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THE DYNAPHONE.

THE following interesting description of The Dynaphone has been kindly sent us by its inventor, Capt. A. C. Fuller:—

The dynaphone is essentially an instrument for electric telegraphic reception. It is applicable to line or cable telegraphy and to certain systems, *i.e.*,* continuous wave systems, of wireless telegraphy.

Its chief characteristic is its extreme sensitivity combined with its robust construction and small size and weight. The dynaphone is, in effect, a type of electro-dynamic relay which further operates as a signal former, and in itself combines the functions of relay and sounder or other signal former. Before proceeding with a description of the instrument and an explanation of its action a few particulars may be given. The dynaphone produces audible signals with a current of less than 1 micro-ampère.† If it is desired to use a very much larger current, such as is usually employed, say 10 to 20 milli-ampères, no adjustment is necessary; as will be seen later, the only difference is in the enhanced strength of the received signals. The instrument as at present designed is wound with two coils each of one thousand ohms.‡ The winding can of course be varied to suit any special requirements.

The instrument consists of a laminated circular stalloy yoke fitted with narrow pole pieces. These pole pieces are bored to have a circular face. In the gap thus formed between the pole pieces and with the least possible clearance, an armature is caused to revolve. This armature is also laminated and carries a drum winding. The clearance between the armature and the pole pieces is only a few mils. This is in order to maintain the reluctance of the magnetic circuit at a minimum. The ends of the winding are connected to a commutator (or slip-rings for alternating current), and brushes are provided to collect the generated current which is passed through a telephone receiver or recording instrument.

The pole pieces are wound with field coils through which the received signals are passed. The pole pieces are also wound with

* The new type (now under construction) will, it is hoped, prove applicable to all systems of wireless.

† The new one is calculated to be 1,200 times more sensitive and should produce signals with a current of $\frac{1}{12} \times 10^{-8}$ ampères.

‡ New one 7,000 ohms.

a further coil called the controlling coil, connected in series with a variable resistance, a reversing switch, and a dry cell. The use of this dry cell and coil, and the need of the reversing switch will be apparent when the action of the instrument is described.

ACTION.—*Single Current.*—The armature is rotated rapidly by a small independent electric motor controlled for speed by a rheostat. This rotation of the armature gives rise, even with no current in the field coils, to a hum in the telephone receiver. It is found, however, that, by passing a current through the controlling coil and adjusting the rheostat in series with it, this hum can easily be suppressed. If a current now passes through the field coils it is obvious that a magnetic field is formed across the pole pieces. This field is cut by the armature winding, with the result that a pulsating direct current flows through the telephone and of course produces a note in accordance with the number of pulsations per second; *i.e.*, the note is controllable by the speed of rotation. A comparison with the action of a telephone receiver, an extremely sensitive instrument, may not be out of place here.

It will be seen that the magnetic circuit of the dynaphone is the same as that of the telephone receiver. Now in the case of the telephone the lines of force of the magnetic field, in order to produce a signal, have to produce a movement of the diaphragm, *i.e.*, have to do actual physical work. In the case of the dynaphone the lines of force only have to exist, and the armature in cutting them does the work by means of mechanical energy. Hence the dynaphone eventually produces in the telephone in series with its armature, an audible note of any desired pitch by means of an original current of too low a value to produce such a note. It will be noticed that the energy finally available for the signal is greater than that received, owing to the slight electrical energy available being reinforced or augmented by mechanical energy. Hence the dynaphone operates not only as a very sensitive signal former but also as an amplifier.

To Record.—It is obvious that by grouping a series* of dynaphones and running them synchronously, the very minute current passed through the field coils of the first instrument can, by a series of steps from field coils to armature and then to field coils of the next instrument, etc., be amplified to any required value to produce a loud signal or to operate some form of recorder or contact relay.

Double Current.—In the case of double current the instrument is even more satisfactory. The figures quoted in the introduction referred to single current working only. For double current working the rheostat and reversing switch are adjusted so that, with the spacing current flowing through the field coils, there is silence in the telephone with the armature rotating at the required speed. This

* It is hoped that one will now suffice.

means that the current in the controlling coil produces a magnetic field equal and opposite to that produced by the spacing current; with the result that while the spacing current flows no magnetic lines of force are produced. Thus it is clear that when the transmitting key is depressed and the marking current flows, the magnetic field produced across the pole pieces is that due to the marking current plus that due to the controlling current; *i.e.*, it corresponds to a field that would be produced by a marking current of twice its value, or by the marking and spacing current assisting each other in combination. The result of a field of greater intensity is that the signals also are of far greater intensity.

From the above description of the action it is evident that the instrument takes the place of both relay and sounder, and does away with any need of a local battery. The signals telegraphed are heard in the telephone receiver as short and long buzzes. If desired they can be made of musical pitch by rotating the armature at high speed. There is no necessity to utilize the controlling coil except for double current working unless extreme sensitivity is required.

Advantages of the Dynaphone Telegraph Receiver.—1. The dynaphone is extremely sensitive and at the same time can work through very severe interference. A current of as little as half a micro-ampère has given legible* signals, and practical working signals for line telegraphy are produced by five micro-ampères.

2. Since the instrument is far more sensitive than any ordinary relay, such relays and the circuits they control can immediately be dispensed with. This renders telegraphy very much simpler and the service very much cheaper to maintain, and does away with many tiresome adjustments.

3. An enormous reduction of battery power follows from the use of the dynaphone. A single dry cell has sent perfect signals through a thousand miles of line.

4. The line may be in a very bad state indeed without rendering work impossible. A light steel wire would suffice in place of the heavy iron or copper wire now in use. A consideration of this shows an enormous saving both in cost of construction and in maintenance. Faults which would render ordinary instruments unworkable would have little effect on the dynaphone, which would continue in action on a line that was far too faulty to work other instruments.

5. Largely increased distances can be worked before translation or relaying becomes necessary.

6. The dynaphone receiver has no moving contact pieces, armatures or levers, and, in fact, requires no mechanical adjustment whatever. Practical men will readily appreciate this advantage.

* These figures are now out of date.

7. The transmitted signals are received audibly* through a telephone head receiver by the telegraph clerk, in a similar way to wireless signals, though the former are of greater intensity. By this means several clerks may work in close proximity, each only hearing his own signals, and with a complete absence of the din so characteristic of a large telegraph office where the usual pattern of sounder is employed.

8. The dynaphone is not affected in any way by vibration, and is perfectly constant and reliable in action.

Note.—The dynaphone can be used with single or double current and can be worked simplex or duplex.

It can be superposed on an existing telephone line.

The current required to work the dynaphone is so small that no interference is caused to adjacent lines.

WIRELESS.—The dynaphone is very well adapted for use with continuous wave stations.

From the description already given it is clear that continuous oscillations, if rectified by any ordinary detector, will establish a magnetic field across the pole pieces of the instrument for as long as the oscillations endure. The unidirectional pulses produced by the rectification of the oscillations are so rapid as to be rightly regarded as a direct current. This current establishes a field which is cut by the rotating armature with the result that a pure note is produced in the 'phones. This is not a theoretical supposition, but a fact proved by experiment. Hence it follows that by the use of the dynaphone the ordinary wireless detectors are made available for continuous wave reception, as well as for spark telegraphy. Any spark station with the simple addition of a dynaphone can communicate with, and receive messages from, a station using continuous waves as well as with other spark stations.

Wireless signals thus received can be amplified sufficiently to be automatically recorded.

The dynaphone is not affected in any way by vibration, and requires no mechanical adjustment. It is perfectly constant and reliable in action.

ACTUAL TESTS.—1. The dynaphone, even before being perfected, has given legible signals with a current of considerably less than one micro-ampère.

2. Clearly legible signals have been sent on the Post Office overhead wire from Cromer to the G.P.O., London, with a battery power of $1\frac{1}{2}$ volts (one dry cell).

3. A laboratory test was made in which perfect signals were sent with one dry cell through 1,000 miles of aerial line.

4. One coil of a telephone transformer was inserted in the line

* They may be recorded if preferred.

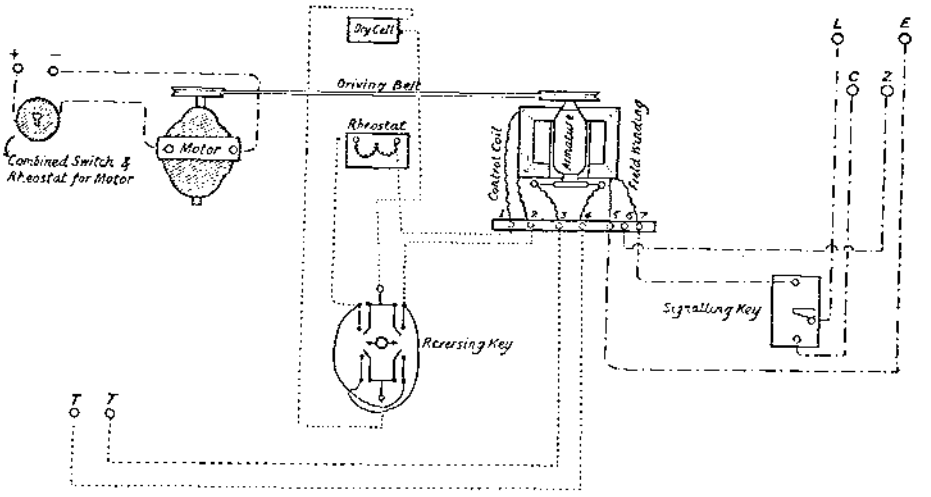
referred to in 3, and the other coil was connected to a buzzer and 4-volt accumulator in series, thus inducing terrific interference on the line. The signals were still perfectly legible with no increase of battery power.

5. One dry cell worked the instrument perfectly through about 200 miles of submarine cable; with 400 miles the time lag reduced the working speed considerably, though the strength remained ample.

6. Continuous oscillations from a Poulsen arc were rectified by a crystal detector, and produced a perfectly pure note on emerging from the dynaphone.

INSTRUCTIONS FOR USING THE DYNAPHONE ON TELEGRAPH CIRCUITS.—The diagram shows the circuits in the dynaphone. The only connections necessary for telegraphy are to connect the power supply for driving the motor to terminals marked + and —. The telephones to terminals marked T, the line and earth to L and E respectively, and the sending battery to C and Z.

If the instrument is used for reception only, then the leads normally put to relay coils are put to L and E, and no connection to C and Z is required.



DYNAPHONE CIRCUIT DIAGRAM.
1 and 2, Control Coil; 200 turns.
3 and 4, Armature.
5 and 7, Field Coils; 80,000 turns.

TO WORK SINGLE CURRENT.—Make necessary connections as above. Start the motor. If the hum in the 'phones is now at all loud adjust rheostat to about 200 ohms and push union switch to left. If the hum is lessened adjust rheostat till silence is produced. If the hum increases push switch to right, *i.e.*, reverse it, and then adjust.

With ordinary strong signals, *i.e.*, using a line current of 10 to 20 micro-ampères or thereabouts it will be found unnecessary to

use the controlling current at all and the union key may be left in the central position. It is well to work with as much resistance in the controlling circuit as possible to lengthen the life of the dry cell used. The resistance of the controlling coil is only about 2 ohms, hence care must be taken not to leave the union key shut if only a small resistance is in the rheostat. A permanent resistance will be inserted in future models.

TO WORK DOUBLE CURRENT.—Make the necessary connections. Start the motor. Adjust the rheostat and union key so that silence is obtained when the distant key is at rest : *i.e.*, so that the controlling coil creates a field equal and opposite to the field produced by the spacing current : result—no field and silence. The marking current then produces signals. These signals are due to the field produced by the marking current plus the field due to the controlling current, which field is liberated as soon as the marking current replaces the spacing current in the line. In double-current working it is better to arrange so that the spacing current is in the direction to tend to annul the residual magnetism of the dynaphone, thus reducing the controlling current required for silence.

Notes.—The dynaphone never requires more than about 50 micro-ampères for the strongest signals, therefore the working current should not exceed this value. If it does so a resistance should be inserted in the circuit.

It will be noticed that the terminal marked 6 on the diagram has a link to connect it to either 7 or 5. This allows the sending current to traverse the home instrument or not at will. As there is no galvanometer in the set it may be considered desirable to hear the signals going out.

INTERFERENCE.—It is obvious that any direct current that affects the line through leakage, etc., can be obviated by adjustment of the controlling coil. Practically any interference due to high-speed telegraphy, telephony, alternating power circuits, etc., can be completely obviated by shunting the dynaphone with a suitable condenser ; sometimes as much as 6 micro-farads is necessary.

Owing to the design of the dynaphone this simple method will allow the signals to be clearly read in the 'phones, with the elimination of practically all interference. In a few cases the use of impedance coils may still further eliminate any disturbance.

For wireless work the rectified oscillations have to be passed through the field coils of the dynaphone. The dynaphone, therefore, takes the place of the telephones in the detector circuit, and the signals received are read in the telephones in series with the armature.

NOTE.—The instrument has been re-designed since the above was written. The figures given therefore do not nearly represent the sensitivity of the new design which is an enormous advance on the one described above. Owing to delays in manufacture the new instrument has not yet been tested.

COMPLETION REPORTS ON DURBAR WORKS, P.W.D., DELHI, 1911.

GENERAL REPORT ON DURBAR WORKS, P.W.D., DELHI, 1911.

By MAJOR S. D'A. CROOKSHANK, C.I.E., M.V.O., R.E.

WITH the opening days of the year 1911, the President and certain members of the Central Committee and staff, as then appointed, assembled at Delhi, and commenced on the preliminary survey of the ground, and investigations in connection with the proposed Durbar at which His Majesty King George V., accompanied by Queen Mary, would announce in person his Coronation as King-Emperor.

Proposals were made and schemes considered, and by the 13th January, on which date the Central Committee held their first formal meeting, the Superintendent of Works, P.W.D. (Major S. D'A. Crookshank, R.E., Executive Engineer, P.W.D., U.P.), had drawn up the note which is attached hereto, to outline the general features of possible operations. This note is interesting as a comparison with the scheme actually carried out.

As time went on, the plans matured and estimates were drawn out in detail for each and every work decided on by the Committee, and with the close of the works, the total number of sanctioned estimates which were prepared in the Superintendent's Office amounted to no less than 140.

It will not, however, be necessary to deal with all of these estimates, and only those which were on a large scale will be briefly referred to in the following paragraphs.

1. *Durbar Amphitheatre.*—The Amphitheatre stood out on the Burari Plain on the same site as in 1903 and again in 1877, and comprised two separate stands, both semi-circular in shape, having a common centre. The Durbar Stand proper lay with the back on the South on a radius of 300 ft., and was roofed over 80 ft. deep with 1,57,243 ft. superficial area, providing seating accommodation for about 15,000 persons, including Indian Chiefs, durbaries, officials, distinguished visitors, privileged guests, etc. Screened-off accommodation was specially provided for Indian Purdah ladies of high degree, in eight central blocks standing on the back rows and terreplein of the stand. These blocks were subdivided into 32 compart-

ments which were screened off and draped so that perfect privacy was afforded. Access to these blocks was given by a porchway on the road at the back, with passage ways which were closed to the view of the public.

Opposite and facing the centre of the semi-circle there was the Royal Shamiana, 60 ft. by 60 ft., of red velvet embroidered with gold and lined with pale yellow silk, in which the Durbar ceremony took place, and on beyond this Shamiana, giving a processional way of nearly 100 yards out to the centre of the semi-circular enclosure, there stood the Throne Pavilion in four terraces ranging up to the Royal Dais, standing at a height of 15 ft. from the ground, which was surmounted by a gilt dome with gold embroidered awning. Open vistas 100 ft. wide stretched out North, East, and West.

The façade of the Durbar Stand and Throne Pavilion were richly ornamented in the Indo-Saracenic style of design in wood and plaster work, painted white, picked out with gold. The other stand having a radius of 900 ft., enclosed the North frontage of the Durbar, and consisted of an uncovered mound in rising tiers providing accommodation for nearly 50,000 spectators, including school children.

Between the Throne Pavilion and this Spectators' Stand there were the Massed Bands and Troops (Regular and Volunteer). In front of the Royal Pavilion on the North vista, stood the Flagstaff flying the Royal Standard, which was made up of two spars, 90 and 60 ft. long respectively, which were supplied from the Bombay Dockyard by the Royal Indian Marine, and erected under the supervision of an officer of that service.

Fire protection and potable water systems were laid on, and there was also a separate canal irrigation channel, but the soil in this locality being impregnated with salts, it became impossible to venture on more than grass borders to the roads and vistas, with alternate plots of palm tubs and flower beds, and some small lawns round the Throne Pavilion.

The Amphitheatre was fed by the broad gauge system and Durbar Light Railway, and by roads converging on it from all sides.

* * * * * *

Communications.—As the roads for the 1903 Durbar were still serviceable, these were repaired and supplemented by new roads for additional access and carriage parking purposes. The main roads were oiled, and the temporary roads watered, so that there was no dust.

2. *Roads.*—The road communications over the Durbar area were in the first instance of a very limited nature, and the few existing miles of narrow metalled roads were soon cut up under the traffic

* The details of the construction of the Amphitheatre will be given in a subsequent report.—[ED., *R.E.J.*]

of the preliminary measures, so that extensive road construction works had to be undertaken, in the necessity for giving easy inter-access to the central camps crowded into a limited area, and providing for congested traffic and for opening out communication with the outlying camps at a distance.

So that, one way and another, public roads have been constructed to an extent of 40 miles in length, the metalling varying in width from 10 to 40 ft. In addition to this, in order to keep out competition resulting in high rates and retarded delivery, the P.W.D. undertook to supply materials for the construction of the roads in all the camps, which involved very extensive operations and caused considerable trouble and anxiety.

The failure of the rains, although it helped to bring in the supplies of road metal, retarded the actual consolidation of roads, which was further put back by the home strikes interfering with the shipment to time of the special light rollers ordered out.

Construction, however, proceeded satisfactorily, and the public, as well as the camp roads, were all completed and opened to traffic within the month of November, that is, within 8 months of commencement, at an expenditure on public roads of about Rs.4,09,000.

Temporary roads carrying light traffic were, as a rule, made of stone metal which was consolidated with "*kunkur*" screenings or "*bajri*" binding, and this answered the purpose very well. The more important roads had, in addition to a stone soling, a travelling coat of "*kunkur*" metal which gave a smooth clean surface.

The consolidation operations were on a very large scale, and at their height the P.W.D. had 13 steam rollers at work, besides heavy hand rollers and gangs of rammers. Light 6-ton rollers were found most useful and efficient for "*kunkur*" consolidation. The difficulties attending consolidation were considerable, as by that time advance parties and camp supplies were beginning to come in, and as all the roads within the Durbar camps area were either altogether new or up for renewal, it became impossible to arrange traffic routes satisfactorily, and consequently in some cases the new roads got cut up, and in others the public were necessarily inconvenienced by having to make détours.

3. *Dust Prevention. Oiling Roads.*—Delhi being proverbial for dust, the necessity for taking special measures to prevent a reoccurrence of the unpleasant conditions of the 1903 Durbar was recognized, and arrangements were accordingly made with the Asiatic Petroleum Company for the supply of 1,414 tons of liquid fuel from their Budge Budge Depôt, which was spread over the main roads in one or more, but only in a very few cases three coats, which entirely eliminated the dust, and also gave a smooth travelling surface.

Not only were the metalled portions oiled, but the open side-widths, and also in some cases the raised side walks, were so treated.

The complete success of these operations was very noticeable, and probably much appreciated, and the excellent results fully justified the expenditure of Rs.1,07,141 incurred thereon. Roads not bearing much traffic, and pathways generally, were watered either by cart, or by hand, so that, combined with the camps watering their lawns and roads, there was no appreciable dust anywhere, in spite of the enormous crowds of foot passengers and continuous congested wheel traffic.

4. *Polo, Hockey and Football Grounds.*—The land allotted for this purpose consisted of undulating fields under cultivation, and it became necessary to level off for three full-sized Polo grounds, each occupying a space 1,000 ft. long by 600 ft. wide, and to provide raised seating accommodation, separately for subscribing members and for the general public, to overlook each of the three grounds. The stands for the Polo grounds lay back to back between the two grounds facing out both sides, and seated 9,000 persons on one side and 7,000 on the other. On this double stand there was a tastefully decorated and furnished Royal Pavilion in the centre with pavilions for members at either end. In between there were sunk gardens with fountains, flower beds and summer houses, and crossed by rustic bridges to give communication from one stand to the other. Opposite the end ground there was a stand for the musicians of the Massed Bands constructed crescent shaped, and large enough to accommodate non-subscribing spectators at each end.

The third ground had a separate stand again, and this ground was reserved for the Hockey and Football matches.

Banks were also made at the ends of all three grounds from which casual spectators could view the matches.

Canal irrigation water courses were laid on to all of the grounds, any of which could be flooded over within a period of 12 hours.

Turfing being impracticable in this part of India, the grass was rooted in by hand all over the grounds and stands, and it took very well considering the failure of the monsoon rains at and round about Delhi.

The expenditure of Rs.1,15,518 on the grounds, pavilions, and stands was more than recovered on entrance fees and subscriptions.

The Royal and Members' Pavilions were designed in the English cottage style, with half-timbered walls and red tile roofs. These pavilions comprised complete refreshment buffets, cloak rooms for ladies and gentlemen, kitchens and store rooms. In addition there were retiring room tents dotted about at convenient places on the grounds. A bakery was provided to meet the heavy demands for cakes and bread for afternoon teas, and a large closed shed was erected as a godown for the mowing machines and garden tools.

A stock of chairs and movable benches was kept on the main stand for ordinary requirements, and these were supplemented by bringing chairs from the Durbar stock whenever there was a large attendance.

The preparation and upkeep of the grounds and flower beds was, for the most part, carried out by the large party of "*malies*" from the Palace Gardens at Gwalior, whose services were very kindly lent by H.H. the Maharaja Scindia.

5. *Electric Installation.*—The Power House, comprising an Engine Room, 35 ft. by 145 ft., and a Boiler Shed, 45 ft. by 145 ft., was made for the P.W.D. by Messrs. Jessop & Co., and is a good example of what excellent work can be done in structural iron work in quick time at their Calcutta shops.

Painted light buff and red outside, and silver-grey and white inside, with its fine display of machinery and fittings, this building was one of the most prominent features of the works undertaken specially in connection with the Durbar.

The remaining buildings in the Power House were provided and erected by the P.W.D., and the settings of the Engines, Boilers and tall steel chimney, the construction of a large circulation tank and other masonry work, was also carried out by that Department.

6. *Review Grounds.*—Here the operations comprised the construction of a central stand for Royalty, and a couple of hundred members of the suites and guests. Combined therewith were provided special retiring rooms for Their Majesties, with large arrival and refreshment shamianas.

The Royal Box was flanked on either side by two covered stands each seating 7,000 persons, and beyond that again by open stands accommodating 6,400 spectators.

Besides these five stands there was a small outlying stand for Warrant and Non-Commissioned Officers and their families, and a large enclosure was made where Indian ladies in purdah could view the proceedings from the privacy of their own conveyances.

All along the frontage of the main stands a lawn was laid, and the Royal Pavilion was enclosed and laid out with lawns and flower beds.

Special road communications were given both for the regulation of the traffic approaching from all sides, and for the sorting out of spectators on arrival, and disposal of empty vehicles.

Water and electric light were laid on.

7. *Central Telegraph Office.*—The Combined Telegraph Office and Telephone Exchange were placed between the Government of India and Press Camps, in order to occupy the most convenient position possible. It was constructed on semi-permanent lines, so as to provide a substantial building for the work of the Department to be carried on in comfort for a considerable time both before and after the Durbar, and it comprised a large central instrument room surrounded by side rooms for the supplementary work. The building was finished off in white with ornamental parapets, quoined pillars,

and patterned horizontal courses, and had a red tiled roof which was afterwards also painted white. The frontage was laid out in lawns, with a wall and gateposts in keeping with the main building.

A Mess house for the European Signallers was provided on similar lines, complete with out-offices.

8. *Central Market.*—The P.W.D. undertook the designs and construction of the Central Market, consisting of three separate sheds for dry foods, vegetables, and meats, respectively. In order to do all that was possible to keep out the flies, the meat, poultry and fish shed was specially enclosed with gauze wire, each of the 16 stalls separately in itself, and again on all the outside openings of the building. The vegetable shed was also so fitted on all the outside openings. Both of these sheds were efficiently drained and adequately ventilated, and the premises generally were surface drained and enclosed, and finished off completely with communications, electric light, and water.

9. *Reception Pavilion on Ridge.*—This stood on the State Entry Route on the crest of the Ridge near the Chauburji Mosque. It was circular in design having an interior radius of 105 ft., and exterior of 142 ft., with the road running through the centre of it. About 4,000 under-cover seats were provided, and the open space in the centre was utilized by the special representatives of the British India community, who presented an address of welcome to Their Majesties on their arrival within the arena.

Without having pretence to any merit of design or construction, the circular shed, decorated in red and white, with its lawns, red paths, white railings, ornamental façade, pennons and floral features, made a smart and neat enclosed pavilion.

10. *Post Offices, etc.*—For the Postal Department, lines were built for the mail vans and ponies, and for the staff. Also the small red and white striped Branch Postal kiosks and Telephone call stations, six in number, which were dotted about within the central area for the convenience of the camps and facility of disposal of business.

11. *Hospitals.*—Hospital accommodation for natives and the temporary treatment of cases, was supplied in a large central Hospital for 24 beds, supplemented by four outlying dispensaries and treatment depôts. These were built on inexpensive lines, as they were only of a purely temporary nature.

An extensive Conservancy Depôt was also provided for the storage of plant, and parking of carts and tumbrils.

12. *Triumphal Arch.*—A fine Triumphal Arch, in the Indo-Saracenic style of architecture, was constructed in elaborate detail from designs prepared in the office of the Superintendent of Works. This arch stood on the return Processional Route from the Durbar, *viâ* the Princes' Road, at the entrance to the Government Central

Camps, where it commanded a good view from both sides, and both by day, and by night, when it was lit up with hidden electric lights, it presented an imposing and highly effective appearance.

13. *Stand at Town Hall.*—The P.W.D. also constructed four large stands, accommodating in all 1,860 persons, opposite the Town Hall in the Chandni Chawk, to view the State Entry. In these stands seats were reserved on payment, for Europeans and Indians alike, whose position required special attention on the part of the Durbar authorities. Indian ladies in purdah were provided for in a screened enclosure on the roof of the Town Hall itself.

14. *Camp Works.*—The Officers-in-Charge of the Camps mostly carried out their own works, referring only on occasion to the Superintendent, Durbar Works, for information and the loan of tools and plant, but they had been invited to indent on him for the supply of road materials, and 83 camps took advantage of this, no less than 11,55,000 cubic ft. of road metal of sorts being supplied by his agency, at a cost amounting to Rs.1,60,227.

In order to ensure uniformity and avoid delays, the Superintendent carried out, at their expense, the erection of wire fencing on the frontages of the Camps lying on the Processional Routes, and constructed the drainage culverts on the entrance roads.

In the case of the King's Camp, the P.W.D. not only provided the road materials, but also consolidated the camp roads amounting to 2,21,075 cubic ft., and within the Royal Pavilion the Superintendent of Works undertook the construction of the whole of the staging for the Investiture, and provided the daises required on that occasion, and for the receptions held by Their Majesties.

The only other Camp having a call on the direct services of the P.W.D. was that of the Foreign Office and Durbar Administration, and here the Superintendent constructed the roads, kitchens, motor and carriage sheds, stables, etc.

15. *Miscellaneous Works.*—Many other jobs, such as the complete overhauling and decorating of Curzon House as a Visitors' Camp; the construction and renewal of bridges; the erection of a large Ticket Office; the erection of temporary structures for works purposes and accommodation of labourers; the collection of 17,000 chairs, and construction of 765 benches, required in connection with the seating arrangements for all the functions; and innumerable minor works here and there, have been carried out through the agency of the Public Works Department, by the Superintendent, Durbar Works, and his staff.

16. *Accounts.*—The following statement is an abstract of the expenditure incurred on the several groups of works carried out by the Public Works Department :—

STATEMENT OF COST.

Item No.	Name of Group.	Estimated Cost.	Actual Expenditure.	Recoveries.	Remarks.
1	Durbar Amphitheatre	5,60,599	5,82,879	89,545	The recoveries were made by sales and transfers to Temporary Works, Delhi.
2	Roads	4,15,240	4,10,298	2,789	
3	Oiling Roads ..	1,28,557	1,07,141	229	
4	The Polo Grounds ..	1,18,520	1,15,518	8,837	
5	Electric Installation ..	1,00,000	1,08,422	35,022	
6	Review Grounds ..	68,863	59,534	12,823	
7	Central Telegraph Office	40,467	36,956	17,079	
8	Central Market ..	38,714	35,038	11,732	
9	Reception Pavilion on Ridge	23,280	22,554	3,279	
10	Post Office Works—				
	*Postal Kiosks ..	10,612	11,267	..	
	Temporary Sheds for Ponies, etc. ..	14,534	14,645	5,770	
11	Hospitals—				
	Hospital Buildings ..	14,577	15,023	1,500	
	Conservancy Depôt ..	955	1,044	..	
12	Triumphal Arch ..	10,000	10,433	..	
13	Stand at Town Hall ..	9,500	10,032	3,272	
14	Camp Works ..	2,55,908	2,61,748	17,667	
15	Miscellaneous Works ..	2,00,054	1,96,814	48,371	
16	Minor Works ..	8,076	8,824	..	
17	Establishment ..	1,12,917	1,12,917	408	
	Totals ..	21,31,373	21.21,087	2,58,320	

* Left standing.

Against this total outlay of Rs.21,21,087 on works, there is an expenditure of Rs.1,12,917 on the establishment, permanent as well as temporary, which was entertained for the execution of these P.W.D. Durbar Works, and includes the salary and all allowances of the whole staff of Officers, Accounts and Routine Clerks, and Subordinates, other than the temporary hands such as Sub-Overseers, Mistries, Jamadars, etc., who were charged off to the works on which they were employed for the time being. The extremely low percentage of 5·3 of establishment to works is very exceptional for operations of this magnitude which have been carried out in great detail and working against time under adverse circumstances.

The accounts were from the first entirely kept directly in the hands of the Superintendent of Works, on the lines of a P.W.D. Division on a large scale, the actual disbursements being made, for road works by the Assistant Superintendent, and on all other heads

by the Superintendent himself. This procedure was adopted in order to ensure direct control over the expenditure, and immediate disposal of bills and payments, so that at all times a careful scrutiny and check was exercised, and the large number of contractors employed, who were mostly men in a small way of business, were kept paid up and in funds to carry on their works without dragging and having to borrow at exorbitant rates of interest from outside sources. As may well be imagined, having to deal with a very large expenditure mostly in small sums at frequent intervals added immensely to the work of the Superintendent and his office, but the results gained were more than commensurate, as delays of any sort would have rendered it not only quite impossible to carry out such extensive works in such a very limited space of time as eight months, but also to keep such a close watch on all outgoings as to be able to work in so well with estimates as the foregoing figures go to show.

From the outset of operations estimates were taken out in full detail for every work, however small, which it was intended to carry out, and this accounted for the preparation of a total number of 250 estimates in the Superintendent's Office. Onerous as this was during a period of high pressure, when immediate commencement and rushing on with works were a necessity, the advantages from the financial point of view, and for purposes of check and compilation of accounts, are obvious, and the time and trouble spent were highly advantageous in the long run.

The usual P.W.D. procedure as regards the disposal of these estimates was, however, not adhered to in this case, as estimates for all works, small or large, were dealt with by the Central Committee, and the Superintendent of Works was not allowed to exercise any of his usual powers of sanction. Work was not ordinarily allowed to be put in hand until formal sanction to the estimate was received, but subsequently in order to save time in carrying out urgent minor works ordered, the Superintendent was given a reserve of Rs.5,000 and allowed to sanction estimates not exceeding Rs.500 within that limit.

17. *Carriage.*—The item which probably caused most trouble was the carriage by road. A lean fodder year further reduced the supply of country carts which was at the best of time unsatisfactory, and consequently the cartmen made extortionate demands and did very inadequate work. This had been anticipated and the purchase of steam lorries recommended, and the single one sanctioned, a 3-ton Sentinel, more than justified its cost by doing continuous rapid work and selling well at the end of operations. A second lorry was obtained on loan, but being out of order very little work was got out of it. These efforts were not enough to stem the tide of rising carriage difficulties, and had it not been for the checking influence of the liberal use from an early stage of the Military and Imperial Service

Transport carts, the trouble experienced and expense entailed would have been most serious.

Other than the Light Railway system and a few lorries, there was no use of mechanical transport about the camps, as there were no defined lines of traffic on which monorail or motor services could with advantage be established, and there were the objections to having such services feeding in all directions with roads and water and electric systems under construction, camps being erected, and lawns laid down, and no surplus space available anywhere.

The value of the assistance to Durbar Works afforded by the broad gauge railways may be fathomed by their having brought in a matter of six lakhs of cubic ft. of "*kunkur*" alone, besides large quantities of other materials, tools, plant, etc. The arrangements made by the Traffic Departments of the Durbar Railways and East Indian Railway in the carriage of materials and liquid fuel for the P.W.D. were most prompt and efficient, and the special rates allowed were a concession which effected a considerable saving to Durbar funds.

18. *Contractors.*—With the opening of works by the P.W.D., and in the camps, contractors came pouring in from all sides, which was very opportune as the Delhi contractors having been altogether spoilt by the high rates prevailing under the operations for the previous Durbar, and by the conditions obtaining in the local market, anticipated a golden harvest and were practically impossible to deal with. Calling for tenders in the usual way was not at first productive of any useful result, as the local contractors had combined to create abnormal conditions and keep up the rates. As time went on, however, outside competition regulated the supply and reduced rates to very reasonable terms, so much so that with the rising prices it is doubtful whether any contractors, who did not happen to secure any particularly remunerative jobs, made more than a permissible profit, and some, no doubt, lost on their transactions.

The following contractors, amongst many others, carried out works on a more or less extensive scale for P.W.D. :—

No.	Name of Contractor.	Resident of	Nature of Work Done.
1	Messrs. Jessop & Co. ..	Calcutta.	Construction and erection of iron work of Amphitheatre, Throne Pavilion, Power House, etc.
2	Messrs. Balmer Lawrie & Co.	Do.	Supply of roofing sheets, cement and steam lorry.
3	Messrs. Main & Co. ..	Do.	Structural iron work Royal Box at Review Ground and Office Shed.
4	Messrs. Bird & Co. ..	Do.	Supply of timber and matting.

No.	Name of Contractor.	Resident of	Nature of Work Done.
5	Messrs. Thomson & Co. ..	Calcutta.	Supply of miscellaneous hardware.
6	Asiatic Petroleum Co., Ltd.	Do.	Supply of crude oil for roads.
7	Shalimar Paint Co., Ltd. ..	Do.	Supply of Paint.
8	Lucknow Iron Works & Co.	Lucknow.	Do. Structural iron work for Market sheds.
9	Messrs. Burn & Co. ..	Raneegunj.	Supply of roofing tiles.
10	Perfect Pottery Co. ..	Jubbalpore.	Do. Fire bricks and clay.
11	Messrs. Fowler & Co. ..	Bombay.	Supply of steam road roller.
12	Messrs. Turner Hoare & Co.	Do.	Do. do.
13	Messrs. Muraglia & Co. ..	Do.	Supply of Marble.
14	Messrs. Richardson & Crudas	Do.	Estimates for sanitary disposal.
15	Messrs. Greaves, Cotton & Co.	Do.	Supply of Pumps.
16	Hill Forest Supply Co. ..	Cawnpore.	Do. Timber.
17	Empire Engineering Co. ..	Do.	Do. Water carts.
18	The Muir Mill Co. ..	Do.	Do. Shamianas.
19	R.S.S. Narain Singh. ..	Patiala.	Constructions of roads, Amphitheatre and Polo Grounds and other buildings, etc.
20	Messrs. Tansey & Co. ..	Do.	Miscellaneous iron work.

19. *Rates and Prices.*—But for the precaution taken to concentrate as much as possible all the collection of road materials in the hands of the central agency of the Superintendent, Durbar Works, there is no doubt that not only would the rates for "*kunkur*," "*bajri*," and stone ballast have risen to a fabulous height, and most inferior quality brought on to the market, but the supplies would never have reached the full amount of the demands, and it was only by very extensive dealings far afield, and the ready co-operation of the railway authorities, that the rates were regulated, a uniformly good quality supplied, and the indents complied with. As it was, with a central supply agency, there was an average rise in the rate of road materials of 25 per cent. only, and very superior materials were supplied, whereas in 1903, when camps were making their own arrangements independent of the Superintendent of Works, the rates for a most inferior class of materials rose nearly 200 per cent.

In the case of timber it was only towards the end of operations that the rates for planks and scantlings rose with the denuded stock of sleepers available locally and near by.

There was little or no fluctuation in iron work, as the requirements

in this line mostly came in from the seaports, and Delhi has in itself very large supplies and extensive dealings in iron of all sorts.

Camp commodities generally, such as tents, furniture, etc., did not come within the scope of Durbar Works, but here again, except that there was an all-round rise in the price of cotton at home and abroad which affected the Indian market as well, it is doubtful whether the demands on account of Durbar made much appreciable difference in the rates and supplies.

The following is a statement which gives a comparison of the rates and prices of labour and materials at normal before, and during the height of, the Durbar operations :—

Item No.	Name of Material or Labour.	Normal Rate before Durbar. Rs. A. P.	Per	Rate during Durbar. Rs. A. P.	Per	Remarks
	MATERIALS.					
1	1st class bricks at site ..	12 8 0	o/oo	16 0 0	o/oo	
2	Kunkar lime ,, ,, ..	25 0 0	%	28 0 0	%	
2A	Do. stone lime slaked at site	0 9 0	c. ft.	0 12 0	c. ft.	
3	Sand at site	4 0 0	%	6 0 0	%	
4	Bajri ,, ...	9 0 0	%	12 0 0	%	
5	Kunkar metal	11 0 0	%	13 0 0	%	
6	Stone metal 1½ in. at site..	7 0 0	%	10 0 0	%	
7	Do. 2½ in. Do. ..	6 0 0	%	8 0 0	%	
8	Chir wood	1 2 0	c. ft.	1 6 0	c. ft.	
9	Do. in 1-in. planks ..	1 3 0	c. ft.	1 8 0	c. ft.	
10	Iron work	10 0 0	md.	12 0 0	md.	
11	Brick Ballast 2 in. at site	10 0 0	%	14 0 0	%	
12	Surkhi, 1st class, screened	15 0 0	%	20 0 0	%	
13	Country tiles	4 0 0	%	6 0 0	%	
14	Ballies 4 to 6-in. diameter	0 0 9	r. ft.	0 1 0	r. ft.	
15	Grass for thatching ..	10 0 0	o/oo	13 0 0	o/oo	
						Poolas
	LABOUR.					
1	Beldars	0 6 0	diem	0 8 0	diem	
2	Coolies, male	0 5 0	,,	0 7 0	,,	
3	Coolies, female	0 3 6	,,	0 5 0	,,	
4	Carts	2 0 0	,,	3 0 0	,,	
5	Carpenters	1 0 0	,,	1 4 0	,,	
6	Blacksmiths	0 14 0	,,	1 4 0	,,	
7	Masons	0 12 0	,,	1 2 0	,,	
8	Bandhani	0 10 0	,,	0 13 0	,,	
9	Stone Cutters	0 12 0	,,	1 0 0	,,	
10	Iron Mistries	1 0 0	,,	1 8 0	,,	
11	Thatcher	0 10 0	,,	0 12 0	,,	
12	Painters	0 10 0	,,	0 14 0	,,	
13	Bullock pair with driver..	1 4 0	,,	1 12 0	,,	
14	Bhisti	0 6 0	,,	0 8 0	,,	

A NARRATIVE OF THE SEVERAL TRANSACTIONS OF THE FRENCH IN THEIR ATTACK OF FORT ST. GEORGE, AND OF THE GARRISON IN THE DEFENCE OF THAT PLACE. ANNO 1758 *AND* 1759.

(Continued).

1759. January 1st. Last night about 10 o'Clock came in 2 Deserters and informed us that Mr. Lally propos'd to usher in the New Year by a bombardment, however the Night and Morning pass'd without any fire but what was on our side. The Enemy having made large Detachments to oppose Usoff Cawn was the Reason I suppose of their working very little last night, for I cou'd not perceive in the morning any Material Alteration in their works to the North or West. Letters last night from Sadrass inform'd us that a Moors Vessell from the Nicobars to Porta Nova brought advice of 12 English Ships being at those Islands, and ready to sail for this place. The Ship which appd. in the offing was from Macao, had touch'd at Masulipatam where a Ship of ours (the Hardwicke) prevented her from selling any thing, so that she intends to break bulk at Nagapatam, and come up the Coast. Usoff Cawn we hear has left the Mount, and is gone to Trivambore about a league South of St. Thomé; and the French apprehensive of that Post have sent all their black Troops from Egmore, and a strong body of Europeans to support them. The working Party was 100 Europeans, 100 Sepoys and the same Cooleys and Lascars as mentioned yesterday. They were employed as before except in making Traverses before the Magazine Doors of the Nabobs Bastion.

2nd. Our Fire of Artillery and Mortars was last night very brisk, but to our surprize as soon as the light appeared the Enemy began to fire from four or five pieces of Cannon on the Western Battery (D)* and 1 Mortar, they also threw 12 Inch Shells from four or five large Mortars placed near the West End of their Battery (C) to the Northward. This early Salute some-what astonished us, but as we had 10 or 12 heavy Cannon which bore on the Enemys battery to the Westward, two of their Guns were soon knocked to Pieces and their Merlons so much damaged that they with drew their Guns before Eight o'Clock. From their Mortars they threw Shells till past 7 at night generally four in a flight which were in general aim'd at the Fort House, and so well thrown that 2 fell on the top, and pierc'd the first and second Roofs, many others fell within the square, and

* See Map issued with May No. *R.E.J.*

ruin'd some of the Rooms. Other houses were also much damaged, but what is remarkable is that not one European or Sepoy was wounded by Shot or Shell nor any other person hurt but a Dubash and Child or two. By Letters from Captain Preston, and five Deserters which came to us in the Evening we learnt that early in the Morning Monsr. Soupire Mgr. General who commanded at St. Thomé had marched a strong body and attack'd him, and Usoff Cawn who lay near Trevambore, in three Divisions. That the Enemy had put our first Division in some disorder taken their 2 Guns and some Prisoners, but that the broken Troops having join'd the second Division fell on the Enemy in Turn and put them to flight killing about 50 Europeans on the spot with two Officers, and if we may believe the Deserters, the Troop of Mr. Aumont was very roughly handled, a Troop of Hussars cut to pieces, and three Companys of Grenadiers greatly disorder'd. Our Guns and Prisoners were retaken. It was to favour this attack of Monsr. Soupiré's that the Enemy begun their fire earlier by some Days than they wou'd otherwise have done, to with draw our Attention from what pass'd to the Southward. We had advice to day that Monsr. La Tour under Pretence of a visit in marching from Pondichery this Way had siez'd on Sadrass, and put a Garrison therein, and that Mr. Lally had given orders for the same finesse to be practised on Pulli-cat. His designs on these Places was the reason we suppose that in a Passport granted some of our Ladys he excepted their going to Pulliacat or Sadrass. However three Boats with several Ladys in them were sent off to Sadrass without Passports before this news arriv'd, so that we fear they will all be siez'd.

3rd. Last night we threw many Shells and fired some Shot at the Enemys works, but they fired neither after Eight oClock. In the morning we observed they had closed up the Embrasures of their Western Battery which was much disorder'd by our Cannon. They had also added something in height and thickness to their Northern Battery, but fired not from either, Cannon or Mortars. We observed this Day about 60 or 70 European Horse returning in a straggling Manner from the Southward towards the black Town, and among them 30 or 40 led horses which we imagine lost their Riders in the Action yesterday against Usoff Cawn. In the evening a small Vessell appeared to the Northward for which we hung out Lights at the Flag staff. The working Party was 100 Men and about 200 Sepoys, who were employed in finishing the work across the Gut to the Northward in making Traverses before the Doors of the Nabobs Bastion, and across the streets leading to the South Curtain where the Guards are in future to parade.

4th. Our Artillery and Mortars kept a brisk fire last night on the Enemys Batterys, but neither Shell nor Shot was returned from them. However in the morning I observed they had opened the

Epaulment of their Northern Battery and let in Fascines for the Facing of the Embrasures; they also had repaired part of the Western Battery, and show'd two Guns in the Morning but on our firing a few Shot they were with drawn, and the Embrasures choaked with fascines. The Vessell which appeared last night was not to be seen in the Morning. Yesterday I drew out the following Instructions for my Assistants, dividing them into two reliefs, and this morning Mr. Leigh and Cotsford went on Duty to be relieved by Lieut. Eiser and Stevenson to morrow. The working Party was 100 Men and 250 Sepoys employed as yesterday. Enter the Instructions at length.

5th. Our Artillery and Mortars fired pretty briskly last night on the Enemys Batterys, but they neither fired Shot, nor Shell in the night, or to Day. They were not idle however but finished the facing and almost opened 7 Embrasures on their Northern Battery where I perceived 3 Guns in the Evening, and in the morning 3 in the West Battery which were soon masked or removed. On the whole there is great reason to believe the Enemy will open their Batterys on us to morrow morning, at least nothing but the want of Ammunition seems to hinder it. Unless we are lucky enough with our Shells to destroy some of their Guns and Platforms in the night, by an explosion or two which we perceived in the Day there is reason to believe some Ammunition or shells were blown up by our Shells. To day I again proposed (for I had done it before) erecting a Battery behind the covered Way in the Saliant Place of Arms before the Demi Bastion, and at last had permission about 6 in the Evening and a Working Party of 100 fresh men, which I immediately set to work under Lieut. Eiser and Stevenson. This Battery of at least 5 Guns I thought absolutely necessary to render our fire equal to the Enemys; for their Battery of 7 or 8 Guns fronts directly the face of the old North East Bastion and will fire on the North face of the Demi obliquely. To oppose this fire we have only three Guns on the North East Bastion which bear direct, 2 in the North Ravelin fire in an oblique Line and 3 or 4 from the Royal Bastion which also fire oblique and therefore have no great Chance of ruining the Enemys Guns. Now the new Battery I propose will be a direct grazing fire, and can neither be infiladed, nor beaten down because the Glacis is the Parapet, and the Embrasures will be cut thro' it. In the morning a small Sloop or Boat which the Enemy had stopp'd fell down to St. Thomé and about 5 in the Evening sail'd to the Southward with 17 Boats which arrived from the Southward just before. The working Party was 100 men beside 200 Sepoys employ'd as before.

6th. Our fire from the Cannon and Mortars was not last night very brisk. The Enemy in the morning as soon as they cou'd well see threw five Shells into the Town as a signal for their other

Batterys to begin, And about seven began to fire from 6 Guns and as many Mortars from their North Battery (B), and from their West Battery (D) with three Guns pointed on Pigots Bastion (g) and 4 (E) with an Howitz firing on the flank of the Demy Bastion and infilading the covered Way before the North face of the Royal Bastion. From these Batterys they continu'd to fire till about five in the Evening, and threw near 150 Shells besides Shot chiefly into and over the Town. The Damage done the Works is very trifling, but the houses in the Town where Shells or Shot fell have suffered much. Our fire of Artillery and Mortars was much superior to the Enemys, and to appearance greatly disordered their Merlons. We also learn by a Deserter from the Enemys Artillery that our Shells dismounted one of their Mortars, and killed three Men in the North Battery. The working Party was 100 Men, and chiefly employed in forwarding the Battery in the North East Angle. As to Sipoys or blacks we had little or no work from them.

7th. Last night the Enemy threw but few Shells and we only a Shot or Shell now and then. About 4 in the Morning we were surpriz'd with the Arrival of three Boats with a french man in each. They were the boats which had been sent the 3rd Instant with the Ladys to Sadrass. The French having Seiz'd that place also seiz'd the Boats, and loading them with 150 Shot of 24 prs. 1000 Empty Cartridges, 50 steel Caps, 50 Barrels of Powder and 1500 Sand Bags, sent them back with a Soldier in each to the black Town. The Boat fellows towards the morning being opposite Madrass seiz'd the Arms of the Sleeping Soldiers, pour'd water on the Locks, then tied the Men and landed the Boats at our Sea Gate. This Action of the boat fellows is well worth recording, and will be perpetuated if Madrass is sav'd as long as they live by some Reward to them and their familys; the value of the things has also been paid them. The Enemys Fire was very brisk till five in the Evening from their Cannon and Mortars; and then they ceas'd from both In order I suppose to repair their works. Our Works tho' not much damaged bear however a rough aspect, and the Demi Bastion as well as Pigots is stuck pretty full of Shot. The Shells the Enemy threw, have greatly damaged the houses in Town but have not hurt many people, three Europeans only being killed this Day. Our working party cou'd do nothing in the Day; a few indeed attempted to work in the N. East Saliant Angle of the covered Way but the Enemy having discovered them fired so briskly that Mr. Stevenson who directed them was knock'd down by the Wind of a Shot, but only slightly hurt on the Cheek, so the party return'd. In the Afternoon we were disagreeably alarm'd by a report from the Steeple of 12 Sail being in Sight to the Northward, which soon vanish'd to Catamarans, and then to nothing. The Enemy opened a new Battery of two Guns near the burying Ground (F).

8th. As I found the Soldiers unus'd to such Duty were in general extremely aukward in repairing the damaged Works I conceived that the Service wou'd be much better carried on by appointing a Pionier Company, composed of Volunteers drawn from the several Corps, and to do no other Duty but repair the Works. So that by constantly employing the same people they might more readily execute the service they were set about. I accordingly made application to the Governour, and the thing was granted. The Company to consist of 2 Officers Lieut. Meyers, and Ensign West, 6 Serjeants, 6 Corporals, and 88 privates. Two Companys of Sepoys were also form'd with proper officers on the same Plan. The Working Party was this Evening 100 Soldiers and as many Sepoys employed in repairing the Embrasures, Platforms, and forwarding the Battery in the covered Way before the Demy-Bastion.

9th. This Morning the Enemy opened 2 Embrasures more from their Battery near the burying Ground and some Earth appeared to be cast up near a little upper room house beyond the Pettah Bridge (h). In the night they threw a good many Shot and Shells after Eleven o'Clock. During the Day their fire was very brisk from their Cannon, but many Shells were not thrown by them. Ten Grenadiers were posted in the N. East Angle of the covered Way to fire into the Enemys Embrasures, and 2 Twelve pounders were fired from the new Battery. The working Party of 100 Men and 100 Sepoys with 6 Artificers were employed in repairing the Embrasures, Platforms and other Damages done the several Works. Also in cutting up a damaged Stone Platform on the old North East bastion, and laying one of wood. A blind of 12 feet thick and seven feet and half high was begun 35 feet behind the flank of the Demy Bastion to cover the people on that Work from the Enemys shot which might come in at the Embrasures of the flank or en ricochet over it. The Merlon next the Shoulder was rose for the same purpose. In the Evening two Sail appeared to the Southward, and anchored near St. Thomé, with white Colors being both of them Ships.

10th. Last night the Enemy threw very few Shells and fired not many Shot. On our side we were almost as silent. The two Ships which appear'd to the Southward still remain at an anchor near St. Thome, and as far as we can discover are french Ships from Pondichery. Our Working party was last night 100 Pioniers, and 60 Grenadiers, besides 160 Sepoys. They were employed in compleating the covered Way Battery to four Pieces of Cannon which were mounted before Morning: In filling Bags of Earth at the foot of the Demi bastion, and clearing what the Enemy had beat down. In repairing the Parapets of the Demy, N. East, Royal, and Pigots Bastions and laying two wooden Platforms on the first Bastion in the room of two Stones ones damaged. In the night the Enemy carryed on part of a Zig Zag about 100 feet long nearly westward

from their northern Battery (k.l.), and taking a turn carryed another 200 feet long back towards the Sea Side as marked in the Plan (m.n.). They also drew part of a trench (L) from the little house in the Pettah towards the Bridge, and repaired their Shattered Merlons with Sand bags.

11th. Last Night the Enemy were almost wholly silent with their Artillery and Mortars, but were not idle with their Shovels for in the morning we discovered that they had deepen'd their Zig Zags begun the preceeding night to the Northward and Lengthened that which stretched towards the Sea almost to the Beach (o). They had also drawn their Trench from the little house quite to the Pettah Bridge, and opened a Battery of two Guns from the Cook room of the new hospital (G) which fired on the N. West Curtain, and the blind before the Mint Sally port, but I suppose were intended to plunge into the Royal Bastion, and batter the East flank in Reverse. Our Working Party was 90 Men of the Pionier Company and 60 Voluntiers Grenadiers besides 160 Sepoys employed in repairing the damaged Merlons and Platforms of the North front, dismounting some disabled Guns, and making blinds before the Doors and windows of the Arched hospital under the old West Curtain. Also in filling Sand Bags at the foot of the Demi-Bastion, and clearing the Earth beat down. This Afternoon I examined the Works as to their State, and observed that the Parapets of the North face of the Demi Bastion are a good deal shattered, that the brick Parapet of the North face of the old N. East Bastion is wholly ruin'd, but the wall being well covered by the blind of Gabions made before it is not much hurt. The West face of the Royal Bastion is but little hurt below the Cordon. And the right hand face of Pigots Bastion being built to a great slope the Enemys fire has had no other Effect than beating the Earth to its natural Slope which is from the extremity of the berm to the top of the Parapet. The old Curtain Wall to the Northward is a good deal shattered about the Parapets, and most of the Pallisadoes of the Caponniere broke by the plunging Shot from the Enemy West Battery.

12th. The Enemy having yesterday brought a field piece or two near the Barr (12) and fired a few Shot on the people and Bullocks which had taken Shelter to the Southward of the Fort; and there appearing to be a breast work and Guard of the Enemy near the sea side it was determined to attack that Post early this morning; accordingly as soon as the moon was gone down the 2d Battalion Grenadiers under Captain Campbell and near 100 Men more with 300 Sepoys all under Major Brereton marched by the Sea Side to the barr, and there received the fire of the Enemys advanced post by which we lost 1 killed and two Wounded of the Grenadiers. Our people without firing marched on to the Governors Garden house, (13) and in a small Lane or street on the South side of it found the

Enemy drawn up with 2 small field pieces and about 50 men. The Enemy fired two discharges of Grape on our party within 50 paces, but the Gunners being killed they made no other use of their Guns. On the contrary the Picquet broke and ran each his own way. The Guns were taken and brought in, 1 Officer and 6 Men were also taken Prisoners; and about 10 or 15 killed or left wounded on the Spot. On our side we had one killed, 1 Officer (Lt. Robson of the Grenadiers) mortally wounded, and 9 Men. This little affair has doubtless given our people great spirits, and damp'd those of the Enemy. A Party with an officer was also sent out in the night at St. Georges Gate which advanced on the bridge leading to the Pettah, and fired into the Enemys Trench but cou'd not perceive any people at work. About 7 in the Evening a party of the Enemy advanced towards our N. East Saliant Angle of the covered way and gave a fire thereon. In the night also a party of our men with an officer was sent out to disturb the workmen of the Enemys Zig Zags to the Northward who advanced to their work, fired on and killed their Centinel and took a stand or two of Arms without any loss. The Fire of the Enemys Cannon was pretty brisk yesterday but they threw very few Shells, and those not large. I cou'd not perceive that they had done much to their approaches last night, but the Merlons of their Batterys seem'd to be tolerably well repaired with sand bags. The working Party was the Pionier Company and about 170 Sepoys who were employed in making a Traverse on the North face of the Demi-bastion; carrying off the Earth at the foot of it; fetching Pallisadoes to set up in the dry ditch before the North face; and repairing the Damaged Platforms and Parapets. On the Royal Bastion, Old N. East, and covered way Battery the Parapets Platform and Embrasures were repaired.

13th. Last night about 7 o'Clock the Enemy advanced pretty near the covered Way on the N. East, and gave a fire of Musquetry on our people there at work. They also fired in the night from their approaches on a small party of ours posted on the Saliant Angle under cover of a boat, and wounded three Men. From the covered Way and North Lunette we cou'd plainly perceive the Enemy at work near the sea side, which we endeavord to prevent by frequent discharges of Grape, Musquetry, and Shells. Our Working party was 78 men of the Pionier Company, and 180 Sepoys who were chiefly employed in removing the Earth at the foot of the Demi Bastion, and the Rubbish before the old N. East, which works I was determined to repair, and secure as much as possible since the Enemy seem'd to bend most of their fire against those Works, and direct their attack that Way. I therefore rais'd and thickened the blind before the North East Bastion whose Parapet was much Shattered, and begun a Pallisadoe at the foot of the Demi Bastion 6 feet within the Cuvette which I propose to carry quite round the flank and

North face. I also propose another between the blind and North face of the old N. East Bastion. The Enemy in the night had covered the Head of their Zig Zag near the Sea by a small return or Crochet (o.p.) beginning near the beach and stretching Westward parellel to the North front. To the Westward the Enemy fired with four Guns from the new Hospital but did nothing to their Trench near the Pettah bridge. Their Sepoys to the Southward of the Barr were at work all Day in raising a breast work for their defence in Case we shou'd make another attempt on that side.

14th. Last night as we imagined the Enemy wou'd be at work again at the crochet before their Zig Zag we began a pretty smart fire of Musquetry from our covered Way, and frequently gave them discharges of Grape from the North Lunette, and covered way Battery. From the Royal and Demi Bastions we threw small and large Shells into their approaches and Batterys, so that they were prevented from doing much Work. By the morning however they had run on their return about 20 Yards, and compleated what they had roughly traced the night before. Our working Party besides 75 Men of the Pionier Company was assisted by 120 Men out of the two Battalions and 170 Sepoys. The Earth near the Shoulder of the Demi Bastion having form'd an ascent almost practicable about 100 Europeans and as many Sepoys were set to carry it off in baskets or sand Bags to repair the Parapets of the bastion above. The Pallisadoe begun at the foot of the Bastion was continued near 100 feet more. The Parapet of the North East Bastion being quite destroy'd, and that work being of the greatest Consequence to be kept in good repair about 160 Europeans, and the rest of the Sepoys under Mr. Stevenson were set to clear away the ruin'd Parapets, and erect others with Sand Bags, Gabions and Fascines, two Merlons of which were finished before the Morning. An old Sally port in the East Curtain near the South flank of the old North East Bastion was opened for the more ready communication with the N. East part of the covered Way, and a Door placed in it.

15th. Last night a brisk fire of Musquetry, Cannon and Mortars was kept up from our covered Way, and the Works of the North front on the Enemys Approaches, and prevented them from doing more than lengthening their Crochet a little, and opening it in the middle (9) from whence they placed 15 or 20 Gabions in an oblique direction towards the Sea Side. Our working party consisted of the Pionier Company, the 1st Company of Grenadiers, and 90 men of the two Battalions, besides 2 Company of Sepoys. They were employed in finishing the Parapet of the old N. East Bastion which was put in very good Condition and three Guns mounted thereon ; In clearing the Earth from the face of the Demi-bastion, repairing the Parapet, and fixing Pallisadoes at the foot of it. On the Royal Bastion a blind was begun to cover the three Guns in the East Flank next the

Curtain from the fire of the Enemys Battery near the new Hospital which takes it in Reverse. The Embrasures of St. Georges and the N. West Lunette being much out of repair a party of 20 Men, and a Serjeant, was sent to repair them. The fire of the Enemys Cannon was this Day very brisk, and their North Battery was augmented to 10 pieces of Cannon with which they fired in Salvo's on the old N. East Bastion, and soon dismounted 2 of the three Guns.

16th. Last night a Picquet of the Enemys advanced to the Boat and drove an advanced party of ours from thence. The fire of Musquetry from the covered way, and the Cannon and Mortars from the bastions, and North Lunette, was well kept up on the Enemys approaches. They in return threw a few Shells and fired a few Shot into the Town and Works, by which one of the working party was wounded. From the Method of the Enemys carrying on their approaches, their Numbers, and our expectation, there is room to believe some sudden attempt will be made on Madrass, and that by the Sea side, and on the N. East Angle of the covered way. To prevent such a stroke as much as lay in our Power it was proposed to carry a breast work from the covered Way on a square with the Angle of the Demi Bastion quite across the Glacis down to the surf, but on examining the Ground, it appeared that such a breast work woud prove more prejudicial than useful by intercepting the fire of the Fascine Battery, and was therefore laid aside. Our working Party of 64 Pioniers, 60 Grenadiers of the 2d Battalion and 130 Sipoys were employed in repairing the Parapet of the old N. East Bastion, which was again compleated for three Guns. In repairing and covering by some Gabions the Pallisadoe before the Fascine Battery near the Sea. In clearing the Earth from the foot of the Demi-bastion, and therewith thickening the blind before the old North East. Repairing the Parapets and Embrasures above, and carrying the Pallisadoe below. This Day the Enemy threw a great many Shells into the Town particularly the North End, and killed or wounded us more men than in any preceeding one, among the rest 2 of the Pionier Company were killed at their Barrack Door, and most of the others were also off Duty. The Enemy last night had augmented their North Battery to 12 Embrasures, and fired from thence very briskly on the old N. East and Demi bastion. They also filled the Gabions they had left empty the night before, and advanced their Work in the same Direction about 20 Yards (r). About 10 in the morning a Snow appeared to the N. East and anchored, on which the French Frigate chas'd, and all their Ships threw out English Colors.

17th. Last night an incessant fire was kept up with Musquetry from the covered Way; and about 12 o'Clock an officer with 12 Men was sent out to fall on the Enemys workmen which he fired on several Times but a large body advancing he was killed himself,

and 3 of his men wounded. Notwithstanding the Interruption we gave them, the Enemy carried on the remaining part of their Zig Zag to (s), and covered it by a Crochet or Boyau (t). Our working party was 76 of the Pionier Company, the first Company of Grenadiers, and 24 Serjeants and Corporals off duty, besides 130 Sepoys. They were employed in repairing the Parapet of the old N. East Bastion which was put in order, and a Platform Lengthened for three Guns, the same Number as at first. The Blind below was thickened, and the Rampart of it enlarged. The covered Way Battery being deem'd no longer useful the Guns were drawn off in the afternoon, and the Platforms taken up. In the night we closed the Embrasures and lowered the Merlons into a regular Slope. Many of the Pallisadoes which were fixed in the dry ditch having been destroyed by the Enemys shot and Shells were replaced, and others fixed round the flank of the Demi bastion. The Embrasures of the Demi-bastion next the Saliant Angle were filled up, the Merlons of the 3 Embrasures next the Shoulder were repaired, and the Parapet strengthened. The Earth at the foot of the face was entirely carryed away.

18th. Last night the Enemy brought two Guns down to the Barr and fired a few shot at some Sepoys of ours posted on the opposite Side. Yesterday and this night the Enemy threw a great many Shells into the Town and some into the Works which did us more damage than any they threw before. The Enemy yesterday in the Afternoon worked at thickening the sand bank to the right of their battery close to the Sea, and this morning they opened three Embrasures thro' it, which in the afternoon fired on the N. East face of the North Lunette, so that their North Battery now consists of 15 Embrasures the Enemy extended their Parallel or Crochet (t) at the foot of the Glacis westward about 15 Yards but in a rough unfinished manner as indeed their whole work appears to be. Our working Party last night consisted of 76 Pioniers, the 2d Company of Grenadiers, and 130 Sepoys who were employed in clearing the Earth at the foot the Demi-Bastion, finishing the Pallisadoes in the dry Ditch, Levelling the Earth in the N. East Angle of the covered Way, raising, and thickening the blind before the old N. East Bastion, and giving the Parapets of that bastion an entire repair. To Day the Enemy fired not from their battery near the old hospital, and the Embrasures appeared clos'd up.

19th. Notwithstanding the fire which we kept up last night from our Musquetry, Cannon, and Mortars, the Enemy advanced by a third Zig Zag (v) across the Saliant Angle of the Glacis. In the forenoon the Enemy fired pretty Smartly from their Musquetry behind their first Crochet. They also brought two heavy Guns (O) to the South of the Barr, and threw some Shott into the Town. Our working party last night was 1 Officer, 3 Serjeants, and 56

Pioniers, the first Company of Grenadiers, and 32 Serjeants, and Corporals who were employed in Levelling the Earth rais'd for the Guns in the N. East Angle of the covered Way; clearing the Earth from the foot of the Demi Bastion; carrying a Pallisadoe across the dry Ditch before the East Wing; thickening and raising the blind; and repairing the Embrasures of the North East Bastion. The Enemy Shells this Day set fire to the Sorting Godown, to a Godown in Gloucester Lane, and to some *Salt Petre in Middle Gate Street, so that the Town was on fire in three places at once, and the fire suffered to burn out.

20th. Last night the Enemy threw very few Shells, or Shott into the Works, or Town; nor did they advance their Works more than by producing the 3d Zig Zag from the ridge of the Glacis obliquely to the Sea Side where they crown'd it by a small return of 4 or 5 Gabions. In the afternoon I observed a few Europeans working at a barbet Parapet (O) near the fishers Huts to the Southward of the Bar where the Enemy had brought two large Cannon, or 1 Cannon and 1 Mortar, for such they appeared to me. Our working Party was the Pionier Company and 120 Sepoys employed in the same Manner as yesterday except driving rows of Pickets in Front of the Fascine Battery, and making a breast work before the Pallisadoe which seperate the Demi-Bastion from the 2d Curtain.

21st. Last night the Enemy threw few, or no Shells, and fired less than in any night of the Siege, nor did they make any apparent approach in their Works. They thicken'd their 2d Zig Zag, and crochet, and laid some sand Bags for their Musquetry. Our Working Party consisted of the Pionier Company, and 120 Sepoys who were employed in repairing the Parapets, and Embrasures of the old N. East Bastion, in finishing the blind for Musquetry; in clearing the face of the Demi Bastion; and driving Pickets in the front of, and laying Fascines on the Fascine Battery; repairing the Parapet and Embrasures of the left face of the North Ravelin; and in clearing the Sea Gate of Rubbish, and making a traverse before the Gate of the Redout. The Enemys Batterys were this Day very silent, but they fired pretty briskly from their Trenches on such of our people as appeared at the Embrasures, or over the Parapets. The Enemys Method of proceeding by simple Sap in so confined, and unsupported a manner as their approaches are form'd giving great room to believe a Sally might easily drive them from their Works, and over sett some of the Gabions, it was determin'd to send out thirty soldiers, and 40 Pioniers to try what cou'd be done. A little past 5 in the

* Many Godowns were burnt during the Siege, and parcells of Salt Petre which we suppos'd not inflammable took fire, and raged with the greatest fury, being fed by the Bags and other inflammable substances.

Evening 10 Men and a Serjeant went out by the sea side, and an officer with 20 Men went out by the Barrier in the N. East Angle of the covered Way. An Engineer with the Captain of Pioniers, and 40 Men followed. The Soldiers were to possess the Enemys 2d Crochet, and cover the Pioniers while they destroyed the Lodgement forming on the Ridge of the Glacis. Every thing succeeded as we cou'd wish ; the Enemy ran out of their Sap in an Instant, and our Pioniers for about 8 Minutes worked hard at distroying Gabions, and such things as they found. The Enemy then began to collect in their first Crochet and a Signal was made for the return of our Party. We lost 2 Serjeants killed, and 3 or 4 Pioniers wounded, what the Enemy (who had mostly Sepoys in their Works) lost we cant guess, but as our Cannon, Mortars, and small Arms play'd briskly on them before, and after the Sally, they no doubt must have suffered. It was apprehended they were carrying a Gallery under the Glacis in order to open the covered way by a Mine but nothing of that kind was discovered.

22nd. Last night the Enemy did not advance their approaches but worked at thickening their 2d Crochet, third Zig Zag and raising the head of their Sap (w) on the ridge of the Glacis. They fired few Shells, and those chiefly into the Works. During the Day the Enemy fired very few Cannon particularly from their Northern Battery where most of the Embrasures seem to blinded. Our Pionier Company having been out on the Sally we cou'd only get a Serjeant and 12 Men to work in the night who were employed in repairing the Parapets of the old N. East Bastion, and 100 Sepoys who work'd at a Traverse before the Pallisadoe which serves as a Barrier between the Royal Bastion, and low Curtain. They also carried Pallisadoes down to the Fascine Battery, and did several other trifling Jobbs.

23rd. Last night a brisk fire of Musquetry was kept up on the Enemys approaches, however they advanced a few Gabions on the Glacis (x) almost Parrallel to the East face of the covered Way, and they opened a Battery (H) of four Embrasures in their 3d Zig Zag with an intent to fire on the right face of the North Ravelin, but it did not answer their expectations in bearing well on that Work. Our working Party of 63 Pioniers and 100 Sepoys were employed in repairing the North East Bastion, in making a Traverse before the Gate leading into the Caponniere from the low Curtain, another before each of the Gates which close the Communication to the Royal and Demi Bastions. Also in filling Sand Bags in the North East Angle of the covered Way, and carrying them to the several Works. Two Embrasures were repaired, and 1 Platform on the Demi-Bastion. And one Platform on the North Ravelin.

24th. Last night the Enemy attempted to push their Gabions close to our covered Way, but some of our men posted there over-

sett many which roll'd into the Sea, and pull'd others in between the Pallisadoe. A smart fire of Musquetry commenced on this occasion and continued two or three hours in which we lost 10 or 12 Men killed, or wounded. From the North East bastion, and Fascine Battery, the field pieces fired Grape in such plenty that 70 discharges were made out of one Gun. The Enemys Loss from such a fire must doubtless have been great, and their work appeared this Morning rough and in-compleat. Our working party was 60 Pioniers, and 100 Sepoys, who were employed in repairing the old North East Bastion, in repairing the Embrasures of the North Ravelin, and making a blind behind the flank of the Royal Bastion; but the Pioniers being sent for to go, and over sett the Enemys Gabions little work was done. We lost of that party 1 killed and 2 wounded.

25th. Last night the Enemy push'd on their approaches in a Line Parallel to the East face of the covered Way as far as the Palmeira Pallisadoe (y), which runs quite into the Sea, parallel to which they made a Return. In the night a small party of our Pioniers went, and pulled several of the Enemys Gabions into the covered Way, and a small party of Grenadiers alarm'd them in their Trenches. Our Working Party consisted of 53 Pioniers, and 100 Sepoys, who were employed in repairing the Embrasures of the old N. East Bastion, in repairing the Parapets and Embrasures of the North Ravelin; filling in the Shell holes in the Caponniere, and making a Banquet behind the Traverse Leading to it. About 2 oClock in the Afternoon it was determined to make a Sally with 20 Men of the Guard behind the blind and 20 of the Pionier Company with an intent to destroy the work the Enemy had done the Preceeding night. They accordingly went out, and drove the Enemy from their approach behind the Stockadoe, and our Pioniers endevored to demolish their Work by oversetting the Gabions and throwing the tools they found into the Sea, or our covered Way. After maintaining their Ground near 15 Minutes the Enemy begun to grow very numerous in their Crochet on the ridge of the Glacis, on which our people were ordered to retire. We had Captain Black who commanded the 20 Men wounded thro' the leg, and Lieutenant Fitzpatrick of the Grenadiers (of whom 20 went out during the Sally) thro' both his Arms, 2 or 3 Men and 1 Serjeant killed. The Enemy must have suffered considerably from our fire which was kept up very briskly from the Works above an hour.

26th. Last night the Enemy push'd on their approaches in a Line almost Parallel to the North face of the covered Way before the Demi-bastion, and made a return (z) at the End of it to cover their flank so that by the Work of this and the preceeding Night they wholly embraced the Saliant Angle of our covered Way, and consequently made it too hazardous for us to keep Troops therein. Our working Party last night consisted of 53 Pioniers, and 88 Sepoys,

who were employed in repairing the North East Bastion ; the Parapet and Embrasures ; in repairing the Embrasures and Parapets of the Fascine Battery ; and lengthening it towards the Sea ; and at the Sea Gate Redout in shutting up the great Gate which was damaged and very difficult to pass by the falling of the Virando ; and opening the small Gate on the South side. Also in clearing the rubbish from the North Flank of the Battery, and filling the Gabions placed on the face. To Day the Enemy fired most of their Shott from their several Batterys into the Town, but threw their Shells chiefly towards the Works on the North Front.

27th. The Enemy last night did nothing but widen, and raise the Work of the preceeding night, which we in some degree impute to the Detachments they made to oppose Usoff Cawn and Capt. Preston who we heard were at Ponamallé. Our Working Party consisted of 47 Pioniers, and 90 Sepoys, who were employed in repairing the North East Bastion ; in repairing the Embrasures of the Flank of the Royal Bastion ; and in repairing the Parapet, and Embrasures of the North East Lunette. They also worked during the Day at the Sea Gate Redout when the North Flank was entirely repaired, and embrasures form'd for four Guns. In the Afternoon Usoff Cawn's Signal of great smoke was seen west of Egmore, and an Hircar came in with a Report that the French had been beaten by our Troops.

28th. The Enemy did not Last night to appearance work much at their approaches, owing I suppose to the extraordinary Guards they were obliged to keep on Account of Usoff Cawn whose Horse were yesterday very near Egmore. This morning the French black Horse, Foot, and their European Cavalry were drawn up in a Line between Egmore and Captain Maskelynes Gardens, and by their motions to the right, and left, we expected that Usoff Cawn was near them especially as several smokes were seen that way, however nothing appeared. In the forenoon we observed that the Enemy with several Yoke of Oxen intended to draw off the Guns they had to the Southwd. of the Bar but on our firing a few Shot the bullock drivers, and Bullocks disappeared. The Enemy having now surrounded our N. East Salliant Angle, and probably intending to make a Battery on the Glacis, it was determined to try last night if we cou'd push a Mine from the Counterscarp that way. An Engineer and 8 Men were accordingly set to open an arch which had been turn'd in the Counterscarp for that purpose. The rest of the working Party being 32 Pioniers and 80 Sepoys were employed in repairing the Parapet and Embrasures of the right face of the North Lunette, and making a Ditch before the South Flank of the Sea Gate Battery in which a Pallisadoe was fixed.

29th. Last night the Enemy drew off one of their Guns to the Southward, but we cou'd not perceive that they had worked anything

at their approaches 'till after 2 oClock in the afternoon when they were discovered throwing up Earth thro' a Small hole just within the Banquet in the covered Way opposite the Stockadoe (y) which was place on the Eastern Glacis. Thro' this I imagine they were working by covered Sap with an intent to open the Counterscarp under cover of the Saliant Angle of the Demi Bastion where they cou'd not be seen from the flank of the Royal, but having come too near the Surface the Earth fell in and they were discovered.* Some Grenadiers were immediately sent out to fire into the hole, and throw Grenades which they did, and thereby stopt the Enemys working. Our working Party was last night 37 Pioniers and 60 Sepoys who were employed in carrying on the Gallery, and in raising the right side of the Caponniere to cover our people passing, and repassing to the North Ravelin. Twelve Men and a Serjeant with some Boatmen worked in the Day at the Sea Gate in raising the South Flank of the Battery, and filling up the useless Embrasures.

30th. The Enemy were last night quite Silent in their Trenches but threw plenty of Shells into the Town, and at the North Ravelin. By their silence and other appearances we concluded they were making a Battery some where on the face of the covered Way, or carrying on a Gallery towards the blind. Our working Party consisted of 45 Pioniers, and about 75 Sipoys who were employed in pushing on the Mine, compleating the right side of the Caponniere, and in repairing the Parapet, and Embrasures of the right face of the North Ravelin. A Sail which had been in sight to the Southward all Day came into the road towards the Evening under English Colors, and proved to be the Shaftsbury from Bombay, having been left by the other 4 India men and 2 Twenty Gun ships which came as a Convoy the 7th Instant off Zeilon, and expected to have found them here. This Ship being the worst Sailor had been made an Hospital Ship and therefore brought us no men but what were sick, and added to our distress for room.

31st. The French Frigate last night came near and recd. a broadside from the Shaftsbury and then sail'd to the Southward, and to Day in the Afternoon returned into the road again. A little before her return several Boats were seen going with Men to the Haarlem a Dutch Indiaman siezed by the French; which Ship immediately weigh'd and stood towards the Shaftsbury, who slipp'd her Cable and stood quite under our Guns. The Haarlem fired several Shot at our Ship, and followed her so close that we tryed to reach her with the Guns from the Sea Line but she was at too great a range to fire with any certainty. The Enemy from their Battery of Two Guns to the Southward (O) and one from the

* We have learnt since that an Engr. and four miners were stifled by the falling of the earth.

Northward (H) Struck the Shaftsbury several Times, but night coming on saved her from the Damage she must otherwise have received. Early in the Morning the Enemy opened four Embrasures on the North face of the covered Way before the Demi Bastion, and begun to fire with three Guns, but the Earth in the Cells of their Embrasures was so high and the Battery so ill constructed that after firing Twenty or thirty Shot, none of which came within several Feet of the Top of our Parapets, the Battery was silent, not only from its inutility but I imagine some of the Guns were dismounted by the fire from our N. East Bastion. The Working Party last night was 48 Pioniers, 12 of which were employed in pushing on the Mine, the rest in clearing the Earth from the Demi-bastion and repairing the Fascine Battery. It being also imagined that the Enemy were pushing on a Gallery behind the Counterscarp under the narrow covered Way to the Eastward with an intent to destroy our blind or blow up the covered Way, it was determined to open another Gallery from the covered passage under the blind, and carry it on to meet the Enemy in case they shoud advance that Way.

(To be continued).

SIEGES AND THE DEFENCE OF FORTIFIED PLACES BY THE BRITISH AND INDIAN ARMIES IN THE XIXth CENTURY.

(Continued).

By COLONEL SIR EDWARD T. THACKERAY, V.C., K.C.B. (LATE R.E.).

FIRST AND SECOND SIEGES OF BADAJOZ.

The retreat of the army under Marshal Massena having virtually freed Portugal from the French, Wellington began to contemplate extensive and decisive operations in Spain. Before being able to carry these out, however, it was necessary for him to recapture Almeida and Badajoz, which had been taken by Marshal Soult whilst the Allies were still occupied with the defence of Lisbon. As soon therefore as Massena had crossed the frontier Wellington invested Almeida and after the defeat of the French at Fuentes d'Onor its retention by them was rendered practically hopeless. Unfortunately the carelessness of some of the subordinate generals allowed General Brennier, the Governor, to escape in safety with the garrison after he had successfully ruined the fortifications, but its fall allowed Wellington to turn his whole attention to Badajoz. He soon realized that, although its capture would tend greatly to the security of the Portuguese provinces on the left of the Tagus, it would not enable him by any direct operations to weaken the strong hold the French had obtained on the south of Spain. He rather proposed, if Badajoz should fall, to attack Ciudad Rodrigo, and thus render secure the Beira and the northern districts of Portugal.

Sir John Jones in his *Sieges in Spain* describes the fortress of Badajoz as follows:—"Badajoz is a large fortified town situated on the left bank of the Guadiana; which river is there from 300 to 500 yards broad and washes about one-fourth of the enceinte of the place, rendering it nearly inattackable; the defences to the land consist of eight large well-built regular fronts, with a good covered way and glacis, but the ravelins unfinished. The fronts have whole revetments, and the escarp of the bastions exceeds 30 ft. in height, that of the curtains being much lower: in advance of these fronts are two detached works; one called the Pardaleras, at 200 yards distant, is a crown work; its escarps are low, its ditches narrow, and its rear badly closed; the other, called the Picurina, is a strong redoubt at 400 yards in advance of the town. On the N.E. at the angle formed by the junction of the river Rivillas with the Guadiana,

rises a hill to the height of 120 ft., the summit of which is crowned by an old castle, and its walls naked, weak, and but partially flanked, here form part of the enceinte of the place.

The space contained within the castle is considerable, and various projects have at different times been under consideration for occupying it by works, but nothing had ever been carried into effect; indeed the defences of the castle had been unaccountably neglected; two or three fieldpieces only being mounted on its walls, and those without the shelter of proper parapets.

Immediately opposite the castle, on the other side of the Guadiana, at a distance of 500 yards, are situated the heights of Christoval, rising to nearly the elevation of the castle; and as the terreplein of the castle is an inclined plane towards the Guadiana, every part of it is seen from the Christoval Heights; to prevent an enemy readily availing himself of this advantage in any attack of the town, a fort has been constructed on them; its figure is nearly that of a square of 300 ft.; the scarp is well built of stone, and is 20 ft. in height. The communication between the town and Fort Christoval is very open to interruption, being either by a bridge 600 yards in length, subject to be enfiladed, or by boats for which there is no security."

From the above it will be seen that the task before Wellington was an exceedingly formidable one, but he determined to lay immediate siege to the fortress if any plan of attack could be evolved which would not require more than 16 days' open trenches. This was all the time that could be considered available, as in that period, including the time required to complete the necessary siege preparations, Marshal Soult would be able to collect a sufficient force to raise the siege. The proper point of attack was one of the south fronts, but to approach either of them would have entailed the reduction of the Pardaleras outwork which would have necessitated the opening of the trenches at a greater distance than usual from the fortress. To carry out this plan of attack would have needed a period of at least 22 days and, in addition, it was realized that the means provided were wholly insufficient to ensure success.

Under these circumstances the Chief Engineer, Colonel Fletcher, proposed to breach the castle, while batteries established on the right bank of the Guadiana took the defences in reverse. False attacks against the Pardaleras and Picurina were to be made by reopening Soult's trenches, and it was necessary to reduce San Christoval before the batteries to take the castle in reverse could be constructed. With this object in view Capt. Squire was directed to break ground there on the night of the 8th of May. The moon shone brightly, he was ill-provided with tools and exposed to a destructive musketry fire from the fort and to shot and shell from the town; nevertheless he worked with great loss until the 10th of May when the French

made a furious sortie and carried the battery. They were immediately driven back by the reserves, but the Allies pursued too far, and being taken in flank and front with grape lost 400 men. By this time five engineers had fallen and 700 officers and soldiers of the Line had been sacrificed, and only one small battery against an outwork was completed! On the 11th it opened, and before sunset the fire of the enemy had disabled four of its five guns, and killed many more of the besiegers; nor could any other result be expected, since the concert essential to success in double operations, whether in sieges or the field, was neglected. Squire's single work was exposed to the undivided fire of the fortress, up to the time of the approaches against the castle being commenced; and two distant batteries which had been constructed at the false attacks scarcely attracted the notice of the enemy. To check further sallies, a second battery was erected against the bridgehead, but this was also overmatched, and intelligence having been received that the French Army was in movement, the progress of all the works was arrested by Beresford. On the 12th, believing that this information was premature, he directed the trenches to be opened against the castle. But the intelligence proved to be true, and being confirmed at 12 o'clock the same night, the working parties were again drawn off and measures taken to raise the siege.

On the night of the 13th all the batteries were dismantled and on the night of the 14th such materials as could not be moved were burned. Part of the Army had already marched to Valverde to oppose Marshal Soult who had already reached Llerena, and on the 15th the remainder of the besieging force moved to join it. Sir John Jones remarks that this raising of the siege was in truth most fortunate, as at that period the strength of Badajoz was not duly appreciated, nor was it realized that the means prepared for the attack were altogether too inconsiderable. "The besieging corps itself," he adds, "was too small, particularly to attack Christoval; from which, and the want of entrenching tools, a sufficient extent of ground to oppose a proper front to the enemy could not be opened the first night and gave an opportunity for the sortie." He also points out the inexperience of the Portuguese gunners and the numerical and other inferiority of the besiegers' guns, and he concludes by saying that, had the enemy not caused the siege to be raised "after a great sacrifice of men, in other feeble attempts, it would have brought itself to a conclusion from inability to proceed."

As mentioned above, the last troops drew off from Badajoz on the 15th and on the 16th Marshal Beresford defeated Soult at Albuera. As soon as the retreat of the enemy was known on the morning of the 18th, the cavalry was sent in pursuit of them, and on the same day Major-General Hamilton's Portuguese Division resumed the blockade of Badajoz, on the south of the Guadiana.

There is no operation in war more certain than a modern siege if the rules of art are strictly followed; and unlike the ancient sieges in that particular it is also different in this, that no operation is less open to irregular daring, because the course of the engineer can neither be hurried nor delayed without danger.

Wellington knew the Siege of Badajoz in form required longer time and better means than were at his disposal; but he was compelled either to incur danger and loss of reputation, which is loss of strength, or to adopt some compendious mode of taking the place. The time he could command, and time is in all sieges the greatest point, was precisely that which the French required to bring up a force sufficient to disturb the operation. Their doing so depended upon Marmont, whose march from Salamanca to Badajoz through Baños or the Gata could not be stopped by Spencer, seeing that those defiles were commanded by the French positions; it was possible also at that season to ford the Tagus near Alcantara, and more than 20 days' free action against Badajoz could not be calculated upon. The battering-gun carriages used in Beresford's siege were damaged; the artillery officers asked 11 days to repair them, and the scanty means of transport for stores were diminished by carrying the wounded from Albuera. Fifteen days of open trenches, and nine days of fire was all that could be expected, and with good guns, plentiful stores, and a corps of regular Sappers and Miners this time would have sufficed; but none of these things were available.

Of the guns some were of soft brass and false in their bore; the shot were of different sizes and the largest too small; the Portuguese gunners were inexperienced, there were but few British artillerymen, fewer engineers, no sappers or miners, and no time to teach the troops how to make fascines and gabions. Regular approaches by the Pardaleras and the Picurina could not be attempted; Beresford's line of attack on the castle and Fort Christoval were therefore adopted, avoiding the errors of that general; that is to say the double attacks were to be pushed simultaneously and with more powerful means. San Christoval might then be taken, and batteries from it sweep the interior of the castle, which was meanwhile to be breached; something also was hoped from the inhabitants, and something from the effect of Soult's retreat from Albuera. In this hope the work was begun. Major Dickson, an artillery officer, conspicuous for talent, prepared with unexpected rapidity a battering train of thirty 24-pounders, four 16-pounders, and twelve 8-in. and 10-in. howitzers used as mortars by placing them on trucks. Six iron Portuguese ship guns were forwarded from Salvatierra making altogether fifty-two pieces; a convoy of engineer stores arrived from Alcacer do Sal; and some British artillery came from Lisbon to be mixed with the Portuguese, making a total of 600 gunners. The regular engineer officers present were 21 in number; 11 volunteers from the Line

were joined as assistant engineers; and a draft of 300 picked infantry, including 25 artificers of the staff corps, strengthened the force immediately under their command.

Hamilton's Portuguese Division was already before the town, and on the 24th May at the close of evening, Houston's division, increased to 5,000 men by the 17th Portuguese Regiment and the Tavira and Lagos Militia, invested San Christoval. The flying bridge was then laid down on the Guadiana, and on the 27th Picton's Division arrived from Campo Mayor, crossed the river by the ford above the town, and joined Hamilton, their united force being about 10,000 men. The covering army which included the Spaniards was under Hill, and spread from Mezida to Albuera; the cavalry pushed forward in observation of Soult, and when intelligence arrived that Drouet was effecting a junction with that marshal, two regiments of cavalry, and two brigades of infantry quartered at Coria as posts of communication with Spencer, were called up to reinforce the covering army.

Phillipon had used the respite given him to level Beresford's trenches, repair his own damages, and obtain small supplies of wine and vegetables from the people of Estremadura, who were still awed by Soult's vicinity. Within the place all was quiet, for the citizens did not now exceed 5,000 souls, and when the place was invested parties of the townsmen, mixed with soldiers, were observed working to improve the defences. Wherefore, as retrenchments behind the intended points of attack would prolong the siege, a large telescope was placed in the tower of La Lippe at Elvas, with which the interior of the castle was plainly seen and all preparations discovered.

In the night of the 29th ground was broken for a false attack against the Pardaleras; and the following night 1,600 workmen, with a covering party of 1,200, sunk a parallel against the castle on an extent of 1,100 yards, without being discovered by the enemy, who did not fire until after daylight. The same night 1,200 workmen, covered by 800 men, opened a parallel 450 yards from San Christoval and 700 yards from the bridgehead. On this line one breaching and two counter-batteries were raised against the fort and bridgehead to prevent a sally; a fourth battery was also commenced to search the defences of the castle, but the workmen were discovered and a heavy fire struck down many of them.

On the 31st the attack against the castle, the soil being very soft, was rapidly pushed forward without much interruption; but the Christoval attack, carried on in a rocky soil with earth brought from the rear, proceeded slowly and with considerable loss. This day the artillerymen from Lisbon came up on mules, and the engineers hastened the works. The direction of the parallel against the castle made the right gradually approach the point of attack,

by which the heaviest fire of the place was avoided; yet so great was the desire to save time that before the suitable point of distance was attained, a battery of fourteen 24-pounders with six large howitzers was marked out.

On the Christoval side the batteries were not finished before the night of the 1st June, for the rocky soil required that the miners should first level the ground for platforms; and the garrison having mortars of 16 and 18-in. diameter mounted on the castle sent every shell amongst the workmen. These huge missiles would have ruined the batteries on that side altogether, if the latter had not been on the edge of a ridge from which most of the shells rolled off before bursting; yet so difficult is it to judge rightly in war that Phillipon stopped this fire thinking it thrown away! The work was also delayed by the bringing of earth from a distance, and woolpacks purchased at Elvas were used instead. However in the night of the 2nd all the batteries were completed and armed with 43 pieces of different sizes, 20 being pointed against the castle; the next day the fire opened but the windage caused by the smallness of the shot rendered it ineffectual at first and five pieces were soon rendered unserviceable. Towards evening the practice became steadier, the fire of the fort was nearly silenced, and the covering of masonry falling from the castle wall discovered a perpendicular bank of clay. Next night the parallel against the castle was prolonged, and a battery for seven guns traced out 650 yards from the breach. On the 4th the garrison's fire was increased by several additional guns, and six pieces of the besiegers were disabled.

Christoval was now much injured and some damage was done to the castle from one of the batteries on that side; but the guns were so soft and bad that the rate of firing was greatly reduced in all the batteries. In the night the new battery was armed, the damaged works repaired, and next day the enemy having trained a gun in Christoval to plunge into the trenches on the castle side, the parallel was deepened and traverses constructed to protect the troops. Fifteen pieces still played against the castle, yet the bank of clay although falling away in flakes remained always perpendicular; one damaged gun was repaired on the Christoval side but two more had become unserviceable.

In the night the parallel against the castle was again extended and a fresh battery traced out 520 yards from the breach; on the Christoval side also some new batteries were opened and some old ones abandoned. During this night the garrison began to entrench themselves behind the castle breach and two additional pieces from Christoval plunged into the trenches with great effect. On the other hand the besiegers' fire had broken the clay bank, which took a slope nearly practicable, and the stray shells set fire to the houses nearest the castle, but three more guns were disabled. On the 6th

there were two breaches in Christoval, the principal one seeming practicable, and a company of grenadiers with twelve ladders were directed to assault it, while a second company turned the fort by the east. Three hundred men from the trenches were at the same time pushed forward by the west side to cut the communication between the fort and the bridgehead, while a detachment with a gun moved into the valley of the Gebora to prevent any passage of the Guadiana by boats.

First Assault of Christoval.

Major McIntosh, of the 85th Regiment, led the stormers, being preceded by a Forlorn Hope, under Lieut. Dyas, of the 51st; and guided by the engineer, Forster, reached the glacis and descended the ditch without being discovered. The French had cleared the rubbish away, the breach had still 7 ft. of perpendicular wall, and above it were pointed beams of wood, and carts chained together, large shells being also arranged along the ramparts to roll down. The Forlorn Hope finding the opening impracticable was retiring with little loss, when the main body which had been exposed to a flank fire from the town as well as a direct fire from the fort, came leaping into the ditch with ladders. Then an effort was made to escalade at different points but the ladders were too short, and the garrison, consisting of only 75 men besides the gunners, made so stout a resistance, and the confusion and mischief caused by the bursting of the shells was so great, that the assailants finally retired with the loss of more than 100 men.

This failure was attributed by some to the breach being impracticable from the first, by others to confusion after the main body had entered. It is however evident that from inexperience, accident or other causes, the combinations for the assault were not well calculated; the storming party was too weak, the ladders few and short, the breach was not scoured by the fire of the batteries. The attack was also ill-combined, for the leading troops were repulsed before the main body entered the ditch. The intrepidity of the assailants was admitted by all sides, yet it is a great point in such attacks that the supports should form one body with the leaders: the sense of power derived from numbers is a strong incentive to valour, and obstacles insurmountable to a few vanish before a multitude.

During the night the iron guns were placed in battery before the castle, but two more of the brass pieces became unserviceable, and the following day three others were disabled. The bank of clay, however, sloped more, and Capt. Patton, of the engineers, examined it closely; he was mortally wounded in returning yet lived to report it practicable. The French as usual cleared away the ruins, and with bales of wool and other materials formed interior defences.

They likewise arranged huge shells and barrels of powder with matches fastened to them along the ramparts, placed chosen men, each supplied with four muskets, to defend the breaches, and in that order fearlessly awaited another attack, which was soon made. For intelligence now arrived that Drouet was close to Lierena, and Marmont on the move from Salamanca, so that another attack on Christoval was ordered. This time 400 British, Portuguese, and French men of the Chasseurs Britaniques, carrying 16 long ladders, were employed; the supports were better closed up; the appointed hour was 9 instead of 12; and more detachments were distributed on the right and left to distract the enemy's attention, cut off his communication with the town, and improve success.

Second Assault of Christoval.

Major McGeechy commanded the stormers, the Forlorn Hope was again led by the gallant Dyas, accompanied by the engineer, Hunt. A little after 9 o'clock the first troops bounded forward, and were closely followed by the support under a shattering musketry which killed McGeechy, Hunt, and many men, but the others with loud shouts jumped into the ditch; then the French scoffingly calling to come on rolled the barrels of powder and shells down, and the musketry made fearful havoc. The two leading columns united at the main breach, the supports also came up, confusion arose about the ladders, of which only a few could be reared, and the enemy standing on the ramparts bayoneted the foremost, overturned the ladders, and again poured their destructive fire upon the crowd below. When 140 had fallen the order to retire was given. After this failure the breach in the castle remained to be stormed; but the stormers could not there gather in force, between the summit and the interior entrenchment, unless Christoval was taken and its guns used to clear the castle of obstacles; this would have taken several days, and Soult was now ready to advance and on the 1st a blockade was therefore substituted for the attack.

This siege, in which 400 officers and men fell, violated all rules. The working parties were too weak, the guns and stores too few, the point of attack ill-chosen; the defences were untouched by counter-fire, and the breaching batteries too distant for the bad guns; howitzers on trucks were poor substitutes for mortars, and the sap was not practised; lastly the assaults were made before the glacis had been crowned and a musketry fire established against the breach.

It was not strange that the siege failed. It was strange and culpable that the British Government after such long wars should have sent an engineer corps into the field so ill-organized and equipped that all the officers' bravery and zeal could not render it efficient. The very tools used especially those supplied from the Storekeeper-

General's Department were unfit for work; the captured French cutting instruments were eagerly sought for in preference; and when the soldiers' lives and the honour of England were at stake English cutlery could not bear comparison with French!

Want of foresight has also been objected to the general, inasmuch as he might have previously obtained a good battering train from England. But in the Lines, the conduct of the English and Portuguese Governments led him to think rather of embarking than besieging a frontier fortress; moreover the extreme badness of the Portuguese guns was not known before trial, and the time between Soult's capture of Badajoz and the siege was not sufficient for bringing out an English battering train. It may also be taken as a maxim that in the requirements of war no head was ever strong enough to fore-calculate all.

The second Siege of Badajoz terminated on the 9th of June but the blockade was kept up until the 16th. The junction of the two French armies under Marshals Marmont and Soult then rendered a retreat necessary and the fortress again became open. There was however, no collision between the armies, but on the 22nd of June the French pushed forward a strong reconnaissance which proved unsuccessful. After this both forces remained quiet for above a month, and it was during this period of inactivity that the preparations for the attack on Ciudad Rodrigo were commenced and that the battering train and siege stores were ordered up the Douro from Lisbon.

But it was not until the 8th of August that Wellington reached the Coa, intending first a close blockade of the fortress and finally a siege, but he was too late, the place having been re-victualled for two months on the 6th by Bessière's convoy. The blockade was therefore necessarily relinquished and the troops were quartered near the sources of the Coa and Agueda, close to the line of communication between Marmont and Dorsenne, and in a country where there was still some cover. From thence, if the enemy advanced in superior numbers, there was a retreat to a strong country and to a position of battle near Sabugal, from which the communication with Hill was direct. Nor was the rest of Beira much exposed, as the Allies could send detachments to the valley of the Mondego by Guarda in time to secure the magazines at Celorico; but the battering train and line of supply from Lamego was unprotected. In these positions the preparation for the siege went on until Wellington learned, contrary to his former belief, that Dorsenne's disposable force was above 20,000 good troops, and Ciudad Rodrigo could not be attacked in face of both that force and of Marmont's Army. Then, changing his plans, he again resolved to blockade the place and to be ready to strike a sudden blow against the fortress, or against the enemy's troops. For it was the foundation of his hopes, that, as the French could not long keep in masses for want of provisions, so he could

check those masses on the frontier of Portugal, and always force them to concentrate or suffer the loss of some important post.

Early in September, Marmont pushed a detachment from Plasencia through the passes, surprised a British cavalry piquet, and thus opened his communications with Dorsenne. Wellington had, however, already formed his blockade, and three of his brigades reinforced by a Portuguese regiment were posted on the Ponçul, beyond Castello Branco, to protect the magazines on that line. The battering train then reached Villa Ponte, the troops made gabions and fascines, and 200 men of the Line were instructed as sappers; the Almeida Bridge on the Coa was permanently repaired, and Almeida was again restored as a place of arms for guns and stores.

During the first arrangements for the blockade in September, 1811, the garrison had made excursions to beat up the quarters of the British cavalry and to obtain provisions from the villages.

Mr. Stuart's exertions had improved the revenue; the ranks of the infantry were filled up by the return of deserters and by fresh recruits, which, with the reinforcements from England, had raised the Allied Army to upwards of 80,000 men, 56,000 being English. The number under arms, however, did not exceed 24,000 Portuguese and 33,000 British (of which 5,000 were cavalry), with 90 pieces of artillery. This was due to the fact that 22,000 men were in hospital, owing to the increasing sickness acquired in the Alentejo, so that, after deducting Hill's Corps, Wellington could not bring above 44,000 men of all arms to the blockade of Ciudad. But Marmont alone could in a few days bring quite as many to its succour; and Dorsenne had from 20,000 to 25,000 men available, because the French reinforcements having relieved the old garrisons in the north the latter had joined the army in the field. An aggravating sense of all his difficulties was pressed on the English general when he compared his own situation with that of the enemy. Neither his necessities nor his money could procure due assistance from the Portuguese, while the French generals had only to issue their orders to the Spaniards, through the prefects of the provinces, and all kinds of aid possible to be obtained were surely provided on the day and at the place indicated. In the midst of these cares Wellington was suddenly called into military action. Ciudad Rodrigo again wanted food, and Marmont, who had received 11,000 men from France and had 50,000 under arms, concerted with Dorsenne a combined operation for its succour.

SIEGE OF CIUDAD RODRIGO.

After the Allies came to Beira in 1811, Dorsenne and Marmont being reinforced became separately equal to Wellington, and, together, too strong. Soult, master of Andalusia, had a movable reserve of 20,000 men, Suchet gained ground in Valencia, the Asturias were

reoccupied by Bonnet, and the army of the centre was reorganized. To besiege Ciudad Rodrigo in form was hopeless, and the rumour of Napoleon's arrival made the English general look once more to the lines of Torres Vedras; but when the certainty of a Russian war removed this fear, the capture of Ciudad Rodrigo became possible. There was then a good battering train in Almeida; the line of communication with Oporto was completely organized and shortened by improving the navigation of the Douro; Rodrigo itself was weakly garrisoned, and the French ignorance as to the state of the Allies' preparations gave hope of a surprise. It was, however, only from surprise that success could be expected, and it was not the least of Wellington's merits that he concealed his preparations for so long a period. No other operation was open, and yet he could not remain inactive because around him the whole fabric of the war was falling to pieces from the folly of the governments he was serving. If he could not effect a blow against the French while Napoleon was engaged in the Russian War, the Peninsula would be lost.

To surprise a third-rate fortress with a weak garrison seems a small matter in such grave circumstances, but in reality it was the first step in a plan which saved the Peninsula when nothing else could have saved it. Wellington knew the Valley of the Tagus could not long support the Army of Portugal and the army of the centre; he knew by intercepted letters that Marmont and the King were at open war upon the subject, and he judged that if he could surprise Ciudad Rodrigo, the Army of Portugal would, for the sake of provisions and to protect Leon uncovered by the departure of the Imperial Guards, concentrate in that province. This first step would therefore break the bar Napoleon had raised to offensive operations. For to keep magazines in reserve for sudden expeditions, feeding meanwhile as they could upon the country, was the French manner, and hence want of provisions never obstructed their moving upon important occasions; yet Wellington thought the tempestuous season would render it difficult for Marmont when thus forced into Leon to move with great masses; wherefore he proposed if Rodrigo fell to march by Villa Velha to Estremadura and suddenly besiege Badajoz also, the preparations to be secretly made in Elvas under protection of Hill's Corps. This was the second step and one of promise, because of the jealousies of the marshals, the wet season, and his own combinations which would prevent the concentration of the French armies and prevent them from keeping together if they did unite. If Badajoz fell, he designed to leave a force to cover it against the army of the centre and fight Soult in Andalusia. For he judged that Marmont could not, in default of provisions, pass beyond the Guadiana, nor follow him before the harvest was ripe; neither did he fear him in Beira, because the torrents would be full, the country

a desert, and the Militia aided by a small regular corps and covered by Almeida and Ciudad Rodrigo, would be sufficient to prevent any serious impression on Portugal during the invasion of Andalusia.

This plan, subtle and vigorous, was the more daring because his own troops were not in good plight. He had indeed received reinforcements, but the infantry had served at Walcheren and exposure to night air or even slight hardships threw them by hundreds into the hospital, while the new regiments of cavalry, inexperienced and not acclimatized, were found, men and horses, so unfit for duty that he sent them to the rear. The pay of the army was three months in arrear, the supplies, brought up with difficulty, were very scanty —half and quarter rations were often served, sometimes the troops were without any bread for three days consecutively, and their clothing was so patched that scarcely a regiment could be known by its uniform. Chopped straw, the only forage, was very scarce, the regimental animals were dying of hunger, corn was rarely distributed save to the generals and staff, and even the horses of the artillery and the old cavalry suffered ;—the very mules of the commissariat were pinched and the muleteers eight months in arrears of pay. The cantonments about the Coa and Agueda were unhealthy from the rains, 20,000 men were in hospital, and after making deductions for other drains, only 54,000 of both nations, including garrisons and posts of communication, were under arms. To finish the picture, a sulky apathy in the Portuguese Regency was becoming more hurtful than the former active opposition. Yet these distresses Wellington with surprising subtlety turned to the advantage of his present designs ; for the enemy were aware of the misery in the army and their imagination magnified it ; and as the allied troops were scattered for relief from the Gata Mountains to the Douro, from the Agueda to the Mondego, immediately after the battering train entered Almeida, both armies concluded that the guns were to arm that fortress as a cover to the extended country quarters which necessity had forced upon the British general. Not even the engineers employed in the preparations knew more than that a siege or the simulation of a siege was in contemplation ; but when it was to be attempted, or that it would be attempted at all, none knew ;— even the Quartermaster-General, Murray, was suffered to go home on leave with the full persuasion that no operation would take place before spring.

In the new cantonments abundance of provisions and dry weather (for in Beira the first rains generally subside during December) stopped the sickness and restored 3,000 men to the ranks ; and the privations had in no manner weakened the moral courage of the troops. The old regiments were incredibly hardy and experienced in all things necessary to sustain their strength and efficiency, the staff was well practised ; and Lord Fitzroy Somerset, Military

Secretary, had established such an intercourse between the head-quarters and the battalion chiefs that the latter had, so to speak, direct communication with the General-in-Chief upon all the business of their regiments, a privilege which stimulated the enthusiasm and zeal of all.

The favourable moment for action so long watched for by Wellington came at last. An Imperial decree had again remodelled the French armies. The army of the south was recomposed in six divisions of infantry and three of cavalry, exclusive of the garrison of Badajoz. Marshal Victor returned to France discontented, for he was one of those whose reputation had been abated by this war, and his divisions were given to eight generals and the younger Soult. The army of the north was exceedingly reduced in numbers, for the Imperial Guards, 17,000 strong, being required for the Russian War, marched in December to France. All the Polish battalions, the skeletons of the cavalry regiments, and several thousand choice men destined to fill the ranks of the Old Guard were drafted ; so that not less than 40,000 of the best soldiers were withdrawn, and the maimed and worn-out men being sent to France at the same time, the force in the Peninsula was diminished by 60,000 men. Marmont having been ordered to abandon the Valley of the Tagus and fix his head-quarters at Valladolid or Salamanca, Ciudad Rodrigo, the sixth and seventh governments, and the Asturias, were also placed under his authority. Montbrun being then near Valencia and Soult's attention distracted between Tarifa and Hill's pursuit of Drouet, the French were employed over an immense tract of country. Marmont also, deceived by the seemingly careless winter attitude of the Allies, left Rodrigo unprotected and Wellington instantly gave orders for the attack of the devoted fortress.

The Siege.

Thirty-five thousand men, cavalry included, were disposable for this enterprise. The materials for the siege were placed at Gallegos, Villa del Cierro, and Espeja, and the ammunition was at Almeida. From those places the hired carts and mules were to bring up the stores to the park ; 70 pieces of ordnance had been collected, but from the scarcity of transports only 38 guns could be brought to the trenches, and these would have wanted their due supply of ammunition, if 8,000 shot had not been found amidst the ruins of Almeida. A bridge was commenced the 1st January at Marialva near the confluence of the Azva with the Agueda, 6 miles below Ciudad, and to secure it piles were driven into the bed of the river above and below, to which the trestles were tied. The fortress was to have been invested on the 6th, but the native carters were two days moving over 10 miles of flat and excellent road with empty carts, and it was dangerous to find fault because they deserted on the slightest offence.

When the place was closely examined, it was found that two convents which flanked and strengthened the bad Spanish entrenchments round the suburbs had been fortified; and on the greater Teson an enclosed and palisaded redoubt, called Francisco, was constructed and supported by two guns and a howitzer placed on the flat roof of a convent having the same name. All the ground was rocky except on the Tesons, and though the ramparts were there better covered by outworks and could fire more heavily on the trenches, it was, following the English general's views, most assailable, because elsewhere the batteries must have been placed on the edge of the counterscarp before they could see low enough to breach; this would have been a tedious process, whereas the smaller Teson furnished the means of striking over the crest of the glacis at once, and a deep gully offered cover for the mines. It was therefore resolved to storm Fort Francisco, form a lodgment there, open the first parallel along the greater Teson, place 33 pieces in counter-batteries to ruin the defences and drive the besieged from the convent of Francisco. Afterwards working forward by the sap, it was proposed to construct breaching batteries on the lesser Teson and blow in the counterscarp, while seven guns, battering a weak turret on the left, opened a second breach with a view to turn any retrenchment behind the principal breach.

Carlos d'España and Julian Sanchez were pushed to the Tornes in observation, while four British divisions and Pack's Portuguese laboured at the siege; but on the right bank of the Agueda there was neither fuel nor cover and the troops therefore kept their quarters on the hither bank, having, although a severe frost and fall of snow had set in, to ford the river each day by divisions in succession, carrying their provisions cooked. To obviate the difficulty of obtaining country transport the English general had previously constructed 800 carts drawn by horses, which were now his surest dependence for bringing up ammunition; and so many delays were anticipated from the irregularity of the native carters and muleteers and the chances of weather, that he calculated upon an operation of 24 days. Yet he hoped to steal this time from his adversaries.

On the 8th January the Light Division and Pack's Portuguese forded the Agueda 3 miles above the fortress, and making a circuit took post beyond the great Teson, where they remained quiet during the day, and as there was no regular investment the enemy did not think the siege was commenced. But in the evening the troops stood to their arms, and Colonel Colbourne, now commanding the 52nd, having assembled two companies from each of the British regiments of the Light Division stormed the redoubt of Francisco; this he did with so much fury that the assailants appeared to be at one and the same time, in the ditch, mounting the parapets, fighting on the top of the rampart, and forcing the gorge of the redoubt,

where the explosion of one of the French shells had burst the gate open. Of the defenders a few were killed, not many, and the remainder, 40 in number, were made prisoners. When the post was thus taken with the loss of only 24 men and officers, Elder's Caçadores were sent to labour on the right of it because the fort itself was instantly covered with shot and shells from the town; this tempest continued during the night, but at daybreak the parallel, 600 yards in length, was sunk 3 ft. deep, the communication over the Teson was completed, and the siege advanced several days by this well-managed assault.

On the 9th the First Division took the trenches in hand, the place was encircled by posts to prevent any external communication, and at night 1,200 workmen commenced three counter-batteries for eleven guns each, under a heavy fire of shells and grape. Before daylight the labourers were under cover, and a ditch was also sunk in the front to provide earth for the batteries, which were made 18 ft. thick at top to resist the very powerful artillery of the place.

On the 10th the Fourth Division relieved the trenches and 1,000 men laboured, but in great peril, for the besieged had an abundance of ammunition and did not spare it. In the night the communication from the parallel to the batteries was opened, and on the 11th the Third Division undertook the siege. That day the magazines in the batteries were excavated and the approaches widened; but the enemy's fire was destructive, and the shells came so fast into the ditch in front of the batteries that the troops were withdrawn and the earth raised from the inside. Great damage was also sustained from salvos of shells with long fuzes, whose explosion cut away the parapets in a strange manner; and in the night the French brought a howitzer to the garden of the convent of Francisco with which they killed many men and wounded others.

On the 12th the Light Division resumed work, the riflemen profiting from a thick fog covered themselves in pits which they dug in front of the trenches and from thence picked off the enemy's gunners; yet the weather was so cold and the besieged shot so briskly that little progress was made.

The 13th the same causes impeded the labourers of the First Division. Scarcity of transport also baulked the operations. One-third only of the native carts had arrived and the drivers were very indolent; much of the 24-pound ammunition was still at Villa de Ponte, and intelligence arrived that Marmont was collecting his forces to succour the place. In this difficulty it was resolved to hasten the siege by opening a breach with the counter-batteries, which were not quite 600 yards from the curtain, and then to storm the place without blowing in the counterscarp; in other words to overstep the rules of science and sacrifice life rather than time, for the capricious Agueda might in one night flood and enable a small

French force to relieve the place. The whole army was therefore brought up from the distant quarters and posted in the villages on the Coa ready to cross the Agueda and give battle.

In the night of the 13th the batteries were armed with 28 guns, the second parallel and the approaches were continued by the flying sap, and the Santa Cruz Convent was surprised by the Germans of the First Division, which secured the right flank of the trenches.

The 14th the enemy who had observed that the men in the trenches always went off in a disorderly manner on the approach of the relief, made a sally and overturned the gabions of the sap; they even penetrated to the parallel, and were on the point of entering the batteries when a few of the workmen getting together checked them until a support arrived and the guns were saved. This affair, coupled with the death of the engineer on duty and the heavy fire from the town, delayed the opening of the breaching batteries; yet at 4.30 in the evening 25 heavy guns battered the "*fausse braye*" and rampart, and two pieces were directed against the convent of Francisco. Then was beheld a spectacle at once fearful and sublime. The enemy replied to the assailant's fire with more than 50 pieces, the bellowing of 80 large guns shook the ground, far and wide, the smoke rested in heavy volumes upon the battlements of the place, the shells hissing through the air seemed fiery serpents leaping from the darkness, and the distant mountains faintly returned the sound. And when night put an end to this turmoil the quick clattering of musketry was heard like the pattering of hail after a peal of thunder, for the 40th Regiment then carried the convent of Francisco by storm and established itself in the suburb.

Next day the ramparts were again battered and fell so fast that it was judged expedient to commence the small breach at the turret; wherefore in the night five more guns were mounted. At daylight the besiegers' batteries recommenced, but at 8 o'clock a thick fog compelled them to desist; nevertheless the small breach had been opened and the place was summoned but without effect. At night the parallel on the lower Teson was extended and a sharp musketry was directed from thence against the great breach; the breaching battery as originally projected was also commenced, and the riflemen of the Light Division continued from their pits to pick off the enemy's gunners.

On the 17th the fire on both sides was very heavy, and though the wall of the place was much beaten down, several of the besiegers' guns were dismounted, their batteries injured, many men killed, General Borthwick, Commandant of Artillery, wounded, the sap entirely ruined, and the riflemen in the pits overpowered with grape; yet towards evening the latter recovered the upper hand and the French could only fire from the more distant embrasures. In the night the battery intended for the lesser breach was armed and that on the lower Teson raised so as to afford cover in the daytime.

On the 18th the besiegers' fire was resumed with great violence, the turret was shaken at the small breach, the large breach became practicable in the middle, and the enemy commenced retrenching it. The sap made no progress, the superintending engineer was badly wounded, and a 24-pounder, having burst in the batteries killed several men. In the night the battery on the lower Teson was improved, and a fieldpiece and howitzer being placed there kept up a constant fire on the great breach to destroy the French retrenchments. On the 19th both breaches became practicable, Major Sturgeon closely examined the place and a plan of attack was formed on his report; the assault was then ordered and the battering guns were turned against the artillery of the ramparts.

Assault of Ciudad Rodrigo.

This operation confided to the Third and Light Divisions and Pack's Portuguese, was organized in four parts.

1*st. Right Attack.*—A company of the 83rd and the Second Caçadores posted in some houses near the bridge were to cross the river and escalade an outwork in front of the castle where there was no ditch, but where two guns commanded the junction of the counterscarp with the body of the place. The 5th and 94th Regiments, posted behind the convent of Santa Cruz and having the 77th in reserve, were to enter the ditch at the extremity of the counterscarp, to escalade the "*fausse braye*" and scour it on their left as far as the great breach.

2*nd. Assault of the Great Breach.*—One hundred and eighty men, protected by the fire of the 83rd Regiment and carrying hay-bags to throw into the ditch, were to move out of the second parallel and to be followed by the storming party, which was again to be supported by Mackinnon's Brigade of the Third Division.

3*rd. Left Attack.*—The Light Division posted behind the convent of Francisco, was to send three rifle companies to scour the *fausse braye* to the right and so connect the left and centre attacks. At the same time a storming party, preceded by the Third Caçadores with hay-sacks and followed by Vandeleur's and Barnard's Brigades, was to make for the small breach, and when the *fausse braye* was carried to detach to their right in aid of the main assault, to their left to force a passage at the Salamanca Gate.

4*th. False Attack.*—This was an escalade to be made by Pack's Portuguese on the St. Jago Gate at the opposite side of the town.

Colonel O'Toole, of the Caçadores, commanded the right attack. Five hundred Volunteers, under Major Manners, of the 74th, the Forlorn Hope, under Lieut. Mackie, of the 88th, composed the storming party of the Third Division. Three hundred Volunteers, led by Major George Napier, of the 52nd, with a Forlorn Hope of 25 men

under Lieut. Gurwood, of the same regiment, formed the storming party of the Light Division.

All the troops reached their posts without seeming to attract the attention of the enemy, but before the signal was given, and while Wellington, who in person had been pointing out the lesser breach to Major Napier, was still at the convent of Francisco, the attack on the right commenced and was instantly taken up along the whole line. Then the space between the troops and the ditch was at once covered with soldiers and ravaged by a tempest of grape from the ramparts. The storming parties of the Third Division jumped out of the parallel when the first shout arose, but so rapid had been the movements on their right, that before they could reach the ditch, Ridge, Dunkin, and Campbell, with the 5th, 77th, and 94th Regiments, had already scoured the *fausse braye*, and were pushing up the great breach amidst the bursting of shells, the whistling of grape and musketry and the shrill cries of the French, who were driven fighting behind the retrenchments. There they rallied, and aided by the musketry from the houses made hard battle for their post; neither side would give way, and yet the British could not get forward, and men and officers falling in heaps choked up the passage, which from minute to minute was raked with grape from two guns flanking the top of the breach at the distance of a few yards: thus striving and trampling alike upon the dead and the wounded these brave men maintained the combat.

On the left the stormers of the Light Division, who had 300 yards to clear would not wait for the hay-bags, but with extraordinary swiftness running to the crest of the glacis jumped down the scarp, a depth of 11 ft., and rushed up the *fausse braye* under a smashing discharge of grape and musketry. The ditch was dark and intricate, the Forlorn Hope inclined towards the left, the stormers went straight to the breach which was so narrow at the top that a gun placed across nearly barred the opening; there they were rejoined by the Forlorn Hope and the whole body rushed up, but the head of the mass crushed together as the ascent narrowed, staggered under the fire, and with the instinct of self-preservation snapped their own muskets though they had not been allowed to load. Major Napier struck by a grape shot fell at this moment with a shattered arm, but he called on the men to use their bayonets, and all the unwounded officers simultaneously sprung to the front, thus the required impulse was given and with a furious shout the breach was carried. Then the supporting regiments coming up in sections abreast gained the rampart, the 52nd wheeled to the left, the 43rd to the right, and the place was won.

During this contest, which lasted only a few minutes in the breach, the fighting at the great breach had continued with unabated violence; but when the stormers and the 43rd came pouring along the rampart

towards that quarter the French wavered, three of their expense magazines exploded at the same moment, and then the Third Division with a mighty effort broke through the retrenchments. The garrison indeed fought for a moment in the streets, yet finally fled to the castle, where Lieut. Gurwood, who though severely wounded in the head had entered amongst the foremost at the lesser breach, received the Governor's sword.

Now into the streets plunged the assailants from all quarters, for O'Toole's attack was also successful, and at the other side of the town Pack's Portuguese, and the reserves meeting no resistance had entered. Throwing off the restraints of discipline the troops committed frightful excesses; the town was fired in three or four places, the soldiers menaced their officers and shot each other; many were killed in the market place, intoxication soon increased the tumult, and at last, the fury rising to absolute madness, a fire was wilfully lighted in the middle of the great magazine, by which the town would have been blown to atoms but for the energetic courage of some officers and a few soldiers who still preserved their senses. Three hundred French had fallen, 1,500 were made prisoners, and the immense stores of ammunition, with 150 pieces of artillery including the battering train of Marmont's Army, were captured. The Allies lost 1,200 men and 90 officers in the siege, of which 650 and 60 officers were slain or wounded at the breaches.

Generals Crauford and Mackinnon, the former an officer of great ability, were killed, and with them died many gallant men; amongst others, a captain of the 45th, of whom it has been felicitously said that "three generals and seventy other officers had fallen, yet the soldiers fresh from the strife only talked of Hardyman." General Vandeleur, leading the Light Division after Crauford fell, was badly wounded, so was Colonel Colbourne and a crowd of inferior rank; and unhappily the slaughter did not end with the battle, for the next day as the prisoners and their escort were marching out by the breach an accidental explosion took place and numbers of both were blown into the air.

To recompense an exploit so boldly undertaken and so gloriously finished Lord Wellington was created Duke of Ciudad Rodrigo by the Spaniards, Earl of Wellington by the English, Marquis of Torres Vedras by the Portuguese; but it is to be remarked that the Prince Regent of Portugal had, previous to that period, displayed great ingratitude in the conferring of honours on the British officers.

Observations.

1st. This siege lasted only twelve days, half the time originally calculated upon by the English general. Owing to the heavy fire from the place the works were more slowly executed than might have been expected; the cold also had impeded the labourers, but

with a less severe frost the trenches would have been under water, because in open weather the water rises everywhere to within 6 in. of the surface. The worst obstacle was the disgraceful badness of the cutting tools furnished from the Storekeeper-General's Office in England, the profits of the contractor seemed to be the only thing respected; the engineers eagerly sought for French implements because the English tools were useless.

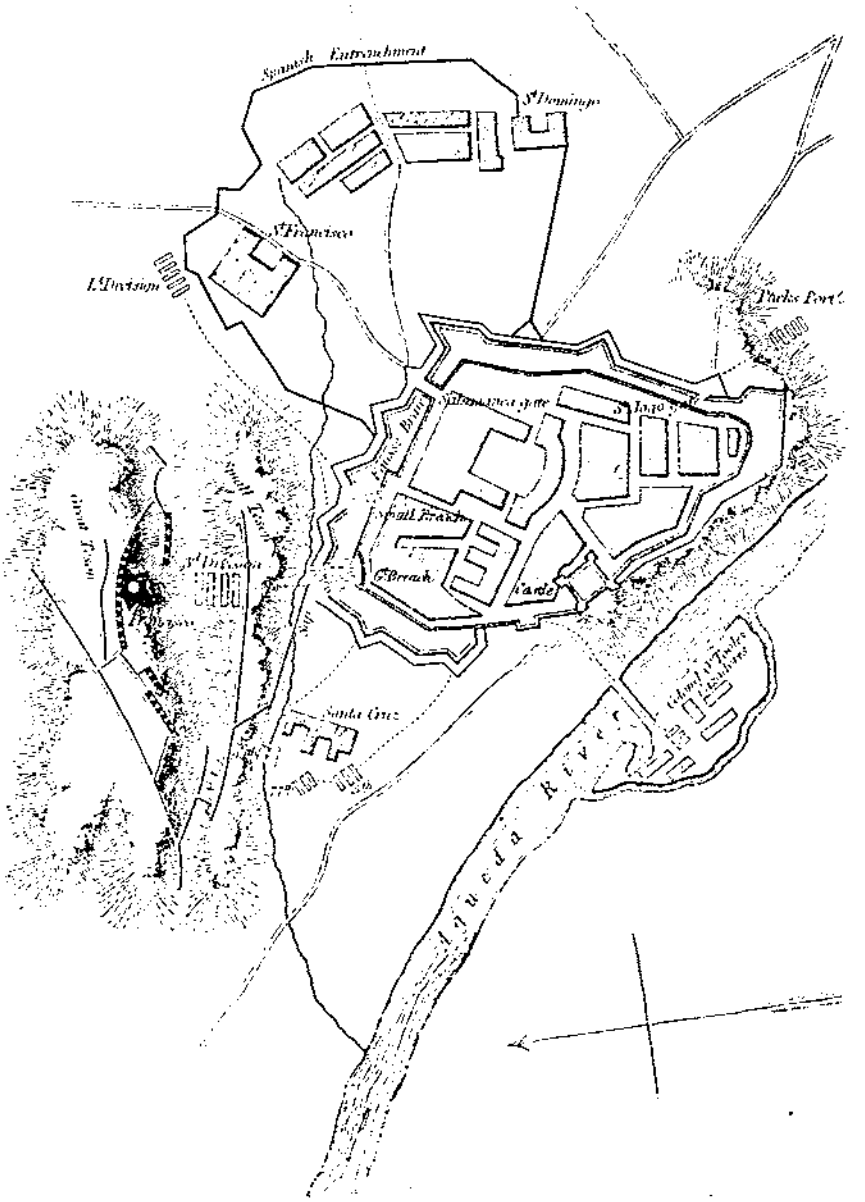
2nd. Wellington's audacity in storming the redoubt of Francisco, and breaking ground on the first night of the investment; his greater audacity in storming before the fire of the place had been even abated, or the counterscarp blown in were the true causes of the sudden fall of the place. Success depended more upon the courage of the troops than the skill of the engineer; and when the general terminated his order for the assault with this sentence, "Ciudad Rodrigo *must* be stormed this evening," he knew well that it would be nobly understood. Yet the French fought bravely on the breach, and by their side many British deserters, desperate men, were bayoneted.

3rd. A perpendicular descent of 16 ft. cut off the great breach from the town, and the bottom was planted with sharp spikes and strewn with live shells. The houses behind were loopholed and manned with musketeers, and on the flanks there were cuts, not very deep or wide, and the French had left the temporary bridges over them; but they had parapets so powerfully defended that it was said that the Third Division could never have carried them had not the Light Division taken the enemy in flank: an assertion perhaps easier made than proved.

4th. The neglect of the lesser breach was a great error. Narrow and high, a slight addition to its defences would have rendered it impracticable. Moreover the small breach was flanked at a short distance by a demi-bastion with a parapet which, though little injured, was abandoned the moment the head of the storming party forced its way on to the rampart. But the real defence of Ciudad was outside; when it fell Marmont's errors at Elbodon became manifest. Neither can that marshal be justified for having left so few men in Ciudad Rodrigo as with a garrison of 5,000 the place could never have been taken.

(To be continued).

SIEGE OF CIUDAD RODRIGO, 1812.



TRANSCRIPTS.

HOW MANY DAYS WILL BE REQUIRED FOR THE CONCENTRATION OF THE GERMAN ARMY?

(Translation of extracts of an article in *Le Matin* by Mons. Adolphe Giroi, Secretaire de la Commission de l'Armée, dated 30th January, 1914).

This translation only deals with the German lines of advance on the portion of the frontier between Metz and Mulhaussen. Their arrangements generally are wonderfully complete and seem to make all possible provision for handling troop traffic as quickly as possible over these main routes. Station design and the general lay-out of the yards are invariably regulated with regard to possible military requirements. Money appears to be no object, and accommodation is usually much in excess of commercially justifiable peace conditions. For instance, fly overhead junctions, even for the smallest branch lines, are being put in presumably solely with a view to prevent delays in war time.

Route III. is especially well provided for—Neuenkirchen, an important junction, Saarbrucken in the coal district, Forbach, Benningen, Remilly, and of course Metz are all equipped for possible military purposes.

An article in the *Fortnightly Review* for February, 1914, gives an excellent idea of the rapid and methodical development in their strategic lines on the Belgian frontier for a possible advance through Holland and Belgium, and also *viâ* Luxembourg.

The discussion of the Three Years Law has resulted in numerous suppositions; some of them serious, others original, but all without foundation, on "l'attaque brusquée" and the necessary delays of a German invasion (of France). Other suppositions are not substantiated by military documents of any real value.

What will be the delay that will take place in the concentration of the attacking German Army? This is the crux of the question. As a matter of fact, it is on this delay depends the nature of the resistance and on it the time, date and character of "des grandes batailles."

Apart from the German "corps de couverture," which mobilize separately, following particular regulations and moving by special routes, and apart from the "Lanwehr" first and second reserves, whose duty it will be to observe the Danish frontiers, and apart from a certain number of units of the 1st, 2nd, 5th, 6th, and 17th Corps left on the Russian frontiers, the French "état major" know that Germany pro-

posed two years ago, to concentrate on the French frontier "une masse de première attaque globale," having the following composition :—

Five army corps of 31 battalions ..	.. 200,000 men.
Thirteen army corps of 25 battalions	.. 450,000 ,,
Six divisions of cavalry of 24 squadrons	.. 25,000 ,,
Seven divisions of Reserve of 16 battalions	.. 125,000 ,,
Total	.. 800,000 men.

In 1870 the Germans commenced main operations with 520,000 men. By reason of the rapid growth in effectives it is necessary to add 150,000 men to the total of 800,000, bringing L'Armée de Masse to actually 950,000 men. This total corresponds to the estimate given by Von der Goltz.

Nowadays the concentration of the armies of two large powers are like tremendous migrations. Each of them puts into movement more than a million men and hundreds of thousands of horses.

How are these millions brought into the battle position ? The study of the German railway system shows this.

Assuming that the neutrality of Belgium is respected, the front over which the concentration will take place is represented by the railway from Metz, southwards, *viâ* Sarrebourg, Zabern, Sshlestadt, Colmar, Mulhaussen : meeting the following ten independent lines of advance :—

Route I. (Ligne de l'Eifel).—Hamburg, Osnabrück, Munster, Essen, pont de Duisbourg, Cologne (Duren), Trèves, Thionville, Metz. It is a double track, but due to the grades in the Eifel Hills, its capacity is limited ; 20 trains in 24 hours.

Route II. (Ligne de la Moselle).—Berlin, Magdebourg, Paderhorn, Barmen, pont de Coblentz, Trèves, Bous, Courcelles. It is double track ; 40 trains.

Route III. (Ligne de la Nahe).—Berlin, Hanover, Dortmund, Duisbourg, pont de Cologne, Bingen, Neuenkirchen, Sarrebruck, Remilly. It is double track ; excellent capacity ; 50 trains.

Route IV.—Torgau, Leipzig, Erfurt, Bebra, Fulda, Hanau, pont de Mainz, Worms, Kaiserslauten, Sarrebruck, Sarreguemines. It is double track ; 40 trains.

Route V.—Dresden, Chemnitz, Bamberg, Nuremberg, Hall, Brüchsal, pont de Germersheim, Deux-Ponts, Sarreguemines, Berthelming. It is double track ; 40 trains.

Route VI.—Berlin, Cassel, Marbourg, Giessen, Frankfort, Darmstadt, pont de Mannheim, Neustadt, Landau, Haguenau, Zabern, Sarrebourg. Double track ; very good capacity ; 50 trains.

Route VII.—Würzbourg, Heidelberg, pont de Spire, Germersheim, Strasbourg, Rothau. Single track ; 20 trains.

Route VIII.—Ulm, Stuttgart, Carlsruhe, Rastatt, pont de Roschvoog, Hagenau, Obermodern, Sarralbe. Double track ; 50 trains.

Route IX. (Black Forest Line).—Passau, Ratisbon, Ingolstadt, Ulm, Sigmaringen, Tuttlingen, Willingen, Ofenbourg, pont de Kehl, Strasbourg, Molsheim. It is single track ; 20 trains.

Route X. (Swiss Frontier Line).—Munich, Memmingen, Stokach,

Radolfzell, Weigen, Waldshut, Lovrach, pont de Mulheim, Mulhouse. Single track; 20 trains.

If the Germans violate the neutrality of Luxembourg, an eleventh route will be at their disposal, viz., Aix-la-Chapelle, Saint-Vith, Luxembourg, Thionville. It is a single track; 20 trains. It should also be mentioned, since it has been so clearly shown by Mons. Georges Leygues, that quite recently, in view of an advance by way of Belgium, numerous unloading platforms have been constructed at stations in the Eifel, and notably in the region of Cologne, Aix-la-Chapelle, Trèves. But this is quite apart from what is now under consideration, for in the case of an advance through Belgium, the railways of the north, instead of concentrating towards Metz, would unload their forces to the west of the Lower Meuse from Aix-la-Chapelle to Mezières. There would then be a pause in the final concentration due to the halting places that will be necessary when crossing Belgium, a large part of the troops coming from the north of Germany.

We now add the daily return of these 10 lines and we arrive at a total of 360 trains in 24 hours; a figure which is considered by the "état major" as a possible maximum. More probably, from hindrances, accidents, etc., there will be, say, 340 trains. If we now estimate, on an average, 130 trains to an army corps (the figure was 120 before the increases in establishments) and 45 trains to the new Reserve divisions, and 35 trains to the Cavalry Divisions, we find that the total transport required is 18 army corps (18×120)=2,160 trains; Reserve Divisions (7×45)=315 trains; Cavalry Divisions (6×35)=210 trains. Total, 2,685 trains.

Assuming a capacity of 340 trains per day, on an average, the moving of the army will take seven and a-half days.

Generally speaking "l'état major" allows that strategic movement can only commence on the evening of the third day. The result is that by the eleventh day, after the order for mobilization, the total German army "de grande bataille" would have reached the area of assembly.

And lastly, if one assumes a delay of two more days to allow the rear corps to come up to their allotted places in the ranks, we see that the army would be ready to march on the thirteenth day.

Looking back to 1870, the German mobilization lasted from the 16th to the 23rd July. The concentration was completed on the 1st August (14 days), Wissembourg took place on 4th August, and on the 6th the Battles of Frœschwiller and Wœrth were fought. Twenty days had passed from the beginning of mobilization to the first encounter.

Finally let me quote a sentence from the "cours supérieur":—"Le réseau ferré militaire français est au moins aussi riche que le réseau allemand."

Nothing proves then decisively that the first operations of the next war between France and Germany will take place in French territory.

A. H. L. Mount.

THE SIEGE OF ADRIANOPLE.

From an article by V. N. POLYANSKI in the September, 1913, and subsequent numbers of *Injenerni Jurnal*.

CHAPTER I.

THE FORTRESS AND ITS EQUIPMENT.

THE materials for this account of the Siege of Adrianople were collected by the author during a visit to the theatre of war in Thrace in the spring of 1913.

Adrianople.

Adrianople, called by the Bulgarians Odrin, and by the Turks Edirne, was the capital city of the Osmans from 1363 up to the capture of Constantinople in 1453, after which it became the chief city of the Adrianople vilayet and the second capital of modern Turkey. It is situated at the confluence of the rivers Tunja and Maritza, and about 2 miles above the junction of the Arda with the Maritza.

The town rests in a hollow surrounded by hills on all sides, except on the south-west, where is the valley of the Arda. Its narrow, crooked streets with overhanging balconies, its large many-coloured bazaars, its numerous mosques, among which that of Sultan Selim is easily recognized by its four minarets, give it a typical eastern character. A traveller approaching the town from any direction will see the high minarets of Selim from a distance of 8 or 9 miles, and these made excellent observation posts for the Turks during the siege. The columns and the dark cypresses, the invariable adjuncts of mosques, give to the town the characteristic appearance of all towns of Southern Turkey.

The population of the town and neighbourhood is a mixture of Mussalmans and Christians, the former, Turks, predominating over the latter, Greeks and Bulgarians, and there are also Jews and Armenians. In peace time the town has a population of 80,000, but during the siege this was increased to 100,000, by the Turks who crowded in from the neighbouring villages.

At $1\frac{3}{4}$ miles to the south-west, on the far side of the Maritza, lies the large suburb of Karagach, which is connected with Adrianople by a fine road with stone bridges over the Maritza and Tunja. Here is the railway station on the Sophia-Constantinople Railway. Its population consists of wealthy Greeks who live in fine well-built houses with orchards and flower gardens. The streets are wide and well kept.

There are no woods in the neighbourhood of Adrianople. In places there are isolated trees and on the river banks small groves and bushes.

On the right bank of the Tunja there is the Greek suburb of Hedirlik, and about 1,000 yards to the north of this the Turks have built the spacious barracks of Yanlik-Kashli for the accommodation of the garrison in peace time.

Strategic Value.

As the key to Constantinople, Adrianople has great strategic importance. The theatre of war in Thrace is very poorly provided

with roads, and here all the lines of communication meet. These include:—(1), The Vienna-Belgrade-Sophia-Constantinople Railway; (2), the Sophia-Constantinople main road; (3), the main road from Adrianople to Kirk Kilisse (called by the Bulgarians Lozengrade); the unmetalled roads from the Balkans to the shores of the Ægean Sea (Dedergach and Kavala) and to the Sea of Marmora (Rodosto and Silivria). From here also the Maritza is navigable to its mouth.

In addition to this, being fortified, Adrianople forms a pivot of manœuvre for the Turkish field armies, and may be used either as a base for offensive operations against Bulgaria, or as a support for the left flank of the Adrianople-Kirk Kilisse defensive line.

Furthermore, if its religious and political importance, as the second capital of Turkey, be taken into consideration, the prominent part which it was expected to play in the late war will be understood.

Fortification.

There is no doubt that the Turks recognized the importance of Adrianople, and they should certainly have taken all measures to make it into a first-class manœuvre fortress, calculated to withstand for a long period all forms of assault. But it will be seen later that at the time of its siege by the allied troops it was by no means an up-to-date manœuvre fortress. It was at best but a position of temporary character.

A project for the renovation of the fortress was prepared by the German instructors, and had been approved by von der Goltz-Pasha, but even if the Turkish engineers had shown more conscientious attention to their duties than had been the case, its recommendations could not have been completed for several years.

Adrianople had been fortified from the earliest times. At the time of the Russo-Turkish War of 1877–78 its fortifications consisted of a belt of 24 temporary battery-forts. These were nearly all of one type; their distance from the town varied from 600 yards to 3¼ miles, and their intervals from one another from ½ to 2¼ miles. The main ramparts of these works were arranged for artillery, in places in tiers. The glacis and covered ways formed the infantry positions. The guns were separated by traverses, in which there were casemates constructed of timber. The ditches were undefended, and gorge parapets were often omitted. The escarps and counterscarps were of earth, standing at the natural slopes. The entrances were screened by semi-circular ramparts not prepared for defence, and no fire could be brought to bear towards the rear. There were no works in the intervals between these forts.

The defences remained in the same state up to 1885 when the Turks commenced to remodel these old forts. The reconstruction consisted only in replacing by brickwork the timber in the casemates, and in building brick barracks in the works. The remodelled forts, or as the Bulgarians called them "permanent redoubts," had ramparts 8 to 11½ ft. in height, parapets 19 to 28 ft. in thickness, ditches 40 ft. wide and 13 ft. deep, without any defence, and the thickness of the brick arches of the casemates was about 3 ft. No attention had been paid to the concealment of these works.

Adrianople again attracted the attention of the Turks in 1908, and then the German project was prepared and the works contemplated in it were commenced.

Bulgarian Information.

According to the information which had been collected for the Bulgarians by their agents, "the manœuvre fortress of Odrin" in 1911 consisted of a ring of 30 permanent redoubts, 26 of which were old, and four new, of which one was built of concrete. The new redoubts were protected by wire entanglements. In the intervals, there were rifle trenches with covered communications to the rear. Altogether 74 batteries had been counted on the positions, of which eight were permanent and built of concrete. The rest were temporary, made of earth with light blindages. The magazines were some of brick and some of timber, and some concrete ones were in course of construction. On some of the fronts advanced positions had been strengthened with fieldworks, consisting of trenches and redoubts.

From all the data thus obtained plans of the fortress had been prepared, and these were frequently revised. Finally on 1st July, 1911, a very detailed and fairly accurate map of all the fortress works was made to a scale of $\frac{1}{20000}$ with 5-metre contours. It was estimated that the number of the garrison would be 45,000, and that there would be in the fortress 192 guns of large calibres and from 320 to 325 field guns.

The information obtained by the Bulgarians appears to have been fairly accurate, except as regards the number of the garrison, which turned out to be greater, and the strength of the new works, which was less, than they supposed. This reacted upon the resolution of the operations during the first period of the siege (up to the armistice), and required a fresh detailed reconnaissance which resulted in the attack by assault, a system fully suited to the existing conditions.

Details of Fortification.

Passing now to a detailed description of the defensive positions as they actually existed during the siege (see map), it will be seen that the hills which surround the town on north and east are offshoots from the Balkans, and those on south and west branches of the Rhodope Mountains. The slopes are fairly gradual, the eastern slopes of the ridge forming the so-called east front being the steepest and falling at angles of from 25° to 30°.

The ridges surrounding the town form natural positions for defence. The reverse slopes towards the town are gradual, and are completely hidden from outside observation. The confluence of three rivers within the fortress area is favourable to the defence, as with plenty of permanent bridges troops can be thrown rapidly from one front to another. The conditions are incomparably worse for the attack, the rivers hindering communication between the various sectors; the construction of crossings is made difficult by the rapid currents and by the width of the rivers, which in rainy weather soon overflow their banks and become rushing torrents, quickly washing away light bridges. The separate hill masses, divided by the open impassable river valleys, make it possible to organize separate defensive groups, well linked together by mutual fire support.

A number of tumuli—old graves—form an excellent system of observation posts. The absence of vegetation along the front and the comparatively gradual fall of the ground, make fields of view and fire alike good.

The soil is clay, easy to work and allowing very steep slopes in

excavations. In fact, the conditions are in the highest degree favourable to defence, and these in conjunction with the abundance of materials—large city, groves and orchards—should have made it possible for an energetic commander (which Shukri-Pasha, unmeritedly entitled Ghazi, or "Invincible," certainly was not) to show a very resolute resistance, in spite of the unfinished condition of the defence works.

The perimeter is divided by the rivers into four "sectors" or "fronts":—

(1). The North-West Front, between the right bank of the Tunja and the left of the Maritza. The N.W. Front.

This front was the strongest. The positions formed two sections, right and left. The right section, or North Front, consisted of a group of two forts, some rifle trenches and 10 batteries, of which four were armed with heavy guns (12 and 15-c.m.). The group was sited on the hill Karagioz-Tarla, about $4\frac{1}{4}$ miles from the town.

The forts, Yeshil-Tepe (1) and Yasi-Tepe (2), were of temporary profiles with glacis-shaped parapets; under the parapets of their front faces there were blindages of light construction, giving protection against shrapnel and splinters.

The work on these forts was still in the initial stage, and the earthwork had been completed only on the front face and part of the flanks, so that the works were really lunettes. The yellowish-whitish earth of the parapets showed up brightly against the surrounding ground and was visible from a great distance. The rifle trenches were successfully applied to the ground and well disguised and were evidently the main positions of defence. In front of the whole group, at 50 paces from the forts, a wire entanglement was erected, with metal posts and about 29 ft. in width. This was the normal width of the entanglements at Adrianople, the posts were of angle iron or wood, fastened into metal plates, and from $3\frac{1}{4}$ to 4 and $5\frac{1}{4}$ ft. in height. The distance apart of posts was from 5 to $6\frac{1}{2}$ ft., of rows, from $6\frac{1}{2}$ to nearly 10 ft.; the wire was barbed.

At 1,100 yards in rear of the forts was the sector magazine built of concrete. Besides this there were in rear of the batteries magazines built of timber, or roofed with semi-circular corrugated iron, giving protection only from splinters and the weather.

In front of the Karagioz-Tarla group, at about $1\frac{1}{4}$ miles to the north, was an advanced position on the hill Uch-Tepeler, consisting of groups of rifle trenches, with communication trenches, and dug-outs on the reverse slopes.

The left section of the North-West Front was a low ridge with an excellent field of fire up to extreme ranges, and with the rear concealed from the enemy's view, allowing the skilful siting of batteries, which had been well done by the Germans. The main position of defence had been sited on this ridge and consisted of 3 forts and 27 batteries, with rifle trenches in the intervals.

An uninterrupted belt of wire entanglement had been drawn across the whole front from the Tunja to the Maritza.

The fort on the right flank of this section, Shaitan-Tarla, otherwise Karagoz-Tabiya (3), sited on the hill of that name, was the

strongest of the whole fortress. It was a closed work of old construction with high ramparts and brick casemated traverses. The rifle positions were on the glacis with a wire entanglement in front. The gorge glacis was also prepared for defence but without an entanglement.

On each side of the work, where there were formerly batteries, concrete barracks had been built, of a type similar to that of the main magazine. In these barracks there was accommodation for two companies of infantry (see *Fig.* 1).

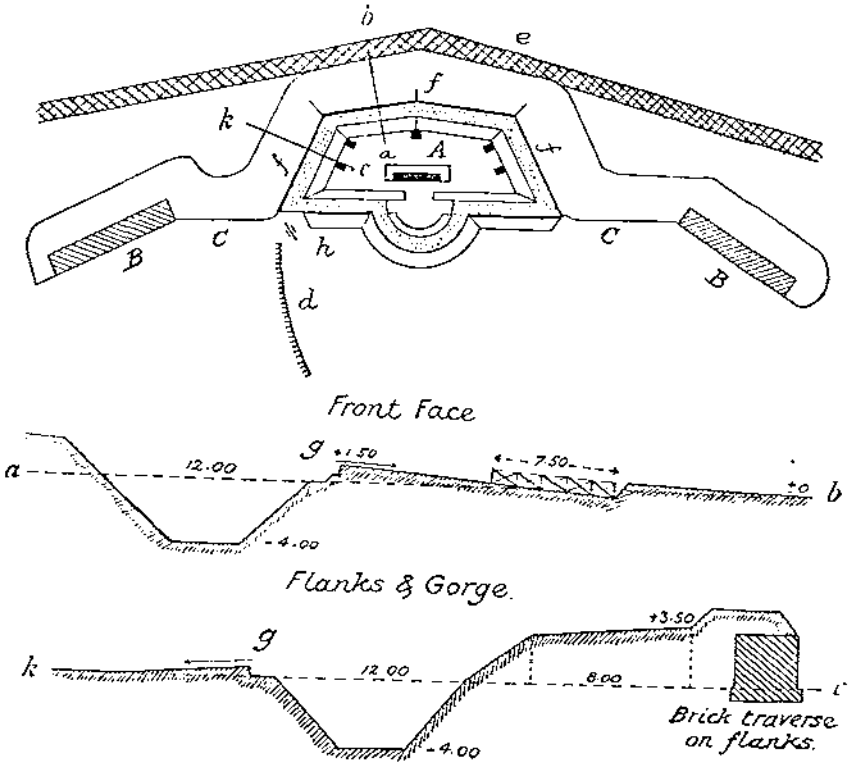


FIG. 1.—*Plan of the Shaitan-Tarla Group.*

A.—Fort Karagoz-Tabiya.
B.—Concrete Barracks.
C.—Communication Trenches.
d.—Rifle Trench.
e.—Obstacle.
f.—Firing Line.
g.—Rifle Positions.
h.—Gun for Opposing Assaults.

Measurements in Metres.

At 1¾ miles to the south of Shaitan-Tarla was the Fort Kazan-Tepe, (4), sited on a hill with a very good all-round command. This was a semi-permanent lunette, of glacis-shaped profile, with an entanglement, defended by frontal fire, and under the parapet concrete recesses for the men, giving overhead protection against splinters and shrapnel and common shells of field calibres. Within the fort were barracks built of stone in cement, the rear walls being of concrete. With gorge protection, this would have been the strongest work in the

fortress, but as there was none, the work could have been turned and easily captured, and had no value as a strong point.

The third fort of this section, Kazan-Kiuprii (5), was within ½ mile of Kazan-Tepe. It had no fighting value as it had been but lately begun and consisted only of a formless mass of earth.

The whole strength of the North-West Sector lay in the well-organized preparation of the intervals with fieldworks. Here were rifle trenches well sited and carefully disguised, which mutually commanded the approaches to one another and flanked sections of the wire entanglement. In rear of these, at 160 to 220 yards' distance, there were batteries, also well sited in concealed positions. Some of these were permanent, built of concrete, armed with 15-c.m. long guns and 21-c.m. mortars, on overbank mountings arranged for all-round fire, which gave them a very large sphere of action, for owing to the small diameter of the fortress they could fire with effect over the town in support of other sections. The concrete roofs of the traverses were less than 18 in. in thickness, and were demolished by single hits from the 15-c.m. howitzers of the most modern type, which the Servians possessed. In addition to this the batteries were very badly built and were damaged by the firing of their own guns, cracks appeared in the roofs, foundations gave way, and the concrete revetments of the parapets were destroyed. In this section of the North-West Front there were two concrete magazines, and several lighter ones.

In front of the main position, advanced positions, fortified with fieldworks, were prepared at the village Kidin-Keui and at the farm Yekmekchi-Keui. These consisted of series of rifle trenches and field batteries.

The main front of this sector, with the exception of Fort Karagoz-Tepe, had been begun since 1908 and was intended to keep the artillery of the attack at a distance from the town. In this it was only partially successful, as Kazan-Tepe was only about 5,500 yards from the town. The advanced positions were occupied to reduce this defect and effectively fulfilled their object.

In rear of the main position there was a second line of defence, consisting of three old forts :—Bash-Yiuk-Tepe (6), Kemer-Tepe (7), and Ainali-Tepe (8), and of several batteries of temporary character. The batteries were sited in front on the north side, in order to command the interval, of about 3,200 yards, between the Karagioz-Tarla and Shaitan-Tarla groups. Lastly, as a keep to the whole sector, there is the old, unaltered, but well-preserved, Fort Hedirlik (9), sited on a hill at about 1,600 yards from the town, near the suburb of that name.

In Fort Hedirlik, in spacious brick barracks, the Commandant Shukri-Pasha lived with his staff. Here also was the station of the wireless telegraph which worked with Constantinople.

This sector was considered as the most probable one to be chosen for attack. The ground favours the siting of siege batteries, and the most suitable road for the transport of siege materials runs through it from the Bulgarian frontier. For this reason the Turks (and Germans) paid most attention to it, and in it began their work of reconstruction of the fortress.

In criticism of this sector, it must be admitted that the *tactical* problem had been well met, the sites for the strong points were well chosen, the fortified groups well linked together by their fire, the batteries well sited. The three separate advanced positions were supported by fire from the main position, while in their turn they enfiladed the approaches to the forts and served as pivots of manœuvre for the active action of the garrison in this direction.

But *technically* the solution was unsatisfactory. The strong points were unfinished and were by no means forts in the real sense of the word. The writer suggests that they belonged to a German type of works "insecure against assault," as they were deficient in all-round fire and all-round obstacles, had no permanent obstacles, no defence of ditches, no cover in the rampart to protect the men from the fire of guns of large calibres, and were unprovided with casemated defence of the intervals between them.

As rifle positions they were unsuitable, as they were badly concealed, had narrow fronts, of from 100 to 150 yards, little area, and no defensible casemates. In no case could firing from them be maintained during an artillery bombardment, and their only value during the siege was that the concrete barracks gave protection against the 15-c.m. howitzers of the attack. As they were unable to protect the intervals between them, their military value was *nil*.

The permanent batteries in the intervals were technically unworthy of criticism, owing to the weakness of their casemates, and their inability to withstand the effects even of their own fire.

The defences of the intervals utterly failed to satisfy the requirements of permanent fortifications. They were purely fieldworks, but since the trenches were very well sited and of well-chosen types—many without parapets—the intervals had great strength as fire positions and were little damaged by artillery fire. The whole defensive strength of the sector rested in the intervals.

The continuous line of wire entanglement across the whole front of the sector was a grave technical error. It precluded any possibility of sorties, cut off the advanced positions from support, and doomed the defence to a purely passive course of action.

The best of the other works were the concrete magazines and the fine development of roads and narrow-gauge railways.

The W. Front.

(II.). The West Front, between the left bank of the Arda and the right of the Maritza, consists of a mass of hills stretching from east to west, shaped in a triangle, of which the apex rests on the village Marash, the point of confluence of the two rivers. A series of separate summits with flat tops and steep sides commands the valleys. The hill named Papas-Tepe is tactically the most important, and from this all the positions of the West Front were named.

The position is naturally very strong. The flanks consist of steep slopes and are protected by the rivers. The considerable width of front allows of the development of strong frontal fire, and the series of ridges allows of the development of the defence in depth. In the folds of the ground there is natural cover for reserves and batteries.

As it is about 6 miles from the town, and stands out in front of the

general line of the adjacent North-West and South Sectors, this sector forms a kind of caponier, commanding the approaches to its neighbours, while in their turn the batteries of the adjacent sectors command the approaches to Papas-Tepe. If an attack succeeded in capturing this mass it would obtain an excellent observation post, with a superb view of the town, the rear of the North-West Front, the suburb of Karagach with the railway station, and the whole of the south, low-lying front. The main and advanced positions of the adjacent sectors would also be commanded. But, although strong, it would be difficult to hold, as its comparatively narrow ridge would be swept by cross-fire from the batteries of the adjacent sectors.

From an engineering point of view the Papas-Tepe defences were entirely fieldworks. The most important item was a strong point, the only one of the kind in the fortress, consisting of a system of fire trenches, for one battalion, with fire in all directions, communication trenches, dug-out shelters on reverse slopes, and an entanglement protecting it on all sides.

This strong point was sited on the hill Papas-Tepe. In front of it, at about 1,000 yards to the west, on "Tomb" Hill, and on other hills in its neighbourhood, there were rifle trenches for about a regiment of infantry, and on the east of Papas-Tepe, on the hill Bekchi-Tepe, there were more trenches which served as a keep to the whole group.

In order to protect the flanks of the group from being turned from the direction of the river valleys the Turks had made trenches on the hillsides and extended them on one side to the Arda and on the other to the Maritza.

Two batteries of 12-c.m. field howitzers were well concealed and entrenched in folds of the ground, near the strong point. The tomb was converted into an observation post.

From this it will be recognized that the defences of the West Front were purely fieldworks, but they had considerable strength.

III. The *South Front*, between the right bank of the Maritza and the right of the Arda, is generally level. From the river valleys, near Karagach, the ground gradually rises towards the south-west, forming a low plateau. At 4½ to 5 miles from the suburb the hills begin, a branch of the Balkans, of which the highest is named Kartal-Tepe. The S. Front.

Near Karagach the ground is completely open, only the valley of the Maritza is hidden by copses and low jungle.

The somewhat wavy character of the plateau makes it possible so to site batteries in its folds, that even if the flashes of the guns are seen by the attacking troops, it is difficult to locate them accurately in any one of a series of such depressions.

The main position consists of a line of four old forts and 13 batteries. In the Maritza valley, at the village of Bosna-Keui, there is a fort of that name (10). At 2,000 yards from this village, at the village of Demirdesh, there is a fort of that name (11). At 3,200 yards beyond, near the suburb itself, is Fort Karagach (12), and at 1,000 yards from the latter is Fort Marash (13) on the right flank of this sector.

Between Forts Demirdesh and Karagach, near the railway embank-

ment there is, besides, an old dismantled fort, named Markez-Tibiya (14).

All these forts are old and of the 1885 reconstructed type, already described. In the 1908 project the Turks intended to make a new line of forts further to the south, in order to hold off the artillery of the attack from Karagach and the railway station. Permanent batteries were also to have been sited in the intervals between and to the rear of the new forts. The work of carrying out the recommendations of the project was begun, by German advice, by making these batteries, which consequently were *in front* of the existing fort line.

These batteries were partly of concrete and partly of temporary construction, and the magazines were only of temporary construction. In order to protect them it had been necessary to make rifle trenches, with a redoubt on the left flank (at about 160 yards from the batteries), and to stretch a wire entanglement from the Maritza to the Arda. Besides this, the following advanced positions, at distances of 5,500 to 7,000 yards from the batteries, were occupied and entrenched:—Pamuk-Sirti, Kartal-Tepe and Daudjaros (near the village of that name). All these positions were strengthened by fieldworks during the siege. The Turks held out in them for five months, and they formed strictly speaking the main defensive positions of the South Front.

The South Front position was also, therefore, mainly one of field character, and the wire obstacles were to a great extent *behind* it.

The advanced positions were correctly selected in accordance with local conditions, but the fortress batteries were too far to the rear and could not well support the infantry positions.

The N.E. Front.

IV. The North-East Front, between the left bank of the Tunja and the left of the Maritza, was in its turn divided into two sections, north and east.

The north section begins at the Tunja and extends to the ruins of the former village Arnaut-Keui. It is linked by fire with the Karagioz-Tarla group of the North-West Sector, and is naturally divided by the river Provadiiska into a plain and a hill section. The plain section was considered by the Turks as liable to be pierced by the attack, and was fortified fairly strongly. Between the Tunja and the Provadiiska, on the height of the Deptli-Mustapha bridge, spanning the Tunja, there were rifle trenches of full profile (*i.e.* with a covered way behind the firing step), with overhead protection against shrapnel bullets; at 1,000 yards to the front, on a ridge to the north of the Provadiiska, was another line of trenches. This front line was strengthened with automatic mines (weight of charge about 10 lbs., fired by means of friction tubes when trodden on), 30 in number, laid in a single line from the Tunja to the Provadiiska.

The second line was strengthened by a wire entanglement which stretched from the Tunja through the whole plain section to the foot of the hill, on which was placed Fort Koyalik (15), with adjoining batteries, armed with non-quick-firing field guns. The fort is of old construction, badly concealed, its high rampart showing up sharply on the hill. The hill slopes are steep and consequently there is dead ground at their foot.

In order to strengthen this fort the Turks dammed the Provadiiska, and made an unfordable inundation in front of it. Besides this, they extended the wire entanglement still further. The position thus obtained was very strong in front and its flanks were protected, the left by trenches on the low ground, sited in échelon backwards, and the right by the neighbouring group of the hill section, Kurt-Kaya, which flanks the approaches to Koyalik.

This Kurt-Kaya group consists of a mass of hills rising to 285 ft. above the valley of the river, and contained two forts, the old Tash-Tabiya (16) and the new Tash-Tabiya (17), with groups of rifle trenches and a few batteries.

The new Tash-Tabiya was a lunette battery of the eighties, with brick casemated traverses, but the guns had been removed. Within the fort there were large brick barracks for the accommodation of the garrison. Old Tash-Tabiya was a dismantled redoubt of the seventies, and lay at about 1,000 yards in rear of the other.

Once more, the strength of the group lay in the rifle trenches, which were well applied to the ground. Their profile was for firing standing, and they had traverses, but cover from shrapnel fire was non-existent.

From Fort Tash-Tabiya, across the whole North-East Front, right up to the Constantinople road, there ran a continuous belt of wire entanglement. Some of the rifle trenches had been pushed forward, and these had the wire obstacle behind them!

In second line, in the north section of this front, at a distance of about 3,200 yards, there were two old forts of the seventies:—Bashi-Tak-Tabiya (18) and Tashlik-Alti-Tabiya (19).

On the reverse slopes of the hills on which the forts were built there were temporary magazines.

Next to Tash-Tabiya stands Fort Aivas-Baba (20) in the salient angle formed by the north and east sections of the North-East Front. The angle is nearly a right angle, and the facility which it afforded of enfilading both fronts was not overlooked by the Bulgarians. The distance of the north section from the town is from 5,500 to 6,000 yards. From Aivas-Baba the fort line runs due south, approaching the town, from which the nearest fort is less than 1 mile distant.

The East Front occupies a sharply marked ridge, with gradual slopes towards the town and steeper ones (25° to 30°) eastwards, towards the valley in which runs the town water supply.

By its local conditions this is a very strong position. The ridge has a command over the approaches of 330 to 400 ft., and has splendid fields of view and fire. There is some dead ground, but its extent is insignificant, at the village Hassan-Aga in the Provadiiska valley. There are splendid concealed positions for artillery, and for communication with the rear, and the movement of reserves can be carried out in complete concealment from the enemy's view.

The fault of this position is the sharp outline of its crest, which facilitates the ranging of hostile artillery. This will be made very evident in the description of the fighting, and here no more need be said about it.

The ridge had been very badly fortified. In front line there were seven forts, 21 batteries, and a limited number of rifle trenches.

The forts, in the order of their siting from the salient angle, were named

as follows:—Aivas-Baba (20), Aidji-Yolu (21), Kestenelik (22), Kuru-Cheshmi (23), Yildiz (24), Top-Yolu (25), and Kavkaz (26). In the second line was Fort Kaik (27) built on a hill within the town.

All these forts were of old construction, remodelled in 1885, and from that time left without any alteration or repair. The remodelling, I would remind the reader, consisted only in providing brick casemates. (Although these roofs were of 3-ft. brickwork with $4\frac{3}{4}$ ft. of earth on the top, they were pierced by single 12-c.m. and 15-c.m. shells). The rifle positions were the glacis and covered ways, or ordinary fire trenches in front. In the covered ways, in rear of the glacis, there were in places traverses of sandbags, but there was usually no protection from shrapnel fire, from which in course of time the Turks received cruel punishment. Some of the forts had ditches, which were quite useless, as they were not swept by fire and presented no obstacles to assault. Fort Aivas-Baba had no ditch, but it had an old reduit, which was, however, not prepared as a firing line.

In order to give an idea of the construction of the "forts" of the East Front a sketch is given of Fort Aivas-Baba, which formed the main objective of the assault on March 24th—26th, 1913 (see *Fig.* 2). All the forts of the East Front had high ramparts ($11\frac{1}{2}$ ft.) above which the casemated traverses rose another 4 ft. The distances between forts were on an average about 1,000 yards.

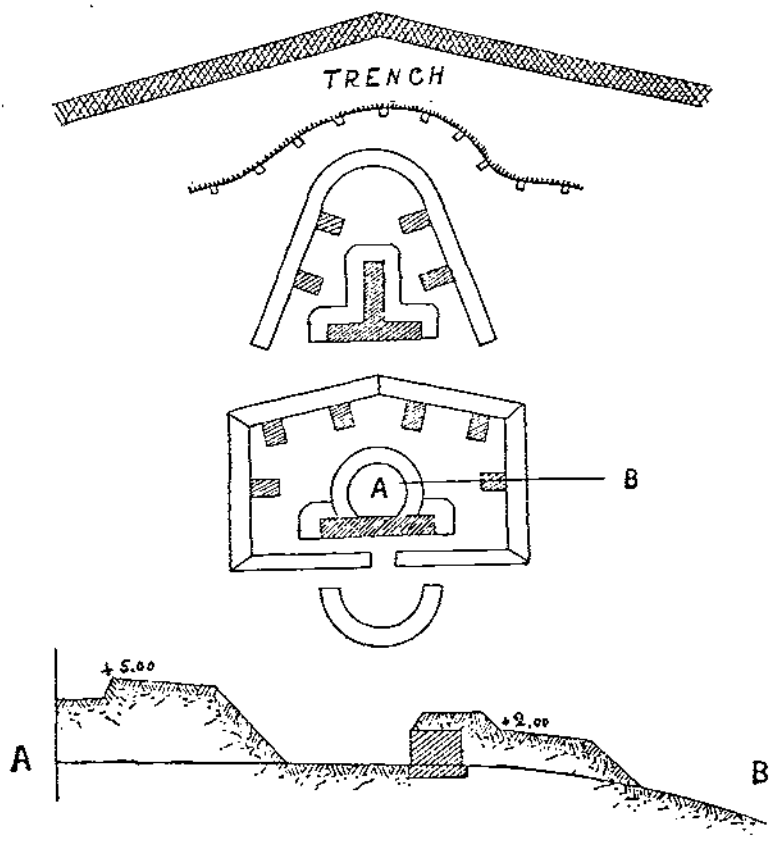


FIG. 2.—*Fort Aivas-Baba.*

The fortress batteries of the East Front were placed between the forts, in line with them, on the same ridge. The sites were exposed, and clearly seen from the front in spite of attempts at concealment. Only two batteries, one of 15-c.m. howitzers of new type and the other of mortars, were well applied to the ground in concealed positions.

The majority of the guns of large calibre had overbank mountings. The batteries were of temporary type with blindages of timber or corrugated iron, giving protection from splinters and shrapnel bullets.

As the batteries stood on the top of the ridge there was under them about 1,500 to 2,000 yards of dead ground, so that they could not be used in opposing an assault; they were also unsuitable for engaging the well-concealed batteries of the attack.

The batteries had magazines of timber, and the group magazines were of similar construction. At 2,000 yards behind Fort Yildiz, in a deep ravine, there were old brick magazines for the batteries of the whole sector.

The intervals between the forts were badly prepared. The trenches on the heights were unsatisfactorily disguised and they had no cover from overhead fire. And yet in this sector the trenches proved themselves the most important works, and offered the greatest resistance to the attack during the assault.

As the forts were so near to the town, the Turks fortified advanced positions on the ridge which began on the height Kara-Bair, through Maslak, Sapupjilar, Eski-Kumluk, to Demir-Kapu, inclusive, where ran the Constantinople main road. The distance of these positions from the main front is from 1,000 to 4,500 yards. Between Demir-Kapu and Fort Kavkaz another intermediate position was fortified on the Helvadji Heights.

These positions were fortified with fieldworks and included rifle trenches of various profiles, communication trenches, dug-outs on reverse slopes and field batteries.

Some of the trenches had the shape on plan of half-closed works, but they were certainly not redoubts, though in the Bulgarian map there is a redoubt shown in the Maslak group.

The advanced positions were separated from the main front by a valley and by a continous line of wire entanglement, which proved fatal to the Turks during the assault.

Thus the North-East Front, strong naturally, was very badly fortified. The Turks had endeavoured to reduce the defects of the main position by the construction of advanced positions, but the latter were weakly fortified, had no cover from artillery fire, and most serious of all, were not far enough away (*e.g.*, Maslak, on the left flank), so that the artillery of the attack without changing position could act effectively against both the advanced and main positions.

The advanced positions received a certain amount of support from the main position by artillery fire, but the infantry could not support them at the right moment as they were separated from them by the entanglement, while their defenders were unable to retire in time.

The advanced positions were of some use in hindering the artillery of the attack from bringing effective fire to bear upon the town, but the long-range guns could throw shells into it.

In any case the Turks should have left the main position and should have carried the whole centre of gravity of the defence to the advanced positions, which should have been more strongly fortified. But Shukri-Pasha, thinking that he had "forts," which turned out to be only shell traps and tombs for his men, took half measures, defending both the advanced positions and the main front weakly, and suffered complete destruction.

This completes the description of the fortress defences.

Recapitulation. Reviewing the whole it may be said that the North-West Sector was the newest and at the same time the strongest. Its strength lay in the favourable conditions of the ground, in its strong and well-sited artillery, in the presence of a small number of solid concrete shelters—barracks and magazines—and chiefly, and this was the case in the whole fortress perimeter, in the well-sited rifle trenches, and in the well-developed network of roads. Besides this the works of the second line and the Hedirlik reduit could co-operate in rendering the defence resolute.

The weakness of this front, as of all, was the want of strong points, proof against assault.

The West Front (the Papas-Tepe group) was strong by conditions of the ground and well fortified with *fieldworks;* the same may be said of the South Front. As regards the North-East Front, notwithstanding its favourable local conditions, owing to a whole series of tactical and technical blunders, it was the weakest.

The most serious technical faults were *the absence of light cover from shrapnel bullets and the misuse of wire obstacles.*

Garrison. In peace time, before the war, the garrison of Adrianople consisted of an army corps of two divisions, with a corresponding quantity of artillery, cavalry, engineers and subsidiary troops. The total number reached 25,000 men. For the siege, the cadres were filled up, and besides this the Bulgarian staff obtained information that the following troops of the 4th Army Corps had been added to the garrison :—

10th Infantry Division—28th, 29th and 30th Infantry Regiments (each of 3 battalions), the 10th Rifle Battalion, 10th Q.F. Artillery Regiment. Total, 10 battalions and 24 guns.

11th Infantry Division—14th, 32nd and 33rd Infantry Regiments, 11th Rifle Battalion, 11th Q.F. Artillery Regiment. Total, 10 battalions and 24 guns.

The 4th Rifle Regiment—4 Battalions.

Redif Divisions—The Adrianople Division, with the 1st division of the 9th Q.F. Artillery Regiment. Total, 10 battalions and 12 guns.

The Baba-Eski Division, 14 battalions.

The Gumurdjina Division, with the 1st division, 12th Q.F. Artillery Regiment, and 1 mountain division, 10 battalions and 24 guns.

The 12th Cavalry Regiment and part of the 2nd Cavalry Regiment, 6 squadrons. (The report of correspondents concealed in the fortress that after the Battle of Kirk-Killisse there were 40 squadrons, appears to be incorrect).

5 Fortress artillery regiments.

5 Machine-gun companies, and engineers.

Total, 58 battalions of infantry, 84 q.f. guns, 5 artillery regiments, 6 squadrons, engineers and subsidiary troops.

If a company is taken as 200 men, the total of the garrison according to this estimate would be about 50,000 to 55,000 men. But according to the information of the Bulgarian headquarters 60,000 prisoners were taken of the rank and file alone, so that taking into consideration losses, the total number of the garrison must be estimated at not less than 75,000 men. It is true that this probably includes a number of forcibly impressed Christians from the surrounding villages, who were serving with the Turkish train. At the head was the Commandant of the Fortress, Shukri-Pasha, who in the opinion of those who knew him was an upright man, but weak in character. The Wali, or governor of Adrianople, had great influence over him, persuading him to act with greater energy.

Equipment. The garrison were well equipped with everything necessary, clothing of a protective colour, boots, and their fezes instead of the traditional red were also of protective colour. A want of warm clothing was experienced, and consequently in the cold weather the soldiers put on anything they could find. This probably explains the quantities of all kinds of rags with which all the Turkish positions were littered.

The officers were well and even smartly clothed. In their case the fez had been replaced by special caps like grey Cossack fur caps.

Armament. *The Armament of the Infantry.*—The Nizam and Redif (European corps) had the 7·65-m.m. Mauser magazine rifle. The bullet was sharp-nosed (partly of the heavy-headed pattern of 1890). The number of cartridges carried per rifle was 120 on the man, 48 in the first line transport, and 131 in the park. Part of the infantry were armed with Henry-Martini rifles. The bayonet was long-bladed.

The infantry equipment included a small shovel.

The field artillery gun was the Krupp 7·5-c.m. shielded quick-firer.

Of machine guns they had 20 Maxims and 45 old Gatlings.

The cavalry were armed with Mauser carbines (9·5 m.m.); the rest of the troops were armed like infantry.

Training. The military education of the troops of the garrison was bad. The Nizam Infantry knew how to fire at a standing target only, the Redif had learnt nothing about shooting, and many of them now saw a rifle for the first time in their lives. In order to reduce their shortcomings in shooting the Turks made use of a method, called by the Bulgarians "parallel firing," of so shaping the parapet that if a rifle is laid on it and fired without aiming, the bullet will travel parallel to the ground in front. The Bulgarians admitted that this had some effect in improving accuracy of fire, but generally the shooting of the Turks was very bad.

Only the best of the Nizams had learnt the use of the shovel, and applied it during their sorties.

The firing of the artillery was little better than that of the infantry. In measuring ranges they were more successful, but they knew nothing whatever about the timing of shrapnel, and consequently their shells burst either very high or on graze.

Besides this the Turks had a habit, once the range was found, of not changing it, even though the target moved, and often continued firing at nothing. The shooting of the heavy artillery was no better than that of the field guns.

Moral.

The spirit of the garrison during the first period (up to the armistice) was kept up by the false information published in orders by Shukri-Pasha, informing inhabitants and garrison of brilliant Turkish victories or announcing retirements in anticipation of premeditated strategic combinations. But after the armistice, when the truth was known to all, it fell and repeated desertions occurred. The permission given for the free passage of Bulgarian supplies for Chatalja through the fortress had an especially depressing effect on the defenders. The Christians who were forcibly impressed into the ranks did not contribute to the *moral* of the garrison.

The Artillery Armament.

According to the information which had been collected by the Bulgarians up to 1911, the Turks intended to place in the fortress 192 guns of heavy calibres, and 320 to 325 field guns. Actually, it was found that the number was greater, exceeding 600.

On the positions, judging from the Bulgarian map, there were 30 batteries of heavy guns and 39 of field guns (without teams). In addition to this there were 72 guns (10·5 c.m., 12 c.m. and 15 c.m.) which at first were equipped with teams, but later lost their horses from want of forage.

The greater part of the guns were Krupp's, of both old and new patterns. By calibres and types the fortress artillery was divided in the following categories :—

8·7-c.m. field non-quick-firing guns	.. ..	39 batteries.
10·5 to 12 and 15-c.m. siege guns	.. ..	14 ,,
15-c.m. on overbank mountings with all-round fire (marked " Krupp—67 g ")	.. ..	13 ,,
15, 18 and 21-c.m. mortars on overbank mountings		3 ,,

The howitzers were of new types, 10·5, 12, and 15 c.m., included in the 72 which were equipped with teams.

Besides these, quick-firing field batteries were also included in artillery armament.

The 10·5-c.m. guns had the longest range (12,000 yards). The 21-c.m. mortars had the greatest explosive effect, making in clayey ground a crater nearly 15 ft. in diameter.

The shells were common (with powder), and high explosive. The shrapnel were of ordinary type, and there were also some star-shell, burning on burst for 2 to 5 seconds with a blue flame. Apparently there was abundance of military stores, for the Turks fired very extravagantly during the siege, replying with ten to each single Bulgarian shot.

The 10·5-c.m. long-range guns equipped with teams were of special value to the Turks; they appeared quickly in the most important sections and did great hurt to the attack. From the reports of eye-witnesses these guns were effective with shrapnel against aeroplanes, but besides these, as the writer was informed by the Bulgarian Head-quarters, the Turks appear to have had two Krupp guns of special construction for firing at aeroplanes.

Communication Roads.—The fortress was well supplied with these, especially in the North-West Front. The provision was worst in the East Front, where there was no metalled road—the main roads leading to Constantinople and to the north were only metalled in places—and the communication between the forts was carried out on an unmetalled road which ran along the crest, in places even in front of the forts. Unmetalled roads also ran to the advanced positions, and these, in rainy weather, owing to the clayey soil, became soft and difficult to traverse. Communications.

A Décauville narrow-gauge tramway was laid in the fortress, well concealed in folds of the ground, and well distributed. There were circumferential and radial lines. The rolling stock included five engines, of which three were small, and about 200 wagons of various types. There were also a few motor lorries.

The communication between the various sectors was carried out by bridges. There were between the North-West and the North-East Sectors, across the Tunja, six permanent bridges, of which two were of wood. Avoiding the town two stone and two timber bridges could be used. Between the North-West and North-East and the South Sector there was a single stone bridge, spanning the Tunja and Maritza, on the Adrianople-Karagach high road. Communication between the West and South Sectors could be carried out by the railway bridge, on which a timber roadway had been laid. Between the West and the North-West Sectors there was no direct communication.

In addition the Turks allotted to the fortress 118 iron pontoons with all the superstructure, etc., for making a bridge, but none was made, and the pontoons remained unused during the whole siege.

The want of good communication between the South and East Sectors prevented the Commandant manœuvring with his reserve, which had a disastrous result during the assault on the fortress by the troops of the Allies.

In Fort Hedirlik there was installed a wireless telegraph which maintained communication with Constantinople throughout the siege. In the same fort was the central telephone station, connected by underground cables with all the important works in which instruments were erected, 26 in number. The works were also connected with one another by telephones. There were also many field telephones. Telegraphs and Telephones.

Victualling Stores.—The fortress was abundantly provided with supplies. All the rumours of shortness of food were spread by fugitives from the fortress, generally by Christians, who actually did starve, as Shukri-Pasha economized the supplies for the sake of the troops. It was only due to widespread help which was organized by the Russian Consul, M. Klimenko, that the Christian population survived the siege. Supplies.

The grain, of which there was a large quantity, was ground in the large flour mills at Karagach. The Bulgarians endeavoured to demolish these mills by artillery fire, but failed to do so. A great quantity of cattle had been collected from the neighbourhood (15,000 head of cattle and 50,000 sheep).

By November all the stores of salt, sugar, kerosene oil, firewood (though many of the groves remained untouched) and hay for the horses had been expended. There remained no food for the horses, but the

soldiers would not eat horseflesh, and so it was arranged with the inhabitants to exchange it for that of horned cattle.

The soldiers received 1 lb. of bread daily. Later on the ration was reduced, probably in expectation of a long siege. There was no want of water, but it was necessary to drink river water, as the town supply had been cut off by the Bulgarians.

Balloons. *Subsidiary Means of Defence.*—There was one *captive balloon* of German make, with the help of which the Turks regulated the fire of their batteries, sometimes successfully.

Searchlights. Three *searchlights*, one of which was sited at first in the work Kasan-Tepe, and later in Shaitan-Tarla. Another was on the South Front and the third on one of the minarets of the mosque of Sultan Selim.

Engineer Stores. *Materials for Obstacles and Blindages.*—Barbed wire. Metal stakes 7'2 and 5'0 ft. in length. Timber stakes suitable for abattis. Half-round sheets of corrugated iron for blindages, of various sizes. A lot of timber, beams, posts and poles.

In addition to this the Commandant had at his disposal the whole town, in which he could obtain bricks, beams, planks, etc., in enormous quantities. He could also have used the rails from the Sophia-Constantinople line, by demolishing the portion of it within the fortress area.

Recapitulation. In recapitulation of the contents of this chapter it may be decided that Adrianople in 1912 was not a *fortress* of modern type, but judging by the North-West Sector the ideas embodied in the latest project are *modern German views*, which might have been materialized in the course of several years. The positions were naturally strong and, generally (except on the East Front), well satisfied the tactical problem, as defensive positions.

Care was displayed in the development of communications, but this was not carried as far as the provision of bridges; great attention had been paid to the fortress artillery, and yet it is impossible to allow that this problem was satisfactorily settled.

Attention had not been fully turned to the organization of the strong points for close fighting. The "Forts" (if one may so name them) were either utterly out of date, or only half-finished. The infantry positions were only field rifle trenches, not always of full profile and without overhead cover. It would follow that as the temporary batteries fulfilled their object with greater success than the quite useless concrete batteries, the material and labour expended on the latter would have been better spent on the better organization of the infantry positions.

The garrison though large was badly trained, the artillery strong but badly sited, and at the head was a man irresolute and weak in character.

In such a case *an attack by assault*, with effective support from heavy artillery, and generally well organized, was bound to be crowned with success; this by no means demolishes the theories of fortress warfare (as is the opinion of some authorities), but was evidently *in the given circumstances* the *normal method* of capturing the fortress.

F. E. G. SKEY.

(To be continued).

REVIEWS.

BUILDING CONSTRUCTION DRAWING (PART I.).

By R. B. EATON.—(Published by E. & F. N. Spon. 1s. 6d. net.).

THIS book which contains 26 plates of building construction details is a primer for students. The drawings are clear and bold and give examples of work which is met with day by day, but the lettering and figuring is rather crude to place before a beginner. There are concise specifications appended to many of the drawings which should prove very helpful to the student.

FLYING; SOME PRACTICAL EXPERIENCES.

By GUSTAV HAMEL and CHARLES C. TURNER.—(8vo. Messrs. Longmans, Green & Co., 39, Paternoster Row. Price 12s. 6d.).

MR. GUSTAV HAMEL and Mr. Charles C. Turner have presented the world with a work which will come as something of a surprise to those who are fortunate enough to open its pages. As the authors remark—"Many books have been written on the history and on the theory of mechanical flight; practical flying has been comparatively neglected"; but the reviewer, with a bookshelf full of works on mechanical flight, could scarcely avoid a feeling of reluctance to embark again upon the perusal of a subject which, notwithstanding the prefatory remarks of the authors, he might not unreasonably consider had been sufficiently written about for the present, and perhaps for some time to come. But having actually taken the plunge—or, rather, taken the book in hand, it was indeed difficult to lay it down again; it is a veritable mine of practical information, about every possible aspect of mechanical flight, written by men who are well qualified from their own experience or performances, to write upon the subject of practical flying; the book is profusely and beautifully illustrated and printed in comfortable-sized type; the subject matter is well arranged and logically divided under suitable headings in the list of contents, while a capital alphabetical index makes reference easy.

The chapter on "Accidents and their Prevention" is deeply interesting, showing as it does how very seldom an accident can be termed to have been unavoidable. "By the exercise of common prudence by manufacturers, mechanics, and aviators, the number of flying accidents

could be immediately diminished . . . every pilot could relate, out of his experience, a number of what might have been serious incidents caused by small and absurd oversights. Yet the lesson never seems to be learned; pilots are incredibly careless and casual, and they leave far too much to their mechanics."

In the taking of precautions the late Mr. S. F. Cody gave a good example, "he always bound his petrol tap, and locked every bolt of his engine, by drilling a hole and binding them with wire." In the chapter on the "Future of Flying" we read: "In spite of the loss of life there is a constantly increasing accession to the number of flyers, so that each year sees the total enormously enlarged. What is far more important is the fact that each year, eminent scientific men and engineers are joining in the study of the problems of flight, in the full realization that aerial navigation is no mere dream, and is not merely a means of play, but serious business that must have a profound effect upon human interests."

It is interesting to note that the authors suggest development "of machines that will fly with their engines working reliably at a very small proportion of their maximum power thus rendering them far less liable to break down; of machines with variable wing area and angle; of machines that will land at very low speed." The difficulties in regard to "variable wing area and angle" are generally realized, but it has only recently been established by Dr. Hankin that the variation of angle is actually practised by birds, through the rotation of the wing pinion, which adds greatly to the interest of mechanical evolution along the same lines.

There is a chapter on wireless for aeroplanes, with notes contributed by Marconi; and also a chapter on the medical aspect of aviation by Y. Elrick Alder, F.R.C.S., which should be studied carefully by all who fly or contemplate flying.

F. G. STONE,
Brig.-General.

NOTICES OF MAGAZINES.

Engineering News.

February 5th and March 12th, 1914.

The Testing of Sand for Use in Concrete.

This article gives detailed instructions for taking samples so that they may be truly representative; instructions for carrying out laboratory tests, with data and measurements required; computations from the data collected and interpretation of results. The details of the tests are too extensive to reproduce and will not admit of condensation. The following notes may, however, prove useful to anyone having to report on the quality of a sand, or to compare various samples. The tests should give 1.—Percentage of moisture in sand as received. This may make considerable difference in long-distance carriage charges. 2.—Percentage of material passing a ¼-in. mesh. This indicates the necessity or otherwise of screening and gives the percentage that can be truly considered as sand for proportioning concrete with broken stone. 3.—Mechanical analysis of sand passing a ¼-in. mesh. This is done by passing 100 grammes through sieves of the following number of meshes per linear inch, 5, 8, 10, 14, 20, 30, 40, 60, 100, 200. The weight passed gives the percentage directly. The result indicates whether or not the sand is well graded. 4.—Weight per cubic foot of dry sand. 5.—Percentage of voids. 6.—Specific gravity of sand. 7.—Specific gravity of particles: should not be confused with 6. 8.—Percentage of silt. 9.—Combustible matter in silt. 10.—Tensile strength of cement-sand mortar of various proportions at 3, 7, and 28 days. 11.—Resulting volume of mortar yield for various proportions. 12.—Weight per cubic foot of mortar. 13.—Percentage of absorption of mortar. 14.—Compressive strength of mortar after 7 and 28 days. 15.—Permeability of mortar or concrete blocks.

February 19th, 1914.

The Autoclave Test for Cement.

This method of test, devised by Mr. H. J. Force of the Delaware, Lackawanna and Western Railway, has been the subject of previous articles (June 13th, 1912; January 23rd and July 10th, 1913) and correspondence. A United States patent has been issued covering this method, which is described below.

Briquettes are made as usual and stored in a moist cupboard for 24 hours. Three are then broken in the testing machine. Three others

are weighed and subjected to boiling under pressure. The pressure must be higher than 50 lbs. per sq. in., and is preferably 285 lbs. per sq. in. as the time required is thereby reduced. The briquettes are placed in a suitable vessel containing water at 70° F., which is then closed and heat applied. It takes about an hour to develop the pressure of 285 lbs. and this is maintained for another hour. When the pressure has been reduced the briquettes are placed in the moist cupboard for half an hour, are weighed and then broken in the testing machine.

The briquettes should be uninjured by the boiling and should show no cracks on the surface; the increase in strength should be at least 25 per cent., and the strength after treatment should be at least 400 lbs. per sq. in.; and the weight should not show an increase of over 1 per cent. Square bars 1 in. × 1 in. × 6 in. treated as above should not increase in length more than ½ per cent. during the test.

Only high-class cement suitable for sound and lasting concrete and of extreme fineness will pass this test. Inferior cements will crumble and disintegrate.

TESTS OF MODERN HIGH-SPEED BRAKES ON FAST PASSENGER TRAINS.

Tests of the new Westinghouse electrically controlled brake were carried out in 1913 on the Pennsylvania Railway. The train consisted of 12 steel passenger cars and a heavy locomotive, weighing in all about 1,000 tons and being about 1,000 ft. long.

Of special interest to structural engineers is the retarding force during stops, which must be allowed for in the design of bridges. The above-mentioned train with the new brake, 150 per cent. braking power and two unflanged brake shoes per wheel produced the following results:—

Speed. m.p.h.	Length of Stop. Feet.	Average Retarding Force. lbs. per ton.
30	200	300
60	1,000	240
80	2,000	214

This force, as far as a bridge is concerned, is distributed according to the wheel loads.

With the new brake the application is simultaneous on all cars regardless of length of train, so that there is an entire absence of shock, and as there is no reduction of train pipe pressure release is quicker. Maximum brake shoe pressure is obtained 2·25 seconds after application.

February 19th and 26th, 1914.

CONCRETE ROADS.

At Chicago, on February 12th, 13th and 14th, there was held the National Conference on Concrete Road Construction. At it reports were presented covering the latest practice in all parts of the country, in connection with this type of construction. Concrete had long been considered an unsuitable material for road construction and even those who first adopted it were sceptical of its success. It is therefore not surprising that the first experiments were failures. Most of the causes of failure are now understood and many successful roads of this material

have since been made. In its favour it may be said that it is second only to granite blocks in point of durability; with properly selected materials it is less slippery than most other road materials; if a moderately rich mixture is used it is homogeneous and impervious to moisture; it requires but little maintenance; and, if suitable equipment is used, it can compete with any other material in point of cost (in fact, there are few other types of road that can be laid as cheaply).

Material and Workmanship.—Both sand and coarse aggregate may consist of the same material, which should be clean, hard, durable granite, trap, conglomerate, gravel or other hard rock, free from dust, loam or vegetable matter. Sand, as defined, is such that it will pass a ¼-in. sieve, of which not more than 10 per cent. will pass a 50-mesh sieve and 2 per cent. a 100-mesh per linear inch sieve. Coarse aggregate is such that it will be retained on a screen with ⅜-in. openings and will pass 1½-in. and 2-in. screens for one and two-course work respectively. For two-course work the top course aggregate should pass a ⅜-in. mesh and be retained on a ¼-in. mesh. Natural gravels and crusher run stone should be screened to above standard and remixed in the proper proportions. For one-course work the mixing proportions are 1 : 2 : 4. For two-course work the proportions are 1 : 2½ : 5 for the base and 1 : 2 for the top coat. The best results, as regards mixing, have been obtained with concrete of medium consistency. No more water should be used than is necessary to allow the correct surface form to be obtained by striking with a template. The surface should be finished with a wooden float. It should be then covered with sacking, sawdust or other suitable material and kept well wetted for seven days.

Drainage.—Efficient drainage of the foundation is a necessity. If the concrete is well made no water will penetrate it and one's whole attention should be devoted to preventing penetration of water under the edges of the slab. If sufficient attention is paid to drainage an elaborate broken stone foundation does not appear to be necessary. The soil should be hardened with a steam roller, great care being taken to avoid soft spots. On clay soils, naturally soft, reinforcement in the concrete may be required in addition to drainage.

Design.—There is a growing tendency to make the foundation level or slightly dished, as this, in conjunction with crowning of the upper surface, gives a slab thicker in the centre than at the edges. For roadways up to 16 ft. wide, on soils more or less porous, taking loads up to 6 tons, the centre should be 7 in. thick and the edges 5 in. thick. For the above road on clay soil, or for wider roads, or for loads up to 10 tons the centre should be 8 in. thick and the edges 6 in.; reinforcement (¼ to ½ lb. per sq. ft.), placed 2 in. below the surface, will generally be required and is an economy. The road should be laid in sections not exceeding 16 ft. in length and the joints filled with a bituminous compound. On country roads where there is no curb to provide lateral support for the edge of the concrete a shoulder of bituminous macadam should be provided. The crown used varies from ⅛ in. to ¼ in. per foot width of road and experience indicates that even smaller proportions can be used with success.

Expansion and Contraction.—Many measurements of concrete roads have been made at all seasons of the year with instruments reading to 1/100 of a millimetre. The results showed that concrete, exposed to the weather, behaved like wood, in that the absorption of moisture caused more expansion than a rise of temperature of 90° F. On drying out the concrete returned to its original length. The greatest length was in April, when the temperature was about average value, and the least length in August, when the temperature was highest, with more or less uniform change between. In general the length varied directly with precipitation and melting of snow.

W. G. TYRRELL.

REVUE MILITAIRE.

September, 1913.

The Army Estimates of Great Britain for 1913–14 are discussed. A *résumé* of the Siamese Army is given.

October, 1913.

FOREIGN INTELLIGENCE.

United States of America.—The American flying corps appears to be still rudimentary, of 18 officers only 9 hold flying certificates. There are flying stations at San-Diego, 10 aeroplanes; Texas City, 2 aeroplanes; Fort Leavenworth, 1 aeroplane; Manila, 2 aeroplanes; Honolulu, 1 aeroplane. All the machines are biplanes.

November, 1913.

THE FINANCIAL PROVISION OF THE NEW GERMAN ARMY LAW.

It is pointed out that the net effect of the law is to bring into being the provisions of the 1912 law within 18 months instead of within 4 years. The result is shown very clearly by means of a table.

THE DANISH ARMY IN 1913.

The army is organized in 2 commands to the east and west of the Great Belt. The former consists of 3 divisions, the latter of a mixed brigade. There is a small garrison on the island of Bornholm, and fortress troops at Copenhagen. On a war footing the army is 69,000 strong; its equipment is inferior.

December, 1913.

THE JAPANESE ARMY.

The remarkable efforts made, since the Russo-Japanese War, by the Japanese War Ministry, by which the army has been almost doubled, are discussed. The original intention was to bring the army up to a strength of 25 field, and a like number of reserve divisions, by a programme distributed over a number of years. The programme is, however, at present in abeyance as the result of popular agitation.

E.R.

Revue Militaire Suisse.

March, 1914.

Self-Instruction for Young Officers outside the Service.

By Major Verrey.—This article contains valuable hints, intended for officers of a Militia army, for acquiring a good knowledge of their profession by study at home. It should be interesting to officers of the Territorial army.

Revolver Practice for Officers.

A lament, from 1st Lieut. John F. Revilliod de Budé, of the Landwehr Artillery, that officers take so little interest in revolver shooting. He calls upon the government to make compulsory an annual course of revolver shooting for all ranks armed with that weapon, and would entirely abolish the sword for officers, except for parade purposes in peace time.

The Bridging Regulations.

By L.—After preliminary remarks as to the absolute necessity for good bridge equipment in the Swiss Army, the writer proceeds to give a short summary of the new regulations. In the first place they are "regulations," and not "instructions" as hitherto. The equipment is not altered. The old instructions did not enter upon the field of tactics, but the new Chapter VI., describing the crossing of a river in face of the enemy, is essentially tactical. The position of the bridge having been determined by tactical considerations, troops must first be passed over to secure the further bank. This operation will probably take place at night or early dawn, and at a different place from that selected for the bridge.

The pontoons are removed from the wagons when the latter can advance no further under cover, and the troops detailed for the attack of the further bank are instructed in embarking and disembarking. The pontoons are then carried to the bank, and two sections joined together to form a boat, which will hold 16 to 20 soldiers in addition to from four to six boatmen. The boats must all be launched at a fixed time, and as rapidly as possible, since signalling will be difficult. Meanwhile the troops intended to cover the crossing, infantry and artillery, will have taken up their positions.

The attacking troops immediately embark, rifles unloaded, bayonets fixed. During the passage the men remain seated till ordered to rise, no reply being made to the enemy's fire. The landing is the critical moment—probably the best method will be to throw grenades, charge with the bayonet and clear the bank. Beyond this the first troops will not advance for the present. The boats then return, and continue to transport the attacking force.

Orders are required (1) for the troops attacking, (2) for the boatmen of the bridging troops. The regulations do not lay down any strengths for these. At Dietekon, Massena transported 600 men at each crossing, and a brigade—one-third of his total strength—altogether, using 37 requisitioned boats, and two bridging companies. For a brigade nearly two Swiss Army bridging trains would be required. (3) for the covering

infantry—probably a battalion, (4) for the covering artillery—at Dietekon, Massena concentrated 28 guns, a strong force for that period, (5) for the main body, which will have to cross later by the bridge, and (6) for the construction of the bridge itself. At Dietekon the actual bridge equipment was brought up as soon as the first 600 men had been ferried over, and the remainder of the attacking troops were conveyed in the requisitioned boats. The bridge was commenced at 5 a.m. and completed by 7.30 a.m., by which hour 8,000 men had been ferried across. By 9 a.m. the whole of Lorge's Division (16,000 men) was on the further bank. The width of the river was 90 m.—16 pontoons.

The army bridging train will suffice for a bridge 158·4 m. long, or 18 boats carrying 360 infantry. The six divisional trains will suffice for a second bridge of the same length.

The old instructions only laid down a bridge 3 m. wide for all troops and vehicles, and a footbridge 1·5 m. wide for infantry in file. The new regulations deal with the construction of three footbridges, 1·5 m. for infantry in file and single troopers, 2·25 m. for columns of march, single troopers or light vehicles without their teams, and a column bridge 3 m. wide, for infantry in column of route, cavalry in file and vehicles up to 3,000 k.g. (3 tons nearly) in weight. For this seven roadbearers must be used instead of five. Also a heavy bridge for 12-c.m. guns on their carriages, and motor vehicles up to 6,000 k.g. This bridge necessitates a special strengthening of the supports, of roadbearers, and double decking.

Another innovation is the carrying of a steel cable, to stretch across the river to moor the pontoons to, where the anchorage is bad.

THE ORGANIZATION OF THE INFANTRY TRAIN.

By Capt. Gouzy, Officer of Train, 4th Infantry Brigade.—Each battalion has a mounted corporal of the train, and an officer of the train (Lieut. or Capt.) is attached to the Regimental Headquarters, also another officer (Capt. or Major) to Brigade Headquarters. A weak point in the organization is that a Quartermaster is often placed in command of sections of the train. He has too many other matters to attend to for it to be possible for him to be always with his column, and even if he is present he generally knows little about horses, and the details of their harness, watering and feeding, dressing of wounds, etc. If no officer of the train can be spared for such a section the Quartermaster ought at least to have a N.C.O. of the train under his orders to superintend these essentials.

The rank and file used to be trained by the artillery, but are now distributed to all arms. This does not tend to uniformity in their training, and many commanding officers cannot take much interest in them, or use them as orderlies and for barrack fatigues. This is to be regretted. The writer would like to see a return to the old system, or some modification of it, and this would probably be financially sound, leading to better care being taken of the horses. Officers should be given some executive as well as departmental control over their men, horses, and equipment generally.

April, 1914.

THE SECTION COMMANDER.

By Lieut. Turin.—The writer sets out to define the qualities necessary to produce the ideal section commander, and comes to the conclusion that character is the basis of all. He must also be endowed with a thorough military spirit, and keep war, and the preparation for it of himself and his men, constantly in view. The success of the Japanese was due in a great measure to their true military instinct, the failure of the Russians to their lack of this attribute. Every soldier must be prepared to sacrifice himself if necessary to save his comrades; it is the good section commander who, by precept and example, can best imbue his men with this spirit.

THE OPERATIONS OF THE SERVIAN ARMY.

By A.—This sketch is continued from the close of the Battle of Kumanovo up to the Battle of Monastir, of which there is a map. The march of the third army to Durazzo is also shortly traced.

THE MICHOUD ELECTRO-MECHANICAL TARGET.

When using this appliance the approximate position of the shot is shown upon an indicator at the firing point. The target is constructed of as many metal rings as there are different points to be scored in the competition (figure targets are divided horizontally into three sections—head, body, and legs) and is fixed in a frame. Behind the target are hung from the frame four pendula. On a shot striking one of the annular rings, this ring is slightly forced back against one or more of the pendula, which by their movement complete an electric circuit through a battery and cable to the indicator. The ring is then returned by springs to its normal position. The indicator is a miniature target, divided by lines into eight sectors (line high, high right, right, low right, etc.), and has under it a dial showing the value of the hit. A hit on the edges of two rings causes two figures to appear. High left, high right, low right, low left are indicated by the letters A, B, C, D in the respective sectors; hits in the intermediate sectors are indicated by two letters appearing, one on each side of the sector hit. The apparatus is said to be very strong and durable, accurate, unaffected by weather, and to be superior to marking by hand, but as it cannot record misses a marker at the target is required to show the direction of a miss.

STUDY OF MOTORS FOR AVIATION.

By Major Le Royer.—Progress is traced from the four-cylinder motor through those with eight cylinders, and cylinders arranged like the points of a star, to rotatory motors. The latter obviate many of the disadvantages of the earlier patterns, and tend to greater lightness of all parts of the machinery for the same horse-power. They however consume more fuel. The writer considers the Rhone engine the best hitherto constructed. When, however, a long flight is projected without a halt the engine with fixed cylinders has the advantage owing to the difficulty of carrying sufficient fuel for the rotatory engines.

A.R.R.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1914.

THE ARMAMENT AND THE OFFENSIVE EMPLOYMENT OF AIRSHIPS.

There is generally a good deal of uncertainty as to the best way of employing airships for offensive purposes, and for many reasons this can hardly be wondered at since experience is lacking in their intrinsic offensive capacity, and the method by which this offensive capacity can be rendered useful in the operations of war.

The first results to be obtained from such experience may be divided under three heads, viz. :—

I. *Armaments.*—How ought airships—dirigibles and aeroplanes—be made and armed so as to be best fitted for employment?

II. *Offensive Action.*—How can they best be used for means of offence?

III. *General Offensive Employment.*—How can the offensive action of the airships can be best utilized in a general action?

Armaments.

The armaments of airships is really regulated by two conditions (1) the specific weight of the different kinds of ammunition, and (2) the natural limited capacity that the airships may possess for carrying useful loads.

At the first glance it would appear that the airship possesses a very secure and efficacious method of offence, but an examination of the question shows that this is not so. Its utility is restricted both by its having to carry heavy loads, such as ammunition in large quantities, and also by the difficulty of determining the right moment for discharging a projectile, when travelling at great speed and under indeterminate atmospheric fluctuations.

When studying therefore the armament of airships the following two special points have to be considered, viz. :—(*a*) that the material should be as light and effective as possible ; and (*b*) that the material be utilized in the best possible way.

The solution of this problem has of course been much assisted by the discovery of light metals of great resistance, and of explosives of great power which can be used with ease and safety. On the other hand one must remember that the ammunition when it consists of large and heavy projectiles, cannot (in a proper sense of the word) be *discharged* from airships, but that it can only be dropped, as the car of a dirigible would not support the weight and the shock necessary for firing large projectiles with considerable initial velocity. Airships should therefore give up all idea of heavy artillery as being unsuitable.

Projectiles designed for dropping only can be arranged more easily and with greater efficacy and are of less specific weight than artillery projectiles, which is of course a great advantage for use in airships.

Light ammunition (as for example that destined for moving objects, or against lightly resisting targets such as the enemy's airships) may be discharged from machine guns or small cannon with considerable initial velocity. Even in the case of dropping fire it is advantageous if possible to use some means of propulsion as it obviates the necessity

of passing exactly over the target. But the need of using heavy mechanism to allow this to be done, counterbalances the advantage gained. It may safely be assumed therefore that heavy projectiles should be used for dropping against resisting targets, and small projectiles should be available for discharge against aerial targets. It must not be forgotten that in firing against moving objects with small projectiles (as for example those discharged from mitrailleuses) the effect is not great owing to the bullets striking at a great angle.

The armament for airships may be treated generally under three headings:—(*a*). Dropping fire with heavy and powerful projectiles against resisting targets; (*b*), dropping fire with bursting projectiles and bullets against moving objects; (*c*), discharging fire with small projectiles against special targets and particularly against aerial targets.

(*a*). *Dropping Fire with Powerful Projectiles against Resisting Targets.*—Destructive action against resisting targets requires the use of large and heavy charges. Ordinary artillery, and especially field artillery, is limited in the employment of these heavy projectiles both because of their weight and also because guns that are designed to fire them are much more difficult to manœuvre. The airship, however, is not affected to the same extent. In this respect it has a very great and special advantage over artillery, and one of the principal reasons for the offensive action of airships is that they can carry greater explosive charges for destructive action than the artillery. Siege guns can use projectiles of the great weight of 164 k.g. with charges of 31 k.g.; ordinary artillery, including heavy artillery, can use projectiles of 40 to 45 k.g., with charges of 8 to 10 kilogrammes. A dirigible—even a small one—can carry projectiles of 100 kilogrammes, containing half a quintal of explosive. Besides this advantage, the airship can use projectiles of a shape and size better fitted for the explosive charge, whilst the artillery require their size and weight to be adapted to the bore and grooving of the guns, independently of their explosive effect. For the ammunition for airships for dropping fire against resisting targets the following types are recommended:—

(*a*). Great shells of 100 to 150 k.g. with 25 to 40 k.g. of explosive to be used against targets of the greatest resistance.

(*b*). Great torpedo shells of 100 to 150 k.g. with 40 to 60 k.g. of explosive of less diameter than the former for targets of not very great resistance.

(*c*). Medium-sized shells of 50 to 60 k.g. with 20 to 25 k.g. of explosive for targets of medium resistance.

(*d*). Small shells of 15 to 20 k.g. with 6 to 8 k.g. of explosive for special fire against targets of secondary importance and of small resistance.

The small dirigibles can only use the medium-sized and small shells. The mechanism for dropping the shells is simple. The shells themselves can be arranged in a convenient position in the car, and dropped through a tube or other system for guiding the commencement of the fall. The use of these projectiles on board is safe and simple provided that the airship is properly steered and that the projectile is dropped at the right moment.

Dropping Fire with Shrapnel Shells against Moving Objects.—To strike moving targets is an important, but not the principal *rôle* of airships. At a height of 1,000 to 1,200 metres it is difficult to see moving objects, and the measures adopted for concealing the troops reduce the offensive action of airships. The ground seen from a height of beyond 1,000 metres assumes a characteristic aspect in which all the distances are shortened and all the secondary details disappear. It becomes, as it were, minute and fading away in the vast horizon. Infantry is only discernible in mass assuming the appearance of a narrow track in the road. Cavalry and artillery have a slightly more consistent appearance than the infantry, but are surrounded by a string of dust which conceals the main body and the rear of the column. Fieldworks, siege works, trenches, batteries and redoubts are usually more visible, but they also appear as small furrows, with thin shadowy lines.

Discharging Fire with Small Projectiles against Special Targets particularly against Aerial Targets.—The automatic weapons of small calibre, mitrailleuses, etc., have now attained a high grade of simplicity and lightness, and work with security and rapidity. These are considerations of much value in the armament of airships. Their weight, indeed, is very small, scarcely more than a dozen kilogrammes for mitrailleuses of small calibre, up to 80 to 100 k.g. for small cannon of 25 to 30 m.m.; their rapidity of fire is wonderful, rendering them capable of developing a great fire action in a short time; and their automatic action works so well that there is less recoil, with the advantage of security against fires. Mitrailleuses with the calibres of rifles are now reported to be installed in the monoplanes and biplanes, and in the cars of dirigibles; mitrailleuses of greater calibre are carried in the upper part of certain dirigibles, viz., Zeppelin.*

E. T. THACKERAY.

* Recently at the fifth exhibition of locomotives at Paris, a Hotchkiss mitrailleuse was exhibited in the upper portion of the car of the dirigible "Astra" of 23,000 m³, built for the French and Russian Armies.

CORRESPONDENCE.

NOTES ON R.E. WORK AT SIERRA LEONE.

DEAR SIR,

With reference to the article on the above subject which appeared in the *R.E. Journal* of May, two points suggest observations, founded on my experience as O.C.R.E. in the Colony in 1909–10–11.

1. *Eaves Gutters.*—In 1908 the eaves gutters at Tower Hill were removed as they were said to harbour mosquitoes. It was found that in their absence the heavy rain streaming down the sides of the buildings did serious damage and caused great inconvenience to the occupants. The gutters were accordingly replaced.

Eaves gutters must be kept clean and constantly inspected to see that they do not sag and furnish breeding places for mosquitoes.

2. Joinery made with locally purchased timber which has seasoned in the Colony is much better, and in the long run cheaper, than joinery made at home.

3. As regards cost of work, a great deal depends on the chasing power of officers and M.F.W.'s. To get work done cheaply both officers and M.F.W.'s must be physically fit.

4. This brings up the most important point of all, viz., how to keep Europeans fit in the unhealthy climate.

I found that moderation in all things, and as much hard work and walking as possible, kept our men the most healthy troops in the garrison. (Sleep and sloth are even more deadly to health than the mosquito).

I hope that these notes may be of some use to future R.E. inhabitants of Sierra Leone.

G. WALKER, *Major, R.E.*

Curragh Camp, 4th May, 1914.

The Editor, *R.E. Journal.*

BOOKS RECEIVED.

WIRELESS TELEGRAPHY. A Handbook for the Use of Operators and Students. 154 illustrations. By W. H. Marchant. 1914. Price 5s. net. Whittaker & Co., 2, White Hart Street, Paternoster Square, London, E.C.

HISTORIQUE DE LA GUERRE SOUTERRAINE. Par A. Genez, capitaine du génie. Un volume in-8 de 297 pages, avec 37 figures et 13 planches hors texte. Prix 5 fr. Berger-Levrault, éditeurs, 5-7, rue des Beaux-Arts, Paris.

LA FORTIFICATION DANS LA GUERRE NAPOLÉONIENNE. Par le Général Camon. Un volume in-8, avec 15 figures. Prix 2 fr. Berger-Levrault, éditeurs, 5-7, rue des Beaux-Arts, Paris.

THE CHANGES IN THE CLIMATE. By Major R. A. Marriott, D.S.O., late Royal Marine Artillery. 1914. Price, paper wrapper, 1s. 6d.; cloth binding, 2s. 6d. E. Marlborough & Co., 51, Old Bailey, London, E.C.

TECHNICAL WORDS AND PHRASES. An English-German and German-English Dictionary. Cloth, 2s. 6d.; leather, 3s. 6d. 1913. E. Marlborough & Co, 51, Old Bailey, E.C.

THE MILITARY POLICY AND INSTITUTIONS OF THE BRITISH EMPIRE. An Essay by C. W. Pasley, Captain in the Corps of Royal Engineers. Edited in the Light of the Science of Organization by Colonel B. R. Ward, R.E. 5th edition. 1914. Wm. Clowes & Son, Ltd., 31, Haymarket, London, S.W.

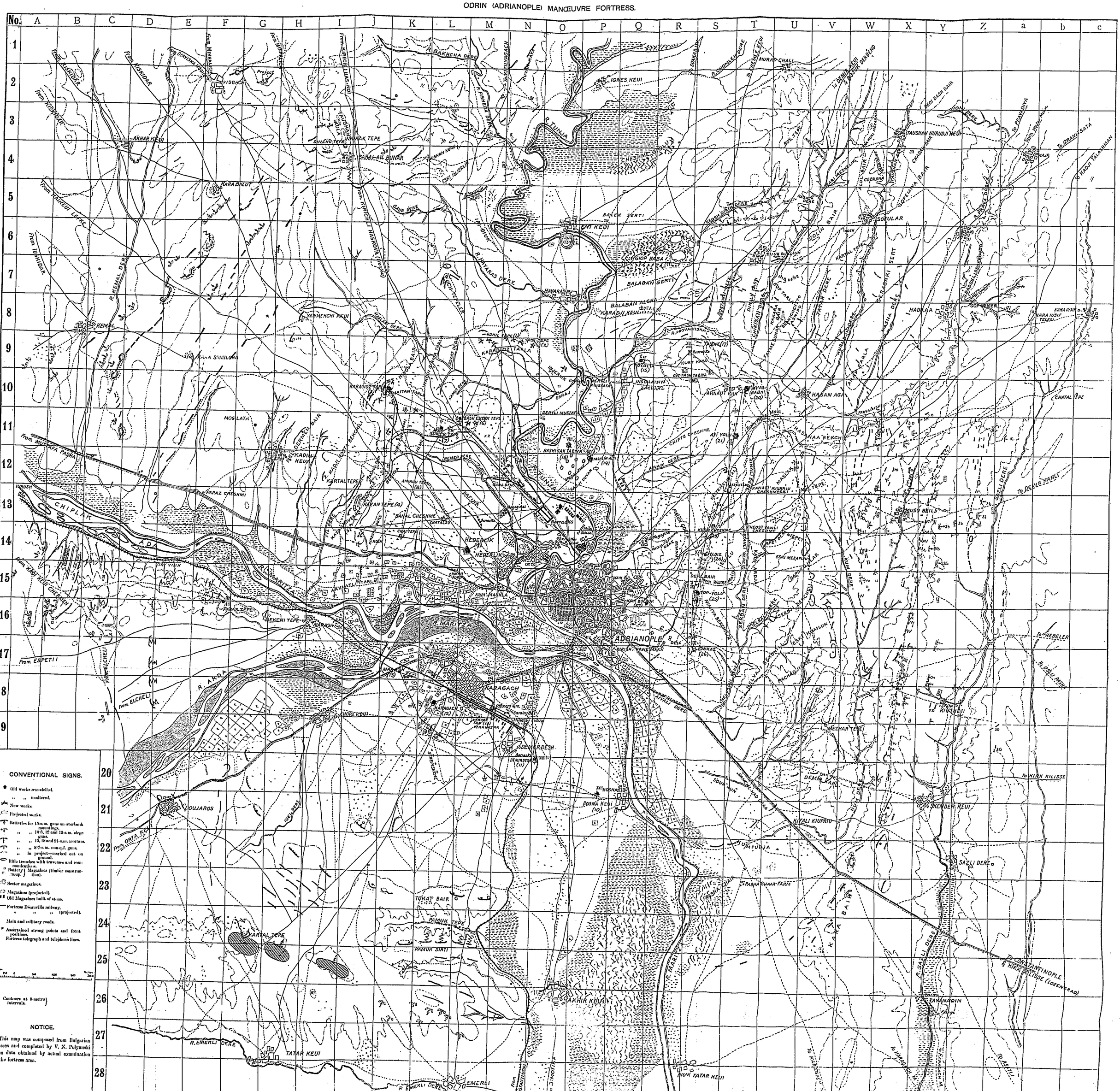
AN ELEMENTARY TREATISE ON THE CALCULUS FOR ENGINEERING STUDENTS. With numerous Examples and Problems worked out. By John Graham, B.A., B.E. 1914. 4th edition. 116 illustrations. Cloth. Price, 5s.; by post 4d. extra. E. & F. Spon, 57, Haymarket, London, S.W.

BUILDING CONSTRUCTION DRAWING. A Class Book for the Elementary Student and Artisan. Part I. 26 plates. By Richard B. Eaton. 1914. Price, 1s. 6d.; post 2d. extra. E. & F. Spon, Ltd., 57, Haymarket, London, S.W.

PLAN

OF THE

ODRIN (ADRIANOPLE) MANŒUVRE FORTRESS.



CONVENTIONAL SIGNS.

- Old works remodelled.
- " " unaltered.
- New works.
- Projected works.
- Batteries for 15-c.m. guns on overlauk mountings.
- " " 10·5, 12 and 15-c.m. siege guns.
- " " 15, 18 and 21-c.m. mortars.
- " " 8·7-c.m. mon-q.f. guns.
- " " in project—marked out on ground.
- Rifle trenches with traverses and communications.
- Battery) Magazines (timber construc-
- Group) tion).
- Sector magazines.
- Magazines (projected).
- Old Magazines built of stone.
- Fortress Décauville railway.
- " " " (projected).
- Main and military roads.
- * Ascertained strong points and front positions.
- Fortress telegraph and telephone lines.

Metres 500 250 0 500 1000 1500 Metres 2000

Contours at 8-metres intervals.

NOTICE.

This map was compiled from Bulgarian sources and completed by V. N. Polyanski from data obtained by actual examination of the fortress area.