at present termed psychic. With the present rapid advance of science, however, the "psychic" of to-day may be the "physical" of to-morrow.

The human nervous system is divided into the cerebro-spinal and involuntary (sympathetic) systems. The cerebro-spinal system supplies the muscles with nerves which convey only voluntary impulses. Since dowsing is involuntary in its action, it is not superimposed on the cerebro-spinal system. It is, therefore, the involuntary nervous system, represented by the sympathetic nerves, that must be examined with reference to the phenomena of dowsing.

The best and most comprehensible explanation I have heard so far is that given by Dr. D. D'A. Wright in an article on the cause of the "Phenomena of Dowsing," published in the first number of the *Journal of the British Society of Dowsers*, and is as follows:—

> "It is a physiological fact that every voluntary muscle of the body has a double nerve supply; one from the cerebro-spinal system which conveys voluntary impulses, and another from the sympathetic nerves through which the tone of the muscle is regulated, and it is to this varying tone or tension of the muscle that the movement of the dowser's rod may be attributed.
>
> "It would be here well to quote other evidence connecting the sympathetic nervous system with processes associated with dowsing. It has been found that particularly sensitive persons sometimes experience faintness or show a marked pallor of the face on passing into the zone of radiation from water, minerals or other substances. This pallor is due to the contraction of the small blood vessels of the skin, which are controlled by the sympathetic system. Again, a sensitive person can be placed in a position facing the west and a bright light made to shine into the eye so as to contract the pupil. A phial containing a drug to which the person has previously been shown to be sensitive is now brought close up to the back of the neck, without the subject's

knowledge. A brief but very discernible dilation of the pupil will then occur, and at the same time a slight acceleration of the pulse will often take place. These are reflex actions brought about through the sympathetic nervous system. These reactions are definitely physico-physiological and can partly be explained on the assumption that certain parts of the nervous system are concerned in their production.

" Evidence exists to show that the human body contains apparatus capable of receiving emanations from substances and transmitting the results to the muscles.

" There are in the brain, the spinal cord and especially in the sympathetic ganglia, certain large nerve cells which have a peculiar structure in that they possess at one end large branching processes much resembling the roots of trees and at the other end are prolonged into a nerve fibre which passes away into the spinal cord, or into the nerves of the body.

" The branches of one cell approach closely to, but do not actually touch, similar branches of a neighbouring cell. Moreover they are motile and capable of being retracted or extended under certain conditions. For instance, in the case of the brain, when sleep comes on it has been proved that these processes retract from one another so that the gap between them is much increased.

," Thus it is seen that cells which are good electrical conductors are interlaced with, but not touching, other similar cells. The insulating matter is a poor conductor. This produces something similar to the condenser of a wireless set and it is not unreasonable to assume a similar action in both cases, viz., that of ' tuning in ' to different wave-lengths and frequencies through a variation of capacity.

" Further, in the nuclei of the cells of the body are microscopical structures capable of ' inductance.' These are called chromosomes. They consist of coiled tubular threads having an outer coat made of a fat-like insulating substance, containing a fluid with mineral salts in solution forming a liquid of high electrical conductivity. It has been asserted that these structures are electro-magnetic oscillators, and that since they vary in size and curvature they all differ in the length of wave to which they are capable of oscillating.

" In the body, then, are two distinct contrivances which are capable of varying degrees of inductance and capacity, both of which are in direct relationship with the nervous system. In physiological language, the whole is linked up in a reflex arc ; which consists of a receiving apparatus—in this case, the skin ; a centrally transmitting apparatus—the centripetally directed

nerves from the skin ; a central receiving station—the large nerve cells which are capable of ' tuning-in ' to the various wave-lengths received ; from this again the impulse is transmitted through the sympathetic nerves to the muscle fibres of the arm and fingers which hold the divining rod. Through this impulse, variations in the tension of the muscles are produced, and a turning of the detector thereby brought about.

" These activities are all of a subconscious nature. The brain itself takes no conscious part in the action. In certain cases, however, it would appear that the higher faculties of the brain take a share in the transaction and it is here that a psychic factor appears. Among the expert dowsers on the Continent, it has been found possible, by an effort of concentration and will-power, to tune in the receptive system to the wave-length of particular substances."

CONCLUSION.

Water supply is a constant worry in military operations in many parts of the world. The detection of underground supplies is then a matter of great importance. It is reasonable, therefore, that officers of the Corps, who are primarily responsible for water supplies, should know something of the practical side of dowsing. Further useful applications would be the detection of land mines and also of sub-soil water in regions where mining operations are proposed.

Much has been done in France in the application of dowsing to the study of medicine. A hospital exists in Nice where all diagnosis is carried out by means of the divining rod.

Machines have been produced containing thermionic valves, on which the emanations of substances in large quantities give deflections of a pointer.

In agriculture, the dowser's art has been used to discover the affinity of seeds for certain soil components.

In Paris I met an enthusiastic master of hounds who carried a hunting whip with a copper and zinc stock whereby he dowsed for his quarry when hounds failed to do their job. *Vive le sport !*

An interesting book has been produced in Germany concerning the detection of " Gamma " rays by dowsing. These rays are apparently produced in planes by faults in the earth's surface. Patients in a hospital, whose beds intersected a plane of " Gamma " rays, took longer to recover than the others.

However fantastic these notions may appear to some, it cannot be denied that men have found water through the ages by dowsing. It is, therefore, reasonable in these days of rapid progress that time should not be lost in reducing the art of dowsing to a science.

The following remarks of the managing-director of a widely-known well-sinking firm, in a paper to the British Society of Dowsers, would seem to form an apt conclusion to this article :—

" To sum up, let us be fair to the diviner. He is up against a big problem. So many things conspire to put him off the track, such as the weather, the time of day, the nature of the soil, the diviner's own state of physical health, even the position of the sun may have more than a little to do with it. After all, we do not condemn the medical profession, merely because on many occasions they fail to diagnose diseases correctly. Let us always apply the same line of reasoning to the water diviner and give him his due."

NOTES.

1. BIBLIOGRAPHY.

The Modern Dowser, by Vicomte de France (G. Bell & Sons), 3s. 6d.

The Divining Rod, by Barrett & Besterman (Methuen), 18s.

Water Diviners and their Methods, by H. Mager (G. Bell & Sons), 18s.

2. *Journal of the British Society of Dowsers*. (Annual subscription to the Society, 5s. Life Membership, 3 guineas.)

Hon. Secretary and Treasurer: T. R. Whitley, Esq., White Gates, Lindfield, Sussex.

A SURVEY SOCIAL.

By "O.R."

1.—IT is seldom that an opportunity occurs for a Sapper to travel abroad on a survey job unaccompanied by theodolites, levels, seven-figure log. tables and a mosquito net. Because I had occasion to accompany my Chief on such a trip, and because it entailed a visit to a little-known European country, I have ventured in the following pages to give a short account of our experiences.

2.—As we were pressed for time, we travelled by the overland route *via* Ostend, Berlin and Riga. The Channel crossing was pleasantly smooth, and as we were fortunate enough to be travelling first-class we slept and fed in comparative comfort.

I understand that the Wagon-Lits Company very seldom pay a dividend. This is hardly surprising considering their charges. It is therefore all the more inexplicable that they should spend money on installing two taps over the basin. It is true that if you press both at once, the water flows a little quicker than if you use the one marked "cold" only, but the temperature of the water is exactly the same. Fortunately the car attendant was a most obliging fellow and produced a beaker of hot water almost as soon as it was asked for. It is unlikely, however, that he would have been equally infallible over the question of soap. Perhaps there is no free issue of this commodity on the Continent? However that may be, I never saw this article supplied in any of the trains or hotels in which we stayed, but we had been forewarned and had brought ample supplies with us.

There is little to do in a train but eat, sleep, read or gaze out upon the passing scenery. Eating was distinctly expensive, and it is impossible to sleep and read all day long. I therefore spent a considerable portion of the day studying the landscape, and was disappointed to see little of beauty or interest. Practically the whole of Northern Europe is deadly flat and very monotonous. Belgium and Western Germany are very akin to our Fen country, while Eastern Germany, Lithuania, Latvia and most portions of Estonia appear to consist largely of a sandy soil, in which trees of the fir variety flourish in great profusion. Even the Vistula was a disappointment, the water being low and very muddy.

As we were due to arrive at Virbalis, the frontier station of East Prussia and Lithuania, at 7.45 p.m. we decided to have dinner after

leaving that place. But when we enquired at what hour the meal would be served, we were dismayed to find that the *Speisewagen* (restaurant-car) was no longer with us, and that we should not pick up another one that night. A rapid glance at the time-table showed us that we were due at Kaunas at 9.22 p.m. Surely there would be some sort of buffet there? There was not; not even a hot-dog man!

The situation looked bad. Fortunately the car attendant was able to produce two glasses of weak hot tea, complete with lemon and sugar, but we still had nothing to eat. "Oh, yes, we have," said my companion, and he straightaway produced from his pocket two pieces of toast, wrapped in an air-tight packet, which he had pocketed in the dining-car at breakfast that morning.

"You never know," said my companion. "Did you get anything?"

I had to admit that the idea had not crossed my mind. As Acting-Adjutant, I had already proved a failure! But had I? A hasty search in a suitcase brought to light a packet of chocolate that I now remembered buying on the Ostend–Berlin train. Picture, then, the two of us making our dinner off a toast and chocolate sandwich and a glass of hot tea. It may sound a nasty mixture, but hungry men enjoy strange fodder.

3.—We reached Riga at 5.40 a.m. Even at this unearthly hour the Hotel Bristol was open to receive us and a night-porter available to show us to our rooms. Having thrown the windows wide open, I felt better. There was a comfortable bed, a separate annexe with shower-bath, basin, etc., steaming hot water and a telephone. There was also one bell-push, and underneath it a little tablet, with the numbers 1, 2, 3 written upon it. Opposite number 1 was a drawing of a waiter travelling at enormous speed (judging by the elevation of his coat-tails) and carrying a tray of wines. Opposite number 2 was a very dainty damsel. Against number 3 was a sketch of a man doing something or other. It did not matter, anyway, because the choice obviously lay between numbers 1 and 2. After some hesitation, I pressed the bell firmly—twice!

She was just like the drawing and had the most engaging smile. The breakfast she presently brought—a roll, some brown bread (very good), butter and jam, a piece of cake (nasty), and coffee (filthy)—tasted much better than might otherwise have been the case. But as the room was still distinctly warm, I soon began to feel drowsy, and slept soundly until about half-past eleven.

After thirty-six hours' travelling, chiefly in trains, it was pleasant to walk round the town. The streets were mostly narrow and roughly paved, but all very clean and the Daugava river in width and colour reminded us strongly of the Thames. Some of the roads were lined with trees, and there were some well-kept parks with

small lakes, closely resembling London's open spaces, but much smaller. We found a restaurant in one of these, where we had quite a good lunch at a reasonable price. The orchestra regaled us with cheerful tunes, but the players looked bored to tears. The general populace, in fact, looked none too happy, and from the little we saw of them we got the impression that the Latvians were not a very prosperous or cheerful race.

At one o'clock it began to pour with rain.

Our hotel had very obligingly provided us with a plan of the town, and various pamphlets on the beauties and amenities of the country. These appeared to be of little interest, as we were there for only one day, when I happened on the page headed "The Riga Seaside." Underneath this more promising heading I read: "Bathing hours:—Mixed bathing is allowed, but costumes must be worn, from 6 to 8 a.m. and from noon to midnight along the whole strand on weekdays. Bathing without costumes is also allowed on weekdays: to men from 8.15 to 10.15 a.m.; to women from 10.15 to noon."

Before I could even find the place on the map, I was amazed to see my companion already in possession of a time-table. But alas, it was pouring with rain; the place was nearly an hour's train or tram journey from Riga; it was a Sunday and it was already afternoon!

At 8.10 next morning we forgathered in the front hall of the hotel. At 8.25 an argument over the bill was still in progress. However, with the assistance of a Cook's man, a satisfactory solution was arrived at, and we were soon at the station. A ragged but cheerful porter seized my cases, and immediately began a long harangue, accompanied by much pantomime. I gathered that he had fought for the Russians in the Great War, was fed to the teeth with peace, and lived solely in the hope of there being another war in the near future. In very truth it is an ill-wind that brings nobody any good. I should have liked to have heard more, but was now too worried to listen further, owing to the fact that I could not find my ticket. My companion besought me to be calm; the ticket was found; and punctually at 8.42 the train steamed out of the station.

There is little to be said about the journey from Riga to Tallinn. The second-class carriages—there are no first on this train—were quite comfortable, but ten hours in the sitting position is too long for comfort. The food in the restaurant-car was quite good and cheap, except for butter, which cost twopence for a very small portion. The country, thickly wooded with fir, was monotonously flat and the atmosphere stuffy. Soon after half-way, the carriage filled up and my companion suffered much inconvenience from a small boy who trod all over his feet every time he made one of his frequent visits to the corridor. After much physical exertion, I managed to raise the window, to the ill-concealed disgust of the other passengers. But it

immediately began to rain hard and clouds of sand blew in, so we had to be satisfied with only a short breather. It was two very grimy and tired individuals who finally crawled out on to the Tallinn platform at 7 o'clock on Monday evening, three days after leaving London.

4.—The Estonian Republic is situated on the eastern coast of the Baltic. Although this country has seldom appeared in the news since the war, it has had a long and chequered history, and more may be heard of it in the future. Owing to its position, it is not likely to play an important part in Great Britain's political or economic history, but there is quite an extensive trade, which is tending to increase, between the two countries, and the Estonians are showing a distinct desire for closer relations with England.

The population consists of 88 per cent. Estonians, 8 per cent. Russians, and 4 per cent. other nationalities, of which nearly half are Germans. It is therefore quite understandable that the national language should be Estonian—a new one to me, I must admit !—and that many of the inhabitants should speak Russian and German. In fact, except for Constantinople, which is probably unique in this respect, Tallinn is by no means a bad port of call for anybody wanting to learn or rub up a number of foreign languages, for there should be little difficulty in getting lessons in Russian, German, Finnish, French, Polish and Estonian.

The Estonians are not a modern race. They have inhabited their country—although it has seldom been theirs—since the beginning of the Christian era. About the middle of the fourteenth century the country suffered its first eclipse, being conquered partly by the Danes and partly by a German Order of Knights. In 1346 the Danes apparently became homesick and sold their portion to the Germans, but about the middle of the sixteenth century the latter disrupted—another form of homesickness—and the whole country gradually became a Swedish province.

It was then the Russians' turn. In 1710 Peter the Great occupied the country and the Russians remained in possession until the fall of their monarchy in 1917.

Now, at last, it was the Estonians' turn. In 1917 the Diet met in Tallinn and proclaimed an independent democratic Republic of Estonia. This did them little good, however, as the country was soon afterwards occupied by the Germans, with the idea of making it a Duchy in personal union with the Crown of Prussia. But the truce of November 11th, 1918, once more put the Estonian Provincial Government in control.

The nation's troubles were, needless to say, not yet over, as the Bolsheviks saw no reason to bother about the principle of self-determination in this case, and they prepared to conquer the country. But the Estonians were by now heartily sick of all this chopping and

changing—it was really quite impossible to know to whom they did belong—so a few schoolboys bought some rifles from some of the Russian inhabitants and prepared to sell their lives dearly. Finally, the Estonian Army, supported by some Finnish volunteers and a British squadron, succeeded in securing the so-called national frontiers, and a treaty was signed in Tartu on the 2nd February, 1920, Russia agreeing to give up all her claims. Thus, after nearly seven centuries of foreign domination, Estonia was once more a free, independent country. It is interesting to speculate how long it will be before her independence is again threatened.

5.—After so much travelling, a bath and early bed would have been very welcome. But the first person we met in Tallinn was Dr. J. de Graaff Hunter, not long since Geodetic Adviser to the Indian Government, and he immediately informed us that we were due at a reception, given by the Minister for National Defence, at eight o'clock. There was just time to put on a tail coat and dash off to the party.

The fellow who was left without a language at the Tower of Babel affair must have felt rather out of things. I had somewhat the same feelings myself as I entered the reception hall and heard old friends greeting each other in many strange tongues. But very soon the inner doors were thrown open and a table laden with good things was displayed to view. As we had had nothing to eat since the lunch on the train, it was obviously not the time to hang about in the background.

There appeared to be an unlimited assortment of eatables, mostly of the *hors d'œuvre* variety. Each guest seized a plate, knife and fork, selected what most suited his or her fancy and either fed standing or seated at one of the tables scattered around the two adjoining rooms. Having finished the first plateful, one refilled it from another dish and returned to the table or joined one of the other parties. *Vodka*, or "schnaps" in slang language, was the chief alcoholic beverage, although white and red wines and liqueurs were also served. One member of the party would raise his glass, propose a toast, and all glasses were drained. The glasses were refilled as if by magic, and the toasts were frequent!

In Poland *vodka* is made from many different varieties of fruit, but in Estonia it is made chiefly from potatoes. It has a slightly methylated flavour, and looks like water. But the after-effects are by no means colourless! Three or four liqueur glasses of this beverage produce a pleasant feeling of internal warmth, and after six or seven I was quite prepared to carry on an animated conversation in any language. There were, however, several people present who were only too pleased to try out their English, and we heard many amusing and hair-raising stories about the Russian Revolution. The time passed all too quickly, but there is no denying that we were

A Survey social.

quite ready for bed when we arrived back at our hotel soon after eleven o'clock.

The next day, Tuesday, the Commission forgathered in the Town Hall for the opening ceremony. The leading delegate of each country attending spoke a few words, saying how pleased he and his fellow-members were to be present. All spoke in German with the exception of the Norwegian delegate and our own representative, who both spoke in English. While my companion was saying his piece, there was suddenly a vivid flash and a vast cloud of smoke ascended to the ceiling. As we were only guests, Great Britain not being a member of the Commission, we were highly flattered to think that the British representative was the only one to have been photographed. The result, which is reproduced opposite, was therefore a great disappointment, although, as my companion pointed out to me, people always do look like that when taken by flashlight!

6.—There are various bodies scattered about the world who interest themselves in geodetic work and methods, perhaps the best known being "The International Union for Geodesy and Geophysics," which was founded after the Great War. In 1924 a new international organization was founded, the Baltic Geodetic Commission, which undertook to verify and organize geodetic work throughout the entire area of the Baltic. The countries belonging to this organization are: Finland, Estonia, Latvia, Lithuania, Poland, Danzig, Germany, Denmark, Sweden, and since 1929 the U.S.S.R. Great Britain, it will be noticed, is not a member, and we were therefore greatly indebted to the President, Dr. R. E. Nörlund, of Denmark, for his kind invitation to us to attend the meeting.

Since there can be no doubt that survey in future wars is likely to prove of even greater importance than it did in the last, it is unfortunately necessary for some Sappers, at any rate, to have some knowledge of geodesy, etc. Unfortunate, because it is such a complicated subject that nobody can really understand it. The earth possibly started as a simple sphere, and it is a great pity that it did not remain one. However, presumably owing to its unstable composition and its absurd persistence in buzzing round at an enormous speed, it rapidly began to bulge in the middle and shrink inwards at the poles. It then became a rotating ellipsoid, or in the vernacular, a spheroid. This was definitely a bad thing. But not content with the complications which it had already introduced into the unfortunate surveyor's calculations, it went on buzzing round and lost all control or sense of proportion. It is now, I believe, a geoid, which is a simple way of saying that it is all sorts of shapes in different places. This is definitely a disaster, because it means that no survey is really right, and it is a frightfully complicated matter to get any survey right enough for nobody to be able to say that it is wrong.

Nothing daunted, the Baltic Geodetic Commission has determined to try to solve some of these intricate problems, and so to study the form of the geoid in the area of the Baltic. Their work will also provide a uniting link between the triangulation systems of the countries bordering the Baltic; with the 25° 20′ meridian arc from the north of the Danube to the Arctic (already done); with degree measurements (partly carried out) intended to extend from the Arctic to Egypt and along the 30th Meridian from Egypt to South Africa; and finally with the projected connection of the U.S.A. and U.S.S.R. triangulation systems by way of the Behring Straits. As the British Empire is obviously interested in the mapping of Europe, Asia and Africa, there is no need to lay further stress on the importance of the work now being carried out by the Baltic Geodetic Commission.

7.—During our three days' stay in Tallinn, the capital of Estonia, much of our time was taken up with official functions, including luncheons—which were enormous meals lasting at least two hours—teas and official sightseeing trips. We were also able to wander round the town on our own and examine some of the very fine old fortifications, churches and buildings. The whole place was extraordinarily clean, and the people appeared to be very cheerful, if not particularly prosperous. For those who like modern relaxation when the day is done, there are cinemas, of a sort, and a quite excellent *danse palais*, with a good floor, a pleasant band, and a cheerful atmosphere. At least, it was pretty cheerful during the few hours that we, and many other members of the Commission, were there.

By Thursday evening most of the serious work of the Commission had been completed, and that night we started on a short tour of the country. We had been advised to arrive early at the station, which the train was due to leave at 11 p.m., and we actually found ourselves there, the first members of the party to arrive, at exactly ten o'clock.

My companion had been allotted a carriage to himself, while I found myself booked to share a four-berth one with Dr. Hunter. The two bottom berths had been made up, but as he had not yet arrived and I much prefer sleeping "upstairs," I proceeded to change the clothes to one of the upper berths. I then had a look round our coach.

The neatly-printed visiting cards outside each carriage door informed me that we were to be a "mixed" company; that is, one carriage had been allotted to three of the ladies (two unmarried) of the party. There was nothing to worry about in that—until I discovered that there was only one wash place, which would have to cater for some twelve people, of varying sex, in the morning. Feeling a little hot and bothered, I attempted to open our carriage window, and after getting a good deal hotter and very dirty at last succeeded in doing so.

By this time most of the remaining members of the party had arrived—and collected on the platform outside my companion's carriage, from which proceeded sounds of vigorous hammering and violent expressions of displeasure. Enquiring as to the cause of this unseemly disturbance, I found that he also wished for air in his carriage, but could not get any. Had anybody got a hammer? Unfortunately nobody had brought one with him, but seizing a spittoon from the floor, I was soon hard at work on the window. The crowd egged us on with cheers and laughter, but to no effect. The station staff were also amused at our efforts, but could offer no helpful advice. It looked as if my companion would have to sleep with his door open, but just before the train was due to start an engine-driver, temporarily out of a job, arrived, and with the assistance of a bag of tools produced from somewhere succeeded in getting the window half-open. With a loud cheer, the party climbed aboard.

It was lucky that both I and the engine-driver had achieved only a partial success. As we drew out of the station, it began to pour with rain, and as it proved quite impossible to shut the window again, I wrapped my mackintosh round the end of the bed and prepared for a wet night. Actually very little rain came in.

Extracts from a diary for the next three days :—

"Friday, August 23rd.—Line not very well laid, but had quite a good night.

"Visited the Tartu Observatory and the ruins of a church burnt down by Ivan the Terrible. Any ruined building which we are shown in this country is certain to have been destroyed by Ivan the Terrible, who seems to have thoroughly deserved the name, and any house is certain to have been slept in by Peter the Great. (Rather like Charles II. oaks and Elizabeth's beds in England.) Then to Tartu University for greetings in German and Latin and afterwards a lunch, which lasted two hours as usual. Then 50 km. by bus to a fine lake, which would have been a very pleasant spot for a picnic on a hot day, but was a little depressing at 7 p.m. on a dull evening. Having no towels or suits we did not bathe. Train left Tartu at 11.30 p.m.

"Saturday, August 24th.—We visited the Narva cotton factory, run by water power and the most modern machinery, and then went to the Barracks. I gathered that the Estonian Army numbers about 15,000 men, 25 per cent. being regulars and the remainder conscripts, who serve for one year. The Navy consists of 1 torpedo-boat, 4 gunboats, 2 minelayers and 2 minesweepers, the personnel being 35 per cent. regulars and the remainder conscripts. Two submarines (620 tons) are now being built.

"The bus then took us to Narva-Jõessuu, which is a coast resort. Unfortunately there was a cold wind blowing and the season appeared

to be over, because there was nothing on the beach except sand. Lunch lasted until 5.15 p.m., so we thought it advisable to take a long walk along the coast. I was surprised to find that the Baltic tastes almost exactly like fresh water, there being no salty flavour, but I have not yet learnt the reason for this. As far as I remember the Mediterranean, a rather similar inland sea, had a distinct salty taste. After supper we returned to Narva and our coaches are remaining in the siding for the night.

"Sunday, August 25th.—We returned to Tallinn to-day, stopping *en route* to look over one of the Government's oil refineries. They extract oil from a pale-brown coloured stone or shale, of which there is a large bed in this district. They actually burn this stone, using it exactly as we do coal, in some of their locomotives.

"The discovery of this oil-bearing rock was, like most discoveries, an accident. One day a peasant built a fireplace, and when all the fuel had burnt away, was surprised to see the fireplace itself burning merrily. The stone lies very near the surface, averaging about 30 feet down as far as I could see, and various grades of oil are obtained from it. The price of petrol to the public is about 9d. a gallon, so motoring in this country should be cheap. Cars seem to run on it quite efficiently, but the exhaust has a terrible smell."

8.—On Monday afternoon, nearly a week after arriving, we left Tallinn for the last time with much regret, and travelling straight through by the overland route arrived at Victoria exactly two days later. We had been royally entertained for the whole of the trip and we shall find it hard to forget the friendliness and hospitality both of all members of the Commission and of all the people we met in Estonia. Although the first-class train journey is very expensive, the route by boat from Hull to Tallinn, which takes about five days, is very comfortable in fine weather, and costs only about £18 for the return (first-class) journey. Living in Estonia is very cheap, a single room and breakfast in a good hotel costing about 6s. There is also good bathing, sailing, fishing and shooting. By no means a bad place for a short holiday abroad.

ERRATUM.

IN the March, 1936, issue of *The Royal Engineers Journal*, on page 77, line 12 of the article entitled "The Work of the Contracting Engineer," the words "for estimating purposes only, the value of C," *should read* "for estimating purposes only, the value of E."

Lieut Gen Sir George Fowke KCB KCMG

MEMOIRS.

LIEUT.-GENERAL SIR GEORGE H. FOWKE, K.C.B., K.C.M.G. COLONEL COMMANDANT R.E.

GEORGE HENRY FOWKE, the youngest son of William Villiers Fowke, of Saling Grove, Essex, was born on the 10th September, 1864. During his earliest youth he lived in Florence, to which he later ascribed his remarkable fluency in modern languages. He passed into the R.M.A. from Wellington College and obtained his commission in the Royal Engineers on 15th February, 1884. Master of several languages and an insatiable reader, with a wonderful memory, his passage through the "Shop" and all subsequent examinations needed little exertion on his part, and thus he earned the undeserved reputation of being a rather idle youngster. At the same time, he told a friend that after getting his commission he realized he knew nothing of mathematics, so set himself to make good the deficiency; starting with arithmetic he worked until he had a thorough grounding in, and working knowledge of, every branch of mathematics which would assist him in his profession. Wherever he went he had the knack of gathering a cheery crowd around him, and his laugh which he retained throughout was highly infectious.

At the "Shop" and the S.M.E. he had a great reputation for football and cricket. He was captain of the Shop Rugger team in his second year, and played cricket for the Corps entirely for his energetic and accurate fielding and throwing in, where his superabundant energy and example on the old unenclosed sloping cricket ground saved many runs, but what he really loved was hitting hard in the right-hand court of the racquet court to the detriment of many a racquet.

Fowke never kept a journal at any time in his life, and until after his marriage hardly ever wrote a letter, even to his own relations, so the writer of this memoir has had to rely mainly on the personal recollections of his friends, and the record is for that reason incomplete.

The following is an extract from a contemporary's note :—"A year "at Gib. and the services of George Fowke, the smart subaltern an "efficient engineer, became a bone of contention between the Chief "Engineer and the O.C. Company. The new defences authorized "under the 1887-8 Defence Loan were of paramount importance, so "the C.E., Colonel Papillon, demanded first choice, and to Fowke "fell the responsibilities of laying out and constructing the new gun "emplacements on the northern peaks of the Rock. His great

" success here laid the foundations for his future employment in large " construction works at the Curragh, etc.

" His motto was ' Work hard and play hard.'

" Fowke was a great reader, an amusing *raconteur*, and a beautiful " linguist and, having a fine memory, he was a champion solver of " old *World* acrostics. He had many opportunities of indulging in " his favourite sport during the winter shooting seasons in Southern " Spain. He played all games with exuberant spirits and great " force rather than skill. The energy with which he backed up his " fast underhand grubs made a timid batsman really believe he was " being charged by a bull. He always had ' rotten luck ' with his " cricket, tennis and racquet bats which broke with such ease. His " beaming smiles and infectious laughter always brought speedy " forgiveness from the many victims of his endless practical jokes, " which were a joy to him and a source of innocent merriment to " many.

" The genial jovial George added much to the gaiety of the Rock, " where he was most popular with the whole garrison—wherever " Georgie went his friends were wont to go."

I first met him at the Curragh in 1891, on his return from his first tour of foreign service at Gibraltar, with a great reputation for smartness in drill and general military efficiency vouched for by our local martinet, Colonel Keith, once Brigade Major at the S.M.E. In those days, 1888, the R.E. at Gibraltar were so strong that they drilled as a battalion, and ceremonial drill by the R.E., under Fowke, the Adjutant, was one of the sights at " the Rock." He was a very fine figure of a man, full of life and energy, doing everything with all his might, never sick or sorry, and quite indefatigable. We at once formed a close friendship which lasted to the day of his death. In 1891, he was a junior captain with about seven years' service; he was appointed officer in charge of the reconstruction of the Curragh Camp—originally built in 1864–5 from huts surplus after the Crimea War. He threw himself into the work with all his customary energy and zeal and quickly justified his selection for the important work he had to carry out for the next seven years.

Fowke's career is a complete answer to those officers of the Corps who hold the opinion that employment in the works services side of the Sapper's duty is derogatory to himself and the Corps.

There never was a suggestion that these seven years, or others later on in his career spent on Public Works, ever dulled the edge of Fowke's military efficiency or reliability as an officer for an instant. On the contrary, whenever Fowke completed a period on Works he was invariably selected to fill some first-rate military appointment.

All the time he was employed at the Curragh he was the life and soul of the R.E. Mess and leader in all games and any energetic form of exercise, bicycling, racquets, walking.

Fowke had a fund of stories of various incidents and accidents which had happened within his knowledge and these were collected into a manuscript volume named *Folk Lore*, and kept in the Mess to make Guest Nights go well. However wild the incidents may have sounded, they were all duly vouched for by one or other of his friends.*

He finished the work at the Curragh in 1897, and was transferred at once to command the 26th Field Company at Aldershot. I came home from abroad about the same time, and we resumed our former comradeship in the Mess for about two years more just as if it had never been broken. His great charm was that you could take him up again after years of absence and find him exactly the same as when you left him—though he never wrote.

He was transferred in August, 1899, to be Captain in the 23rd Field Company at Aldershot, which was then being raised to higher establishment preliminary to embarkation to South Africa, where it arrived just in time to be shut up in Ladysmith. During the siege, he and E. V. Turner were selected as the R. E. officers to lead a raid, on the 8th December, 1899, to destroy two Boer guns, a Long Tom and a 40-pdr. on Gun Hill, which gave considerable annoyance to the garrison. No description from Fowke exists of this brilliant episode, but a contemporary diarist has written "the raid was gloriously successful. It was a lesson in military expedition to see the Engineers going to work at gun destruction." Fowke never told me anything about the raid except that General Sir Archie Hunter supplied the R.E. party with cigars, so that there should be no difficulty in lighting the fuses of the guncotton charges. It was characteristic of him to remain at the top of the hill until the raiding party had cleared off, in order to make a thorough examination of the damage done, thereby causing some anxiety to the commander of the enterprise until the R.E. reported all present. He was mentioned in dispatches on 2.12.99 and 23.3.00, and awarded a Brevet Majority on 29.11.00.

Throughout his service he was greatly interested in explosives and was most expert in handling them. In France he delighted in taking German bombs to pieces, smoking a cigar the while, not always to the delight of the officers sitting in the same room with him.

After the siege he accompanied the 23rd Company to Lydenburg and thence to Middleburg, Transvaal. There he was closely connected with the manufacture of Rice's Blockhouses which contributed materially to the successful conclusion of the war.

In 1901, shortly after the annexation of the Transvaal, the Military Governor—Sir J. G. Maxwell—asked the E.-in-C., Major-General Sir Elliott Wood, for the loan of an R.E. officer to undertake the duties of Town Engineer of Pretoria. Sir Elliott Wood, whose A.D.C. I was at the time, asked me if I knew anyone who could and

* No trace of this volume can be found. If any officer knows of its whereabouts, would he communicate with the Secretary, Institution of R.E.?

would accept such a job, and I immediately suggested Fowke's name, knowing of his success at the Curragh. General Maxwell asked that Fowke should come and see him. That settled the appointment to my mind, for no one could resist the atmosphere of *bonhomie* and confidence which personal contact with Fowke always inspired.

Fowke took up his duties on 1st May, 1901, and at once attracted to himself a *coterie* of R.E. officers who were employed in various capacities in Pretoria. The Mess he formed became as popular a resort as the R.E. Mess at the Curragh, and held together long after he had gone home.

During the next three years Fowke built up the Public Works Department, with the help of the *Regulations for Engineer Services*, on an organization of 5 districts, each under its own engineer who was responsible to him for all the work in his district and for the expenditure of his share of the special loan budget. The personnel of his staff were selected from applicants from the colonies in S.A. and elsewhere, few of whom had any Civil Service experience. It was highly interesting to watch how this heterogeneous group of workers gradually fell under the influence of their chief and acquired a reputation for efficiency and rectitude which gained the confidence of the principal financial officers of the Government. The special loan was provided by the Home Government and was intended to make good the war damage to the Government Buildings. When it is realized that nearly every public building in the many and widely-separated country towns had been either pulled down or converted into a blockhouse, some idea of the scattered and various nature of his responsibility can be realized. As time went on, the P.W.D. Transvaal gradually absorbed the others, Natal, Orange River Colony and Cape Town and finally became the P.W.D. Union of South Africa. No small memorial to its founder—it was stamped all over with his own personality and integrity for honest dealing—admirably established in its highest position some years later by his warm friend and admirer, Dr. Charles Murray, C.M.G., of Aberdeen, an original member and Lands Officer of Fowke's Public Works Department, Transvaal. I cannot recall that he ever made a set speech in the Chamber of the Legislative Assembly, but his remarks were always received with attention and his advice was usually followed. In 1904 he went home, to the universal regret of all who had dealings with him.

On arrival he was sent to Plymouth, and then once again to Salisbury Plain, accompanied by his pony, *The Babe*, which he had brought home with him from South Africa.

On 5th May, 1905, he was selected to go to Japan as one of the Military Mission with the Army in Manchuria. After remaining with the Japanese for a year, he returned home with the boast that in spite of the cold he had never worn a waistcoat all the time he was in Manchuria !

He received the Japanese war medal and the Order of the Sacred Treasure (3rd Class).

He had an opportunity of showing what he had learnt at Port Arthur when, as Chief Instructor in Fortification at the S.M.E., he conducted a Siege Operations Staff Ride in 1907, directed against the forts of Chatham, as realistically as was possible in peace-time.

After two years at Aldershot and four years at the War Office as A.A.G., R.E. and Inspector R.E., he embarked for France on August 5, 1914. He must, therefore, have been known personally to all the Staff and to nearly every one of the R.E. officers of the original British Expeditionary Force, and was thus admirably fitted for the appointment of Engineer-in-Chief.

In accordance with *F.S.R.*, 1914, no executive duties were entrusted to the Brigadier-General R.E., G.H.Q., who was to be employed in an advisory capacity only. Fowke's official staff consisted of one warrant officer clerk, his transport was a motor-car, which he had to share with the Inspector of R.A.; he was graded as an Inspector of Infantry; his designation was Engineer Adviser. To get his work done he was dependent on any unemployed officers he could find to gather in as his assistants. The first duty he was called upon to perform was the reconnaissance and marking out of successive defensive positions for the B.E.F. to occupy while retreating from Mons. Needless to say that, due to the conditions of the front, very little advice or other useful help could be given, though by his own personal exertions he managed to get one or two bridges destroyed, notably the one at Soissons.

After the first battle of Ypres, when the rival armies had stabilized their lines, Fowke clearly appreciated that his chief duties would not be solving engineering problems but reorganizing and distributing the personnel already provided. He at once entered into the work with his usual enthusiasm. Firstly, Divisional Engineers had to be increased; secondly, the staffs of Chief Engineers of Corps had to be strengthened in personnel and units; and while he was engrossed in this he was suddenly met with urgent demands from nearly every part of the Front for means to reply to a completely new danger—mining. No special provision for this had been made before the war, but on the first mention of the danger the War Office sent out a Civil Engineer, Sir John Norton Griffiths, *M.P.*, who as a contractor had long experience in tunnel construction for sewers in clay, to consult with Fowke as to how his special knowledge might be applied to military mining in Flanders.

In a few hours Fowke and Norton Griffiths had drawn up the first establishment of Tunnelling Companies, as these units were to be called, and so successful was Fowke in his building up of the organization, that they were soon known to be the most efficient and best organized units for any engineering work in France.

This is an example of Fowke's quickness in recognizing the value

of new ideas, no matter how unfamiliar they might be. Each demand was treated by him in the same way, and special units for Forestry, Gas, Camouflage, Water Supply and Land Drainage, etc., etc., were considered, organized, and added to the Army almost daily; no one ever saw him flurried or put out.

In the hurly-burly of re-organization, his own office and title came in for consideration, but not at his own instance. It was suggested to him by a brother officer on the General Staff, that in former wars "Engineer-in-Chief" had always been the title of the senior engineer, and Fowke consented, though rather unwillingly, to be known by that name. This was due to a sort of shyness, and a horror of self-advertisement. The gradual evolution of his office at G.H.Q. must have reminded him of a similar evolution in Pretoria, about 15 years before, when he formed the P.W.D., Transvaal, out of nothing.

After the creation of new units was well started, and his own office had settled down, the ability and personal charm of the Engineer-in-Chief became more widely known, and this engendered general desire on the part of every office at G.H.Q. which had a particular difficulty of its own, to bring it to the E.-in-C.'s office, not because he was E.-in-C., but because of the general belief that Fowke's advice would be worth having, whether or not the subject had anything to do with his office.

His greatness was immortalized in the Christmas Card for 1917, drawn by the artists of the Camouflage School, entitled "War Babies," and dedicated to the E.-in-C. Fowke was very proud of this tribute from his staff.

From this brief survey can be realized the extent of his influence at G.H.Q., which was as remarkable as his personality.

Knowing the close relations with which he had worked with the Adjutant-General, Sir C. F. N. Macready, ever since they landed in France, and the mutual confidence that each had for the other, it was always hoped by his personal staff, that should the appointment of Adjutant-General fall vacant, the E.-in-C. would be selected to fill the vacancy. This is exactly what happened, for when the Adjutant-General, B.E.F., was appointed Adjutant-General to the Forces in February, 1916, Fowke, to the complete satisfaction of his own staff, became his successor, with the rank of Lieut.-General. His immediate predecessor says, "I do not know how Fowke's appointment came about, but I do know that the appointment was an excellent one—the new A.G. and staff were a happy family, and the work, of which I had a good insight from the War Office, could not have been better done—over the many difficulties of man power and drafts he was always understanding and helpful. I could never have wished for a better colleague over in France." He held the appointment until the end of the war, but as he had never graduated at the Staff College, or exercised command in the Field, and was now a

Lieut.-General, there was no further employment for him, and he retired at the comparatively early age of 58, a very real loss to the Army and the Corps of Royal Engineers.

The following appreciation of Fowke is written by one who had to work with him very closely during the early part of the war and had ample opportunity of studying his character.

" From his earliest days at the ' Shop ' Fowke was marked as an " outstanding personality and so it was at the S.M.E. also. His " invariable cheerfulness and good humour were most notable and " his good stories and infectious laugh were well-known features of the " Mess life at Chatham. He had the keenest appreciation of humour, " was an excellent *raconteur*, and a delightful and inspiring companion.

" He took little interest in the obvious or matters of routine, but " delighted in the solution of problems or knotty points. Through- " out his service, and indeed throughout his life, he never lost this " trait. Extraordinarily quick at the uptake, of wide experience " and sound in judgment, he impressed everyone with confidence in " his opinions. Thus he was an ideal man to work for or under, content " to confide all routine details to his staff and to deal himself only with " major matters. As Engineer-in-Chief in France his personality " and influence were invaluable in obtaining for the Corps its due " share of requirements in personnel and matériel in the earlier " stages of the war.

" Mention must be made of his unique knowledge of the officers, " not only of the Corps, but of the Army at large, their antecedents " and qualifications. Unquestionably this knowledge contributed " to his appointment as A.G. in France. As such he was singularly " impersonal and impartial in his dealings. If he had any prejudice " it was directed against individuals who showed signs of self- " advertisement or settled melancholy, characteristics entirely " opposed to his nature. In Fowke we have lost the biggest man of " our generation in the Corps."

He settled down at Dinard, and lived in retirement in the greatest happiness until his sudden death on 8th February, 1936, leaving his widow, Beatrice, the daughter of Mr. E. Wynne Roberts, after 24 years of joyous happiness, and a host of friends to mourn his loss.

During the war he received the C.B. (1915), the K.C.B. (1916), and the K.C.M.G. (1918). He was also awarded the Legion of Honour (3rd Class), the Order of Leopold (3rd Class), the Belgian Croix de Guerre, the Military Order of Avis (2nd Class) and the American Distinguished Service Medal.

He was gazetted a Colonel Commandant in the Royal Engineers in April, 1921.

R.N.H.

MAJOR-GENERAL GEORGE ARTHUR JAMES LESLIE, C.B., C.M.G.
COLONEL COMMANDANT R.E.

ON February 26th, 1936, there passed away at Bournemouth a very distinguished officer of wide experience in the Corps, and one who was marked out for still higher distinction as a soldier and leader of men, had Fate been more kind to him.

George Leslie was born on December 23rd, 1867, and was therefore little over 68 at the time of his much lamented death. Educated at Dulwich and King William's College, Isle of Man, he passed high into the R.M.A., Woolwich, in the spring of 1885, and there soon became prominent in the realm of sport. A stalwart of magnificent physique, he gained a place in the Shop XV in the season of 1885–86, and captained it the following year; while he narrowly missed a place in the Shop XI of 1886 as a fast bowler. He proved himself also a fine horseman by winning the saddle of his batch.

Passing out of the Shop on February 16th, 1887, Leslie was gazetted to the Royal Artillery; but three additional commissions were granted later to the Sappers, and he was transferred to the R.E. on March 16th, 1887. He thus enjoyed the uncommon experience of being a Gunner first for the period of one month; while it may truly be said that what the Gunners lost in his personality and character proved a great gain to the Sappers.

As at the Shop, so at the S.M.E., Leslie took a leading part in the athletic activities of the Corps, particularly on the football field. His great dash as a powerful forward won him a place also in the Blackheath XV, and he might have gained an English cap had he not been transferred to India early in 1890. He frequently played cricket for the R.E. teams, too, and stroked his batch four on the Medway, thus clearly displaying his all-round ability as a keen sportsman. He spoke French fluently and was, moreover, a pianist of no mean merit, who added to the sparkle of many a cheery guest-night at Chatham.

On completing his two years' course at the S.M.E., Leslie was appointed to the submarine mining branch of the Service there, but proceeded to India the following year, when he joined the M.W.D. at Lahore. He was soon posted again, however, to submarine mining, being stationed at Monkey Point, Rangoon, from March, 1891, to October, 1892, and then at Karachi until March, 1894. That was his last spell with submarine mining, for he was shortly after transferred to the M.W.D. as an Assistant Engineer at Loralai. Here he served from May, 1894, until November, 1895, when he was

Maj Gen George Arthur James Leslie CB CMG

moved to Aden in a similar capacity before proceeding home on leave in 1896.

On his return to India he was posted to the M.W.D. at Quetta, where he soon became one of the mainstays of the R.E. polo team at that station, which enjoyed a high reputation under Captain (now Colonel) P. E. Dixon. He played a prominent part, too, in local racing, being a fine judge of horse-flesh; and though his weight precluded him from riding races himself, at most meetings in Baluchistan and Sind his ponies met with a considerable measure of success.

Leslie soon exhibited a gift also for mastering Oriental languages; and it seemed simple for him to acquire fluency in a number of tongues spoken by the inhabitants of the regions in which he was stationed. Thus Pushtu and Baluchi, besides Urdu, Hindi, Persian and other exams were successfully passed by him, bringing in very acceptable additions to his pay during this early period of his career. He also studied Turkish later, and acquired a good working knowledge of it.

In the autumn of 1897, when the whole of the N.W. Frontier of India burst into a blaze, Leslie's services were utilized as a Survey Officer in Tirah with the 2nd Division. He took part in the action of Chagru Kotal, the capture of the Sampagha and Arhanga Passes, the Reconnaissance of the Saran Sar, and action of 9th November, 1897. These were followed by the operations at and around Dwatoi and the action of 24th November, 1897, and those in the Bara Valley, 14th December, 1897. Leslie's courage and resource at once won the special commendation of his survey chief, the late Sir Thomas Holdich, with the result that his services were rewarded with a mention in the *London Gazette* of 5th April, 1898, and a brevet-majority on 20th May, 1898, together with the Frontier medal and two clasps.

Leslie had been promoted to Captain in the Corps only a few months before, on 23rd November, 1897; so the ball now appeared to lie at his feet. He was not destined, however, to take part in any further military operations until the outbreak of the Great War. Meanwhile, his ardent spirit sought outlets in other distant fields, and not long after his return to Quetta in April, 1898, as an Executive Engineer in the M.W.D., he left for Chitral and Gilgit—in the autumn of 1899. During the next three years, until December, 1902, he led a most strenuous existence as C.R.E., Chitral Force, amid the rugged Himalayas, supervising roadmaking, bridge-building, construction of fortified posts and the like, to improve the communications from India to these outposts of Empire.

Brig.-General John Charteris, C.M.G., D.S.O., who was with a company of Bengal Sappers in Chitral for part of this period, describes Leslie as "an admirable chief—none better. He controlled but

never unnecessarily interfered. His knowledge was always available to correct one's errors and to suggest improvements. He was utterly loyal to those serving under him. Throughout the year I was with him he never missed an opportunity of *shikar*. He was by far the most expert and successful after big game, markhor and ibex, and I think held the record of the time."

There seems little doubt, however, that the serious heart trouble from which Leslie suffered, towards the close of his life, may be attributed in no small degree to the enormous strain he put upon it, at high altitudes, during his tremendous climbs at this period in pursuit of big game. Such certainly was his own opinion, expressed to the present writer on several recent occasions.

Leslie introduced at the same time also a new form of polo for the officers (based upon the local game played by the inhabitants), riding diminutive ponies on miniature grounds, broken by occasional boulders and far from level! Apart from his work, Charteris considers Leslie's chief characteristics then were his untiring energy and magnificent physique.

Leslie came home to England on leave early in 1903, and on his return to India in November was posted to the Bombay Sappers and Miners at Kirkee as Superintendent of Park. With them he served until March, 1908, being promoted to substantive major on 22nd October, 1905. Taking up polo again with his usual zest for a favourite pastime, he soon established himself as a tower of strength in the Bombay Sappers' team before leaving for a " refresher course " at Chatham for R.E. officers on the Indian List. He returned to India at its close for two or three months only, however, and then took up an appointment on the West Coast of Africa, where he was employed during the next three years from 1909 until 1912.

Here in Ashanti and the Northern Territories of the Gold Coast he laboured with his usual energy in the construction of roads, bridges and buildings through little-known regions, consisting largely of formidable forests, inhospitable wastes and malaria-infested tracts, in order to open out paths of progress to the backward folks beyond. Those under whom he served chiefly during this period have, unhappily, passed over into the Great Unknown. Thus the present writer cannot obtain first-hand opinions of Leslie's great civilizing work during these trying years from those who would have been best able to give them. We may be quite certain, however, that he never spared himself in this task, and that its fruits long served as a testimony to his efficiency.

And so, his work successfully completed on the West Coast, he returned to India in November, 1912, being posted as A.C.R.E. to Jullundur. The following year he married Edythe Angela, the daughter of Archdeacon Spencer, and was still at Jullundur on the outbreak of the Great War. In the autumn of 1914 he was detailed

to accompany the British Expeditionary Force to France from India with the Indian Cavalry Division.

Leslie had been promoted to Lieut.-Colonel in the Corps on 20th September, 1914, and early in the Indian Corps operations in France became C.R.E. of the Cavalry Division. In March, 1915, he was appointed C.R.E. of the 7th (Meerut) Division, and in that capacity sailed with it for Mesopotamia, to assist in the Relief of Kut towards the close of that year.

The valuable services rendered by him in France were acknowledged by the bestowal of the C.M.G. in the *Honours' Gazette* of January 1st, 1916; but he was now to gain greater distinction on the pitiless plains of Mesopotamia. Space does not permit, however, more than a brief reference to the stern struggles that failed to succour Kut; but it may be stated that Leslie's services as a Sapper were ceaselessly sought throughout these operations, and that he received a well-deserved brevet-colonelcy in June, 1916.

When, at length, the tide turned against the Turk, and General Maude had driven him from Kut and captured Baghdad, Leslie received the command of the 21st Brigade. This he held for nine months from 28th March, 1917, when he was given command of the 17th Indian Division on 17th December, 1917, after a number of Indian units had been transferred to assist Allenby in Palestine, and the army in Mesopotamia was considerably reorganized.

Of his later services in that theatre, Major-General Sir Theodore Fraser, K.C.B., C.S.I., C.M.G., writes:—" Immediately (on obtaining a brigade) Leslie made his mark as a trainer and leader of troops; and promotion to the command of the 17th (Indian) Division followed naturally at the end of 1917. It was a new formation; but in a very short time Leslie made it not only an efficient division, but also a happy one, distinguished by that undefinable 'spirit' which only a sympathetic and trusted commander can engender.

" After being 'blooded' at Tekrit, and in various minor operations on the right bank of the Tigris, its opportunity came at last in the battle of Sherghat (October, 1918), where the last Turkish army in Mesopotamia, caught between the 17th Division and the 11th Cavalry Brigade, was defeated and forced to surrender *en bloc*.

" That result was, of course, largely due to the tactics of the higher command and to the courage of our troops; but, even so, it would hardly have been attained but for the personality of the leaders most concerned in it, namely, George Leslie, 'Bob' Cassels (now C.-in-C. in India) and 'Gerry' Sanders—another Sapper!

" It was Leslie's individual encouragement which forced his infantry to maintain unremitting pressure on the Turks, and thereby prevented them slipping away to the West out of reach of Cassels' strung-out line.

"After this success, Leslie was marked for high honour, and he did, indeed, act as Commander-in-Chief in Mesopotamia during the winter of 1919–20. Of the misfortune that befell him in 1920 (the Arab Revolt), all that need be said is that it did not prevent the then C.I.G.S., Sir Henry Wilson, putting his name on the 'selected list' and promising him re-employment in due course; but, alas, Sir Henry Wilson was murdered before he could redeem his promise."

For his services during the Great War, Leslie received a brevet-colonelcy, as already mentioned, on 3rd June, 1916, and was promoted to Major-General on January 1st, 1919. The C.B. was added to his C.M.G. in 1917, as also the French Legion of Honour, 4th Class. He received, too, the 1914 Star, British War Medal and Victory Medal at the close of the war. The C.B. and C.M.G. were both presented to him by H.M. the late King George V at an investiture held at Buckingham Palace in the summer of 1919, Leslie being then at home on leave from Mesopotamia. He received last year, too, the King's Silver Jubilee Medal.

A few months after his return to Mesopotamia he was handed over the command of the Forces by Lieut.-General Sir George MacMunn, who then left for India. Leslie remained as C.-in-C. until a short time before the Arab revolt, when Lieut.-General Sir J. L. Haldane arrived from England and assumed command of the army in Mesopotamia. During a critical period of the revolt in the summer of 1920, the new C.-in-C. and Leslie were, unfortunately, unable to see eye to eye concerning certain operations in progress, with the result that the junior went to the wall, receiving only the medal and clasp.

And, thus, Leslie ultimately passed into a retirement which was clouded by a sense of injustice, for which there appeared to be good reason. He remained on the unemployed list in India and elsewhere for some years in the hope of re-employment, but finally retired on December 22nd, 1923, when not yet 56.

On 29th October, 1926, Leslie was appointed Colonel of the Royal Bombay Sappers and Miners; and this honour was followed in March, 1934, by his selection as a Colonel Commandant of the Corps. He was then a sick man, but this signal recognition of his past services by officers of his own Corps caused him immense satisfaction, and helped him to regard his former disappointments in a more equable frame of mind, for he always had an intense pride in the Corps and was devoted to it.

During recent years Leslie's health had steadily begun to decline; and last summer he became seriously ill with acute cardiac asthma, to which he would probably have succumbed but for the devoted nursing of his wife. When considered sufficiently convalescent, he sought further recuperation at Osborne in the autumn, but made little progress there before rejoining his wife at Bournemouth shortly

before Christmas. The long, damp, sunless winter, however, even in that health resort, re-acted unfavourably on his greatly impaired constitution, and he sank suddenly during a sharp attack of pneumonia. He left no children.

A number of letters from distinguished officers to his bereaved wife have been placed at my disposal for perusal, and these speak in the highest terms of Leslie as a soldier, and of his charm as a friend. Not a few deplore the unfortunate *contretemps* in Mesopotamia, but for which they are confident he would have risen to still greater heights in his profession. Letters have also been received from natives in India and Mesopotamia mourning the loss of so upright an English gentleman.

In spite of much that he suffered of late, both physically and mentally, he bore his troubles with Christian fortitude and remained a cheery companion to the end. None so fond as he of fighting his old battles over again, and telling a good story; while memories of his infectious laughter, and kindly thoughts and deeds, will linger long with those who knew him to be one of the best and straightest of men, and the most faithful of friends.

His cremation at Southampton on March 2nd was private, but attended by representatives of the King, the Corps, the Royal Bombay Sappers and Miners, and other organizations, together with relatives and a number of old friends. May his brave soul now rest in peace!

H.H.A.

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.)

MEMOIRS OF AN UNCONVENTIONAL SOLDIER.

By MAJOR-GENERAL J. F. C. FULLER, C.B., C.B.E., D.S.O.

(Published by Ivor Nicholson & Watson, Ltd., London. 1936. Price 21s. net.)

The author of these Memoirs tells us that he frankly detested public-school life. He had no inclination towards soldiering, but his future was decided for him and he found himself in the Army Class at Malvern. His education "mainly consisted in "sitting at the back of the classroom and educating himself. Given Bright's *Smaller* "*History of England* to study—the dullest book ever written—instead I read *The* "*Three Musketeers, Monte Cristo,* and a large number of other novels, English and "French, and by the age of seventeen years was thoroughly well educated in things "general and so incapable of passing into Sandhurst." With the aid of a famous cramming establishment—"Jimmy's"—of whom he tells a good story—and blessed with a good memory, he managed to pass into Sandhurst, and on August 3rd, 1898, joined the old 43rd at Mullingar.

Mullingar, despite its ancient and prison-like barracks, was a good station—for sport. The officers could hunt, shoot and fish cheaply. But Fuller could not afford to keep a horse, and looked upon a gun as no more than an excuse to induce him to go out. He read philosophy. "A most extraordinary thing for a subaltern to do. "I have still a book marked 1898, called *The First Philosophers of Greece,* which "when picked up by another subaltern so shocked him that he went off to the "regimental surgeon, to inform him of the fact. . . . In the spring of 1899 we went "to the Curragh to carry out our field training and musketry on orthodox Brown "Bess lines. Even then I took no interest whatever in things military, it all appeared "to me very ridiculous; yet what did it matter? We had to fill in time somehow, "and what had been good enough for Wellington was good enough for us."

From Ireland the Regiment went to Plymouth and, after the outbreak of the war in South Africa, to Aldershot to mobilize. "For us, mobilization consisted mainly in "pipe-claying our equipment. . . . Our brains we left exactly as they were. We "had not been trained for war, we knew nothing about war, about South Africa, "about our eventual enemy, about anything at all which mattered, and upon which "our lives might depend." The author does not draw on his imagination.

In a contemporary weekly newspaper there appeared recently an article entitled "Some Memories of Soldiering in an Almost Forgotten Era," in which Lieut.-Colonel G. E. Hawes writes as follows:—"The Army of my youth was as different from the "Army of to-day as is the mind of the officers. Both have become mechanized. "Whereas the pre-war youth thought entirely of nothing else but huntin' and "shootin' and fishin', his modern prototype is obsessed with aeroplanes and motor-"cars. The last thing that . . . the mental attitude of the officer could have been

" accused of was being military. . . . It would be difficult to imagine any profession " less interested in the business of that profession than the Army of the early nineteen " hundreds. . . . Let us hope that the upheaval of the Great War and the general " spread of independence amongst modern youth may have led to a wider, saner and " more understanding attitude towards the education of the young officer of to-day."

The fact that an article in *The Field*—of all papers—should discuss the mental attitude of the young officer towards his profession instead of, say, *Pigsticking in the Old Days*, goes some way to justify the writer in his pious hope, despite the shattering remark of the Editor in an introductory note: " These views must not, necessarily, " be taken as those of *The Field!*" All of which goes to show that Major-General Fuller, whose book is reviewed in the following issue of *The Field* under the title *Tanks in the Great War*, was and is an unconventional soldier. That he survived the upbringing which he describes proves that he was modest as to his own capabilities.

War gives a soldier the opportunity of his life. This is true whether he be in the ranks, a regimental officer or on the Staff (G.S. or Q.). Lieutenant Fuller certainly seized the opportunity given him towards the end of the war in South Africa where he commanded a small body of mounted native Intelligence Scouts—mere riff-raff—whom he trained and horse-mastered into a useful fighting unit in the district west of Kronstad. He recognized his opportunity again in France when he saw his first tank at Yvrench. The idea of the Cambrai offensive was entirely his, though the success of the plan was ensured by the gallant leadership of our present M.G.O. and his magnificent tank crews.

To have the brains, the imagination, the will to carry through a project is, unfortunately, not enough. Even a genius, which Major-General Fuller undoubtedly is, must train himself not to be impatient with red tape, out-of-date ideas, financial restrictions, slow progress and half-measures. He hated peace-soldiering, but after the South African War when he, like other soldiers whose keenness had been aroused by war, might have chucked the Service in disgust, he made the most of a peace-time opportunity when he left his Regiment for a Volunteer Adjutancy, and turned a crowd of untrained men into an efficient Territorial battalion. It may be argued that he was a whale among the minnows, a war-trained regular officer among a horde of ignorant but keen volunteers: that he had a free hand with a C.O. who was only a C.O. in name. But he made good in spite of great difficulties. About this time he took to writing and has recorded his experience in two of his many books, now numbering twenty-four in all. He had already written a pamphlet, still unpublished, *The Last of the Gentlemen's Wars:* he now wrote *Hints on Training Territorial Infantry*, and followed it up with *Training Soldiers for War*. " At this time," he writes, " I did not realize that, though I had never been, in the strict meaning of the " word, a ' professional ' soldier, I was now, at the age of 31, incapable of becoming " one. What with my freedom as an Intelligence Officer in South Africa and my " freedom as a Territorial Adjutant, I was completely spoilt professionally."

In the Great War he had the luck to come under a C.O. who gave him his head but still retained the reins in his own hands. It was a fortunate combination. He had passed through the Staff College—after failing at his first attempt to pass in—before the outbreak of war. After the war and four years at the W.O. he returned to the Staff College as a Chief Instructor. The students, nearly all of them with war experience of their own, recognized his outstanding genius, but few of them were able to follow his meaning in some of his advanced lectures. On pages 417–420 he gives the gist of his first lecture to the students. It was certainly unconventional, as was his request that his four years' appointment should be reduced to three. In which he was right. He had no use for men of ordinary capacity. He was not a leader of men, nor was he like a brother Staff Officer in the Tank Corps in France, whom he describes as: " One of those exceptional people who can tolerate a fool " without committing a folly. Suave but fearless, tactful and yet truthful. . . ." In 1926 Colonel Fuller returned to the War Office as Military Assistant to the C.I.G.S.

(General Sir George Milne) who had heard of his capabilities and was anxious to make use of them. During the year that this appointment lasted Fuller was sent on a hurried visit to India and returned with a revolutionary report on what he had seen. It was too revolutionary for the cautious C.I.G.S.

He was offered the command of the 7th Infantry Brigade at Tidworth. Fuller was under the impression that this Brigade was to be transformed into an experimental or mechanized force, but when he discovered that it was only to be a half-measure, he asked for another appointment and was made G.S.O.1, 2nd Division, at Aldershot, under his former chief at the Staff College, General Ironside. The latter was succeeded by General T. A. Cubitt, with whom Fuller had served in the 37th Division in 1915–16 in France. All was well, because " he found Cubitt to be a " refreshingly unconventional soldier, the real fighting-man type who called a spade " a spade, and something more. He was full of commonsense and uprightness." His estimate of his General's character is correct. The present writer can add to it that he was fearless in action and equally fearless when, as Governor and Commander-in-Chief in Bermuda, he had to battle with the Colonial Office.

In 1929 Brigadier Fuller was appointed to the command of the 2nd Rhine Brigade in Germany, an appointment which lasted only three months because of the evacuation, and he was then transferred to the 13th Infantry Brigade at Catterick, " a spot defined by the Romans as *Ad Fines*," and by most private soldiers as " the " bloody limit "—so little does military psychology " change." This lasted only a year, for he was promoted Major-General on September 14th, 1930. Shortly afterwards he was informed that he had been selected to command a 2nd Class District in India, which proved to be Bombay. He refused this appointment, and after three years on half-pay was retired, a disappointed, and judging from his book, an embittered man.

To Major-General Fuller the Army owes a great debt. The progress, little enough, that has been made in mechanization is undoubtedly due to his brains, initiative and determination in an unending fight against obstruction. It is to be hoped that, although the Army has lost a most valuable officer, it will continue to benefit from his facile pen and unfearing criticism.

The book must be read. There is so much that is good in it. The British Army has still to be reformed. If only he had survived to see the present demand by the nation for the placing of our Army on a modern footing after years of shortsighted retrenchment! He had the bad luck to come up against a particularly lean time in the public purse and consequently against a brick wall in the Treasury. We cannot, however, forgive him for making it almost impossible to retain his services in the Army. He has many friends in it.

To young officers the book contains a warning, but it is to be hoped that the author's unfortunate experience will not stifle their initiative. His final words are worth repeating—" Fear is Failure and the Forerunner of Failure: Be thou without " Fear; for in the heart of the Coward Virtue abideth not."

The volume is provided with some clear diagrams illustrating the lessons of tank tactics and organization, and with what is practically a name-index only.

H.B-W.

NAPOLEON AND WATERLOO.

By A. E. BECKE.

(Kegan Paul. Price 10s. 6d.)

This book is a revised and partly rewritten edition of the author's previous work on the subject. The military student is advised to cut out, before reading, all the maps and sketches, so as to make them easy of reference. It is rather sad to find a modern edition of a genuinely important study of military history with maps and

sketches stuck in anywhere, not folding out clear of the letterpress. At times the reader is referred to two or three maps and sketches, all of which are essential to an understanding of the argument, but which are dotted about in various parts of the book.

Having rid oneself of that grievance, one can only very strongly recommend this careful analytical study to any historian. The narrative is written from the French side, and the author starts with an analysis of the alternatives facing Napoleon. The allied forces were holding the outpost line along the Belgian frontier from the Lys to beyond the Meuse, and were, if concentrated, in a two-to-one superiority. Napoleon's only chance was to break through at Charleroi and defeat the allies in detail. He is criticized for having too many troops on other fronts and not concentrating against the allies. 30,000 more troops, in the opinion of the author, could have been produced on the Belgian frontier.

The author analyses most carefully and interestingly the results of Ligny and Quatre Bras: Waterloo could still have been won, even if the D'Erlon muddle had taken place. Grouchy was given bad orders, he started late, and there was an almost complete lack of reconnaissance, but the real cause of the debacle was poor leadership. Napoleon was not the same man. He started late, there was a completely haphazard conduct of the actual battle, he launched the cavalry prematurely, almost unsupported by artillery, against the allied squares—in fact the whole conduct of the battle does much to support the author's diagnosis that Napoleon was suffering severely from the disease of acromegaly, for which theory there is much purely medical support to-day.

The author is a fervent admirer of Napoleon, and produces rather a tragic figure of the man who had become almost lethargic, except in short spasms, and, most important of all, had lost his judgment in choosing his subordinates.

If the student will take the trouble to deal with sketches and maps, as suggested, this book will be a most valuable modern short study of this remarkable campaign.

GLORY AND DOWNFALL.

By General P. A. Polovtsoff.

(G. Bell & Sons, Ltd. 15s.)

Few reminiscences by foreign officers are so attractively written as this book by a Russian General Staff officer. General Polovtsoff has a remarkable command of the English language, and although he does not indicate at what period of his career he studied English, he must have worked very thoroughly at it. He writes fluently and admirably.

His career was as varied as it was exciting. He began as a trooper in the Nijny Novgorod Dragoons in 1896, and was put through a severe gruelling. He was a born soldier, and very soon rose to be troop sergeant. After two years with the Dragoons he went to the Cavalry School at St. Petersburg to qualify for his commission. He was next posted as a subaltern in a Guards Cavalry regiment, the Grodno Hussars. His description of the life of a Cavalry subaltern of those days is both amusing and interesting. The standard was very high, and Polovtsoff was in his element. But he was a worker, too, and in 1901 he entered the Staff College, passing out first three years later. By this time he was a marked man, and as the Russo-Japanese war broke out just before the Staff College course was over he naturally applied for service in Manchuria.

In that campaign Polovtsoff distinguished himself in many ways, and on the conclusion of the war he was sent on a special mission to France; and later he acted as Military Attaché in London for six months. Here he met King Edward VII, and gained many friends in English society. In 1906 he was sent to India, ostensibly on a sporting trip, but in reality to make a tour over the Himalayas, through Chinese

Turkestan back to Russia. He was welcomed in India, and was cordially received by Lord Kitchener, then Commander-in-Chief. His account of this journey over the Pamirs is well told, and he missed nothing of importance on his way.

Having means of his own, and a somewhat restless spirit, Polovtsoff resigned from the General Staff in 1910 as a Lieut.-Colonel, and spent the next four years chiefly in East Africa where he acquired a sporting estate. In 1914 he returned to Russia and sought military employment. He was not welcomed at first, but presently he was appointed to command a native cavalry regiment which was being raised in the Caucasus. He took his regiment to Galicia and commanded it there with distinction until the autumn of 1916, when he was sent to the Rumanian front.

Early in 1917 he was sent to Petrograd to obtain official sanction for the conversion of the Caucasian Native Division into a Cavalry Corps. While he was there the Revolution broke out. A Tsarist by birth and upbringing he found himself in a difficult position; but he was first and foremost a soldier, and one with wide staff and regimental experience. His advice was eagerly sought, and before he knew where he stood he found himself in the capacity of military adviser to the Provisional Government. How he contrived to steer between the extremists on both sides and successfully preserved order among the troops of the Petrograd garrison, some 300,000 strong, is well told. Those anxious days demanded the finest qualities of courage and tact.

When Kerensky became Prime Minister he appointed Polovtsoff as Military Governor of Petrograd. He could not have made a better choice. The troops knew Polovtsoff and trusted him; but the Bolshevik elements from outside, especially from the mutineers of Cronstadt, were making headway, and while he still carried weight and influenced the best of the troops, he had to propitiate the Soldiers' Soviets, and go through the formality of recognizing them. Gradually the extremists got the upper hand, and the General had to go. He first went back to his native troops in the Caucasus, as a cavalry divisional commander; but Bolshevism spread everywhere, and eventually he had to leave Russia in disguise. He has since spent his life at Monte Carlo, where he is well known to a wide circle of English friends.

This brief account of his story cannot convey the fascination of his book, which will appeal to a great many readers for the cheerfulness and the spirit of adventure in which it is written.

W.H.K.

THE ROAD TO GLORY.

By F. BRITTEN AUSTIN.

(Thornton, Butterworth. Price 7s. 6d.)

Mr. Britten Austin calls his latest book a novel. This is a cunning move on his part, since it provides the complete answer to anyone who would be so industrious or so foolish as to waste time checking up his historical facts. There may be one or two minor discrepancies, but they in no way decrease the interest of the book for the lay reader, or its value for the military student.

The Road to Glory gives a graphic account of Napoleon's amazing campaign in Italy. At the beginning of the operations he was an insignificant military upstart, with no very extensive experience of war or practice in the handling of large bodies of men. Yet in the course of a few weeks we see him earn the respect and admiration of jealous senior generals, and by his sheer will to victory accomplish the apparently impossible with a rabble of half-starved, ill-equipped, mutinous troops.

It is certainly open to argument whether a study of the small details of military history is of any practical value to the modern aspirant for a Field-Marshal's baton. The mere memorizing of the units engaged, the time table of their movements, the crushing effect of this or that charge, etc., is a snare and a delusion. The sneer of the unbeliever, "That stuff is hopelessly out of date," is so apt and so true. But the

real essentials—the quickest possible manœuvring, the surprise movement, the foreseeing of the unforeseeable, the plan with at least two alternatives open until the last possible moment and the unshakable belief in one's superiority over the opposing general—those have been, and always will be, the ready means to a rapid victory. What some military histories have failed to bring out in true perspective Mr. Britten Austin has accomplished without distortion of facts or mere seeking for effect.

This book must be read with interest and profit by all ambitious soldiers. One thing which it lacks, a good map, is worth obtaining before commencing to read it. Those portions of the text which refer to Josephine may be of interest to the psychologist, but will probably be found an irritating interruption to the progress of the war. A.R.L.

TUNNELLERS.

THE STORY OF THE TUNNELLING COMPANIES, ROYAL ENGINEERS, DURING THE WORLD WAR.

By Captain W. Grant Grieve and Bernard Newman.

(Herbert Jenkins, Ltd. Price 15s.)

This account of the activities of the Tunnellers was orginally compiled by Captain Grieve with the intention of providing a detailed history of the Tunnelling Companies for the Tunnellers themselves. It was then redrafted by Mr. Bernard Newman with a view to appealing to a wider public.

The joint authors are to be congratulated on their success in making a selection from the mass of material available, combining it into a coherent whole and presenting it in a form which is easily readable and intelligible to the non-technical reader. The result is a story of absorbing interest and of very considerable military and technical value. It describes a remarkable example of the development of a highly organized and elaborately equipped service from improvised beginnings and furnishes a striking illustration of the British habit of "muddling through," with its initial stages of neglect of experience, lack of foresight and failure to make effective use of unfamiliar methods, leading up to an unusually successful employment of civilian technical skill and experience for military purposes.

The opening chapters deal with the formation of the first Tunnelling Companies and their activities up to the end of 1915, when some twenty companies were at work, but their efforts were spasmodic and unco-ordinated, confined to defence or minor local offensive operations. Full justice is done to the work of Sir John, then Major, Norton Griffiths, the founder of the Tunnelling Companies. The difficulties which he encountered, and the energy and ingenuity with which he overcame them, are well described, and a full account is given of the method of "clay kicking" which he introduced into the Army. The authors refer to this as "a method of driving a gallery so small that the miner has insufficient room to swing a pick" and do not, perhaps, lay enough stress on its value as a silent method of working. Many companies, when engaged in underground fighting in suitable ground, made it a standing order that no picks should be taken underground, irrespective of the size of the galleries, and the general use of "kicking" accounts for the numerous instances in which "live" German galleries were broken into.

Chapter III deals with mine warfare in Gallipoli, which was conducted on a much more extensive scale than is generally realized. The authors refer to the possible effect of an intensive mining attack on the peninsula, an addition to the many "might have beens" of the campaign.

The next two chapters cover 1916, including the first attempts to combine mining with a major offensive and the introduction of tunnelled subways under no-man's-land, both in connection with the battle of the Somme and both only partially successful. The difficulty of ensuring that attacking formations, who arrive on the

ground just before zero, shall understand and make use of the secret work of the Tunnellers was not yet realized or overcome.

Chapter VI, Arras, 1917, describes the effective use of subways, on a large scale in combination with existing caves, and introduces the Tunnellers to the detection and removal of delay-action mines and booby traps, one of their principal duties in the later stages of the war.

Following accounts of mine warfare at Givenchy and elsewhere, the strange situation in the Bethune-Lens area, where the coal-mining system connected the British and German lines, and work on the coast at Nieuport, Chapter X deals at length with the battle of Messines, the most spectacular success achieved by the Tunnellers. The scheme, first suggested in May, 1915, culminated on the 31st of July, 1917, in the discharge of 250 tons of explosives on a front of 4,500 yards. The material effect was enormous and the moral effect was described by Ludendorff as "simply staggering." The two together put an end to all resistance on the front attacked. Very serious physical obstacles had to be overcome, but the maintenance of secrecy in work carried out on such a scale and over such a length of time was even more remarkable. In the words of the Inspector of Mines "the miners didn't talk and no one else knew."

Succeeding chapters deal with the work of the Tunnellers at Passchendaele, principally on mined dugouts; during the retreat of March, 1918, on bridge demolition and in the Engineer Battalions which formed the last reserve of the Fifth Army; at Givenchy, where the tunnelled defences set a limit to the width of the German advance on the Lys, and in the final advance, on every form of engineer work, from bridging and water supply to the collection of concealed charges, to the amount of two and a half million pounds.

The last chapter is a tribute to the Tunnellers' friends, the canary and the mouse, whose sculptured portraits, on the Scottish War Memorial, form the frontispiece of the volume. The former was unsurpassed as a gas detector and had only one fault. His engaging manners so endeared him to his companions that miners have been known to descend doubtful shafts to see if the air was all right for the canary. The mouse's good work is also recognized by the authors who, with laudable reluctance to criticize an old comrade, make no reference to his distressing habit of shamming dead.

In the concluding remarks the suggestion is made that this very ancient form of warfare cannot yet be considered obsolete and a strong plea is put forward for the formation of Territorial Tunnelling Companies. The possibility of air attack, from which no part of the British Isles can be considered safe, will certainly produce an urgent demand for underground shelters and the continued reliance on mass armies, to be seen on the Continent, seems to point to a reversion to trench warfare and siege tactics .It may be added that all that the military miner requires for the exercise of his art is a fixed objective and such objectives have been, and are likely to be, constructed on European frontiers on a very large scale.

Major-General R. Napier Harvey, C.B., C.M.G., D.S.O., Inspector of Mines at G.H.Q., 1916–17, has contributed a foreword which gives an excellent summary of the development and progress of the Tunnelling Companies. It can only be criticized on the ground that his own share in the work is underestimated.

No review would be complete without a reference to the instances of gallantry and resolution with which the book is crowded and which are themselves only a selection from countless others. The intrepidity displayed, in the most trying circumstances, by these temporary soldiers, many of whom arrived in the front line without any previous military training, was only rivalled by their resourcefulness and adaptability. Their history goes far to justify General Harvey's claim that they became "the most "valuable engineering units in France, and the most highly prized by the commander "of any formation who managed to get possession of even one company of them."

J.N.C.

HISTORY OF THE GREAT WAR.

ORDER OF BATTLE OF THE DIVISIONS.

Part 2A.—*Territorial Forces Mounted Divisions and 1st Line Territorial Force Divisions* (42–56).

Compiled by MAJOR A. F. BECKE, by direction of the Historical Section of the Committee of Imperial Defence.

(H.M. Stationery Office. Price 10s. 6d. net.)

This is the second of this very useful series, the first of which, dealing with the Regular Divisions, was published in 1935 and of which five more remain to be issued. It follows the plan of Part I and deals with five Mounted Divisions, two of which became Cyclist Divisions, and fifteen Territorial Divisions. Three of the Mounted Divisions were employed on Home Defence, though the formations were continually sending drafts and units to theatres of war; the remainder all served overseas and the volume, besides being an invaluable record of the composition of the Divisions, summarizes the extent of the service rendered by the Territorial Force during the Great War. E.V.B.

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.)

This is a good book and will be of considerable value to officers preparing for promotion and also for Staff College examinations.

It incorporates changes introduced in *F.S.R.* Vol. II, 1935; though it does not appear to be quite in line on the subject of what should go in an appendix to an operation order, and what in an operation instruction.

There are five schemes, which serve as concrete examples illustrating the subject matter of the book. They are concerned mainly with a small mixed force of a battalion and attached troops. Suggested solutions and full explanatory notes are given. The schemes are based on a 1/25,000 map. The three rifle and one support company organization is used.

There is also a chapter on the technique of handling a Tactics examination paper.

E.K-S.

THE LIAO-YANG CAMPAIGN.

BY Lt.-Col. A. H. BURNE, D.S.O.

(Wm. Clowes. 1936. Price 5s.)

Here is a short book of military history written as military history surely should be written. Instead of baldly stating the action taken and then commenting on why it was right or wrong, this book in many cases vividly presents the reader with the strategical problem, then with the main considerations which were known at the time and which affected the decisions, and lastly with the course of action taken. This makes the book both more instructive and far more interesting; because the reader, as in a good detective story, is given the opportunity to exercise his own skill and to pause to make his own decision, before reading on to see what decisions were actually taken and their results.

The author's own excuse (though none is needed) for another book on this campaign is that insufficient attention has up to the present been paid to the light thrown upon the war by the Russian Official History, thanks to which we now have a fairly complete picture of leadership on the Russian side, of the clash of personalities and of

the framing of policy. It is the main object of the book to show the bearing of these personal relations on the leadership and on the course of the war, and to bring out the human interest of the story.

To permit this object to be achieved within the compass of 150 pages, tactical details are omitted. There are twelve sketch maps which include all places mentioned in the text.

The book can be recommended both for general reading and for examination purposes. E.K-S.

OLD SOLDIER SAHIB.

By Private FRANK RICHARDS, D.C.M., M.M.

(Faber and Faber, Ltd. Price 7s. 6d.)

This is the autobiography of a private of the Line during the early years of this century, as a recruit and a trained soldier in England and in India. During this period, the author was never on active service and had no experiences which might not fall to any man in the ranks. His narrative simply presents the Army and India as remembered thirty years later by an observant soldier. Every aspect of this—life in barracks and on troopships, hot weather in the Plains and the Hills, dealings with "natives" and women, even "House" and "Crown and Anchor"—is recorded in detail and without restraint. The result is not a highly moral picture and should give plenty of ammunition to enemies of the British Army; but, if to modern eyes the soldier of thirty years ago seems a hard case, he was adequate to his work and never failed in his duties. To those who served in India at the beginning of the century, the book is little but a record of common knowledge. To a new generation it should be an interesting page of history.

E.V.B.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(*January*, 1936.)—1. *Tactique d'infanterie.* An unpublished article by the late Colonel Sonderegger.

In 1929 Colonel Sonderegger, formerly Chief of the General Staff, wrote a book entitled *Infanterie-Angriff und strategische Operation*, in which he pressed for a strengthening of the infantry armament, as he considered that infantry should no longer be dependent on the support of a numerous artillery. The present article, of which this is a first instalment, was written in 1933, and in it Colonel Sonderegger brought his views up to date.

2. *Défense des localités.* By Major Jacot.

The writer compares the instructions relating to the defence of villages as laid down in the Swiss Field Service Regulations and the French Infantry Regulations respectively.

The introduction of tanks and armoured cars has increased the importance of villages in a line of defence, since buildings provide cover for infantry against these methods of attack.

The writer discusses the different ways in which a village may be held, *i.e.*, with the line of defence:—

(i) In front of the village boundary;
(ii) In the actual outskirts of the village;
(iii) In rear of the village.

The circumstances in which these various positions may be held, and the advantages and disadvantages of each, are made clear by sketches.

3. *Notice sur la perforation des blindages.*

Captain Daniel deals with the perforation of armour, which, nowadays, is made of special steel, such as chrome, nickel, molybdenum steel, etc.

(*February*, 1916.)—1. *L'artillerie d'accompagnement et grande puissance.*

General Rouquerol discusses the best form of arm of accompaniment for the infantry. The experience of the war shows that field artillery, as an arm of accompaniment, was not a success.

2. *La manœuvre d'aile et la manœuvre défensive.* By Colonel Lederrey.

This is a review of a book, by General Loizeau, entitled *Deux Manœuvres*, which deals with the handling of higher units in wing manœuvre and in defensive manœuvre. According to General Loizeau, the next war will begin by manœuvre.

3. *Tactique d'infanterie.*

This is a second instalment of Colonel Sonderegger's article.

(*March*, 1936.)—1. *Le cerveau du régiment.* By General Clément-Grandcourt.

A résumé of a manual by Commandant Andriot on infantry command posts. This instalment deals with the emplacement and general organization and construction of the post.

2. *La poste de campagne suisse.*

In this article Lieut.-Colonel Bonjour, director of the Swiss field post-office, explains the object and organization of his department.

The article explains the inter-connection between the civil post-office and the field post-office, and the working of the latter.

3. *Tactique d'infanterie.*

With this number Colonel Sonderegger's article is concluded.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*November–December*, 1935.)—1. *I carburanti succedanei per l'alimentazione dei motori a combustione interna.* By Captain Tatti.

The question of fuels for use in internal combustion engines, to take the place of petrol, is a very important one for Italy, and more so than ever at this particular time. The writer tabulates a series of conditions that such substitutes should fulfil. The first one is that the fuel should be produced entirely on Italian soil and should require no primary ingredients obtained outside the country.

With regard to solid fuels, Captain Tatti compares the relative merits of wood and wood-charcoal; the production of coal in the country being insufficient to make it worth considering as a substitute. Both materials, as gas producers, have their advantages and disadvantages. An extensive use of wood and charcoal would, however, soon deplete the country's forest reserves, and alternative fuels should be investigated. Suggestions made are: carbonized olive stones, and powdered lignite made up into ovoid briquettes.

With regard to liquid fuels, there is a choice between ethyl alcohol, methyl alcohol, and synthetic petrol. Ethyl alcohol is obtained by fermentation of molasses and by hydrolysis of substances containing cellulose or starch, such as agaves, potatoes, and corn. Although uneconomical in use as compared with petrol, it has certain advantages over it, and experiments are being made to reduce its disadvantages.

Methyl alcohol or methanol can be prepared either by distilling wood, or, synthetically, from coal gas. But coal is essential as a primary material, and so far no method has been discovered of preparing methanol from the indigenous lignite. Its properties are somewhat similar to those of ethyl alcohol.

Synthetic petrol has been prepared in Germany from low-grade coal and lignite and it is hoped that plant for its production will be erected in Italy in due course. Synthetic petrol has the same properties as that obtained by distillation.

Gases for motive power are subdivided into natural and artificial products. There is a good deal of natural gas in parts of Italy, mostly methane. Of artificial gases, coal gas, acetylene, hydrogen, butane and propane may be mentioned. For practical work, gas must be compressed in cylinders, and the weight of these cylinders renders its use uneconomical. But this disadvantage is being largely overcome by the discovery of new metallic compounds of great strength.

2. *La produzione di armi e munizioni in Austria-Ungheria nel* 1916.

In this article General Bollati describes the prodigious effort made, in 1916, by the Austro-Hungarian Empire to increase the output of arms and munitions, especially of artillery, in spite of the shortage of primary materials. During that year Austro-Hungary was engaged on the Russian, Rumanian and Italian fronts, and economy in man-power became essential, necessitating a very large expenditure of artillery and munitions.

Marshal Conrad's programme for the year required an output of 13,000 new guns, of which 520 were heavy. Actually, up to the end of 1916, only 5,000 guns had been turned out and of these only 90 were "heavies."

The half-yearly output of the various munition works (viz., Skoda, Steyr, and others) increased as follows between 1914 and the second half of 1916:—

Guns, from 240 to 3,554 (total construction 9,462).
Gun-carriages, from 148 to 1,900 (total construction 6,998).
Machine-guns, from 1,087 to 3,912 (total construction 11,102).
Rifles, from 149,000 to 630,000 (total construction 2,252,000).

3. *La televisione ed il suo eventuale impiego in guerra.*

Lieut.-Colonel Gatta begins this article by describing the fundamental principles on which television is transmitted and received. He then goes on to examine the construction and the functioning of the apparatus employed for this purpose and, finally, considers the possible uses of television in future military operations.

The electronic method of recording and reconstructing images has now superseded the mechanical method. Synchronism may now be considered technically solved. By adopting ultra-short waves and, eventually, micro-waves, it will be possible to employ a number of television stations working simultaneously.

For the present, however, television is in an experimental stage, and it is limited to a range of 50 km. The instruments are of a delicate nature and expensive, and require a highly-specialized staff to work them.

The writer looks forward to the day when the television service will become a special branch of the engineers, and when a commander will be able to overlook operations as they take place, over a definite section of the front.

4. *Artiglieria sugli strapiombi.*

Major Molinari describes the work done by pack artillery during manœuvres carried out in extremely difficult mountainous country. A series of photographs illustrate the skilful way in which the mountain gunners handle both guns and mules along almost sheer precipices.

5. *Sullo svuotamento, per ragioni militari, dei laghi artificiali.*

Lieut. Di Fabio describes a method of determining the time required for emptying out artificial lakes, or the size of outlet required to empty a lake in a given time, as well as the velocity of the water and the discharge. It is assumed that the work may have to be carried out in connection with one of the large masonry dams in the Alps, under war conditions.

6. *Abbaco per il tiro di sbarramento controaerei.*

Lieut. Borsani here completes his study, begun in the August–September number, on ranging for an anti-aircraft barrage.

(*January*, 1936.)—1. *La batteria di accompagnamento del reggimento di fanteria.*

Colonel Caboni, writing from the artilleryman's point of view, expresses his satisfaction with the new organization by which a four-gun battery of 65/17 guns is to be attached to each infantry regiment. The gunner's ambition has always been to fight, not only for the infantryman, but along with the infantryman.

Under a previous organization three 65/17 guns were attached to each regiment. This involved the splitting up of sections, and single guns might be attached to battalions or companies. Guns may be employed singly under the new arrangement, but it will be the exception and not the rule.

The greater part of the article is devoted to the principles of employment of artillery of accompaniment.

2. *Difesa di un corso d'acqua.*

Lieut.-Colonel Verna discusses the question of the defence of an unfordable river. A position behind a river may be selected for two reasons, firstly, to economize one's own forces, so as to have a larger force available in less favoured sectors and, secondly, to strengthen a defensive position.

In this article the writer deals with the second case. Here the defender has two alternatives. He may occupy an advanced position and contest the crossing with all the means in his power, or he may occupy a position some distance to the rear and endeavour to destroy the bridges that the enemy may construct across the river.

Both methods have their advocates, and Colonel Verna discusses their pros and cons at some length. A point that deserves special attention is the great increase in mechanization in modern armies. This makes it important that there should be no gap in the line of defence. The construction of bridges and the passage of armoured vehicles over them must be prevented. The obstacle must be kept under infantry and anti-tank fire. Artillery fire by itself is not sufficient. It will answer its purpose by day, but cannot do so by night or in artificial fog.

The choice of a rearward position is the more attractive and spectacular of the two. It gives the defender the opportunity of carrying out a counter-attack on an enemy who has the river at his back. But it is risky and requires a large force.

A forward position is the safer alternative and requires fewer troops. It is a matter of playing for safety, and is less likely to achieve a brilliant success.

The selection of one solution or the other will depend upon the forces available, the general situation, and very largely upon the character of the commander.

3. *La viabilità nella guerra motorizzata e la relativa attività del genio.*

Lieut. Rosario Corso considers that in modern warfare rapidity of movement is equivalent to an arm in itself. The three characteristic features of future wars will be signalling communications, mechanical vehicles and roads.

The writer lays stress on the importance of mechanizing and motorizing engineer units. It is important that engineers should be moved up quickly to repair interruptions to communications. Moreover, owing to the scarcity of trained specialists, it should be made possible to utilize at once those available in the places where they are needed.

The most important works on which engineers are likely to be employed are :—

Construction and maintenance of roads ;
Checking the carrying capacity of bridges and strengthening them ;
Constructing extemporized bridges and footbridges ;
Constructing regulation bridges and footbridges.

Each of these sub-heads is described in turn.

The writer concludes by discussing the question of the training of officers. He is very much averse to the scheme, adopted in certain armies, of separating signals from other branches of the engineers.

4. *Risoluzione di alcuni problemi inerenti alla preparazione topografica del tiro valendosi degli astri.*

This is a criticism, by Lieut. Braga, of an article that appeared in the *Revue d'Artillerie* for June, 1934, entitled "Pointage direct des pièces sur les astres."

The writer maintains that sufficient account has not been taken of the earth's curvature between two stations in taking star observations, and he explains what corrections should be made.

5. *Il tiro di più pezzi con dati calcolati o mediante trasporto* By Captain Cavicchioli.

A technicle article on gunnery.

6. *Sulla costruzione dei ponti a contrasto.*

Lieut. Giuliani has worked out a series of calculations regarding the strength of single-lock bridges. Some of the conclusions that he has arrived at are briefly as follows:—

(*a*) Single-lock bridges, with an overhead roadway, are steadier and easier to construct than single-sling bridges, with a suspended roadway.
(*b*) The dimensions of the legs, as given here, are greater than those normally accepted.
(*c*) The inclination of the frames can be between 1 in 1 and 2 in 1.
(*d*) For inclinations between 1 in 1 and 2 in 1·5 the bending moment of the legs exceeds the shear; between 2 in 1·5 and 2 in 1 the shear exceeds the bending moment.
(*e*) Single-lock bridges are suitable for medium loads, which should on no account exceed 12 tons on the two axles.

7. *Il tetracene ed il suo impiego quale esplosivo.* By Lieut. Valente.

The explosive "tetracene" is a yellow, flaky, non-hygroscopic solid. First prepared in 1910, it was used in explosive mixtures before its characteristics had been studied. Messrs. Rinkenbach and Burton have investigated its properties in the Picatinny Arsenal laboratories, and the writer here gives a *rés. mé* of the results that they obtained.

Tetracene can be prepared from calcio-cyanamide.

(*February–March*, 1936.)—1. *Come si è armata la fanteria italiana.* By Brig.-General Soddu.

After a careful study of the best armament for the Italian infantry, carried out during the past three years, it has been decided to equip it with the following weapons:—

(i) The Breda light machine-gun, 1930 model.
(ii) The Fiat gun, 1935 model, as arm of accompaniment, with a flat trajectory. With a special type of projectile, it can be employed against aircraft.
(iii) An assault mortar, 65/17, which has given satisfactory results as an arm of accompaniment with curved trajectory and high-explosive shells.
(iv) The assault tank, 35 model; the 47-mm. anti-tank gun; and the 20-mm. anti-aircraft gun.

2. *Problemi di strade e movimento. Particolari aspetti d'interesse militare.*

General Maltese here discusses the problem of roads and movement, which he considers should be studied by officers of the artillery and engineers. The question is one of first-rate importance in the civil life of the country, but from a military point of view the outlook is slightly different. The formation characteristic of military activity is the column of mechanically-propelled vehicles—a very different thing from a series of vehicles moving independently. The various points that a commander of such a column should take into consideration are discussed at length.

3. *Influenza del nuovo armamento della fanteria sull' azione dell' artiglieria divisionale.* By Colonel Chiricleison.

Modern infantry armament consists of the following weapons:—Rifle, hand-

grenade, light machine-gun, machine-gun of accompaniment, assault mortar, anti-tank and anti-aircraft gun, assault tank, all in strict co-operation with the batteries of accompaniment.

In this article, Colonel Chirieleison discusses the influence that the introduction of these weapons exerts on divisional artillery, considering the question under each of the following sub-heads :—(*a*) march against the enemy, approach ; (*b*) encounter battle ; (*c*) attack on an enemy in position ; (*d*) development of the attack ; (*e*) exploiting a success, pursuit.

The strength of divisional artillery has recently been increased by three batteries.

4. *Impiego di riparti del genio nel forzamento di un corso d'acqua.* By Lieut.-Colonel Biagioli.

This is a scheme in which the general idea is that a (northern) blue force, in pursuit of a (southern) red force, has reached the Arno, the red force having retired to the south bank of the river.

The special idea is one of a pursuit of the enemy. The bridges over the Arno have been destroyed, and the divisional engineers are called upon to provide :—

2 ferries for dismounted troops ;
1 footbridge for dismounted troops ;
1 bridge for all arms.

The width of the river varies from 62 to 94 metres ; the average depth is from 1½ to 2 m., and the velocity of the current 1·50 m. per second.

For each ferry service twelve equipment pontoons are detailed, with their complement of oarsmen. Each pontoon will carry 24 men with their equipment, besides 1 commander, 1 pilot and 4 oarsmen, but in practice smaller numbers will be embarked so as not to break up units.

The footbridge will consist of folding canvas-boats ; each standard bridge-length of 48 metres consists of 11 boats and 12 bays of superstructure.

For the bridge to carry all arms, pontoon and trestle equipment will be used. A bridging train consists of four sections ; each section has 8 boats, 4 trestles, superstructure, etc. With the material of one section, a normal bridge (to carry 5-ton axle-loads) can be built of a length of 69 metres, with 13 bays.

By doubling the boats, trestles and chesses, and increasing the number of road-bearers, bridges can be built carrying loads up to 10 tons.

The time taken for constructing a normal bridge may be taken as half an hour plus as many minutes as the number of metres in the length of the bridge.

The article is illustrated by means of plans, photographs and tables.

5. *La 1a batteria da montagna nelle giornate di Amba Alagi. 7 dicembre* 1895—28 *febbraio* 1936. By Lieut.-Colonel Molinari.

An account of the career of Captain Angherà who commanded the 1st Mountain Battery in Asmara. He was killed in the disaster that befell the force under Major Toselli on the 7th December, 1895, and was buried at Amba Alagi. The 1st Mountain Battery formed part of the force that reoccupied Amba Alagi some forty years later.

6. *Sguardo d'insieme sulla nuova organizzazione dei materiali da ponte.* By Major Barela.

There has been little change in the method of crossing rivers from ancient times up to a comparatively modern date. In more recent times, the Italian bridging equipment of 1860 had only been slightly modified by 1914. But the great increase in loads has since necessitated great changes, and the year 1935 has been an important one for pontooning engineers, as it has seen the solution of an intricate problem.

The tactical use of bridges has been rendered difficult by the increased power of artillery and by aerial warfare, but they are likely to be used on the outbreak of hostilities when frontiers are only held by covering troops.

If a river is not held, the passage can be undertaken with ordinary precautions. If it is held, the enemy may be holding a forward or a retired position, and the attacker may be able to effect a passage by surprise or by main force.

The writer proceeds to discuss a passage carried out by main force. Information must first be obtained of longitudinal- and cross-sections of the river, low-water and high-flood levels (which will determine the use of boats or of trestles), the velocity of the stream, the nature and height of banks, etc.

To determine the front to be attacked, the points to be considered are: the range of the defenders' artillery (assumed to be 18 to 20 km.) and the distance of the artillery from the river. In order to protect the bridges from hostile artillery (assumed to be 5 km. from the river) the front of the attack should not be less than 35 km. and the depth about 18 km.

Such an extension will necessitate operations on a grand scale, and an organization that will include, amongst other matters:—

Information of the enemy's organization;
Secretness of preparations;
Selection of troops for crossing, of sectors of attack, of positions of assembly, etc.;
Signalling communication;
Distribution of engineer personnel;
Preparation of available material for:—
Ferry-boats. Ferrying by rafts. Footbridges. Bridges for all arms. All these require knowledge of time for embarking, crossing, disembarking, etc.
Reserve parks and reserve troops. For a passage by main force the material required should be multiplied by three.
Transport of men. Routes to be followed.
Anti-aircraft defence of bridges.

Formulæ are given for calculating rafts of tree trunks or casks. Rafts are slow and difficult to steer. If only a single raft were available to carry a company of armoured cars across a swiftly flowing river, 100 metres wide, it would save time to make a detour of 200 km. by road.

Footbridges are useful for crossing in the presence of the enemy in places where they are free from observation. If the current is sluggish they may be built up to a length of 100 m. The standard length (48 m.) of footbridge may be used for a river with a rapid current (1·5 m. per sec.), and such a bridge would, normally, take half an hour to construct.

Landing-stages should be provided for boats. The boats should be spaced at intervals along the bank, each boat being allotted enough space to allow for the probable drift downstream. Oars may be used for the first part of the crossing, but the moment the enemy opens fire outboard motors should be taken into use.

Boats and barges can be made up into rafts with the regulation equipment. Rafts are specially useful when artillery fire or aerial attack makes the construction of a bridge impossible, but they are not so easy to handle as boats. In their case, too, outboard motors are useful.

The material of "O" equipment has been adopted for bridges. It consists of boats, trestles, and superstructure that can be rapidly put together. A bridge can be constructed at the rate of one minute per four metres' run. This speed has been attained by increasing the spans to seven metres. The modern method is to construct bridges by rafts, since aerial attacks make it impossible to allow a bridge to remain in position for any length of time.

Girder bridges, with two continuous girders, can be built with ten-metre spans. But for such bridges fixed supports are preferable to floating supports.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*November–December*, 1935.)—1. *Étude sur les téléferiques.*

Captain Leygue continues his article on wire ropeways in this number. In Chapter III he explains the methods of calculating the diameter of wire ropes, viz., the hauling and carrying rope of a bi-cable ropeway and the single cable of a mono-cable ropeway. The position and height of the supports and the power necessary to work the ropeway are next calculated. In Chapter IV a number of sub-heads are dealt with regarding the stability of a ropeway, viz. :—(1) Influence of a modification brought to bear on a support on the value of the reaction of the cable on the same support ; (2) Variation in the length of a line ; effect of temperature ; (3) Action of the wind ; (4) Influence of the elasticity of the cable ; (5) Influence of a variation in the loading of the line ; (6) Influence of a variation in speed.

In Chapter V the writer deals with the rapid execution of installations in the field, and explains methods of calculation. In such cases the diameter of the cable and the weight of the individual loads will already be known.

2. *Enquête sur la radiesthésie.*

Lieut.-Colonel Metz writes a concluding essay on this subject. He is not biased either way.

In 1853 Chevreul was asked by the *Académie des Sciences* to investigate the subject of the divining-rod, and he published, in the following year, an extremely interesting memoir on the subject. Certain facts were established. The movements of the rod were caused by involuntary muscular impulses on the part of the person holding it. On the other hand, objects that caused the movements when they were seen, no longer caused them when the diviner could no longer see them. This suggests that imagination may have played a part in the result. The influence of imagination on muscular activity was little known in Chevreul's time. Modern developments in psychology may throw some light on the phenomenon.

Colonel Metz quotes two instances, likely to be of interest to Sappers, that occurred in connection with mining during the war. In one case a Captain, a well-known "dowser," discovered, by means of a pendulum, that the enemy were mining under a portion of the French trenches. The trench was evacuated. Subsequently the engineers were ordered to investigate, but they were unable to find traces of an enemy gallery. The trench was reoccupied, and a few hours later the mine exploded, causing heavy casualties. In the second case two reserve officers, who had specialized in divining, affirmed that there was an enemy mine at a given spot. Two trial pits sunk at the point indicated showed that they were mistaken.

3. *Exercice sur la carte.* (*Sapeurs-Mineurs*).

This is a solution of a scheme given out in the previous number of the *Revue du Génie Militaire* and set as an exercise to reserve officers of sappers and miners. The scheme is a crossing of the River Seine at Ablon.

Colonel Thabard, who has worked out a solution, explains his reasons for selecting the sites of a 4-ton bridge and two 9-ton raft-ferries, and gives details of the construction and the methods of crossing.

A.S.H.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1936.)—*Guerre d'hier et de demain. Offensive et motorisation*, by General Pichon, is a companion to the article on the defensive by the same writer in the October number. The present instalment, like the first, seems disconnected and inconclusive. No particular operation is specified in the text, but there are four examples with maps in an appendix. These give a variety of situations which might occur in the field with motorized divisions. Certainly, the task of a divisional commander is going to be complicated in the highest degree.

Les Forts de Verdun dans la Bataille is a short article comprising the report written by Colonel Benoit in November, 1917 on the Verdun forts, which had undergone bombardment during the long battle which lasted from February, 1916, to October, 1917. Colonel Benoit was an authority on fortification, and was deputed by the Chief Engineer of the Second Army to report on the effects of the bombardments.

During the great battle, the French positions were forced back some four kilometres on the left bank of the Meuse, and seven to eight on the right bank. This brought the original forts of Verdun, which in August, 1914, had been almost stripped of their armament, into the front system of defence. Three of these forts—Douaumont, Vaux and Thiaumont—fell into German hands, but the support line, although pierced in the centre, managed to hold, thanks to the forts on the flanks—Froideterre, Fleury and Souville.

The conclusions arrived at by Colonel Benoit may be summarized as follows :—

(i) In spite of the great weight of the enemy's artillery, the forts stood the bombardment better than was expected. The greater part of the shelters were insufficiently covered to protect the garrisons against the intense vibrations produced by the largest projectiles ; the water-tanks were cracked and emptied and the supply pipes broken, thus cutting off the essential water for the men. Much deeper communications and shelters were required ; and these were made later. Tunnels were carried back to a distance outside the shelled zone surrounding the forts.

(ii) The surfaces and outer edges of the forts must be stubbornly defended. The French were unable to recapture Vaux Fort because of the German defence ; the Germans were unable to capture Froideterre and Souville owing to the French resistance above ground.

Machine-guns in pill-boxes or even in the open outside the area of intense bombardment are recommended ; but it would appear that these would only be effective until they had been located.

(iii) The occupation of the upper works of a fort did not necessarily mean its capture. In May, 1916, the French held the top of Fort Douaumont, but were not the masters of it ; on June 2nd, 1916, the Germans were masters of the top of Vaux Fort, but not of the fort itself.

(iv) The capacity of a fort for resistance depends a great deal on the morale and energy of the defenders and their commander. The forts of Douaumont and Vaux were recaptured easily because the enemy was demoralized. On the other hand, Fort Vaux, in June, 1916, resisted for more than five days, owing to the heroism of the defenders, who were only overcome by thirst.

Colonel Benoit's report, written in November, 1917, is followed by the covering report of General Decourtis, the Chief Engineer of the Second Army, who points out that in spite of the bad repute, into which the failure of Liège, Namur and Maubeuge had brought all the pre-war forts of renown, where the forts had been stoutly defended they had defied the most powerful artillery. With the exception of the small fort of Thiaumont, all the Verdun forts were still in a fighting condition at the close of 1917.

The article closes with extracts from the original reports giving details of the damages sustained at three particular forts.

Une Liaison Imperiale au Sahara, by Colonel Charbonneau, describes the meeting at Ayoun abd el Malek of three separate columns which set out in December, 1934, to explore the routes and to prove the practicability of opening up communication with the interior of the Sahara from three different directions. The occasion was noteworthy inasmuch as the columns employed were furnished by Algeria, Morocco and Mauritania.

Mauritania is that part of French Sahara which lies between Senegal and the Spanish territory of Rio de Oro. Several attempts had previously been made to get through this region from the north, but until the pacification of the Anti-Atlas in 1934 there were numerous difficulties in the way.

On the present occasion the little force which met in the desert comprised 13 aeroplanes, about 50 motor vehicles, 700 men and 350 camels.

In spite of the presence of aeroplanes, it was not all plain sailing for the motors, a column of which lost its way in the sands, and had to be refuelled by camel convoy and retrace its tracks.

The author remarks that where the motor vehicles can find firm going, they are undoubtedly the essential means of transport, but as sand covers much of the country and is liable to obliterate tracks, camel convoys cannot be discarded; but with these two resources there is no need to maintain the local native contingents.

The columns, setting out on different dates from Adrar, Tindouf, Atar and Tidjikja, collected a varied amount of information along their routes. There does not appear to be much left for the French to pacify in those inhospitable regions, but the opening up of desert routes goes on continuously, and the combination of air services and motor transport will extract all that is to be had from a hitherto inaccessible part of the world.

In the section of the *Revue* devoted to foreign military news, there are some notes on the new German Army, and the growth of the German population with regard to its military possibilities. Most of the details given have already appeared in the public Press. Detailed figures of the growth of the population since the war are given from Dr. Burgdorfer's recently published *Bevölkerungs Entwicklung im dritten Reich*. As elsewhere in Europe, economic stress has been responsible for a considerable reduction in the rate of growth of the population, though no alarming effect seems to have resulted yet. But the Hitler régime is convinced that every step that is possible must be taken to check any decline.

It is remarkable that while the present-day dictators are hard put to it to find employment for ever-growing populations, they are all taking measures to aggravate the problem.

(*February*, 1936.)—*Les Combats autour de Lille*, by Captain Van Belle, is concluded this month. The previous instalment carried the story to October 9th, when Lille had been evacuated by all males of military age, and had once more become an open town. On the morning of October 10th, two Uhlans appeared at the Hotel de Ville and announced the approach of German troops who would take possession of the town. In the afternoon, a detachment of Uhlans arrived, and collected a number of hostages, whom they left in the charge of the *maire* while they themselves proceeded to the Citadel to take possession. On their way they were met by fifty French infantry and a troop of Chasseurs, who drove them back to the *mairie*. Here they took over their hostages and proceeded with them by another route to the Citadel. But again they ran into French troops and were dispersed, the hostages escaping in the *mêlée*. Further encounters took place between the Uhlans and the French skirmishers, and an officer and 12 troopers were taken prisoners. By the evening not a German was left in the town.

This little encounter was due to the sudden reappearance on the scene of the advance guard of Pardieu's detachment which, on the 9th October, had fallen back, somewhat unjustifiably, on Estaires, covered by the 20th Chasseurs of the 7th Cavalry Division, and had been ordered forward again by General de Maud'huy. At this time Joffre was hastening up forces to the area Courtrai–Lille–Hazebrouck to attack the German right wing, and it was essential to hold Lille. The British Army was on its way up from the Aisne, and the new 7th and 8th Divisions were arriving to join the force. Joffre would thus have the eight British Divisions, Allenby's Cavalry Corps, two French Cavalry Corps, and de Maud'huy's newly-formed Tenth Army with which to envelop the German flank. The chances of success were not remote, and Lille was the important pivot. The insufficient French forces on the spot were required to hold Lille until the arrival of the main body of de Maud'huy's Army, which was expected by the 12th. Joffre complained in his memoirs that the British request to be transported from the Aisne to the north had interrupted the French

transport arrangements, and seriously delayed the projected move. As, however, the Germans were already moving up rapidly, the opportune arrival of the B.E.F. in the Hazebrouck–La Bassée area must have been a great relief to the French Commander-in-Chief.

Meanwhile, on the German side, the evacuation of the town on the 9th encouraged General Wahnschaffe, who commanded a mixed detachment in the east suburbs, to make a further attempt at occupation, but his approach was given a warm reception by the Territorials of Pardieu's force, now established at commanding points on the city ramparts. At 6 a.m. on the 11th an ultimatum was sent to the *maire* demanding the surrender of Lille, but no answer was returned, and for an hour and a half Wahnschaffe shelled the town with his single battery.

On the south much stronger German forces were approaching; and at 9.30 p.m. (11th October) bombardment by heavy artillery began, followed at 11 p.m. by shells from field-guns, which continued until 12.30 a.m. The XIX (Saxon) Corps was coming up, and the situation of the little garrison was becoming precarious. But the German Corps Commander, who had already received numerous reports that Lille was unoccupied, had expected an unobstructed entrance. He now learned that General Wahnschaffe had been repulsed. He referred to the Sixth Army for orders. These arrived without delay, and the XIX Corps was ordered to attack on the 11th. But by the time the troops had marched up to the ramparts the Corps Commander considered that they were too tired to carry out a night attack, and he wisely postponed the operation until next morning.

Another demand for the surrender of the town was rejected by Colonel Pardieu, who conducted the resistance with particular skill and tenacity. His territorials proved themselves to be staunch and determined. An aeroplane, landing near the Citadel early on the 12th, brought a congratulatory message from de Maud'huy, promoting Pardieu, and urging him to resist to the end as help was close at hand.

But the German attack was now too strongly organized. Two divisions, the 24th and 40th, launched their columns against the southern gates, and although the 24th Division failed to get in, the 40th was more successful, and at the Porte de Douai effected an entrance. At 5.30 p.m. the resistance gave way, and the garrison capitulated.

Some 3,000 French troops, mostly territorials, with four field-guns had held the town for a whole day against 30,000 Germans with 140 guns. It was a fine piece of work.

Had the garrison been able to hold out another day it is doubtful if the Tenth Army could have prevented the fall. But the resistance certainly prevented the XIXth Corps from reaching Armentières that day. Had it not been for the timely arrival of Pardieu's detachment the subsequent battle of Ypres might have taken a different shape, for the Germans might have been considerably farther west by the time the B.E.F. came up.

The article is well furnished with sketch maps.

La Mobilisation Industrielle, by Lieut. Ailleret, is a long article of sixty pages on a subject which has been engaging much attention among Continental Powers and is now engaging attention in our own country. The French organization in 1914 was not, of course, equal to the enormous demands made on it; not even Germany was prepared for the colossal scale on which the war would be waged.

After discussing the advantages and disadvantages of a Ministry of Armaments, to co-ordinate the requirements of the three services, the author advocates a whole series of ministers and a central body to co-ordinate them. He goes into technical details of factory organization; and provides several tables of statistics. The subject is really too large for an article, and the article is too long for easy recapitulation.

Of more general interest to-day is the next article, entitled *Discours de Reouverture de l'Academie de Guerre Allemande*, describing the reopening of the famous *Krieg*-

akademie at Berlin on 15th October, 1935. It summarizes the speeches made at the opening ceremony, by Germany's leading soldiers, and breathes the regular Prussian glorification of war. General Beck gave a long account of the history of the Academy, and compared the two periods of German disaster: 1806 and 1919. Out of the defeat of 1806 Scharnhorst had created (1810) the original *Kriegsakademie*. Since 1919, it was General von Seekt who had resurrected the German Army, and moulded the 100,000 men allowed by the Treaty of Versailles into a real army by creating the auxiliaries, and gained the gratitude of the whole country.

General von Blumberg, the Minister of War, reminded his hearers of the vital importance of regarding the army and the nation as one. Military service was the highest duty of honour of the people. He referred to the failure of the German Army at the end of 1918, due, he said, to the separation between the army and the people.

General von Fritsch, Commander-in-Chief designate, addressed himself principally to the professors of the Academy. They had not only to inculcate learning into their pupils, but to work resolutely to form "personalities."

The final address was given by General von Seekt, and is given in full in the *Revue*. He remarked that as soldiers it was not for them to decide to make war, but it was their duty to see to it that they were able to do so. The highest form in which the manly virtues could be expressed was in war. War was at the end and at the beginning of each epoch in the life of nations.

It was a speech typical of the Prussian determination to revive military power in all its strength. W.H.K.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*February*, 1936.)—*La défense nationale en Belgique depuis* 1830.—(*IV*).

In this fourth article Major Mersch deals with the national defence of Belgium from 1909 until the end of the World War.

Under the reorganization scheme of 1909 the drawing of lots for service was abolished, and compulsory service was introduced for one son in each family. But, even so, the number of war effectives was limited to 180,000 men. This limit was fixed by an exaggerated optimism in the value of the guarantees of Belgian neutrality.

The Agadir incident of 1911 woke up the Belgian Government to the necessity for strengthening its defences. In 1913 a reorganization scheme was passed, introducing general service, with a view to maintaining a military force of 340,000 men, distributed as follows:—

150,000 for the field army;
130,000 for garrisoning the fortresses;
60,000 for supply and auxiliary corps.

Unfortunately, this scheme was designed to take 13 years to realize in full, and the outbreak of war in 1914 found the Belgian Army utterly unprepared.

The Belgian General Staff had to consider three possible alternatives. In the case of—

(i) A German threat, a concentration on Liége;
(ii) A threat on both frontiers, a concentration on Namur;
(iii) A French threat, a concentration on Mons.

Everything was in favour of the aggressor, who could conceal his intentions up to the last minute.

The great efforts made during the war to maintain and increase the strength of the fighting forces, both in personnel and in guns, are described at the end of the chapter.

2. *La protection future des quartiers généraux et postes de commandement.*

Captain Defrasne quotes various instances of the siting of command headquarters on the Western Front, and shows the dangers to which they were exposed. For

want of a mobile escort, von Kluck's staff was severely handled during the retirement from the Marne to the Ourq, losing three killed and four wounded out of seven officers. During the period of stabilized warfare a French headquarters owed its safety to being well away from main roads; another French headquarters, placed in a quarry within two kilometres of the front, lost all its officers from the effect of gas shells. In July, 1918, the command post of the XIth German Corps, completely unguarded, was surprised and captured in a British attack.

The writer attempts to show how modern conditions have affected the question of locating and guarding headquarter posts. The various factors are :—

(*a*) The progress of artillery and the employment of large-bore automatic arms.

(*b*) The development of motorization and mechanization.

(*c*) The extension of the domain and the intensity of aerial warfare.

(*d*) The possible employment of terrorism as an act of warfare.

The article concludes with a series of tables showing suitable guards for divisional, corps, and army headquarters.

3. *Les avant-postes.* By Major Wanty.

An outpost scheme, with maps, that was worked out on the ground in the *École de Guerre.*

4. *Renseignements sur les matériels d'artillerie.* Major Colsoulle concludes his article.

Gun-shields are used on field-guns and field-howitzers, but they have been practically abandoned on other guns.

Various types of ball-bearings and cylindrical bearings are used in gun-mountings, and especially in those of anti-aircraft artillery. They save a vast amount of friction in training the gun.

The range of guns of accompaniment need not exceed 3,000 metres; a low initial velocity is therefore needed, but the rate of fire should be the same as that of field-guns.

Anti-tank guns should be capable of piercing the thickest armour at 1,000 metres; this requires a high initial velocity.

Anti-aircraft guns require a very high range, great accuracy and rapidity of fire, high initial velocity, and mountings for all-round fire.

It is impossible to design a gun having the properties of all three.

The writer gives details of the requirements of anti-aircraft guns, and describes some of the sights and correctors in use.

There is nothing special of note in the latest design of shells. As regards fuses, the latest developments are those of mechanical fuses. Clockwork fuses have distinct advantages over others. They are remarkably accurate, and there is no burning composition to deteriorate. On the other hand, they are delicate and expensive. The "Tavaro" fuse is specially worthy of note.

5. *Le sport motorisé en Allemagne.*

Lieut. Dinjeart, continuing his article, enumerates some of the competitions held in Germany by motor and motor-cycle clubs. One test is held at night, without lights, under conditions resembling, as much as possible, those that might be realized in war-time.

For many years motor vehicles have been strictly confined to roads, a state of affairs that has hampered the development of army motorization. Cross-country motorized sport is helping to provide new ideas, and is deserving of every encouragement.

(*March*, 1936.)—1. *La défense nationale en Belgique depuis* 1830.—(*V.*)

In this final article Major Mersch reviews the present position in Belgium. The new territorial situation created by the restitution of Alsace-Lorraine to France makes Belgium, more than ever, the only channel by which Germany can invade

France. The object of the military organization of the country should be either to avoid war or to keep the line of battle on the frontier. One of the main lessons of the World War has been the importance of surprise. The army should be ready all the year round. For Belgium it is the first battle that matters, and not the last.

In 1926 a peace organization was approved which fixed the strength of the army at three army corps (each consisting of two infantry divisions and an artillery regiment), a cavalry corps (of two divisions), besides other units. This was a considerable reduction on the previous reorganization of 1921.

In 1931 the Parliament adopted a plan for the fortification of the country, which consisted of :—

(*a*) A series of works along the frontier on the line Bastogne–Arlon ;

(*b*) The Liége and Namur positions on the Meuse ;

(*c*) On the Scheldt : bridgeheads at Antwerp and Gand, with forts and redoubts. These works have made good progress up to date.

2. *Le plan allemand de l'attaque de Liége, en* 1914. By Captain Gerard.

The plan originated by Marshal von Schlieffen for the invasion of France contemplated a march through Dutch Limburg and Central Belgium, taking the risk of making Holland hostile. The German armies were to march along both banks of the Meuse between Liége and Namur, neither of which places was to be captured at first.

General von Moltke, who succeeded von Schlieffen in 1912, modified his predecessor's plan, as far as the right wing of the German Army was concerned, by abandoning the idea of violating Dutch territory. This change of strategy made the capture of Liége necessary.

The writer describes the various alternatives considered by the German staff.

The force detailed for the *coup de main* against Liége consisted of six mixed brigades besides other units : and the artillery included two 210-mm. mortars per brigade. The whole was under the orders of the 2nd Army.

The article describes the execution of the operation, after the addition of a considerable force of siege artillery, which included 420-mm. mortars, whose existence had been kept a profound secret. A sketch illustrates the lines of attack of the different brigades.

3. *La protection des avant-postes par l'artillerie.* By Lieut.-Colonel Vermaelen.

This is a study for the use of artillery and reserve artillery officers, explaining the principles of the regimental organization of outposts as laid down in the Field Service Regulations and other instructions.

4. *L'artillerie dans les campagnes coloniales.*

Colonel Jadot gives us a first instalment of an article on artillery in colonial campaigns. He deals specially with conditions prevailing in the Belgian Congo ; he himself commanded a battery in the campaign in German East Africa during the war.

5. *Méthodes de chiffrement.*

Captain Flahaut describes various types of cipher, viz., those obtained by transposition of letters, or by substitution of letters, and those obtained by the use of a dictionary. A.S.H.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*January*, 1936.)—*Retrospect and Prospect.* Austria's two great troubles in 1934, in February the suppression of the Socialists and destruction of their strong points (*v. The R.E. Journal*, June, 1934, p. 350) and in July dealing with the *coup de main* and murder of the Chancellor by National-Socialists (*v. The R.E. Journal*, December, 1934, p. 658), both interfered sadly with military training, the troops being occupied with security measures for many months.

In the more peaceful conditions of 1935 the good work has been got on with. Austria, although it has not yet been able to follow Germany's example in re-introducing conscription, has much progress to record. The army of six brigades has now developed into one of seven divisions and one rapid division. The A men, *i.e.*, lower category short-service men permitted to enlist in the long-service army to make good deficiencies up to the number of 30,000 laid down in the Treaty of Versailles, are now kept for twelve months. The infantry have received increases in infantry-guns (47 mm.), and in light machine-guns. New batteries have been raised, and the 15-cm. howitzer reintroduced. Two air brigades have been formed, and motorization has made good progress. To ensure the supply of officers for an enlarged army the Military Academy at Wiener Neustadt has been extended, and a new military school started at Liebenau. Pre-military training is now being given in all schools. For the second time, thousands of volunteers have been accepted, from among those who have matriculated on leaving school, for receiving one year's training in the ranks in order to qualify as officers of the Reserve. These measures point in the main to the happy day when Austria shall again have universal liability to military service, " the highest and the most social of institutions for popular education," and " the symbol of the modern sovereign state."

Mining Warfare on the Krain, 1917, by Colonel Baron Wolf-Schneider. Between Flitsch and Tolmein, hence on the exact front of the great German-Austro-Hungarian break-through in October, 1917, and in the middle of it, the Italian and Austro-Hungarian fronts ran within a few yards of each other across a col connecting the Krain, 2,245 metres high, with an outlying peak of 2,163 metres. The col was only 75 metres broad and with precipitous sides. After the capture of the Krain by Italian Alpine troops in May, 1915, the line remained intact for two and a half years. The only change during this time was that due to the masses of snow which, obliterating all, rose to a height of nine metres above the original positions. Fresh front lines were dug in this, and fresh wire put out, to which the enemy contributed. The narrowness of the col prohibited any attempt on the part of the Austro-Hungarian troops to recapture the Krain. Warfare, if any, would have to take place underground. But, as the author points out, an attack by mining is a purely tactical action, and like all such, together with the quite special troubles of every kind necessary for its execution, is only justified precisely when a tactical end is thereby gained. The recapture of the Krain would have served no useful purpose, and the Corps and Division concerned are praised for not starting mining-warfare. With the Italians it was another matter. A successful mining-attack on the col would have been for them a good start-off to their next attempt to break through on the Isonzo. Baron Wolf-Schneider tells the thrilling story of how the Italian first gallery was discovered through a gallery in the snow, how two Italian mines were discovered and their contents laboriously removed, and how the Austrians eventually countermined them.

Tank Troops in the Framework of the Operation of an Army (concluded). The narrative continues :—On the 4th and 5th June the leading divisions cross the Seine, and occupy the bridgehead ; by the 8th and 9th the bridges at Vernon and Meulan have been strengthened up to 13 tons, and the bridge at Mantes up to 17 tons ; on the 9th the march southward is resumed, the enemy's resistance stiffens, and the edge of Rambouillet forest is reached on June 11th.

Lieut.-Colonel Michoux's exposition deals finally with (1) the role of the commander of the tank troops of an army in preparation for the battle ; (2) distribution of the tanks among the marching columns of army and corps ; and (3) the conduct of a retreat. The last-mentioned is purposely chosen as a possibility which officers are little accustomed to practise. In order to bring it into the narrative, Paris having been captured by the " North," the 10th Army has to be pulled out of the fight, and change direction 90 degrees to go and defend it.

Field-Marshal Schäfer recommends officers to get the complete exercise from the *Revue d'Infanterie* and to work through it carefully.

The Question of the Unified Gun, by Major-General Rieder. This article discusses whether the light field-gun and light field-howitzer cannot be replaced by a single weapon. The author concludes that, with the diminished comparative importance of shrapnel, a 9-cm. unified gun, firing also reduced charges, can replace both field-guns and howitzers.

Alpine Dangers, How Recognized and Avoided. Lieut.-Colonel Lagger runs over, with practical hints, the elementary dangers of rock, snow, avalanches (new wet snow, new dry, and old snow), *Wächten*, *Firn*, ice, glacier, storm, mist (the greatest enemy) and night, which threaten all mountaineers alike, but cause less casualties than the subjective dangers, due to lack of head, lack of heed, inexperience, over-confidence and fatigue. The article is written not from a military so much as from a mountaineer's point of view. It contains, however, much that is of great importance to the soldier who has to fight above the snow-line.

One of many good tips is: "When caught by an avalanche keep head and feet up as if you were swimming." This advice presupposes that the unfortunate one will not have his skis on, since the weight of snow on the skis would make it quite impossible to follow. It leads thus naturally to the corollary: "To cross a slope where there is danger of avalanches, off with the skis, and cross on foot obliquely up or down, and treading as deeply as possible."

The two remaining articles in this number are: *The War in East Africa* (up to 17.12.35), in which Captain Kachina deals with the Italo-Abyssinian conflict, history, geography, dispositions and narrative of operations, the whole being clearly and objectively written, but disclosing nothing new to readers of the daily Press; and an admirable *International Political and Military Review* up to 20.12.35, by Major-General Paschek.

(*February*, 1936.)—*The Fighting in the Travenanzes*, 1916–17, by Captain von Raschin. In the Dolomites west of the well-known resort, Cortina d'Ampezzo, are two *massifs*, the Tofana (3,225 metres) and, three miles farther away, the Lagazuoi (2,817 metres). The heights mentioned occur at the southern ends overlooking the Falzarego Pass. From the watershed between these two mountains the valley of the Travenanzes runs first north and then north-east, leading towards the valley of the Puster, and thus giving access into Austria. To deny the Travenanzes to the enemy was therefore of the greatest importance, and the Austrian front line ran from one height to the other.

In these wild and inhospitable uplands the author commanded a sector, and stoutly resisted superior numbers of enterprising Italian Alpine troops, as here described with plan and photographs. Weather horrors were added to those of war, and one spring day 120 of the defenders were swept away, and 65 killed, by an avalanche. The resistance by means of raids on outlying posts was eventually great enough to cause the Italians to take to mining, against which countermining was often impossible. The Austrians were often shaken by charges fired in the Italian galleries, so that even glasses fell over on the table. The only comfort the Austrians got, when shaken more and more daily, was from the thought that as long as the noise of the borers continued all was well, and that when it ceased 48 hours would still be required to load the mine.

In Captain von Raschin's accounts of daring exploits it is interesting to note how much success depended upon the individual leader, *i.e.*, upon the intrepidity of one of the band of young officers and officer-aspirants under his command. The difficulty and danger of their tasks have already been brought before the general public in spectacular form by the blowing-up of the Schreckenstein as part of Trenker's film, "Mountains in Flames." (*To be continued.*)

The Russo-Polish War, 1919–20. This fourth instalment of Colonel von Wittich's account (*v. The R.E. Journal*, September, 1933, p. 537; September, 1934, p. 494, and June, 1935, p. 330) is devoted to the battle of the Vistula (August 6th–25th), the dramatic surprise in which the defeated Poles, after having been driven over 250 miles, turned and routed the Russians, then followed them up and destroyed them. The facts are astonishing enough to arouse wonder and curiosity as to know how it could all happen. A satisfactory explanation can be arrived at from a study of Colonel von Wittich's "critical and uncritical remarks," in which all factors are examined and weighed. For instance, it may be said that the Russian Commander-in-Chief, Kameneff, should not have given the commander of his right group of armies, Tuchatschevsky, a free hand, but should have concentrated both groups on Warsaw, when he could have surrounded it: that Tuchatschevsky's plan was faulty, that he lost the valuable services of the IIIrd Cavalry Corps by sending it off on a raid, that his armies were too much scattered, that he had no reserves, that he was let down by the non-co-operation of the 12th Army and of Buddenyi's Cavalry Army: that there was a lack of leadership and control generally on the Russian side: that orders did not always arrive, and even when they arrived were not always obeyed: that through the Russian heedlessness in the use of wireless the Poles were constantly informed of moves, actual and intended: that the Red soldiery had much deteriorated, and so on.

Or, on the other hand, the very real services to Poland of General Weygand, head of the French mission, may be extolled, or the gallantry of the 5th Army under General Sikorski. All these points of varying importance were contributory factors. The chief factor was certainly Pilsudski. It has been argued that what defeated the Russians at Warsaw in 1920 was what defeated the Germans on the Marne in 1914, viz., that having followed up a retiring enemy, whose powers they underestimated, they were caught by a counterstroke which they were unable to meet, and so the initiative passed to the other side. In any case the resemblance with the Marne ends here, because the Poles were able to follow up their successful counterstroke against the Russians' left flank and rear by marching 80 kilometres in 48 hours, and in consequence taking 65,000 prisoners and ultimately driving six Russian divisions and a cavalry corps over the German frontier to internment. This was the classical case of victory being followed by pursuit and destruction.

The originator of the Polish counterstroke which freed Warsaw was Pilsudski. General Camon, in his book *La manœuvre libératrice du Maréchal Pilsudski contre les Bolchéviks*, calls it "unquestionably Napoleonic." Pilsudski himself called it "mad" (*unsinnig*). It was Pilsudski also who executed the counterstroke, taking over the command of the 4th Army himself for that purpose, considering that it would be unfair to call upon a subordinate to undertake the responsibility of anything so foolish, ordered by a superior. It would not have been carried through to complete success unless Pilsudski had been able to animate the troops with quite extraordinary enthusiasm, telling them in an order of August 12th: "The legs and the bravery of the Polish infantry must win this battle." To put "legs" first was a stroke of genius. The troops knew exactly what was required of them, and, as generally happens in all armies when that is the case, they rose to the occasion.

The Sand-Model Box. Major Swiatko shows by photographs what realistic models of landscapes can be made with simple materials for indoor instruction. The size of sand-box was in each case 2 metres × 1·5 metres, and the models at 1 in 500 and 1 in 2,500 were produced by enlargement 20 times from the 1 in 1,000 and 1 in 50,000 maps respectively.

An Unsuccessful and a Successful Break-through by the Russians. Referring to the article on this subject (*v. The R.E. Journal*, March, 1936, p. 156), Colonel von Zeynek, who was Chief of the Staff of the 7th Army during the retirement, in order to correct a possible wrong impression, writes to say the question never arose of the 7th Army

retiring except in a direction which would maintain touch with the neighbouring German South Army.

International Political and Military Review. Major-General Paschek completes his half-yearly review by dealing under three heads with "Outside Europe"(the British Empire, the U.S.A., the Far East), the League of Nations, and Progress in National Military Strengths. The latter gives budgets, present states and proposals. Information on these points, instead of being taken from the former great authority, Loebel's *Annual Reports*, is now derived from Lieut.-Colonel Müller-Löbnitz's *The World's Armament*, 1935 (Mittler & Son, Berlin). Now that the narrower conception of war as an army affair has been extended to its including all national, cultural, technical and economic resources, General Paschek calls for a new Clausewitz!

(*March*, 1936.) *The Fighting in the Travenanzes*, 1916–17 (*continued*). In July, 1916, the Austrians decided, in order to anticipate an enemy attack, to take in a re-entrant, thereby also shortening the front line by a thousand metres and saving in garrison. The strength of the troops in the sector, including sappers, labour and transport, amounted to about three battalions, and included Germans, Czechs, Slovaks, Poles, Ruthenians, Hungarians, Rumanians and Bosniaks. It is a testimonial to the Mahomedan religion for war purposes, that out of all this mixture Captain von Raschin picked the Bosniaks as being the most suitable for the thoroughly unpleasant task of constructing a new front line within 200 yards of the enemy, and without frontal protection. The Bosniaks had orders not to fire unless attacked in force, but to deal with all enemy patrols noiselessly. Four days after the work was completed the Italians attacked with two Alpini battalions, who, stumbling on the new switch 1,000 yards short of where they expected the wire to be, were driven off, leaving 8 officers and 160 men as prisoners. The Italian Press report claimed the capture of the Travenanzes, presumably on the strength of these prisoners not having returned with the others!

Comparative peace above ground having been re-established, mining warfare was resumed with greater intensity. The Italians, who were mining up the cliffs, had only to set their spoil rolling to get rid of it, as the Austrians could see for themselves daily, the while their own spoil had all to be dragged laboriously upwards. Mining and countermining continued, but the blowing-up of the Little Lagazuoi (2,779 metres), upon the galleries for which the Italians had worked for two years, was destined never to come off. In November, following the great break-through of the Italian eastern front at Flitsch–Tolmein, the Italian front in the Dolomites suddenly withdrew, and Captain von Raschin's stout mountaineers found themselves following it into the plains.

The Russo-Polish War, 1919–20. The author narrates finally events subsequent to the great battle of Warsaw, and the calling-off of the Polish pursuit (25th August); Tuchatschevsky's rallying of the defeated Russians at the Niemen, where with his remnants and reinforcements he formed four new armies; the Poles' decision to attack, and their assembly by September 19th; owing to dissensions Pilsudski is again obliged to command in the field; in ten days the Poles advance 100 km. and gain their second great victory—though the battle on the Niemen "cannot be placed in the same category with the battle on the Vistula"; the armistice on 12th October, and peace.

Colonel von Wittich compares this war with the Great War, and warns that its peculiarities (untrained troops, lack of material, etc.) will necessarily impose narrow limits to the lessons to be drawn from it. Nevertheless it was a real war, and will repay study. There are even signs to-day that Europe may in future have more wars of this kind.

Naval Strategy Questions of the Present Day in the Mediterranean, by Lieut. Sokol, late Austro-Hungarian Navy, sums up the situation ably, giving relevant statistics, comparative naval strengths of Great Britain, France and Italy, both in the Red Sea and Mediterranean combined, and the grand totals; merchant tonnage totals

of the same and other European powers; the value in millions of lire of Italy's imports from and exports to individual countries. Mention is made of the work being carried out at Alexandria, Haifa and Zeiba; also of proposals regarding Hodeida, Mocha and certain islands belonging to Yemen. Italian fortifications are reported at Kasos, Karpathos, Stampalia and Kalimoros, all in the Dodecanese, while landing facilities have been provided at Bandar Kassim, Obbia, Marki, Brava and Kismayu. A testimonial is paid to Italian roadmaking and transport achievements.

There are too many unknown factors for anyone to attempt a forecast, but one thing is certain, that, even if the solution is peaceful, the situation will have given a fillip to all naval armaments.

Tanks for Small Nations. The perfecting of the tank has reached such a pitch that no great constructional change is to be expected any more, even though slight improvements are still possible. The time has come, therefore, for the small nations also to start equipping themselves with tanks. The writer, who in 1911 invented the Burstyn "motor-gun" (*v. The R.E. Journal*, June, 1933, p. 365), investigates the tank question from this standpoint. His argument runs:—The small nation cannot afford to attack its large hostile neighbour, but in order to avoid the certainty of being crushed out of hand must remain behind his frontiers on the defensive, however little this may appear to accord with purely military teaching. The attack he must await will be made with tanks, and in spite of the best-organized defence and the stoutest resistance the aggressor may well succeed in gaining local successes. Then he must be counter-attacked and thrown out again, *i.e.*, tanks will be necessary for counter-attacking. What type should be provided for this purpose? The writer decides on a three-man tank, with one automatic gun (25- to 30-mm. calibre and muzzle velocity of 800 m.p.s.) and one heavy machine-gun, with all-round fire; armouring in front, correctly inclined, 35 mm.; sides and underneath, 12 mm.; top, 6 mm.; speed, 50 km.p.h.; weight, 10 to 12 tons; to climb 40 degrees, surmount ·75 mm., cross 2 m., and wade 1·2 m.; clearance ·4 m.

If Heigl's *Pocket Book of Tanks* be now taken as a guide, it will be found that the leading tank nations, Great Britain, France, and the U.S.A., cannot fill the bill. There are, however, two tanks therein described which do so. They are the Swedish medium *Landsverk* 10, and the Russian rapid tank. Of these the Swedish has the better shape.

The very smallest number of such tanks would be 150. The cheapest and best method of moving them by road is for each to have its own transport wagon.

The remaining articles in this number are *Parachute Troops*, which points out that parachuting has become almost a mania in Russia, that it has hardly yet got beyond its initial stages, but must be seriously watched, since the Red Army in its recent manœuvres landed 1,000 men, with machine-guns, from gliders, towed as many as seven in a string. The discovery and disposing of parachute troops, coming over at great heights, will be one more task of the air patrols, which must be in the air when the enemy approaches. *Replacing the Bridge over the Save, October–December*, 1915, refers to a lattice-girder railway bridge of five bays and 462 metres long. Including the removal of the remnants of the original bridge the work was done by four railway-construction companies in 60 days. Captain Pihera's rules-of-thumb for working out how long such a job will take, the amount of labour, the quantity of wood, etc., are interesting, but the tables are not given. The basis of these calculations is the longitudinal sectional area of the obstacle from rail-level to river-bed. There are five very good photographs. *The War in East Africa* (up to 16.2.36). *The Preparation of the Terrain*, Austrian State Press, Vienna, 1935; 110 pages with seven tables and 108 plates and figures. The issue of these field fortification regulations has been eagerly awaited, as the book in use dates from 1908. The regulations now issued had to await, and be revised after, the appearance of Section XI of the Combat Regulations (*F.u.G.*), which lays down the principles governing the

utilization and preparation of the terrain. Under the title *A Contribution to the History of Central Europe*, Colonel Heller reviews two recent publications, Jaschke's *Austria's German Inheritance* (Moser's Verlag, Graz) and Professor Kirn's *Political History of the German Frontiers* (Bibliographic Institute, Leipzig) and recommends both very highly, as containing much which contributes to an understanding of present-day problems. The two books are written from diametrically opposite points of view. There is also a *précis* of Major Fowle's "The R.E. Problem of the Tank Brigade" from *The R.E. Journal*, June, 1935.

F.A.I

MILITÄR WOCHENBLATT.

A writer in the *Militär Wochenblatt* (No. 31 of 1936) makes some excellent suggestions for the general layout of field defences. First, a continuous outpost line traced in big zig-zags, with broad wire, flanked by machine-guns and covered by field-guns placed behind the line of resistance.

The line of resistance itself, about 550 yards behind the outpost line, is also laid out in big zig-zags, but formed of a series of "group nests," in two lines and connected by shallow "crawl trenches"; the obstacle is an irregular series of wire-fence rectangles—small fields—so that the enemy who gets over the first fence will only find himself in a trap.

All the dug-outs are off the communication trenches, *behind* the line of resistance.

There is a third, reserve line, about 550 yards behind the line of resistance; and in rear of it the number of communication trenches is reduced to about one-third the number of those in front.

J.F.E.

WEHRTECHNISCHE MONATSHEFTE.

(Formerly *Wehr und Waffen.*)

(*January*, 1936.)—*Angular Measurement.* Professor Maurer weighs the manifold demands upon any system of angular measurement in order to ascertain which system satisfies most requirements. General Marx, examining the same question from an artillery standpoint, recommended a division of the circumference into 6,400 parts, or preferably each 180 degrees into 3,200 (*v. The R.E. Journal*, March, 1933, p. 183); while Professor Maurer for all purposes, including artillery, selected as the best the division into 6,000 parts, with further decimal sub-division (*v. The R.E. Journal*, March, 1934, p. 179).

In order to induce people to see for themselves the advantages of his above proposal, Professor Maurer here describes an angle-converter and angle-clock, *i.e.*, a quadrant having the various divisions marked on it in two series of concentric sectors, of which the outer is forty times the scale of the inner; and two clock hands, a large and a small. The scales repeated in the two series are:—time, degrees and minutes, degrees and tenths, new degrees (of 100 to the right angle), degrees and sixteenths (5,760), new degrees and sixteenths (6,400), and "sets" (6,000). A patent has been applied for, and the Askania Works, Friedenau, Berlin, will manufacture.

Mining Warfare and Military Geology on Mount Pasubio, 1916–18, by Major Kranz. The writer, who was a geologist with the German Army on the western front, has examined Italian and Austrian accounts of mining warfare, and collated them so as to give a description of the mining on both sides. He reports generally on mining warfare in high mountains that it takes up much time, labour and materials, that success was achievable only by using large charges, that such success thus obtained was generally tactically small and strategically *nil*. In general, mining

circumstances were simple, and such as professional miners could deal with. Geologists were little used. Major Kranz produces, however, one clear case in which the advice of a geologist would have been invaluable to the Italians. The strata of dolomite rock, interspersed with layers of clay, the former good and the latter bad conductors of sound, dipped about 20 degrees from the Italians to the Austrians. The direction of the Austrian mining was misjudged by the Italians, who broke out their gallery too soon, and on a level which put them above the enemy.

The Achilles-heel of the Great Island Powers. To the two great island powers, Great Britain and Japan, Dr. Ruprecht adds, on account of her long seaboard and a land frontier so mountainous as to hamper seriously the import of heavy goods by rail, a third, Italy. The three powers are then compared as regards their dependence on coal, iron ore and oil. In which comparison Italy turns out to be the worst off of the three; so much so that Dr. Ruprecht says that many people deny to Italy a place among the Great Powers.

The Achilles-heel of the three great insular powers is that they live and die with the control of their sea communications, being unable to produce at home what is necessary to feed their populations, or the raw materials for war. While Great Britain and Japan have both been able, by far-seeing statesmanship and armament policy, to take measures to counteract this weakness, Italy is to-day suffering heavily for it, and will continue to do so as long as the British Empire exists.

The Vickers Anti-aircraft Command Apparatus. With a plan and photographs of Vickers' "Predictor," which has already been adopted by Great Britain, the United States and a number of other countries, for the automatic control of a.a. artillery, Dr. Kuhlenkamp reviews the arrangements and the theoretical principles, as laid down in the patents of Schneider in France, and Vickers, No. 236,250, in England.

After Lieut.-Colonel Eckardt has contributed some historical notes on *The Development of the Automatic Pistol* the rest of this number declines from small pica to bourgeois. It includes an exhaustive study of the *Armament Industry* by R. Metzel, which, especially as regards France, produces much evidence in support of its conclusion :—" But not only France, which issued a short time ago a loan of two milliards for purposes of national defence, and England, but also the Soviet Republic and the equally impregnable United States, although it is five years ahead of Europe in the air, arm and arm and arm! It remains for the other nations to draw from this the often forgotten, old and yet ever new, and only true teaching, that armament means power, and is the best capital outlay, that armament also permits the small and weak to throw into the scale the sword of Brennus against the great and the strong! "

What Demands are made To-day of Heavy and Light Machine-guns? is answered by a list of the conditions laid down for a competitive test, recently made in Brazil. Among the heavies competed Colt, Vickers-Maxim, Hotchkiss, Z.B. (Brünn), and the Madsen unified machine-gun. According to a report issued by the Madsen Company, their unified gun was first among the heavies in six of the tests; Colt was second in five of these, while Hotchkiss and Z.B. (Brünn) withdrew without completing the tests. The results of the light m.g. trials are not given. *Slumbering Defence Forces*, by Lieut.-General von Metsch, published by Stalling, Oldenburg, is praised very highly by the editor. The book is a cry for the superman, the superwarrior. With the warning that nothing will make history which rests alone on technics and the machine, the author calls for the firm belief that "invincibility will result from a German synthesis of military technics and military ethics."

(*February*, 1936.)—*The International Automobile and Motor-cycle Exhibition, Berlin*, 1936. A preliminary notice announces two new features, an historical exhibition to mark the fiftieth anniversary of the first patent being taken out, by G. Daimler, for a self-propelled road-vehicle, under the heading of air- and gas-power machines; and a department to show the present state of motorization in the German Army.

National Oil Politics in Germany and in Foreign Countries. Dr. Meier starts with tables showing the results of the German census of motor vehicles in 1914 and in 1935, and for various intermediate years. It appears that the total number of cars, lorries and motor-cycles in Germany has multiplied during the period named fourteen, twenty-five and fifty times respectively. The next table is looked upon as an index to national "motormindedness." It gives for various years from 1925 to 1935, and for fourteen different countries, the figure arrived at when the total population is divided by the total number of motor vehicles. Thus, in 1925 the United States had one motor vehicle to every six persons in the whole population, and Germany had one motor vehicle to every 245 persons. The last-named proportion has by 1935 increased to 1 in 63, and Dr. Meier hopes that Germany's continually improving economic position, the adaptation of roads to the requirements of motor traffic, culminating in the provision of 7,000 km. of national automobile roads, and the ample scale on which the army is being motorized, will all lead in the next few years to Germany's gaining a place amongst the most highly-motorized countries in the world, *i.e.*, with the United States, Canada and Australia. This would be in accordance with the wishes of the Leader, who has laid down that "motorization is a vital necessity to the German people."

As regards reducing or abolishing Germany's dependence upon imported oil, oil found in the country and oil substitutes are both to be considered. A certain small amount of oil is got out yearly, principally at Tegernsee, since the chief source at Pechelbroun in Alsace has passed into French possession. To increase this amount the Government is financing boring operations, stipulating only that they must take place away from known oil areas, and that there shall be no question of recoupment except where operations are successful. Up to now, 110 borings have been made, some of which are still in progress, and some of which have been carried down to 1,400 metres. The number of oil-fields discovered is five, the largest of which is near Hoheneggelsen in Hanover. It remains to be seen whether the discovery of these fresh sources will result in an increase of the total output of home earth-oil or not.

Dr. Meier then runs over shortly H.T. carbonization, from which yearly 250,000 tons of benzol are produced, a figure which is limited by the inability to market more coke and gas; L.T. carbonization, which on account of its using Germany's brown coal, and of many recent improvements, is destined to play a leading part in the movement for independence of imports; and Dr. Bergius' hydrification, at present the only feasible proposition both technically and economically. The Leuna Works in 1935 produced 300,000 tons of petrol, and another 100,000 tons were produced in the works of the Brown-Coal Petrol Company. To make a million tons of petrol would take 3½ million tons of coal, pit or brown, which is only 2½ per cent. of Germany's total output of pit-coal in the year.

The total effect of these three processes will be in a few years to decrease Germany's yearly import of petrol by 1¼ to 1½ million tons. There remains, however, the problem of how to get the necessary heavy oils, since the demand for these for the use of power-stations, shipping, heavy road transport, etc., has increased latterly even more than the demand for petrol. The consumption of diesel oils has risen from being hardly one-quarter of Germany's total oil used in 1931 to over one-third of the total used in 1934. The heavy-oil engine using gas-oil is gaining importance also in aviation, since it is both technically and economically superior to the petrol engine. For the heavy oils which are lacking, German chemists have succeeded in finding a perfectly efficient substitute in the form of gas drive. The gas is either carried in cylinders or generated on the vehicle. In the former case the gases used are either by-products of oil distillation or coal hydrification, like propane and butane, or they are coke-furnace gas, or town gas, or obtained from coke-furnace gas or in great quantities from nitrogen work, viz., methane, or Ruhr-gasal, which is a mixture of the three lowest paraffins with the three lowest olefines. A regular delivery service of gases, condensed or in liquid form, has been started by the Ruhr Chemistry

Company; but the production of generator gas on the vehicle itself from charcoal, wood, coke, or briquets, has far better prospects.

Government measures, such as increased duty on petrol and imported diesel-oils, reduced vehicle tax for those not having liquid drive, arrangements for the collection and regeneration of old oils, and also the work of the Earth-Oil Research Company, have done much to make the country independent of power-fuel imports. It would be dangerous optimism to think that this gap in the country's economic armour will soon be closed, but "what was yesterday a pious hope, a dream without prospect of realization, has now become a clear, firm object for to-morrow."

The remaining articles are:—*A Contribution towards Evaluating the Results of Machine-gun Fire*, in which Major Dänicker, the well-known Swiss m.g. and small-arms expert, shows by means of an example how far musketry theory is necessary for this purpose. *The Building-up of Russia's Technical and Economic Strength since the War*, an imposing picture by Major Wünsche of the growth of a vast army, numbering in peace 1½ millions and in war over nine millions of fully-trained soldiers, and equipped on modern lines, contributes to explaining Germany's present alarms. The editor points out, however, Russia's weakness, which derives from the fact that the huge and over-hurried expansion of its armed strength in no way accords with the peculiarities and desires of the Russian people. *The Improvement in Performance of Gun and Rifle by using Conical Barrels*, in which Lieut.-Colonel Justrow, omitting the theoretical side which has already been dealt with in the military technical Press, shows that the constructional and other difficulties are such that it would be better to concentrate upon further improvements in the conditions imposed upon cylindrical barrels, viz., by propellants and projectiles. *Air-cooled Engines for Army Purposes*, taken from *The Military Engineer*, Washington; and a comparison of the *Service Rifles of all Nations*.

(*March*, 1936.)—*The Significance of Railways and of their Working Arrangements in War*, by O. Dost. We have passed through a short period of overrating newer means of transport, when attention was turned away from railways, but this change of attitude could not be maintained. Motor transport is not able fully to replace railways for the mass conveyance of troops. Why this is so, and must be, should become part of the knowledge and conviction of every commander and of every defence expert. This knowledge is hardly technical in the strict sense of that word, and the technical principles here laid down are very close to general knowledge. When neighbouring nations go to war they compete in rapidity of mobilization and of execution of the subsequent assembly march. Of decisive importance in this race are the general lay-out of the railway system and locomotive speed. The most essentially military point of view of the advance by railway is that only masses decide, and not single portions of the army. The collection of small formations, like strengthened brigades or single divisions, will have no effect upon the state of preparedness for battle. The whole army, or at least one army capable of being put in as a whole, must have been brought up. All other points are technical:—The locomotive as tractor; the wagon as carrier; means of loading and off-loading; stations; and traffic arrangements. The only one of these affected by the troops is time taken in training and detraining. The rest the railway engineer must decide. The speed at which the railways can carry out the movement depends on marshalling and following on of trains, and rate of travel. The technical capacity of the railways for army purposes is limited by the reasons for which they were built, viz., economic and social. No country has yet faced the enormous expense of fitting out its railways according to purely military requirements. The locomotive which draws troop trains is a peace locomotive, so must come from one of the types, express, ordinary passenger, goods, or tank engine. War traffic is in railway technique heavy fast goods. It is uneconomic to use express engines for such, as they would have to go slower and be over-taxed. The fastest of these are so few that they would not carry out the movement alone; hence slower engines must be used, which will determine

the speed of the whole. Thus, for example, on the Prussian railways in 1914 there were seven types of engine in use. The slowest of these (45 km.p.h.), but of which there were twice as many as of any other type (running 55 and 60 km.p.h.), had to be chosen on that account. Ordinary passenger locomotives are for the greatest part as good as and better than goods engines for troop trains, and it would be ideal to use them alone for the forward movement following mobilization, but for this their number will not be sufficient.

The types of wagon used will also have a certain influence, as they affect the length of the trains, one of the technical peculiarities and weaknesses of railway working. The R.T.O. will like to make his trains as long as possible up to the limit of 550 metres, imposed by the length of stations, and instead of third-class coaches will provide cattle trucks for the men, saving 3·2 metres in length and 8 tons in weight for every 40 men, and gaining in flexibility.

By far the most important of all technical changes in railway working since the Great War has been that caused by the introduction of the Kuntze-Knorr pneumatic brake, also for goods trains. The goods trains of to-day, thundering by at high speeds, instead of crawling along under hand brakes, as they did up to 1918, are very impressive. Means of loading, because of the very great difference between peace and war requirements, can be a great hindrance to military transport. Platforms too short, end-loading instead of side-loading, and sidings reached only by crossing a main line, may even bring it about that the time of loading and unloading is greater than the time taken by the journey. The answer to that most important of all questions, " When can the next train start ? " is determined by the length of the longest sector in the block system. For mass transport of troops there should be short equal lengths of sector.

An ideal mass transport conveyance, if it only travelled faster, would be the canal barge with its 500–1,000-ton load. Against this the train, 550 metres long, carries, say, 850 tons. To carry this weight by m.t. would require 200 lorries, or a column 4 kilometres long. The railway remains therefore in general the only means of mass transport of troops ; but it needs to be adapted thereto, and the troops must also understand the nature of troop movement by train, or we may have, as has happened before, a squadron commander holding up his own train, and therefore the movement of all the trains, in order to water his horses.

Motor transport can replace the railways, *e.g.*, in sudden retirement, or when the latter are destroyed, but it needs a 5-ton wagon.

War and Technics. Lieut.-Colonel Justrow writes attractively on this subject, marking the appearance of a third edition of Field-Marshal Count Schlieffen's *Cannæ* (E. S. Mittler & Son, Berlin). A quick, decisive blow, and the complete destruction of the enemy was von Schlieffen's idea, and that these alone can lead to real victory. Upon this idea, which his book shows to have been based upon examples taken from the campaigns of Hannibal, Frederick the Great, Napoleon, and Moltke, von Schlieffen build his famous plan ; which was broadly carried out in 1914. It failed, but nobody nowadays finds fault with the plan, attributing blame for its failure rather to those, who in its execution departed from the strict leading lines which von Schlieffen had laid down. More knowledge is required of the causes of failure, not of " why we lost the war in 1918, but why we did not win it in 1914." Unprejudiced investigation leads to the recognition that the idea of surrounding the enemy is still just as sound as ever it was over 2,000 years ago at Cannæ, only the means are entirely different, even from what they were as lately as 1870–71. Future warfare will be entirely dominated by technics, by railways, signals, weapons, transport. Technics is no catchword. It is something which must be mastered from the soldier's standpoint in order to fit man for war. Technics alone clears the fighting man's way to wider activity. This does not mean that the general must be replaced by a technical expert. He must be strategist and technician, too. If in future warfare complete envelopment will be hardly possible, technics will help us to partial envelopment.

By its conquest of the air, armies have now a new threatened flank, vertical instead of horizontal. A victory like Cannæ is still possible, even though the scale of operations is vastly increased, because of the great energies released by technics and the vast space it controls.

The remainder of this number contains an attempt by Professor Hänert of the Naval School, Mürwik, to discover theoretically a curve for the rifling which would keep the pressure of the groove on the projectile constant: a continuation of the article on oil politics, dealing with nations other than Germany; an examination by Dr. Vieser of Poncelet's and Petry's equations dealing with penetrations into solids; a caution against the over-motorization of armies; and descriptions of recent patents in Germany and Switzerland for gun-laying with the larger ordnance.

F.A.I.

VIERTELJAHRESHEFTE FUER PIONIERE.

(*February*, 1936.)—*Field-Marshal Baron von der Goltz*, from 1898 to 1902 Commandant of the Engineer and Pioneer Corps, and Inspector-General of Fortifications. A portrait of this officer forms the frontispiece and is accompanied by a short account of his career, which discloses a remarkable character.

Like many other great men von der Goltz suffered from *res angusta domi* in his youth. He had the further advantage, as a soldier, of gaining experience of active service early, having the 1864 campaign against Denmark and the 1870–71 campaign against France to his credit by the time he was 28. He had passed the Staff College between these two wars. He was always an original thinker and writer, and his proposals for army reforms soon got him into trouble with the authorities, who sent him back to his regiment from the General Staff. Reinstated subsequently, he produced two of his greatest works, *Rossbach and Jena*, in which he threw light on the causes of Prussia's downfall, and *The Nation in Arms*, in which, foreseeing how war would increasingly involve the whole nation instead of only the army, he aimed at giving the general public the necessary information and understanding.

From 1883 to 1896 von der Goltz worked at, and for most of that time he was in charge of, the reorganization of the Turkish Army. If the results of his labour did not escape criticism when Turkey was defeated by the Balkan States in 1913, they were amply justified by the stout struggle put up by Turkey in the Great War. In 1898, as a Lieut.-General and commanding the 5th Division, he was called upon to take over the highest engineer command. That this post should fall to one who, however brilliant his career, had started life as an infantryman, was due to the fact, pointed out by a later I.G.F., General von Mudra, that at that time the Engineer and Pioneer Corps led "a somewhat unprofitable separate existence." This unfortunate state of affairs called for remedy. It could be altered only by a large scheme of reform, and von der Goltz tackled the job with excellent judgment and characteristic energy. A basic principle he laid down was: "Our (Engineer) officers are to make technics of service to the leader in the most critical situations and in the foremost line in mobile warfare, and through powerful measures in fortress warfare. An appropriate adjustment of the rigidity of technics to the situation at the right place and time is to-day, under conditions which have changed essentially when compared with the past, more difficult than ever, and quite impossible without clear tactical understanding." These words are still true n 1936, only more so.

General von der Goltz realized that the iquick campaigns of 1864 and 1870–71 were no criterion and, foreseeing the immense demands on the engineers in future, strove for their numbers to be increased. He brought it about that exercises of the other arms always included their due proportion of engineers, and turned what had hitherto been carried out as purely engineer exercises into manœuvres by bringing the other arms into them. His personality awakened everywhere fresh life.

In 1902 he left to take over command of the Ist Corps, and in a farewell letter thanking his Chief of the Staff, General von Mudra, he said: "The hard work that the Engineers have to do in peacetime strengthens both nerves and sinews, and brings its reward in wartime."

From 1907 to 1913 General von der Goltz was Army Inspector, and in the Great War successively Governor of Belgium, G.O.C. Dardanelles Army, and G.O.C. 6th Turkish Army in Mesopotamia, where he died of fever fourteen days before the surrender of Kut-el-Amara. Not his least title to fame is that by his understanding and ceaseless efforts he established a new relationship by lifting the engineers of the German Army to a higher plane of utility. In himself he furnished a good example of what he was alluding to when he wrote: "Courage in accepting responsibility, and the pleasure which welcomes it, arise from a quality of soul, which ennobles the leader's whole being."

Motorization and Blocking Operations. Under this title Colonel Dennerlein discusses only the defence side of this subject, and that only to the extent that such defence is to be carried out, wholly or partly, by engineers. It is hoped to reproduce a translation of this article in a subsequent issue of *The R.E. Journal.*

Motorization and Mechanization of the Engineers in the British Army, by Major Rothardt. This article is based for the greater part upon articles which have appeared in *The R.E. Journal*, and quite especially upon Lieut.-Colonel N. T. Fitzpatrick's *Mechanization and Divisional Engineers*, of which the two parts were in the June and September, 1931, numbers respectively. Twenty-one of the original photographs are reproduced by permission of H.M. Stationery Office. Two photographs which fall out of the series show a bridge-building tank with a girder slung, and laying it in position over a gap.

Examples of the Employment of Motorized Divisional Engineers, by Captain Meltzer. The object of these examples, which with one exception have already been tried out practically, is to stimulate ideas on the subject, and further to show, on the one hand, how important the tasks may be that befall motorized field engineers, and on the other hand, the necessary limitations imposed by their present equipment. The examples are:—(1) March exercise of a corps troops motorized field company to deny to the enemy a river front with two bridges. (2) Reconnaissance exercise. (3) Bridges having been destroyed, a motorized engineer company is sent to extemporize ferrying arrangements. (4) Laying and removal of blocks in great depth. (5) A map scheme in the Masurian lakes district for a blocking detachment consisting of a battalion of motor-cycle rifles, a company of engineers, and a detachment of a.t. guns, the scheme being based upon the situation at the end of the first day of the battle of Tannenberg.

Germany's Fortifications at the Outbreak of the Great War deals only with land fortresses. Coast and island fortresses, although also marked on the map accompanying the article, will be dealt with on a later occasion. Major Dinter first runs over the history of permanent fortification in Germany from the beginning of the nineteenth century, recounting how the successive advances in ordnance constantly rendered forts obsolete or in need of modernization. After this necessary preliminary to an understanding of the subject, Germany's land fortresses are then treated *seriatim*, with details as to type and armament, and falling into three categories, western frontier, eastern frontier, and inland. The whole are then re-classified in five classes of fortresses, from those of the greatest power of resistance down to those of very slight resisting power, and followed by three more classes of fortifications, the last of which consists of no more than arrangements for the immediate protection of bridges and railways.

The author sums up: "The German fortresses, with the exception of Lötzen (between two of the Masurian lakes, and on the Königsberg–Lyck railway), were not attacked during the Great War. They were thus not able to prove that their nature

and strength accorded with requirements. The stronghold Boyen (Lötzen) in spite of its weakness (in the 5th Class and having no advanced works) was able to hold out. This fact perhaps permits the conclusion that it was right to spend what money there was first and foremost on the western fortifications, where stronger means of attack had to be reckoned with. One thing is certain, that western and eastern fortifications alike by their presence alone permitted the carrying out of our assembly and strategic plans, and duly influenced those of our enemies."

The remaining articles in this number are *Training of the Field Company*, in which Major von Ahlsen approves of the article on this subject in the May number, which dealt with the training of H.Q. and section scouts and runners, but wishes to add to them certain points which have come out in training. *Umpiring and Blocks*, in which Colonel von Schaewen points out that the difficulty in umpiring, which makes high demands on the soldier's imagination, owing to the absence of hostile weapon effect, will now be increased by blocking operations, since it is often not possible to indicate the effectiveness of the block. To make blocking on manœuvres real, umpires will have to be specially trained. *A Case of Rock-blasting*. In the winter of 1929 a rock weighing 250 tons came down the mountainside to within 50 yards of the village of Etterzhausen, to which it remained a standing menace. Many consultations took place, and after civilian contractors had demanded prohibitive prices for removal, the army was called upon. A section of a pioneer company from Regensburg, with two compressors and pneumatic tools, made 48 bore-holes from 2 to 4½ metres deep in three days, and, after having hung splinter-nets on the trees between the rock and the village, and having induced the inhabitants to protect their roofs with brushwood and straw, removed the rock with charges totalling to less than 100 kilos. Except to the tops of the trees, which were shaved off, no damage was done at all. *Prussian Pioneers about 1550*, describes, with two facsimile illustrations, a hand-written *War Regulations*, compiled by Duke Albrecht of Prussia, whose high appreciation of the "fortification-builder" antedates by two and a half centuries Napoleon's "never injurious, almost always useful, often indispensable."

F.A.I.

THE INDIAN FORESTER.

(*January*, 1936.)—Vol. LXII begins with the report on the fourth Empire Forestry Conference, held in South Africa in 1935; it was attended by 60 or 70 representatives, responsible between them for administering about 2,200,000 square miles of forest. South Africa has a very small amount of indigenous forest, and as the erosion problem is ever getting more serious, the question of afforestation is becoming one of increasing importance. The next Empire Conference is to be held in India.

Some 302 members of the Forest Department have earned the India General Service Medal, with clasp "Burma, 1930–32," for services to the military and police during the recent rebellion.

"Planting of *Dalbergia Sissoo* in Keonjhar State" records the phenomenal growth of some *shisham* trees. Seedlings, 12 in. high when planted in 1930, had grown to a height of 50 ft. with stems 24 in. in girth by 1935. Keonjhar is one of the Orissa feudatory states.

In an article on earthquake-proof buildings, Mr. Maclagan Gorrie claims immunity from shock for a system of timbered masonry, used in Kangra and the adjoining hill tracts of the United Province, known in the vernacular as *kat-ki-kona* (timber-cornered).

Lastly, there is a most interesting account by Mr. Riaz Ahmad, of the Galis forest division. As many of the hill stations of the Rawalpindi district are situated therein, it is one which is well known to many Sappers.

F.C.M.