APR 1922

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THE "CANADIAN" PHOTO-TOPOGRAPHICAL METHOD OF SURVEY.

By CAPT. AND BT.-MAJOR E. O. WHEELER, M.C., R.E.

THE principles of the "Canadian" Photo-topographical method of survey are perhaps not so well known as are those of map making from aeroplane photographs. The essential difference is that the latter method depends on the photo being taken with the optical axis of the camera pointing vertically downwards (or being "re-distorted" to produce that effect), while the former requires that the axis be truly horizontal—in other words, a true perspective of the country to be mapped is used. I have called it the "Canadian" method: for, although it was invented and has been used elsewhere, it has been elaborated and far more extensively applied in Canada than in any other part of the world.

Plotting by stereo methods from pairs of photographs, while based on the same principle of perspective, involves the use of totally different methods for obtaining points, and is not in any way connected with the "Canadian method;" the following is a brief explanation of the latter, which was first tried in India with the Mount Everest Expedition in 1921.

Instruments.—The instruments required are the camera, a small theodolite for fixing the position and height of the camera station and measuring the direction of the "orient points," and, in the case of little known country, but which contains triangulated points (such as the neighbourhood of Mount Everest), a light plane-table to assist in the identification of those points.

Camera.—The form of camera adopted consists of an inner metal box open at one end and with the lens fixed at the other; a pair of cross levels are fixed in the sides of this box to enable the instrument to be levelled in two positions. For this purpose it is fitted with a levelling base similar to that on a theodolite. The inner box is protected by an outer wooden cover, at the back of which is a movable carrier, worked by a screw and butterfly nut from the outside: in this the plate holder is placed, and, after the slide is withdrawn, the plate can be screwed forward against the open end of the inner box, thus securing constant focal length and, when the camera is properly levelled, verticality of plate. Slots in the wooden cover allow the bubbles to be read.

In the centre of the edges of the inner box sharp notches are filed, so that they appear in each photograph taken and form reference marks from which the "principal" and "horizon" lines (see *Diagram*) can be measured. $4\frac{3}{4}$ by $6\frac{1}{2}$ plates are used: the lens adopted is a Zeiss Tessar f 6·3, series II b, *anastigmat*, to cover a 4 in. by 5 in. plate, which gives a wider angle for a shorter focal length (6 in.) than would be possible if the proper lens for the plate were used. The angle of view is 51° by 36°. By stopping down, the larger plate is fully covered, and the photograph, being almost free from distortion throughout, is practically a true perspective. At f 45, the stop usually used, the focus is definite from about 15 ft. to infinity. A heavy yellow screen (Wratten "G" filter on optical flats, five times) is used to obtain good contrast and colour rendering with a backed panchromatic plate. (Wratten and Wainwright found to be suitable). This necessitates exposures of from 3 to 5 seconds on a bright day, at f 45. Exposures are made by means of an ordinary between-lens shutter with antinous release. To improve the brightness of the image, a shade is invariably used over the lens. The camera, together with 11 plates (1 in the camera), note-books, pencils, etc., is carried in a stout leather case, arranged to carry on the shoulder like a knapsack; the whole weighing about 30 lbs.

Theodolite.—The theodolite is a 3 in. vernier instrument, reading to minutes, which fits in two parts in a wooden box. The tripod, which is collapsible and serves for both the camera and the theodolite, consists of three two-section legs, measuring 20 in. closed and 3 ft. 4 in. open, which fit on a metal tribrach carried with the theodolite. In use, the instrument is steadied by filling a 3-cornered canvas bag, which is suspended from the joints of the legs, with stones, and if necessary piling stones inside the legs up to the tribrach. The theodolite box and legs are carried in a canvas case similarly to the camera, and weigh about 27 lbs.

On the Mount Everest Expedition, an 18 in. square plane-table was used, of which the edges were arranged to fold back so as to form a pack 18 in. long by 9 in. wide, and which fitted on the camera levelling base. The plane-table was held open and steady while in use by means of two removable wedge-shaped battens sliding in grooves underneath the table. The paper was cut at the joints so as to fold under with the edge of the table.

Triangulation.—Triangulation may be carried out separately or concurrently with the detailed survey, using either the 3-in. or a larger instrument. The former method is preferable. Camera stations are interpolated by readings with the 3-in. instrument to three or more fixed points. The interpolation may be computed, but it is usually sufficiently accurate to plot them graphically, first plotting the rays on a piece of tracing paper, fitting the rays to their respective stations, and pricking the point through. For this purpose an "arm protractor" of (including the arms) about 12-in. radius, reading to minutes by means of a vernier, is used.

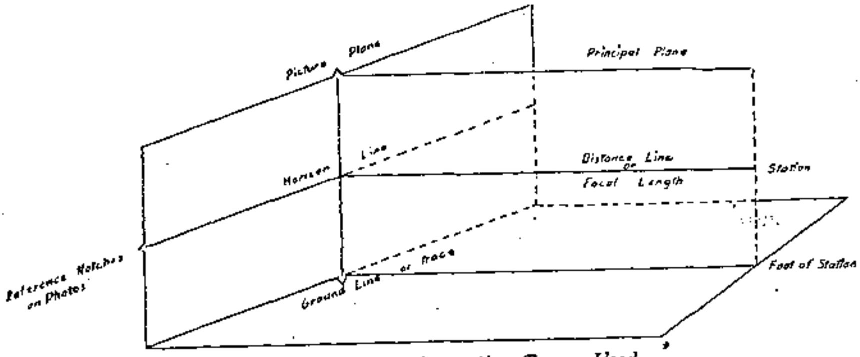


DIAGRAM NO. 1.—*Illustrating Terms Used.*

Orient Points.—In each photograph there must be an "orient point," either a triangulated point or one whose direction with reference to a triangulated point has been measured, which is plotted on the plan by means of the protractor.

Plotting "Traces."—To enable the "Trace" (horizontal projection of the picture-plane) of the photograph to be laid correctly on the plan, and to enable heights to be measured on the photograph, it is necessary to know the positions of the "principal line" (vertical centre line) and "horizon line" of the photograph. These are measured with reference to the notches which appear on each photograph, the camera level bubbles being used throughout the season in a constant position; this position is found by experiment before the work is begun, as described later on.

Having the direction of a point in the photograph (the "orient point") laid out on the plan, and knowing the focal length or "distance line" of the photo or enlargement in use for plotting: and knowing that the trace of the photograph falls at the length of the distance line from the station and perpendicular to it, it is easy, by measuring the distance along the horizon line of the photograph from the orient point to the principal line of the photograph, to draw the trace of each photograph in its proper position on the plan. In practice this process is expedited by the use of a celluloid "tracer" on which the horizon and distance (principal) lines and station point are previously drawn, and on which the orient points are marked as required. By laying the station point over the station on the plan and the orient marked on the tracer over the corresponding ray drawn on the plan, the positions of the distance line and trace are at once given. This is done for all the photographs.

Plotting Points.—When the traces have been laid on the plan and all points required to be plotted have been projected vertically downwards or upwards to the horizon line of the photograph and then transferred to strips of paper (the principal line being marked on each

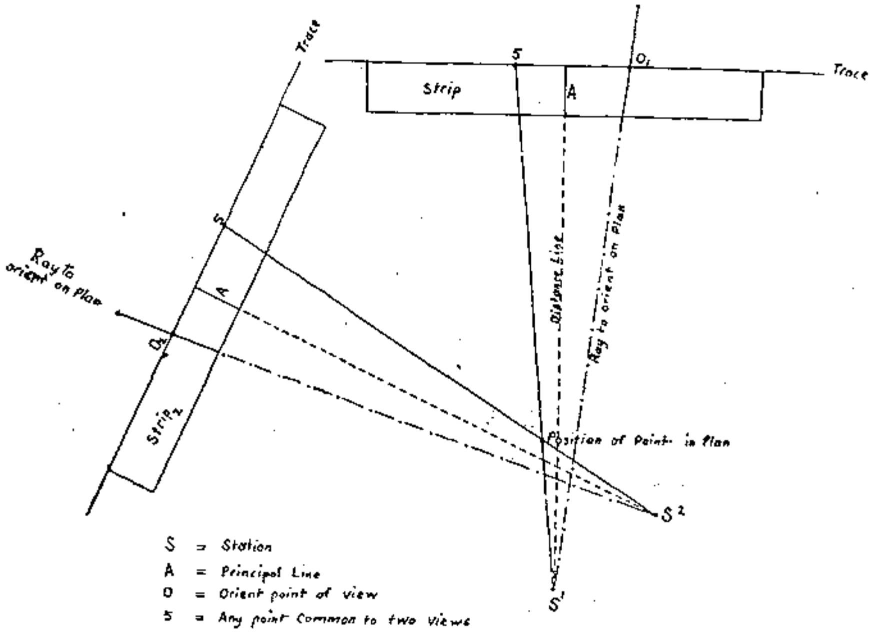


DIAGRAM No. 2.—*Illustrating Plotting Points in Plan.*

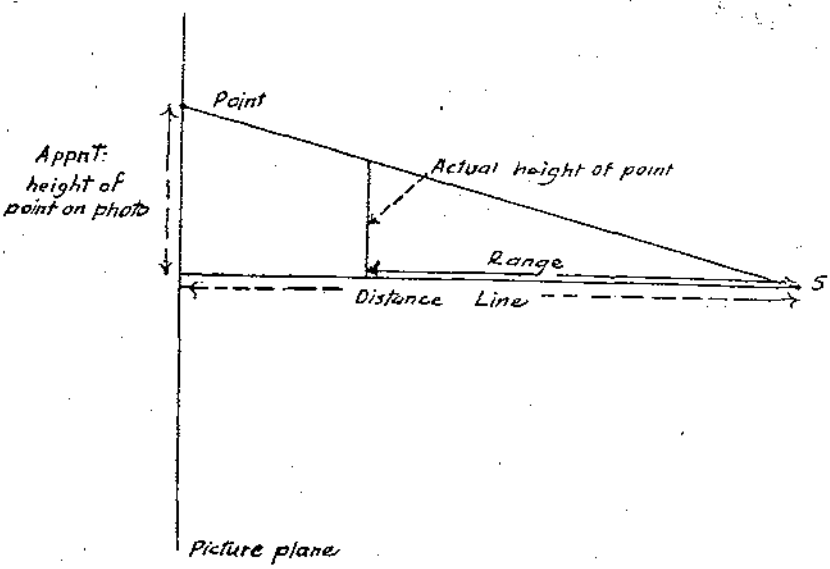


DIAGRAM No. 3.—*Illustrating Computation of Heights.*

strip and registering with the principal line of the photograph) and the strips have been laid in their appropriate position on the traces on the plan, obviously the intersection of the rays joining the projections of the same point on two or more photographs of the same terrain (taken from different stations) will represent the position of that point on the plan; and the better the intersection of the rays the more accurate will be the position fixed. This process is carried out for all the points required to be plotted.

Heights.—To obtain heights. The distance line of the photograph is known and the apparent height of the point above or below the horizon line of the photograph can be measured on the photograph. The range of the same point can be measured on the plan, and the actual height of the point above or below the horizon line, *i.e.*, above or below the station from which the photograph was taken, can be computed by means of similar triangles.

In practice an instrument is used to expedite this process. It consists of two fixed arms to represent the base and "height" of the fixed triangle, *i.e.*, the distance line as base and the apparent height of a point as "height," the latter being projected on the *principal* line of the photograph and transferred to paper strips as in the case of points in plan. There is a sliding arm, carrying a scale, which can be placed at the range of the point on the plan; and a revolving arm radiating from the station on the plan which, when placed at the apparent height of any point as shown on the paper strip on the fixed height arm, obviously reads the actual height of the point on the sliding arm scale, when the latter is placed on the point in plan. A mean of heights thus obtained from two or three stations is taken.

As many points on ridges, valleys, etc., as are required are thus fixed and their heights computed. Contouring can then be done by examining the various photographs covering the same area.

Method of Squares.—One further process is extremely useful for plotting lakes, streams and similar figures contained in, or nearly in, a horizontal plane, provided the difference in height between the station and figure to be plotted is known.

This is the method of "squares," and consists in drawing the perspective of a network of squares over the figure to be plotted; and a corresponding set of squares on the plan. It is usual to lay the side of the squares parallel and perpendicular to the distance line on the plan (*i.e.*, vanishing in perspective at the principal point) though any direction (such as North or South) may be used. The relation between the sides of the square in plan and on the photograph and their position on the plan, is dependent on the length of the distance line and the difference in height between the station and the plane of the figure to be plotted. This is most easily obtained graphically, and is usually done once for all (for photos of the same distance line) on the "perspectometer." To construct the "perspectometer," horizon and principal lines, and the perspective of a network of squares vanishing at the principal point (the intersection of the horizon and principal lines) are drawn on paper and

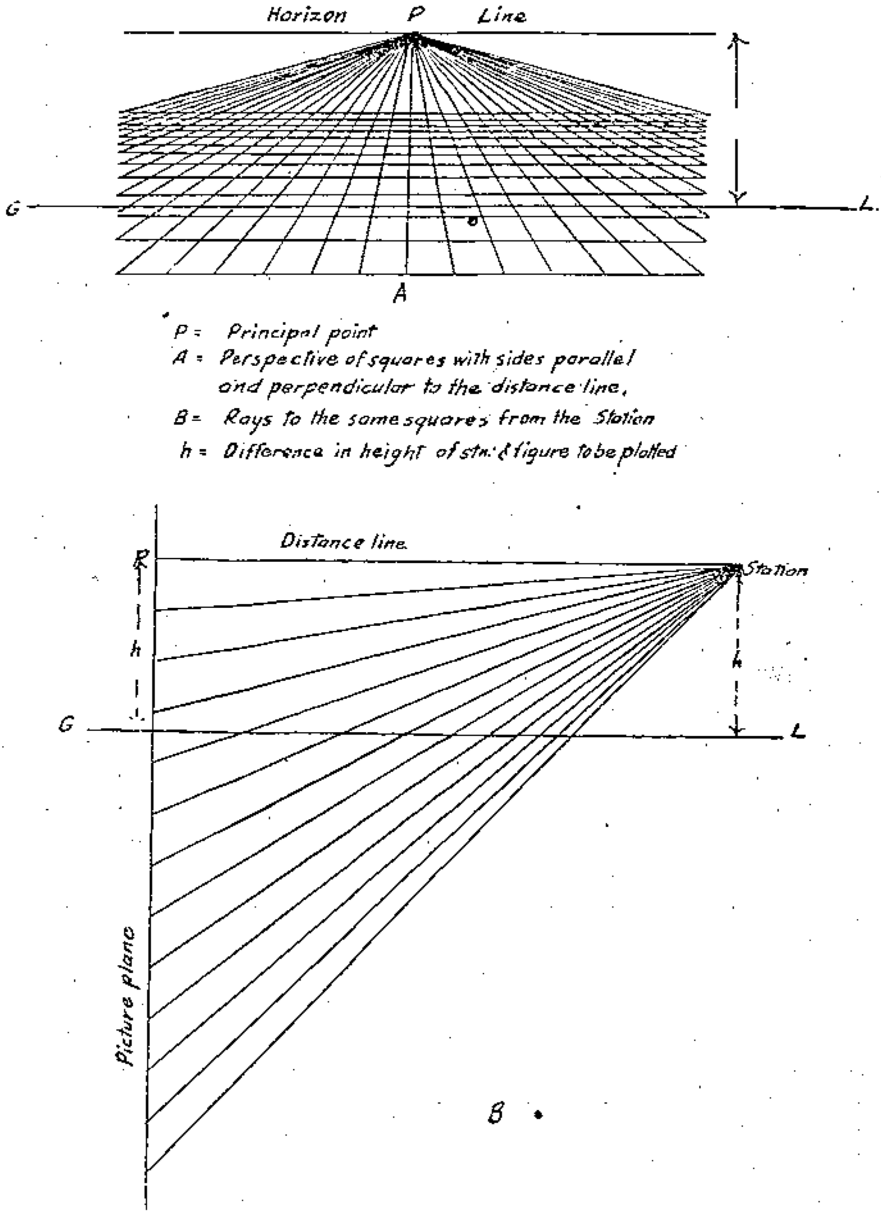


DIAGRAM NO. 4—*Illustrating the Perspectometer.*

photographed on to plate glass. The instrument is placed in position over the photograph and the appropriate squares required for plotting the figure transferred to the plan, their size varying with each particular case and dependent for a fixed distance line only on the difference in height. These may best be obtained by drawing the "Ground Line" for the particular photograph and figure under consideration, on the perspectometer. The ground line will fall on the perspectometer at a distance (in "scale feet") below the horizon line equal to the height of the station above the figure to be plotted, and on the plan, in the trace of the photograph. The size of the squares in plan may be obtained from *Fig. A, Diagram IV*, at the intersection of the Ground Line with the squares: and their position relative to the trace, from *Figure B*, at the intersection of the Ground Line with the picture-plane. The outline of the figure enclosed in the squares is then transferred square by square to the plan.

Testing Camera.—Before starting the season's work it is necessary to ascertain the readings of the camera level bubbles which will make the plate vertical, and will make the true horizon line approximately cut the notches filed in the camera box; and before plotting, to ascertain the focal length or distance line of the prints or enlargements to be used, and the exact position of the horizon and principal lines with reference to the notches appearing on the prints. In the case of a contact, the distance line is equal to the focal length of the camera; but as it is usual to use an enlargement, it is best to measure the distance line actually on the enlargements to be used; obviously a fixed focus enlarging camera must be used to ensure constant scale and distance line.

Verticality of Plate.—Tests for verticality of plate are carried out by placing the lens of the camera and a mark some 300 to 400 yards in front of it in the same horizontal plane by means of a level, racking a plate glass reflector forward against the inner box in the same place as the plates will occupy, and by means of the levelling screws of the camera, making the image of the mark coincide with the cross hair of the level.

The readings of the "fore and aft" bubble are then noted. This is done for the two positions of the camera.

Horizon and Principal Lines.—To ascertain the position of the horizon and principal lines and to calculate the focal length (or distance line) three marks are put up and levelled as above, and photographs taken: in the vertical position of the camera so as to include two marks, and in the horizontal position all three, the transverse bubble being kept in the centre of its run during the operation. The line through the targets will then represent the true horizon in each position of the camera, and its position with reference to the notches may be noted. If the true horizon falls inconveniently far from the notches, the process may be repeated with the transverse bubble appropriately out of centre.

The horizon line of the photograph in one position of the camera being transferred to a photograph in the other position, will give the principal point of the photograph at the intersection of the two lines; these lines will not necessarily be perpendicular to each other, but a line through the principal point *perpendicular* to the horizon line of each photograph will be the principal line of that photograph, the principal and horizon lines being perpendicular to one another by construction.

Focal Length.—To obtain the focal length or distance line, the angle between the outer marks for each position of the camera is measured with the theodolite (angle W), and the distance from each mark to the principal point measured on the photograph. This can most conveniently be done in feet on the plotting scale.

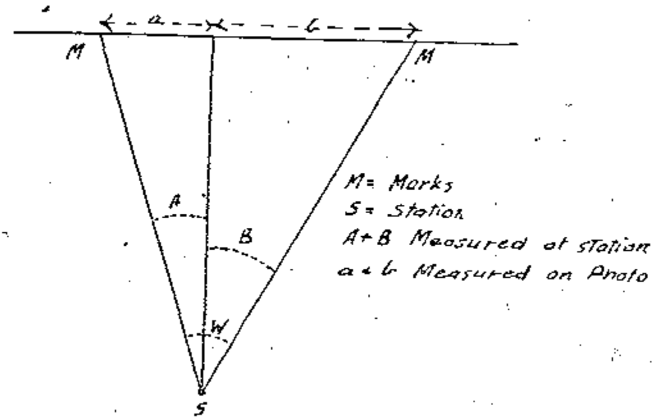


DIAGRAM No. 5.

The distance line may then be computed from the formula:—

$$\tan (A+B) = \tan W = \frac{\frac{a}{f} + \frac{b}{f}}{1 - \frac{ab}{f^2}}$$

where f = the distance or focal length.

Field and Office Work.—At the station in the field, photographs are taken of all country required to be mapped. A good overlap is allowed to avoid plotting too close to the edges of the photographs, and in case an orient point is for any reason omitted. Notes of exposures and angles are kept in the field, and the work plotted on return to headquarters It is convenient sometimes to develop plates in the field and to make sufficient prints to assist in the identification of mountains, etc. Development is done by time and can be carried out almost anywhere. Otherwise no drawing or office work whatever is done in the field. Full advantage is therefore taken of a short mountain season and there is no question of sketching detail with numbed fingers, as is the case with the plane-table at high altitudes.

Advantages of method.—The method is particularly suited to rugged country and the more rugged the country the more favourably it compares with the plane-table. The precision, in ordinary hill country is equal to that of the plane-table; and in high, rugged country is likely to be greater, for with the aid of several photos of the same country under his eye at the same time to assist in the identification of points, and the advantage of being able to work in the comfort of an office, the draughtsman is able to sketch in detail at his leisure and without having to trust to his memory to interpret intricate topography. It should be clearly understood, however, that the method is a method of surveying detail only, and is equally dependent with the plane-table on an accurate framework.

DARDONI.

By MAJOR A. H. BELL, D.S.O., O.B.E., R.E.

IN a recent army examination one of the papers dealt with a part of the Trans-Indus situated between the Kurram and Tochi Valleys. One of the places referred to in this paper is Dardoni. It is possible that a short account of the origin and growth of this place may be of some slight interest to others besides the Sapper whose lot it was to get it built.

For many years before the last Afghan War peace was kept on the Indian Frontier by means of the Militia Force which owed its inception to Lord Curzon. The Headquarters of the Militia which garrisoned the Tochi Valley, known as the Northern Waziristan Militia, is at Miramshah, a place on the North side of the Tochi Valley, about forty miles by road west of Bannu. The Militia post consists of a large fort with high walls of sun-dried brick, surrounded by a barbed wire entanglement. The Civil part of the post contains the living quarters and offices of the Political Agent, and the Military part barracks for several hundred men and a comfortable Officers' Mess and Quarters. Outside are the well-kept gardens of the Political Agent and Militia, watered by an irrigation channel taken from the Tochi some miles away.

In 1915 an incursion of outlaws and raiders took place from Khost a few miles to the north. A force was hurriedly sent up from Bannu, and after defeating the enemy with great slaughter, near a Wazir village called Dardoni, settled down under the north wall of the Militia post to await more peaceful times.

A kind of defended camp, with partly dug-out huts for Officers and men and a perimeter wall, was built there. The best features of this camp, from a constructional point of view, were the rapidity with which the work was done and its small cost. From a sanitary point of view, the camp was not so successful. Its area was very circumscribed, horses had to be kept in it at night, there was no proper water supply, men died of pneumonia and fever was common.

As a result of medical agitation, it was decided in 1916 that a new camp with a proper water supply should be built at some distance from the old one.

The force to be provided for consisted of two battalions of Indian Infantry, two squadrons of cavalry, two sections of a Mountain Battery and various details.

As water was the all important factor, two trial wells were started, one about $1\frac{1}{2}$ miles from the Militia post, at a higher elevation on the plain or "dandi" on which it was built, and the other about two miles further away. The latter was soon abandoned, whilst the former was carried on till water was reached through a soil like soft rock at a depth of 120 feet.

The site for the camp, to be known as "Dardoni" after the Wazir Village, was therefore chosen on the gently sloping "dandi" between the Militia post and the well, about one mile from the former and to the north of it.

It is about 3,100 feet above sea-level, and distant in a straight line about nine miles from the Afghan border and 25 from Matun, the chief village of Khost; about 100 miles from Ghazni, the nearest Afghan town of any importance to which the track up the Tochi valley leads; 120 from Kabul; 30 from Makin in Mahsud Country, and 32 from Bannu (but 41 by road), the nearest rail-head. It is about three miles from the north bank of the Tochi.

It was decided that the camp should take the form of three large squares laid out on a common diagonal to facilitate flank defence. The largest enclosure, to accommodate personnel, was 680 yards square; the next, for animals, was 250 yards square, and the third, which was intended for the convoy which periodically brought up supplies from Bannu, was 100 yards square.

Various examples of hutted camps exist on the Frontier, which have been laid out in an unsatisfactory manner; Tank and Thal may be cited as instances. Buildings have been put up far too close together, radiation from the mud walls which surround one on all sides increases the heat and produces an atmosphere of oppression.

At Dardoni the barrack huts were spaced with large intervals round the perimeter. The Officers' huts were built on the sides of a square near the centre of the large enclosure, which was traversed by three metalled roads running North and South and two running East and West.

It was naturally arranged that all the material needed for the construction of the buildings should be obtained locally. All walls, with a few exceptions, were made of sun-dried bricks, which were moulded near the irrigation channels some two miles away. Nearly all the buildings were made of a standard section, 18 ft. wide, with a central row of pillars, 2 ft. square at 9 ft. central intervals, the side walls consisting of panel walls 1 ft. thick, between pillars 18 in. square, opposite the central pillars. The roof covering was of the ordinary type on the Frontier, namely about 4 in. of mud, covered by 1-in. layer of mud plaster. The mud was laid on a double thickness of grass matting which was supported by thin poles (ballis) at 6-in. central intervals. The poles spanned the distance between the rafters, the ends of which rested on the pillars.

The rafters and the poles could be purchased at Miramshah from tribesmen who bring them down the Tochi from the well wooded Shawal District to sell at Bannu. Grass mats could be bought locally and mud for the bricks was everywhere.

The barrack huts, when they were finished, were most uninviting and met with almost universal disapproval. A type of hut which had been put up at Tank had by advice been taken as an example. There were no windows, but a space of about 2 ft. was left open at the top of the panel walls to admit of air and ventilation. This result was certainly obtained, but a frousty atmosphere is as much prized by the Sepoy as it is by the Tommy, and after many complaints half the number of openings were closed by grass panels or were built up altogether. Probably by this time there are glass windows. The floors were originally of mud, but the medical authorities objected to dust, so eventually all the floors in living-rooms were paved with roughly squared stone blocks, which could be quarried about three miles away.

The Officers' huts were more elaborate. The central pillars were omitted, and the rafters supported by struts instead; they had proper windows, fireplaces and stone floors.

Each of the three enclosures was surrounded by a mud wall, 6 ft. high, and a wire entanglement, and the largest enclosure had a blockhouse at each corner.

The huts intended as hospital wards were more elaborate than the barrack huts. They were 20 ft. wide and the roof was supported by trussed beams. The floors were of concrete, and there were verandahs on both sides.

The water supply was all derived from the aforementioned well. A circular shaft was dug a few feet away from the well and connected to it by a tunnel. This shaft was lined with stone and a direct-acting steam pump (to be duplicated later) was fixed on a concrete platform at the bottom, the suction-pipe going through the tunnel into the well. The boilerhouse and a reservoir were built near the top of the well with a double-storied stone blockhouse alongside for protection.

The reservoir was built of local lime-stone masonry in cement mortar in two compartments with a ferro-concrete roof, the floor being at ground level.

From the reservoir water gravitated to the camp and was laid on to standpipes fixed at convenient centres, to water-troughs in the animals' and convoy enclosures, and to various taps in favoured buildings, such as kitchens of Officers' Messes.

The supply, when finished, was much superior to that in many cantonments in India which have been in existence for a hundred years or so, *e.g.*, Nimach in Central India, where, until recently, at any rate, water was only obtainable from two or three wells;

and Nasirabad where water was drawn from a system of wells in leather bags by bullocks, which, in times of drought, when the water-level was very low, had to work night and day. The water fouled by the bullocks gravitated to a reservoir several miles away, from which it flowed through a pipe of insufficient diameter to the cantonment two miles distant, where the delivery was inadequate and intermittent.

When the camp was nearly completed, it was decided to add a company of Sappers and Miners to the Garrison, and additional huts were built; owing to the liberal spacing of the huts in the first place there was no difficulty in providing the room required.

Latrines were of a superior type; they were of C.G.I. and bought ready-made with a view to their being re-erected elsewhere should the camp be moved in course of time further up the valley, and as being more sanitary than latrines of mud-brick. They were put up in four groups, two outside the north face, and two outside the south face of the large enclosure, with an incinerator in the middle of each group.

At the beginning of the Afghan War in May 1919, the camp was practically complete as originally planned. For a few days it appeared likely that Nadir Shah would advance from Spinwam towards Dardoni and invest it, but luckily for Dardoni he selected Thal for his attentions. As a measure of precaution the walls of the animals' and convoy enclosures were flattened out, and all the animals were picqueted in the large enclosure at night.

Later in the same year an ice-machine, which had been lying in the camp for a year whilst sanction for its erection was being granted and refused by two apparently antagonistic branches of the Staff at Simla, was hastily erected by a devoted R.E. Officer, whose health gave way under the strain of working continuously throughout the day in a hot summer for several days in succession.

Shortly afterwards electric-light engines were installed, and fans and lights were then available in the hospital and Officers' Quarters.

Later Commanders than the famous mountaineer, under whose auspices Dardoni was started, considered the arrangement by which the main source of water supply was outside the perimeter of the camp to be a dangerous one, so a new well and another reservoir were made inside the walls.

In the actual construction of the camp labour was, as usual, the great difficulty. There was none obtainable locally. A contract for the whole camp was first arranged with a Hindu contractor at reasonable rates. He started well, but soon came to the conclusion that he was not getting enough out of his contract and refused to continue.

Various small contracts were then given out to Punjabi contractors, but they were all unable to collect sufficient labour, and made very slow progress. Eventually a contract was arranged with a Hindu at rates much exceeding those originally allowed, and, although he made fair progress, his work was not as rapid as he had promised it would be. His workmen, who all came from India, were timid and unhappy, they were always trying to run away to Bannu, the nearest railhead, but were always relentlessly and quite illegally sent back.

One of the greatest difficulties was in transporting the mud-bricks; they had to be moulded near an irrigation channel about two miles from the camp and were carried thither somewhat grudgingly by camels and mules belonging to the S. and T. Corps.

In retrospect, it is clear that a camp of this kind, situated in an out-of-the-way spot, accessible for wheeled traffic only by a road which is liable to attack at any time, where food is dear and water difficult to get, where workmen have to live in a protected area, should be built by organized labour under military discipline, such as a Works Company, of which there were several working on the Frontier during the Waziristan operations last year, and that special arrangements for transport should be made by allotting S. and T. troops for that purpose only.

From an announcement in the papers a few weeks ago, telling how a convoy had been attacked between Datta Khel and Mohammad Khel, it appears that the Upper Tochi, which was abandoned at the beginning of the Afghan War, has been re-occupied. So it may well be that Dardoni is destined soon to relapse again into its original mud, and to be re-born under a new name a few miles further from the Indus but nearer to Ghazni and the heart of Afghanistan.

SOME EXPERIENCES OF AN ENGINEER OFFICER WITH THE SALONIKA ARMY.

By COLONEL-COMMANDANT G. WALKER, D.S.O.

(*A lecture delivered at the S M.E., Chatham, on* 3. 3. 21).

(*Concluded.*)

SURVEY.

7A. The first survey troops to arrive in Salonika were the Topographical Section. The only existing maps were the 1/200000 and 1/2500000, both of Austrian origin and both very inaccurate. These were what were issued to the troops on first arrival and they were of very little use. The French had started a trigonometrical survey from a base measured on the Vardar plain with an astronomically determined azimuth, and were pushing a triangulation through the country. The British, in January, 1916, commenced a survey by measuring a base on Hortiack Plateau. This base was 1,355 metres long, measured with a 300-ft. steel tape which had seen much wear in Gallipoli and had not been tested with any standard subsequently; no corrections were applied, and the mean of two measurements only was taken. No astronomical observations were taken for latitude or azimuth.

This base was extended to the Langaza plain to join up with the French system.

The triangular error for 44 triangles, 3 of which were not closed, averaged 36 secs., the greatest being 124 secs.

Co-ordinates were computed on a rectangular basis and the French value for the side on which the British closed was used in computations.

The White Tower in Salonika was taken as the initial station and the French co-ordinates for this accepted. When the work reached Langaza a new base of 3,562 metres was measured. On the completion of this work the triangulation was carried eastwards to connect with the Naval system at Stavros.

No azimuthal check was obtained, as the Naval system was based on geographical co-ordinates, and no attempt was made to convert them to the rectangular system used by the Army. More or less at the same time a triangulation was commenced in the Struma valley where a new base was measured. This was carried westwards and southwards to Langaza and Stavros, and large errors were found in closing with these places.

The triangulation was subsequently extended to the Doiran area and Katerini. In January, 1917, a Survey Company was formed at Salonika, and the work put under an officer of the Royal Engineers.

Difficulties were constantly arising about the value of the points determined in the operations outlined above. Many points determined from each of the three bases had three different values, and it was realized that the work done was not sufficiently accurate to extend from, in case of an advance, or to attempt any artillery work, as was being done in France. To give examples, differences of as much as 200 metres existed between the lengths of co-ordinates and the triangular errors were often large (up to 2 minutes) and often only two angles of a triangle had been observed.

It was consequently decided to start a new network as a basis on which to recompute the old work.

In June, 1917, a new base, 6½ miles long, was measured in the Langaza plain with apparatus borrowed from the French. Two measurements were made and corrections made for temperature and level.

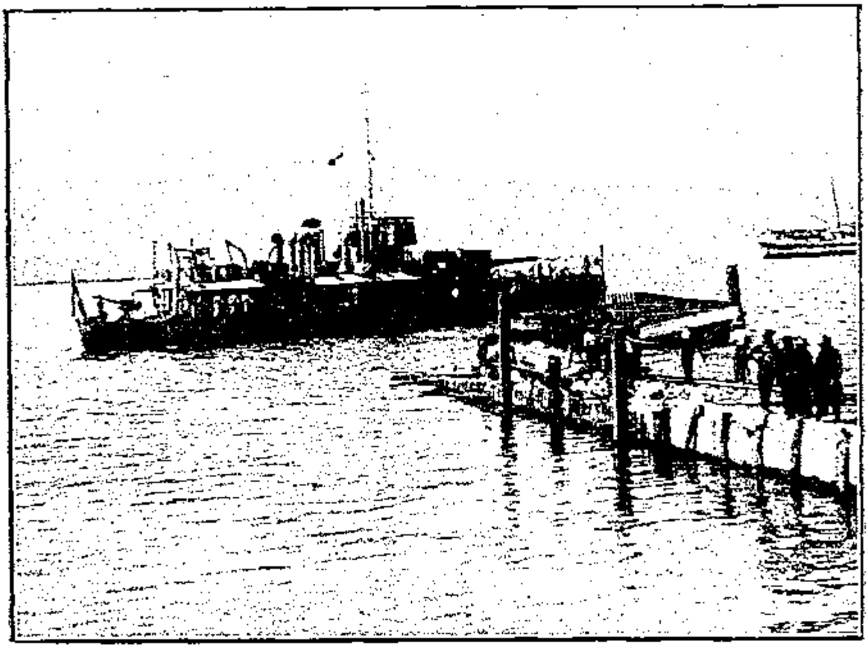
The difference between the two measurements was 6 cm. Observations for latitude and azimuth were made. The net-work covered the whole British area and the average triangular error was 7 ft. 4 in. for 64 triangles; geographical co-ordinates were computed. The initial azimuth was that of the south end of the base line. The initial latitude was that of the White Tower, as given on the Naval Chart, and this was carried through the triangulation. It only differed from that taken at the south end of the base by 1 ft. 8 in.

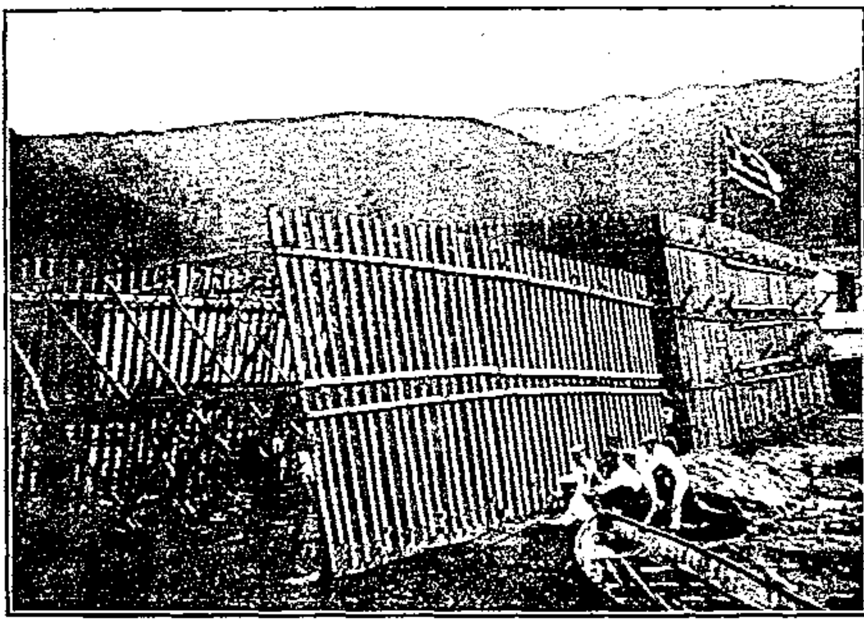
The geographical co-ordinates were converted into rectangular co-ordinates. All the old triangulation was recomputed, using, wherever possible, the value of the sides of the new triangulation.

Eventually, when we were able to join up with the enemy's triangulation in Bulgaria, the British and German results were very close.

Topographical Work.—When the Army first reached Salonika every division was ordered to make reconnaissance sketches of the area it occupied. This work fell very largely on the R.E. Field Companies. The work was done with plane tables but it was found most difficult to connect it up, as the survey authorities at the base could not give any true north and south line to work on, test compasses, etc. The reason for this is clear from the description of the way the original survey was initiated. I mention this point to show how inaccurate arrangements for survey work affect even the advanced troops at times. Ultimately the Survey Company at

STAVROS PIER.

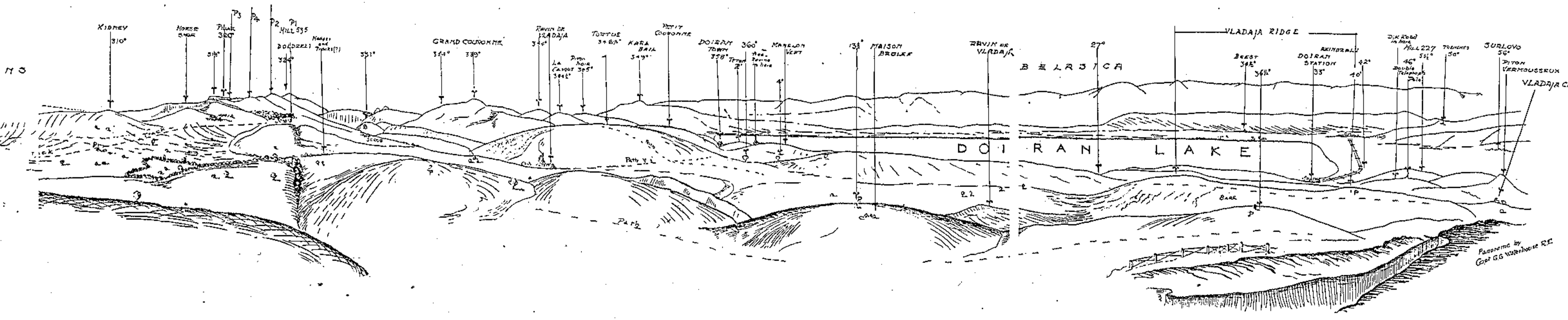




General Construction of Cribs. Ready for Launching.

PANORAMIC VIEW OF FRONT FROM HILL 420.

TRUE BEARINGS.



Salonika filled in their triangulation with extremely good and accurate topographical work.

At first the British maps were based on French data.

They were issued in two series :—1/50000, 1/20000.

A certain number of 1/10000 sheets were produced later of ground not covered by the French.

In January, 1917, a complete new survey was started in two series :—1/20000 for front areas, 1/50000 for back area.

These sheets were extended beyond the enemy lines by means of air photos adjusted to a skeleton forward triangulation.

Location of Hostile Artillery (Sound Ranging and Flash Spotting).—The results of this work in Macedonia are specially interesting as they show how useful it can be if carefully organized, even in a hill country, where artillery have every facility for concealment.

The work was carried out from locations on the existing maps which were good and accurate (1918) and not from triangulated points, as there were no surveyors available for this latter method.

It was found that the observer should have artillery as well as survey knowledge, and that if individuals of this sort were not available, the work should be done by two officers, one of whom should be an artillery officer ; the results obtained being then sifted by a third man who controlled several parties.

The 12th Corps front was divided into three areas for the work :—

(1) " P " Ridge to Doiran (*see* attached panorama sketch) ; (2) " P " Ridge to Vardar ; (3) West of the Vardar.

The results in (1) and (2) were as follows :—

(1) Thirty-nine Batteries existed, as found from reconnaissance after the advance. All had been located—32 within 50 yds., 1 within 100 yds., 6 over 100 yds.

(2) Forty-seven Batteries were located out of 57 subsequently found, that is, 82 per cent.—25 within 50 yds., 14 within 100 yds., 8 over 100 yds., total, 47. Ten were not located, but of these, nine had been spotted from one set of observations only, but this was not considered sufficiently accurate for record as actual location. The actual natures of 215 guns were also identified between Doiran and the Vardar by these methods.

These results were very satisfactory and depended almost entirely on the accuracy of the mapping. To give point to this remark I may say that in 1917 application was made to me by the Artillery for the loan of a theodolite for range-finding purposes by triangulation.

I lent the instrument, but warned the borrower that, unless he was sure of the accuracy of the location of his observing stations, the results would be useless. The result was not satisfactory because the maps available were not sufficiently accurate.

The moral of the above story seems to be clear, namely, that good mapping is essential in all military operations. Laymen are so apt to pin their faith absolutely on the accuracy of any map, just because it is a map, that the issue of bad maps is a serious source of danger. I think I have also indicated how the inaccuracy of survey work produces trouble even in the front-line fighting areas.

From a purely engineering point of view too great stress cannot be laid on the necessity for accuracy. A good map saves the engineer an enormous amount of reconnaissance work in the location of routes for rail and road and also as regards water supply.

In Macedonia no geological survey was available, and there was no time to make one. If such a survey had existed it would have saved the engineers a great deal of labour.

Disease.

8. The diseases common in Macedonia were chiefly:—

Malaria.
Dysentery.
Typhoid.
Smallpox.

It was from the first two that the Army chiefly suffered.

The last three were dealt with by inoculation, and I never came across a case of either cholera or smallpox; though there were several scares about the former.

Malaria was our principal enemy, not excluding the Bulgar. The country and inhabitants were rotten with it, and the area abounded in the Anopheles mosquito. The worst places were the Struma, Batkova and Vardar valleys, but the mosquito was to be found wherever there was water, even in the Hill Country. As far as I know personally, the Army at large went to Macedonia in complete ignorance of this, and no protection arrangements were provided when we went out. On our arrival in January, 1916, we heard rumours, and I remember saying to General Milne that, if this was a true rumour, we should lose more men from malaria than from several general actions. He agreed, and in his Division precautions started as soon as possible.

They consisted principally in the collection of materials for the building of mosquito-proof huts in the most dangerous localities. We were then engaged on the Birdcage line and there was no idea of going any further; in fact, we were confidently expecting to be attacked where we stood. There were great difficulties in getting materials, especially mosquito-proof wire-netting.

In June, 1916, when we moved forward in the middle of the malaria season, we left our few mosquito-proof huts and occupied the Vardar-Doiran-Struma line with no other protection than one square yard of cotton mosquito-net per head.

The result of this move, which was unavoidable, is shown by the Hospital Returns. I myself was in hospital at Malta with 22,000 other patients, most of whom were suffering from malaria and most of whom came from Salonika. We were only those who were so bad that it was thought advisable to get us out of Macedonia for recovery, and were additional to those in hospital and convalescent camps in that country. A very large proportion, of course, returned to their units eventually, and I only state the figures to give an indication of what the Salonika Army suffered from this disease.

When the troops reached their new positions, anti-malaria work started afresh and consisted of draining, cleaning and housing in mosquito-proof huts or dug-outs. Veils and gloves were also issued for night work and a mosquito-proof *tente d'abri* for two men was issued. It may be of interest to note that ultimately the men of gun detachments and nurses and orderlies in hospitals worked at night in veils and gloves. Such protection was impossible for working parties, however.

In fact, protection against the mosquito at night for fighting troops is a most difficult problem. The malarial mosquito only works at night, and even then movement is a considerable protection to a human being. The sleeping man is the easy victim.

The Bulgars, and eventually the British, retired during malaria months to the higher land, and left the valleys and marsh areas as much as possible.

The point I want to bring out is that it is absolutely essential to take time by the forelock in dealing with disease. You may not be able to do the best thing, but every little helps, and this little must be done quickly. Further, that the study of the diseases of the country and the way to combat them is essential for a soldier, especially for the Engineer, as upon his shoulders falls most of the actual work. Engineers and Doctors must work hand in hand in this matter and unless they do disaster will follow.

A few details may be of interest. Clearing ground for a distance of 400 yds. outside camps is a great assistance. All streams should be cleared or canalized to preserve a quick flow (1/100 is a useful grade). Swampy areas should be drained, and pools near camps oiled with paraffin. When possible, in standing camps everyone should sleep under protection. In huts all apertures must be closed with wire. In tents protection is almost impossible, but it is easy to treat dug-outs. The great difficulty in hot countries is to get the troops to sleep under protection. They say it is too hot. Good discipline and education are the best cures for this failing.

Dysentery.—This disease in a very bad form is endemic all round the Balkan coasts and up country. The British Army did not suffer from it very severely, owing to the stringent precautions taken.

The great enemy is the fly, so that fly-proof latrines (with self-closing seats), larders and cookhouses are essential. Absolute cleanliness as regards food and the person must also be impressed on everyone. The items mentioned above were all R.E. work and entailed a great deal of labour and arrangement.

Every unit, however small, was supplied with a fly-proof larder or meat safe. Another precaution taken was the careful burning of all excreta, whether of men or animals. This entailed the building of incinerators of various patterns. The units as a rule built their own with our materials.

Hospitals.

9. Following a description of our bodily ailments there should follow logically some remarks as to the provisions for curing them.

To fully describe the Salonika hospitals would require a book. My remarks shall therefore be very short. The first thing to be said is that they were excellently good. Nurses and doctors vied with each other to make us comfortable and happy, and I should know, as I was several times a patient.

The following hospitals were in being at Salonika :—

"General," (1,600 beds), 4 hutted, 19 tented.
Stationary, (600 beds), 7 tented.
Convalescent Camps, 11, mostly tented.

They were situated principally round the base or within 14 km. of it, but there were hospitals also at Sarigol, Guvesne and Lahana.

The above do not include the Clearing Stations in the Corps and Divisional Areas. All these hospitals entailed an enormous amount of engineer work, such as approach roads, water supply (by pipe or well), pumps, lighting (E.L. in some cases), ward huts (when hutted), hut kitchens, latrines, other accessories (always), operating theatres (sometimes).

The operating theatre is the central feature of a military war hospital. In Salonika we nearly always had them in huts at the Clearing Stations. We built one for each of the C.C. Stations at Karasouli and Janes and, I am told, thereby saved a good many lives.

Piers.

10. A great deal of work had to be done at Salonika to facilitate the unloading of the ships. The difficulty was the shallowness of the water and the depth of the mud—the latter varied from 40–60 ft. The former necessitated long piers, and even then the stores had to be trans-shipped in lighters.

At Salonika itself five piers were constructed west of the railway station. They were "piled" and the superstructure was simple timber work. Lines of rail were laid on the decking.

(1) Malta Pier, length 178 ft., width 16 ft., water 7 ft.
(2) Gravesend Pier, length 1,021 ft., width 19 ft., water 7 ft., pier head 286 ft. long.
(3) New Pier, length 590 ft., width 22 ft., water 15 ft.
(4) Hay Pier, width 33 ft.
(5) Marsh Pier, length 1,169 ft., width 43 ft., water 7 ft.; head 269 ft. long.

At Stavros a very interesting piece of pier construction was carried out. Stavros was the supply port of the troops in the Southern Struma area. These troops were at first supplied entirely by sea, and it was essential to construct a pier for supply ships to lie at in all weathers. The site was selected by the Navy and the construction was commenced under Major (then Lieut.) J. H. Waller, D.S.O. an officer of one of the field companies of the 10th Division, who had had previous experience of building fishing piers on the Irish coasts.

The method of construction was unique as far as I am aware. The pier was built in lengths of crib work of suitable height according to the depth of water, of convenient length for launching, and wide enough at the top to carry the designed superstructures. Actual dimensions were 22 ft. deep, 50 ft. long, and 25 ft. broad.

The cribs were made of 4 by 4 timber, cut near the site by Greeks with supervision by Sappers of the 17th Field Company, R.E. They were lashed together with wire and the bottoms were lined with wire netting. They were then launched on ways and towed to their positions by a monitor. They were then sunk in position by being gradually loaded with Greek labourers, who were marched on from the shore. These men were withdrawn as the stone-filling was put in. Finally the cribs were crowned with a concrete superstructure. This was made by reinforced concrete beams round the tops of the crib spars, connected at 15-ft. intervals by horizontal tie beams.

The concrete went down to water-level (there being little or no tide).

The whole of the top of the pier was brought up to level with ballast and covered with torpedo net which was securely tied to the concrete on the weather (south) side.

This was then covered with gravel. The object of the net was to prevent the stones in the crib being washed bodily upwards and out of place by the wash of the sea. In a heavy sea the waves would break green over the pier and also force their way under the concrete and throw the stones right out of position.

After a gale the surface of the pier over the netting had to be remade. The whole work was completed in two and a half months, the first section being finished in a month.

The pier took 30,000 tons of stone to fill it and was in position in 1919.

The attached Photographs generally illustrate the work.

Besides the above there were subsequently five shallow-water piers for lighters constructed in 1918. These were made of steel caissons sunk in position and loaded with stone.

Before leaving this subject, a word should be said about the Salonika Base. A British force of five Divisions was landed at Salonika, that is to say, a force four times as large as that employed in Egypt in 1882, and to this was joined about the same number of French troops. That is an unprecedently large overseas force of all arms.

This Army was based upon an ill-kept and ill-equipped town inadequately supplied from the oversea base, and it was operating in practically a desert country.

The initial facilities for landing men and material were entirely insufficient and the water in shore was so shallow that piers of great length had to be built.

No arrangements were made to co-ordinate the port facilities to the positions of the troops of various nationalities, with the result that the streams of traffic from the landing-places crossed and recrossed each other in the most inconvenient way.

The confusion that obtained must always remain an object lesson to those who witnessed it.

It is a lesson which teaches the absolute necessity for proper organization of a sea base, both as regards landing facilities and leading away stores from the beach, when two or more nationalities are operating together.

It may here be added that throughout the campaign the numbers of technical troops were inadequate. Besides the R.E. field companies with the Divisions there were at first, I believe, only five Army Troops and one Base Park companies, R.E. These were added to later by the arrival of two more Army Troops companies and the formation of various railway units as the railways were extended.

The country provided no manufacturing facilities, skilled labour was scarce, and the unskilled undisciplined at first. These difficulties were bad enough at the beginning, but when the Army moved forward they were greatly increased.

If we are to look for a cause for all this, I think it can be found in the fact that no one at home or abroad really realized what the requirements of a large modern army operating in a roadless and almost desert country were likely to be.

Ropeways.

11. Although plant was available, ropeways to overcome transport difficulties in the Hill Country were not used at the beginning of the campaign.

A ropeway was projected in 1916 from a point on the Seres road to gain access to the S.E. flank of Kotos Mountain and give communication with the right flank of a defence line in this area. The approach road from the south was surveyed and commenced, but the ropeway was eventually abandoned, as easier communication was procured from Hortiack. Subsequently ropeways were constructed at Karamudli and Krusoves and at the Dranista Mines (two).

Karamudli.—This was a single line between Karamudli and Arakli—operated by petrol engines of Marine type, 7 h.p. Total length, 7,845 ft.; rise, 640 ft.; capacity, 70 tons in 8 hours; speed, 210 ft. per minute. It was used for supplies and munitions for the military posts in the Krusa Balkan and obviated mule-haulage up the very steep Baisili hill. It was initiated in November, 1917, and completed early in 1918.

The Krusoves line was a gravity line to supply troops on Ahinos lake below the Krusoves hills. No details are available of its construction.

Dranista Mines.—The details of these ropeways were as follows:—

(1) Carriers' capacity, 160 lbs. each; speed, 250 ft. per minute; single line; length, 300 ft.; fall, 57 ft.

(2) Single-line gravity; carriers and speed as (1); length, 1,500 ft.; rise, 178 ft.

Besides the above a much more important line was projected between Bralo and Itea Pier. It was intended to carry stores from the port of Itea to railhead at Bralo, but the line was never constructed.

Details of Design.—Speed of rope, 360 ft. per minute; diameter, $2\frac{5}{8}$ in.; carrier's load, 5 cwt., spaced 60 ft.; capacity, 30 tons an hour; engines, 30 h.p. (petrol marine type); single line (mono cable); length of line, about 40 kilo.; total rise from Itea was 1,880 ft. above the sea, though in one place the maximum height was 2,930 ft.

Defences.

12. The actual details of the defence work in Salonika differ but little from those in the western theatre of war.

The front lines of defence were practically continuous on the Vardar-Doiran and Struma fronts. The section between Doiran and Butkova was not so strongly defended, as the ground was stronger and difficult to approach. Even here, however, the wiring was practically continuous.

On the "Birdcage" line round the Base itself the line, where occupied, was continuous. In every section occupied there was but little depth. There were practically few reserves and the principle of defence involved was to hang on to the end on a fixed line. Everywhere, however, there were rear lines of defence, constructed on the same lines as the front line, on which troops could fall back. From the Vardar to Doiran there were two or three of these in some places, one or two in others, all inter-communicating.

Besides the front-line systems and the Birdcage there was a retired line running from the Vardar at Vardino through Janes, Kurkit and Vurlan to Lahana, a distance of nearly forty miles.

This line was commenced in 1917. Originally it was what might be called an embryo line. Wiring and M.G. posts were completed, but the fire-trenches and communications were simply sketched on the ground by digging 18 in. deep.

It looked pretty strong from the air. Later, when the 1918 reverses in France made people nervous, the line was much improved and a lot of work was also done on its communications in the Hill country.

The great difficulty with this retired line work was labour; few troops were available and the major portion of the work was done by civil labour, men, women and children. One or two points are worth special mention.

(1) *Birdcage Line, Stavros Section.* This section was occupied by one Brigade. The line ran over the tops of the hills, which were covered with high, thorny, holly-oak scrub. It was awfully blind and the first thing was to clear and lay a field of fire and make obstacles, then provide communications and finally dig trenches, etc. This is worth mentioning, as it brings out the order of work in such cases. On the flat ground between the hills and the sea, also, a rather special type of work was erected for the infantry defence. The design came from Egypt, where opinions differed about it and, I confess, I was not over fond of it myself.

The general idea was to have company defensive areas, sited about 600 yards apart, giving mutual support by echeloning back the flank platoon works and also providing gorge defence by the same means. My feeling about them was that they would prove to be shell-traps. However, they were never attacked, and this accusation must be taken as "not proven." This type of work was also erected between Langaza Lake and Langavuk.

(2) *Retired Line, Vardino to Lahana.* This was started in 1917, when Roumania broke up, and when we thought we were liable to overwhelming attack.

The first object to be attained was to mark the general positions so that retiring formations could make no mistake as to where they were to stand and fight.

We did this by siting M.G. emplacements and then running the wire along lightly at first and then more thickly, suitable and well-marked gaps being left for the retiring troops.

After this the infantry line portions were broadly marked with shallow-dug trenches deepened later on.

The method was, I think, sound, as it is essential in a retirement to a given position that at any rate the position shall be clearly marked *on the ground*.

General Remarks on Defence Work.

(*a*) The Engineer must study war from the General Staff standpoint, for he must be able to discuss the situation on common ground with the Staff and bring thereto his technical knowledge to assist in arriving at the right decision.

(*b*) An Engineer must remember the men who have to fight in the works he designs, and always must consider their mentality and *morale* when designing. He should always consult with the infantry involved when designing.

(*c*) It is not the duty of R.E. officers to select positions. That duty belongs to the General Staff. I always made a great point of this. Our work comes in designing works suitable to the position selected. To cite one case. The decision as to whether the British line at Neohori on the Struma was to be east or west of the river depended on whether the Engineers could guarantee safe bridge communications across the stream, which was a torrent. We gave the guarantee and the line went on the east side on much the same ground as that held by the Athenians in B.C. 424.

(*d*) Field Service Regulations, Part I, is a very good book and was not written for fun.

(*e*) A word about defences in a hilly, steep country with very well marked ground. Re-entrants are best defended by machine guns at their apices or from behind a lateral sub-feature of the main spur. Salients can usually be controlled by fire from the flanks, and it is usually better to withdraw the infantry fire positions from their points to, say, half-way back across the spur.

(*f*) Everything should be standardized as much as possible. Timber work for dug-outs, M.G. posts, etc., was made so that it could be loaded in sections on mules to transport it up the mountain paths.

(*g*) The heaviest nature of shell which we had to provide for was 8-in. This, I think, was only on the Doiran front; as a rule, 6-in. was the largest. As the result of various trials we found that the following protection was proof against

8-in. shell:—12 in. stone bursting layers, 18 in. earth: 24 in. stone cover; 4 ft. 6 in. in all. The best support is a steel "Elephant" shelter, but for large emplacements girders of the same character as those used for Komarion Bridge, as described under Military Bridging, were found useful to carry the weight.

Military Bridging.

12A. The most important work of this nature was undertaken in connection with the attacks made across the Struma in September, 1916. The 16th Corps was acting in this case as a sort of strategic flank guard on the East, while the 12th Corps was attacking in conjunction with the French and Serbs at Doiran and Monastir.

There were 11 bridges eventually completed: six for 3-ton lorries, three for 6-in. guns, and caterpillars, and two for light traffic. They all had small beginnings. The first crossings were generally made with rafts. Then trestle bridges were built, and improved later on by piling. The work was all done by the Field Companies with the Divisions.

The river Struma is a difficult one to negotiate, as it has a soft sandy and shifting bed, is liable to flood, and the floods break out new channels. In dry weather it is shallow, and not suitable for pontoons, although there was one pontoon bridge in the Neohori Gorge.

When piling, it was necessary to drive the piles a minimum of 16 ft. into the river-bed. The piles were usually 9 in. diameter. The average width of river and approaches was about 100 yards.

In every case when a bridge was completed a wire rope ferry was installed above the bridge as a "stand-by" for use in time of flood. It will suffice, I think, to mention two bridges only particularly.

(a) *Komarion Bridge.*—Built by the 500th Field Company, R.E.

Piers, 9-in. by 9-in. piling, driven 20 ft.; Road girders, 20 ft. long; Top boom, 6 in. by 6 in.; Bottom boom, 6 in. by 6 in.; Stanchion, 6 in. by 3 in.; Web cover, 18 or 19 gauge, sheet iron web, 26 in. deep (*i.e.*, width of sheet iron plates). These girders were tested with a 14-ton concentrated load moving, and gave a deflection of $\frac{11}{16}$ of an inch.

(b) *Neohori (Hall's) Bridge.*—Built by 17th Field Company, R.E., 27th Division. Length 414 ft. (23 spans of 18 ft.). Each pier consisted of four 9-in. by 9-in. piles, 18 ft. long, driven 8 in. into the shingle. Water 10 ft. 6 in. deep, very strong stream. Each span was carried on four wooden girders, each 3 ft. deep. Top boom, 12 in. by 6 in.; Bottom boom, 6 in. by 6 in.; Web, 1-in. planking; Decking, 12 in. by 6 in. Roadway, 10 ft. wide, with a footpath bracketed out on the outside.

As the main line of resistance of the 16th Corps in case of serious attack was on the West side of the river, all the necessary preparations were made for demolishing the bridges with explosives at short notice. The demolition gear was kept ready connected up in bomb-proof dug-outs near the bridge sites.

In this connection it is interesting to note that when the Bulgars retired, they destroyed their bridges by gun-fire. The demolition was very complete above water, but the piles were found intact and capable of re-use below water-level.

WATER SUPPLY.

13. Macedonia is, except in the alluvial plains, a very well watered country. On the Doiran front we were never short of water and could always get it by gravity from springs in the hillsides. The work therefore only consisted in the protection of the sources, piping and storing.

In the Base area on the plain, however, things were somewhat different. The ancient supplies for Salonika town came from the Hortiack and Urenzik Aqueducts.

The Hortiack aqueduct was a Roman work. It was a simple trench, 1 ft. by 2 ft., on the level, and 8 in. by 1 ft. 6 in. on the grades. It ran on a surface grade and was the most wonderful piece of grading I have ever seen. The supply was 16–20,000 gallons per hour, or about 240,000 gallons *per diem*, sufficient for about 8,000 animals and 11,000 men.

The above, however, was not sufficient, and recourse had to be made to well boring to provide the additional water required for hospitals, base camps, etc., etc., in places which the aqueduct did not serve.

The wells were pipe-bores, 6 in., 8 in. and 10 in. diameter. The average number of feet in depth was 300. The deepest was 680 ft. Average cost, £360. In all, 125 wells were sunk.

The wells were drilled by American oil drilling machines operated by a special civil staff under Mr. Hunter. Engines, 7-8 h.p.

The system was by "percussion," and was generally suitable, but in heavy soils the "rotary flush" system is better. Deep-well pumps were used in the bore-holes. These varied from 700 to 2,500 gallons per hour capacity. Of the 125 wells sunk, only 17 were unproductive. Some details as to water rations and consumption may be useful.

Daily Water Rations.—Hospitals—14 gallons per head, summer; four in winter. Camps—Five gallons per man, ten gallons per animal. Pipes—The largest pipe used was 4-in.

A Bakery for 60,000 lbs. of bread per diem required 4,700 gallons per day.

The total number of gallons pumped per hour from all the Base wells was 9,000 gallons. All water was chlorinated to purify it. In large units this took place in the storage tanks. Hospital tea made of chlorinated water was the most poisonous drink imaginable!

MISCELLANEOUS.

14. Besides the work that has been alluded to above, there were many other services which the R.E. were called upon to carry out, such as:—(1) Veterinary Hospitals; (2) Rest Houses; (3) Officers' Clubs; (4) Soldier's Clubs; (5) Theatres; (6) Workshops, etc.

(1) *Veterinary Hospitals and Remounts.*—A large amount of work was entailed. The salient points that were disclosed were:—

(i) Usefulness of wind screens when complete cover was impossible; (ii) The fact that animals did quite well without overhead cover; (iii) Dry standings are essential.

2. *Rest Houses at Railheads.*—In the 12th Corps we had two. One at Janes and one at Sneyce. Both had cubicle accommodation and baths. We made nice teak furniture for them, each had a good cook, good food, and in each you could get a bottle of champagne in emergency.

3. *Officers' Clubs.*—There was a big one at the Base. I never saw it, but I believe it was good.

4. *Soldiers' Clubs.*—I only know of one at the Base, but we provided facilities up country in connection with the Y.M.C.A.

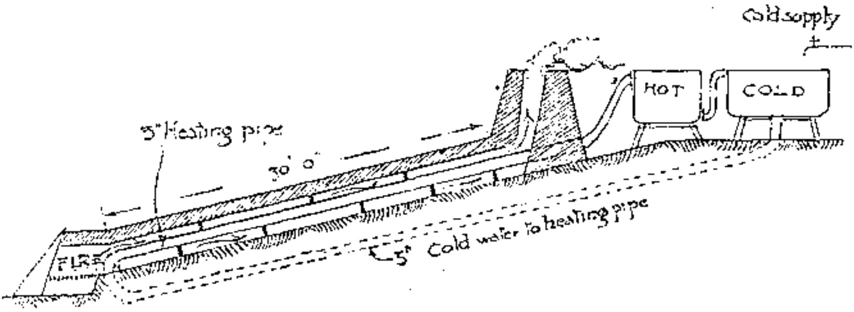
5. *Theatres.*—We made rather a feature of these. The first built was at Kopriva, I think by the 16th Corps; we had three in the 12th Corps area ultimately, at Janes, Rathes and Kalinova. I never saw the latter, but the first two were built of brick, with dressing-rooms, stage, etc., etc. The Janes Theatre was lighted with electric light, from a lorry set, and had hot-water heating. It held 500 people who had seats provided, and a bar. In our theatres the slope of the ground was used to get super-elevation for the seating.

6. *Workshops, etc.*—Includes all the Base workshops, stores, bakeries, etc., etc., for R.E., Ordnance, and R.A.S.C., besides railway buildings. In addition, a large amount of brick-making and lime-burning was done. It must here be stated that Salonika, except for raw materials, was at the end largely self-supporting; we even repaired boots and made soap. Our timber latterly came from the East, when teak and mahogany were much easier to get hold of than common deal.

7. As regards actual construction of the buildings, methods differed very largely. Wood and corrugated iron were principally used; brick also, but sparingly. Very good buildings were produced

out of wattle and daub, finished smooth inside and rough-cast outside. The frame-work was of squared timber, the walling of scrap brushwood. These houses were cool in summer and warm in winter—they were quite nice to look at and very cheap. Roofs were of corrugated iron, and, for summer use, this should be covered with matting panels.

8. Bathing in winter in Macedonia was not all a joy, as it was so cold, and hot water was, therefore, in great request. The following sketch shows a very simple method of getting plenty of hot water in the field.



Chimney flue to be "Baffled." Ball cock on cold supply. There may be as many returns of the heating pipe inside the flue as desired. The apparatus is really a field water-tube boiler, and is extraordinarily effective.

9. Very good cook-house, latrine and bath-house floors were made with well rammed road metal covered with 1 in. of cement rendering. They were quite good enough to last "for the duration."

The Life of the R.E. Officer.

15. This lecture would not be complete without some reference to this subject. In dealing with it I shall refer only to the most important class of R.E. officer, namely the subaltern. To narrow it down further we will discuss the Field Company subaltern, as his life, I think, was the most exciting.

The Field Company subaltern or Section Commander is a man whose life in war has many sides. To begin with, he must be a good domestic organizer and be an adept in getting food and house-room for his Section and himself. His first care is the well-being of his 50 men, in respect of their health, clothes, food and water, recreation and bathing. It's up to him to see that his men don't get killed for nothing, and that the routes by which he takes them to work are reasonably safe. In fact, he must be their father and their mother. If he is, they will see him through anything he is likely to run up against—in this world, anyhow.

Besides his men, he has his horses to see to, and his wagons with their contents. His animals' food, water and grooming require his attention if the animals are to be fit. Harness also must not be forgotten, for dirty, hard, harness means galling and inefficiency. A smart turn-out means a good one, with good men who have respect for themselves and their " push."

As regards vehicles, they require constant care, care in keeping them and also keeping them in good order, and their contents require more care still. If you don't look out for the latter, someone else will. A really good subaltern generally has a lot of surplus gear before he has gone far. Where he gets it from, the angel that looks after good subalterns alone knows. However, take care not to overload animals in your anxiety to have lots of stores.

Now for the Engineer work, the most amusing job of all. It covers :—

(1) Reconaissance by day and night. A rather hectic entertainment, sometimes requiring good nerves or better still, no nerves.

(2) Then the work itself—clearly defined to all by word of mouth or on paper by sketches. It must be carefully thought out and laid out, well ahead of the arrival of the working parties, who must be carefully shepherded to the site or they will get lost.

The procuring of working parties is not really the subaltern's work at all, but a persuasive young man can do a great deal in this direction, by means of *quid pro quo* " deals." Carrying parties for stores are also a source of trial for the young R.E. officer. Their facility for getting lost, and their almost incorrigible habit of losing their loads, which are usually heavy, have both to be combated ; not by oaths, but preferably by cajolement and friendship with their commander. Careful bundling of stores in loads of suitable weight for a man to carry is a great help. Preparation of stores and organization of work from day to day give much food for thought. You must have the right stores from night to night and not too many for the carrying parties to tackle.

You have to ask for the carrying parties, and if you ask for too few it's your funeral. Always ask for double what you want (if you expect to get only half your demand). As the work goes on, make reports and sketches of what you are doing, so that if you get shot someone else will carry on comfortably—write very legibly. One last point as to the work. You will have to decide whether it must be carried out by day or night. You will then have to study your enemy's little ways and may run some risk in so doing. Men don't work well if they are suffering heavy casualties and you lose men and gain little by working under too adverse circumstances, unless time is an important factor in the operation. I have given a rough idea of the way a subaltern should tackle his work; may I say a word about his own conduct ? My advice is—keep smiling and keep on at it. It pays all the time. Be prepared to undertake anything with a light heart. Trust your men, lead them and show them you know how. Above all, know everyone from Corps Commanders down, they don't bite subalterns. Drink with anyone, be friends with everyone, don't be a critic, but be helpful in every way you can. Remember this, that the milk of human kindness is more valuable when we all stand in the presence of Death, than at any other time, and that is all there is to be said.

Moral.

16. I suppose no story has ever been written from which there is no moral to be drawn, no lesson to be learned. The lessons I learned in Salonika were as follows :—

(1) That the Military Engineer must learn not to depend on specialists. Out there every R.E. officer pretty well had his turn at everything, and Field Company officers had to build defences, piers for ships and hospitals, find water, lay railways, make roads and in fact, do anything that turned up. There is a place for specialists in big wars, but they are scarce in a side-show.

(2) An Engineer must have courage and imagination. He must be able to look ahead and see in his mind what is coming, strategically and tactically, and be ready. An engineer without imagination is like an "appreciation of a situation" without a "definite proposal for action" as the text-books used to say, which has been compared to a "horse without legs." Courage and a smiling face are necessary to carry the Engineer through the vicissitudes of health, climate and adverse military situations.

(3) In a rough country the engineer that counts is the one who has learnt the arts of observation and quick decision. In civil life men are liable from their environment to observe only one class of things. The soldier engineer must be a close observer of nature and of men, and must cultivate this art continuously. He must go through life with his eyes open and his mouth shut (for choice). By this I do not mean that he must not give his opinion. Far from it. He must not think and talk engineering continually, but must think in concert with the general Staff and then give them his opinion, when it is wanted, tempered by his technical knowledge. If he can then persuade the higher powers that his views are theirs, his path will be a smooth one. Before all things he must remember that he exists for the good of the Army, and not be obsessed with the idea that the Army exists to give him employment.

(4) Any man with engineering qualifications takes a very short time to learn the military application thereof. In the Salonika Army there were very few regular engineer officers. In the Division in which I served as C.R.E., the most I ever had were five, if I remem-

ber aright. There were only two regular pre-War units of R.E. in the Army, the 17th and 38th Field Companies, the former in the 28th, and the latter in the 27th Division. In the 12th Corps there were never more than eight regular officers at one time. All the R.E. units were Territorial or of the New Army. As far as I know, they never failed. They certainly never failed me in anything. The thing that astonished me most, was the celerity with which these citizen Sappers imbibed the traditions and methods of the pre-War R.E. They had just the same pride and affection for the Corps and its traditions as any of the rest of us.

The Salonika Army.—I must say a word about the Salonika Army as a whole, before I close. In some respects it was a most remarkable force. It served continuously for three years in a most inhospitable and unhealthy country. It constructed many miles of defences, fought continuously from day to day, in the same way as we fought in a "quiet" sector of the line in France, and, in addition, fought several severe actions incurring heavy loss. It practically never got any leave. There were no *estaminets* or relaxations of any sort—no theatres or kinemas until just at the end.

It suffered desperately from disease, and disease of a most depressing and enervating nature and, moreover, one which will last most of its victims for the rest of their lives.

In spite of all this the *morale* of the Army never deteriorated, its industry never flagged, its discipline was exemplary, its gallantry unquestioned. In the end, when the final phase was opening, the sick swarmed out of the hospitals to join the ranks, so strong was their desire not to miss the fun. It was an army, which its distinguished Chief has said he was proud to have commanded, and with which any man may be proud to have served; even if its activities have, by some, been considered to have been a side-show and a joy ride.

In conclusion, Gentlemen, the future rests with you. Never forget that it is only by maintaining the spirit of comradeship, engendered during the war, between the civil and military branches of the profession, that you will, in the time to come, be able to take the place which it is your duty to fill in the Army of the Empire.

THE FORTRESS OF ANTWERP

By Brig.-General J. E. Edmonds, C.B., C.M.G.

By the fall of Antwerp in October, 1914, the faith of the public in permanent fortifications was much shaken, if not entirely lost. No attention was paid to the patent facts that the Belgian field army was far too small to have withstood the first advance of the German legions in the open, and that it must have been defeated, have surrendered, or retreated into France in August, 1914, had not the defences of Antwerp been ready to receive it—thereby incidentally keeping the German observation corps, the equivalent of some six divisions—from the battle of the Marne. Now that Lieutenant-General Deguise, the "Commandant of the fortified position of Antwerp," from 8th September to 10th October, 1914, has published his account of the defence in *La Défense de la Position fortifiée d'Anvers en* 1914 (20 *août*—10 *octobre*),* our wonder is, not that the siege was so short, but that resistance continued so long.

In one respect, in particular, the book is deserving of attention by other than soldiers: it reveals authoritatively, supported by official documents, what has been the cause of so many military disasters:—neglect by politicians of the advice given by their responsible military advisers, and economies effected for electioneering purposes at the expense of the vital interests of a country. Most of us knew that the fortifications of Antwerp were out of date and too close to the town, and that the so-called "shell-proofs" had not the cover over them, found necessary by experiment in France, Russia and Germany, sufficient to resist even 6-in. shells; but it is with almost a shock we read that the great fortress, the national refuge in time of danger, had no smokeless powder for its guns, and was not provided with a single high-explosive shell. Further, that even the improvements authorized on 30th March, 1906, had not all been carried out, *e.g.*, the concrete aprons round the gun emplacements had not been constructed, and there was no telephone system. The expenditure required for these and other urgent matters had been "deferred for political reasons." In peace-time the Minister of War silenced military representations by declaring—"I am responsible to the people"; on the approach of the Germans, as

* Paris: Berger-Levrault, price 25 francs.

he stepped into his motor-car to make off, he said to General Deguise, " You are responsible for the defence."

After an historical survey of the defences of Antwerp, there follow in General Deguise's book chapters on the " Powers of resistance of the forts, redoubts, and *points d'appui* of the principal line of defence," and " The situation in August, 1914, as regards guns and ammunition ; " " The methods of fire," an artillery appreciation ; " The Garrison," etc., and a second part relates the defence against the Germans. Taken in combination with the official account, "*Antwerpen*, 1914,"* the book presents a very complete story of the siege. The Belgian account gives us the state of the forts, etc., before the bombardment ; the German provides the number of guns used and rounds fired, with the targets, and finally the state of the defences at the capitulation.

The thickness of concrete (plain ; ferro-concrete is not mentioned, and there was very little of it) in the shelters was 2·25 to 2·50 metres. The extrados of the concrete arches had 250 kilog. cement per metre cube, the intrados and walls, 170 kilog. The Germans found that the concrete had " faults both in the composition and the laying." The forts, and the redoubts in the intervals between them, made no pretence at concealment ; they stood up like green islands from the plain in which Antwerp lies.

As regards the artillery defence, " in August, 1914, the armament was not entirely installed, nor even delivered ; " the guns were entirely inside the forts, in cupolas or casements ; they were entirely outranged (extreme range, 8,400 yards) by the German guns ; there was only three-fifths of a 6-in. gun per kilometre of front ; and the flanking guns were old smooth bores, " dating from 1862." " There were only two machine-guns per work."

As regards observation of fire, although a permanent communication system was lacking, all the telephone cable available was carried off by the field army, and electric bell wire was used in its place ; the observers had to provide their own telescopes and field glasses : " many possessed only opera-glasses."

The war garrison consisted entirely of men of the older classes— " who had left the Army five years, even thirteen years before ; they had only received altogether insufficient refreshing courses, and remembered nothing of what they had learnt during their short period with the colours in peace time."

The German account shows that 590 shells from 42-cm. (say 16-in.) howitzers, 2,130 from 30·5 cm. (say 12-in.), and 11,800 from 21-cm. (say 8-in.) were fired against Antwerp, the 21-cm. mostly against the works in the intervals between the forts. These intervals, it may be noticed, were defended by field-works, but owing to the high

* Issued by the *Reichsarchiv* (Berlin : Stalling, 19 marks).

water level, the trenches were shallow, and " there were no shelters, not even against shrapnel bullets."

Tables in *Antwerpen* show exactly what shells were fired against each fort, with the range. Thus Wavre-St. Catherine, the first attacked, received 171 16-in. from 10,000 yards, and 327 12-in. from 8,500 yards: both its cupolas for two 6-in. guns were destroyed. Four photographs show the other damage done: the left half of the fort appears to be rubbish heap, and the roof of the shell-proof barracks was simply cut through in five places and exposed in section. It is worthy of note that the small redoubts were not rendered untenable by artillery fire. Thus, though Fort Wavre-St. Catherine was evacuated on the 28th September, Dorpveld, the redoubt next to it, held out until the 2nd October, and then was taken only by assault, in which the attackers placed charges on the roofs of the casemates in which the Belgians still held out. Salvation from heavy mortars lies no doubt in small works, interspersed with dummy defences, as the Germans knew and had adopted in their *Feste*. It will be recalled that Lötzen, the Prussian fortress in the Masurian district, though invested and bombarded by the Russians, was not captured.

TRAINING OFFICERS IN THE CORPS OF ENGINEERS, U.S. ARMY.

Extract from the Annual Report, for 1920–21, of the Chief of Engineers, U.S.A., Maj.-Gen. Lansing H. Beach.

(Reprinted from *Engineering News-Record* of 19th January, 1922).

ENGINEER officers of the Regular Army enter the Service from two principal sources, military organizations and civil life. Officers from the first source include those commissioned from United States Military Academy, from the Regular Army, and from units of the Reserve Officers' Training Corps. Those from the second source have had little or no military training and usually enter the Service within a short time after being graduated from civil technical institutions.

The difference in preparation prior to appointment in the Army involves some variations in the training of these officers during their early years. Those entering the Army with previous military experience usually require special stress on technical subjects in the formative period of their commissioned Service, and those entering without previous military experience require special stress on subjects peculiar to the military profession, such as military art, military administration, military law, etc.

On his initial entry into the Corps of Engineers the officer in the normal case is sent to the Engineer School at Camp A. A. Humphreys, Va., to pursue the basic course. This course, during the last year of five months' duration, comprises only elementary subjects such as administration, guard duty, law, military courtesy, military hygiene, hippology, field-service regulations, infantry and cavalry drill, minor tactics, and troop leading, to include the company nomenclature, care and use of engineer equipment, map reproduction and photography, elementary bridges, railroads, etc. . . . The course was followed by actual service with troops.

While the basic course is adjusted as fully as possible to the varying needs of the student officers drawn from the several sources, it is evident that on its completion the fundamental differences in the early training of these officers will not have been compensated. Those from the Military Academy and those from the best private military schools will usually be stronger on military subjects and weaker on technical subjects than those drawn from civil technical schools. These differences are taken into account in making the assignments for the six or seven years following the completion of the basic course.

The next step in school training is covered by the company commanders' course at the Engineer School and the civil engineering course conducted under the supervision of the Engineer School at high-grade civil technical institutions. All officers take the first of these two courses, but those who hold degrees from civil technical institutions of recognized excellence are not required to pursue the civil engineering course. They may, however, attend special courses in lieu thereof, such courses being designed to supplement their previous training.

Either before or after pursuing the company commander's course, officers commissioned from military sources are sent to civil institutions for one year of instruction in those technical subjects which either are not taught at West Point or which are given there in a very elementary form, but which are needed by the engineer officer in the discharge of his professional duties.

It is proposed that the policy adopted for this year's civil engineering course be continued, that is, that of sending the students to civil institutions of recognized high merit. This policy is not new. Since 1910 officers of the Corps of Engineers in small numbers have been sent to civil technical schools for instruction. Other government departments and arms of the service, notably the Navy, have committed themselves to it as a fixed policy. There are many good reasons for this policy, and the result of this year's work fully demonstrates its highly beneficial effects.

Among these reasons may be cited the psychological effect on the officer student and on the general public. In the past the military and the civil have been most distinct, both in training and method of life. This has led to mutual distrust, a pretended fear of militarism, which is not only bad for the service but ruinous to the country at large. Entirely due to ignorance of our former method of instructing our officers in technical subjects, civilian engineers have somewhat the same misgiving as to the professional attainments of army engineers. Such criticism is at this time quite prevalent in connection with the campaign for the creation of a department of public works. It is without foundation in fact and overlooks the achievements of army engineers which exist in public buildings and monuments, such as the Congressional Library and the Washington Monument; river and harbour improvements such as the Panama Canal, and the vast and complicated engineer undertakings in France, all of which were under the supervision of army engineers. Such doubts will disappear, and no grounds whatever will exist for mistrust when the engineer in civil life realizes that his colleague in the army is a product of the same, an equal, or a better civil institution than himself. The reciprocal knowledge of the technical capacity of civil and military engineers will be established for all time by contact formed at these civilian institutions.

Another reason for the use of civilian institution for the civil engineering course is that by eliminating this course from the Engineer School proper the use as instructors of many high ranking officers may be avoided and much overhead expense may be thus eliminated. This point is particularly important at this time when the demand for economy is so great. It is to be noted, if officers are to be developed as instructors of efficiency equal to those in civil institutions, some of them must devote their entire life to pedagogical work, and even then they may not reach so high a plane of teaching as those instructors in the best civilian schools. Still another reason for using civilian institutions for the civil engineering course is that better equipment can be obtained at less expense in the better civil institutions.

A consideration of the foregoing appears to show conclusively that the policy for instruction in technical subjects is sound. Officers of the Corps of Engineers should attend civil schools which possess ample equipment, a corps of selected instructors, with efficient courses and methods of instruction. Further, through the intimacy of college life mutual relations of respect and good-will can be established and maintained between the professional military engineer and his colleague who remains in civil life. Such relations undoubtedly benefit the administration of government affairs, not only in time of war but in time of peace.

On completion of those two courses the officer spends two years in practical work in connection with river and harbour improvements or fortification projects and is then again detailed with troops for a period of two years. In addition to the practical work which can be furnished by the corps itself, officers are detailed to various industrial concerns, such as railroads, large construction companies, etc.

The programme above indicated covers the first six or seven years of the officer's commissioned service and during this period of service as a lieutenant, and, perhaps captain, aside from instruction received by school courses, he receives training in administrative and executive work as an assistant in the office of the Chief of Engineers or as an assistant to Army, Corps, or department engineers, or he may receive training in supply work as an assistant or a principal in charge of an engineer depôt. He acquires experiences in construction as a district engineer or as an assistant to a district engineer on river and harbour and fortification work.

On or shortly prior to promotion to the grade of field officer he may take the field officers' course of approximately six months at the Engineer School, Camp A. A. Humphreys. This course endeavours to acquaint him with the duties of a field officer of engineers and of a staff officer for the Engineer Service. It stresses the relations of engineers with the staff and other troops. On completion of this course the officer is either sent to the school of the line or is returned to engineer duty.

PROFESSIONAL NOTE.

CLEANING OF HOT WATER BOILERS.

In most districts it is necessary periodically to clean all Hot Water Boilers on account of the scale of sediment deposited from the water and which not only greatly reduces the efficiency, but, if allowed to accumulate, becomes a source of danger from the probable burning of the boiler-plate.

This deposit is greatest in the parts where the furnace heat is most intense, and often where it is inaccessible without removing the boiler. Especially is this the case with "Boot" and other small domestic boilers.

In order to reduce the expense and labour thus entailed, the practicability of cleaning by chemical means has been considered, and experiments carried out with satisfactory results.

When the deposit is mainly due to "temporary" hardness of the water, *i.e.*, consists largely of calcium carbonate, it should readily dissolve in hydrochloric acid.

Small quantities of insoluble deposits derived from slight "permanent" hardness of the water would probably disintegrate as the calcium carbonate goes into solution, and could be removed in the form of sludge.

Should the deposit be mainly due to "permanent" hardness, this method of cleaning would not be very effective.

Hydrochloric Acid of commercial quality is used diluted with water, the strength varying with the thickness of the deposit from 2½ per cent. (2½ pints commercial acid made up with water to 4 gallons of liquid), to 8 per cent. (2 pints commercial acid made up to 1 gallon). A stronger liquid should not be used.

The operation is as follows :—

(1) The system is drained. (Provision is usually made for this by means of a plug on the return pipe).

(2) A sufficient quantity of the liquid to fill the boiler is introduced at any convenient point above the boiler, or the boiler may be filled through a short length of hose-pipe connected to the drain outlet.

Violent gassing ensues (due to the liberation of carbonic acid gas), and gradually subsides, generally ceasing within about two hours. The cessation may indicate either that the whole of the deposit is dissolved or that the acid has expended itself.

(3) After standing about two hours, the boiler is drained. If the acid is spent and inspection of the boiler shows that the scale has not been removed, fresh acid is added. The drained-off liquid can be easily tested for acidity by the addition of a small quantity of washing soda. If spent, there should be no effervescence.

So long as gassing occurs on the addition of fresh acid the liquid drained off will have a milky appearance, absence of this denotes that the solution of scale is completed.

(4) Boiler is drained and cold water supply turned on for a short time to thoroughly wash out any sludge. It is then again emptied.

(5) Boiler filled with 5 per cent. solution of common washing soda to neutralize any possible trace of acid. After standing for a quarter of an hour this is drained off and the boiler re-connected and filled ready for use.

A rough estimate of the quantity of acid which will be required can be obtained if the thickness of the scale is known, by allowing 2½ lbs. of the undiluted commercial acid for every pound of scale to be removed. The cost of acid is about 20/- per cwt.

The risk of corrosion of the boiler plates is very small if the application of acid is not prolonged after removal of scale, and the chances of damage are probably less than if cleaning were effected by chipping.

Galvanized hot-water cylinders must not be treated in this manner, as zinc is readily attacked by the acid.

It must not, in any case, be used for steam boilers without the sanction of the responsible Insurance Company.

MEMOIR.

COLONEL W. D. LINDLEY.

COLONEL WALDEMAR DELMAR LINDLEY was born in 1853 at Flensburg in Denmark, where his father was then engaged in railway construction. Lindley was educated at Eton and the "Shop" and obtained his commission in the Royal Engineers in 1873. Of his total service just half was spent abroad, chiefly in India, where he joined the Madras Sappers in 1877. With them he accompanied the Indian contingent to the Mediterranean in 1878, serving in Malta and Cyprus. He also went through the Afghan War of 1878 to 1880, being *inter alia* engaged in the Bazar Valley Expedition, and in the operations against Khugianis and Hissarak Ghilzair. "Always cool and collected under fire" is the recollection of a comrade. It was characteristic of Lindley that on returning from the first phase of this war he insisted, although his health had suffered severely, on going to the second phase, for which a junior had in the first instance been detailed. Lindley also went from India with the Egyptian Expedition of 1882, during which he took part in the celebrated night march to Tel-el-Kebir. Later, he was at Suakin during the Soudan Expedition of 1885. He completed his Indian service (Madras S. and M. and P.W.D.) in 1890, afterwards serving at home and in Hong Kong. Finally he was C.R.E. Jersey for three years.

Colonel Lindley did not marry. He retired in 1905 and lived very quietly near Dover, spending most winters abroad, often in Algiers. For the last few years of his life he was an invalid. He died at Torquay on the 21st November, 1921, and was laid to rest in Elmstone churchyard, in his brother's parish near Canterbury.

Never of very strong constitution, fever in Cyprus, and strenuous work on roads and demolition in the Khyber, followed by active service in Egypt and a prolonged tour in India, undermined his health to an extent from which he never recovered. This, coupled with his extreme reserve, prevented him from becoming widely known in the Corps; but those who served with him remember "Father

William," as he was affectionately called, as a hard and thorough worker, a first-rate rider, and a gentleman in the best sense of the word.

His brother writes that at Eton Waldemar "first became fascinated with that peculiar love of his for boats" which remained a marked feature of his character. Indeed, it was on the sea that his rare intimacies were chiefly formed. At sea he seemed to cast off his reserve, revealing the real charm of his personality. The writer sailed often with him in the brave days of the schooner *Violet*; and again, of recent years until the war, in many cruises to Scotland, Orkney, Shetland, the West of Ireland, and other remote waters. Lindley was the ideal companion. An expert yacht hand, with infallible instinct for doing the right thing, not only was he invaluable on board, but nothing could damp his spirits or disturb his equanimity. Even when under way for a week or more in a small vessel, no exigencies of weather or food annoyed him. He loved the sea and, aided by a strong dry sense of humour, found enjoyment in everything that came.

A cruising friend of long ago writes, "At the S.M.E. Lindley was distinguished as a first-rate oar and an intrepid sailor. I have delightful recollections of the strength and gentleness, the fiery spirit under perfect control, and the benevolent smile of dear old 'Father William.'"

These words remained true of him, and well recall the picture treasured in memory by his friends.

M. A. C.

PRESERVATION OF COMPANY WAR DIARIES AND WAR RECORDS, AND COPIES OF PRIVATE DIARIES.

Many officers, no doubt, kept diaries during the War, and preserved various documents and maps that they used.

To ensure that these unique documents do not disappear in the course of time, it seems desirable that it should be known that there are several courses open to officers who possess such papers, namely, to deposit them :—

(1) With the Institution of Royal Engineers ; or

(2) In the British Museum ; or

(3) With the Historical Section (Military Branch) ; or

(4) In the Imperial War Museum Library.

It is hoped that all who are still in possession of original records of any sort will provide in some way or other for their permanent custody.

If these records are deposited with the Military Branch of the Historical Section, they are at once filed in their proper place among all the other War Records of which that Branch is the custodian. Further, as the War Diaries of all formations and units are stored in the same building, the completion of these records, in even a small particular, will mean that a more connected and detailed story of the period under review can be written when the time comes. There is a reading room in the building where properly accredited officers can read and work; so whatever is deposited is always available for study and research.

A copy of every privately printed book, giving the War record of any unit should, in any case, be deposited at the British Museum; and it is hoped that another copy will be presented to the Library of the Historical Section, so that it will be always available to amplify the existing documents.

J. E. EDMONDS,
Brig.-General, late R.E.

Historical Section (Military Branch),
Committee of Imperial Defence,
2, Cavendish Square, W. 1.

March, 1922.

REVIEWS.

MILITARY ENGINEERING (PROVISIONAL). (VOL. III). BRIDGING, 1921. (Price, 3/6 Nett).

By J. W. Landon, M.A. (Cantab).

On opening this volume the first thing which strikes one is the price; not because of its prominence on the title-page, but on account of the smallness of the amount. It is, of course, due to the fact that this is an official publication. Considering the quantity and quality of the information the volume contains, it must be by far the cheapest engineering book produced since the War. The book is issued by command of the Army Council for the guidance of all concerned, and the issue is provisional, pending the introduction of a new pontoon equipment to carry heavier loads. A simplified pontoon drill for light bridge is introduced which has stood the practical test of the war. The steel-girder bridges described have been selected from the many used in the war, as those most suitable for retention for training purposes. This information is extracted from the Preface. Turning to the contents, one notes a considerable change from the *Military Engineering, Vol. III.B*, issued before the War, the chief difference being the prominence of heavy bridging, including steel-girder bridges. The latter is an entirely new feature. Comparing the two volumes, one can realize easily the enormous difference in the magnitude of the bridging problem as presented in the Great War, and the bridging problem of previous wars. Indirectly, one also sees how successfully this problem was solved. The foundations laid down in the pre-War training were sound and had only to be extended. The chief difference was in the magnitude of the loads to be handled; which, instead of being a few tons, rose to a launching weight of over fifty tons.

Part I of the book deals with Military Considerations, Reconnaissance, and Bridge Loads. The chapter on Reconnaissance is very full and thorough, and bears the stamp of actual experience. Complete particulars of overall dimensions and weights of all vehicles likely to be met with are tabulated. In one table the various bridge loads are conveniently grouped as "Light loads," "Medium loads," "Heavy loads," "Tank loads," and the maximum axle load and the equivalent uniformly distributed dead load for each of these groups is given for different spans. These are extremely valuable for rapidly designing improvised bridges. In the field, the most troublesome calculation is the estimation of the maximum bending moment and shearing force which the bridge has to carry. Given these, the necessary calculations are relatively straightforward and simple, and can be made rapidly.

Part II deals with pontooning, and is to some extent provisional as noted before.

Part III treats of "Field Bridges of Various Types," *i.e.*, bridges which are largely designed and constructed in the field from whatever material is available. Accessories required for bridging operations occupy a chapter which is full of useful information, dealing as it does with cordage, ropes, chains, etc., and the various machines used for raising and moving heavy loads.

Another chapter is devoted to "Suspension Bridges and Aerial Ropeways." The latter are dealt with in considerable detail and the standard ropeway which has been introduced, known as the "General Utility Ropeway," is described.

Tension bridges have been omitted from the new volume, presumably owing to the difficulty in making them stiff enough for heavy loads. When constructed with light steel girders for the roadway and steel piers and concrete foundations, this type of bridge may be made entirely satisfactory. In this form, the French made use of Tension Bridges. One good feature of the type is the ease and accuracy with which the stresses may be estimated.

Under the heading "Trestle Piers and Timber Bridges," design and details of construction are dealt with, as well as the strength of various types of joints.

A new form of pier construction, introduced during the War, is described and illustrated. In this construction the piers are built of skeleton steel cubes, 3 ft. by 3 ft., by 3 ft., and these are braced together every 3 ft. by horizontal timber members fitting between the cubes, and connected to them by coach screws. The cubes themselves are built of lengths of steel angles with steel flats as diagonal bracing. These can be transported in bundles and be bolted together at the site. Each cube will carry 40 tons, provided it is only loaded at the corners. This type of pier is very quickly constructed. The bearing-stress on the timber would appear to be high, if the cubes are fully loaded, but this could easily be reduced by introducing small triangular plates at the corners of the cubes. The plates would distribute the load on the timbers and would also ensure that the cubes were only loaded at the corners. Apart from their military use, these steel cubes appear excellently suitable for building falsework and might profitably be employed by civilian contractors.

Although this volume deals but briefly with strength of materials and design, many useful examples are worked out, showing the calculations necessary in the field. These call for some slight comment in cases where *shear* in timber beams is dealt with. The shear is assumed to be uniformly distributed down the cross-section, whereas actually the maximum shearing stress is $1\frac{1}{2}$ times the mean in beams of rectangular cross-section, and $1\frac{1}{3}$ times the mean in beams of circular cross-section. In one example, the maximum shearing stress along the grain is as high as 326 lbs. per sq. in. and the allowable maximum is stated as 150 lbs. per sq. in.

Abutments and piled piers are next dealt with, and the chapter contains much useful and practical information about pile driving.

Part IV. treats of "Steel Girder Bridges," and is entirely new. The sections dealing with "Organization of Work" are particularly good and deserve a close study by those who are likely to be in charge of this class of work. Success depends to a very large extent on proper organization, and the foreseeing where delays are likely to occur.

A useful account of suitable methods of erection and launching of girders follows. One point of detail calls for criticism. The method adopted in launching the 120-ft. Hopkins Bridge consists in bracing the two girders together and using two independent derricks on the far side of the gap and two independent preventer tackles on the near side; a main hauling tackle and a preventer tackle being attached to each girder. This method, although it has been successful, is undoubtedly unsound and risky. It is impossible to guarantee that all the tackles are worked at the same rate, and if this is not so the load will be unevenly distributed. One tackle may have to take a much greater load than was intended, and there are no ready means of detecting whether this is so or not until failure begins. If, instead of two preventer tackles, a single one is employed, connected by a snatch block to a long wire rope sling, and one end of the sling is attached to each girder, then any inequality of the pulls in the main tackles will show itself by the tail of the bridge moving somewhat obliquely to the centre line of the abutments. This is easily detected and remedied.

A chapter is devoted to the various types of the Inglis Bridges, the girders of which are built up of steel tubes and specially constructed steel junction boxes. These bridges are remarkable owing to their portability, the novelty of construction, and the truly surprising rate at which they can be erected and launched by a trained party. A bridge of 105-ft. span to carry 35 ton tanks can be erected in a single night.

Hopkins Bridges are next dealt with. These are built up of standard steel sections, bolts being used for the connections instead of rivets. As the heaviest single member weighs only 10½ cwt. they are quite portable. They admit of a large number of erectors being employed simultaneously, but, owing to the time required to make the bolted connections and the method of launching, the time required for construction is long compared with that of the Inglis Bridges.

The text of the book finishes with a chapter describing the Stock Spans up to 60 ft. Full particulars of construction and directions for erection are given.

Though written specially for the instruction of military engineers, any engineer who has to construct improvised bridges, or erect steel bridges, will find much of value and interest in the book. The heavier the type of bridge, the more nearly do civilian practice and military practice approach. The chief difference lies in the amount of labour available, and the absence of consideration of cost from military practice.

The book is in no sense a theoretical text-book, but a book full of sound practice based upon actual experience, and contains a lot of valuable information not usually available in a single volume.

HYDRO-ELECTRIC DEVELOPMENT.

By J. W. MEARES, F.R.A.S., ETC. (London, Sir Isaac Pitman & Sons, Ltd.) (Price, 2s. 6d. net.)

One of Messrs. Pitman's useful series of Technical Primers, this book deals with the general principles of the utilization of the energy of falling water. Commencing with the elementary dynamics of the subject, the probable available flow from a given rainfall and run-off is next considered. The section dealing with map reading and reconnaissance will be familiar ground to all military engineers. Other chapters deal with the lay-out for various conditions of fall and flow, the elementary design of works and miscellaneous application such as combined steam and water-power stations.

The print is good and the book is well indexed: the illustrations, however, are somewhat inadequate, some 15 out of the total of 17 being of the thumb-nail sketch order. The book, however, can be recommended as being a sound survey of the present state of water-power engineering. A large amount of useful data is given with numerous references to standard works.

R. C. B.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 26.—*The German War Office in the War.*—General von Wrisberg's account of the German War Office and its activities during the war appears. He defends the War Minister of the years just before the war (von Einem) for not supporting the demand for three additional Army Corps, for which the General Staff under von Moltke was then pressing, on the ground that to have created them before 1914 would have disorganized the Army. In the memorandum (December, 1912) by the General Staff their formation was advocated in order to give sufficient strength for the offensive in the West, combined with adequate defence in the East. The additional expense was, the General Staff said, nothing compared to what the country would have to bear in case of defeat.

General von Wrisberg adds that, as a matter of fact, the three additional Corps were, numerically, equalized by the Reserve Divisions which were so quickly formed at the beginning of the war, and that von Moltke's predecessor, von Schlieffen, never reckoned with them in his plan of operations. The latter was prepared, if necessary, to give up all ground east of the Vistula, if thereby victory in the west could be assured. The *M.W.B.* says that it was not the lack of three Corps which lost the Marne, but the lack of nerve at G.H.Q.

That the expansion of the German Army was not carried even further than it actually was, is said to have been due to inability to dilute the Officers' Corps. To us this hardly seems a sufficient reason, but the *M.W.B.* attributes the failure to break through at Ypres in 1914 to the inferior quality of the new Divisions which were there first employed. Expansion was nevertheless carried to considerable lengths; for instance, in 1918 there were 2,800 field batteries as against less than 600 in peace time, while heavy batteries increased from 150 to 1,660. In May, 1917, there were 7,030 heavy pieces at the front, of which no less than 1,016 had been captured from the Allies.

It is admitted that at the beginning of the war Germany did not retain nearly enough officers at home, a mistake which every country seems to have made.

General von Wrisberg seems to have been able to leave his post as "Director of the General War Department" fairly frequently, and at one time actually held a command in France. On one of his visits to the Second Army in May, 1918, he noted a serious diminution in discipline. It was this army which failed, on August 8th, before the Fourth British Army.

German Propaganda in the War.—At the outbreak of war there was no organization in existence, and it was not till the Spring of 1915 that propaganda in Germany was undertaken by the Home Office. Six months later efforts were made to get the Foreign Office to take it up abroad, but without much success, as the psychology of the subject was always misunderstood, sometimes with ludicrous results. How much better, says the *M.W.B.*, did the Entente work, and how successful it was in "striking the sword from the hand of Michael"!

Who Was to Blame for the War?—There have recently been published in Germany letters between the ex-Kaiser and Hindenburg on this subject. The latter pointed out to his former master how the confession of guilt forced from the German delegates at Versailles was affecting the whole position of Germany in the world. In reply the ex-Kaiser, after asserting the innocence of Germany and the guilt of her enemies, said, "The true facts can only be made known by means of an international and impartial commission, the establishment of which has been refused by the Entente. For Germany it is a sacred duty to gather together all evidence bearing on the subject, and to publish it to the world, so that the real culprits may be made known."

War Pensions.—In view of the increase in the cost of living in Germany, pensions have to be continually augmented. From 1. 10. 21 a new scale came into force; the following are some instances of the pensions payable under it:—

Lieutenant	with 15 years' service	...	...	9,444 Marks
Major	,, 30 ,, ,,	...	...	28,455 ,,
Colonel	,, 40 ,, ,,	...	...	63,900 ,,
Maj.-General	,, 40 ,, ,,	...	...	71,400 ,,

All the above amounts are "per annum" and with the exchange round about 800 Marks to the pound sterling, give some idea of the conditions under which German officers are existing.

No. 27.—*With the Russian Army*, 1914–17. Major-General Sir A. Knox's book is reviewed at length and receives high praise. The *M.W.B.* hopes it will be translated into German so that the public can learn from it what the Bolshevism, with which they trifle so light-heartedly, really is.

Death of General von Beseler.—The victor of Antwerp and of Novo-Georgewski has died, at the age of 71. He was originally in the Pioneers.

The German Trade Flag.—The German Chamber of Commerce in Valparaiso has passed a resolution protesting against any change in the colours under which German merchant ships sail. It points out that in South America such a change would be a death-blow to German trade, since the old black-white-red was always associated with honesty and enterprise.

No. 28.—*Political and Military Review of* 1921. The German 100,000 strong Army has solidified as well as could be expected, and has suffered no severe shocks during the year. The prohibition of any political action by or towards the Army has had an excellent effect on it. Recruiting is not so brisk as might be hoped, and it is not possible to select as high a class of recruit as is desirable. For the present the officer question presents no difficulties, but the *M.W.B.* is anxious about the future and hopes that the old officer families will not hold their children back. Promotion, which can only come through the ranks, will not be so quick as recently, but will probably be better than it was before the war.

The Inter-Allied Mission of control has continued its, in German eyes, nefarious work. Gen. von Cramon seems especially to dislike it and apparently had a row with one of its members in Munich.

French armaments are also a ground for complaint—and envy. The inclusion of large numbers of coloured troops in the French Army, and the quartering of the greater part of the Air Service on the Eastern Frontier is also noted. Franco-British relations constitute a brighter spot in the political horizon, and it is pointed out how developments of artillery have not only rendered any action of the British fleet against land defences more ineffective than ever, but have also brought large stretches of British coast line within easy range of French land batteries! England, the *M.W.B.* is careful to point out, is no more inviolable, and hopes the French will turn their attention to the North instead of watching so steadily towards the East.

The Laws of War.—In a recently published French book an account is given of how two Germans were captured by the French on the Chemin des Dames front on the 26th May, 1918 (the day before the German attack).

On being examined by the French, one of the two declared that every preparation had been made for an attack on the morrow; the other, an officer-aspirant, stated that there was no thought of attack. The same day they were sent back to Corps Headquarters for further examination, and gave the same answers, the officer-aspirant protesting volubly that no attack was contemplated. It was then pointed out to him that, though the laws of war could not compel him to speak, yet he had volunteered information and must be responsible for it. If it turned out false he would be treated as a spy. On this the officer-aspirant was clearly embarrassed, and on further questioning gave full and exact information about the forthcoming attack.

The story is ordinary enough, and the French procedure seems to have been perfectly correct from every point of view, yet Gen. von Winterfeldt seizes upon it as another instance of French cruelty to German prisoners!

No. 29.—The cost to Germany of the pay and allowances of the personnel composing the Inter-allied Mission of Control is causing some comments, and the emoluments of similar ranks are compared in a table, showing that a private soldier in the Mission receives more than a full general in the German Army.

At the same time, complaint is made of the extravagant cost of the French Army of Occupation, in which the proportion of officers to men is as 1 to 25. If this is thought excessive, what must be thought of the British Army?

Instruction in Sports.—A sports school has been started in Wunsdorf, near Berlin, where not only young officers and N.C.O.s are instructed but there it is intended to send also more senior officers and some staff officers so that commanders may be well advised and assisted in all matters of games and sports.

No. 30.—Contains little of interest.

L. Chenevix-Trench, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

November, 1921.

The Revision of the Regulations.—A continuation of the article by "Lucius" embracing the second portion of the 4th period, viz.: the Allied offensive on the Somme, July to November, 1916. Besides the 12 divisions and 700 heavy guns sent by the French, they brought 580 trench-guns; a total force which was quite unexpected by the Germans. The troops for the most part were of very good quality, the infantry newly equipped with automatic rifles and the Vivien-Bessières grenade, and specially trained for attack, besides preserving the advantage of experience gained at Verdun. To face the combined force, the Germans could only dispose of the Second Army (von Bülow), of which one Corps deployed five divisions in front lines to the north of the Somme on a front of 30 kilometres, the other Corps four divisions on a front of 28 kilometres south of the river. Behind these was a first reserve of three divisions, and in rear again a second reserve of one division only, allowing on the average six or seven kilometres of front to each division, far too small a force, and yet the attack was not altogether a surprise for the Germans. Their Air Force, since February, had indicated a probable British attack, but it was not until May that co-operation by the French could be foreseen, and the Second Army was only reinforced in artillery; partly, no doubt, owing to the wastage of Verdun, and partly to Brusilov's offensive of June in Galicia. In spite of the German experience at Verdun, the Allies adopted similar tactics at the Somme, and in addition to attempting to wear down the enemy, also proposed to break through his position, although surprise was out of the question. It was agreed that successive attacks on limited objectives must by degrees wear out the enemy and in the end result in the rupture of his front. Instructions to the troops warned them against unduly pressing local successes which would form dangerous salients, but pointed out that when the organized defences were destroyed the methodical advance could be abandoned for bolder measures. The dash of infantry is not so much weakened by a slow and cautious advance as by the unexpected appearance of obstacles or flanking machine-guns. The artillery preparation need not be slow, but must be thorough, the ensuing infantry attack must be as rapid as possible, and so much the better if it involves surprise.

Here follows a short account of the Battle, which is omitted.

The result of the offensive was to restore the initiative to the Allies, the Germans had to bring troops from Verdun, and when Hindenburg replaced Falkenhayn on 20th August, the German offensive at Verdun was put an end to. The Germans, in two months on the Somme, lost as many men as in six months at Verdun. It is noteworthy that it cost less in killed and wounded to gain ground than to lose it, the French experienced this also at Verdun, and the fact will be confirmed in 1918. However, the Allies could not manage to break through to open warfare, not that the means were insufficient, but the procedure did not admit of such rapidity in the succession of attacks as to prevent the enemy from re-establishing the situation by preparing a new position further back. Moreover, at least two favourable opportunities were lost owing to stereotyped methods. Ludendorff has now admitted that following on Verdun the Germans were always on the verge of a catastrophe on the Somme.

Lessons of the Offensive.—Surprise was not obtainable, except perhaps south of the Somme, where the Germans did not expect such a powerful attack on the part of the French. At the Somme, as at Verdun, the increasing weight of artillery in the attack, and the development of aviation were marked features. On 3rd September the artillery averaged one field-gun per 38 metres, one heavy gun per 20, and one trench-piece per 22 metres, which appears to be about the maximum density possible. The value of mastery in the air was proved. The employment of gas-shell became general and gave good results, not only in neutralizing the enemy artillery during an attack, but also in reducing the length of the artillery preparation. At the Somme the British introduced tanks on 15th September, unfortunately in too few numbers, and before the infantry had learnt to co-operate with them, with the result that German attention was too early directed towards means for combating them. In the attack the procedure advocated by the Instructions of January, 1916, was not quite satisfactory, infantry formations were still too dense, and orders were not always complied with as quickly as they should have been. A note of 27th August drew attention to the increased offensive power of infantry, due to the issue of automatic rifles, the new hand grenade, and the 37-mm. gun, which should enable successes to be exploited without delay, but the action proposed was still too hesitating, the principle of maintaining the continuity of the general lines, and not advancing beyond the limits laid down by the formation commander who controlled the supporting artillery (generally the Division Commander), was still recommended. Commanders of Armies, indeed, directed more prompt following up of successes, and pointed out that the artillery could not do everything; that the infantry were there to fight and not only to occupy ground when it had been absolutely swept clean by the guns, and that they must take their fair share in ousting the enemy from his defences. It is evident that the infantry had accepted a little too willingly the secondary rôle which had been allotted to it in the attack, but common-sense will admit that once the infantry is ordered to advance it must assume its own initiative. Method and deliberation are at first necessary to carry an organized defensive position, but when only improvised defences are to be dealt with, rapidity in the attack is all-important, thorough reconnaissance must be forgone, any guns on the spot must be used for preparation and support, even if they do not belong to the division engaged there, and the absolute centralization of command must be abandoned. However, if the Instructions had their faults, they realized great progress in many points, *liaison* between the infantry and the commander of the artillery showed an important advance. The rolling barrage dependent on the pace of the infantry, took the place of the old barrage advancing by bounds, and the infantry accustomed themselves to pressing up to the barrage, thus to a great extent surprising the enemy. Counterbattery work, whether for destruction or neutralization, was so perfected that the Germans adopted it in place of their zone-fire. The signal service improved enormously, and artillery fire, directed from aerial photographs, attained great accuracy. The rapid organization of ground during an attack still left much to be desired; much earth was thrown up, but so disconnectedly as in most cases to be wasted labour, and formation commanders were enjoined to decide rapidly, and transmit their orders for earth-works in the form of plans, to ensure better co-ordination. Reserves were to assist. At Verdun, and later on the Somme, motor-transport was used for the first time on a large scale, and was organized on the model of railway traffic.

Lessons of the Defence.—The battles round Verdun and the Somme took place before the defence had realized the preponderating effect of the intense and prolonged bombardment brought to bear by the attack. Too much attention was given to holding the foremost trench, and retaining every yard of ground while the aim and object of defence—to subject the enemy to greater loss than he can inflict—was lost sight of. Both sides recognized the necessity for plans showing the details of intended reinforcements, and the part to be played by each unit, and also the efficacy of promptly executed counter-attacks. Battalion and Regimental Commanders are the soul of the defence. The French soon realized that the attacker, if provided with sufficient resources, could capture the foremost trenches without the infantry firing a shot; the principal position of resistance was therefore organized somewhat to the rear. The enemy's artillery preparation must be discounted by deepening the defence, holding the advanced trenches only lightly and arranging for counter-attacks, siting the essential defensive elements, such as machine-guns, automatic rifles, and observation-posts, away from the infantry trenches and carefully camouflaging them, and by employing shell-proof shelters and underground communication trenches. The system of centres of resistance having been condemned at Verdun, continuous lines of trench were again used with supporting points enmeshed in them. It was found at Verdun that even the débris of trenches could be usefully held at the moment of the assault. To aid their infantry, the defenders' artillery must be decentralized and organized in groups corresponding to the infantry formations in line, but this specialization is limited by the necessity for obtaining, when required, powerful concentrations of fire. The tactics of the defenders' artillery, when superiority has been won in good time, is to reply to every concentration by a similar preparation, to every increase of violence by a corresponding augmentation of fire, and thus to overwhelm the assaulting troops before they can launch their attack. This is the *offensive counter-preparation* used with such excellent effect at Verdun. As the artillery preparation may destroy all telephonic communications over a great depth, other methods of communication must be in readiness, such as runners, flares, carrier-pigeons, visual-signalling, wireless, etc. Every man must be trained in mining and sap, and the moral factor is of greater consequence than ever.

The German conclusions are much the same as those of the French.

(To be continued.)

A. R. REYNOLDS, *Colonel.*

REVUE MILITAIRE SUISSE.

No. 10.—*October*, 1921.

Operations on the Sangarios.—Colonel Feyler gives an account in the original article of the operations of the Greek Army against the Turks during the period August 14th–September 13th, 1921. These operations divide themselves into four distinct phases, viz., a stragetic movement towards the E. from Eski Chehr to the Sangarios; a seven days' battle on the E. bank of the Sangarios and on those of its tributaries, the Gkéouk and Katranki; a lull of ten days; and the retirement of the Greeks to the W. bank of the Sangarios. After giving a description of the theatre of operations and stating in outline the movements of the opposing forces, Colonel Feyler comments upon the main features of the operations. The advantages gained by the Greeks in the operations on the Gkéouk were, he points out, that their Lines of Communications became perpendicular to their front and, at the same time, were shortened to two-fifths of their former length; further, it also became possible for the Greeks again to bring into use the Eski Chehr–Sangarios railway. Against these advantages, on the other hand, are to be set off the fact that the casualties suffered were heavy and the Greeks did not gain, either politically or stragetically, a success sufficiently definite or decisive to compensate them for the losses incurred.

The Reichswehr.—The original article is a continuation of one on the same subject begun in the July number of the *Revue.* In the contribution under notice Major de Vallière deals with the death agonies and dissolution of the old Army of the late German Empire, and also touches upon the German Revolution and the Armistice which brought the Great War to a close. He points out that if General Maerker's views are to be accepted, the *foul work of disorganizing* Germany's fighting forces was initiated simultaneously with the outbreak of war. Haase openly stated in 1919 that the German Navy began working for a Revolution at the beginning of 1915. It is, of course, well known that there were, in 1917, mutinies in the German Fleet, whilst it was on the high seas: it was in this year that the "rot" set in throughout the Teuton Empire. The Government and the Great General Staff did their best to find a cure, but their efforts proved unavailing. The Russian Revolution, no doubt, had a disastrous effect upon the discipline of the German people. The Kaiser's Divisions, which had come into contact with the Bolsheviks, became infected with the poison germs, and carried the contamination into their homes, whence it spread throughout the length and breadth of the land. The discipline of the German Army broke down seriously early in the War, owing to the disappearance of the professional class of officers and N.C.O.'s, who had been killed and wounded in very great numbers: the young "Kriegsleutnant," commissioned during the later years of the War, despite all the eagerness they showed to master their profession, never really inspired the troops with confidence in their ability to command men older than themselves. By 1918 the casualties in the ranks of the officers of the German Army totalled 60,000, of whom 46,815 belonged to Prussian units. Apparently Ludendorff was fully convinced in September, 1918, that the German

Army was badly beaten and could no longer hold out: on October 1st of that year he telegraphed to Berlin, urging that an armistice should be arranged forthwith. Mutinies broke out at camps on the Lines of Communications about this time, and on the 28th *idem*, the German sailors hoisted the signal for the Revolution, and refused to take their ships out of Kiel Harbour. Thereupon Noske, the socialist, was appointed Governor of Kiel and restored order with an iron hand. Later, disorders occurred at Hamburg, Bremen, Munich, &c., and on November 9th, Scheidemann proclaimed a Republic from a window of the Reichstag, and on the same day Liebknecht broke the Red Flag on the staff of the Emperor's Palace at Berlin. In these circumstances, those representing the old Government could not do otherwise than sign the armistice. The withdrawal of Hindenburg's Army to the Rhine then took place, and the old Imperial Army ceased to exist.

NOTES AND NEWS.

France.—A special correspondent calls attention to the fact that the Second Part of the Official Instructions relating to the training of the French Infantry has recently been published. The First Part was published in February, 1920, and deals with the preliminary training of the infantry soldier and drill movements: the Second Part treats of the "Infantry Combat," and is the first expression of official opinion, since the conclusion of the Great War, on the subject of infantry tactics—Lieut.-Colonel Lachèvre is the author of the latter volume. The subject matter is handled under four main heads: a preliminary statement, in which war is examined in all its aspects; general remarks upon the employment of infantry; the offensive combat; and, finally, defensive positions. The highest praise is given to the compiler of the Second Part of these Instructions for the manner in which the whole subject has been treated by him.

No. 11.—*November*, 1921.

Rapidity of Attack.—The original article is by Jean Fleurier, who modestly states that he played but a minor part in the great drama upon which the curtain has not yet been finally rung down. In contributing an account of his experiences, M. Fleurier's intention is not so much to trace the changes in tactics which developed during the period 1914–1921, nor yet to criticise the measures adopted on the battlefield, as to indicate the manner in, and the means by, which rapidity in attack can be made to serve the ends of success; he was much impressed with certain plans which proved eminently suited to the present-day armament of troops, and is consequently impelled to place the same on record. M. Fleurier points that when the Great War broke out in 1914, both the German and French Armies had fully imbibed the doctrine of the "offensive," and extracts are given from War diaries, &c., to show how deeply embedded this doctrine had become, not only in those who were called upon to act as leaders of troops in the early phases of the War, but also in those of the rank and file who first rallied to the colours on the call to arms. The want of success responsible for the three years' hold-up of the Entente troops on the Aisne is attributed by him to the too great expectations regarding the efficacy of the artillery bombardment as a means for neutralizing machine-gun fire from defensive positions, whilst the attacking infantry were rushing forward withholding their own fire. The system of swiftly-delivered attacks, which, in 1915, failed to carry the line of obstacles, was, M. Fleurier points out, succeeded in 1916 by "ram" tactics, which, in their turn, were in 1917 replaced by a method of attack consisting of movements planned to be carried out with a regularity similar to that associated in men's minds with the movements in the mechanism of clockwork. In M. Fleurier's opinion it was in connection with the operations of September, 1918, in the Champagne, that there will be found the perfect model of an attack delivered with the rapidity essential for success. In these operations the objectives were initially screened behind an impenetrable veil of mystery; night marches were carried out with the greatest secrecy, and with such methods as to secure the greatest comfort to the troops, and to inspire in them the utmost confidence; reliefs were effected with such rapidity and order that the units which had to break through were brought into their correct positions without confusion or mistakes just 48 hours in advance of the "zero" hour; the artillery preparation preceding the attack, although lasting but a few hours, was exceedingly effective and violent—it silenced the German artillery and put its counter-preparations out of gear. Once the "*unités de rupture*" were sent forward on their errand, they continued their advance for two long days without a halt, and ended up by capturing 22 successive lines of trenches—on a depth of 7½ km. The details of the organization whereby the foregoing results were secured are given in the original article, which provides an interesting account of the tactical developments during the Great War.

Responsibilities of the Soldier.—An incident is described in the original article which bears upon the problem of the responsibility of soldiers when employed upon quasi-military duties. During the mobilization of the Swiss Army in connection with the Great War, sentries, furnished by a squadron of the 18th Dragoons, posted near the village of Benken, (Canton of Zürich), saw a motor-car approaching them; they challenged it, but as it continued its course without heeding the order to halt, the sentries, in accordance with the instructions issued from Army Headquarters, fired in the direction of the motor-car, with the result that the chauffeur and the owner of the car, who was riding therein, were both killed. Thereupon the Commander of the Squadron to which the sentries belonged was indicted for murder: he was acquitted. Subsequently, the widow and children of the owner of the car brought an action in the Civil Courts against the Commander of the Squadron and two of its N.C.O.'s, claiming 40,000 francs as damages. The plaintiffs were non-suited. The judgment of the Federal Court, which finally disposed of the action, is published in the original article, and sets out the Swiss law on this very difficult question of the responsibilities of soldiers when employed upon what are practically police duties.

Search for a New Discipline.—Captain Cingria, the author of the original article, considers that in Switzerland military discipline is paralysed by two serious failings on the part of those responsible for its maintenance: a superstitious reverence of archaic forms and ceremonies, and the desire to render as complicated as possible certain simple and meritorious principles handed down by tradition. Soldiers are, he points out, ultra-conservative, and he expresses the opinion that the present-day methods of discipline and the ideas prevalent in relation thereto no longer conform to the necessities of the times and to the present-day organization of society. However, we are not told what is to take the place of that which is declared to be obsolescent.

Greek Second Army Corps at Kutahia.—Colonel Feyler describes, in the original article, the operations of the Greek Second Army Corps in Anatolia, which took place in July, 1921: the Turks were, at this time, occupying a front of approximately 130 km. in extent on the line Eski Chehr–Kutahia–Afiun Karahissar. Three Greek Army Corps were set in motion against the Turkish position; the First Army Corps advancing from the W. of Ouchak, was ordered to drive the enemy from the positions held by its left wing W. at Afiun Karahissar; the Third Army Corps was directed from Brousse against the Turkish centre at Kutahia, whilst the Second Army Corps (forming the Greek centre) was sent forward from the line Dounli Selki–Serai to occupy the mountainous country of Umali Dagh and Kara Boujon, where it was to halt until the First Army Corps came into line with it. The mission of the Second Army Corps was to act in co-operation with the First Army Corps: these two Corps were to deliver an attack in the general direction of Kara Tepe with the object of cutting the enemy off from the roads leading to Seindi Gazi and Eski Chehr. The instructions issued to the Second Army Corps are set out in detail in the original article and the operations based thereon are given in outline: the Greeks attained their objectives, after having driven the Turks out of their positions with heavy loss. Colonel Feyler, commenting on the operations of the Second Army Corps, expresses the opinion that it achieved all that could have been expected of it.

NOTES AND NEWS.

France.—A special correspondent calls attention to some of the important changes which have taken place at the Headquarters of the French Army. General Margot has become head of the *Direction de l'Infanterie,* in place of General Lagrue; General Nivelle has retired from the *Conseil supérieur de la guerre,* and has been succeeded by General Nollet; General Gassouin, of the General Staff, having obtained an important appointment in a commercial company, has retired from the Army, and General Raguenau has been appointed a *sous-chef* in his place. General Serrigny has been placed in charge of the Historical Section of the General Staff. The Army Law provides that the Air Force shall be organized in four Regiments; experience has shown the desirability of grouping these Regiments in Brigades, and they have accordingly been formed into three Brigades, with Headquarters at Paris, Dijon and Lyons, respectively. Further particulars concerning these groups are given in the original notes.

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