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THE R.E. MUSEUM.

By MAJOR W. A. HARRISON, LATE R.E.

Now that the reorganization of the R.E. Museum is almost completed, a short account of its history and contents may prove of interest to readers of the R.E. fournal.

Although from soon after the foundation of the S.M.E. articles of interest were collected together in the Model Room, which was used both as a Model Room and Church, the first attempt at an organized Museum dates only from the completion of the R.E. Institute, when one of the largest rooms was set apart as a Museum under the charge of the R.E. Institute Committee.

A further advance was made towards the end of 1880, when, on the motion of Major and Brevet Colonel (now Sir Richard) Harrison, C.B., a sub-committee consisting of Lieut.-Colonel (afterwards Sir J.) Donnelly, Capt. (now Sir H.) Jekyll, and Lieut. L. Darwin, with Major R. Vetch as Secretary, was formed to consider "how best to furnish and arrange the Museum at the R.E. Institute at Chatham."

This sub-committee reported towards the end of 1881 that there were "two Museums" (a) The Model Room which was not under the management of, or in any way connected with the R.E. Institute Committee, and (b) The Museum Room in the R.E. Institute, which was under the management of the R.E. Institute Committee. It was of opinion that the two rooms should be under one authority by whom the collections might be rearranged, duplication avoided, and the space used to the best advantage. It suggested therefore that either the room in the Institute be handed over to the S.M.E., or that the Model Room and its collection be handed over to the R.E. Institute Committee, and it recommended the latter as the better course.

It further recommended that a sub-committee composed of the Commandant and two members of the Institute Staff be appointed to manage the amalgamated museums. Colonel Donnelly did not entirely approve of the latter suggestion and added "I am anxious to bring the following paragraph of the Draft Report before the Committee of the Institute though my colleagues do not concur in it, because I am strongly impressed from all my experience that the primary condition of a good Museum is a good curator—someone directly charged to keep it up and constantly at work in it. A committee may very well manage or supervise, but there must be someone to do the work." The paragraph of the Draft Report

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referred to was:—" In conclusion we venture to express a hope that the Committee of the Institute will provide a curator for the Museum. We believe that as soon as it is generally known that it has thus been put on a proper footing many officers of the Corps will be glad to contribute when they know what classes of objects are required."

Unfortunately Colonel Donnelly's suggestion was not approved by the Committee, but time has shown how thoroughly justified he was in his contention. This report was referred to the Commandant, S.M.E., for his observations, and he was asked, if he approved of it, to take the necessary steps to effect the transfer. This he did, and in 1882 his application was sanctioned and authority was given to transfer the charge of the Model Room to the R.E. Institute Committee, on condition that it paid any costs of upkeep, etc. A resolution proposed by Colonel Harrison and seconded by Major (afterwards Sir F.) Marindin was carried that "the charge of the Model Room be accepted by the R.E. Institute Committee on the terms set forth by the D.A.G." As already mentioned, the proposal to provide a curator was not approved and the management was handed over to the sub-committee as proposed in the report.

In 1890 the Museum was handed over to the S.M.E. on condition that "it still remained the property of the R.E. Institute." This arrangement was apparently entirely forgotten in the course of a few years, and by 1902 both museums had practically ceased to exist, the exhibits were crowded on one side, whilst the room in the Institute was converted into a class room and the Model Room was principally used for concerts and dances.

After the South African War the want was again felt of some place in which to exhibit the trophies and relics of the Corps, and in 1904 the Colonels Commandant discussed at their meeting the possibility of providing a Corps Museum, and General Sir R. Harrison proposed at the Annual Corps Meeting that "this meeting thinks that instructions should be issued to the R.E. Institute Council to take up as soon as possible the question of the provision of a Museum for articles of interest collected by the Corps."

This proposal was carried unanimously, but for some years nothing further was done, owing partly to the proposed transfer of the Headquarters of the Corps, and partly to the difficulty of finding suitable accommodation. In 1908, however, the question was again raised and a Committee to formulate a scheme for providing a suitable Museum was appointed, with Sir R. Harrison as President, Colonels J. A. Ferrier and F. Rainsford-Hannay as Members, and Major W. A. Harrison as Secretary. There was no chance of Government providing a Museum and the cost of a new building was prohibitive. The only suitable existing building was the Model Room and the Commandant was unable to spare this until a suitable place was

provided in which to hold the concerts, dances, etc. The Committee recommended that this might be done by enlarging the existing lecture theatre. The two end schoolrooms and passage were to be made into a stage and thrown into the main hall, and two new schoolrooms added to replace them. The Commandant agreed that this would provide a suitable substitute, and the scheme was approved at the Annual Corps Meeting of 1909-the Council being authorized to sell out £1,750 worth of Stock to cover the cost of structural alterations. Official sanction was also obtained, the Army Council undertaking that "although no guarantee can be given that the Model Room can be retained permanently as a muscum, still so far as the interests of the public service will admit the R.E. Institute will not be disturbed in its occupation.' The alterations to the theatre were carried out by the S.M.E. workshops and were completed by the end of 1910, when a sub-committee was formed with Sir R. Harrison as President, the Commandant, S.M.E., and Colonels N. Lake and C. F. Close as Members, and Major W. A. Harrison as Secretary, to report "upon the alterations it considers advisable in the existing Model Room, and to decide which models, etc., at present in the room shall be retained for the Museum." At its suggestion, Colonel E. H. Hemming was co-opted on the sub-committee and was asked to submit a design so as to make the Model Room suitable in every way for a Museum. This he did with a success which may best be judged from the accompanying photographs. The work was most satisfactorily carried out by Messrs. Harrod, and was completed towards the end of last year, when the collection and arrangement of exhibits was taken in hand,

General Arrangement of the Museum.-In the first place it has been decided that, although the Museum is primarily intended for trophies of the various campaigns, peace relics of general Corps interest as well as old uniforms, will have a place in it. It has also been arranged to subdivide the Museum into sections by large screens, each section representing either a separate campaign or group of campaigns. This plan has been carried out, the chosen campaigns being :--(1) The Siege of Gibraltar, (2) The Peninsular War, (3) The Crimea, (4) The China Expedition, (5) Egypt and the Soudan, (6) The South African War, and (7) The Abyssinian and Zulu Campaigns and minor wars in East and West Africa. Two smaller sections have been allotted to the various Indian Campaigns, one to early campaigns and one to Corps records and peace relics of interest. Down the middle of the Hall are three cases containing the batons, medals, decorations and personal objects of our first three Field Marshals, and finally the Gordon relics are placed in the right-hand portion of the gallery.

A good deal of difficulty has been encountered in sorting out the mass of models and "exhibits" which had been stowed away under the galleries, so as to see what was really worth keeping. Profit-

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ing, however, by the lesson taught by the original disregard of Sir J. Donnelly's warning, the Council has approved the appointment of an excellent curator—Mr. (late C.S.M.) Whiffen—and it is mainly owing to his exertions that the history of each exhibit has been carefully looked up, objects of value have been put aside and objects of little interest have been got rid of. The descendants of former officers of the Corps have also been appealed to, and have given or loaned many most interesting articles, until the nucleus of a really valuable collection of Corps relics has been formed.

It is proposed to give a short account of some of the principal exhibits in the various sections, and from it the Corps will be able to form some opinion of how thoroughly the Institute is trying to carry out its wishes:

Early Campaigns.—Under this heading are grouped any records of the various early campaigns and expeditions which can be found. The earliest is a MS. diary and plan of the Siege of Barcelona in 1706, during the War of the Spanish Succession. It was presented by the late Major-General E. R. James and was compiled by his ancestor, Colonel Jacques St. Pierre, who acted as Chief Engineer to the expedition. A full account and transcript of it, written by General James, appeared as a *Professional Paper*.

The original MS. Engineer records of the Siege of Belle Isle in 1761, as well as many documents relating to the mission to Syria in 1798 are also in this section. The Syrian Expedition was originally under the charge of Brigadier-General Koehler, R.A., but after his death, Sir C. Holloway, R.E., commanded. The MSS. comprise Lord Grenville's original instructions on the scope of the missionwhich was intended to aid the Sultan of Turkey in driving Bonaparte and the French out of Egypt-a notice of the intention to send out Abercromby's Expedition in 1800, one or two letters from R.E. officers describing battles between the Turks and the French, and finally an interesting copy, in Sir C. Holloway's handwriting, of his summons to surrender, sent to the French garrison of the citadel of Cairo after Sir R. Abercromby's victories at Aboukir and Alexandria. In addition to the above expeditions, are two very interesting old atlases, lent by the Army Council, one containing the early maps of Canada and the American Colonies, as well as plans of some of the more famous sieges such as Quebec, etc., and the other containing the plans of the various battles and engagements during the American War of Independence. There are also some MS. plans made by R.E. officers during this campaign as well as the original lists of Engineers entitled to prize money for a number of the minor expeditions.

Siege of Gibraltar, 1779—1782.—Gibraltar, as the birthplace of our rank and file, has, of course, a special Corps interest, and a section has therefore been allotted for the relics of the great siege in which Sappers played so conspicuous a part.



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- China. ٢.
- Siege of Gibraltar. Egypt and Soudan. Early Campaigns. Early Records. Sir J. Burgoyne. Lord Napier. 2,

- 3;4 5;6

- 7. 8. Sir L. Simmons.
- Brennan Torpedo, 9.
- Miscellaneous Curios. African Campaigns. 10.
- 11.
- South Africa. 12.
- India. 13.
- 14. Crimea.
 - Peninsula.
- 15 16 India.

The old model of Gibraltar has been repaired and occupies the centre of the section, and, in cleaning it up, Mr. Whiffen found an inscription engraved upon it which shows it to have been constructed by order of the Master-General of Ordnance in 1781. On the screen and round the walls are many of the MS. plans signed by Sir W. Green and made during the siege itself. Also a series of drawings of the batteries, etc., made by Lieut. Koehler, R.A., and lent by the Army Council. There are, besides, the original plans of the galleries. and one of particular interest is a rough pen-and-ink drawing evidently prepared by Sir W. Green himself, and from which the others seem to have been elaborated. General Nicholls, R.A. (great-grandson of Sir W. Green), has kindly lent a number of interesting oil paintings of incidents of the siege, etc., and also Mrs. Green's original diary and Sir W. Green's Gibraltar Medal. An original MS. General Order issued to Sir C. (then Lieut.) Holloway, R.E., during the siege has also been lent, and the officers of the Mess in Gibraltar have contributed a model of one of the furnaces used for heating the shot. and also the original warrant making the Corps "Royal" Engineers and allotting it its place on parade.

The Peninsular War .- Owing to the great kindness of Sir Lawrence Jones (grandson of Sir J. T. Jones) the collection of Peninsula records is particularly interesting. Sir J. T. Jones kept all the letters and orders he received whilst acting as Brigade Major in the Peninsula, and Sir Lawrence has generously presented the most interesting of these to the Museum. They comprise several autograph orders from the Duke of Wellington, the principal of which is his original orders for the final assault on Badajos. These are without doubt written by Wellington himself, and contain several corrections and marginal notes also in his handwriting, as well as a couple of pages of "Additional Orders" evidently added hurriedly as they are completed in pencil only. These orders were transcribed in full in the January Journal. Capt. Squire's MS. reports on the first and second unsuccessful sieges of Badajos; Sir A. Dickson's report on the artillery operations at Olivença, Ciudad Rodrigo and Badajos; Sir H. Clinton's autograph report on the operations of the divisions under his command in the various battles, also Sir C. Colvile's; numerous descriptions and reports of the various battles sent in by R.E. officers to the C.R.E.; the original diaries of Sir J. T. and Sir Harry Jones; Sir R. Fletcher's autograph order book and Reid's diary of the Siege of Burgos, are amongst the many papers. The whole of the original correspondence between Sir R. Fletcher and Sir J. T. Jones on the Lines of Torres Vedras, as well as Lord Wellington's original appreciation of the situation in the Peninsula in 1809, and his instructions to Sir R. Fletcher to examine and report upon the various positions and details in connection with the Lines, have also been given to the Museum by Sir Lawrence Jones. On the screens and walls are a number of water-colour drawings of various places in the Peninsula made by Sir C. Ellicombe during the war. Amongst the old original trophies in the Model Room were a number of grenades and cups used in firing the rockets, musquetoon shells, a miner's trolley, a petard and other relics actually used during the war and sent to Chatham early last century. These have all been carefully sorted out and classified by Mr. Whiffen, and in conjunction with a portion of the original obstacle used in the breach at Badajos, and the sword taken by Sir H. Jones from a French-officer whilst a prisoner in San Sebastian, form a most interesting collection of Peninsula relics.

The Crimea.—Amongst the Crimean relics are the whole of the diaries of the Siege of Sebastopol; many of Sir H. Jones' letters during the siege; a number of the original plans made by our officers during the siege; numerous muskets, fireballs, grenades, drums and other old trophies which have been sorted out by Mr. Whiffen, a rope mantlet used in Sebastopol, and the original mess table used by our officers and made out of old mortar platforms. On the walls are several contemporary drawings of the Crimea and the original duty diagram of officers in the trenches. The V.C. and French Medal of Honour won by Sapper Perie, which have been lent to the Museum, are also in this section.

The China Campaigns.—In the China Section are, amongst other things, several old Chinese weapons captured in 1860; an embroidered screen captured at the Summer Palace and lent by Sir R. Harrison; a "torture box" used by the Chinese, numerous original sketches and plans made at the time and given by Sir R. Harrison, and also two interesting plans and letters from General Gordon whilst in command of the "ever victorious" army.

The Indian Campaigns.—Although comparatively speaking there are but few relics of our Indian campaigns, the original diary of the Siege and Capture of Madras in 1758-9, the diaries of the Siege of Bhurtpore, the diary and order book kept by the 23rd Company during the Mutiny, and the Kandahar Gazette, a MS. journal kept throughout the siege during the last Afghan War, are all of interest. On the walls are four coloured engravings made by Lieut. (afterwards Sir T.) Aubury of the Engineers in 1799, and also a number of Indian weapons. There are but few relics of the Mutiny. Sir R. Harrison has kindly lent a sword which he captured in the assault on the Kaisar Bagh and which is believed to have belonged to one of the princes.

Some of the original sketches made during the Mutiny are hung on the screens and there is also a most interesting old MS. survey of a portion of Afghanistan, undated but evidently made early last century on paper water-marked 1821.

 $\hat{E}gypt$ and the Soudan.—This section is still almost empty, the signboard of Tel el Kebir Station, a drum and rifle taken at Tel el Kebir, a Dervish djibbeh and the original "boat orders" issued by Sir

R. Buller during the advance up the Nile, forming the whole of the relics of the Egyptian War and of the many Soudan campaigns. There is little doubt, however, now that the Museum has been put on a satisfactory basis, that many trophies will in course of time be sent, as so many officers took part in the campaigns which are so specially connected with the Corps.

South African Section.—Unfortunately the same remark as above applies to this section. Although the Corps was so particularly associated with the war the Section only contains a few maps made on service, one or two interesting documents, a pom-pom shell and cartridge taken at Paardeberg, some Boer bandoliers and cartridges given by the late Colonel J. L. Irvine, and a Boer mine, intended to blow up an armoured train, given by Major Henniker.

Amongst the most interesting of the many loans are Sir J. Burgoyne's bâton, medals and decorations which are being lent by his granddaughters, Lady Barrington and Mrs. Morton Philips. The baton and sword of honour of Lord Napier of Magdala as well as the black leopard skin stole presented to him by King John of Abyssinia and the flag of his Division in China (the first British flag ever planted on the walls of Pekin) have been kindly lent by his widow, the dowager Lady Napier. Mrs. Orman, daughter of Sir Lintorn Simmons, has lent not only his baton, medals and decorations but also numerous personal objects of the greatest interest. Mr. C. H. M. Lennox is lending his father's medals and decorations amongst which is the first V.C. won by the Corps.* The medals and decorations, uniform and other interesting personal objects of General Sir John Cheape, G.C.B., are being lent by his daughter, Miss Cheape. Τo Sir John, who obtained his commission in the Bengal Engineers in 1809 and who commanded in the Burmese War of 1852, probably belongs the honour of being the first R.E. to command a mixed force in the field.

The original MS. plan of Waterloo and the neighbourhood which was used by the Duke of Wellington at the Battle, and on which he roughly pencilled the position he wished to take up when giving instructions to Sir W. de Lancy as to how to place the troops, has also been lent to the Museum. This plan, which is on a scale of about 4" to the mile, was compiled by the R.E. officers in Flanders in 1814 and 1815, under the orders of Colonel Carmichael Smyth, and on it is the following history written and signed by General John Oldfield, who was Brigade-Major, R.E., at Waterloo :--

"This plan consists of reconnoitering sketches of the position of Waterloo, and the adjacent country, made by order of Lieut.-Col. Carmichael Smyth, Commanding Royal Engineers in the Netherlands,

Sir Wilbraham Lennox was awarded the V.C. for his gallantry in the attack on the Russian Rifle pits on November 20th, 1854. by his Officers in the years 1814-15. One fair copy had been given to H.R.H. The Prince of Orange, when Commander of the Forces, a second was ordered for His Grace The Duke of Wellington, but not being in a sufficient state of forwardness this original plan was sent to the Field when called for by His Grace on the 16th June, 1815. It was in custody of Lieut, now Lt.-Colonel Waters, R.E., lost and recovered in a melee with the French Cavalry at Quatre Bras.

On the 17th upon the Duke deciding upon retiring on Waterloo, His Grace called on the Commanding Engineer for the plan, who took it from Brigade-Major, now Colonel Oldfield, Royal Engineers (to whose custody it had been transferred on his joining Head Quarters) and given to the Duke, by whom it was handed to his Quarter Master-General, Lieut. Col. Sir William De Lancy, K.C.B., with directions to place the troops in position; orders being at the same time, given to Lt.-Col. Carmichael Smyth, relative to his own Department.

This plan was on the person of Sir William De Lancy when that Officer was killed. It was recovered for Lt.-Col. Carmichael Smyth by Brigade-Major Oldfield from Lt.-Col. Sir Charles V. Broke, D.Q.M.-General at Cateau Cambresis on the advance upon Paris in June, 1815, since which time it has been with the papers of the then Lieut-Colonel, but subsequently Major-General Sir James Carmichael Smyth, Baronet, C.B., K.C.H., K.M.T., K.S.W.

(Sd.) J. OLDFIELD, Colonel, and Capt. and Brigade-Major, Royal Engineers. 31st January, 1846."

It remained in the possession of Sir James Carmichael Smyth's family until about 1860, and was then lost sight of until it was purchased by the writer a couple of years ago. The plan consists of the various field sketches mounted on a canvas backing and the pencil marks made by the Duke on the 17th June are still plainly visible. In the left-hand bottom corner are blood stains of Sir W. de Lancy, on whose person it was when that officer was mortally wounded during the battle.

The "Gordon relics" are too well known to need description, but consist generally of his yellow jacket and other Maudarin coats, etc.; his frock coat as a Turkish Pasha; flags used or captured during the Taiping rebellion; the large map he used during the operations, and numerous objects of interest, plans, drawings, etc., made by General Gordon both whilst at Woolwich and after he had joined the Corps.

Amongst the early records of the Corps are some old Board of Ordnance orders relating to the fortifications of Portsmouth and other places in 1667-8-9, the original lists of all the Companies of Sappers and Miners in Flanders on June 18th, 1815, as well as the whole of the returns, etc., of the Army in France and the Netherlands between 1814--1818. There is also Sir J. Burgoyne's original sketch for a stand

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on which to test the ranges of muskets at different angles of elevation. These experiments were carried out at the S.M.E. and on them was apparently based the sighting of muskets for different ranges. A copy of Capt. Fowke's provisional patent for the bellows camera, dated 1856: a contemporary letter from Capt. (afterwards General) H. Sandham, giving a full description of the first submarine-mining operation ever attempted, viz., the blowing up of the brig Kent near Gravesend in 1838. There are also a number of beautifully drawn MS. plans of Chatham, Gravesend, Dover, Harwich and other places dating from about 1705, and finally the original model of the Brennan torpedo, brought over by Mr. Brennan from Australia, as well as a complete torpedo of the latest pattern have been handed over to the Museum. The above are only some of the many interesting trophies and objects which have already been collected. and it is to be hoped that now that the Museum has been put on a proper basis with a well-qualified curator, many more trophies will find a permanent home there. Flags of the Soudan and China Expeditions v ild be particularly acceptable, as, with the exception of a few boat mags amongst the Gordon relics and the flag of Lord Napier's Division, there are none in the Museum.

The entrance and small adjoining lobby have still to be put in hand and various other minor details require completion. In the centre window a stained glass panel of the Arms of the Corps has been inserted, and it is hoped some day to put similar panels, with the coats of arms of our most distinguished officers, in the other windows. As each panel costs about $\pounds 20$ it will probably be some time before this is done, but when finished it will still further greatly improve the appearance of the room. Still a good beginning has at last been made, and there is every reason to hope that, in a few years time through the co-operation of the officers and men of the Corps, the R.E. Museum will be one of which all can justly be proud.



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SHOWING THE NEW GALLERY.



A SURVEY PROBLEM IN SIEGE WARFARE.

By CAPT. W. A. DE C. KING, R.E.

MUCH attention has of late been paid in the pages of the R.E. *Journal* to the work and tactics of Field Companies, R.E., while the work of the Siege Companies, R.E., of which there are now two in the Service, has not been discussed. The following sketch illustrating a Survey Problem in Siege Warfare is, therefore, submitted.

The scheme has been worked out to show, in detail, the survey work which would be required in a phase of subterranean warfare, and some methods of carrying it out.

In this warfare the general direction devolves upon an officer, R.E.—the "Controller of Mines." Under him are other officers for specially superintending the mining operations, one of whom is detailed to keep the plans.

General Idea.—In the general idea, it was assumed that a fortress had been invested.

Special Idea.—In the special idea, an imaginary "Zone of Investment" and the "Front of Attack" were described, it was also stated that a work "Z" was included in the "Front of Attack," that two sapheads had approached to within 700' of the ditch of this work and that the officer commanding the attack had decided to resort to subterranean warfare.

Intelligence.—It was assumed that a certain amount of intelligence had been obtained in peace, and that aeronauts had obtained information during hostilities as to the defences of the ditch.

Preparations.—The general line of an imaginary entanglement and the two sapheads were marked by pickets, a 5["] theodolite being used. It is assumed that observations could be taken through specially constructed loopholes.

Work Carried Out.—Theodolite observations were taken from the two sapheads to a conspicuous point, the distances and heights were then worked out.

With the information obtained, the contoured plan (see Plate, Fig. I.) was taken.

Fig. II. shows the work "Z" viewed from the saphead "A."

SIEGE OF "Z" WORK.

Extract from Diary of Controller of Mines.

January 15th.—Two saps from the 2nd parallel have reached the points A and B as shown on Fig. I. The points A and B were

roughly fixed by triangulation from the 2nd parallel (assumption); but it will be necessary to ascertain the distance between A and B more accurately. Point A is approximately 375' above M.S.L.

January 16th.—Set up a subtense bar 11' long at A, and observed angle subtended by the rod from B by means of 5" theodolite.

The total of the angles (10) being $12^{\circ} 32' 32''$: the angle subtended by the rod being $1^{\circ} 15' 15''$.

By the formula $x = \frac{11}{2} \cot 1^{\circ} 15' 15''$

AB = 502.5 feet.

January 17th .-- Parallel completed between the points A and B.

The distance was then measured with a 50' steel tape and found to be 500'. Fortunately the trench was straight, and it was therefore possible to chain in a straight line, otherwise it would have been necessary to run a theodolite traverse.

For calculations, the length of AB is taken as 501 feet.

January 18th.—It has been decided to advance by mining from A instead of carrying on the deep sap the reasons being :—

- (a). Necessity for secrecy.
- (b). Owing to the steep drop in front, it would be impossible to construct saps with impunity. The objective chosen being point "P," the caponier in the salient.

Saps are being pushed forward on the flanks, and it is hoped that the besieged will be deceived as to our intentions.

January 19th.—Set up theodolite at A and B, and observed angles to the conspicuous points on the glacis, and to posts in the wire entanglement, as follows, vide Plate, Fig. II. :—

"P." Stone slab on top of caponier.

"Q." Telegraph pole.

"R." Straining post in wire fence on or near edge of ditch.

"S." Post in wire fence on or near edge of ditch.

"T." Post in fence running down the valley which is formed by slope in front of AB and the glacis.

"U." Ditto.

"V." Chimney.

"W." Ditto.

a, b, c, d, e, and f. Six conspicuous posts in the wire entanglement.

The angles of depression and elevation were observed to the feet of all posts.

Height of instrument at A, 5.25 feet.

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Observations from A.								Observations from B.			
	Horizo	ontal A	ngles,	Verti	cal Aug	les.	Horizontal Angles.				
A B a b c d e f P Q R S T	° 259 259 269 269 267 278 262 275 252 261 262	, 0 1 7 6 20 8 38 2 5 ² 36 20 8 3 ⁸ 2 5 ² 47	" 0 30 30 30 30 0 30 30 30 30	$ \begin{array}{c} $, 12 27 46 30 30 35 30 6 45 6 2		° 	, 50 50 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5			
U V W	276 250 263	45 50 2	0 0 30	-6 -6 -	56 13 —	0 30 —	30 41 50	56 10 13	. 0 0 0		

Table of Observations.

Table of Distances and Heights.

Point.	Distance from A.	Height above or below A.	Height above M.S.L.			
Point. a b c d c f P Q Ř S T	Feet. 312 330 328 350 360 378 560 510 545 480 300	Feet. - 8:099 - 4:928 - 14:811 - 10:031 - 17:294 - 11:254 + 25:784 + 11:926 + 34:706 + 22:851 - 15:947	Feet. 367 370 360 365 358 364 400 387 - 410 398 359			
U V W	290 675 725	- 30:01 5 + 78:876 	345 453			

The contours on *Plate*, *Fig.* I., have been drawn with the aid of the above, after an inspection of the ground from the sapheads.

January 20th.—It is decided to run an inclined gallery at a slope of 1 in 5 until the top of the gallery is 6' below the ground and then drive the gallery straightt owards "P," keeping 6 feet below the ground until a point is reached underneath the line of the fence TU (320 ft. measured horizontally).

No direction posts are to be allowed above ground.

To obtain direction of the caponier P, the objective set off at A, with theodolite, an angle of $97^{\circ} 52' 0'' (360^{\circ} - 252^{\circ} 8' 0'')$.

The true bearing of B from A is 129° , and that of P from A is $32^{\circ} 30'$. The depth of the ditch of the parallel at the point A, where the common gallery is to commence, has been increased to 8 ft. and then runs with a slight fall. The parallel is blinded at this portion for a short length to protect the mouth of the gallery.

The slope of the ground in front to the fence TU is approximately $\frac{1}{20}$. The gallery at $\frac{1}{2}$ must be therefore driven for a distance of 23' (measured horizontally) the topsill will then be 6' below the ground, the topsill of the first case is 2 ft. 6 in. below the ground line. From this point the gallery must be driven at a slope of $\frac{1}{20}$ for a distance of 297 ft. (measured horizontally); the topsill should then be 6 ft. below the ground at the line of the fence TU.

The angles of depression for slopes of $\frac{1}{5}$ and $\frac{1}{20}$ are 11° 18' 35" and $\frac{2}{5}$ are 11° 18' 35" and $\frac{2}{5}$ 51' 44" respectively.

The following is imaginary.

January 21st .- First case in position.

January 22nd.—Changed slope to $\frac{1}{20}$ at the 23rd case. Verified direction at this point with theodolite from A, observed on to a plumb line held in front of a sheet of paper behind which a candle was held, a horizontal line is marked on the paper for observing vertical angles, and in order to save calculation the paper screen is adjusted so that the horizontal mark and the axis of theodolite are the same distance from the topsills above them. Fixed small eye in 29th topsill from which the line can be plumbed when required for future reference. The line to objective has been marked with chalk on the underside of the topsill.

Found theodolite legs (short ones) difficult to manipulate in the gallery, so have tried fixing instrument on a stout plank supported by two blocks of wood which can be screwed into the stanchions of a case. The theodolite rests on a wooden base which can be clamped in position on to the plank.

As the project deals with the survey work of setting out the gallery only, it is unnecessary to carry it further—the later stages possessing no particular interest from this point of view.

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By CAPT. E. D. CARR-HARRIS, R.E.

THE following are plans of steel concrete culverts which have been found useful , road work in those parts of the Frontier Province named in the cable below.

Simplicity of design is at all times an advantage, and especially so when work has frequently to be carried out by unskilled workmen. For this reason only one class of steel $(\frac{1}{2})^n$ square bars) is used for all spans from 2' up to 5'. The necessary variation in strength is given by spacing the bars at different intervals.

Twenty-six culverts, two bridges of 10' span and one bridge of 30' span, have been constructed on this design in the last six months and have all proved satisfactory.

In the case of bridges, the steel concrete decking is carried on rolled steel beams, and the thickness of concrete is slightly reduced as the decking between any two rolled steel beams may be regarded as a fixed beam.

The designs are calculated for maximum load due to a moving steam road roller weighing 12 tons when fully charged with fuel and water. Factor of safety 4 with 9" of filling on culvert, and the following is a summary of their design and cost :--

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Summary of Foregoing Steel Concrete Slab Culverts.

Road Roller-Distribution of Weight.



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Two 3" square steel tie rods to be imbedded in centre of concrete at right angles to dars,

Scale 4' to 1'

Reinforcement 1" steel bars. Ends of bars to be turned up 2".

THE A.B.C. SYSTEM OF TRAIN CONTROL.

By MAJOR H. F. E. FREELAND, M.V.O., R.E.

General.

THE A.B.C. system of train control is so-called on account of its simplicity and was first instituted on the Northern Pacific Railway between Spokane and the west coast; it is in effect a combination of the "Despatcher," or American standard, system of operation and the "line clear" system as practised on Indian railways. Under the provisions of the former one responsible control directs the movements of all trains within a certain area, while under the latter no train may enter a section unless an assurance has first . been received that the line is clear of obstruction. The American standard system while making for efficiency leaves much to be desired in the matter of safety and is abandoned without hesitation when the density of traffic demands closer attention to safety of The Indian "line clear" system on the other hand movement. regulates with care the passage of trains over each "station to station" section in turn but the control exercised is purely local and does not provide for the efficient direction of a large mass of traffic moving at varying speed over long distances.

On the Northern Pacific the problem to be faced was briefly this :--Sixty-three miles of single line, through mountainous country, with stations averaging 4 miles apart, was called upon to carry a constantly increasing traffic, and it was found that the greatest number of trains that could be run each way, under the standard American system, was 18 per diem. The only solution appeared to be the doubling of the line, a very costly business on account of the heavy bridging, cutting, bank and tunnelling work to be executed; as an alternative it was suggested that the A.B.C. system should first be tried. It was accordingly installed with the result that the maximum was at once increased from 18 to 25 trains a day each way, and the cost of doubling the line indefinitely postponed. The telephone was used as the means of intercommunication between the Controller at Spokane and the operators at roadside stations,

When traffic is small or all trains are timed at a more or less uniform speed over the division between engine-changing stations the difficulties of operation are reduced to a minimum but when a heavy long-distance traffic requires to be handled and fast trains are to be

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run up to their scheduled time through a mass of slow moving traffic without seriously disorganizing the latter, it will be generally admitted that some system which provides for direction from a common centre promises the best chance of success. Whether such a system is to be adopted or not is largely a consideration of relative cost.

The most confirmed optimist will agree that goods trains very rarely run up to a time table, or in other words a goods train timetable is hardly ever of any value for the purpose of locating the position of the train at any time because there are so many unknown factors in the calculation; they must give way to faster traffic, and the amount of shunting and other work to be done day by day varies considerably. If anything is certain in railway operation it is that given a dense passenger traffic goods trains will be held back to give it precedence.

Consider what happens when a train service becomes disorganized and important trains run persistently late; orders are sent out to all stations on the offending division pointing out the necessity of showing better results and Inspectors-even officers sometimesare specially detailed in the hope of improving matters. Attention is fixed on a certain late running train for the time being with the result, more often than not, that other equally important trains suffer. Endeavours to keep a "difficult" train to time usually bring to light some defect in the existing time-table for the district concerned, and opinion is reluctantly formed that no permanent improvement can be effected without a radical alteration of the whole. A new time-table is in due course brought into force with probably many other defects merely because the enquiry which has brought about the alteration has been centred on the running of one particular train to the exclusion of others the importance of which is not felt until they, too, commence to run out of course.

It should be remembered that trains in India run comparatively very long distances, and this applies to goods as well as to passenger traffic; the former cannot, as in many countries differently situated, be kept off the road to allow the latter free movement.

The making of a time-table is an art in itself, requiring, if it is to be successful, very precise knowledge of local conditions; the more dense the traffic the more difficult it is to allow a margin which will obviate the disorganization of the remainder of the service when an important train runs late. The time-tables of a railway are prepared by an expert after full consideration of the special requirements of traffic for the different seasons of the year; these requirements are brought to his notice by the officials located at various points on the system, and with full information at his disposal there should be every reason to hope that the expert may get out a scheme of movement which, as far as fast passenger and mail trains are concerned, will be satisfactory. But although an expert can, with

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the information usually placed at his disposal, prepare a time-table which will normally give good practical results, a sudden and temporary change of conditions at some point will upset all his carefully calculated scheme. The effect of a train running late in such a country as India, where through connections are to be made over many hundreds of miles, is far greater than is generally supposed, and the denser the traffic the more far-reaching the effect. Such being the case how can a high standard of efficiency be maintained with a purely local and inelastic system of working in force and without some central authority having a comprehensive view of the whole situation at any moment and power to direct the general movement ? The personal element merits consideration in every country in the world, and in India very particularly; then consider what happens to a train after it leaves one engine-changing station to run, say, 100 miles to the next and to pass, say, 20 small roadside stations manned by Indian station masters. All goes well while the whole service is working up to time, but as soon as one train runs late, crossings are thrown out, and the efficiency of the service is entirely at the mercy of the individual faults and idiosyncrasies of the local-Indian station masters at each of the 20 roadside stations, who are probably not very intelligent or reliable, and who have no knowledge of the general situation beyond their station limits, or having it would in most cases be prone to sacrifice the general good to their own station's convenience.

These men, it must be allowed, are generally keen enough to keep the passenger service up to time, because, if they are not, punishment is certain to be meted out in some form or other. Their one idea appears to be to shift the responsibility from their own shoulders to someone else's as quickly as possible; acting on this rule of life they will infallibly do all they can to get rid of a train from their station even at the cost of detaining at the station in advance another to give precedence to which would be advantageous to the successful movement of the whole. It may also be assumed with certainty that if there is an officer or an inspector present the Indian station master will gladly accept his orders in such a case, and so shift the responsibility.

Although of recent years the financial side of the question has come more and more prominently forward in India it has not, in the past at any rate, been generally considered necessary to pay much attention to the running of goods trains; they get through "somehow," until complaints begin to come in from train crews of long hours on the road and of irritating and seemingly unnecessary detention at roadside stations, where no work has to be done, but where they lie side-tracked for faster traffic to go through unchecked. Some consideration, however, is due to the fact that such detentions, even to goods trains, mean a bigger coal bill, greater wear and tear on the keenness of the staff or an unnecessarily high establishment, and a considerably larger equipment in locomotives and goods stock than would otherwise be required.

A time must come, then, when the question of doubling a single line in order to compete with the rising traffic has to be considered, or when traffic on a double line becomes so dense or is so complicated by intermediate junctions as to be unmanageable by a purely local system of working.

It is at such a time that some central control agency can possibly be established with successful results and may as in the case of the Northern Pacific Railway put off the day when doubling has to be undertaken, or, as in the case of the Durbar Railway in 1911, handle an enormous double line traffic on a complicated network of lines with a degree of success which it is believed could not otherwise have been attained.

DESCRIPTION OF THE A.B.C. SYSTEM OF TRAIN OPERATION.

The A.B.C. system of train control is a system whereby the Controller or directing authority is in communication with operators at every station on his division, and by means of information obtained from them and with a visual record of the position of each train at any moment is enabled to make intelligent plans for the movement of traffic, and give intelligent orders for the precedence of one train over another.

The Control Office should be located at some convenient point on the division operated, which will vary in length according to the density of the traffic; on a busy single line this division will usually be an engine run of about 100 miles with stations situated 4 to 5 miles apart.

At the Control Station will be the Directing Staff, consisting of a Chief Controller, and his Deputy if traffic demands it, and three or more Controllers each doing nominally four hours' work at a time and up to eight hours during the periods when traffic is slack.

The Control Office should be connected with each station on the division by an independent telephone, which should be so installed as to enable the Controller to call up one or several operators simultaneously and which must be inaccessible to any but the Train Operating Staff. Each station on the division should also be connected with the station on either side by a local telephone set apart for train working only.

The general procedure is briefly as follows :----

It is required to send a train from A to an adjacent station B.

A will telephone to the Controller and ask for orders to be issued to run the train to B, or in many cases the Controller will take the initiative. If the Controller has no other movements in view over the Section A—B he will simultaneously telephone orders to A and B

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to move the train, *if line is clear*. A will then ask B for line clear and if the line is clear B will give the necessary authority, all by telephone. As soon as the train leaves A, that station will telephone the departure timing to B and to the Controller, and as soon as the train reaches B, that station will telephone the in-report to the Controller and to A; this completes the transaction.

The chief point to remember is that no train may leave any station to run to another unless the Controller has first given orders in the prescribed man⁻⁻ for it to be started *and* unless a line clear has been obtained in the usual way from the receiving by the starting station.

CONTROL OFFICE EQUIPMENT.

Control Table.

In order that the Controller may be able to give his orders in a manner conducive to safety and efficiency, he should be provided with a long table the face of which is formed of as many countersunk parallel grooves as it is estimated will correspond with the maximum number of trains to be handled simultaneously. The Controller sits in front of this table which is arranged so as to move to his right or left on runners; this enables him to move up into a convenient position any particular groove requiring his attention and obviates the necessity of moving his chair. The grooves run transversely across the table and are capable of receiving what is known as "Train Slips" (see specimen attached) which will be run in from the bottom of the groove (nearest the Controller). Each groove is also equipped with a small red pointer, which can be moved by means of a handle or lever situated at the bottom of the groove, up or down to the position occupied by the train, the movements of which are recorded by the Controller on the train slip in a manner to be This red pointer gives a visual indication on described hereafter. the table of a train's position and the lever or handle which operates it may with advantage be constructed so as to simultaneously change the position of discs on a line diagram, fixed upright at the back of the table in full view of the Controller and of his Chief. diagram should show the whole division operated, and each running line, reception and departure siding at stations; the discs may either be moved electrically or mechanically the latter for choice. It can further be arranged that, if the Controller pulls his lever or turns his handle so as to bring the pointer and disc into a section already occupied by a train, an electric contact will be made, and cause an alarm bell to ring; the Controller can thereupon put the handle or lever back and is prevented from giving an order which he will have to cancel as soon as he is informed by stations at either end of the blocked section that line is not clear. Each groove has a small button at the top, which is inserted in a hole punched in the train slip and holds it in position.

Control Telephone.

The Control Office in order to call up any operator or be called up by him must be equipped with an exchange, which may be either of the ordinary modern type with plug switches, or a special selective instrument usually adopted for this work in America. A press key bell is more convenient than that operated by revolving a handle, and it is desirable to arrange for a subsidiary dynamo equipment in order that a more powerful current may be available in case "through orders" (to be explained below) require to be transmitted over long distances to several stations simultaneously.

The simpler the operation of the exchange can be made the more quickly will the Controller get through his work, the more trains he can handle successfully and the less strain there will be upon his powers of endurance.

The exchange should be fixed in a position right in front of the Controller's chair and within a short arm's reach, so as to lessen the fatigue entailed in working it; it is not desirable to have the exchange erected on the right or left-hand side of the table. To provide for this essential and at the same time to so place the diagram that it may be mechanically or electrically operated by the movement of the handles or levers on the table will not be easy. The diagram must necessarily be fixed to the table and move with it, but the width of the diagram board need not be very great and the exchange could be fixed to the wall behind the table and project out over it but clear or the diagram (vide sketch attached).

Train Slips.

A specimen of the train slip is attached. It is not necessary that the arrangement of columns or of the general information given shall be precisely as in this specimen which was that adopted on the Delhi Durbar Railways to suit the special requirements of the traffic.

The train slip for single line operation might well contain much more information than was considered necessary at Delhi; for example it would be easy to include details of vehicles attached and detached to trains at the various points:

The number of entries on a slip is only limited by the time at the Controller's disposal, and by the size of the slip, the width of which cannot much exceed $2\frac{1}{2}$ " in width or 15" in length, without necessitating a table of unwieldy and inconvenient dimensions.

The train slip is intended not only as an indication of a train's movement from station to station for the guidance of the Controller but also as a permanent and complete record of all movement of and work done by that train throughout the run.

The blank train slips, arranged in series ready for use should be

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placed on a small table on the Controller's right hand; when the train has completed its run, its particular slip should be drawn out of the groove and, after being signed by the Controller, inserted by him in the drawer of his table through a slot provided for the purpose. Thus there should be no completed slips on the table to confuse the Controller by their presence. It will be found most convenient to allot one end of the table (say left) to up trains and the other (the right) to down mains, and to run a blank slip painted red into the centre groove so as to emphasize the division.

It may not be considered imperative to use private numbers or codes in the interchange of messages, but it is thought that this procedure will be found eminently desirable in practice, if only for the purpose of distinguishing between a large number of similar transactions between Controller and operators. To save the labour of writing out each private code or number on the train slip every time the Controller orders the movement of a train, it is as well to have these codes or numbers printed on the slips as shown in the specimen.

Miscellaneous Additions to Control Table.

The red pointer which, as has been explained, is moved on the ratchet principle step by step, up or down the groove, can then be so adjusted as to come to rest opposite the station's name, where the train actually is standing, so as to cover the private number or code which is to be given as the last word of the order for the train to move into the section in advance. Before he can give the order to move the Controller must uncover the private number or code by turning the handle or lever and moving the pointer, which with a half turn of the ratchet comes into the next section in advance, and while resting there reminds the Controller that that section is blocked. As each station name is so printed on the slip as to be in one horizontal line with the same station name on any other slip, it is obvious that a glance at the position of the red pointers, will show the Controller the situation on the whole division under his direction. In American practice the provision of these distinctive pointers is not considered essential, their train despatchers relying solely on the relative positions of the last entry on each slip to indicate the whereabouts of trains.

If the pointer is combined with a danger gong, which as soon as an attempt is made to move that pointer into a blocked section will indicate electrically when the section is already occupied, the advantage is obvious, because, although an accident would be obviated by the knowledge of the operators at each end of the section, the audible signal that the line is not clear will prevent the Controller from giving an order which he would inevitably be compelled to cancel.

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Train-Ordering Procedure.

To consider now the operations which must be gone through by the Controller, when a fresh train comes under his hand. As soon as information is received from the starting station, be it a junction or engine-changing station, that a train will shortly be ready to leave, the Controller will select a train slip for the division over which the train will run and fill in the headings, viz. (in the case of the specimen attached) the train number, engine number, driver's and guard's names, load and date ; he will then run the slip into a convenient empty groove on the up or down side of his table, as the case may be, and fasten it securely in position by means of the button at the top of the groove, then turn the red pointer so that it covers the private code opposite the name of the starting station. As the time for departure draws near he will enquire, from the station master if all is ready to start "to time," if not when will the train be ready. It is not desirable for the Controller to order the movement of a train too long in advance, for it should be remembered that the operators as soon as they have received the order will at once proceed to ask and give "line clear" and then lower their signal; five minutes before a train's probable departure is guite time enough to allow for the " line clear" operation. If then the Controller is assured by the starting station operator that the train will be ready to leave in five minutes, he will, if the section is clear ahead, move the red pointer one notch and expose the private code or number, which was concealed by it. His next step is to plug the starting and next receiving stations on his switchboard, ring them up simultaneously and order the train's movement, giving as the last word of his order the private code or number disclosed by moving the pointer on his table. This order will be acknowledged by the two operators who will, commencing with the starting station, repeat the train number and Controller's private code, a repetition which will be acknowledged by the Controller's "O.K." All three men will enter the time of the completed order in their records, which in the case of the operators is the Train Register and of the Controller the Train Slip; this concludes the transaction. The starting station operator will then ask " Is line clear for No. ... (train number)" from the next receiving station operator, and give as the last word of his enquiry the Controller's private code; if the line is clear of all obstruction, the last train having arrived complete, and the Controller's code is the correct one received by him the receiving station operator will give "Line is clear for No. ... (train number) and give as the last word of the message his own private code or number from the printed list in his possession. The starting station operator is then in a position to issue an authority to proceed to the driver, and lower signals for the train to start.

All operators must be provided with the Control Train Order

Registers, in the columns of which will be recorded all private codes or numbers received from the Controller and the times thereof, and must also have line clear books where the times which trains pass their stations and leave or arrive at the stations in rear or advance respectively must be entered. These entries must be made in ink, and no erasures are permitted; if a wrong entry is made it must be cancelled by a clean horizontal line drawn through it, and the correct entry inserted immediately above. This rule as regards erasures applies more particularly to the Controller whose entries are considered indisputable; it is better that whenever the Controller finds it necessary to cancel an entry the Chief Controller should at once be asked to initial it.

All this takes a long time to describe, but the whole transaction of ordering a train's movement and of obtaining a line clear does not take more than from 15 to 20 seconds by telephone. It may so happen that the Controller orders the movement of a train into a blocked section, but as above insisted the ultimate responsibility for safety lies with the operators at each end of the section, and it is hardly likely that three men will all make the same mistake of acting as if a section is clear when it is actually blocked. The fact is that the Controller very rarely makes a mistake ; in actual practice on the Durbar Railway it was unknown although the number of private codes given by the Control Office in ordering movements exceeded From the moment he takes his seat at the table till the 70.000. time comes for his relief, he is obsessed with the scheme of movement. constantly in difficulties owing to trains not doing what he expected, incessantly making plans as far ahead as possible, and altering them to suit new conditions as the situation develops, he has the whole division and the trains running mapped out in his head, and if he doesn't know exactly where a train is he is keen to enquire its whereabouts in order that his plans may proceed intelligently. The strain is severe, but he knows how much depends on his clever manipulation of the traffic and that he is the heart of the machine and is keen to maintain his reputation for efficiency; there is much less likelihood of a Controller ordering a train into a blocked section than there is of a driver running past signals at danger.

In addition to the ordinary Train Order there is the Through Train Order which is conveniently used when it is required to push an important train through two or more stations over a clear run. To give a Through Order the Controller will use the private code of the station at the commencement of the "clear run," and will cancel and initial those which follow it and are not to be called into use. For a "Through Order" several stations may require to be plugged on the switchboard simultaneously, and the power of the battery or dynamo must be sufficiently great to enable this to be done, as has already been indicated.

Line Diagram.

As has been mentioned above, the line diagram is a very useful adjunct to the Control Table, and provides an additional visual indication of the position of all trains on the division; it should be fully visible from the Chief Controller's table or from any point in the room, and its existence will constantly make it unnecessary for the Chief to ask the Controller the whereabouts of a train in order to answer an enquiry on the telephone from the Station or District Office. This diagram if worked mechanically by the movement of the pointers on each groove must necessarily be part of the table; if on the other hand the interlocking is designed to work electrically there is no reason why the diagram should not be fixed in one permanent position. Mr. E. A. Scott, the Signal Engineer of the N.W.R. of India, has designed a table and diagram combined which are admirably suited for the purpose and full particulars can be obtained from him.

Briefly the diagram consists of a distorted plan of the track on the whole division controlled, the various running lines and sidings at stations being clearly shown. In each line on the diagram, whether representing the track between stations or the running lines or sidings at the stations themselves, a circular orifice is pierced, through which may be made to appear from below a white, red or blue disc, according as the line is unoccupied, is occupied by a down train or by an up train respectively. These discs can, as has been stated, be moved into position either mechanically or electrically by the turning of the handle moving the red pointer along the grooves on the table.

The line diagram of the railways controlled by the Delhi Durbar Administration was not operated in this manner, owing to the very complicated nature of the train movements and the expense that would have been entailed in interlocking the diagram with the table. Instead of so doing, separate diagram operators were appointed to manipulate the discs, above described, by hand, and to enable them to do so with accuracy and certainty they were equipped with cap telephone receivers the leads of which were taken direct to the terminals of the Controller's cap receiver, and thus made it possible for the diagram operators to ascertain at the same moment as the Controller what each station operator reported.

The operation of this diagram, 10' by 4' in dimensions, at Delhi was a constant source of interest and amusement to the unemployed and gave a perfect visual indication of the state of affairs on the system at any moment.

ADDITIONAL EQUIPMENT IN CONTROL OFFICE.

The office should be big enough to allow of the Chief Controller's table being placed in a convenient position to enable him to view the line diagram.

This officer should also be provided with a telephone receiver on his table the leads of which are joined to the terminals of the Controller's receiver, so that at any time he desires to do so he can ascertain first-hand what is transpiring on the line.

He will also require to be provided with telephones connecting with other offices, *e.g.* District Superintendent, Station Master, Loco. Foreman, etc.

It was found desirable at Delhi to issue to the Chief Controller daily a graphic of the train service for the next day; this graphic was placed in a prominent position on his table, and by its means he was enabled to plan out the movements and issue general instructions to the Controller, when the latter came on duty.

The blank train slips should be kept under lock and key in the Chief Controller's possession, and it is his duty to take over all the completed slips at the end of a day's work and bring to the notice of the District Superintendent any matters requiring attention.

In short the Chief Controller is the fountain head of all information in regard to the train ______ vice, and he is most favourably situated for giving advice as to requisite alterations and additions in a time-table.

EQUIPMENT OF OPERATORS' OFFICES.

Operators as a rule should do their work standing; they must be constantly moving either to reach a telephone or to see for themselves whether their instructions are being carried out in the local yard. A high narrow desk is therefore necessary to carry their registers, so that they can fill in the entries without sitting down. The Control telephone and those joining up with the operators at the stations on each side should be fixed immediately over this desk and within easy reach for a tall man; if the operator happens to be short in stature a small movable platform should be provided for his use. If telephones exist connecting the operator with the signal boxes or auxiliary lever frames in the yard they also must be grouped with the Control 'phone in as convenient a position as possible.

LOCATION OF OPERATORS' OFFICES.

The location of the operator's office is a matter of some difficulty and must largely depend on the size and shape of the yard. It is very important that the operator should be in close touch with the station master; if the latter has control of the shunting in the yard and the points and signal staff are under his orders, a very complete system of interchange of information between the two must be devised. Even so there is a probability of divided responsibility and it is without any question better to make the operator responsible for all movement into, out of and within the yard, in short for all train working, while the station master's duties are confined to the issuing and collection of tickets, booking and delivery of goods, parcels and luggage, the upkeep and preparation of the necessary records and returns and the interior economy of the station and correspondence in connection therewith. If the work is divided in this way there are three different kinds of stations the location of the operator's office at which has to be considered. To take the simplest first, namely that of an interlocked or non-interlocked roadside station the signals of which are lowered from a frame on the platform, no signal boxes or cabins being provided; the operator's office should then be situated in the station building as near the lever frame as possible. Next is the case of a moderatesized interlocked roadside station with a control cabin at one end and a lever frame or subsidiary cabin at the other; here the operator should also be located in an office on the station platform in a central position for viewing the condition of the yard and of the signals giving access to or exit from it, but it is most necessary that he should under these circumstances control the actions of the cabin men in the matter of lowering signals by means of a Hepper's key transmitter or some similar device. If this electrical control is considered too costly, the alternative seems to be to place the operator in the main cabin and arrange for him to interchange information with the station master by telephone messages accompanied by private codes or numbers.

Lastly comes the case of a big yard with two c_{-} nore cabins where the operator should be placed in a central position in close touch with the station or yard master, and control the cabins by means of an electrical key transmitter.

It should again be repeated that a division of duties whereby the operator is only responsible for the movement of trains between stations, and the station master for that within the yard itself is not satisfactory however carefully thought out may be the methods of interchange of information between them. This division was adopted on the Delhi Durbar Railway, but there was friction between the two men owing to the station master being in most cases the senior in the service and resenting orders for train movement emanating from his junior. This trouble was only obviated by the operators prefacing their instructions to station masters by the words "Chief Controller orders that . . ."

PROCEDURE IN CASE CONTROL TELEPHONE BREAKS DOWN.

In all traffic operation one of the greatest sources of confusion, and even of danger, is the temporary suspension, owing to a fault in or failure of the apparatus used, of a recognized method of train movement, whether by means of an electrical token or by ordinary written "authority to proceed." In the case of the A.B.C. system it is laid

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down that no train is to be sent on without an order from the Controller. But suppose the Control telephone breaks down, what then ? The answer is that the operators shall carry on without the Control orders, and give and receive "line clear" as before, taking upon themselves the responsibility for precedence, which is under normal conditions vested in the Controller, in addition to that for safety which they always had. This does not involve a "change" in procedure, such as that from "Tyers' Tablet" to written "line clear," or electric staff to pilot working, and it is in "change" that the danger lies, as all railway men know. In order to obviate confusion and delay it is necessary to convey by some rapid means to operators the information that the Control telephone has broken down, and this can be done by ordinary Morse telegraph, the provision of which at all stations on the division is essential not only to meet situations such as that under consideration but also for the transaction of ordinary railway business. A code word meaning "Control 'phone out of order, carry on without Control," and accompanied by a private code from the Controller is all that is necessary to send by telegraph to the station or stations with which telephone connection is broken.

Much useful experience of the adequacy of this arrangement was obtained during the operation of the Delhi Durbar Railway, where in the early days of its installation the telephone apparatus was constantly breaking down, and although some small delays occurred, as they are bound to occur no matter what procedure is adopted, no serious confusion or semblance of an accident was ever occasioned.

Similarly when the telephone between two operators fails, recourse can at once be had to "the station-to-station" Morse telegraph, which provide a necessary alternative on a busy section.

IMPORTANCE OF THE OPERATOR BEING ON HIS TELEPHONE WITHOUT A BREAK.

It cannot be gainsaid that if the man in charge of the train working is compelled for any reason to absent himself from his instruments in order to perform other duties, the train service must sooner or later suffer. In English working the cabin signalman never leaves his box during his tour of duty, except to hand up the "token" to a driver, but in India the station master on duty not only has to attend to the "line clear" working of a small station, but as often as not he is also required to issue and collect tickets, answer passengers' enquiries, book and deliver parcels, luggage and goods, all or any of which will take him out of call of his Morse instrument.

That any system of working a heavy traffic shall have a fair chance of success it is imperative that the duties of operators at stations, whether they be called station masters or signalmen, shall be con-

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fined to train working and train working only. This applies more particularly to the A.B.C. system, inasmuch as the Controller in order to plan the movements must continually require information from the operators at distant points and the absence of one of them from his telephone may seriously detract from the completeness of the Controller's information and consequently to a greater or less extent spoil his schemes.

The busier the division the more truth there is in this statement. During the operation of the lines controlled by the Delhi Durbar Railway, the operator in one of the cabins was called upon to leave his office and for a few days hand up a written permission to drivers to pass a defective signal at danger; the traffic was not at its height but was sufficiently dense to cause this short absence from the telephone to be a serious handicap to the Controller.

The A.B.C. system of operation will not be resorted to unless traffic is very heavy, and it therefore follows that the operators' duties must be limited to train movement only, and if there is any outside work such as handing up "permission to proceed or written orders" to drivers it is a question for careful consideration whether operators should not be given the assistance of menials, such as levermen or peons.

MAXIMUM NUMBER OF TRAINS WHICH CAN BE HANDLED SIMULTANEOUSLY BY THE CONTROLLER.

The experience gained on the D. for Railway went to show that the greatest number of train slips which the Controller could deal with single-handed at one time, irrespective of direction, was 17. As many as 22 were on the table simultaneously, but it was then necessary to have two Controllers at work, one operating the exchange and telephones and the other maintaining the written record. It must be remembered, however, that the line was double and the average distance apart of stations was only $1\frac{1}{2}$ miles, several signal boxes being as close as a quarter of a mile to those on either side.

If the stations had been an average distance of 3 miles apart, the Controller could theoretically have handled twice as many trains simultaneously, in absolute Block working, as he actually did with stations $r\frac{1}{2}$ miles apart.

On the double line trains in opposite directions do not impede one another, being allotted separate running tracks, but on the single line two opposing trains cannot be on the same section at the same moment, and by the same process of reasoning the Controller could on the single line with stations 3 miles apart simultaneously handle four times the number of train slips which were the limit of his capacity under Durbar Railway conditions.

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The matter need not, however, be laboured further, for it is abundantly clear that the Controllers on the Durbar Railway were tried far more highly than is ever possible on an ordinary single line, where it may be assumed that stations will rarely be closer than 4 miles apart which is the same thing as saying that the maximum number of sections on a 100-mile division will not exceed 25.

It may be laid down with confidence that the maximum number of trains which will be running simultaneously in one or the other direction on a single line division of 100 miles under exceptional conditions will not exceed 25, a total which the Controller should be able to handle without embarrassment.

CONTROLLER'S CHIEF DIFFICULTY.

The arrangements for precedence and crossing of trains at roadside stations on a single line will not be found to cause the Controller much anxiety; the most harassing part of his work is the movement into, in and out of the various junctions and terminal yards of his There must be some point at which his responsibility division. for the precedence of trains commences and if the movement within the limits of, and into and out of both ends of, the junctions and terminals is outside the jurisdiction of the control, trains will be brought into or depart from these yards in accordance with what is locally convenient and without consideration for the general effect on the traffic on the division controlled; to obviate such short-sighted methods is precisely why the system of a central directing agency will have been established. As a case in point may be quoted the incessant difficulty of moving trains into and out of the yards at Delhi Main and Delhi Sadr during the Durbar. Up to a certain point the staff at those stations were perfectly willing, nay anxious, to fall in with the Durbar Railway Controller's desires, but they were not under his orders, and when it was considered locally convenient to execute movements other than those proposed by him, his wishes were disregarded. The result was that the Controller's schemes were repeatedly nullified, and if the system of working had not been extraordinarily elastic, and the station-to-station distances comparatively short, confusion must inevitably have been experienced. For example the Controller would ask if Delhi Main could receive a goods train which was ready to start from the Shakurpur sorting yard; the reply was "Yes, send her along." The train was accordingly started, and although the run was only 25 minutes, as often as not Delhi would hold the train up at signals and thus block the main line, because it was in the meantime discovered to be necessary to execute shunting on a passenger train in the main yard and so block the entrance. There was a want of some central authority to direct the whole movement not only in the junction, but immediately adjacent

to it on both sides, and if this central authority can be placed in full possession of information as to the whereabouts of every train and the work required to be done in connection with it, he must necessarily be in a far better position to judge what shall be done and when it shall be done than the station master, even of a big junction, who can only deal with the situation within his station limits. The obvious deduction, therefore, is that, when a system of central control is established on a division between two engine-changing stations, the movement of running trains, within the limits of these stations and of any intermediate junctions, must be under the direct orders of the controlling authority and not only that, but the jurisdiction of this authority must extend to the arrivals and departures of all trains into and out of both ends of these yards.

TELEPHONE WORKING.

The idea that the telephone is an unsafe instrument for train working is deep rooted in the minds of many experienced railway men; in America on the other hand this idea is daily losing weight, and the Morse instrument is rapidly being superseded where traffic has become exceedingly dense. It should be hastily added here that the many serious accidents which have occurred of recent years in that country can in no case be attributed to telephone working but to some other weakness in the system adopted, in most cases a failure of the h in element. It is proposed to adopt the telephone for train working under the A.B.C. system chiefly because of its convenience in the matter of *interchange* of information between Controller and operators, and because it is undeniably less tiring to manipulate for lengthened periods than the Morse telegraph.

The experience gained during the Delhi Durbar must again be brought forward. The total number of trains handled in 40 working days was 8,479, and eliminating the seven hours daily during which traffic was infinitesimal the average for the remaining 17 amounted to no less than 11.52 trains per hour. The greatest number of trains handled in a 24-hour day was 256, and the greatest strain was thrown on the control on two occasions when 73 and 75 complete trains were handled in a period of two hours on each date. That the strain could have been successfully borne with the Morse telegraph as the only means of communication is unbelievable, and yet not a single accident of any sort in the movement of trains was experienced.

It is stated also that the native of India is not adapted to conversation on a telephone; every native of India is certainly not born to be a successful telephone operator, any more than any Englishman can easily acquire the art of so conversing in Russian or even in Hindustani, but he can be taught. A curious case came under the

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writer's notice at Delhi; on one occasion an officer happened to be in one of the signal boxes, and heard the assistant station master making a series of curious sounds into the trumpet of a telephone; these sounds were a series of short and long clicks made with the tongue thus :- Click ... click, click, pause, click, click, click ... pause, click ... click ... pause, click, click ... click, etc. It sounded most absurd and uncanny, but on the performer explaining that he was reproducing the Morse code, so that the man at the other end could understand, the mystery was unravelled. Further it transpired that the man at the other end could understand clearly what was said to him on the 'phone, but his conservative instincts were such that he would not accept spoken messages, unless they were spelt out in the way he was accustomed to receive them, namely by the Morse alphabet! The fact was he had never been taught to use the telephone, and naturally looked upon it with grave suspicion, as an instrument which was bound to get him into trouble sooner or later.

Some maintain that any inexperienced person can speak through a telephone in a clear intelligible manner; this is not so, even intelligent men require to be shown how to use it. If one hundredth part of the time considered necessary to make an efficient telegrapher were devoted to the training of men in the use of the telephone there is no reason why the latter should not be a perfectly adequate apparatus for train signalling and operation.

The training of a telegraph signaller is a lengthy and difficult business in India, and the results leave much to be desired. The value of telephone operation is undeniable, apart from its association with the A.B.C. system of working, inasmuch as a very short training is sufficient to make a good operator, provided he is the right class of man to start with. If telephones were more universally installed on the main lines and normally used for giving and receiving the authority to proceed under the Absolute Block system of working there can be no doubt that the fear of a telegraph strike would be greatly diminished. During a great military concentration also when the resources of all railways will be heavily strained, a much shorter time will be required to train new men in telephone than in Morse telegraph working, so that they can be drafted out to strengthen existing lines, or detailed to man military railways across the Frontier.

The conversation necessary for telephoning messages in connection with trains lies along well-beaten paths, and the experience of the Durbar train operation brought to light only one difficulty; this was the signalling of the private codes, consisting of a series of four letters each. It was found that some letters of the alphabet when pronounced singly sounded very much like some others and it was necessary to compile a table of letters A to Z, and their corresponding numerals

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I to 26, so that to obviate confusion owing to similiarity of sound, the distinguishing numeral could also be given when the letter was not clearly understood.

A great deal of trouble was taken to instruct Durbar railway operators in the proper tone to be used in speaking through the many telephones installed in each cabin, and without this instruction many irritating breakdowns must necessarily have been experienced.

The best way of acknowledging an important message received by telephone is to repeat it back to the source of origin, and when a very important message has been communicated, it is often desirable to insist on its repetition letter by letter; this on the face of it appears to be a laborious procedure, but the time taken is infinitesimal as compared with the repetition by Morse sounder.

One matter must be strongly insisted on, and that is that if the new system is to have fair play the whole telephone apparatus, exchange, cable, overhead line, batteries and instruments must be of a very efficient type and thoroughly well installed and maintained.

RECORD OF ORDERS.

The method of registering or recording messages is precisely the same as it is when the Morse telegraph is in use.

The Controller will maintain on the printed train slip a record of the time he gives a train order, and this order will be entered by the receiving operators in a register spec. 'y prepared for the purpose. In this register five columns only are necessary, viz. :—Date, number and description of train, time order received, the private code or number received from the Controller and any special order in connection with this train, *e.g.* restriction of speed, observance of signals, line under repairs, orders for crossing another train, and the like. Such special orders require a separate order book on the Controller's side table to enable him to number and keep a record of them as they are communicated to the line.

In conservative India, it will no doubt be considered desirable to retain the stereotyped form of line clear books for the up and down direction on the single line, and there is much to be said in favour of this procedure, if only because it causes a complete written record of train messages received to be maintained by the man responsible for the safety of movement. If this were not the case a register such as is usually adopted for double line working might be a satisfactory substitute, and with the five columns for Control orders added would obviate the maintenance of two registers instead of one.

This however is a matter for the consideration of each individual railway, and no cast-iron rules can be made to suit all alike.

RECAPITULATION.

It only remains to briefly summarize the various advantages which the A.B.C. system of control appears to possess over other systems of working.

With one highly-trained official in immediate touch with all stations on a division, the consequences of irresponsible action on the part of isolated station masters are eliminated, and there is no necessity to endeavour to strengthen this weak link in the chain, as is at present done, by laying down an arbitrary precedence of one train over another under all circumstances.

The presence of the Controller not only removes the tendency to slothful operation on the part of operators or station masters at outlying points, but the feeling in their minds that he is there to assist them in difficult situations is very real. Disputes between the men at adjacent stations become practically impossible, and once it is laid down that the Control record is indisputable, enquiry into delays, complaints and misdemeanours becomes an easier matter. Working at high pressure and specially selected, as he will be, the Controller's record of what has taken place is most likely to be unbiased and truthful, inasmuch as he has no time to falsify his entries, and his training would in any case prevent his desiring to do so.

There is undoubted additional safety of movement ensured under this system of working, in that not only does the movement of a train into a section outside station limits involve the co-operation of the operators at each end, but also an order from the Controller, who has a visual indication of the state of each section on the division recorded on his table and on the line diagram. In short each of these three men, who must all agree that the line is clear before allowing a train to move, act as a check upon one another, and it is hardly possible that, being situated at different places, they will all make a mistake at one and the same time.

Hardly less important than the safety aspect is the efficiency in working claimed for it; each train will be moved according as its movement will effect the working of the whole machine and not as a stray unit. The result must inevitably be that the capacity of the division, so operated, can be taken full advantage of, and trains can be pushed through or held back as may best suit the exigencies of any particular moment. It is claimed that the adoption of this system of working will cause a great saving in men, rolling stock and fuel.

That the train crew should not be kept longer on the footplate or in the brake van than a regulation number of hours is obviously of paramount importance, and with goods trains at any rate it is under the isolated station-to-station system of working by no means easy to obtain good results. Long hours are now spent unnecessarily on

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the road, and a higher establishment of running staff is required to meet the traffic. Precisely similar reasoning can be applied to the number of locomotives, and coaching or goods vehicles in service; move the trains through quicker, obviate all unnecessary delays, and not only is a reduction at once made in the staff employed, and in the rolling stock equipment necessary, but also the coal statistics will show considerably better results for every mile run and ton lifted. It should not be forgotten to set off this very considerable saving against the cost of installation and maintenance of the telephone line, and of the pay of the Control Office staff.

There is much to be said, too, for the moral effect on the running staff of knowing that when they leave an engine-changing station with their train every effort will be made to get them through to destination with as little delay as possible. If drivers and guards knew that the eagle eye of the Controller watched every movement of their train during the run, and that the dilatory methods of the roadside station master, which now have such a deadening effect on the keenness of the train crews, of goods trains more especially, would be suppressed with promptness and severity, they would feel that they were to receive fair treatment, and their enthusiasm would consequently be aroused to a level impossible under existing conditions.

The new system does not require any alteration in the General Rules and Regulations for Indian Railways, being merely an amplification of the ordinary "line clear" system.

No radical change of operation is necessitated by a breakdown of the Control telephone; the regulation of the precedence of trains is temporarily removed it is true, but the actual order for the train to move, namely the "line clear" can still be obtained either by telephone or by Morse telegraph.

Occasions when the "line clear" must be cancelled will occur much more rarely than at present, owing to the fact that a "line clear" will only be asked for under orders from the Controller, whose comprehensive knowledge of the whole situation will obviate his giving an order which has a chance of being withdrawn.

Further the methods of operations by telephone are so much more rapid than by telegraph that no long period need be allowed between the time of the Control order, and the writing out of the necessary authority to proceed.

The fact that information as to a train's whereabouts can at any time be obtained for the benefit of the public or of the Superintendent is a very real advantage; a reference to the Chief Controller will at once elicit a reply without the long delay now experienced in sending and obtaining a reply to a telegram. This advantage would greatly facilitate action in case of an accident at a distance from the headquarters of a "breakdown" train. The Controller who watches the working on his division hour by hour and day by day is in a specially favourable position to advise of necessary time-table alterations, and can after a few days' experience say precisely to what timing both "through" and "pick-up" goods trains have the best chance of a clear road.

Lastly the "Train Slips," as soon as completed, form an absolute record of the train's movements from the beginning to the end of its run, and there is no necessity to await the submission of guards' reports from a distance.

CHIEF CONTROLLER.

One last word on the subject of the scope of the Chief Controller's duties. On the Delhi Durbar Railway he was responsible for the training of the Control and Operating Staff, took every available opportunity for visiting the various stations and attending to the wants of the operators, received all orders in regard to the movement for the next day and instructed the Controllers accordingly, and spent most of his spare time answering enquiries and receiving orders by telephone. In addition to these various duties, which in Delhi were all-sufficient to keep the toughest man occupied, the American Chief Despatcher would be required to actually order out engines from shed for the various trains, and would, in short, take upon himself many of the duties now assumed by the station master of a big terminal yard, more especially where those duties were in connection with the work on either running trains or on trains which were made up ready to start or had terminated and were ready to break up. It is probable that the Chief Controller of an ordinary single line division of an Indian railway could take upon himself these duties also; he is not likely to be required to devote as much of his time to satisfying the inquisitive, if admiring, unemployed, as he was called upon to do at Delhi.

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A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779-83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802). EDITED BY COLONEL E.R. KENYON, R.E.

(Continued).

Sund 22. Westerly Wind. Clear fine Morning. The Colonel and 22nd October, Child went to the Mount to Breakfast. The Sctee from Algiers 1780. is safely come Round. The Enemy were at their New Work last Night. The Captain upon the Batterys did not hear them till pretty . far on in the Night. He threw some Light Balls and one Shell, but the Balls were Instantly put out ; either by Water or Sand. In the Morning it was Seen how Large a Quantity of Sand they had thrown up in Front of the Work. The Govr went in the Forenoon to Williss and orderd two Shells to be thrown at 10 this Night and Light Balls frequently. This forenoon a Barge with a Flag of Truce came from the Enemy. Capt Vallotton, as first Aid de Camp, went from the Govr in the Cutter to Receive the Message &c. It was a letter for the Govr. The Gun Boats have been exceedingly Bold and Impertinent all Day and at 3 oclock 4 of them came within Gun-Shott of the Shiping in the Mole &c-fir'd at the St Fermin Frigate and our Shiping; and at the Garrison too. We return'd their Compliment and fir'd Several Balls from 32 prs on the Kings Bastion and from South Bastion &c. One of the Shott from Kings Bastion went through the Sail of one of the Boats. They were Drove off in about half an hour and did not return any more this Evening. A Shott from one of the Gun Boats came on Shore at the Clay Pitt at South Shed. It went 5 feet Deep into the Solid Earth ; the Serjant upon that Work had the Shott taken to the Kings Yard. It Weighed 26 lb (a Spanish Arrove). An other of their Shott also came against the Line Wall near the Shed where some Provisions are kept but did not do any harm. Death at the Convent, after two months Sickness, and Buried at South Port-21 Years Old.

Mond 23. Westerly Wind. Fine Day. All Remained quiet last Night. The Flag of Truce was a letter to inform the Govr that Mrs Gledstanes and family were Safely arrived at Cadiz and had every Civility paid Them. More Gun Boats all Day. 241h October, 1780.

Tuesd 24. Westerly Wind. An exceeding Warm Day. Every Body wishing heartily for Rain. The Colonel up at Rock Guard and afterwards breakfasted at Williss with Captn Loyd; had an opportunity of Seeing every Manœuvre of the Enemy, as the Morning was Uncommonly Clear. This Day the Cask Fruit from on board the Danish Ship is Selling by Auction,—consisting of Raisons, Figs, and Grapes; the last Article done up in Large Bunches in Sand and in a Jarr; the Jarrs of Raisons Sold very Dear—some 8 Dollars; the Jarrs of Grapes sold at different prices. We got an exceeding Good Supply of every Article,—and a Cask of Figs. The oil was uncommonly high pric'd; the Sallad oil at 15 Dollars a Arrove, which used to be 6 and 7 Dollars, and Lamp oil for Kitchin Use, that was frequently Sold for 2 Dollars we now give 10 and a half for.

Wed 25. Westerly Wind. The Enemy have added Something to their Work last Night. We continue to throw Light Balls, and after that Shells every Night, and also Ball and Grape Shott in the Day time, but it does not Seem to affect them in the least. They are likewise Busy at a Work, seemingly a Strong one, at Caberita point, and this Day carried away some Guns from their Artillery Park with an Intention We suppose to go to Caberita. We know to a Certainty the Enemy have 80 Mortars in their Lines and at the Camp. It is believed there are already 42 of that Sort at the Lines. I find the Boat will Certainly sail this evening for Minorca, therefore I write a letter to my Sister, as it now is Said to be the only tolerable chance We have. We Understand there is a paquet between Minorca and Leghorn. Several Jews and Inhabitants going. More Gun Boats every Day.

Thursd 26. Westerly Wind. The Boat went last Night. A very fine Day. The New Regulation of officers Provisions took place; N.B. The Beef is quite Rotten and Stinking. It seems to hurt every Body. The Troops are far from Well; and to a Certainty are very weak and greatly fallen off in their Strength and likewise in their Spirits.

Fry 27. Westerly Wind. A Cold Raw Day, looking like Rain, but it did not. I had fix'd in my Mind to go out; which I did in forenoon, went as far as Back of Graud Store. The Enemy have added considerably to the Work on this Side the Lines, and have thrown up a vast quaintity of Sand (a Parallel)— upon each Flank. The Govr has orderd Shells and every other kind of Fire to be sent, according as the officers see them, more or less employ'd. In the mean time our Garrison is very Alert in all Respects and Strengthening in a most Surprizing Way every part, which indeed Seem'd as Strong before as possible. The Number of Traverses is prodigious, and are still adding. It is really Comfortable (as far as Such a Circumstance can possible be) to See how Much the Safety of the Troops is consulted by the Chief Engineer. The Govr and Chief Engineer Seem

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wholly devoted to Care and Anxiety for the Garrison. This even 27th October, very cold.

Saturd 28. Westerly Wind. The Weather very cool; and Rain in the Evening, but very little. The Govr Here this forenoon and almost every Day. We now fire very much at the Enemys New Work. N.B. I shall make a few Remarks at the Close of this Month with Respect to this Work. A Flag of Truce was sent in a Barge this Day from Us—which was answerd by a Barge from the Orange Grove. It began to Rain at 10 at Night and continued till one.

Sund 29. Westerly Wind. A very Cold Raw Morning, and afterwards turn'd out an exceeding Wet Afternoon and Night. The Enemy have last Night and for many past ones added to the New Battery—Notwithstanding all our Firing.

Mond 30. Westerly Wind. More Work done last Night. General Boyd here in Evening having first been with Col Green to the Montague Bastion where some New Experiments were try'd,— Firing for the first time from Montague Bastion—it seemed to burt the Enemys New Works.

Tuesa 31. Westerly Wind. Two men Deserted from their post from Upper Alls Well*,—one of the 39th the other of the 56th. The Captain at the Lines did not make a very Regular Report of that, or of our firing &c &c to the Governor. It is thought He will receive a Severe Reprimand. A Large Number of Vessels going through to the East—supposed to be a French Convoy.

At the End of this Month all Degrees of people begin to be Uneasy at the total Silence that We are cruely obliged to have with our Friends.

The Work that the Enemy began to throw up and was discovered upon the first of October was a Front Epaulment with two returns at right Angles, advanc'd upon the Isthmus, about 600 yards before their Established Lines.

On Oct 2 we in our turn Now added to our Works by making the Great Traverse on the North Bastion the Basis of the Parapet of a Cavalier for four Guns. This and Several additional Strengthenings towards the North part of the Line Wall were Laid out by the Chief Engineer.

Wed November 1. Westerly Wind,—raining and very cold. The Enemy making every addition they possibly can to their New Work on this Side the Lines. We fir'd Shells and Shott from Montague Bastion last Night and frequently in the course of this Day. A Man of the 56th deserted. It makes every Body Uneasy to find the Spirit of Dissatisfaction beginning to encrease amongst the Troops. Most of the Regts are affected, more or less, with the Scurvy. About this time we had several of the Large Tunny Fish brought In.

* This is a post above the eastward end of Princes Lines.

2nd November, 1780. Thursd 2. Westerly Wind. Cold and Wet. The firing much the Same on our Side. We know that Some of our Shott and Shells have taken Effect, as our people upon the high Batterys frequently hear the Groans of the Enemy, and likewise We have Seen them this very Morning carrying away Several Wounded Men upon Hand Barrows. The Enemy are likewise Busy at a New Work on their own Side of the Lines, as also upon a Strong Work at Caberita point. ² Large Ships appearing like Frigates are this Day gone over to Algezira—and are supposed to be Loaded with Stores. The following was in Garrison Orders :—" The 56th and Field Marshall Hardenbergs Regts to hold themselves in readiness to Encamp on the Shortest Notice. Upon these Regts being order'd to encamp they will assemble on the Kings Road—Hardenbergs with their Right to the Castle, and the 56th on the Left of Hardenberg's."

Fry 3. Westerly. Cold Morning. The Enemy have been very busy all Night, have made a pretty deep Track from their Barrier to the Tower near to their New Work, but it is not thought deep enough for Heavy Artillery. This morning early two Men Deserted, one of 12th the other 56th. They went off together, got round Under the Line Wall and Swam off it is Supposed, as their Cloaths were found there. This Evening the officer Commanding the Marks Men* went up to Williss and to the Head of the Kings Lines, and fir'd very frequently all Night, as did the Captain upon the higher Batterys. Also we fir'd a good Number of Shells from the Montague. It now is become exceedingly Uncomfortable, for as soon as it is dark the Enemy begin to Work, and of course We begin to Fire. Our House is just in the Line of Fire, and we are Shook by every Shott, particularly from the Montague-it absolutely Shakes my Bed with Violence. I believe I may add with Truth that there are hundreds keep awake beside those on Duty,-and this is the case every Night. I have not mentioned anything relating to Fresh provisions lately, as it is only to repeat the Same Unhappy Circumstances for the poorer Sort of People, some few only being able to look at what little Meat is kill'd,-and that now begins to be only Pork. We believe the Calves are all Kill'd,-the fish too is very Scarce. This Weather is very good for the Gardens.

A Memorandum in Orderly Book.

"When the 56th and Hardenbergs are Order'd to encamp, the 72nd to remove their people Quartered in Town into the Casemates under the Kings Bastion and Montague Bastion. 2 of the 4 Companys of the 12th Regt Quarter'd in Irish Town to be doubled on their own Corps, and the other 2 on the 39th Regt. Genl La Mottes to be doubled on the Pavilions and their own Barracks at the back of the Parade. If it shall become

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Necessary to remove the 3 Companys of the 12th from the head of the 3rd Novem-Parade, and Captn Loyds Company of Artillery, the Company of Artillery ber, 1780. and one Company of the 12th to be Quarter'd in the Casemates under Water Port, and the other 2 in the Nitch's of the Galley House. The officers in the first Instance to be distributed as follows:—Artillery, Engineers, 12th, 39th, Redans, and La Mottes, amongst themselves,— 72nd Regt in their present Quarters. The officers of the 58th and 73rd to remove to the South, and to be Quarter'd with their own Corps. All the Hospitals to be ready to Move on the Shortest Notice."

Saturd 4. Westerly Wind. A great Day this in Spain, being St Carlos, the Name Day of the King. Barcelo and all the Ships at Algezira are Dress't; and fir'd three times, as Usual on those Occasions. The Track to the New Battery was Deeper this Morning than before. We fir'd very much this Night.

Sund 5. Easterly Wind. Raining very hard at Gun Fire and at Guard Mounting. Find myself very indifferent all Day and not in good Spirits,—had a fire by desire of the Colonel in my Bed Room to Day. Much talk of the Supposed Intentions of the Enemy, as to whether they will come on or not at this time. Every Body seems Anxious to Move to the Southward. The Navy Hospital is to be taken in part for the Garrison General Hospital. Doctor Baynes has reported room enough at this Instant for 400 men, but there are Wards for 1,500,—only some are full of Stores for the Navy. Numbers of the 72nd* dieing every Day. A Meeting of the Corps of Engineers this Day, in consequence of the Orders relating to the Quartering in Case of the Enemy firing,—as all the Engineers are at present quartered on the North Side of the parade except Captn Phipps, whose Quarters are near the Bomb House. The Gun Boats were again troublesome this forenoon, as also in the Evening.

Mond 6. Westerly Wind. This forenoon the......was at our House and unexpectedly gave a good deal of trouble and Vexation to the *Chief*. It hurt his Temper all Day, and broke In upon his Intentions. The Colouel went to the American Club, but did not Stay longer than half past 4. He then went upon business, and afterwards return'd Home alone, not over well pleased. A good deal of firing all the Evening.

Tuesd 7. Westerly Wind. The Man of the 12th who deserted on Fryday last was drove on shore near to the Convent Battery. He was directly known, and this Morning a Coat was first discover'd, behind the Rock, belonging to the 72nd Regt, with some hard pieces of Bread and cheese in the pockets,—the Coat torn all to Rags. In the forenoon upon making a Close Search, the Body of a Man Dreadfully Broke to pieces was discover'd. He had Undoubtedly belong'd

73rd in the other copy of the diary.

[912.]

7th November, 1780. to the 72nd as the mark upon one stocking shewed. He and 2 others got away near a Year agoe, and it was always Supposed had got clear The Way this Body was found makes it plain He had not off. been of the Lucky ones in Escaping. The Col: is but indifferent all this Day, went to the Weekly Whist Party at Capt Loyd's in the Evening. Very little firing this Day. The Enemy are doing what they think proper to their New Work, in the Day, as well as at Night-Notwithstanding our Shells &c. &c. We kill an English Sheep at this time-use it in our own family ; and exchanged one Quarter as Usual with Genl Boyd. This Evening about 7 oclock there was some firing at Caberita point, and Signals made, which We believe to be in consequence of Some Vessel coming In from the West, and just afterwards a Loud Explosion was heard, and it was judged by many people that a Boat or Some Vessel, must have been blown up,-perhaps one of the Enemys Gun Boats. We continue a a good deal of firing all Night.

Wed 8. Westerly Wind. It is now Certain that it was a Gun Boat Blown up, as there was only 3 discover'd this Morning in the usual place where there has ever been 4, and We can also See an English Cutter over at Algezira. This Morning at 8 oclock, a Man of the Artillery who was Under Confinement in the Provost and had been concern'd in a Robery at Captn Martins and had turn'd Kings Evidence took an Opportunity to Settle the business by Hanging himself in the absence of the Centinel. He was quite Dead—a Young Man about 22 years old. The Enemy have added 3 Good Traverses in front of their New Work, and have Workmen now employ'd in it. Captn Lesley and Captn Falkner and Several others of the Navy Din'd with Us to Day. It is exceeding Cold, but very Clear Weather Just now. The Govr here in forenoon. A Great firing in the evening.

Thursd 9. Westerly Wind. Cold Weather. Find myself very ill. We fire a great deal during the last Night, but the Enemy advance greatly with their New Work.

Fryd 10. Westerly Wind. Cold Raw Weather. The Enemy have taken a Large Mortar from the Lines and sent it away in a Boat to Algezira. Captn Loyd upon the Batterys to Day, and at 8 in the Evening began a very heavy firing. It was at Large Working parties and Carriages. A Boat arrived this Evening from Minorca.

Saturd 11. Westerly Wind. A fine Day, rather Warmer than of Late. I went out to Dine at Col Pictons. Moderate in firing till towards Evening, and then as Usual We began to be very Brisk. It is now full Moon and We can discover all their Manœuvres. We know for a certainty that We have kill'd a great many of their mules, as we See them Lay dead on the Neutral Ground, and it is not to be doubted but We have also kill'd their meu.

Sund 12. Westerly Wind, fine morning. About 7 oclock a Vessel

was observed coming over from the Barbary Coast. The Row Boats, 12th Novem-Gun Boats, Xebeques, all got Under Sail. They Surrounded Her ber, 1780. and fir'd frequently, She came close In towards our Batterys at Europa where she was exceedingly Well assisted. She fought with great Spirit and Judgment and as the Gun Boats advanc'd she fir'd Grape Shot. She was not able to Use more than 4 of her Guns for want of Hands. She has 8 Guns, 6 pounders, but had only 9 Hands including Boys. Two of his Men would not Stand to the Guns. The Enemy attempted to Board Her, but she pour'd In Grape Shott and also fir'd from Musquetoons, and by that Well Managed and Spirited Conduct was able to keep them off, and about to oclock We had the Good Fortune to get her safe into the New Mole. Great is the pleasure it affords every Body, who all strove to praise the Conduct of the Master before it was known what she was. It proves to be a Polacre, Captn McLorg Master, in the Employ of Mr Frazer in London, is 18 Days from Portsmouth, has Brought a most Wellcome Supply from England, consisting of Salt Beef, and Pork, Flour, Potatoes, Sugar, Butter, Porter, Cheese, Bacon, and Hams, &c, &c and a Number of News papers and Letters, but chiefly for the Merchants, who it is not to be doubted will avail themselves of the Necessity of the Garrison. The Master is a Resolute, Bold Irish Man. The Vessel is of 200 Ton Burthen; a French Prize. What makes this Vessel more Welcome than Common is that it is the first We have had from England since the Hyena Frigate; which was in April last. This Polacre brings word of a Grand Convoy that was getting ready with all Expedition for this Garrison,-and also that we are to have 15,000 Troops sent here. Soon after she got into the Mole the Wind came about strong to the East. This Morning also We got in an other Boat from Minorca, with Oil, Sugar, Cheese &c, &c. These two Welcome Vessels have afforded the Utmost Joy to every Individual. They may be realy call'd God Sends. This Evening We fire very much upon the Enemy. It is just a 12 Month since the Cutter call'd the Buck, Captn Fagg, came In ; the 2nd Sunday in Novbr.

Mond 13. Easterly Wind. The Enemy have been bringing Carriages from the Lines to the New Work, and also some people are employ'd in fixing many more pickets as if intending to throw up more Works. They have also mounted some cannon upon a Fascine Battery near the Sea Side.

Tuesd 14. Westerly Wind, fine Day. An other Boat came In from the East; last from Alicant, brings Some Useful Articles, but We had the ill luck to Lose a Setee that was coming In from Minorca. Several of the family articles which have come in the late Boats from Minorca, and also part of what came In on Sunday from England, are Selling this Day at Auction. Suppose they will go off very high; yet we are Bless't in having them. There is but a Small quaintity of

JUNE

14th November, 1780. Potatoes; and they sold at an Astonishing price. The Govr has order'd them to be sold in Small Lots, z_5 lbs each, as it is chiefly Meant to have them Sow'd, which it will be time to do in two Months. They sold at three Rials 4 quarts pr lb,—equal to fifteen pence English Money! The flour sold cheaper than any other thing, owing to there being a tolerable Quaintity in Garrison. We got a Cask, near 200 Wt, z_5 Drs 4 Rs. There is a good deal of flour in the Garrison We Understand; tho' it Seems chiefly kept up for the Troops and the English.

Wed 15. Westerly Wind, fine Day. The Enemy still Busy, and are forming their Boyaus of approach. It appears as if this Work was Undoubtedly intended for a Mortar Battery. It is said They have already brought some Mortars to it, but that is very Uncertain; tho' it serves to make people seem Knowing.

Thursd 16. Westerly Wind. Fine Cold Day. We bought a great many family Articles from the English Vessel, but all at an advanc'd and high price...as follows :— 1 Teirce of Beef 85 Drs, £12; 1 Cask of Pork 68 Drs, £10; a Side of Bacon 43 Drs, £5 165 6d; Tongues, at pr lb 1 Dr, £0 35 6d; Hams at pr lb 6 Rials, £0 25 6d; Butter at pr lb 5 Rials, £0 25 od; Sugar 6 Rials, £0 25 6d; Cheese 6 Rials, £0 25 6d; 100 Wt of Potatoes 45 Drs, £7 05 od.

The Porter is 60 Dollars a Hogshead. N.B. It is impossible to avoid taking some part of these high pric'd articles. A Fore Or of Mutton from Genl Boyd. This evening about 9 oclock 7 Gun Boats came over from Algezira and the Rivers, and fir'd at many parts of the Garrison, as well as upon our Ships. We return'd their fire from the Bastions &c. One of their shot came on Shore upon Mr Raleighs the Secry House, and drove In the Corner Stone, and Broke into a Room. It did no Material Harm but greatly alarm'd all the family. A very heavy fire was keep up until We drove them off. The Batterys also keep up a Smartt fire; but it is Supposed the Enemy are very Busy at their New Work and it is likely have sent those Boats in order to amuse the attention of the Garrison, whilst they go on, but the Captain upon the Mountain fir'd a great deal the whole time. One of the Shott from the Gun Boat hurt the Main Mast of the Enterprize, and the Splinters Wounded 5 Men. Also a Shot went over the Navy Hospital.

Fry 17. Westerly Wind. It is now observed that the Enemy have done a good deal of Work and are determined to go on; in the Mean time we Fire in the most Violent Way at Some Times, particularly every Night, as it is now Dark Nights, and we know they always make use of those times. They are also at a Strong Work at Caberita point; and have taken large Mortars from the Camp there.

Saturd 18. Westerly Wind, very Cold Day. The Enemy have added greatly this last Nt to their New Work in a continuation of their Line. The Governor has given the Work the Name of The

Mill Battery, it being near to an old Mill. I shall therefore call it by 18th Novemthat Name. This Battery is about 1,000 yards from our Grand ber, 1780. Battery. It appears as if they meant to add more to their Line ; and it is the opinion of the Chief Engineer that if they add two more Lines in a Certain Direction it will then be Evident they mean to attack Us. Captn Loyd upon the Batterys to Day and he fir'd Several Shott and one thirteen Inch Mortar which fell directly into the very Middle of the Work,-it threw them into a good deal of Confusion. This forenoon the Bed of the 13 Inch Mortar Split into a thousand pieces ; and in Consequence the Shell fell very Short. It got no further than the Gardens and burst amongst some of the Towns people who were out in those Gardens, but did not do any hurt. About half past Eight this Evening the Gun Boats came again. It obliged us to Fire upon them as Usual. In so doing a very Unfortunate Accident happen'd. A 32 pounder on the Kings Bastion Burst as it was going off,-Kill'd one Artillery Man upon the Spotexactly took Him through the Middle of his Body, and separated his Head from his Body,-it greatly Wounded an other Gunner and Burnt a Man of the 12th Regt and Slightly Wounded Several Men who happen'd to be upon the Bastion. It was attended by many Uncommon Circumstances, amongst which was that of a very large piece of the Gun being thrown as far as a Quarter opposite the Bomb House, where Capt Phipps of the Engineers lives, and which is about Ninety Yards from the part where the Gun was mounted-this piece weighd 270 Wt.* It carried away a Water Spout and brought down a great deal of the Stones and Mortar belonging to the next Quarter. It fell into a little Sort of Garden and Sunk very deep into the Ground. It alarm'd the family greatly but did not do any hurt except Unpaving the Court Yard &c. The apron of the Gun was Blown into the Main Street, and many other pieces were found in different parts of the Town. It Broke away all the Banquet on that part of the Bastion went down to the Casemates under them. This accident has alarm'd and affected every Body. It was an exceeding bad Gun-and like too many others here-as the Remaining part was try'd with a Screw Borer the next Day.

Sund 19. Westerly Wind; Cold Raw Day, and every Body Seems affected by what pass'd last Night. I went out in the forenoon but was very ill and continued so all Day. All quiet from the Enemy. They carried over a Vessel that was Supposed to be such an other as that which lately arrived from England.

Mond 20. Westerly Wind and Some Rain. The Enemy very busy all last Night, and We as Usual firing.

Tuesd 21. Westerly Wind, fine Day. The Work at Caberita point going on and at the Mill Battery. The Colonel had the Whist Party at our House in the Evening.

i.e. 2 cwt. 70 lbs.

[1912.]

UNE.

22nd November, 1780.

Wed 22. Westerly Wind. All the Same. Nothing very particular. I went to Sup at Lt Col Trigges this Evening. Am still exceeding Lame, and affected by the Cold Weather, and other Uncomfortable Matters. A great deal of Firing this Evening and all Night.

Thursd 23. Westerly Wind. The Enemy more advanc'd and our firing more frequent, both by Day and Nt. The family articles which came in the Polacre are now Selling at Auction. We gave forty five Dollars for a 100 Wt of Potatoes for Sowing at the Mount,-equal to \pounds 7 sterling.

Fry 24. Westerly Wind, exceedingly Cold. The Enemy have added greatly to their Works and are exceedingly Bold and Daring, firing upon our Towns People, and indeed every where with Small Arms. They have been employ'd for Several Days past in Collecting a very considerable quaintity of Chandaliers, Casks, Fascines and Sand Bags; making a Depositt in the Round Tower near their Battery, and this Morning it was observed their making their Line of approach as during the foregoing Night, the Enemy have Debouched through the Lines with a Boyau of approach running from the Saillant Angle of the Well Battery, about South West, 100 feet in length. A New Method of firing was try'd from the Montague whilst the Govr was there about 8 oclock this Evening, at which time the Gun Boats came again and fir'd very much at the Shiping. We did not fire from the Garrison but encreased our firing from the heights. The whole Night We keep throwing Shells and Shott. Those Boats are Resolved to trouble us, -and they Effectually do So.

Saturd 25. Westerly Wind. The Colonel up upon the Mountain for Many hours this Day as well as for Several other Days, and the Govr at our House this and every Day now. I am desired to get letters ready against the Boat is expected to go which will be try'd the first Easterly Night after this. The Gun Boats came as Usual this Evening and We fir'd greatly from all parts. Several of their Shott came on Shore last Night and particularly at the Southward. Thank God, No harm as yet has happen'd from any of their Shott. This firing from these Boats is very uncertain as the Shot are often carried in a Contrary Direction.

Sund 26. Easterly Wind. Every Body Seems Busy. A Shott from a Gun Boat came last Night into the House of Mr Booth, Pratic Master. Broke thro' into the Kitchin. His House is near the Line Wall. I write to my Sister and sent it to the public packet this Day, and one to Captn Nicolls of an old Date and was meant to have gone in Septr by some Ships.

Mond 27. Westerly Wind. The Enemy greatly advanc'd in their New Work, and seem'd as if they would continue to go on ; yet we are certain that every means are try'd to hinder them by our firing. They are at too great a distance as yet to Regard it so much as we wish. They are about 200 yards too far off. The Boat not gone.

1912.]

Tuesd 28. Easterly Wind, very fine Day. This Boat Still here, as 28th Novemthe plans and papers are not ready. The Colonel and Mr Holloway ^{ber, 1780.} exceedingly busy, putting down on the plans the progress that the Enemy make every Night, and this is attended with a good deal of attention and trouble, and keeps the Colonel in a constant State of Anxiety and Business.

Wed 29. Easterly Wind. Dull looking Day. I write a letter to my Son and send it to Mr G. Ward. The Enemy greatly advanc'd with the New Work. About this time most of their Ships are gone to the East from Algezira, and those few that remain are Closely hauled In shore. The whole House in hurry.

Thursd 30. Easterly Wind and Raining. A Polacre arrived this Morning, last from Algiers, is a prize taken by Mr Anderson's Vessel. She brings a Number of Useful Articles, being a French Ship, Loaded with Oil, Wine, Soap, Candles, &c, &c. It is a very fortunate Circumstance, the getting In any kind of Vessel at this Juncture. More planns getting Ready. This Boat is to go to the Eastward it being impossible to get out to the West,—and the Way of Minorca Seems the only one that is any way Safe.

Fry Decr 1. Easterly Wind. A pretty good Day. The Colonel still adding to the plans, and this Morning has afforded a good deal to put In, as the Enemy have Done a good Number of feet of Work in the course of last Night. About Noon this Day a very large Ship appear'd from the East. It was at first taken for an English Frigate, but proved to be a Ship from the Levant, Loaded with Silks and other rich Commodities for England, is a Letter of Mark, Commanded by Captain Huges, 26 Guns, 70 Men. She was Surrounded by Gun Boats and other Vessels. She came into the Harbour very Safe, and we hear is to stay only to take In Water. The Grand Parade plow'd up this Day, and Such other parts of the Town as had not been plow'd up before.

Saturd 2. Easterly Wind. Raining most of the forenoon, and appears as if there would be bad Weather. The following was in Garrison Orders this Day:—"Several officers of the Garrison having Communicated observations and hints to the Governor which have proved, and others may prove very advantageous to the Kings Service; officers of every Rank are desired to Communicate any remarks which appear to them Useful. The Governor assures themsuch beneficial discoveries shall be publickly acknowledged at a proper time." About 6 oclock this Evening it began to Rain very Hard,—and Directly came on the most Violent Storm of Hail, Rain, and Thunder that I ever Remember ; which Continued about half an hour,—and happy for this Garrison it was that it lasted no longer. As it was it has done a great deal of Harm. Several old Houses thrown down, and a vast quaintity of Rubish came from the Mountain. The whole Garrison was full of Bustle and hurry. The Colonel

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was at the Convent^{*} when it began and could not get away till near 9 oclock, for tho' the Violence of the Storm was only of a Short Duration, yet it continued to pour with Rain till near 11. We had continually the different Engineers coming about Drains &c. The Rain and Thunder seem'd much abatted and We were all quiet when going to Bed. The Captain upon the Mountain fir'd frequently during the Storm and all Night, as did also the officers from Prince of Oranges and Montague Bastions. It seem'd to be tolerable calm Weather when we went to Bed at 12.

Sund 3. Easterly Wind. At 6 oclock this Morning it began to Rain and Blow very Violently and Many people were fearful that it was going to be as bad as last Night. However it clear'd up. was Showery all the Morning. The Colonel most amazingly hurried. in order to send off some papers and Despatches by the Letter of Mark which We find intends going this Night. We hear of a good deal of harm done in the New Made Gardens upon the Mountain, and at all the Grounds at the Southward. All pretty well at Mount Pleasant except that the Hail has destroy'd the Beans and Peas and the Young Salleting. † The Enemy seems rather at a Stand just now. It is supposed they are Waiting for a Supply of Fascines and Wool Bags &c, this late Wet Weather having hinder'd them a good deal. The Vessel that came In last fryday intends going away as this Evening, and in consequence the Col is exceedingly hurried in geting away his dispatches. I cannot as yet learn if it is expected that the letters which are now waiting in the post office are to be sent or not as every thing of this kind is kept a profound Secret. We have some letters at Mr Wards, which We think to send and others in the office.

Mond 4. Easterly Wind. Raining and dull Weather. The Ship did go last Night, and Captn Leslies first Lt and a Lt of Marines went Home. This Day the Colonel had a good deal of More hurry in Settling for other plans to be got Ready to go in the Boat to Minorca, which will most certainly sail the first Westerly wind. We live in a State of Earnest doubts and Expectations, which is of all Situations most distressing. The American Club Day. The Col went but came away before six oclock. It Rained all this Day and likewise at Night. We have but little Firing now. Find that the Porter which came in the last Vessel from England is already 'Lower'd in the price, Ten Dollars the Hogshead, and it is Supposed will be Still cheaper. We had near 500 Dollars Worth of family Articles from this Vessel.

Tuesd 5. Easterly Wind. Raining all this Day. All very quiet from Us and from the Enemy. The Whist Meeting at Lt Col Craigs. It was in Orders of the Garrison this Day :---" Lt Booth of the Corps

* i.e. Government House.

† i.e. Salad, see table under date December 30, 1780.

of Engineers is to have the Inspection, as Director, Under the Chief 5th Decem-Engineer, of all the Mines; and all Persons employ'd therein; Taking ber, 1780. his Orders from, and reporting to, the Chief Engineer."

N.B. His appointment is Eight Shillings pr Day for the above Duty. It has given Universal Satisfaction; particularly to the Corps as Mr Booth is much Esteemed by Every Body.

Wed 6. Easterly Wind. A very Wet Morning and continued so all Day. About 9 this Evening the Captn upon the Batterys threw a Carcase at the Enemys New Work which shewed a good deal of that Battery, and He also followed it closely with Grape Shott. N.B. We have been very quiet of late from the Gun Boats.

Thursd 7. Easterly Wind. Still Raining and Wet Weather. The Enemy advancing every Night. This Evening a good deal of firing from the Montague Bastion, the Artillery officer upon that post being order'd to Fire a Certain Number every hour.*

Fry 8. Easterly Wind. Raining and bad Weather. The Enemy have added a Strong Traverss in front of the New Work and brought down some heavy Carriages, as it appears from the Deep Tracks in the Sand. Many of the *Knowing* Ones boldly pronounce there are already mortars in the Work—however the more *Steady* Persons say it is merely Conjecture. The Enemy have, and still continue to affect to shew great Matters; such as Seting out in View Mortar Sponges, Hand Spikes, &c, &c, &c, but all that is well Understood by this Garrison.

Saturd 9. Easterly Wind. A fine looking Day. In the forenoon an Experiment was try'd from Old Mole-to throw Shells from Howitzers to the Enemys New Battery. It answer'd very well for the most part. One Shell fell Directly in the front of their Work and threw down some Fascines, which they instantly repair'd. The officer who appear'd to command their party behav'd Remarkably Well, with much Seeming Coolness and Conduct, and Stood upon the Front Epaulment the whole time, and seem'd to encourage the Men. Our Captain upon the Batterys was expected to have fir'd upon the Enemy during their Working, but He did Not! The Govr Seem'd to express a surprize at his not firing. However it was amply made up by the Constant Fire He keep up all the Evening and Night, which it is not to be doubted did greatly hinder their Working. At half past Six in the Evening it began to Thunder, Rain, and Hail with the greatest Violence, much indeed as it did this Day Week. It alarm'd us a good deal, fearing it would be attended by the Same Unpleasant Consequences, but it did not continue more than about Ten Minutes,-after that it was a Settled Rain all Night.

Sund 10. Easterly Wind. Raining all Night and till about Noon.

¹⁰ The entries for this day and the next, except as regards the weather, are transposed in the other version of the diary.

10th December, 1780. A most Welcome Sight presented this Morning. A brig from Leghorn, Loaded with Wine, Brandy, and Oil, and 3 Setees from Minorca, all get Safe into the New Mole, it being impossible for the Enemys Boats to Move from over the Way. The Brig brings flying Reports with regard to an Engagement that has been between Sir George Rodney and the French in the West Indies, in which We had been Successful, and also that the fleet was gone from Cadiz; in order it is supposed to meet the Expected fleet coming from England to this Garrison. We also hear of an Insurrection in the South America; that it was discover by means of a Priest which We had taken. The Setees from Minorca bring as Usual, many little Useful Articles but that Governor will not let them bring Live Stock.

Mond .11. Easterly Wind. Cold and Raining. The Enemy have done a good deal last Night. The Brig brings Letters with the following accounts of the Rebellion in South America. N.B. It is just the heads of a Letter which I took.

Extract of a Letter, Dated London, Septr 26th, 80.

"The *Bellona* privateer, from Buenos Ayres, brings Word the Rebellion took place in March last, commenc'd at Aregiupa; a general Revolt at Cochambamba, Oriero, Chicuto, and the other districts of Potosi, where the Kings Treasure is, and it had got as far down as Paraguay."

Tuesd 12. Easterly Wind. Cold and Rain. The Colonel not Well; did not go to the Parade. An auction of the Prize Goods. The Evening was fine. The Whist Meeting at Col Kellets. Good deal of firing this Evening and also in the forenoon, at the Enemy's being in the Gardens all Day.

 \overline{Wed} 13. Easterly Wind. Cold Morning. The Colonel not well. It Rained hard this forenoon and continued to do so all Day. At Night it came on very Violently and brought down still more Rubish.

Thursd 14. Easterly Wind. The Colonel better and at the Parade.

Thursd 21. Westerly Wind. This forenoon a Vessel appear'd; coming In from Under the Barbary Coast. She prov'd to be a Kings Cutter, the *Speedwell*, from Portsmouth, commanded by Lt Gibson, bringing Dispatches for the Govr, does not chuse to mention the exact time she has been from Engd, and the whole Seems to be a profound Secret. She yesterday fell In with one of the Enemies half Galleys. As the Cutter lay over near Ceuta the Enemy sent out an Arm'd Boat to see what she was, and from the manner she came In Concluded she was only a Small Vessel from Ireland, as it was formerly the Custom to send Cutters of this kind Loaded with Provisions. After the Boat had observed her a Galley came out from Ceuta and attempted to Board Her, in doing which a Spainiard fir'd a Musketoon which greatly Wounded Lt Gibson. The Galley was drove off, having first 21st Decem-Received a Number of Hard Knocks; and it is Suposed she was ber, 1780. hardly able to get Into Ceuta. The Kings Cutter got Safe into the New Mole. The Lt was the only Person hurt on Board. He was Drawing his Sword at the time the Gun hurt him.

Fry 22. Westerly Wind. Very Wet, Cold Weather. Lt Gibson is not Mortaly Wounded We hope, is brought on Shore to the Navy Hospital. It is keep a profound Secret as to what this Cutter is come out for. Therefore all Manner of Conjectures are forming. It is most Certain that it is on business of Consequence. We also Seem to Understand that a Frigate came out from England at this same time. There has not been one Single letter for any Body, for not a person on board the Cutter knew of their Destination when they were order'd at a Moments Warning to go out to sea from Spithead, and the Lt Received Positive Orders not to open his Instructions till he arrived at a Certain Latitude. This is the only Kings Vessel we have had Since the Hyena Frigate in April last. There is not a Man on board allow'd to come on Shore, or to answer any Questions that are Ask'd of Them.

Saturd 23. Easterly Wind, raining hard, at Day Break. A Snow arriv'd this Morning from the West, a privatter from Portsmouth, call'd the Hannah, Captn Venture, belonging to Mr Turnbull, She came last from Lisbon, from which Port she brings Letters dated 5th of Decbr. She has Various Articles for this place, such as Hams, Bacon, Butter, Leather, &c, &c, and a Number of letters for different Persons in the Garrison. We got Letters from our Family dated 26th October. Our Son informs Us of the Royals* being order'd for foreign service, and were at that time at Portsmouth, perhaps would embark in a week. This has afforded Us a good deal of Concern, and the More So as their destination is a total Secret. I have the happiness of hearing that all the family were well. We still remain in Ignorance both with respect to where that Regt was going; or if there is any time fix'd for a Convoy's coming out to this Garrison. This Evening the following after Garrison Orders were given out :- "There being the Strongest reasons to believe that Colonel Ross is appointed Colonel to the 72nd Regt or Royal Manchester Volunteers, altho' no official Notice has yet been received by the Governor, He is therefore only to do the Duty of Colonel in the Garrison and no longer to act Lt Col to the 39th Regt, Untill further Orders, and there being the strongest reasons to believe that Captains Baugh, and Mercier of the 39th Regt and Captain Hamilton of the 56th Regt are appointed Brevet Majors they are to do Duty as such, till further Orders.

Sund 24. Westerly Wind. A Cold Morning. Various opinions of what the Kings Cutter and this last Vessel has brought with regard

• His own regiment, which he afterwards commanded. See preface.

to News, particularly the Cutter. We hear that the *Brilliant* Frigate of 36 Guns is hourly expected, that she left England the Same time the Cutter did, being it is Supposed charged with Some public Despatches. Got a very large and fine hind Qr of Mutton from General Boyd, 22 lbs. This may be called a very Cool, Melancholy Season and much unlike what We us'd to have in this Garrison. We cannot make any great preparation for Christmas Day.

Mond 25. Westerly Wind. Christmass Day. A very fine Day indeed, and Usher'd In by a most truly Welcome Circumstance, viz., a Polacre from Liverpool, Loaded with flour, Butter, Hams, &c,-no less than 300 Casks of flour which is so much a greater Blessing as it. now is openly known that there is not more than three Days flour for the Inhabitants in the Garrison. This Vessel may be plac'd amongst some of the God Sends that we have experienced since the Blockade, and has put every Body into high Spirits. The Boat is to sail this Night for Minorca by which I send several letters; and a Long one to my Sister, acknowledging the Receipt of the letters which arrived on Saturday last, and had a letter inclosed to a friend of Mr Wards, for my Son. At Noon this Day the Spainish Deserter who came In from the Enemy upon Septr 29th and who has always been suspected to be a Spy was taken hold of upon Suspicion and instantly sent Prisoner to the Provost. He was Search'd and many papers found upon Him. He has been very Closely Watched of late by Capta Uniacke of 58th whose Company is guartered upon Windmill Hill. This man went it seems, into the Soldiers Barracks there ; and asked them to lend him some Sealing Wax. The Captain happen'd to be in some part of the Barrack and heard him. He directly went up to him and ask'd him what He wanted with Sealing He Directly laid hold of Him and had Him Searched. Wax. Several Suspicious papers were found upon Him, particularly a Letter, wrote in English and intended to be sent to a Colonel Nugent who has the Regt He belongs to. It acknowledges in that letter, his having Recd several sums of Money from Col Nugent and also letters. He also tells the Way that He has plan'd for his geting away. He was directly taken up to the Provost at the Moorish Castle.

Tuesd 26. Westerly Wind. A very fine day indeed. The Boat with the packet, and also an other went away last Night. I went out this forenoon and call'd upon Several and went to the South Bastion. Variety of opinions with respect to the Deserter and what will be done with Him. He has not been examined as yet. The Enemy have brought four Mortars into St Carlos Battery, as We find they have given that Name to the New Work. They are at Work this Day,—and last Night. N.B. I omitted to mention that Divine Service was performed yesterday in the inside of the Court Yard at the Convent, Round under the Colonade, and afterwards the Sacra-

24th December, 1780. ment administer'd at the Judges Court House. This is the first time 26th Decemthat the Service has been at the Convent since the Church was made ber, 1780. use of for a Store House. It is now full of Dry Provisions. Every Sunday the Service has been under the Kings Bastion, when ever the Weather allow'd.*

Wed 27. Westerly Wind. A very fine Day. The Govr and the Colonel went Round to Europa and Examin'd the Boom at New Mole. We keep up a Smart firing all this Day upon the Enemys Working Partys.

Thursd 28. Westerly Wind. Rainy. A Man of 39th Regt who was confin'd in Barrack Yard for Stealing a Watch made his Escape from the Centry who had him under his charge. It is supposed he is upon the Mountain. We go to Captn Phipps in the Evening.

Fry 29. Easterly Wind. A Spainish Setee was seen off Europa and after our firing upon Her from thence the *Enterprize* Frigate sent out Boats and brought Her In, but every Body had quited Her and taken to a Small Boat. She was going to Malaga from Algezira, had a Number of letters on board, which most likely may be useful. The Setee is a very pretty Vessel and may be Worth about $\pounds 150$. This Day I had a Minorca Pig kill'd; which I bought in Septr last. I gave 22 Cobbs for it. It now weighs 100 Wt beside the Inside, which as pork is now sold at Six Rials a pound would amount to 75 Dollars and she cost 33 Dollars. Sent hind Qr of this Pork to Genl Boyd weight 24 lb, and a neck to Mrs Phipps.

Saturd 30. Easterly Wind. Cold Raw Day. No Comfortable preparation for the New Year. Altho the Garrison is Well Supplied with Variety of every thing except Live Stock, yet is every family Article so extravagantly Dear, that the poor sort are Dreadfully off. Three Guineas has been ask'd for a Roasting Pig, and the cheapest are sold for two. On board the Liverpool Vessel is almost every useful thing,-Corn'd Rounds of Beef, pickeld Tripe, Herrings, Bacon, Hams. and a vast Number of other articles, all to be Sold at public auction. The Rounds of Beef Sold for Seven Rials pr pound, which is equal to three shillings, and they are very Large for the most of them; a Round that was bought by Colonel Ross, 35 Dollars. I shall endeayour to set down the prices of family Necessaries at the Close of this year, and compare them with what those Necessaries were last year. It must be Remark'd that as We have been So Lucky as to get In three Vessels lately from England it has lower'd the high price of some few articles. At this time last year there was a few Oxen and Cows kill'd but that is not the case now. We have not had any Beef for many Weeks past. The last sold for 7 Rials. There has not been any Mutton for Months at the Market, nor any Goat of late.

• The other version of the diary says " upon the Kings Bastion."

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30th December, 1780. 400

Fish has been at an astonishing price all this last year, particularly Hake Fish. We give a Cobb for what used to be only 2 Rials. Vegetables are now pretty reasonable, owing to the Number of Gardens at the Southward, and every Person is obliged to send to the public market all they do not want in their own family. A Large good Cabbage is sold for two Rials and a half (equal to a Shilling.) Upon the whole we may think ourselves very fortunately Supplied; our greatest Wants are Firing, and Wine for the Troops. The Large Supply that came some weeks agoe of Lemons has been of the Utmost Benefit to the Troops. The Scurvy is greatly abatted. The few Coals that were left on board some of the Ships which have been here many months have been sold lately. Sixteen pounds sterling pr Chauldron. Soap is cheaper than it was.

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Soap has been exceedingly Dear all this last year at pr lb 4 Rials but of late is 2 Rials.

(To be continued).



General Sir Alexander Taylor, G.C.B., Royal Engineers (Bengal).

MEMOIR.

GENERAL SIR ALEXANDER TAYLOR, G.C.B., ROYAL ENGINEERS (BENGAL).

By COL. SIR EDWARD THACKERAY, K.C.B., V.C., LATE R.E. (Bengal).

In the death of General Sir Alexander Taylor, G.C.B., late President of the Royal Indian Engineering College at Cooper's Hill, which took place at his residence at Englefield Green, on Sunday, 25th February, at the age of 86, we have to deplore the loss of one of the most distinguished of the old Punjab officers trained in the school of the Lawrence's, and one who took a most important part in the Siege of Delhi during the great Indian Mutiny of 1857.

Sir Alexander Taylor belonged to a family of Scotch extraction, settled in Ireland. Among his earliest recollections were the venerable figures of his great-uncles, Major Alex Taylor, R.E. (b. 1746), Major Archibald Taylor, H.M. 81st Regt. (b. 1747), and that of his grandfather, Capt. George Taylor (b. 1748), all of whom were born near Aberdeen, and were able, strong-brained, and strong-tempered men. They were all three Commissioners of Lighting and Paving in Dublin, in the neighbourhood of which they held property.

The career of George, the youngest of these brothers, is characteristic of the family predeliction for engineering and military adventure.

He began life as a Civil Engineer at Aberdeen, where his father, Alex Taylor of Anfield, lived. Before he was thirty he had planned and superintended the construction of the Aberdeen-Inverarie Canal. He was also employed on the construction of the harbour of Howth (Dublin).

In 1776 he published, in conjunction with his friend, Mr. Skinner, a detailed survey of the Roads of Scotland ; and, in the following year, a similar survey of the Roads of Ireland.

Next year the background of his life changed suddenly. We find him in 1779 serving as a Volunteer in the British Army, fighting under Sir Henry Clinton in the United States, first at New York, and then at the successful Siege of Charlestown. His force of character and ability speedily made themselves felt; in 1781 he was attached to the guides, and was appointed Capt. Surveyor to the Commander-in-Chief, Sir Henry Clinton. In the following year he held the same office under Sir Guy Carleton. He afterwards went to Jamaica, where he immediately received a commission as Captain in the Duke of Cumberland's local regiment. Shortly after this he returned to Aberdeen, married his cousin, Barbara Thompson, daughter of Alex Thompson of Mount Haillee, inherited, or bought, his father's place, Anfield, was made a Free Burgess of the City, and became the Captain of the Aberdeen Volunteers.

Ten years later he left Scotland for Dublin, where he remained until his death, at the age of 88, in 1836. In conjunction with his two brothers he undertook, in addition to other charges, the management of certain high roads connecting Dublin with the South and West of Ireland.

He had three sons :—Archibald, who joined the Royal Engineers, George, who in his turn became Commissioner of Lighting and Paving in Dublin, and William, the father of the subject of this Memoir.

The profession towards which every member of this family had a natural bias was engineering; it was towards this that William Taylor turned, not so much as a scientific art, but as an instrument for promoting certain social and economic public ends which were the chief interests of the little group of Scotchmen, (his father and uncles), in the midst of which he had grown up.

Having entered into partnership with the celebrated engineer, Sir John MacNeill, he moved to London in 1833, returning to Dublin, however, after five years "exile," to devote himself to furthering the introduction into Ireland of the new steam locomotion, the use of which he confidently expected would launch his country on an era of prosperity. To the energy, tact, and enthusiasm with which he prosecuted this difficult work was largely due the rapidity with which, in spite of almost disabling difficulties, the Great Southern and South Western Railway of Ireland was opened. This railway was his passion. He worked for it *con amore* from the day when it was but a project in a few eager minds, to the day of his death in 1870.

Alex Taylor, the subject of this Memoir, was William Taylor's eldest son, and was born in Dublin in 1826.

At the age of 12, he was sent to the celebrated school at Hofwyl, near Berne, founded and personally managed by Pestalozzi's famous collaborator, Herr von Fellenberg. The foundations of this great educationalist's system were religion and altruism; the love of man being considered the natural outcome of love of a divine Creator. His own life was the embodiment of his teaching. Aiming at the production of healthy, capable, public-spirited, and god-fearing citizens, he devoted as much attention to the education of his pupils' bodies and characters, as to that of their intelligences. He trained their hands, their eyes, and their ears as carefully as he did their brains; a circumstance to which Alex Taylor owed much of his success in after life.

The practical and public-spirited bias of Herr von Fellenberg's teaching, so different to the purely scholastic system then in vogue, appealed to William Taylor; for the character and activities of his

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progenitors, and his own connection with great engineering works had taught him to value all that tends to promote the civilization of a country by developing its material resources.

Alex Taylor remained at Hofwyl till he was fifteen; three years, to which he always looked back as among the happiest of his life. He rose rapidly to a position of mark in the school, more especially in bodily exercises: he was one of the best gymnasts of the place, a notable skater, a good rider, boxer, and fencer. He was also one of those selected to recite on public occasions. The moral influences to which he was subjected in Switzerland formed the man of the future.

He entered the H.E.I. Company's Military College at Addiscombe in August, 1841, and passed out in the Engineers in June, 1843. His contemporaries of the same term were the late General Charles Waterloo Hutchinson, Inspector-General of Military Works in India, Colonel Commandant, R.E.; the late Colonel Daniel George Robinson, C.B., Director-General of Indian Telegraphs; and the late Capt. George William Wright Fulton, who was killed at Lucknow during the defence of the Residency in September, 1857.*

Lieut. Taylor arrived in India in 1844, joined the Headquarters of the Sappers at Meerut in September, 1845, and was shortly afterwards sent to Ferozpore in command of a company of Sappers.

His chief amusement at Chatham had been sailing, a pastime, which, if it had militated somewhat against the attainment of the highest places in the list, now stood him in good stead; for, on the strength of his reputation as a yachtsman, he was put into temporary charge of Lord Ellenborough's flotilla of some 56 boats for military bridging, which, built in Bombay, had just made its appearance on the Sutlej.

On the outbreak of the first Sikh War (1845-1846) he had orders to sink these boats and to fall back on Ferozpore, which shortly afterwards was threatened by Tej Singh, at the head of 30,000 Sikhs, to whom General Littler could oppose 10,000 men only, chiefly Sepoys.

Although a young subaltern, Taylor was put in command of the Sappers and Miners, on whom depended the defence works of the city at this critical time. He was a member of the skeleton army, 1,000 men only, left to deceive Tej Singh, when Littler, slipping out of Ferozpur, reinforced the hardly-pressed British troops at Ferozshah (December 21st, 22nd, 1845).

After this dearly-bought victory, the Sikhs having withdrawn from

* Capt. Fulton was one of the leading spirits of the defence; active, resolute, and cheerful under all difficulties. He had been inspecting a new battery, and, lying at full length in one of the embrasures with a telescope in his hand, had turned his face, with a smile, towards his comrades, saying, "They are just going to fire," when a round-shot carried away the back of his head. His loss to the garrison was said to have been the most important after that of Sir Henry Lawrence. the neighbourhood, he had orders to raise the boats he had sunk, which afterwards formed the bridge across which the victorious British Army marched to Lahore after the Battle of Sobraon (February 10th, 1846).

For this campaign Taylor received a medal and two clasps.

On the outbreak of hostilities at Mooltan (1848) he carried down 200 miles through the dangerous shoals and rapids of the Sutlej to the neighbourhood of Bhawalpore, in the same unwieldy boats built not for purposes of locomotion but for bridging, the heavy Engineer train required for the siege.

He served during the double siege of Mooltan under Robert Napier,* who had been his sole passenger throughout this adventurous yoyage. It was during this journey that the Chief Engineer learned to know and value the qualities of the subaltern of whose promptitude and resource he availed himself largely during the siege; to whom, as will be seen, he afterwards committed the construction of the Grand Trunk Road lying between Lahore and Peshawur; and finally to whom, long years later, he offered the post of Quartermaster-General of the Bengal Army.

Alex Taylor was in charge of the Engineer's Park† throughout both sieges, and made himself a reputation both as an Engineer, and as the maker of brilliant and hazardous reconnaissances.

He guided the cavalry at the affair of Sooruj Koond (November 8th), at which engagement five guns, which had been firing for some days into Edwardes' Camp, were taken—the success of this operation being largely due to his extraordinary knowledge of the enemy's ground and positions.

When the breaches in the walls of Mooltan were completed, he was allowed by Robert Napier to act as guide to the party assaulting the left breach, a perilous honour which was not his by right of precedence. The assault was successful, but he was severely wounded.

At the decisive Battle of Goojerat (February 29th, 1849) he was Orderly Officer to General Sir John Cheape, the Chief Engineer, and had his horse disabled under him. He joined in Gilbert's pursuit of the broken enemy from Chenab to the mouth of the Khyber, and was present at the submission of the Sikhs near Rawul Pindee. After this campaign he was thanked for his services in despatches, and received a medal with two clasps.

In May, 1849, Robert Napier, the Chief Engineer of the newly

^o Field Marshal Lord Napier of Magdala, G.C.B., G.C.S.L., Colonel Commandant, R.E.

t "Major Siddons, R.E., the historian of the Siege," writes Sir Herbert Edwardes, "makes justly honourable mention of Lieut. A. Taylor, the officer in charge of the Engineer's Park, who, with a singular zeal and ingenuity prepared all kinds of contrivances for facilitating Siege operations, making his Park quite a show."—H. Edwardes. A Year in the Panjab, II., 537. annexed Panjab, entrusted him with the construction of a new military road destined to connect Lahore and Peshawur :--- a distance of 290 This great work had to be commenced, ab initio; the country miles. was wild and unsurveyed; no regular roads existed; no maps; no machinery; and no organized body of labour, skilled or otherwise. The Lahore-Peshawur Road is now the first military road in India, and in its extent, and in the dimensions of its bridges can be compared only with the grand military roads over the passes leading from Italy to Switzerland. The first project was to open a main line of trunk road from Delhi to Peshawur. The viaducts over the Five Rivers were to be postponed, but the bridges of all the lesser streams were to be undertaken, and a good passage made through the rugged region between the Jhelum and the Indus. The roadmakers under Lieut. Taylor immediately grappled with all the engineering difficulties over the whole length of this extensive line, connecting most of the important stations of the province with each other, and with the other provinces of India. From this trunk line there radiated branches in every direction; the most noteworthy of which was the road from Lahore, the capital, leading southwards to Mooltan and immediately connecting the Punjab with Sind. Taylor worked unremittingly on this road from 1849 to 1857.

The young roadmaker, with the experience and lessons of Mooltan fresh in his mind, joined the force before Delhi on June 27th, 1857, and was present throughout the greater part of the rest of the operations as second in command of the Engineers, under Colonel Baird Smith, the Chief Engineer.

It is unnecessary, in this short and inadequate account of Sir Alex Taylor's great services, to dwell on the so-called "controversy," of which the subject is the degree of credit for the happy issue of the Siege due respectively to Colonel Baird Smith, and to his second in command, Capt. Taylor. The subject was irksome and painful to Sir Alexander himself, who, though naturally pained by certain miscarriages of justice of which he was the victim, always begged his many friends to neither speak nor write on his behalf.

Certain letters bearing on the points in dispute have been kindly placed at my disposal by Lady Taylor. They were written by Sir Alexander Taylor, under the pressure of circumstances and in reply to direct questions, to Sir John Kaye, after the publication of his history of the Mutiny. As they will probably be published shortly, in their entirety, the quotations made from them here will be confined to passages containing technical matter relating to the Siege, which may be of use to Engineer officers engaged in siege warfare.

Before giving these extracts I would call the reader's attention to a short note by Sir Frederick Maunsell on this group of letters, a note which I publish with his permission. It bears witness to Alex Taylor's chivalrous and self-sacrificing nature, and runs :---" Sir Alex Taylor's letters give the best evidence concerning his action and work in the Siege. I knew him first at Mooltan, and afterwards at Delhi. These defensive replies were forced from him by those who demanded the facts from him directly. Never was he one to claim more than his due. At Delhi he simply did as a duty, what was laid on him, and humbly let others . . . take the credit and honour really due to him."

The following extracts are taken from a letter to Sir John Kaye dated November 29th, 1875, in which Alex Taylor describes the manner in which the plan of attack was gradually evolved.

"It will be convenient," he writes, "to consider separately the time wewere on the defensive, and that during which we were the assailants. During the first period the engineering works were as compared with the second, on a smaller scale. Our general routine was the following :- The work to be done to-morrow was decided upon to-day, generally on my return to camp in the evening; but, sometimes, on the report of the Engineer officers who came off duty; or on the requisition of an officer commanding a post. The detailed orders, when drawn up, were placed on record, and issued. Anything emergent was dealt with on the spot, generally by me, and reported to Baird Smith on my return to camp. This arrangement worked excellently. I do not remember meeting any difficulty in having what I wished done,-'put in orders,'-or that I was ever directed to carry out what I did not approve of.

"But beside the current work there was the big question ever present :----'How is the attack eventually to be made?' I often talked the matter over with Baird Smith. We both agreed as to the front which was to be attacked; and it was also clear to us both of what immense value time would be when once we had taken such a step as would disclose our. intention to the enemy.

"An attack in full form, with trenches, etc., was clearly out of the question. We could not hope to have the men for it . .

"Before a project could be framed which involved the formation of a breach it must be clearly ascertained that the walls could be seen from a distance so low down as to admit of their being breached. If they could not be thus seen, then an attack of this kind would be impracticable.

"Again, in a race against time it was evidently necessary that the proposals, whatever they might be, should have been critically examined beforehand on the very ground. There must be no question as to whether the objects to be fired at by the different batteries proposed would be visible from the sites intended for the aforesaid batteries. There must be no room for error

""The ground we purposed to operate on had been in the hands of the enemy since May; and part of it at that time was studded with large buildings and trees. What had the enemy done? Had he levelled the Custom House? The Khoodsia Bagh? Ludlow Castle? Had he fortified them? Did he occupy them in force? A time project could be prepared only when all these questions could be answered with certainty . . .

"The first thing to be done was to get on to the ground on which our

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work would lie. But how to do it? It had long been in the enemy's hands, and he had a large piquet of perhaps a regiment in Ludlow Castle. But we wished, carefully, to avoid alarming him in this direction; it would not do therefore to ask the General to drive in this piquet; nor, even if this were done, were we likely then by open force, to be able to carefully examine the ground we wanted:—to get into the Khoodsia Bagh, and to examine the Custom House, and the ground round it, lying close, as they all did, to the ramparts. The prospect was not encouraging.

"Watching Ludlow Castle, however, one day from the Ridge, it seemed to me that the old piquet had been vacated, and that the new one had not arrived. I thought I had now a chance of examining the ground personally. Disencumbering myself of my sword, and armed with a pistol only, I took a party of 16 men from a piquet of the 'Guides' and advancing from Metcalfe's piquet passed between Ludlow Castle and the river, and reached the Khoodsia Bagh. Leaving the men in extended order outside, with strict orders on no account to fire, I entered the enclosure with the havildar, and explored it thoroughly; then, mounting on the wall next the city, I could see the sentry on the ramparts, seemingly so close, that it was difficult not to think that he must hear the noise my climbing unavoidably made. The Custom House, 180 yards from him lay immediately in front of me, and for more than an hour, lying on my face on the top of the wall, behind a small shrub, I carefully examined it, and the ground around it. Finally, after a stay in the Khoodsia Bagh of about two hours, we effected our retreat without having been observed.

"This work was of course of extreme risk and danger. We knew that our left flank was safe, as it rested on the river; but, obliged as we were to keep ourselves strictly in the dense cultivation,—chiefly groves of orange-bushes,—we could not know what was happening on our right; and, with the enemy's piquet-house between us and our nearest post, more than a mile off,—escape would be hopeless should we be discovered.

"I learned on this occasion that the roof of the Custom House had been burnt, and had fallen in, but, that the brick walls remained standing (this was eventually the site of Battery No. 3); that the ramparts could not be breached from the Khoodsia Bagh; that neither the latter place, nor the Custom House were, or had been, occupied by the enemy, the vegetation around them being fresh and untrampled; and that the only place in the vicinity outside the walls which was occupied in force was Ludlow Castle.

"Other opportunities similar in character seemed to offer at intervals throughout the operations in July, August and September; and I always tried to take advantage of them, though not always with success. Sometimes we stumbled upon the enemy, and had to fall back.

"On one occasion, when far in front of our most advanced posts, we were allowed to march to within 60 yards of a low stone wall which crossed our path at right angles, —myself and twenty men, —when suddenly a couple of hundred men, —who seeing us coming concealed themselves behind it, —sprang up; delivered a volley in our faces; and jumping over the wall, tried to close with us. After a little hesitation, we turned, and took to our heels, with a lead of perhaps 30 yards (fortunately in the hurry and excitement the fire had been bad, and only one of our men had

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"On another occasion, Ludlow Castle seeming to be unoccupied, and an escort not being readily procurable, I made my way to it alone, and was using my eyes from the *top of its roof*, when the head of a regiment appeared; I saw it entering the gateway, literally only a few yards off; I succeeded in getting downstairs; out at a door on the other side of the house; and over the garden wall; fortunately without having been observed.

"On most of these explorations I was not accompanied by any officer. The work was of a very dangerous and risky kind, and lives in those days were very valuable. But Greathed, I remember, was with me on one of my failures; and Lieut. Thomason, R.E., on another day, when we succeeded in getting into the Khoodsia Bagh.

"In this laborious way I was able to mature a project which would bear scrutiny.

"The breaching batteries were placed where alone they could be successful, *i.e.* on the prolongation of the right flank of the Cashmere Bastion.

"The other batteries were all placed where their guns could clearly see to do the duty assigned to them.

"The Khoodsia Bagh, which still remained unoccupied by the enemy, and unimpaired, provided a secure and well-sheltered post close to the ramparts, for the troops required to protect the advanced battery, No. 3.

"Ludlow Castle similarly afforded a good cover for the guard to protect the breaching battery, No. 2.

"Battery No. 1 would not only silence the Moree Bastion, but would also close the open plain between that Bastion and the Ridge against a sortie in force; it would also prevent a similar sortie being made through the Cashmere Gate.

"Every one of these points I made sure of in broad daylight. There was no room for error.

"This project I unfolded to Baird Smith from time to time as the different facts on which it rested became established.

"When laid, by the Chief Engineer, before General Wilson, the latter doubted,—I learnt this from General Nicholson,—that I could possibly have visited Ludlow Castle, and the Khoodsia Bagh, and he questioned the information I gave concerning them; to which, however, he attached so much importance, that General Nicholson undertook to go to them under my guidance, and to report the result. Accordingly I took him at midnight into Ludlow Castle, which we had the extraordinary good fortune to find unoccupied; then, to the Khoodsia Bagh; and finally got him safely back to camp.

"Of the nature of his report I can have no doubt, and I never afterwards heard of any objections to my project.

"We now come to the execution of the attack. The project was strictly adhered to. Our only trouble was with the old brick walls of the Custom House at Battery No. 3. These caused more trouble than we expected, and the battery took longer to construct than we anticipated. . .

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"Early in the Siege some delay occurred in searching for the Officer Commanding in the trenches for the purpose of having certain orders issued (the importance of *time* at this juncture must be remembered). General Nicholson, hearing of this, afterwards passed *every* day—I think—of the Siege with me on the works, in order to give me the benefit of the weight of his authority. He was also in constant communication with Baird Smith on siege questions both before the attack and during it. We certainly all worked together with the greatest harmony."

In another letter Alex Taylor refers again to the excellent relations which obtained between him and General Nicholson during the operation preceding the assault. He describes himself as "on the Works every day, from an hour before dawn till sunset, with General Nicholson beside me for nearly the whole of the time;—any movement of the troops I wanted effected, he at once arranged for; the rapidity of action, which, under the circumstances, was of such importance, was thus secured."

The following extracts are taken from a series of notes made by Alex Taylor in November, 1875, on one of his own reports, unexpectedly put into his hands by Sir John Kaye. This report deals with events subsequent to the Assault; it records the movements made by his orders on September 18th, and illustrates the unusual independence of action accorded him on account of the circumstance that his chief was incapacitated by sickness from active work.

It records four steps taken by him on September 18th :---

"Nicholson had lost his life in attempting to carry Burn Bastion," so this note runs, "the attempt had been renewed under Colonel Greathed, and had again been unsuccessful. The aspect of affairs was gloomy. Under these surroundings the Officer Commanding on the spot, on my personal application to him, placed a large body of men at the disposal of Lieut. Geneste (the Engineer Officer on duty at the spot) to enable him to make a further attempt.

"In the centre I had had the large block of houses, between the workshops and the Begum's gardens, occupied by our men. I had seen that the enemy held this block of buildings weakly. We had just experienced a very serious repulse on the right, which would give him confidence, and we might soon expect a hot time, during which any advance would be difficult. The opportunity that now offered should not be lost. I applied therefore at once to the Officer Commanding on the spot to have the 'block' occupied before the conditions should change to our disadvantage. He complied with my recommendation. Wilde's regiment was moved forward, and took possession.

"I announced my intention to move the detachment then in the Magazine up to the Canal.

"With regard to the occupation next day of the Sahiba Mehal; I would have to examine the ground once more, and have it occupied, or not, as I thought best. I well knew that Baird Smith would not make any objection to what I wanted done. I had by far the best means of judging, and he quite knew it. "This report clearly shows that I did not feel I required any support. from Headquarters to enable me to carry out on the spot any work or movement of the troops likely in my judgment to become desirable. I was satisfied that I had sufficient influence with the Officer Commanding. I would also say that the General in giving me authority next day to attempt to carry the Burn Bastion, after the previous failure with the troops, who detested street fighting, gave a strong proof of his confidence in my judgment."

The following is Sir John Kaye's lucid account of the events of the same day, and of that following :—"Ever to the front, ever active, ever fertile in resources, the Engineer Brigade had much work to do, and did it well in this conjuncture. It had been terribly shattered during the assault. One after another, the subalterns attached to the different columns had fallen beneath the fire of the enemy. Few had escaped the perils to which they had been exposed.* But happily Alexander Taylor was alive, though not unhurt, as a bullet had struck him painfully on the chest on the morning of the assault. And there was work for his active brain in devising the best means of securing what we had gained, and in superintending their execution. All the professional resources of 'those who were left' were brought in to play, to entrench the different commanding positions, as they fell from time to time into our hands.

Much had been done but the Lahore Bastion[†] was still in the enemy's hands. No advance had been made in that direction since Nicholson had fallen. It was evident that the appetite of our troops for street fighting had not been improved and that our attempts to gain our ends by open force must be superseded by some more insiduous method of attack. . . . So Alexander Taylor, suggested at headquarters that each brigade should be ordered to work, under guidance of the Engineer officers attached to it, not along the open streets, but through the sheltered houses during the advance; using them as a means of fortification; fortifying all commanding buildings as soon as they could be secured; and placing garrisons in them. The project met with willing concurrence and consent; and Taylor and his subalterns went to their work with the thoughtful activity which had characterized all their proceedings. But the progress was not yet rapid. On the evening of the 18th they were little more advanced than in the morning. The cause was not very remote; nor was it very unintelligible. The veterans of the different brigades did not fall in very readily with the views of the Engineers, or cheerfully recognize their temporary supremacy. So situated, Taylor, with the concurrence of the Chief Engineer, went to

* At the assault on the 14th September Lieut. Tandy was killed; Lieut. Salkeld died a few days afterwards, from wounds received when blowing in the Cashmere Gate; and eight other Engineer officers were wounded. † Or "Burn" Bastion.

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the General, and drew from him an order to the Brigadier of the Kabul Gate to place at the disposal of the Field Engineer a force of some 500 men, European and Native, to carry out the above-mentioned design; and early on the 19th the advance began in earnest. This was not the least of the great services of Alex Taylor. Some 30 houses, important both by their size and position, fell into his hands, and were duly garrisoned and barricaded. Nothing could have been more satisfactory than the result. . . Working onwards in this insiduous but most effective way, our people towards nightfall found themselves in possession of a building which so entirely commanded the Lahore Bastion, that the enemy, seeing their danger, were fain . . . to escape . . . and so the Bastion became our own ! . . . Taylor reported the success of his operations." *

Alex Taylor's services at Delhi, though their full extent was known to few, were appreciated not only by those behind the scenes, but by the great mass of his brother officers in the camp. "He was one who thought nothing impossible; all men worked under him with the heartiest good-will, for he animated and inspired all who came into contact with him in battery or in trench." "The younger officers of the Engineers swore by him." "Those who were above him were equally impressed by his noble exertions":--writes Sir John Kaye, summing up the testimony of the many witnesses he had heard.

I feel I cannot bring this section of my paper to an end more fitly than by quoting the very words in which men whose commanding ability, high position, or circumstances gave weight to their verdicts, expressed their consciousness of the importance of the *rôle* played by Alex Taylor at Delhi.

Lord Lawrence, the *deus ex machina* of the Siege, wrote to Lord Dalhousie on January 14th, 1858, *i.e.* :--before the fall of Lucknow, and the complete suppression of the Mutiny :--" We have indeed had a terrible time. Up to the capture of Delhi, the scales were trembling in the balance. The Panjabis of all classes have behaved admirably, and the zeal and the courage of the Punjab troops far surpassed my hopes and expectations. Still, if Delhi had not fallen, we must have been ruined. Had the troops retreated all must have been lost.

To Nicholson, Alexander Taylor of the Engineers, and Neville Chamberlain, the real merit of our success is due.

Chamberlain was severely wounded soon after his arrival at Delhi, and, until the actual storm, was in a great measure laid on the shelf. But when our troops got inside, and Nicholson was mortally wounded, Chamberlain came again to the front, and kept up the spirits of our people, and directed the movements of the troops.

John Nicholson from the moment of his arrival was the life and the soul of the army. Before he went down he struck the only real

* Kaye. Sepoy War, iii., 624, 625, 626, 627, 631.

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blows which the mutineers received in the Punjab, he led the assault and was the first man over the breach.

Alexander Taylor, though only the Second Engineer before Delhi. was really the officer who designed and arranged all the scientific operations which led to the success of the assault, and in the actual attack was as forward as any man that day." *

To Taylor himself he expressed himself warmly.

October 8th, 1857.

"" I have to congratulate you on your success at Delhi. I look on it that you and Nicholson, poor fellow, are the real captors of Delhi; particularly after Chamberlain was wounded. I think the world also gives you credit for the part you played." †

Brigadier-General John Nicholson,-whose whole-hearted collaboration with Alex Taylor throughout the Siege proper ensured the erection of the siege works with the rapidity essential to success .-has characterized the young Engineer's services in well-known words.

"He was indignant against wrong or injury, against untruth of any kind, and knowing well the brave part that Alex Taylor took in the engineering difficulties and triumphs of the Siege, was indignant at the thought that he had not had justice done to him, and said, 'Well, if I live through this I will let the world know who took Delhi . . that Alex Taylor did it," writes Lady Edwardes, quoting from Sir Herbert Edwardes' Journal.‡

General Sir Frederick Maunsell, the Engineer officer in charge of the Right Attack, and therefore of the construction of No. 1 Battery, the key of the position, writes :--" It is certain that even Nicholson's determined and magnetic leading would have been ineffectual, had it not been chiefly used to back Taylor's scientific knowledge, reconnaissances, and resolution. I was not the next senior officer to Taylor, but was one of the senior engineers at Delhi, and I can frankly state that none of us were capable of doing what Taylor did. We doubtless all thought ourselves fine fellows,-more or less,-but as to a mastery or control of the great questions and issues involved, we were nowhere as compared with him. We all believed in him as a first-rate man, and as a resourceful engineer, but it was just in the conception and grasp of the great issues, and of the means necessary to their realization, that his superiority made itself fully felt. A master of engineering detail, civil and military, and cognizant of the means

* Life of Lord Lawrence, Bosworth Smith. Vol. II. p. 286.

† Bosworth Smith. Life of Lord Lawrence, H., p. 251. ‡ Lady Edwardes. Life of Sir Herbert Edwardes, Vol. II., p. 62. These words were spoken in Chamberlain's tent towards the end of the siege, the late Sir Henry Daly being present. On the return of the Guides to Peshawur (1857) Sir Henry Daly reported the conversation to Sir Herbert Edwardes (who was writing a life of John Nicholson) by whom it was immediately committed to writing.

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available in artillery and soldiers ; untiring in bodily energy, and unsparing of himself, he, in fact, was the hero of the Siege, and the common saying :—" Taylor took Delhi," was perfectly true.

Colonel Baird Smith, the Chief Engineer, filled his place alongside the General in command most suitably. He had a *diplomatist's* duty to perform, to the success of which his knowledge of India, and his exceptional powers of speech and pen contributed immensely.

I think that the Siege of Delhi and the immense issues depending upon it were never fully appreciated. The great anxiety as to the fate of Lucknow, which filled all hearts, fixed public attention on the beleaguered garrison; while the despatch of large forces from England and Persia to its relief naturally led the home public to ascribe the salvation of India to them, and tempted it to rather ignore Delhi; yet it was the success of the Siege of Delhi which alone saved India to the British Crown. There can be no doubt of this whatever.*

In his "Notes on the Siege of Delhi," published in this Journal, the same officer writes :--- "The real interest of the Siege of Delhi centres in the *heroic and hazardous way in which the scheme of atlack was slowly pieced together*; and in the gallantry,--equally displayed by all, --which enabled a much-tried General to utilize to the fullest extent the inadequate means at his disposal.

It seems a curious fact that the most striking feature of the Siege of Delhi has never been noted. It is surely unprecedented in warfare that not only in *the face of*, but also, almost in *the midst of* a watchful enemy, what was obviously the site for the final struggle was *completely surveyed*, and the positions of every gun; of the attacking force itself; and of all the approaches were clearly marked out on the ground, and the *action finally carried out exactly as originally planned*."

The following statement, signed Felix[†], is embodied in the "Narrative of the Campaign of the Delhi Army," officially published by Major Henry Norman, in 1858 ‡ :--

"For the complete success that attended the prosecution of the Siege the chief credit is undoubtedly due to Colonel Baird Smith, the Chief Engineer, and to Capt. Taylor, the Director of the Attack. On this latter officer, in fact (in consequence of the Chief Engineer being wounded), devolved the entire superintendence of the siege works; and his energy and activity will doubtless meet with their due reward. Throughout the operations he seemed to be omnipresent, and to bear a charmed life, for he escaped without a wound. The plan of the attack was bold and skilful; the nature of the enemy we were contending with was exactly appreciated, and our plans shaped accordingly.

⁹ "A Few Notes on the Siege of Delhi," R.E. Journal, July, 1911; see also "The Siege of Delhi, a Reminder from One Who was Present," *Nineteenth Century*, October, 1911, both by General Sir Frederick Maunsell, K.C.B., Colonel Commandant, R.E.

† The late Major-General Julius George Medley, с.в.

t The late Field Marshal Sir Henry Norman, с.с.в., с.с.м.с., Governor and Commander-in-Chief of Queensland.

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Pandy⁹ can fight well behind cover, but here he was outmanœuvred, his attention being diverted from the real point of attack, until the last, and then the cover, which might have proved such a serious obstacle to us, was seized at the right moment, without loss, and all its advantages turned against him. With plenty of skilled workmen the siege works might have been more speedily constructed; but, with the wretched means at our disposal, the wonder is that so much was done, with so little loss."

The late Major-General Thomason, who, in 1857, was one of the Engineer officers attached to the Left Attack, and consequently accompanied Alex. Taylor on more than one of his dangerous reconnaissances in the Khoodsia Bagh, and in the neighbourhood of Ludlow Castle, writes of Colonel Baird Smith as an officer "whose position as the head of a very important Government department gave him a power and influence such as was exercised by no one else"; and, as "an unrivalled administrator," adding : "In nothing was this ability better evinced than in the completeness, vigour, and steadfastness with which he backed every proposal of his second in command, Alex. Taylor."

Alex. Taylor himself pays the following tribute to the services of his chief :---" He did all that could be done by a Chief Engineer of great capacity, but crippled by heavy sickness. Indeed, he did more. He was a master of organization; took a sound view of our position, and its requirements; gave firm and wise counsel to General Wilson, more than once, at very critical times; accepted and carried an immense load of the very heaviest responsibility; and, lastly, provided the engineering means without which the work could not have been done. For all this grand work he deserved the thanks, not only of the Delhi Field Force, but of every white face to the north of Delhi, whose fate depended on our success."

NOTE.—The compiler of this short Memoir was on duty engaged on fortifying the houses and loopholing the parapets of the buildings opposite to the King's Palace throughout the night of September 20th. The enemy kept up a desultory fire.

The last stronghold was stormed by the 60th Rifles on the morning of the 21st.

Duncan Home of the Engineers, who, with Philip Salkeld, had blown in the Cashmere Gate on the day of the assault, advanced with a small party of Sappers, and blew in the outer gate.

At sunrise on the 21st we were again masters of Delhi, and the British flag waved over the Palace of the Great Mogul.

(To be continued).

⁹ The name given to the rebel Sepoys from Mungul Pandy, the mutineer of the 34th Native Infantry at Barrackpore, who when the mutiny broke out in that regiment fired at the Adjutant, Capt. Baugh, and was afterwards executed.

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TRANSCRIPT.

NOTES ON THE INSTRUCTIONS FOR CROSSING AND DESTRUCTION OF OBSTACLES IN FORTIFICATION (PROVISIONAL). WAR OFFICE (FRANCE). 1909.

With the kind permission of Messrs. Mare Impans et René Chapelot, 30 Rue et Passage Dauphin, Paris.

Preface—The object of the pamphlet is to point out the technical methods to be followed, the tools to be used, and the formations to be adopted by working parties detailed to carry out, in the face of the enemy, the various works of crossing and destroying the principal obstacles in fortification, whether siege or field. It is divided into three parts :—

- (i.). Crossing and destruction of the principal obstacles in the outer line of defence.
- (ii.). Crossing ditches and iron fences.
- (iii.). Destruction of iron fences.

The crossing and destruction of obstacles should always be planned and carried out by surprise, and generally at night time; in very rare instances these operations can be attempted in force, while the artillery fire is concentrated on a defence which infantry fire at close range has already shaken or temporarily overpowered.

It is only possible to carry out these operations successfully by employing methods which are rapid, silent, and free from complication; simplicity of method in the critical period which precedes and accompanies an assault is a quality absolutely essential; consequently amongst the many ways of crossing or destroying obstacles, there is generally only one, the most simple one, in each case, which can be considered; others may be adopted instead only if circumstances demand it.

In the pamphlet the type methods are fully described, as they should be well known to all, both N.C.O.'s and men—the other methods are shortly referred to, and should be known by N.C.O.'s and may be taught to sappers in the later stages of their training.

General Instructions.—1. The work of making a way through the obstacles is in each case carried out under the superintendence of an officer, who has under his orders one or more working parties led by N.C.O.'s. The officer and N.C.O.'s are, if possible, chosen from those who have taken part in the preliminary reconnaissances.

2. The composition of the parties, the arms and dress of the sappers detailed to carry out the work of handling the stores, depend on the nature of the task in each particular case, and the conditions under which they are carried out. The only duty of the sappers is to bring up and place in position the stores used for crossing or destroying the obstacles so as to open a passage for the assaulting troops. In some cases it may be advantageous to send out unarmed working parties so as to leave them complete freedom of movement.

If the working parties are unprotected by patrols, it may be necessary to attach a few determined men with the special object of noiselessly suppressing the enemy's sentries.

Clothing should be adapted in colour to the ground where the operation is to take place.⁹

Footgear should be either rubber or felt-soled, or should be bound round with cloth to muffle the movement of the feet—it may be advisable to blacken the men's hands and faces.

Stores, especially charges of explosives, should be similarly treated.

3. The method of destroying the outer line of obstacles (abatis, wire entanglement), by means of explosives, generally consists of long treble charges made up in accordance with Art. 282 and 283 of the School of Mines. These charges are generally divided into sections 5 metres long, the last of which makes up the total length required. The charges do not contain primers, in order to avoid risk of explosion during transport and placing in position. The last section has a strip of detonating fuze attached which is detonated by means of a special primer.

4. The destruction of fences is carried out by means of long charges, each about 6'' less than the width of one bay of the fence, which can be sufficiently accurately determined during the preliminary reconnaissance.

Each of the charges is provided with a length of detonating fuze about 2 metres long.

Simultaneous detonation of several bays is obtained by fixing the detonating fuzes to a detonator which is fired by means of slow fuze. This is usually done by means of a rubber ring. The detonator is carried by the N.C.O. in charge.

PART I,

CROSSING AND DESTRUCTION OF THE OUTER LINE OF OBSTACLES.

5. Passages through the obstacles should be about 12' wide,

I. Abatis.

6. Crossing.—Crossing abatis is only possible by single men advancing slowly.

7. Destruction.—A treble charge of melinite, of a length equal to the depth of the abatis is exploded under or amongst the abatis.

* For example, white when the ground is covered with snow.

8. Stores Required.—The treble charge is made up in 5-metre sections, with a piece of detonating fuze fixed in the centre of each section.

The charge is fastened to wooden scantlings about $2'' \times 3\frac{1}{2}''$ section, the ends being constructed to fit into wrought-iron sockets. The foremost section has a wrought-iron point, and is provided with two hard-wood wheels 6" in diameter at the front end.

9. Personnel .-- One N.C.O., and two men for each section of charge.

10. Method of Placing.—The N.C.O. advances first with the detonator; on reaching the fringe of the obstacle he points out to the bearers of the front section the best spot to insert it, and they push the charge under the abatis—the second party, with the help of the first, connect the second section to the first by means of the sockets and push the whole forward : and so on till the further edge of the obstacle is reached.

The detachment then retire about 50 paces, while the N.C.O. connects the end of the detonating fuze to the detonator and lights the slow fuze. After the explosion he rejoins the assaulting column who are now approaching.

If necessary, a party of sappers precede the assaulting column armed with axes to clear away any trunks of trees not removed by the explosion.

The explosion should make a passage at least 4 metres wide. The *débris* does not fall beyond 50 metres in the direction of the charge, and 150 metres laterally.

11. Alternative Method.—Simultaneous explosion of several 6 or 8-lb. charges of melinite thrown by hand into the abatis.

II. Military Pits.

12. Crossing.-Military pits can be crossed on light ladders with planks nailed to them, lashed together.

13. Stores Required.—Ordinary ladders, as light as possible, and of such a length that two ladders, lashed end to end, will be long enough to stretch across the rows of pits. Planks $\frac{1}{4}$ to $\frac{1}{2}$ " thick are nailed to the rungs on each side.

14. Personnel.—One N.C.O. and as many squads as there are ladders (usually four crossings will be made). Two men are required for each 5 or 6 metres length of ladder. Two men of each detachment carry picks in their belts.

15. Method of Placing.—The N.C.O. goes out ahead followed by the ladder detachments who should, if possible, reach the obstacle simultaneously. Pace is regulated by circumstances, a slow advance is sometimes less liable to discovery.

When they reach the obstacle the N.C.O. points out the places to be crossed.

Each detachment then lifts the ladder and launches it as far as possible in the air, then pushes it forward along the ground. The picks will be used to clear away any obstacle to progress.

16. Alternative Method of Crossing.—The stakes can be covered by throwing straw, brushwood, etc., into the pits, or the obstacle crossed by walking round the pits.

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17. Alternative Method of Destruction.—The pits themselves on the line of crossing can be partly filled by bundles of straw brought up by men who then jump into the pits and pull down part of the sides with a pickaxe.

III. Petits Piquets (Short Stakes).

18. Crossing.—This obstacle can be crossed on ladders similar to those used for crossing military pits.

19. Alternative Method.-Two lines of brushwood hurdles placed with the long side of the hurdles normal to the direction of the crossing.

20. Destruction.—There is no practical method which can be adopted in the face of the enemy.

IV. Wire Entanglements.

21. Crassing.—Crossing a wire entanglement is only possible by single men, advancing slowly, or crawling beneath the entanglement; in the latter case the men should be supplied with wire cutters so as to cut the strands which will prevent the explosives being dragged under the obstacle

Destruction.- A. By Explosives.

22. (a).—A treble rigid charge of melinite of a length 18'' greater than the width of the entanglement should be exploded under it.

The procedure is the same as that for crossing abatis.

N.B.—It is best to place the charge along a line of posts. If the posts are steel it is desirable to explode two continuous charges about 2 metres apart.

23. After the explosion a dozen sappers with axes and wire cutters cross the gap ahead of the assaulting column to remove stray wires, etc.

24. (b). If there are obstacles such as planks, earth banks, etc., under the entanglement, making it impossible to use the long charges made up on scantlings, a continuous non-rigid charge is used and is dragged into position by men who crawl through the entanglement by night.

25. Stores Required.--Sections (5-metre) of explosive, contained in thick canvas tubes with cords sewn to them to enable them to be dragged; the sections are connected by stout threads 2 metres long.

A detonator, and a pair of wire cutters bound with cloth.

26. Personnel.-- I N.C.O.

One man per section of explosive with leather clothes and gloves.

27. The N.C.O. precedes the party, chooses the spot for attack, and the first man crawls with his charge under the entanglement followed by the rest, guided by the threads which join the sections. The leading man is provided with wire cutters and clears away a passage for himself. Each man places his charge so as to break joint with the preceding one.

When the charges are placed the men return by the same route.

28. Alternative Method.—If neither of the preceding methods can be used, rigid charges can be thrown across the entanglement, or a number of 25-lb. charges thrown into it by hand.^o

 \ast A charge placed on top of an entanglement produces only half the result of one placed beneath.

B. By Means of Wire Cutters.

29. A passage should be made with the wire cutters at least 4 metres wide.

This can generally only be done in the very early dawn.

30. *Stores Required.*—Seven wire cutters (cloth covered) plus twice as many wire cutters as there are rows of posts on the width of passage to be opened.

Two axes (if wood posts). Four pairs of leather gloves. 31. Personnel.—1 N.C.O. 2 squads.

- 1st squad. Twice as many men as there are rows of posts plus two men. Each man with a pair of wire cutters hung round the neck on a lanyard. The squad is directly under the N.C.O.
- and squad. Under a corporal carrying a pair of cutters. Four men with cutters hung round their necks, and leather gloves.

32. Method of Procedure.—Suppose for example the preliminary reconnaissance has shown the necessity of destroying a width of three bays, and consequently two rows of posts. The 1st squad consists of six men, and the whole detachment of 10 men plus the N.C.O. and corporal. The men of the 1st squad are told off to sever all the wires up to the posts along the line of passage; the 2nd squad have to clear all wires out of the passage, cutting those which are not broken, and clear away any posts which may have fallen across the way.

The 1st squad are placed thus by the N.C.O. in charge :--

No. 1 to the left of the right-hand post. Nos. 2 and 3 one on each side of the next post to the left. Nos. 4 and 5 one on each side of the next post to the left. No. 6 to the right of the left-hand post.

The 2nd squad follow without waiting further orders.

PART II.

CROSSING OF DRY DITCHES.

33. When a ditch is provided with a counterscarp fence, it is necessary to destroy portions of it before the materials for crossing can be placed. A crossing cannot be made until the flanking defences of the ditch have been destroyed or masked. The only two cases to be considered then are those in which the escarp is (i.) revetted or (ii.) provided with a fence at the foot of it.

Crossing a Ditch with Revetled Escarp.

34. Stores Required.—Long supple poles for descending into the ditch (fastened in pairs). Ordinary ladders (one per two poles) to ascend the escarp.

The length of the ladders, etc., depends on the height of the obstacle, e.g. not less than 7 metres for the poles (diam. 3-5'') for a counterscarp 6 metres high; the poles and ladders should have an iron point at the lower end to prevent the foot from slipping.

The poles are fastened in pairs by means of cross-pieces lashed or nailed on, one at each end, and have a cord fixed to the upper cross-piece. Ladders have a cord fixed to the upper rung.

Other stores :- 4 axes, 4 picks, 2 shovels.

35. Personnel.—One officer and one or more detachments. Each detachment consists of as many squads as there are ladders, etc., under an N.C.O. A squad is eight men one of whom is a corporal. The eight men of the squad are in two ranks, the front rank are pole-men and the rear rank ladder-men.

A reserve squad (1 N.C.O. and 10 men with pioneers' tools) is told off to destroy any remaining obstacles which would prevent the ladders, etc., being placed, and to replace casualties.

36. Method of Procedure.—The officer, accompanied by detachment commanders goes ahead followed by the reserve squad; the squads advance in line or in file as rapidly as possible to the edge of the ditch, pole members in front with the corp oral of each squad. Two men carry the ladder on their shoulders. The poles are dropped into the ditch by Nos. 2 and 3 and held by No. 4 by means of the rope attached while one of the numbers fixes a pick into the ground in rear for an anchorage; to it the rope is attached.

The ladder numbers on reaching the ditch, drop the ladder alongside the poles (two men are enough for this, the other two numbers holding the rope). The ladder numbers then climb down the poles, two by two, and erect the ladder against the escarp.

37. Action of the Storming Parties.—The storming parties are told off in groups, and the groups arranged in pairs. Each pair starts off together and arriving at the top of the counterscarp, grasp one another round the neck or waist and slide down the poles together. The remaining numbers follow without waiting for the first pair to finish its descent.

A rate of 10 men per minute per pair of poles can be easily obtained.

II. Crossing a Ditch with Iron Fence at the Foot of the Escarp Slope.

38. Crossing such a ditch is carried out in a similar manner, with the substitution of special ladders (Dupommier) for crossing the iron fence.

The only respect in which the procedure differs from the last is in the actual crossing of the fence.

39. Stores Required, -Dupommier ladders-one for every two poles used for the descent into the ditch.

The Dupommier ladder is a light ladder 4 metres long, with a pole

2 to 3" in diameter fastened to the right-hand side of the same length as the ladder, kept in place by an iron ring at the upper end, and by a strap in the centre. There is a right-angle bracket, free to slide along the ladder by means of four hooks.

A rope is attached to the upper rung of the ladder.

40. Personnel .- Two men per ladder.

41. Method of Procedure. - The ladder is fixed against the escarp fence as follows :-

Two men place the ladder against the fence, bracket to the rear. The bracket is placed on the points of the fence, being free to slide along the ladder, the latter can be placed at the necessary inclination.

One man then sits down with his back to the fence holding the foot of the ladder in both hands. The other unfastens the strap which secures the ladder-pole; mounts the ladder with the pole in his hands and sticks it into the ground on the far side, the top being held by the ring attached to the side of the ladder. He is then free to slide down the pole.⁹

42. Action of the Storming Party.—In crossing the Dupommier ladder, each man commences to climb as the next man steps off the ladder to slide down the pole. (A rate of 8—16 men per minute can be obtained).

43. Note.—Experience has shown that the crossing of a fence on the top of the counterscarp is such a difficult operation that it could not be undertaken during an assault; the only successful method of dealing with such a fence will be to destroy it by means of explosives, before the crossing of the ditch is attempted.

PART III.

DESTRUCTION OF IRON FANCES.

Destruction by the Aid of Explosives.

44. Operations of this nature will, usually, be carried out at night, advantage being taken of a moment when the attention of the enemy's sentries is distracted by noises such as wind, rain, etc.

45. General Procedure.—Usually the bays alone are attacked, the uprights being left alone.

46. Charges.—Treble longitudinal charges (rigid) are placed against the bars, the scantling to which they are fixed being on the outside in order to tamp the charge. If the horizontal bar is close to the bottom of the fence a non-rigid charge may be used, placed on the ground along the bottom of the fence.

47. Mode of Fixing.—The charge may be either fastened to a horizontal bar by means of two wire hooks, or hung by two short cords fixed to the charge—the free end being tied by a thumb-knot to one of the vertical bars. If it is desired to place the charge too high for the hooks to be fixed, or a thumb knot tied, it is supported against the fence by long struts having an iron hook at the upper end.

* The Dupommier ladder can be placed in position in less than a quarter of a minute.

48. The fuzes are fixed by the method already described, arrangements being made for simultaneous demolition.

49. Personnel.—The detachment is commanded by an officer and consists of as many squads as there are bays of fence to be destroyed.

Each squad consists of three men (two charges) or four men (three charges).

There is an N.C.O. to each squad,

50. Method of Procedure.-Each squad fixes its charge to the bay of fencing and arranges its detonating fuze, connecting up the latter to the detonator. The N.C.O.'s remain with the slow fuze in their hand ready to light them when the signal is given.

E. ROGERS.

NOTICE OF MAGAZINE.

RIVISTA DI ARTIGLIERIA E GENIO.

December, 1911.

THE ESGINEERS IN THE WAR IN TRIPOLI.—The *Rivista di Artiglitria e Genio* reports with pride two orders of the day of the commander of the expeditionary force awarding the highest praise to the Italian troops in Tripoli. The paper adds "To our comrades in the new Italian lands who maintain the fine traditions of the artillery and the engineers, always and everywhere leading to victory, we offer our salutations. But especially the fervent hope for the honour and greatness of the country and that in the performance of their arduous duties there should not be wanting occasions in which their valour will add new splendours to the history of our arms.

The orders of the day are as follows :----

Command of the Expeditionary Forces in Tripoli and Cirenbica. Order of the Day N. 3.4.

TRIPOLI, 22nd November, 1911.

Subject. Work of the military engineers.

I am pleased to bring to the knowledge of the expeditionary forces the following telegram from His Excellency the Chief of the General Staff of the Army:---

ROME, 21st November, 1911.

His Excellency General Caneva—Tripoli 3549.—From all the reports received from the seat of war it is evident that the work of the military engineers fully sustains the noble traditions of that arm for courage, skill, and endurance.

I shall be grateful to your excellency if my name be added as a tribute of the highest praise.—GENERALE POLLIO.

In my order of the day N. 29 of the 15th current I have announced to the troops in Tripoli the excellent work performed by the detachments of engineers.

To the commanders, the officers and the troops of the army, the highest praise that can be conferred is that of His Excellency the Chief of the General Staff. to which I add with warmness my thanks to the officers and troops of the expeditionary force.

> The Lieut.-General Commanding the Expeditionary Forces. CANEVA.

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ECONOMY IN WORKS OF DEFENCE.—In the pages of the Löbells Jahresberichte über das Meer- und Kriegswesen of 1910, published a few months ago, an important article appears on the above subject. It treats with very delicate questions which have of late years occupied the consideration of military writers, both in Italy and other foreign countries, especially Germany; the same subject was ably treated by General Rocchi in his work L'economia nelle opere di difesa, extracts from which were published last year in the Rivista.

It is an undeniable fact that during the last decade the expenses for the construction of fortresses have notably increased owing to the everincreasing efficiency of the artillery. France, which has always been generous in allotting large sums for the defences of the country, has been forced to place a limit on the reorganization of its fortresses, which have been constructed or enlarged since 1870. Colonel Piarron de Mondésir states that only the great places of importance have obtained all the perfections required by modern exigencies, and even in these places all the sections are not of the height which is now necessary.

It is worth noting that, in the sums expended on fortresses, a large part is absorbed by the armament, since the standard of the guns of the defence with their ammunition must necessarily be kept up to that of an attacking force. Of the 755 million frances expended on fortresses in Germany from 1871 to 1908, not less than 171 millions, or about 23 per cent., was devoted to armaments.

It is most important, therefore, in the interests of national economy, to examine the methods by which works of defence may be more economically constructed. High military circles in Germany have lately been carefully considering general complaints that large sacrifices have been entailed in the construction of fortresses.

The funds authorized for defensive work in the first period from 1870 to 1881, amounted to 200 million francs, or about 7 per cent. of the 2,876 millions allotted for military expenses. Had this same percentage been maintained from 1900 to 1907 the amount allotted for defensive work should have been 390 million francs, as 5,550 million francs were the complete expenses for the whole army. As a matter of fact only 115 million francs were allotted, or about 2 per cent. on the total expenses.

The allotments for the defence of the country therefore are not only relatively but absolutely diminished by an annual average of from 15 to 18 million francs. The question naturally arises as to how this result can be satisfactorily obtained. After a careful consideration of the principal German fortresses the following answer is arrived at :--

Only places of absolute importance are retained, and it has been found possible to give greater and more desirable efficiency to these at a moderate cost. Fortresses of secondary importance have been abandoned, and in consequence the following distribution of 570 millions of francs for expenses to the end of 1910:-

Coast fortifications		1	Millions	54.5.	Equal to	96%.
Great enclosed fort:	'esses		21	448.7.	,,	7 ⁸ ·6 "
New fortresses		• • •	"	42'9.	;,	7.5 "
Remaining places			**	24.1.	,,	43 "

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The expenses of each work are naturally increased with the introduction of armoured plates and cement, and it is an error to suppose that greater efficacy can be obtained for the same cost, by strongly fortifying certain points, and in consequence leaving a number of guns unprotected with armour.

Of 570 millions of francs, expended on fortifications from 1870 until now, only 35 millions or 61 per cent. of the total sum have gone to armoured works.

When considering the possibility of arriving at economy in the construction of fortresses, General Rocchi complains that modern fortification is costly, based as it is on antiquated forms and predetermined types, and that in many cases it is superfluous and not adapted to the ground. His verdict on the Italian methods of fortification is very severe, when he asserts that they are fossilized and are the consequences of a too rigid scholastic application of deductions of scientific experiences, and of the habit of treating a work of fortification like an algebraic formula.

General Rocchi believes that he can find a remedy applicable for fortifications both offensive, or defensive. He condemns the spacious detached forts with their casemates and double stories, and with their deep ditches provided with flanking defences. In the same way as Sweitschine, in opposition to Buinitsky, formerly condemned the type of Russian forts, in which the idea was to conceal the casemates with masking defences of great relief, so Rocchi endeavours to give more perfect technical means to such works only, as, by their permanent and positive capacity for resistance, can successfully assist in the defence of the position.

The type of armoured batteries according to him should be the following :--the guns-installed above a mass of armoured cement of the least possible width and depth--in a series of revolving turrets, with reserves in the immediate vicinity; behind these a communication corridor which should also serve as a place of recovery with a few other local places of recovery at the sides.

The height of the mass of the work should be limited, and great command over the ground is not thought necessary. The obstacles, consisting for the most part of barbed wire, should be under the fire of the rifles, and the organization of recovering places is necessary not only for the artillery but also for the garrison of intantry.

Deep ditches with revetted scarps and flanking defences are only necessary for works which have to resist a regular siege with covered approaches. All the arrangements for an ordinary defence should have the character of lightness and activity. The ammunition for the guns should be stored only in such works as might be isolated for a long time. In other cases, General Rocchi maintains, this would only lead to loss owing to the increased space.

These proposals are absolutely opposed to the present ideas of Italian fortification.

The General condemns recovering places in casemates on the grounds that the troops shut up in them are ignorant of what is happening outside, and that they are therefore morally detrimental. The necessities of the present day seem to call for a simply organized method of warfare, mobile and effective. It is on this principle that the Austrian military writer Hanika bases his remarks on the preparation of fortresses, and affirms for the same reason that the modern armament of strong fortresses does not really satisfy the desired exigencies of the defence.

January, 1912.

LIGHTNING CONDUCTORS FOR BUILDINGS USED FOR THE PREPARATION AND STORAGE OF EXPLOSIVES.—On the 7th June, 1910, one of the buildings used for the washing and filtration of nitro-glycerine in the factories of the Carbonit di Schlobusch was struck by lightning, a very violent and disastrous explosion which completely wrecked the building and seriously damaged other buildings being the result. The building that was destroyed was completely furnished with lightning conductor protective apparatus of a type approved by the Prussian minister of industry and commerce. An enquiry which was opened immediately on the cause of the disaster came to the conclusion that the regulations for the fixing of the above-mentioned apparatus had not been scrupulously adhered to.

Shortly afterwards the Westphälische-Anhalter Sprengstoff A.G.—which had provided its establishments with lightning conductors of the usual type, and had rigorously attended to all the regulations—suffered a serious disaster, and in March, 1911, a new catastrophe happened at Blomfontein owing to the buildings used for the preparation of nitroglycerine being struck by lightning. In consequence of these disasters Dr. Von der Hagen was deputed by the Sprengstoff Actien Gesellschaft Carbonit to study the subject, and to give definite replies with regard to the efficacy of the arrangements until now adopted for the protection of buildings against electrical atmospheric discharges.

Dr. Von Hagen in a lucid article in the Zeitschrift für das gesamte Scheifs und Sprengstoffwasen has given the results of his observations and comes to the conclusion that the arrangements hitherto in use are absolutely insufficient and ill-adapted for their purposes.

At the same time as Dr. Von Hagen, Professor Rinkel was occupied with the same questions and his conclusions were almost identical, and in consequence of these reports the Prussian minister of industry and commerce approved, by a decree of 13th November, 1906, of a series of regulations regarding the fixing of lightning conductors in the factories and depôts for the storing of explosives.

The protective apparatus for factories used for the manufacture of high explosives and surrounded by earthen embankments should be thus constructed :—(a). An external network placed far from the building for the purpose of arresting the action of electric discharges. (b). An inner network to arrest partial discharges which might escape the action of the outer network. (c). Arrangements for security relative to the metallic conductors and to all metal objects in the interior of the building. The outer network should be of zinc or copper $\frac{2}{3}$ m.m.² in section. It should be supported at a height of about 1 m. on a series of iron rods placed above the earthen embankments. The rods s are also in contact with the

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soil by means of another metallic conductor g'' enclosed in small wooden cases.

The above-mentioned rods are joined with another conductor g' in the same manner, but forming a ring at the foot of the external scarp. Both the conductors g'' and g' are sunk to a depth of about $\frac{1}{2}$ metre in the earth. If there is water in the vicinity two of the conductors should be sub-

If there is water in the vicinity two of the conductors information merged by metallic prolongation with wide plates at the extremities. When there is no water at least two of the conductors should have four or more diverging branches with a length of about to metres and a depth of about $\frac{1}{2}$ metre beneath the earth.

The inner network (m) should be of zinc netting about 2 m.m. in diameter, and should be supported on the roof of the building. This network is also connected with the earth by means of lateral conductors: two subterranean conductors t and g surround the building.



The internal network may be dispensed with in the case of buildings which do not contain large masses of metal. All the metallic objects contained in the interior of the building should be absolutely isolated from the interior network : the Minister orders that tests for the lightning conductor apparatus should be made if possible at the beginning of March.

Every four or five years the subterranean conductors should be opened out at different points to ascertain if they are in a good condition and well connected with the network. It is also thought necessary to test the electrical resistance of the soil surrounding the conductors.

Lightning darts in a zigzag manner, and always with an oscillatory discharge of the same nature like the discharges from Leyden jars. Its length varies from 3,000 to 1,000 metres; and the intensity of the current may sometimes be above 20,000 amperes with a tension of several millions of volts. The earth is charged by the influence of the electricity in a manner contrary to that of the clouds, and the potential difference increases up to saturation by ionization of the strata of the interposed air. It is impossible to study the phenomena of lightning from Leyden jars, and to maintain the proper proportion of distance because the sparks produced in the apparatus are evidently too short.

Dr. Von der Hagen has made a series of very interesting experiments of which a full description is given, and on the whole he is of opinion that the dangerous effects of lightning are difficult to demonstrate practically,

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because the current employed in the experiments is always less in intensity than that of atmospheric discharges. He writes that his researches are not yet completed.

Professor Rinkel has also made similar researches and studied a method of protecting buildings used for the manipulation and fabrication of explosives, from atmospheric discharges (effects of auto-induction, oscillatory discharges). He observes "we are not yet satisfied that owing to the enormous intensity and the high potentials of atmospheric electricity the networks are sufficient to impede the effects of auto-induction and with these the secondary discharges which always follow the first."

In considering the important studies of these two German scientists relative to the system of protection against atmospheric electrical discharges we arrive at the following conclusions, viz. :--(1). The great efficiency and usefulness of lightning conductors placed as rods above the earthen embankments surrounding the buildings. (2). The small utility of horizontal networks, and their danger from the strong effects of induction caused by these. (3). The use of vertical metallic networks connected with the lightning conducting rods. These have the effect of lowering the potentials at the moment of discharge. The more the metallic masses of the networks are increased, the less will be the danger caused by the presence of metallic masses in the interior of the building. (4). The great importance of circular connections above and below by means of thick metal bands with all the metal apparatus within the building, (5). The necessity of all the metal apparatus within the building, as well as that used for protection, being in connection with the earth. (6). The necessity for metal pipes (for gas, water, etc.) being always underground. (7). The use of a short and thick lightning rod placed on the summit of the roof of the building. This rod should have its own metal conductor and should be in perfect connection with the earth.

E. T. THACKERAY.

CORRESPONDENCE.

PASLÉY ON NAPOLEON.

DEAR SIR,

The following letter, written by Sir Charles Pasley, which appeared in The Times on the 16th November, 1813, will, I think, be found interesting at the present time. It shows very clearly the wonderful manner in which he foresaw the right way to crush the power of Napoleon. The letter has been kindly placed at my disposal by Miss Tyler, the grand-daughter of the author of the Essay on the Military Policy of the British Empire.

It is right and fitting that we should, during this centenary year, do honour to the memory of Pasley as the originator and founder of the S.M.E. It is well however that we should also recognize the great influence which he exercised over the actual Military Policy of the Empire, the insight which he displayed in his book as regards the true principles of war, and the sound judgment shown by him in realizing the probable advantages to be obtained by an offensive campaign in the Spanish Peninsula.

25th April, 1912.

SIR,

Yours faithfully, B. R. WARD, Colonel, R.E. To the Editor of the "Times."

I herewith transmit a paper, which you are at liberty to publish if you think it will be acceptable to your readers. It was written by me in the year 1809, after my return from Corrunna, but previous to the sailing of the Walcheren expedition. I had an intention of producing it in my Essay on the Military Policy and Institutions of the British Empire. If I had followed my original plan of discussing the Institutions at large before the Policy, it would have appeared in the First part of that work published in 1810. - It was shown to Capt. Tailour R.N. and to many other private friends, at or soon after the period, when it was actually written ; otherwise I should have had great hesitation in now publishing it, as it might be suspected to have been composed, not before, but after, and in allusion to, the late glorious public At the period of disaster and despondency above mentioned, although I foresaw the events. practicability of making an impression on the French Empire, by a vigorous display of our military strength, yet I must confess I had not the smallest hope that the attempt would ever have been made on a scale capable of ensuring success. The perusal of this paper may therefore place in the strongest light the wonderful change for the better, which under Providence, has been effected in our National affairs, through the wisdom, energy, and perseverance of the executive Government of this country, within the short period of four years ; since it calls to mind the former gleomy impressions and Resperts (?) which had resulted from the former unenterprising mode, in which our military operations had been planned and conducted, during the first years of this memorable war. Impressions which had been of late almost obliterated from our memory, in consequence of the series of brilliant Victories achieved by Lord Wellington in Spain, and subsequently by our continental Allies in Germany. It will be seen that the Ideas and general mode of reasoning contained in this paper, correspond with that part of my Essay which has appeared before the Public, and that even some of the observations have actually been introduced in it. Having for the last three years been prevented by my military duties from proceeding in the remaining part of that work, I have not looked over any of my old manuscripts composed with that view until a few days ago, when the enclosed paper, of which I had but a faint recollection appeared of such a striking nature that I thought it likely to prove interesting at the present moment.

CHATHAM LINES Nour. 12th.

I am &c C. W. PASLEY,

Extract from one of the Chapters of an Essay on the Military Policy &c. of the British Empire, written in 1809, but not before published ; the first part of which Chapter related principally to the comparative organization of the French and British Army :---

⁴⁴ I shall now lay before my readers the effective force of the British Army, according to the Official returns presented to Parliament from the Adjutant General's office dated 26th Febry 1809:--Effective Cavalry British and German, 27,336; Effective Infantry, including foreign Corps, 183,253; Effective Militia, S1,577; add for the effective strength of Ordnance Corps, 20,000; Total, 313,001.

Great Britain therefore from the most authentic information to be had, does at this moment maintain in constant pay an Army of more than 303,000 men, and yet such is the badness of her military Policy, whose errors I have before noticed, that with so large a force, she is incapable of doing any thing on a great scale; incapable of giving any efficient aid to her Allies, or of inflicting any serious evil mon her enemies.

Let us suppose that any one had told Hannibal the exact situation in which this country was to find itself at this moment, describing its force and prospects, and the force and views of our enemies : What would he have said?

"Great Britain you tell me" he would say, "has nearly annihilated the whole of her enemies' fleets, and rules despotically by sea. She also possesses an effective army of 313,000 men, and has nothing to fear at home. She will therefore no doubt send 150 or 200,000 Men abroad, to carry on War in the heart of France, whilst the French Armies are on the Vistula, and beyond the Alps and Pyrennees. She will maintain this force at the expense of France, and thereby strike at the very heart of the enemies resources, who will consequently be obliged to withdraw his forces from foreign countries, and to abandon his conquests with all the revenue and force he derives from them, in order to defend himself at home. In the meantime Great Britain, which you say was able to maintain 313,000 soldiers by her own native resources and revenue, when she comes to find so large a portion of them in France, will have a considerable part of her revenue free wherewith she may raise and pay more men in order to form supplymentary Armies of her own and at the same time bring forward powerful Allies to act on all sides of the frontiers of France ; whilst she herself catrics on a desperate attack in the very heart of that country in the way I attacked, and would have destroyed the Romans had not the Senate of my country, blinded by commercial notions and distracted by factions withheld the necessary supplies of men and money from me. This is of all modes of attack the best, when circumstances permit, or authorise it, -this therefore is the mode which Great Britain with all the vast power which you say she possesses, will andoubtedly adopt."

But if it were explained to Hannibal, that the frontiers of France, on almost every side, were so strong by nature and art, that supposing our Allies acted with the greatest vigour, they would have to penetrate double or even triple fortresses; consequently whilst they were engaged in tedious and destructive sieges, the French might keep them in check with a small portion of their force, and bring the greater part of it to overwhelm us. Besides which that even if the coast by which we should have to enter the enemy's country, presented numerous fortified places, amongst which were all the important Harbours, so that we could not ourselves venture to move forward, nor could we feel at all secure after our landing, until we had taken two or three fortresses which would occupy our Army so long, that the enemy would bring a superior force against us before we could strike any blow of consequence : and that independently of this objection there was another insuperable one, which was that our Armies were not organised, as to undertake any siege with any fair prospect of success.

Hannibal would then reply : "These people whom you call French seem to have acted with great wisdom; in making themselves strong and almost invulnerable at home, before they set out in their career of foreign conquest; But you astonish me by saying the British cannot undertake a regular siege. However as Sieges depend on the application of ingenuity and the mechanical arts, to War, and as you tell me the British are a learned ingenious people, and abound in skilful Mechanics and Artificers of every description, they will of course soon remedy this defect in their military establishment. Less than a year will suffice to organise their Engineer Corps, so as to be equal to the most arduous Sieges. In the meantime as you say that Spain is universally hostile to the French, but unable of herself to shake off her yoke, the British will, no doubt, send 150, or 200,000 Men into that country, which by the co-operation and goodwill of the Spaniards, will be more than equal to any Army that France can oppose to them there. Having driven the French out of Spain, and taken the few remaining Spanish fortresses they occupied, which, when their Armies were beaten out of the field, would not be a difficult task; the British would then in concert with an allied Spanish force, cross the Pyrennees, and carry the war into the heart of France, in order to strike at the source of the enemy's power, on the principles that I before suggested. The undertaking will be perfectly practicable, and exposed to none of the hazards of the former scheme, which was the first that

naturally presented itself to my mind, before you explained to me the wise and judicious plan, on which the French have secured all other parts of their frontier. The rigorous attack on the side of Spain, which I propose would throw the French into the utmost confusion. They would be obliged to withdraw all, or the greater part of their force from Germany; the friends of Great Britoin would then gain confidence ; the little States in alliance with France would either abandon her, or he subdued by Austria, who would, of course, declare herself, as would also all the other powers that were secretly hostile to France. Italy would revolt as well as Switzerland. In short the French in consequence of such rigourous measures, would be obliged to evacuate all the countries beyond the Rhine and Alps, and bring their Principal force to defend themselves on this side the Pyrennees. But by evacuating these countries they would lose a great portion of their revenue and the considerable Armies which they now derive from them. They would therefore no longer be able to support nor to recruit their Military establishment to its former extent, and as long as you would vigorously carry on the War, in the way I propose, you would every day become comparatively richer and more powerful whilst your enemy becomes poorer and weaker. In the end you might even destroy him, certainly you would break his power, so that he could not attempt with any reasonable hopes of success, to overcome any nation protected by you."

After having expatiated in this manner, on the way that Great Britain might, and in all probability would, carry on her Wars-If Hannibal were told the way in which she actually does conduct them, he would then say: "The People whom you describe to me are exactly the reverse of what Pyrrhus described the Romans to be, you say they are civilized and enlightened, but it appears to me that they have nothing but barbarism in their military Policy and Institutions. You say they have nothing to fear at home, and 313,000 soldiers to dispose of, and yet you tell me they never do send, and by some unaccountable error in the distribution of their military force, that they absolutely cannot send more than 20 or 30,000 men to carry on War in any part of the World ; against whom their enemy may in a short time bring a force of 2, or 3, or 4 times as great. The small Republic of Athens, that had not half the resources of one City in the country you mention, sent as large an Army against Syracuse as this nation ever employs. You tell me that instead of acting on a wise and vigorous System of Policy, these people are guided in their military operations by the News of the day, that they will embark one of their ridiculous little armies because there happens to be good news from Spain ; stop its sailing because a rumour of bad news arrives ; and send it after all on some other change of news; reinforce it, recall it, in short give it a thousand contradictory orders because of the news of the day. Now a nation that acts in this way like a miserable stock-jobber, fluctuating and speculating on the News of the day, cannot possibly prosper in War. A great nation should act on a sound system of military Policy; neither suffering herself to be frightened from her object by bad news, nor elated by rumours of success. She ought to form her schemes in such a way as to command success, and send out her Armies on such a scale as to create good News.

"It is not difficult," Hannibal would add, "to foresee the fate of a Nation, that seems to me to act with so little wisdom and firmness. If instead of 313,000 Men, as you say she possesses, she had a million of the bravest soldiers in the world in her service, since she has neither the sense nor the energy to make a proper use of her Troops, she would continue to send out, petty, despicable little expeditions from time to time, like the paltry sorties of a few brave men from a besieged Fortress, who may give a little momentary trouble but are always certain of being driven back. Her enemy may in the meantime be teazed and provoked by these little attacks, which he will despise, but will never be diverted by them from any grand object. Consequently he will go on conquering the rest of World, until he find at some future period, a favourable opportunity of successfully attacking a Country, which having so little foresight, wisdom and energy, will not be able to make any effectual resistance."

This reasoning which I fancy Hannibal would have used in regard to the present Policy of the British Nation, is, I am persuaded, the sentence that will be passed upon it by an imparial posterity, when we shall come in review before the great tribunal of History, on a par with Rome and Carthage and other mighty states that are no more, to be judged by men, who will despise our Parliamentary paties, just as much as we now do the Green and Blue Factions in the Circus at Constantinople; who will be as little disposed to respect us for our Riches, as we now do the Memory of Crossus, or the character of the Sybarites, and who will soon deny, what what we now proudly deny to other nations—the being possessed of any real patriotism, for (which is the only true criticism) they will judge of us, not by our speeches in our Senate, or the paragraphs in our Newspapers, but by our public measures and actions, and by the events which result from them."

THE ROYAL ENGINEERS JOURNAL.

A PONTOON BRIDGE FOR STEAM TRANSPORT.

Sir,

In the letter from Major Matheson, R.E., published in the March R.E, *Journal*, some points are brought up as regards the hypotheses of my calculations for a Pontoon Bridge for Steam Transport. The chief question centres round the extra factor of safety for live load.

I always understood that such a factor was necessary not only because a load travelling across a bridge could produce a greater strain than if stationary, but because the constant variation (and in this case, reversal) of stresses weakened the fibres of the road-bearers *after a time*, especially when the deflection was appreciable.

If I am correct, a test lasting only a short time, such as is referred to at the end of Major Matheson's letter, does not allow fully for this extra factor of safety, unless the baulks used have before been frequently under an equal strain. As to the correct amount to allow for this extra factor for moving loads, I think it is usually admitted that the stresses caused by the driving axle of a mechanically propelled vehicle are always greater than they would be if that vehicle was not self-propelled. As $1\frac{1}{2}$ to 1 is the extra factor in the case of ordinary transport, I have allowed 2 to 1 for mechanical transport, but this may be too great a difference.

I think Major Matheson is right in saying that, in the case of a floating bridge in calm water (as is usually the case), these extra factors of safety might be reduced.

The point raised as to "the pontoons b, c, d, sinking evenly under the load" is the fault of ambiguous wording on my part, but the paragraph and calculations following show that the deflection of the baulks bd is allowed for.

The weight of superstructure was taken from the table on page 133 of Part 3, *Instructions in Mulitary Engineering*, allowing double that given there for medium bridge.

The width of baulks was obtained by measurement at Upnor. All the old baulks there that I measured, and some of the new ones, vary in width from $2\frac{\pi}{5}$ to $3\frac{1}{5}$, only a few of the new ones being $3\frac{1}{4}$ wide, from which dimension a slight allowance must be made for the hollowing out along the centre of the baulk.

These latter points as to weight of superstructure and widths of baulks have, however, very much less effect on the number of baulks required to carry any definite load, than has the amount of the factor of safety necessary, a question for the determining of which I have little practical experience to guide me. Whatever this factor is taken to be, I hope the result of my work may be of some use as regards a comparison of the different ways of arranging the superstructure under the varying circumstances that may arise.

Yours faithfully,

Chatham, April 28th, 1912. The Editor, R.E. Journal. W. L. CAREY, Capt., R.E.



