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PAPERS

ON SUBJECTS CONNECTED WITH

THE DUTIES

OF THE

CORPS OF ROYAL ENGINEERS.

CONTRIBUTED BY

OFFICERS OF THE ROYAL ENGINEERS,

AND

EAST INDIAN ENGINEERS.

NEW SERIES.

VOL. IX.

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1860.

5477

PREFACE.

The delay in publishing this volume has been caused by the Paper on our New Fortifications, with the numerous plates required to illustrate it, not being completed; but I feel sure that they will prove very useful to officers at a distance from Head-Quarters in constructing works of defence.

It is to be regretted that no details have yet been obtained relative to the Operations of the Engineers either in the defence or the attack of Lucknow, and that the Journal of the Siege of Delhi cannot appear in this volume, the Government of India having determined to publish it first in that country.

The introduction into our service of Armstrong's gun, and the probability that other nations will employ artillery of a similar nature, require a thorough consideration of their powers as far as they affect Fortification, and Paper XVII directs attention to this subject; but we require *careful experiments* as to their effects in "curved" and "ricochet" firing, and upon large masses of masonry and iron having surfaces inclined at different angles to the line of fire, before we can be certain as to their real capabilities, so as to enable us to apply them or resist them, most successfully.

P. J. BAINBRIGGE,
Lieut. Colonel, Royal Engineers,
Editor.

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REPORT ON THE RESULT OF FIRING AGAINST AN EXPERIMENTAL BUTT, AT PORTLAND, CONSTRUCTED OF GRANITE AND PORTLAND ROACH STONE, WITH A VIEW TO TEST THEIR COMPARATIVE POWERS OF RESISTANCE.

BY MAJOR NUGENT, R.E.

Weymouth, 1st October, 1859.

SIR,—A question having been raised by the Engineer-in-Chief of the Breakwater at Portland, as to the relative powers of resistance of granite and Portland roach stone, with a view to the expediency of substituting roach for granite in certain masonry-works authorized to be constructed for the defence of the harbour of refuge at Portland, a small experimental butt was constructed of similar blocks of both kinds of stone, set side by side.

The butt was built in two equal courses of nine blocks of stone, four in the upper, and five in the lower course. The two blocks on the right of each course were of granite, averaging about 13½ cubic feet to the ton, and the others were of Portland roach, averaging about 16 feet to the ton.

The butt was 6 ft. 6 in. in height, 19 ft. 6 in. in width on the upper, and 23 ft. 3 in. in width on the lower course; but of this lower course a length of only 21 feet was exposed, about 11 inches at each end being covered with clay from the hill-side, built up to stop lateral splinters from the stone.

The blocks, which were of the average depths of 3 ft. 9 in., and 5 ft. 6 in. on the upper and lower courses respectively, were circular on the face, with radial joints, and were bedded and set in a mixture of one part cement and one part sand.

The whole was backed, to an uniform depth of 9 feet, with a concrete composed of one part of ground blue lias lime and 6 parts of broken stone and sand; the joints were raked out and pointed with Portland cement, and in the centre of each joint an oaken dowel, 1 foot long and 4 inches square, was inserted angle-wise, and run with Portland cement.

The stones were some of those prepared for the service of the breakwater, and had a 6-inch chamfer on their upper surfaces, but in order to obviate any tendency it might have to throw off the shot upwards, the lower arris of the chamfer of the under course was rounded off.

The butt may be supposed to have fairly represented a section of a tower, such as that proposed to be erected on the inner pier-head of the breakwater.

To stop the flight of splinters, four 13-inch timbers were placed on the top of the masonry, and over their ends, which projected 3 ft. 6 in. beyond the face of the stone, was laid close 7-inch sheeting, surmounted with stiff clay; wing-

walls of packed clay were also formed, as mentioned in a preceding paragraph.

The practice took place on the 8th September, 1859, from the forecastle of Her Majesty's steam-ship "Blenheim," with a 68-pr. of 95 cwt. at a range of 450 yards; twenty rounds were fired, and the results are recorded in the following table.

From this table it appears that, of the 20 rounds, 9 rounds took effect on the granite, 5 rounds took effect on the roach, 2 rounds took effect on the junction of the two kinds of stone, while 4 rounds need not be taken into account, as striking either the earth or timber.

Of the granite, one stone was left practically entire, one defensively serviceable, and the other two serviceable, though in a far less degree.

Of the roach, one stone was left untouched, one slightly injured, two very much injured, and one completely destroyed, as far as the concrete.

Setting aside two stones on either hand as not materially affected, and apportioning equally to each kind of stone the effects of the shot on the junctions, it appears that 7 rounds effected a more complete destruction of three blocks of roach than did 11 rounds of two similar blocks of granite, a result which indicates a far higher power of resistance on the part of the granite.

The effect of a blow on the granite was to form deep cracks extending through the adjoining stones; but the portions so cracked were not detached till after many other blows, and then only piecemeal.

The effect of a blow on the roach was to form more numerous cracks, apparently slighter in depth and less extensive, being generally confined to the stone struck; the face, however, was readily and largely detached by succeeding blows, and even by concussion on the adjoining stones.

Of the two rounds classed as equally affecting both kinds of stone, the impact of one was far more on the granite; a fact further corroborative of the result arrived at.

From the granite the splinters were large, and after a time numerous, but they did not appear to range far; the shot were in most cases destroyed, the pieces rebounding in two instances to a considerable distance.

From the roach there were no splinters worth taking into account; the shots were not destroyed, with the exception of that in the fourth round, which was cracked nearly through the centre; the two halves did not however part. The shape of each shot was well indicated in the roach, and the crater formed by it was found to be surrounded by a fine impalpable powder.

The granite made use of was some that had been condemned as unfit for the service of the breakwater, and was very much marked with iron stain, especially in the case of the two inner blocks, the lower of which proved, when its surface was destroyed, to be nearly disintegrated; these two were unfortunately the blocks which principally sustained the trial; possibly their state may have rendered them less liable to crack and splinter.

The result of the experiment is not altogether satisfactory, it being impossible to note accurately the effects of those shots which struck the junction of the two stones. A better comparison would have been obtained by firing an equal number of rounds at two precisely similar butts of each kind of stone.

On removing the stone from the face of the butt, the concrete which backed it was found to be uninjured, with the exception of a slight crack behind the roach; it was of no great depth, and was evidently the effect of a cross blow on an end stone.

The test was probably the most severe (in the present state of gunnery) to which the butt could have been subjected.

I am of opinion that Portland roach may, if carefully selected, be substituted for granite in the tower for the inner pier-head; and, observing how notably in this material the effect was confined to the stone struck, I recommend the adoption of blocks rather less in surface than those of which the butt was constructed.

I do not feel justified, after this trial, in recommending it for a work of such magnitude, and so liable under certain contingencies to be exposed to severe battering as the tower at the end of the breakwater.

I am further of opinion that the best and cheapest mode of constructing such walls as those now under consideration will be found to be in forming them of a certain depth, probably from 4 to 6 feet, of stone facing, backed with sound concrete to the required thickness.

The employment of oaken dowels of the shape shewn in the drawings appears objectionable, the cracks radiating from the angles of the cavities formed in the stones to receive them; probably oval-shaped iron dowels, run with lead, with the longer diameter of the oval across the joints, would better answer the purpose.

From a conversation with the Engineer-in-Chief of the Breakwater, I fancy that it may be possible to form, with Portland cement, concrete blocks which shall equal in resisting power the better of these two stones. Such concrete blocks might be formed with a continuous and coursed face of stone, either granite or roach, so that the appearance of the work would be that of small ashlar.

If such a mode of construction was found to answer, the cost of works, especially circular ones, would be considerably lessened, and the time employed in their erection much shortened.

I believe that the relative cost may be nearly expressed thus: Concrete, (Portland cement), 1; roach, 2; granite, 6.

Several blocks of variously faced concrete are now lying useless at Portland. Built experimentally for the service of the Breakwater some six years back, they may be assumed to have attained to whatever hardness concrete may be capable of. As these blocks can probably be procured for a mere trifle, I venture to request that I may be authorized to construct of them an experimental butt, and subject it to 20 rounds from a 68-pdr. of 95 cwt.

Noticing carefully the result of such practice, and comparing it with those now recorded, an idea will be obtained of the respective powers of resistance of granite, Portland roach, and concrete.

For the unreasonable length of this report I have to urge the peculiar interest of the subject, and the anxiety I was under to note minutely and accurately the effects of the different rounds, in the hope that some data might be elicited, both as to the thickness of masonry necessary to resist the heaviest guns and also as to the best materials and best mode of applying them for the attainment of this end.

I have the honour to be,

Sir,

Your obedient servant,

(Signed) C. H. NUGENT,

Capt. Royal Eng. and Major Commanding

TABLE SHOWING THE RESULTS OF THE PRACTICE CARRIED ON WITH A 68-PR. OF 95 CWT. AGAINST AN EXPERIMENTAL BUTT OF GRANITE AND ROACH STONE AT PORTLAND, ON THE 8TH SEPTEMBER, 1859.

Commenced at 9.30 A.M.; Wind, W.S.W.; Force, 3; Charge, 14 lbs.; Elevation, $\frac{3}{4}^{\circ}$; Range, 450 Yards.

Number.	Stone.	Penetration.	Crater.		Effects.	Remarks.
			Horiz.	Vert.		
1.	Granite.	9″	1′ 3″	8″	Started joint above, detaching cement.	Struck the ground in front of the target, and ricocheting entered at the ground-level, between two lower blocks of granite, starting the joint for its entire length, and detaching the cement from it and also from the bed of the stone immediately over it. Shot recovered whole.
2.	In Earth	9′ 5″	. . .	. . .	. . . . .	Entered the earth underneath the sheeting over left upper roach stone, and buried itself in transverse timber of sheeting, where overlying sleeper. Shot recovered whole.
3.	Roach.	1′ 1″	3′ 0″	1′ 5″	Cracks extending from point of impact to edges of stone in all directions.	Struck the centre middle roach stone of lower course, producing a large crater with numerous cracks extending to beds and joints of the stone. Stones on either side uninjured; the stone above exhibited slight cracks in all directions.
4.	Junction	7″	1′ 0″	1′ 0″	Brought away portion of roach stone previously injured, and opened wider the joints and beds.	Struck the junction of the granite and roach of upper course about 15″ above the bed, falling rather on the granite, which preserved the beat from the blow much longer than the roach; the right portion of the roach stone, which had been cracked in the previous round, was destroyed to a depth of 6″ over a space of 2′ 6″ wide by 1′ 3″ in height.
5.	. . . .	. . .	. . .	. . .	. . . . .	Struck timber over joint of granite.
6.	Roach.	1′ 6″	. . .	. . .	Opened joints of stones on either side and enlarged cracks in stones previously damaged. Shot cracked.	Struck right roach stone of upper course, 7″ above its bed, and 10″ from its left joint, penetrating to a depth of 1′ 9″. This stone had been much damaged by previous blows; the joint of the stone on its left was freed from cement to a depth of 14″, that of the stone on the right to a depth of 10″ for about 2′ from its upper bed; large deep cracks were made in the block struck, and the block below, previously damaged, was still further cracked.
7.	Granite	. . .	10″	6″	Joints shaken, piece knocked off one corner. Shot broken into small pieces.	Struck the rounded surface of the right lower block of granite, in right upper corner, taking off a piece 10″ by 6″, cracking the stone from thence diagonally across to within 1′ of the joint and 2′ 1″ from upper bed, shaking the bed and joint very much; the shot broke into many small pieces which flew upwards. Three splinters of granite fell close in front weighing 18, 28, and 33 lbs. respectively.

Number.	Stone.	Penetration.	Crater.		Effects.	REMARKS.
			Horiz.	Vert.		
8.	Granite.	6″	3′ 0″	1′ 3″	A large rectangular piece knocked off; several deep cracks in the lower part; a small piece, 1′ 4″ × 8″ × 2″, shaken off adjoining roach.	Struck the left-hand stone of the lower course of granite 1′ 6″ from its upper bed, and 1′ 6″ from its left joint, knocking off a rectangular piece 3″ × 1′ 3″, and cracking deeply the lower portion. A piece, 1′ 4″ × 8″ × 2″, was shaken off the adjoining roach stone; the centre roach stone very much shaken, and the joints and cracks very much opened. Shot broken.
9.	Granite.	1′ 0″	1′ 0″	1′ 0″	Widened old cracks, formed fresh, shattering overlying stone.	Struck the same stone as the previous shot about 1″ below its upper bed and 1′ 1″ from its left joint, destroying the face of the stone at this point to a depth of about 1′; increased the depth of the old cracks; formed new and very deep ones.
10.	Granite.	½″	8″	8″	Slight cracks, shot rebounding backwards into water.	Struck the ground about 16 yards in front of the target, and then struck the right-hand lower block of granite, about 1′ 8″ from upper bed and 3″ from left joint, forming a crater 8″ in diameter, and about ½″ deep, and throwing out a crack from hence to its under bed, at about 1′ 3″ from its left joint. The shot flew backwards at an angle of 45°, falling into the water some 100 yards off.
11.	....	...	...	...	.....	Earth (right wing,) bringing down a considerable portion.
12.	....	...	...	...	.....	Earth above sheeting over granite. Shot penetrated 6′ 9″; recovered whole.
13.	Granite.	1′ 1″	...	...	Shook down a large piece of face. Shot broken.	Struck the road 11 yards in front, and hit the left granite block in lower course 1 foot from its top bed, and 2′ from left joint. General impression increased to 13″. A large piece of this stone, previously much cracked, was shaken down; the shot divided into four large pieces, flying back apparently two-thirds of the distance from the ship.
14.	Granite.	7½″	1′ 2″	1′ 2″	Further opening of cracks.	Struck ground 3 yards in front of target, and then hit the left hand upper block of granite about 14″ from its lower bed and 17″ from its left joint; making the penetration about 7½″ over a circle of about 14″ radius, and greatly extending the cracks. Shot splintered and flew back.
15.	Granite.	1′ 0″	...	...	Moved the blocks above, and cut a large portion off the surface.	Struck left block of lower course of granite 2″ below upper bed, and 1′ 9″ from right joint, shaking the joints and lifting the blocks above; rending that immediately above to the upper edge, and detaching a triangular piece about 18″ × 15″ from its lower corner; the penetration increased to 1′. The block had, generally, its upper surface destroyed to a depth of 1′. Splinters flew to the left profusely.

Number.	Stone.	Penetration.	Crater.		Effects.	Remarks.
			Horiz.	Vert.		
16.	Granite.	1′ 3″	. . .	. . .	Removed a great portion of the face of overlying stone, detaching large splinters, and opening the joints.	Struck on rounding of same stone, and close to the point of impact of last shot; shot flew upwards, bringing down a large piece of the overlying stone so much damaged in previous round. The surface of this stone was torn off over the left upper portion to a depth of 2 feet, laying open the joint to the joggle, but not injuring the joggle. The penetration at the point of impact was now 15″. A crack appeared to extend right through the stone; a great part of the surface of the adjoining stone on the left was destroyed to a depth of 14″. A splinter weighing 30lbs. was thrown about 20 yards obliquely to the front.
17.	Roach.	1′ 4″	1′ 0″	1′ 0″	Stone cracked deeply.	Struck centre block of roach in lower course, about 1′ 8″ from upper bed, and 1′ 2″ from left joint, increasing the penetration at point of impact to 16″, and cracking the stone deeply throughout. Shot cracked. Much impalpable powder about the crater formed by shot.
18.	Junction	. . .	. . .	. . .	Brought down large pieces of the granite; texture of roach thoroughly destroyed, and crumbling under touch.	Struck between the roach and granite of upper course 8″ from their upper beds, but rather on granite, from which it detached large portions, tearing off the top to a distance of 15″ from upper bed and to a depth of 2′. The roach was defaced and its texture thoroughly destroyed. These two stones had been already much injured. The shot glanced off and buried itself in the earth above the sheeting, forming a hole about 18″ in diameter.
19.	Roach.	1′ 0″	. . .	. . .	Detached large pieces.	Struck between the two right blocks of roach of the lower course, took a large piece off the corner of right block (already damaged); also a piece, 1′ 10″ wide by 2′ long, off right upper corner; the face was stripped to an average depth of about 13″.
20.	Roach.	2′ 6″	. . .	. . .	Detached large pieces from adjoining block.	Struck the centre block of roach of lower course about 10″ from its right joint, and 2′ 6″ from upper bed, penetrating about 2′ 6″. The surface of the adjoining stone was shaken off to a depth of 1′ 6″.

3rd October, 1859. (Signed) C. H. NUGENT, Capt. R.E., and Major.

Note.—I am much indebted to Captain Harvey, R.E., for the careful observations by means of which this Table and the Plans have been prepared.

EXPERIMENTAL TARGET

constructed at

PORTLAND

in 1859 of

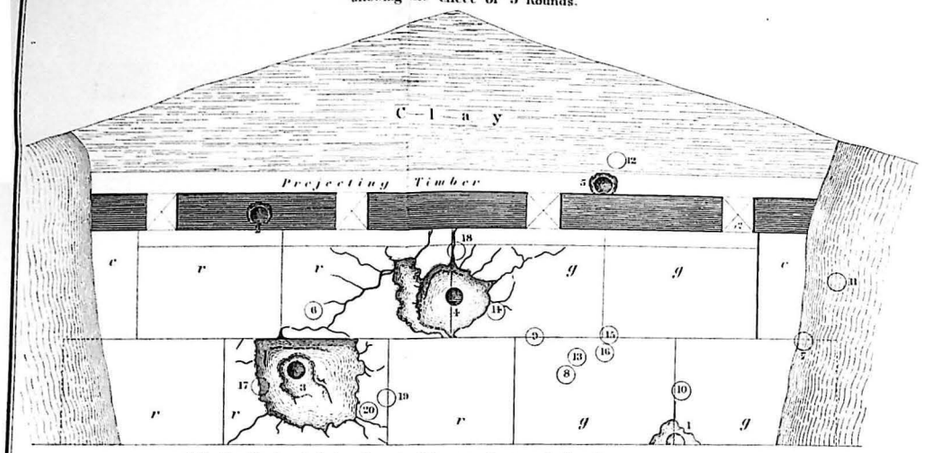
GRANITE & ROACH STONE.

References.

The Granite is shewn by the letter g and diagonal shading, and the Roach by horizontal shading and the letter r, the part shewn by the dotted lines being destroyed by 68 Pr Shot.

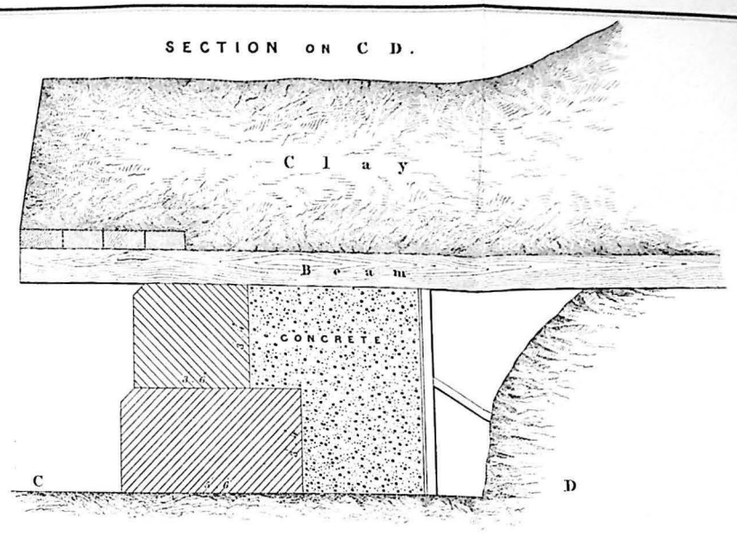
FRONT ELEVATION,

shewing the effect of 5 Rounds.

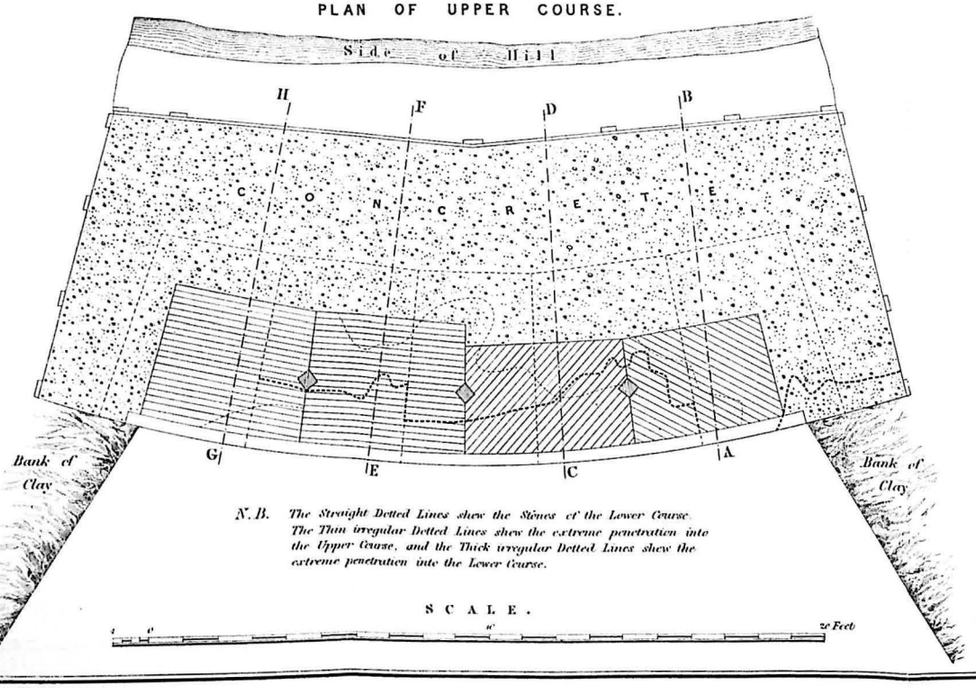


N.B. The Numbered Circles shew the Points struck at each Round.

SECTION ON C D.



PLAN OF UPPER COURSE.

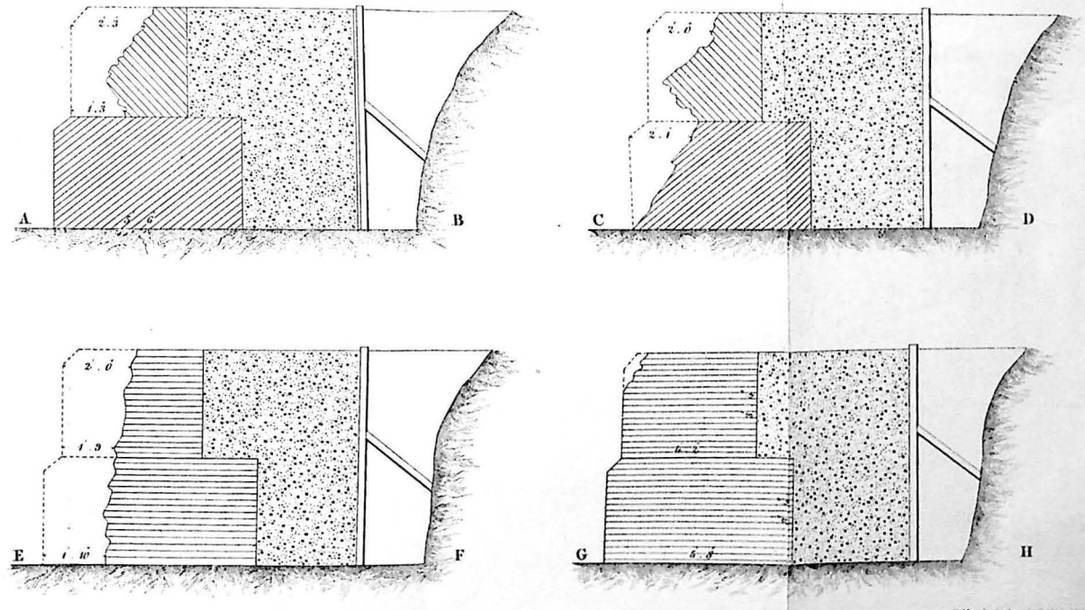


N. B. The Straight Dotted Lines shew the Stones of the Lower Course. The Thin irregular Dotted Lines shew the extreme penetration into the Upper Course, and the Thick irregular Dotted Lines shew the extreme penetration into the Lower Course.

SCALE.

0 6 12 20 Feet

SECTIONS SHEWING FINAL RESULT.



Indexed 24/7/65

PAPER II.

Report on the Demolition of Fort Ruttunghur.

By CAPTAIN CUMBERLAND, R.E.

The effective demolition of this native hill-fort was ordered in June, 1858, in order to prevent its occupation by the rebel troops.

Accordingly on the 30th June, the 11th Company Royal Engineers (69 non-commissioned officers and men) with native detachments of 25 Infantry and 7 Troopers, left Neemuch, and arrived at the fort on the 2nd July, encamping in the interior.

Fort Ruttunghur is situated on a spur of a range of hills, of the same height as the range, at about 300 feet above the plain. It is defended by one line of works towards the south, but has three lines on the north, all of masonry. The lines appear to have been built at successive periods. The spur has steep sides, much covered with jungle. There is a large tank inside the inner line, and the place has the command of a spring in the valley on the west. The range of hills forms another spur on the west, which slightly overlooks the fort at 400 or 500 yards distance.

The demolition was ordered to be *effective*, and yet to be as quickly performed as circumstances would permit. I therefore decided to destroy the strongest points, to provide practicable breaches in each of the three lines to the north, and also to demolish one or two parts where little labour would be required.

Outer Line of Works.

The outer line of works was about 280 yards long, and consisted of round bastions on each flank, a gateway, and right and left centre bastions.

A ditch had been excavated out of the solid rock, except in front of the gates, from 20 to 30 ft. wide at top, but less at bottom, and varying from 16 to 24 ft. in depth: the escarp had then been faced with masonry, which was carried up until the work attained a relief of from 25 to 30 feet on the right of the gate, and from 35 to 45 feet on the left: the thickness of the parapet at top was about 3 feet, and the thickness of the wall at the level of the ground from 5 to 7 feet.

As demolition from the bottom of the ditch would be most perfect, attempts were made to drive a gallery into the escarp at its foot; but this attempt, as might be imagined, failed, the natural rock being reached in a few hours. It was then decided to drive shafts from the interior, and lodge the charges on the natural rock, a foot or more within the masonry.

140 coolies were obtained by means of the political agent (C. Burton, Esq.), and these were divided into four gangs, to correspond with the four reliefs into which the Sappers were divided.

Work commenced at 6 P.M., on the 2nd July, the day of arrival at the fort.

The following Table will show the details of the demolition of the outer line of works, the powder expended, and the effect produced :—

ABSTRACT OF CHARGES IN THE OUTER LINE.

Name of Work	L. L. R. in Feet.	Charge in lbs.	Excavation in Feet. Shaft	Gallery.	Total	Position of Charge.	Remarks.
Right Bastion.	5	25	10	2 / 4	16	On the natural rock, 1′ 6″ into, and from the back of, the wall.	The looseness of the stony "filling in" behind the wall prevented the driving of the galleries farther. Practicable breach formed.
	6	30					
	6	30	11	4 / 4	19		
	6	30					
	6½	40	11	6 / 4	21		
	6½	52					
Right Centre Bastion.	6½	40	10	6½ / 6	22½	Do.	Practicable breach formed.
	6	40					
	6	40	10	6 / 6½	22½		
	6½	40					
Gate..	. . .	in small blasts of ¼lb to 4lb		Nil.		Various positions.	Demolished.
Curtain on left of Gate.	3½	10	Chamber		3	At the level of bottom of ditch. At the back of a staircase leading to bottom of ditch.	An exit to the exterior was here found, a staircase being led down in the thickness of the wall. These charges effected a partial filling of the ditch: (could do no more as the natural rock rose from the bottom of the ditch here—25 feet).
	8	75	Do.		5	15′ above do.	
	7	50	Do.		3	25′ above do.	
	4	12	4	3	10	On the natural rock 1′ into wall.	
	4	12		3			
Left Centre Bastion.	6½	52	8	6	14	Do.	Could only displace about 16 ft. of face, filling up 11 ft. at bottom and leaving 8 ft. of the middle height undisturbed.
	6½	40	10	3	13		
	6½	52	8	8	16		
Curtain on left.	4½	40	4	3	7	4′ under parapet and 4′ from its face.	Slight labour and time were here expended in endeavouring to expose the interior by throwing down 9 or 10 feet of wall. Four charges of 12 lbs. only effected the rising and falling of the mass. The subsequent charges of 20 did not effect much more, the parapet remaining in loose blocks.
	4	12+20	4	4 / 4	12		
	4	12+25					
	4	12+25	4	4 / 4	12		
	4	12+20					
Left Bastion.	8	100	11	6 / 8	25	On the natural rock. 1′ into wall.	The degree of demolition was satisfactory, the debris at the bottom scarcely however reached the broken slope at the top. The displacement did not reach down to the site of the charges.
	7½	63					
	8	75	10	6½ / 6½	23		
	8	75					
	7½	63	11	10 / 5	26		
	8	100					

Second Line of Works.

The second line of works was less massive than the outer line. It was about 250 yards in length: a large full round bastion was its strongest work; on the right of this was a gateway and round tower, and on the left a small round bastion. The large bastion was nearly 20 yards in diameter, and had a command of 22 ft. 6 in., its revetment of masonry being 4 ft. 6 in. thick at top and 10 ft. at bottom. The curtain wall was only 9 ft. thick at its base. As no ditch existed outside this line (but merely an unfinished excavation about 5 feet deep, having a wide berm of 4 feet) galleries were driven at the foot of the wall from the exterior; however, on the right the masonry proved too loose, and the charges of that portion were lodged by means of interior shafts, sunk not too deep.

Abstract of Charges in the Second Line.

Name of Work.	L.L.R. in Feet.	Charge in lbs.	Excavation in Feet. Shaft.	Gallery.	Total	Position of Charge.	Remarks.
Right Bastion.	4	10	8	2	10	In the wall 8′ below terreplein.	The masonry here was very loose, it had been necessary to abandon an exterior gallery. Effect of explosion good.
Right Curtain.	5	25	4	2	6	Within the wall at its feet.	Practicable breach here made.
	4	10	4	4	8		
Gateway.	5½	20	4			At the foot of the wall.	Effect very good; practicable entrance over the ruins.
	5½	20	4				
	5½	20	4				
	5½	20	4				
	5½	20	4				
	5½	20	4				
Centre Curtain.	4½	30	7½ main gallery	4	15½	In centre of wall at base.	Practicable breach.
	4½	30		4			
Full Round Bastion.	8	100	main gallery	7½	26	8 feet from the face at the foot of the revetment.	Complete practicable breach from the exterior.
	8	75	11	7½			
	8	75	11	7½	26		
	8	75		7½			
	8	75	Shaft	7½	33		
	8	100	18	7½			

Inner Line of Works.

The inner line of works formed the gorge of the fort, 110 yards in length. These works were strongly built, having an outer casing (at the foot) of extremely hard masonry, 4 or 5 feet in thickness; they consisted of a right bastion, a centre bastion, and a complication of works about the main entrance on the left, the chief of which was a large bastion which overlooked the ground in its front, its height being 45 feet on that side, and 50 feet above the courtyard between the gates. These bastions had revetments from 9 to 13 feet thick at the base. The charges were lodged by means of galleries from the exterior, excepting at the right bastion, where, the masonry not being very firm, shafts were sunk from the interior.

Abstract of Charges in Inner Line.

Name of Work.	L.L.R. in Feet.	Charges in lbs.	Excavation in Feet. Shaft.	Gallery.	Total	Position of Charge.	REMARKS.
Right Bastion.	5	25	Main Gallery.	4½	16	1 foot within the back of wall, not so low as its foot.	Demolition fair.
	5	30	7	4½			
	8	75	Shaft.	6	22		
	6½	40	11	5			
	6½	40	10	5	20		Breach difficult.
	6½	40		5			
	6½	40	11	5	21		
	6½	40		5			
Centre Bastion.	8	120	Main Gallery.	7½	25	8 feet from the face at the foot of the wall.	Charges slightly increased on account of toughness of masonry.
	8	100	10	7½			
	8	100	10	7½	25		
	8	100		7½			
	8	100	10	7½	25		Breach practicable and easy.
	8	120		7½			
Large Bastion.	9	150	Main Gallery.	11	29½	On a level with external ground.	The bastion was no less than 45 to 50 feet high, and had a batter of 8 or 9 feet.
	9	120	11½	7			
	9	120		9	29½		
	9	120	11½	9			The effect of explosion left the earthen heart of the bastion standing, blowing away the revetment.
	9	120		9	29½		
	9½	140	10	4	14		
Inner Gateway.	7	50	Main Gallery.	1½	14½	4 feet below ground level.	The destruction of this gateway (which was built of hewn stone closely set), was most complete, a complete passage being made.
	6	30	11	2			
	7	50	6	5	16		
	6	30		5			
	5	30	7	4	15	At ground level.	The last 9 charges were made large in consequence of the extreme toughness of the outer casing.
	5	30		4			
	5	30	7	4	15		
	5	30		4			
	5	30	7	4	15		
	5	30		4			
Outworks at Gateway.	4	12	5	3½	12	At ground level.	The effect of the explosion of these charges was to lay all the small outworks of the main entrance in a mass of ruins, so that a complete breach into the interior of the fort was made over all.
	4	12		3½			
	4	12	6	3	15		
	8	75		6			
		10	13 charges. . .			All these charges were placed in the masonry walls of the various works about the main entrance, and their position was reached by an exterior gallery at ground level.	
		12	1 charge. . .				
		20	3 charges. . .				
		30	1 charge. . .				
South-west Bastion of Enceinte		100	Shaft.	5	17	In the body of the work — not at ground level.	These charges would have been placed at a lower level had the ground been firmer and therefore safer for excavation. The effect was moderate on this account, the *debris* scarcely sufficing to reach the craters.
		75	9	3			

DETAILS.

The charges were in all cases enclosed in sand-bags, and fired by means of inch powder hose, which was laid in bamboo casing until the hose was well clear of the gallery or shaft. Bamboo casing is prepared by taking hollow bamboos, splitting them, and smoothing off the joints of the interior; the hose is then laid in one half, the other half is laid over it, and fixed by string. The hose, after leaving the bamboo, was carefully arranged, and covered with earth, about three inches of portfire fixed at its end, and the portfire carefully kneaded round with clay. The tamping of the charges was first commenced with two or more sand-bags filled with sand, after which it was completed with earth and stones, up to the mouth of the gallery or shaft; a heap was then made over the entrance.

No charge failed throughout this demolition excepting in three cases, when, in consequence of heavy rain, the powder hose had become damp; in these cases fresh powder hose was laid.

The working parties were constituted and arranged as follows; there were 4 reliefs (8 hours each,) working continuously day and night; each relief consisted of one non-commissioned officer superintending, and 13 sappers, with about 30 native coolies; sufficient to work at 13 shafts or galleries, at each of which was one sapper with 2 coolies.

	N.C.O.	Sappers.	Coolies.
General Superintendence	1	0	0
Relief ditto	4	52	130
At the Magazine	1	3	0
Sick and casualties	0	8	0
Total employed ..	6	63	130

Grand Total——199

The native coolies were obtained through C. Burton, Esq. (Political Agent with the detachment), from the surrounding villages, and paid at the rate of 2 annas a day. They were found very useful and willing, some relieving the sapper at the excavation from time to time.

The hours of relief were 8 a.m., 4 p.m. and midnight. Tools and materials were brought with the Company from the Engineer park at Neemuch; they were of the usual kind. A number of leathern buckets were brought to drain the shafts of water should this be required; (it was the rainy season). The native coolies use their own tools. The native shovel or hoe is found useful in clearing out excavations; the rubbish can with this tool be raked out between the legs of the workman.

The powder used was English powder, obtained from Neemuch Arsenal. The quantity expended was as follows:—

100 Charges .	Outer line .	1,350 lbs.	= 4,793 lbs.
	Centre line .	725 lbs.	
	Inner line .	2,718 lbs.	
700 yards powder hose			70 lbs.
		Total .	4,863 lbs.

The time employed in the excavation was 12 days, viz., from the 2nd July to the 14th July.

Remarks.

The demolition was performed as quickly as was consistent with proper execution, as the rebels were hovering in the neighbourhood. Fortunately not much rain fell, for its quick or slow execution depended very much on this.

It may be noticed that on the night of the conclusion of the operations a very heavy thunder storm occurred with much rain, completely flooding the country, so that the first march from Ruttunghur was a matter of difficulty, on account of the sudden rise in the rivers.

The Company and detachment arrived at Neemuch on the 17th July. The rebels arrived at Ruttunghur a few days later, but finding the fort partially demolished, plundered the town below, and left.

I much regret to state, that one fatal casualty occurred during the operations, the death of Sapper G. Hake, by a blow from a stone, thrown out by one of the explosions on the 10th July. The circumstances of this accident were fully reported in my letter, No. 164, of 10th July, to the Commanding Royal Engineer, Bombay Presidency.

(Signed) C. E. CUMBERLAND, Capt. R.E.
Commanding 11th Co. R.E.

Toka. 19th March. 1859.

Lieut. Col. Browne, C.B.,
Com. R.E., Bombay Presidency.

PLAN OF THE
HILL-FORT of RUTTUNGHUR,

shewing the positions
of the Charges employed in the Demolition in
July 1858.

BREACH
PREVIOUSLY EXISTING

PREVIOUS BREACH

TANK

RUINS

ENCLOSURE

ENLARGED PLAN
OF ENTRANCE OF INNER LINE.

SCALE.
40 FEET TO ONE INCH.

A. B.
LARGE BASTION (SECOND LINE)

D. C.
R^t BASTION (OUTER LINE)

E. F.
CURTAIN (OUTER LINE)

H. N.
CURTAIN (OUTER LINE)

O. P.
LEFT BASTION (OUTER LINE)

E'. L'.
BASTION ON R^t OF MAIN GATE.

E. A.
BASTION ON LEFT OF MAIN GATE.

B. N.
WALL NEAR
N. W. BASTION.

T. R.
N. WEST BASTION.

B. D.
S. FACE NEAR R^t BASTION
OF INNER LINE.

C. L.
N. FACE NEAR
MAIN GATE.

Z. W.
OUTWORK TO MAIN GATE.

K. M.
CENTRE BASTION OF INNER LINE.

L. N.
R^t BASTION OF INNER LINE.

Scale of Plans. 20 Yards to 1 Inch.

Scale of Sections. 20 Feet to One Inch.

The Masonry is shown by Horizontal Shading.
The Rock is shown by Oblique Shading.
The Shafts and Galleries are distinguished by straight Dotted Lines, and the Profile after demolition by irregular Dotted Lines.
The Charges are shown thus ■ with the number of Pounds of Powder annexed to each.

Surveyed by Lt^ D. C. WALKER, R.E.
Lt^ J. PATERSON, R.E.

Drawn by Lt^ D. C. WALKER, R.E.

Drawn by Lt^ D. C. WALKER, R.E.

Signed C. CUMBERLAND, CAPT. R.E.
J. BROWNE, CAPT. & Lt^ COL. C.R.E. BOMB. PRES.

PAPER III.

Report on Experiments made at Dover in 1859, on the escape of Smoke from Casemates after Firing from them.

By CAPTAIN E. F. DU CANE, R.E.

It having been thought desirable to test the efficiency of the means provided, in the casemates flanking the ditches of the Citadel at Dover, for carrying off the smoke after the discharge of guns, the casemates in the Wings of the Citadel, marked A and B in the accompanying plate, were selected for the purpose: the former flank the North Lines, and the latter flank the North Ditch of the Wings.

Each of the casemates marked A is 19 ft. 6 in. long by 11 ft. 2 in. broad, and 12 ft. 3 in high, to the crown of the arch, and contains one 18 pr. carronade. An opening 3 feet wide, in the pier wall, affords communication between the casemates, and a gallery 3 ft. 6 in. wide extends behind them.

Each casemate has a fire-place, from which a flue, having an area of $1\frac{1}{2}$ feet superficial, ascends to the surface of the parapet above, which is 23 ft. 6 in. above the floor of the casemate. There is also a hole 1 foot in diameter, in the front wall, 4 ft. $9\frac{1}{2}$ in. above each embrasure. The embrasures are 3 ft. 7 in. by 2 ft. 2 in. at the throat. The total superficial area of communication with the external air is therefore nearly 10 feet in each casemate, not including the galleries in rear.

1st Experiment.—This was carried on in the casemates at A. Blank ammunition was used, the charge being 1 lb. 8 oz., and each piece was fired independently and as fast as possible. 28 rounds altogether were fired, in about seven minutes, the quickest rate attained by one of the carronades being two rounds per minute.

Contrary to what has been said to be the case in firing from casemates, the smoke went straight outside, and did not return at all into the casemates through the embrasures. There was a *slight* breeze blowing across the face of the wall during the firing, but this did not assist much in clearing away the smoke, as it was observed that the course which the smoke took was first to come violently forward, and part then rose and went away at once, but a great part sank into the deep drop or ditch in front of the embrasures, and after a short time rose again and was carried away. The only smoke which there was in the casemates was that which hung about the guns during their recoil. The greater part of this escaped through the chimney flue; some rose to the crown of the arch, and kept hanging about there, very little indeed going through the hole above the embrasure.

There was never enough smoke in the casemates to cause the slightest inconvenience in breathing, or in any way to interfere with the efficient use of the casemates. In a few minutes after the firing ceased all the smoke had cleared away, partly through the embrasures, but principally through the chimneys.

2nd EXPERIMENT.—This was made in the casemates marked B, in which the means of ventilation are less than in those at A, as there is no fire-place except in one of them, and there is no gallery in rear; but each has a hole above the embrasure 1 foot in diameter. These casemates are 11 ft. 6 in. broad, 18 ft. 6 in. long, and 12 ft. 6 in. high.

Fourteen rounds were fired from the three carronades in these casemates, the time between the rounds being 1½ minutes, an interval which was caused by their being mounted on wooden carriages with block-trails, which stopped the recoil, and thus necessitated their being run back each time to load.

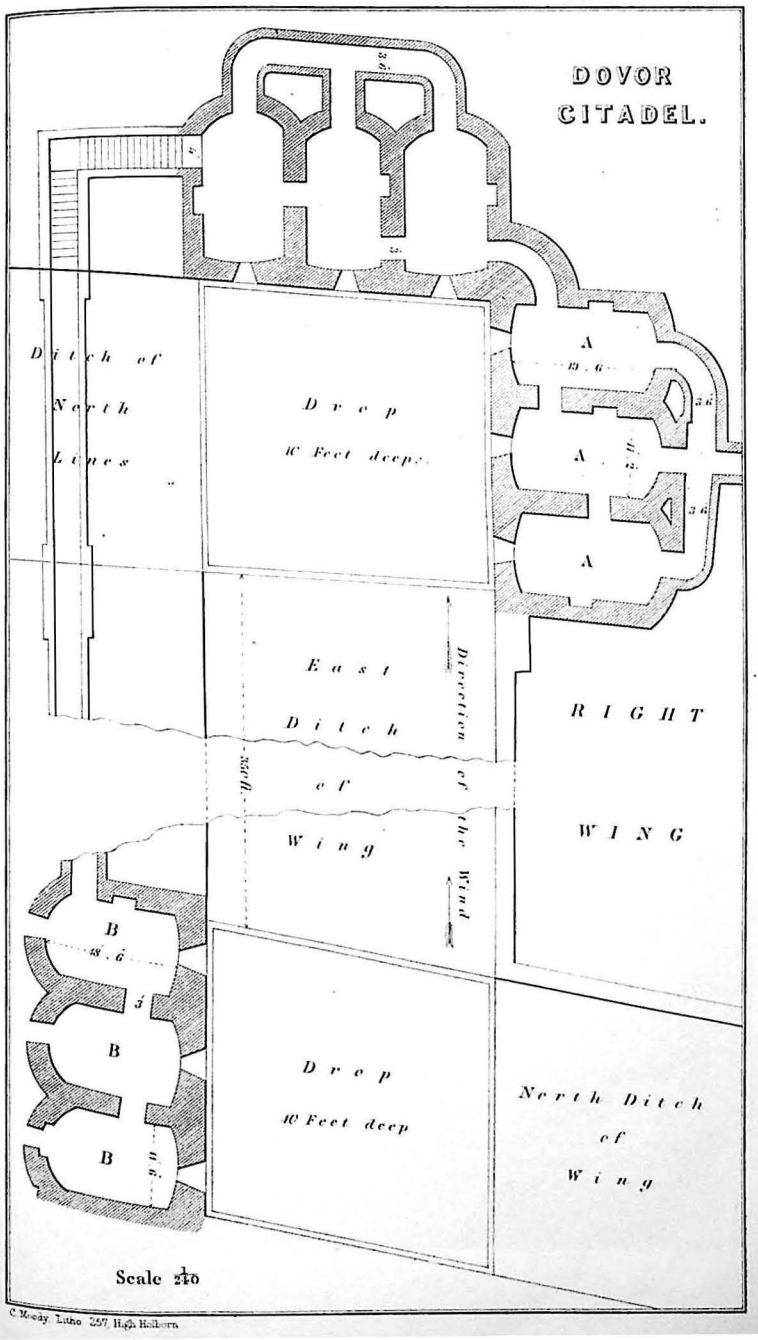
The result was as satisfactory as in the other case, no inconvenience being caused by the smoke in the casemates; and indeed there was rather less smoke in this case than in the other, which perhaps was on account of the greater interval between the rounds. The embrasure soon afforded egress for the little smoke that did accumulate.

It would appear that in flanking casemates, where small charges only are used, there does not occur the rush of smoke back into the casemates, after the discharge, which is said to cause such great inconvenience in other cases. Perhaps this is because the vacuum caused by so small an explosion gets quickly filled by the air from the interior, and thus no back draught takes place. This result, is however at variance with that recorded in the account of experiments at Neuf Brisach in 1799. (See "Professional Papers," Vol. V.)

It is satisfactory to know that the means of ventilation in these casemates are just about sufficient for the purpose.

It may be remarked, incidentally, of what importance it is that the carronades should be mounted in such a manner as to recoil freely; for the firing in the casemates at A was three times as quick as that in the casemates at B, owing to a difference in this respect; and the importance of this difference, in case of an actual assault, would no doubt be very great.

E. F. DU CANE, Capt. R.E.


DOVOR
CITADEL.
Ditch of
North
Lines
Drop
40 Feet deep.
A
A
A
East
Ditch
of
Wing
Direction of the Wind
RIGHT
WING
B
B
B
Drop
40 Feet deep
North Ditch
of
Wing
Scale 1/240
C. Moody Litho 257, High Holborn

PAPER IV.

Account of the Portable Iron Ovens and Mode of Baking Employed at the Camp at Woolmer Forest, near Aldershot, in 1859.

By ASSISTANT COMMISSARY GENERAL H. ROBINSON.

The field ovens represented on the accompanying plate are the result of experiments made by Assistant Commissary General Robinson, at Aldershot, to provide the means of baking bread for troops on the line of march, with portable ovens; and four of them are in successful operation at Woolmer.

Each oven is made of two pieces of sheet iron, 5 ft. × 2 ft. 6 in., and $\frac{1}{16}$th inch thick, having three longitudinal bars 1 inch wide and $\frac{1}{4}$ inch thick, riveted to each on the inside, and five transverse ones, 1 inch wide and $\frac{3}{8}$th inch thick, on the outside, the latter being formed with hooks and eyes, (by which the two pieces are connected together along the top of the oven,) and having their outer ends bent, as shown in Fig. 1, to allow of their being fixed firmly in the ground. When the two pieces are connected and fixed in their places they form an arch, the span of which is 3 ft. 9 in. and the rise 1 ft. 4 in.

Each oven is closed by an iron door with two handles; and where the soil is clay, or favourable, the end opposite to the door may be closed by a wall of clay, but if it is sandy or loose, an iron plate will be required there also.

No chimney is required, and the whole is covered with a mass of earth only 8 inches thick, which is preferable to a larger quantity on account of the weight of earth bending the iron when heated. The door has been kept in its place by means of a wooden prop, but it is intended to hang it on by means of a hook and eye, and to do away with the prop.

An excavation 3 or 4 feet deep is made, about one or two feet from the door, for the baker to stand in.

As each of the pieces forming an oven weigh only about 75 lbs., they can easily be carried by a pack animal: they are easily handled and require no tools except a pickaxe and shovel to erect them, as they merely have to be placed on the ground and covered with earth or sand.

Each oven will bake enough bread for 1,000 men, if in operation for 24 hours, and can be erected and prepared for use in a quarter of an hour.

Two hours are required for heating at first starting, but each subsequent heating requires only one hour. About 112 pounds of wood are placed at the far end or back of the oven, and ignited at the inner end, the mouth being kept open. The wood must not be put in all at once, but in small quantities at a time, as it thus burns better and heats the oven more quickly. 56 lbs. of wood will be enough for subsequent heatings.

The ashes of the wood should be raked out when the oven is at a white heat, and the bread is introduced in tins: the oven must then be closed by means of the iron door, and if any apertures are left they must be filled with earth.

Tins may be dispensed with if the floor is made of brick, otherwise the bread would get dirtied by the ashes, &c. The time required for each baking is three-quarters of an hour. Each oven holds nine tins, and each tin twelve rations of 1½ lbs. each; thus the total amount of bread made at one baking is 162 lbs.

The dough for the bread is made thus—40 lbs. of potatoes are thoroughly boiled and mashed; to these are added 12 lbs. of *well scalded* flour, and 10 gallons of water heated to 100° Fahrenheit; these must be well stirred together, and 6 quarts of yeast added. This is called the *ferment*, and is allowed to stand for five hours.

In hot climates potatoes may be dispensed with, and a ferment may be made with scalded flour and yeast alone. 12 gallons of water heated to 95° Fahrenheit, 2 sacks of flour and 5 lbs. of salt are now to be mixed, stirring in first a portion of the flour, then adding the ferment as above described, and so on, so as to mix all thoroughly. This is to be allowed to stand four hours to rise, after which it is made into bread, of which it will yield 720 lbs.

The dough is kneaded by means of Stevens's Patent Kneading Machine, but this is not well adapted for moving about with troops on the march. If hand kneading be resorted to, ordinary kneading troughs on trestles must be made, or they may be fixed on the ground, and trenches excavated for the kneaders to stand in, close to them. The kneading requires about 45 minutes, if done by hand labour.

If a regiment of 1,000 men halt for 14 hours in every 24, they can be supplied with fresh bread daily on the line of march, by means of two of the ovens above described and six or eight men of the Commissariat Corps.

Each of these ovens cost £3, but they are now being made by a blacksmith of the Commissariat Corps for half that sum.

It has been found that they can be much more rapidly set up and heated than the French ovens used at Woolmer (each of which consists of 199 pieces), and twice as many batches of bread can be drawn from them in a given time.

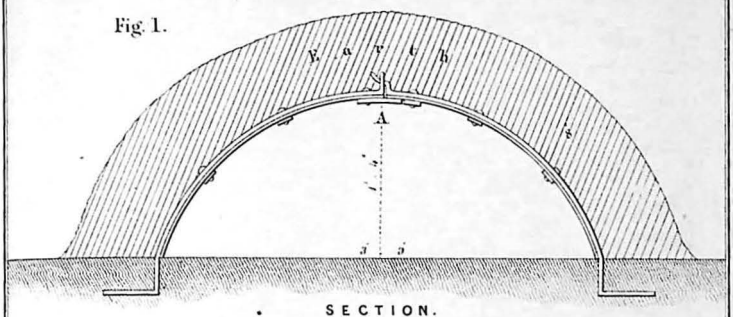
NOTE.—Colonel Chapman, Commanding Royal Engineer at Aldershot, considers these ovens very serviceable, and more portable than the French ovens tried there; they have now been in use for upwards of four months, and have been proved to be durable and well constructed.—ED.

PORTABLE IRON OVEN,

used at Woolmer Camp.

Scale $\frac{1}{15}$

Fig. 1.



SECTION.

Fig. 2.

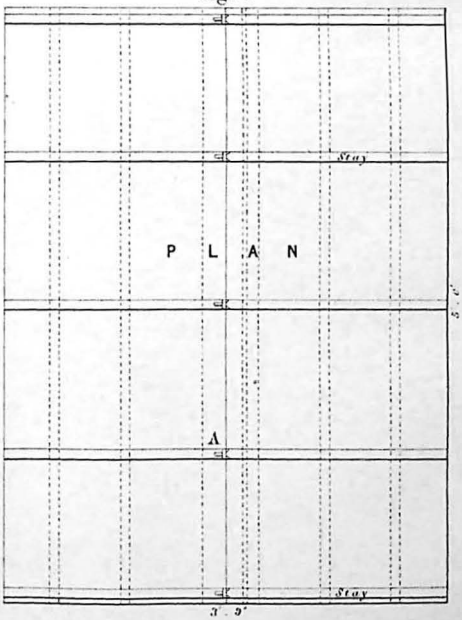
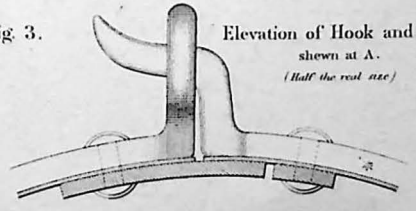


Fig. 3. Elevation of Hook and Eye.

shewn at A.

(Half the real size)



PAPER V.

Reports on the Defences of Lucknow,

By Brigadier General SIR R. NAPIER, Bengal Engineers, and other Officers of the Royal and Bengal Engineers.

Memorandum on the Military Occupation of the City of Lucknow.

By BRIGADIER GENERAL SIR ROBERT NAPIER, K.C.B., Bengal Engineers.

The City of Lucknow, from its vast extent, and from the absence of any very prominent features of the ground on which it stands, must always remain difficult to control except by a large body of troops. That dificulty may be greatly diminished by establishing a sufficient number of military posts, by clearing such spaces round the posts, and on their lines of communication with the open country, as will render them at all times accessible, and by opening broad streets through the city, and practicable roads through and round the suburbs, so that troops may move rapidly in any direction. As far as a general view of the city enables me to judge, it is situated on an incline descending towards the Goomtee; the sites of the Residency and of the old fort called the "Muchee Bowun" are more elevated than the parts of the city surrounding them, and are probably spurs from the high edge of the incline, which stretches round the south side of the city, and the drainage between them falls into the Goomtee near the iron bridge. The height of the buildings is so great, compared to the natural features of the ground, that the latter are only discernible on close examination. The point which gives the nearest command over the city is the old fort or "Muchee Bowun," in close proximity to which is the great Emambara, which affords excellent shelter for troops. I propose to make here the principal post in the city; it completely commands the masonry bridge, and greatly influences the communication by the iron bridge. I propose to form an esplanade of 600 yards in width round the "Muchee Bowun," and to open the following roads radiating from it through the city. *

No. 1. to the Char Bagh Bridge,
„ 2. to the Tal ka tora Bridge,
„ 3. to Bowlee Hussan Gunj,
„ 4. to Serferaz Gunj on the Sundeela Road.

* See Plan annexed.

The Jumnia Bagh, called also Hosseinabad, appears to offer no military position; the shelter of a few buildings there is convenient for the present moment, but it will probably be found expedient hereafter to clear away the whole of them, leaving merely the highly ornamental gateways, and laying out the ground surrounding the great masonry tank in walks and gardens for the use of the garrison in the "Muchee Bowun," avoiding to construct or leave any cover that would be injurious to it. All suburbs and cover lying on the banks of the river, which would interrupt the free march of troops from the "Muchee Bowun" to the Moosa Bagh, must be swept away: Ali Nukee Khan's house, on the banks of the river, and the Moosa Bagh must be held as out-posts.

A second post in the city must be formed at the iron bridge, and connected with the "Muchee Bowun" by strong picquets; a little labour will convert an existing hollow into a covered way for a considerable part of the distance.

From the iron bridge, a road, No. 5, must be opened to the Char Bagh Bridge; this may be effected by enlarging and prolonging the present road until it falls into the street proposed between the "Muchee Bowun" and the Char Bagh Bridge, or No. 1 road.

The roads No. 6 and 7, from the masonry and iron bridges, must be prolonged northwards beyond the Goomtee to the open country, and the suburbs encumbering those lines of road must be cleared away.

A third post is to be formed at the Residency, which will maintain the communication between the bridges and the Kaisar Bagh.

The palaces of the Furrad Bux, the Chutter Munzil, and the Kaisar Bagh, together with the range of palaces and houses stretching from the Kaisar Bagh to Banks's house, will form barracks for our troops for the present.

The parts of the city lying immediately south of them are almost entirely in ruins, and will be cleared away, and every building and garden-enclosure not required for the use of our troops, which exists between the Martinière Road and the Goomtee, will be cleared away.

A bridge of boats may be maintained near the Motee Mahal, for communication with the Badsha Bagh, which must be held as an outpost, and all the bridges over the canal, destroyed by the enemy, must be repaired.

A direct road, No. 8, must be opened from the Kaisar Bagh to the Char Bagh Bridge; also No. 9, from the Kaisar Bagh to the Tal ka tora Bridge; No. 10, from the Kaisar Bagh to Sitrapore Bridge; No. 11, from Sitrapore Bridge to Serferaz-gunje and the Sundeela Road, and No. 12, from the Char Bagh Bridge to Bowlee Hussan-gunje, and thence to the Moosa Bagh.

The strong garden-walls on the line of canal, and the several approaches to the city from the south, must be levelled.

The whole of the enemy's offensive works near the Alum Bagh and on the line of canal will be levelled.

With reference to the extensive removal of parts of the city, both for esplanades and for roads, it must be remembered that a very considerable part of the population was supported by the Court and its dependants. Their houses are for the greater part in ruins, their property has been removed or plundered, and there will exist no inducement for them to return to their former places of residence.

The ruins and few deserted houses, if suffered to remain, would harbour the lowest part of the population and become an intolerable nuisance.

With the cessation of the lavish expenditure of a large Eastern Court, the population of Lucknow must diminish very considerably, the demolition proposed therefore will hardly anticipate the inevitable results of the change in the fortunes of the city.

With regard to the streets which it is proposed to open through the dense parts of the city, those which are to form the main arteries, Nos. 1, 2, and 4, should not be less than 150 feet broad: they are absolutely necessary in a military point of view to reduce to order a large and turbulent city, of which not a single inhabitant came forward to our assistance, either openly or secretly, during the time of our misfortune. Hardship will, no doubt, be inflicted upon individuals whose property may be destroyed, but the community generally will benefit, and may be made to compensate the individual sufferers.

A very extensive system of culverts, on a scale unusually grand for a native city, exists at Lucknow; they should be traced out and cleared.

Efficient drainage should be given to the new streets. The tortuous course of the Goomtee gives assurance that a stream of water may at some future period be brought to refresh and purify the city by going a moderate distance from it for a head of supply.

(Signed) R. NAPIER,
Brigadier Commanding Engineer Brigade.

26th March, 1858.

MEMORANDUM ON THE MILITARY OCCUPATION OF LUCKNOW, CONTINUED FROM THAT DATED 26TH MARCH, 1858.

The following alterations in the original memorandum, which was written when the city was in our full possession, appear desirable. Instead of roads Nos. 3 and 4, radiating from the Muchee Bowun to Bowlee Hussan-gunje, and to the Sundeela Road, one road, No. 3, carried from the Muchee Bowun or the Emambara to the Moosa Bagh, will lead to the Sundeela Road. This is a road of military necessity, and it will also benefit the city, the present exit being a narrow and tortuous gulley, impracticable for wheeled carriages. Should the civil authorities find an intermediate line between Nos. 2 and 3 to be necessary, it can be opened at their instance.

The present military communication between the Muchee Bowun and Moosa Bagh is by the bank of the river, passing Ali Nukee Khan's house. This is circuitous, and has the disadvantage of crossing a drain unfordable during the rains and about 25 feet wide; it is inundated to a considerable depth during floods, but it is a most valuable road, passing out of the city from near the Muchee Bowun, completely covered for a considerable distance by the Hooseinabad post and the Jumnia Musjid, and leading into the open country well clear of the suburbs after passing Ali Nukee Khan's house. I strongly recommend its being embanked and raised above the flood level, and furnished with strong timber bridges across the drainage lines. The embankment will be of considerable height, but its length will not exceed a mile and a half, and it will save a large piece of land from inundation. The Lucknow government has set us a good example by raising nearly a mile of road, of which the new one will merely be an extension.

The direction of No. 5 must depend on examination of the ground after clearance of the esplanade.

No. 7 road will only require improvements. No. 8 is very urgently wanted: the only existing road wanders through the suburbs and may be altogether condemned.

No. 9 is a military road, and if opened from the east side of the Kaisar Bagh will serve for the magazine and Emambarah, and to give access to the occupants of Huzrut-gunje.

Nos. 10, 11, and 12, are for the better division and police arrangements of the town, and should be arranged with the civil authorities, who will probably find other lines also necessary, in the laying out of which the aid of the Engineer department should be called in.

The width of the three military lines radiating from the Muchee Bowun should not be less than 150 feet, a width less than that of the roads laid out by the Lucknow government between the Roomi Gate and Hosseinabad.

A good gun-road should be opened round the south-west suburbs from Moosa Bagh to the Tal ka tora Bridge, from thence to Char Bagh, and continued outside the canal to Banks's house.

The intricate and inaccessible city and suburbs cannot be opened too much by good wide roads.

The distance cleared for the esplanade has been reduced from 600 to 500 yds., in order to avoid cutting into the Chowk, at the entrance gate of which it ends.

This distance is the smallest that can be adopted with safety to the military posts. The fire of matchlocks is very effective from high buildings at 400 and 500 yards, and that of the Enfield rifle at double that distance, and many of the last mentioned weapons have fallen into the hands of the enemy, nor is it likely that the improved fire-arms of late years will be confined to our own troops. In the use of shells for the defence of posts their splinters fly back more than 400 yards, hence any shorter range would be liable to cause loss to the garrison.

It is very necessary for the improvement of the city that strict supervision be maintained over the buildings permitted to be constructed in the new streets, and along the front of the esplanade: all houses should be built on sanctioned plans, and no encroachments on the allotted frontage should be permitted. The future appearance of the city will depend on the vigilance of the civil authorities on this point.

The several measures recommended for the occupation of Lucknow may be detailed as follows:—

1st. To occupy with troops the shelter afforded by the strong line of buildings extending from Banks's house to the eastern side of the Furrad Bux. To render these in themselves as defensible as their nature may admit of; to clear a good esplanade for them to the south, so that they may not be approachable under cover; to render the communication between them easy, and to clear away, between them and the Goomtee, all suburbs and buildings not required for our establishments, so that the buildings occupied by our troops may command as great a range as possible, and that an enemy approaching them may have the greatest extent possible of open ground to pass over, liable to attack from our Horse Artillery and Cavalry, whilst our line of buildings may be held by a minimum of troops.

The position is not a very good one; the description of shelter which we hold of necessity affords little communication compared to its mass and extent, but the walls are generally high and inaccessible, and, with the south front cleared and connected, will cover the triangle between it and the river, of which it may be called the base, the third side being the canal, within which our civil and military establishments may find shelter.

2nd. The next points are the two fortified posts to hold the bridges over the Goomtee and overawe the town, and a third one on the high ground of the Residency, to secure their communication with the first position in the strong buildings.

The treatment adopted for these was to take advantage of all existing buildings that could aid in giving shelter or defence, to add such fortifications as circumstances would permit, and to confine the limits of each post to the minimum of enceinte that the features of the ground would allow; to clear around each a sufficient esplanade, and to protect the inter-communication of the posts as much as possible by a screen-wall held by picquets at intervals where necessary; to clear the left bank of the Goomtee opposite to the posts, so that it may be entirely laid open to their fire, and to establish such works at the north ends of the bridges as would hold strong picquets and be defended and commanded by the guns on the right bank.

Shah Beharee Lall's house, a large building with a strong garden-enclosure, together with the adjacent Emambarah, also a strong building, give shelter to a regiment, and, if fortified, would form a strong post commanding the approach from the north to both bridges, but, as a post once fortified must be held, it is desirable to defer recommending any defensive works there until the suburb has been cleared away and the ground laid open to examination.

3rd. On the west side of the Masonry Bridge post, and extending to the open country, are the following posts, which we occupy at present as much for the shelter they afford as for other reasons. Hoseinabad, a rectangular enclosure containing a garden and ornamental building, which give accommodation to our men. Overlooking these is the Jumnia Musjid, or great mosque, which will hold 100 men, commanding Hoseinabad too much to be left out; also near it some minor buildings outside of the enclosure, which hold two batteries of artillery. This post is 800 yards distant from the Masonry Bridge post, is completely commanded by it, and its retention is not absolutely necessary, but its position covers the line of march along the river bank towards the west from the city, and the shelter it affords is convenient.

Further west is Ali Nukee Khan's country-house and garden, touching the banks of the Goomtee, affording accommodation to our men, and being a connecting link between Hoseinabad and Moussa Bagh, which last is a strong house and garden, about one and a quarter miles further to the west, which forms our entrance outpost, and shelters men.

These three posts, being in temporary occupation, have merely slight defences, such as closing all external openings, making loop-holes in the walls and sand-bag parapets on the roofs of the buildings and enclosures, but they will have an extensive clearance effected of suburbs and cover within musket range all round them and along the river bank, so as to complete as free a line as possible for our troops to move out to the west.

The Martinière and Dilkoosha are also used as outposts on the east side. Thus our troops will occupy cantonments altogether seven miles in extent between the entrance outposts from east to west, in the centre of which will be three permanent fortified posts which will require garrisons aggregating 1,000 men, and will hold the roads from the city on the north bank of the Goomtee.

The communication with our base at Cawnpore are the roads through the city by the Char Bagh Bridge and the outer line of road by Dilkoosha and Jellalabad, which will be unserviceable in the rains.

The position of the troops is one entirely forced by circumstances, and by the necessity for taking advantage of the useful shelter which is only to be found on the line occupied, and of holding the line which controls the city and its communications with the north bank of the Goomtee and northern districts of Oude.

It requires a large garrison, which should be independent of the moveable columns. The force required to hold the position may be represented as follows, the second column showing the minimum garrison which should be left to retain the posts for a short period not exceeding a very few days whilst the column is absent.

	Ordinary Garrison.	Men to hold the posts in emergency, the column being in their front.	Guns	Remarks.
Moosa Bagh	Present garrison exclusive of sick, 6,819 rank and file. Sick (not included) 1,035.	200		
Ali Nukee Khan's house		200		
Hoseinabad and its dependencies.		150		
Jumnia Musjid				
Muchee Bowun Post.		600		
Iron Bridge Post.		200		
Furad Bux		200		
Kaisar Bagh and its dependencies.		300		
Emambarah (Magazine)		200	4	In addition to the guns attached to troops or batteries.
Zahoor Bux				
Begum's Kotee		250		
Banks's house.				
Motee Mahal		200	4	In addition to the guns attached to troops or batteries.
Residency				
Total		2,500		

The force now present here furnishes 5,105 regular Infantry, exclusive of sick; and after deduction of the garrison to be left in the several posts (2,600) yields theoretically 2,665 men for active defence; and if a column of 1,500 is sent into the field it should still be possible to collect out of the garrison 1,000 men to support or defend any part of the position that might be attacked.

The strengths are on a scale in accordance with the actual force available, and not by any means what would be desired.

The Force should be able to furnish at least three moveable columns, of 2,000 Infantry each, and leave 3,500 Infantry in garrison.

But with reference to the limited force available, and the nature of the enemy to be dealt with, the posts may be held by the number allotted, provided the defensive means recommended are not neglected.

The duty of fortifying the three posts in the city was allotted to Lieutenant Greathed, Bengal Engineers, and that officer's report on them is appended, with such alterations in detail as seem necessary, noted in the margin.

Lieutenant Greathed has with much judgment traced out the most advantageous features of the ground for the Muchee Bowun Post, which consists of three portions, neither of which could well have been removed or excluded from the work. The trace or enceinte is larger than was desired, being 2,400 yards in extent, but the scarps are generally so high and the flanking defence is so good that the number of men required to hold it is not in proportion to the size of the work. It commands both banks of the Goomtee and the Masonry Bridge completely, and its guns will range over the city for 1,800 yards. The work has been hastily done, and existing walls and buildings have been converted into revetments, therefore damages and the necessity for repair may be looked for in the rains, but the work may even now be considered, not merely tenable, but strong: much remains to be done to complete the accommodation for troops and stores, to give the ramparts and parapets their proper dimensions, and to prepare batteries for guns on the south and west faces. The two bastions at the southern angles of the work are as yet uncommenced, but will be begun immediately.

The fine Emambarah and its dependent buildings afford much accommodation, but some is required in the old Muchee Bowun, where there are walls that only require roofing to shelter about 180 men, and a bungalow under repair will accommodate the officers.

On the mound overlooking the river, called Luckmeen Teela, existing buildings will shelter about 150 men and officers, and the walls of a small building for 30 men are being roofed in.

In the Iron Bridge Post, Lieutenant Greathed has also taken advantage of the high points of ground, and his south front has a very good command, but the flanks and bastions require defilading from the high ground of the Residency and the left bank of the river. Existing buildings have been used for shelter and defence, but further accommodation is required for 100 men, and barracks are being constructed accordingly. The Iron Bridge is swept by a barbette battery for four guns. The post is all but ready for occupation, except the buildings for sheltering troops, which are not quite complete, even for 100 men. Powder magazines have to be constructed. An esplanade of about 25 yards wide has been completed nearly round the post.

The Residency Post has not been commenced, all available men having been employed in the other two.

To Major Nicholson, Royal Engineers, was entrusted the duty of disposing of the line west of the Stone Bridge, but as he was shortly afterwards ordered out with the moveable column he was only able to furnish a brief report, which is annexed; and the direct line of road still remains untraced, but the river line has been opened by a track which has been found of the utmost convenience.

The posts of Hoseinabad, Ali Nukee Khan's house, and the Moosa Bagh have been made defensible by musketry, and cover is being removed for some hundred

yards round them; but some objectionable buildings still remain near the two first posts.

The part of the position east of the Residency was allotted to Major Lennox, Royal Engineers, who was also ordered on service before he had done more than make a brief report, which is annexed.

Much remains to be done. A considerable clearance has been made on the south of the Kaisar Bagh, and a road is in course of construction through the Esplanade to relieve the only other line through the Huzrut Gunje and the China Bazaar. Loop-holing and minor defensive arrangements have been made by the Executive Engineer, and every commanding officer was furnished with a memorandum of instructions to enable him to strengthen his own posts; but, owing to their frequently going into camp, they were able to do little or nothing. Much is still required to render the eastern front of the position secure; and much clearance towards the south, and also between the bungalows and the Goomtee, is necessary.

I may recapitulate the works in progress:—

1. The Masonry Bridge Post.
2. The Iron Bridge Post.
3. The Residency Post (clearance of ground only made).
4. The clearance of the Esplanade.
5. The opening of the military roads through the city, which are not yet carried beyond the esplanade.
6. The embanked road to Moussa Bagh, not yet commenced, awaits sanction.
7. General clearance and defensive arrangements for the buildings occupied by the troops. When the works were made over to Major Crommelin, about thirty-four thousand rupees had been expended, including the opening and repair of roads and bridges over the canal, removal of the enemy's bastions, and clearance and white-washing of hospital accommodation.

The following additional ordnance is required for the works when completed:

24-pounder guns	10
8-inch howitzers	10
10-inch mortars	5
8-inch ditto	10
5½-inch ditto	10
Field guns	6
Total	51

with 500 rounds of ammunition for mortars and guns.

(Signed) R. NAPIER, Brigadier, Chief Engineer.

Lucknow, 12th May, 1858.

Memorandum by Major Crommelin, Chief Engineer of Oude, on the Military Works that have been executed at Lucknow, in pursuance of Brigadier General Sir R. Napier's Scheme for the occupation and defence of the City.

The principal measures recommended by Brigadier General Sir Robert Napier, K.C.B., for the occupation and defence of the town, may be briefly described as follows:

1st. The establishment of a number of military posts for sheltering the troops, extending along the river, or north front of the city of Lucknow, from Dilkoosha, on the central east, to Moosa Bagh on the extreme west.

2nd. The construction of three strongly fortified posts; one near the Stone bridge, another near the Iron Bridge, and a third at the Residency, which should overawe the city and command the bridges over the Goomtee and their approaches, as well as the line of communication along the river.

3rd. The demolition of certain portions of the city, viz., the clearance of all houses and obstacles between the line of posts and the river; the clearance of esplanades, 500 yards broad, around the forts, and of esplanades (varying in width according to circumstances) around the minor posts; and also the clearance of the suburbs along the left bank of the Goomtee, to a distance of 300 yards from the river.

4th. The construction of a series of roads through and around the city, which should afford ample means of communication.

Posts for Shelter of Troops.

The following are the posts which were occupied. The Dilkoosha House, the Martinière, the Begum's Kotee, the old barracks, the Mootee Mahal, the Zahoor Buksh, the Kaisar Bagh Palace, the Chutter Mumzil, and Furad Buksh Palaces, Ameenabad, Hoseinabad, the Jumnia Bagh, Dowlut Khana, Jumnia Musjid, Ali Nukee Khan's two houses, and Moosa Bagh. The Badsha Bagh and Beharee Lall's house, on the left bank of the river, were also occupied.

The whole of these posts were placed in a defensible state, and were useful, not only as a shelter for troops, but as preserving a chain of military positions along the line which controlled the city and its communication with the country on the north bank of the Goomtee. As the garrison of Lucknow was from time to time reduced, these posts were gradually abandoned, and at present only four are occupied by troops, viz., the Begum's Kotee, the old barracks, Ameenabad, and Moosa Bagh; the remainder have been made over to the civil authorities, and are used for various civil purposes; but possibly some of them may be again occupied by troops during the hot weather, in the event of sufficient shelter not being provided in time at the Dilkoosha cantonment.

Forts.

Stone Bridge Post.—The original sketch-design of this post is described in Brigadier General Napier's memorandum, and has been generally adhered to, but as the works progressed, and the nature of the ground and its capabilities for defence became better known, very considerable modifications were made in the trace, profile, and other details of the fort, a plan of which is annexed.

The fortifications of the post are nearly completed: a portion of the parapet and glacis on the south and east faces are still unfinished, and in other places a few minor defences are wanting, but the whole of the defensive works will be finished by the end of February.

There is sufficient good accommodation in the fort for 500 men, and in time of need 3,000 Europeans would find shelter in the various buildings; improved arrangements for out-offices are in progress, and a few additional buildings, such as canteens, library, sergeants' mess, &c., are necessary, and will be provided immediately. As regards accommodation for ordnance stores, but little has been done up to the present time. The Principal Commissary of Ordnance, who visited the post in November last, considered that there was ample space for a second class arsenal, and proposed a scheme for the same to the Inspector General, which has probably been submitted to Government.

There is a good deal of covered accommodation in the squares, allotted to the magazines, and for general stores; but the powder magazines and gun-sheds ought to be commenced at once, and it is desirable that the orders of Government on the general question should be communicated as soon as possible.

The incomplete details of this post may be thus summed up:

A small portion of the defensive works.

A few minor buildings for the accommodation of troops.

A new range of officers' quarters.

Arsenal.

Improvement of buildings allotted to the Commissariat Department.

Iron Bridge Post.—This post (see plan annexed) is also described in Brigadier General Napier's memorandum, and the original trace has been only slightly altered. Owing to the peculiar features of the ground it is very irregular, and the fort was rapidly constructed, as it was required for the defence of the iron bridge; but it is not large enough for an isolated post, and requires the support of both the Stone Bridge and the Residency forts. In the event of its being kept up the river front must be re-constructed. This front is weak, badly flanked, and masks the fire of an important battery in the Stone Bridge fort.

Residency Post.—This post has not yet been commenced, the whole of the resources of the Garrison Engineer having hitherto been applied to the two other posts, and as the emergency which led to the recommendation by General Napier of the original scheme has now passed, it may be questioned whether it is really desirable that this third post should be constructed.

It has already been pointed out that, if the Iron Bridge post is to be maintained, a fort at the Residency is necessary; the question therefore is, whether there should be three posts or only the one at the Stone Bridge.

The Stone Bridge post, as has been already shown, is sufficiently spacious to accommodate a large garrison, an arsenal, and a commissariat depot, and might be held effectually against any but a well organized and equipped army; but it

overawes only a portion of the city, has only a partial command over the river line of communication with the new cantonment, and, unless supported by the other posts, could be readily invested on all sides on the occurrence of hostilities.

The chain of three posts, however, would overawe nearly the whole city, would render the river communication almost perfect, and, whilst requiring only double the Garrison of the single fort, would add tenfold to the strength of the position.

Annexed is a plan,* showing a fort traced to suit the features of the ground, which would enclose the whole of the high plateau around the Residency, and be sufficiently large easily to accommodate a garrison of 500 men. In time of need a larger garrison might be thrown into it; but it would not be sufficiently strong if reduced to smaller dimensions. The Residency might be restored either as a residence for the Chief Commissioner, or for the officers of the garrison. The banqueting hall would make a good office for records, treasure, and other civil purposes, and the three other buildings which remain, being only partially injured, could be converted into good cover for the garrison.

It would be sufficient if ample barrack accommodation, complete in every respect, were provided for 500 men. In ordinary times a single company of infantry, and a reserve company of artillery, would suffice to hold the fort, and the barrack buildings might be so arranged that such as would not be required for the minimum permanent garrison might be converted into kutcherries for the civil officers, as the present offices in the Chutter Munzil palace will probably not be kept up. The whole of the buildings should be well constructed, and have under-ground apartments as places of security during time of hostilities.

The expense of such a fort would, on a rough estimate be as follows:

Defensive Works	200,000 rupees.
Restoration of old buildings	50,000 „
New buildings for troops and magazines	350,000 „
Total rupees	600,000

By this arrangement of the forts, the Stone Bridge post would contain the Arsenal and depot for military stores; the Residency fort would protect all the civil offices and records, and the Iron Bridge post would be a connecting link between the two main forts.

Demolitions.

The demolitions on the right bank of the river have been nearly completed around the three main positions; no building within the prescribed limits has been allowed to stand, but in other quarters care has been taken to spare all buildings of an ornamental character which did not interfere with military arrangements.

A portion of the demolitions on the west front of the Stone Bridge post are still incomplete, and the clearance of the strand, 300 yards broad, on the left bank of the river, has only just been commenced; this however will soon be completed as there are not many buildings to be destroyed.

* This is omitted here, as the work was not executed.—Ed.

In the neighbourhood of the Chutter Munzil and Kaisar Bagh the demolitions have been smoothed, and those around the Stone Bridge post have been thrown into glacis.

It will be necessary to smooth the areas between the posts, but elsewhere it is not necessary to incur the expense of smoothing; the clearance must be gradual, and the removal of bricks for building purposes, the filling up of hollows, the effects of the rains, and gradual clearances, will probably in two years efface all traces of the demolitions.

Roads.

The whole of the military roads recommended by General Napier have been either completed or are in progress; viz.

1st. The great roads, each 150 feet broad, radiating from the Stone Bridge post, and passing right through the city, the first to the Char Bagh Bridge, the second to the Tal ka Tora Bridge, and the third to the Moosa Bagh. The first two roads have been bridged, and opened throughout to traffic; the houses have been demolished to the full width, and the levelled track throughout is 40 feet wide, and about two-thirds of the length of each road have been levelled to the full width of 150 feet. The houses on the third road have been demolished to the full width, but the levelling of the track has only just been commenced.

2nd. The embanked road between Ali Nukee Khan's house and the Moosa Bagh was completed in July, and satisfactorily withstood the force of the inundation.

3rd. A road has been opened from the Huzrut Gunje, passing across the plain to the Chutter Munzil, and then on along the river front of this place to the old strand road under the Residency.

4th. Another road has been opened in continuation of the Chenee Bazaar, passing through the courts of the Chutter Munzil, direct to the Bailie Guard gateway.

5th. A road passing from Banks's House past the south boundary of the Kaisar Bagh, as far as the Residency; it will be continued to the Stone Bridge post, and will define the limit of the demolition and esplanades.

6th. A metalled road from Banks's House to the Char Bagh Bridge has been completed by the civil authorities; from thence the old track, skirting the canal, has been cleared as far as the Tal ka Tora Bridge. The portion of the line necessary to complete the circuit of the city to Moosa Bagh has not been commenced, but will shortly be taken in hand. It will be a mere track, sufficient for the passage of guns and patrols.

7th. A short but important road from the Kaisar Bagh to the Ahmeenabad post has also been finished.

Other roads have been opened, but they are not strictly military lines of communication, and do not require notice in this place.

Annexed is a plan of the city on a small scale, showing the position of the forts, minor posts, roads, line of demolition, and position of the proposed new cantonment at Dilkoosha.

(Signed,) W. A. CROMMELIN, Major,
Chief Engineer, Oude.

Report on the Forts at Lucknow.

By MAJOR GREATHED, Bengal Engineers.

Muchee Bowun or Stone Bridge Post.

The general outline of the post as proposed, subject to modifications in detail, is shown in the Plan B.

Advantage is taken of strong buildings and of natural features of the ground whereby it happens that escarp walls have to be constructed only at the two bastions proposed to be thrown out on the city front.

The line of defence includes all that remains of the ancient Muchee Bowun Palace, after its partial demolition by the late Sir Henry Lawrence, K.C.B., in June, 1857, the magnificent Emambarah of Ashrufoodowlah, which itself holds a regiment, and the high ground called the "Lutchmun Teelah," intervening between the Emambarah and the river. The city is completely commanded to the full range of the guns in the Muchee Bowun Battery, and of mortars on the roof of the Emambarah itself. Guns placed in the south-west and south-east bastions, proposed to be constructed, will see the same ground at a lower level, and the mortars in position in the Mobarik Mahal are turned in the same direction. The ground in front of the Jumnia Bagh and Jumnia Musjid is seen from the south-west bastion, from guns on the Emambarah Mosque, and from a battery to be constructed at *p* on the site of the "Bearres Mosque."

The opposite bank of the river is powerfully commanded by guns on the faces *Q*, *Q*, and if necessary at *P*, *P*. A battery *R* will enfilade the military road, and, as well as the flank gun at *B*, will see the ground on both sides of the Iron Bridge, whilst guns in position at *S* are on the prolongation of the line of the Stone Bridge. The general section of the parapet is shown in the Plate. The rampart on which it stands varies in construction according to circumstances.

The principles adopted are that all scarps must be 20 feet high, as a minimum; where this is unbroken there will be no ditch, otherwise rampart and ditch together will be 24 feet in height at least. A covered way, 30 feet wide, will run round the outside of the works, at the foot of the scarp where there is no ditch, or along the counterscarp. Beyond this covered way there will be a glacis varying according to circumstances, but always as high as practicable and provided with a banquette for musketry. The section is shown on the plan.

There will be no thoroughfares through the post, the traffic being conducted round it by new roads. Three gates will be furnished for the convenience of the garrison, the Roomi Gate, the present gate-way (or one made on the south or city side at some point not yet determined), and a barrier gate at the bridge-head *a*, which will prevent access to the neighbourhood of the work from across the river.

From *A* by *B* to *C*, the rampart will be built up behind the present escarp wall, which will be repaired where necessary and strengthened by buttresses, the interior slope and embrasures being revetted with timber. From *C* to *C'* a new rampart and parapet must be raised, the buildings being destroyed in this part. From *C'* to *D* and *E* the parapet should be formed on the roofs of existing buildings, supported from below as may be necessary. From *E* to *F* an existing wall, with a row of shops behind it, requires only to be loop-holed to furnish a rampart and parapet complete. The bastion *F* has to be raised entirely and supported by a masonry revetment, save at the flank *F G*, which already exists. The bastion will enclose a guard-room. The line *G G'* has a ready-made rampart and parapet, the high walls require only a banquette behind communicating with the Mobarik Mahal and Emambarah, the wall of which presents a scarp 21 feet high to the verandah level. The details of the south-western bastion *H H* cannot be arranged until its site shall be completely levelled, but it must be certainly thrown forward, on account of the lowness of the ground immediately adjoining the Emambarah.

It must be built behind a new revetment, as at the South-eastern Bastion, and a caponnière communication can be advantageously made to it from the front of the Emambarah.

A passage from the inside for guns, on the verandah level, can be made at *K*, whence to the bastion the verandah must be increased to 8 feet in width, for the passage of guns, with the loop-holed parapet wall on the outer edge; this work will probably be best built on masonry arches. If it is found that guns are required on the flank *K L*, the space must be increased as shown on plan, otherwise musketry fire can be fully given from the end of the mosque as it stands. The mosque near the wall *L M* has a noble scarp 30 feet high to the verandah. From *N* to *O* a parapet must be made upon the present buildings, of which the portion outside the parapet must be removed to allow of the counterguard in front of the Roumi Gate being freely flanked from the end of the mosque *M N*.

The counterguard is shown on the plan and also in section.

From *O* to *P'* a row of shops, behind a high wall, affords a ready-made rampart and parapet, which has to be loop-holed for so much of the length as will flank the face *P P²*. The windows of the gate-tower must be built up and loop-holed: a screenwall, loop-holed, will suffice from *P* to *P²*, and a flank for the face *P² P³* must be contrived at the salient.

The space between the salients *P* and *Q* and the river's edge will be stockaded. The parapet at *P²* must be of such dimensions as to act as a traverse to the face. From the battery *p* to *P²* a second line of parapet will be constructed on the higher level of the ground there met with, and continued on the edge of the high scarp from *P²* to *Q*. Between *Q* and *R* the parapet will rest on houses filled in: a revetment must be built for part of the rampart from *R* to *U*. At *V, W, A*, there will be a parapet for musketry only. The road will be widened to 60 feet, and the line *x x* will represent the crest of the glacis, a place of arms being formed where the debris of buildings now lie. The buildings *Y* will be prepared as an outwork to flank the river front *P³ P⁴*, and will be approached under cover from the sally posts *Q³ Q⁴*, which are necessary for the convenience of the garrison in procuring water. The Table shows the proposed armament of batteries, being 20 heavy guns, 12 light guns, and 15 mortars.

ARMAMENT OF BATTERIES IN THE MUCHEE BOWUN POST.

No.	Position.	24 Prs.	8-in. Howrs.	Field Guns.	Large Mortars.	Small Mortars.	Total.
1	Muchee Bowun	1	1	....	....	....	2
2	Park	....	....	2	....	....	2
3	South-east Bastion . . .	2	1	2	....	....	5
4	Mobarick Mahal	....	....	....	6	....	6
5	Ditto ditto	2	....	....	....	....	2
6	Emambarah Roof . . .	....	....	....	....	6	6
7	South-west Bastion . . .	3	1	2	....	....	6
8	Mosque Battery	....	....	....	....	....	....
9	Ditto ditto	....	....	2	....	....	2
10	Roomi Gate	....	2	....	....	....	2
11	Bearres Mosque	1	1	....	3	....	5
12	River Bastion	2	2	....	....	....	4
13	Strand Battery	....	....	2	....	....	2
14	Bridge Battery	....	....	2	....	....	2
20	Muchee Bowun	1	....	....	....	....	1
	Total.	12	8	12	9	6	47

A guard-room must be built for the Artillery on duty at the South-west Bastion. In other cases existing buildings can be or have been prepared for this use, and magazines can be contrived in existing buildings.

The garrison now contemplated for the post, viz., one Regiment of European Infantry, and one Company of Artillery, Commissariat stores, and provisions for one month, can hereafter be permanently accommodated thus:—

Regiment of European Infantry in the Emambarah.

Officers' quarters for ditto	To be constructed on the sides of outer square.
Company of Artillery and officers	Mobarick Mahal.
Commissariat	Sheds and stores to be converted in space *B B*.
Ordnance	Ditto, ditto, in space *A A*, now used as prize agents' yard.
Hospital	Ashrufoodowlah's Mosque.

This leaves the Muchee Bowun empty, and the Lutchmun Teela available for the departmental offices and staff quarters. If it be desired, barracks for another Regiment of European Infantry might hereafter be constructed on the ground occupied by the Mobarick Mahal and the open space *C C* in its rear. The Commissariat and Ordnance would remain as before, and quarters for Artillery would be built on the Lutchmun Teela.

These proposals are for future consideration and must not interfere with present temporary arrangements detailed elsewhere.

There will always be difficulty and great expense in building heavy structures in the Muchee Bowun on account of the depth to which fragments of masonry are buried in ruins. The Lutchmun Teela, on the other hand, is a natural elevation.

The space within the boundary wall of the quadrangle, between the Lutchmun Teela and the Emambarah, should be cleared, and a row of shops constructed as the bazaar of the post. It is within a definite enclosure and under absolute military control. The drainage of the post will also require great attention.

Iron Bridge Post.

This work occupies a high spur of land between two ravines on either side. The front follows a natural line of scarp which abruptly terminates the spur in that direction; advantage is taken of a considerable number of houses which adjoin the scarp, openings in the outer walls of which houses will be built up: passages open through them parallel to line of defence, and the houses are connected generally by earthen ramparts and parapets of the section shown in Plan B. A scarp of 20 feet will be maintained, and all walls bearing on the defence will be loop-holed.

All houses adjacent to, but outside, the defences will be destroyed excepting *B*, *C*.

A battery of four guns, to command the bridge, will be formed at *A*. Four guns at *B* sweep the left nullah, whose eastern bank will be uniformly sloped down from the high site of the Residency. Other four guns at *C* will look up the right nullah, and a battery of four pieces at *D* will command the front. Six mortars may be advantageously placed at *E*. The rear of the work will be closed by the range of houses *C G*, made continuous save in the immediate front of the Bridge Battery.

All openings towards the road will be closed, and the houses loop-holed each way. A loop-holed wall, of such height as the line of fire will allow, will form the boundary in front of the Bridge Battery. Tambours will be thrown out from the upper stories of the buildings which rest on the road, at either flank, to defend the rear of the work.

The only communications with the batteries *B* and *C* will be from the interior of the work. They will be enclosed on all sides, and must be guarded in front by ditches drained to the river.

The permanent road from the Iron Bridge to the city will be on the Residency side of the left or east nullah. When this road is open a stockade will close the present road at *F*. There will be no openings in the line of communication along the Strand-road near the battery at *C*. Barrier-gates will be placed at *G*, *H*, and *K*, and a guard-house is left adjoining the latter.

The proposed armament of the batteries is given below:—

Battery.	24prs.	8-inch Howitzers.	Field Guns.	Mortars.	Total.
1. Bridge Battery . . .	1	1	1	...	3
2. East Flank Battery. .	1	1	...	...	2
3. West Flank Battery .	1	1	...	...	2
4. Front Battery.	1	1	...	...	2
5. Mortar Battery . . .	...	...	...	6	6
6.	...	1	...	...	1
Total	4	5	1	6	16

There are no buildings in this work sufficiently good to afford permanent quarters for European troops, and I would recommend the construction of two parallel lines of barracks, the exterior sides of which would form part of the parapet on the long east or west sides. The old mosque, forming the present magazine, may be strengthened and permanently occupied. A good building on

the road has sufficient accommodation for Commissariat requirements. The interior space can eventually be levelled for upper and lower parades. The proper garrison for the post may be two Companies of Infantry and half a Company of Artillery.

Communications.

Such of the houses on the southern margin of the Strand-road between the Stone and Iron Bridges as offer substantial cover for picquets, at from 300 to 400 yards apart, will be retained for this object. The intervening houses will be demolished, the outside wall excepted, which will remain standing. This will be loop-holed and furnished with a banquette, all openings being bricked up on the city side. The higher this wall and banquette can be maintained, the better, but the height must in all cases be made up to 10 feet, at least on the city side. It will be seen from the plan that the spaces along the road unoccupied by houses are very small: a mud wall not less than 10 feet high, and coped with brick plastered, will be constructed in these spaces. Flanking fire must be given along the city face of the walls from the picquet houses, to which projecting balconies may be added where necessary.

By this means the communication will be secured by the river on one side, and covered from observation by the parapet wall, on the other side. The barriers at *a* in Plan *A*, at *H*, *K*, in Plan *B*, and *b* in Plan *C*, will then bar the means of access to a definite position along the river bank from the Roumi Gate to the Iron Bridge, which will command both bridges, overawe the town, and be covered on that side by a curtain flanked by the artillery of the two posts, and bounded by an esplanade 100 yds. in width, free from annoyance of commanding houses. This secures a certain hold on the town until the posts further east may be constructed.

The communication is liable to be interrupted by an enemy's fire from across the river. The removal of all cover on that side for a mile from the river bank becomes therefore of importance. All buildings on the north or river side of the road will be destroyed, the debris being shaped into a glacis.

Report on the Progress of Works up to the 20th April, 1858.

Stone Bridge Post.

When the design was first conceived of establishing this post, it was surrounded on the north, west, and south sides by buildings, which approached very closely to, and frequently rested on, the outline adopted, so as greatly to obstruct the discovery of the features of the ground. On the south side these buildings were of the best class. The Lutchmun Teela, on which the river horn-work is constructed, was densely crowded with inferior houses accessible only by narrow tortuous paths.

The roofs and upper stories of the houses have been laboriously removed from the buildings on the south and west sides for a space generally of 200 yards from the outside of the adopted line of works; on the north side a mass of mud buildings has been cleared away, and also a group of mosques and houses at the corner of the road at the Stone Bridge, which commanded the road. A great deal remains to be done in shaping these masses of ruin, but no part of the post is at present commanded by buildings within musketry range.

The interior of the Lutchmun Teela has been cleared, two-thirds of the revetments of its parapets are in place, and the eastern river-bastion is ready, on emergency, for guns, which have been brought to it by a newly formed road. The parapet on the roof of the Emambara is provided with sand-bags on the city front: the rest of the parapet wall on that side is loop-holed for musketry, and communications have been opened throughout the work. Before beginning the Bridge Battery, which must be built across the present road to the city, it was necessary to open a parallel road, running in great part through houses. This, which has been very heavy work, is all but completed, and the Bridge Battery will be commenced in a day or two. A road has been opened into the Muchee Bowun itself, to the level of the second story of the palace. This work, which is one of great labour, is nearly completed, and guns may be mounted in a day or two. Ten large mortars are in position in the Mobarick Mahal, four field guns and six small mortars are mounted on the roof of the Emambara, and two guns on that of the mosque adjoining. A road, in prolongation of the Chowk Road, and passing outside the works, has just been put in progress; on its completion, probably by the 1st of May, the post may be completely enclosed. It is now open at three points only, viz., by the road leading to the Chowk, where a picquet is stationed; by the road from the bridge, which runs through a narrow pass and is overlooked by sentries on the river bastions; and by the Strand Road, held by our own picquets.

Quarters have been prepared, and are occupied by Her Majesty's 53rd Regiment, in the Emambara, by artillery in various guard-houses, and by pioneers and Engineer Staff in the Mobarick Mahal. Two other houses on the river Homesorth, and two quarters in the Emambara Square, will soon be available for other artillery.

The Commissariat stores are housed, and the chief Engineer's quarters are established in the same work. The whole garrison is thus provided for, the whole of the officers, overseers, sappers, and labourers, employed in the construction of the post, together with the establishment, are quartered in the works, and it is most desirable that this arrangement should be maintained for some time to come. The work at this post has been carried out with considerable vigour by Lieutenants Carnegie and Smythe, Bengal Engineers.

Iron Bridge Post.

At the Iron Bridge, the whole of the buildings which do not enter into the design of the work have been removed from the inside, the demolition of houses for 200 yards to the front is well advanced, the rampart is in a great part completed, about one-fourth of the parapet in course of construction is completed; a gun road has been made into the work, the road underneath it diverted through houses and a portion of the Bridge Battery, for two guns, nearly prepared for their reception. This work will probably be enclosed by the 1st of May.

Arrangements have been made for preparing quarters in the houses existing within the post.

Lieutenants Maunsell, Bengal Engineers, and Tulloh, Bengal Native Infantry, have been employed on these works.

The ground on the city side of the Kaisar Bagh has been cleared of the houses which covered it, under direction of Lieutenant Beaumont and other officers of Royal Engineers. The clearance extends in length nearly up to the front of the Zahoor Bux Palace.

A passage has been cut through the city by Lieutenant Pritchard, Royal Engineers, as one of the new main lines of communication from the Stone Bridge to the Tal ka Tora Bridge on the canal.

It is 20 days since the first survey and examination of the ground on which the works are being constructed was commenced.

W. H. GREATHED,

Lieutenant Bengal Engineers.

REPORT ON THE LINE PROPOSED TO BE OCCUPIED IN ORDER TO RENDER THE RANGE OF STRONG BUILDINGS ALONG THE RIGHT BANK OF THE GOOMTEE SECURE AND TENABLE BY THE SMALLEST NUMBER OF TROOPS;

BY LIEUT. COLONEL LENNOX, ROYAL ENGINEERS.

Kaisar Bagh, Lucknow, 6th April, 1858

Banks's house* has been fixed upon as the left of the position which fronts the south. The enemy had connected Banks's house with the adjoining houses of Tidder Hoscin and a small mosque by earthen works, which are in a fair state of repair. I would propose to hold Banks's house and these adjoining ones as a detached post; mud parapets will be necessary on the small towers at the angles of Banks's compound, and round the western side of the raised platform of the mosque. A few sheds to the west and south-west of Tidder Hoscin's house must be removed.

The fire from Banks's post and from the Begum's Palace will command all the ground between them, within such short range as to render any intermediate line of defence unnecessary.

Commencing from the Begum's Palace, I would propose that the front line of defence should be the south-west wall of the garden, as far as the gateway into the lane. The enemy threw up a work to cover this gate, and I would continue this work up to the wall of Sultan Nais's garden; this would afford flank fire to the left. As the walls of Jaffir Ali's and Jarar-oo-Dowlah's gardens are not good, I would therefore, and to cover more effectually the magazines, take the northern wall of Sultan Nais's garden, until it reaches the lane. From thence, the line of defence should, I consider, turn to the north-west, join the north wall of the Lal Bagh, and continue along this wall to Buktawa Sing's house, which I would retain. A little alteration of the enemy's bastion would be necessary to connect Buktawa Sing's and Azeem-

* See Plan C.

oo-shan's houses, the outer walls of which would here form the boundary. There is a lane between Azeems-oo-Shan's house and the Chowlakka, across which a wall would be necessary. The southern wall of the Chowlakka would form the line of defence here. The Chowlakka joins on to the Kaisar Bagh, the outer wall of which is very good, and would complete the line of defence up to the Chutter Munzil Palace; but the consideration of the line to be taken up to the west of the Kaisar Bagh will necessarily depend upon the nature of the defences about to be constructed near the Muchee Bowun, which, I have heard, will extend nearly to the Residency. A good flanking fire along the south wall of the Kaisar Bagh can be obtained from an archway which has been left standing, and also from two fronts of a house *A*, close to the Kaisar Bagh, and in prolongation of a line from the Grand Mosque, through the lane between the two houses, with gunpowder and grain in their vaults, in the Grand Square of the Kaisar Bagh.

This report has been drawn up hurriedly, and for that reason I have been unable to append a sketch to scale.

(Signed) W. O. LENNOX,
Captain, Royal Engineers.

P.S.—The north wall of Sultan Nais's garden is not high in some places, and would require a ditch in front of those parts.

It would be advisable to construct stockades with barrier gates across the lanes east and south of the Emambara.

The communications in rear of the line of defence taken up will require to be improved considerably.

(Signed) W. O. L.

REPORT ON THE DEFENCE OF THE NORTH-WESTERN PORTION OF THE CITY OF LUCKNOW.

BY LIEUT. COLONEL NICHOLSON, ROYAL ENGINEERS.

Lucknow, April 6th, 1858.

SIR,—It being necessary to keep some communication open between the Emam Barra and the outskirts of the city, the Jumnia Musjid appears to me to be the position best adapted for this purpose.

The Jumnia Musjid is a mosque situated on high ground, with a scarp wall of about 20 feet in height on three sides; it commands this part of the city, and, one or two buildings in its neighbourhood being cleared away, people in it could not be annoyed by musketry-fire from roofs, &c.

It is beyond the Hoosainebad, and to its left front, and should the communication mentioned above be made from the Hoosainebad, in a direct line towards Moosa Bagh, through the city, it would pass to the right of the Jumnia Musjid and be entirely protected by it.

The Hoosainebad and Jumnia Bagh form an enclosure in the shape of a double square, or rather one square within another, the side of the outer one being about 200 yards long: in the garden thus enclosed is a mosque and two smaller buildings, which, with the entrances, would contain about 400 men with a proportion of officers. Between the Hoosainebad and the Roumch Durwasah (about 300 yards) the ground to the left of the road is covered by buildings, but the communication between the two places may be established by taking a line parallel to the road, and about 50 yards from it, which is already partially defined by a high wall. Thus, making use of this wall as a curtain, and continuing it in one direction towards the Emam Barra, and in the other towards the Hoosainebad, it would be flanked by these two works at its extremities.

From the Hoosainebad to the Jumnia Musjid the road must also be protected by works, and on the ground occupied by the Musjid itself one or two guns must be mounted, a breastwork thrown up around it, and the post made otherwise secure.

From the Emam Barra to the Moosa Bagh the road at present is circuitous: it leads through confined streets, and in one spot is subject to inundations, therefore some other course must be adopted.

The town ends about 300 yards beyond the Jumnia Musjid, and between the outskirts of the town and Moosa Bagh, the road leads over a flat plain with high ground rising immediately to the left; the road there is subject to the inundations of the river and drainage from the high ground, therefore, to make it passable at all times of the year, it must be secured from the inundations on one side and from drainage on the other.

A better course, however, would be to lead the road a little higher up the hill, and cut straight through the town from the Hoosaine Bagh in the direction of the Moosa Bagh: a cut thus made would be entirely protected by the Jumnia Musjid position.

It is possible, however, that the bank quite close to the river may be a little higher than the plain, in which case the best direction for the road would be along the present course as far as Nuki Ali Khan's house, which is situated near the outskirts of the city and quite close to the bank of the river; from thence, by means of a bridge, it should cross a small nullah which runs into the Goomtee about 150 yards from the house, and following the bank of the river until it may be considered safe from inundation, it should lead by the shortest line across the plain to the Moosa Bagh Post.

This latter route would of course be longer than the road cut straight through the town from the Hoosaine Bagh, but it would have the advantage of being flanked on one side by the river.

To secure this flank of the line of entrenchments beyond the Muchee Bowun and Emam Barra, the following works would seem to be necessary: clearance of the ground to a distance of 200 yards outside the curtain joining the Emam Barra with the Hoosainebad, also around the Hoosainebad and Jumnia Musjid, and round Nuki Ali Khan's house to the same extent; and likewise cutting a

road from the Hoosainebad in a direction straight to Moosa Bagh through the city, the width of which should be at least 100 feet.

The outside gates of the Hoosaine Bagh require to be protected against sudden assault, the walls loop-holed, and emplacements for guns constructed.

Breastworks and parapets require to be constructed along the wall already in existence round the Jumnia Musjid, and all the large mosques and houses must be blown up and destroyed beyond this wall.

The defences of the Jumnia Musjid must be so carried out as to be flanked as much as possible by the distant works of the Emam Barra and the nearer ones of the Hoosaine Bagh; and they must be so arranged as to afford no cover to the enemy should they ever succeed in getting within the outer line.

The road from the outskirts of the city to the Moosa Bagh must run along the side of the hill at a higher level than that at present in existence, and, to prevent any enemy from taking a force in flank whilst marching along it, the plateau should be cleared of trees and enclosures.

Sections must be made of the plain and bank of the river, to ascertain the possibility of constructing along its edge a road which would be safe from inundation.

These works being executed, I think the objects in view would be fully gained, but, in addition, I would certainly propose to clear an opening at least 100 feet wide from the Jumnia Musjid to Nuki Ali Khan's house: thus the clearings at present in course of execution would be continued unbroken from the Muchee Bowun to the river Goomtee.

I have the honour to be, &c.,

L. NICHOLSON, Major,

Royal Engineers.

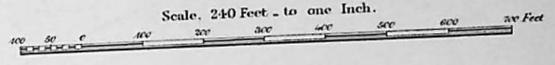
To Colonel Napier, Bengal Engineers,

Commanding Engineer Brigade,

Plan A

PLAN
OF
STONE BRIDGE FORT,
AT
LUCKNOW.

Scale, 240 Feet - to one Inch.



The Numbers indicate the several Batteries referred to in the Report.

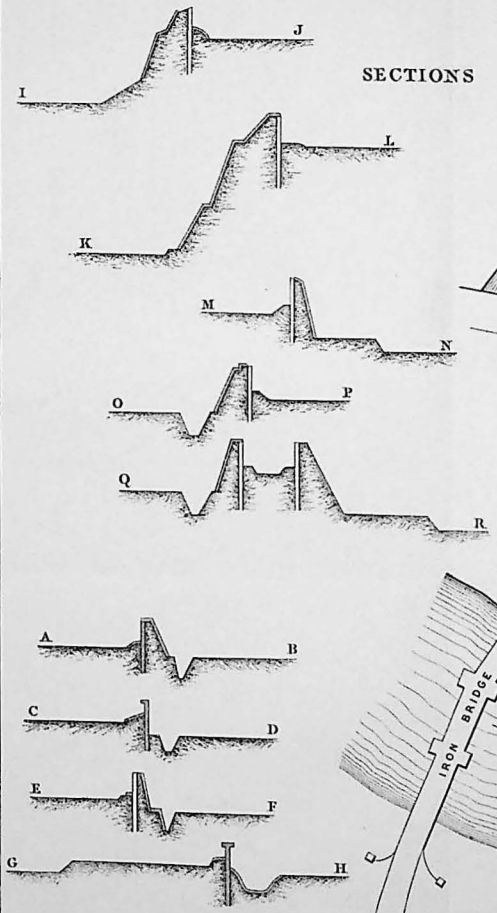
SIGNED W. A. CROMMELIN, MAJOR,
Chief Engineer of Oudh
Chief Engineer of Oudh.

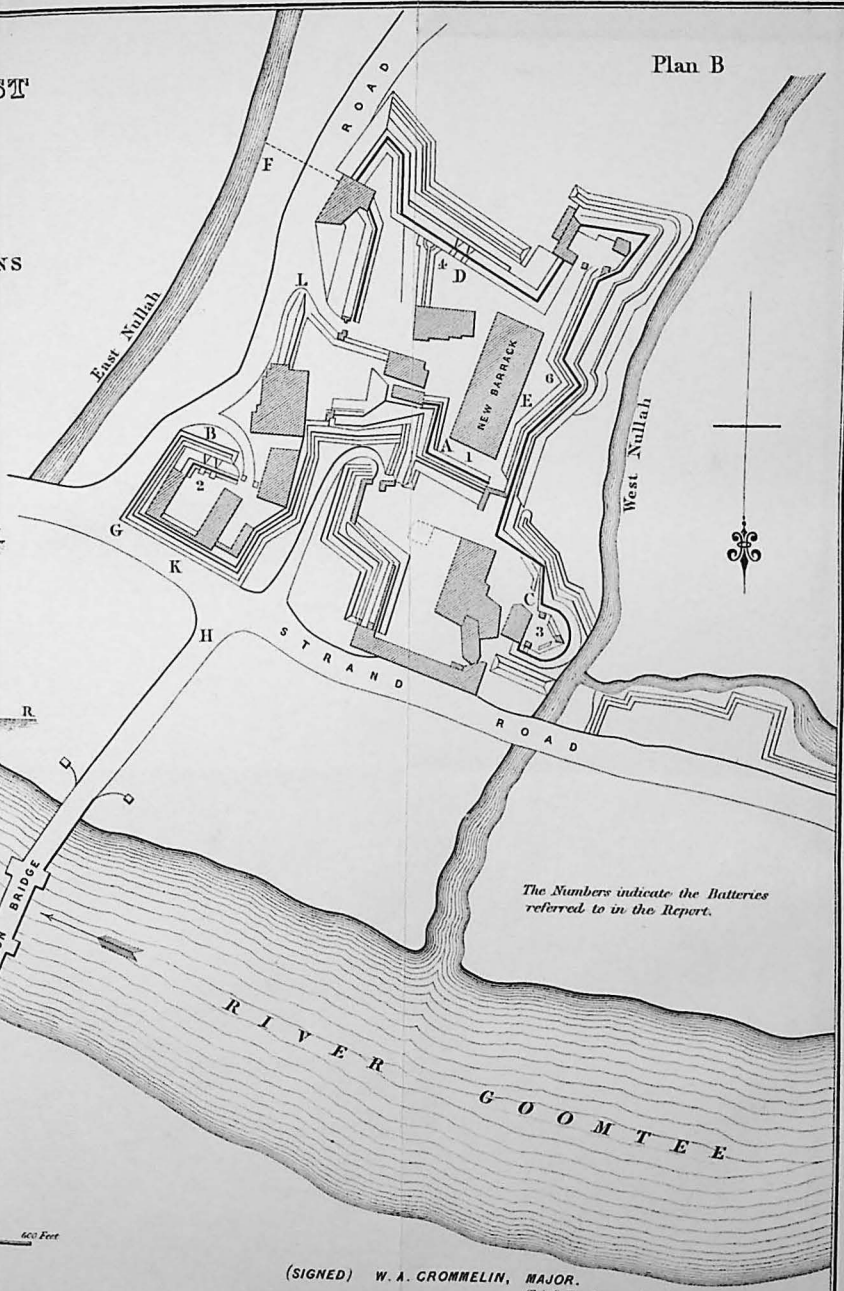
C. Moody Lithe 257 High Holborn
C. Moody Lithe 257 High Holborn

Plan of the IRON BRIDGE POST AT LUCKNOW.

Plan B

SECTIONS





The Numbers indicate the Batteries referred to in the Report.

Scale for Sections.

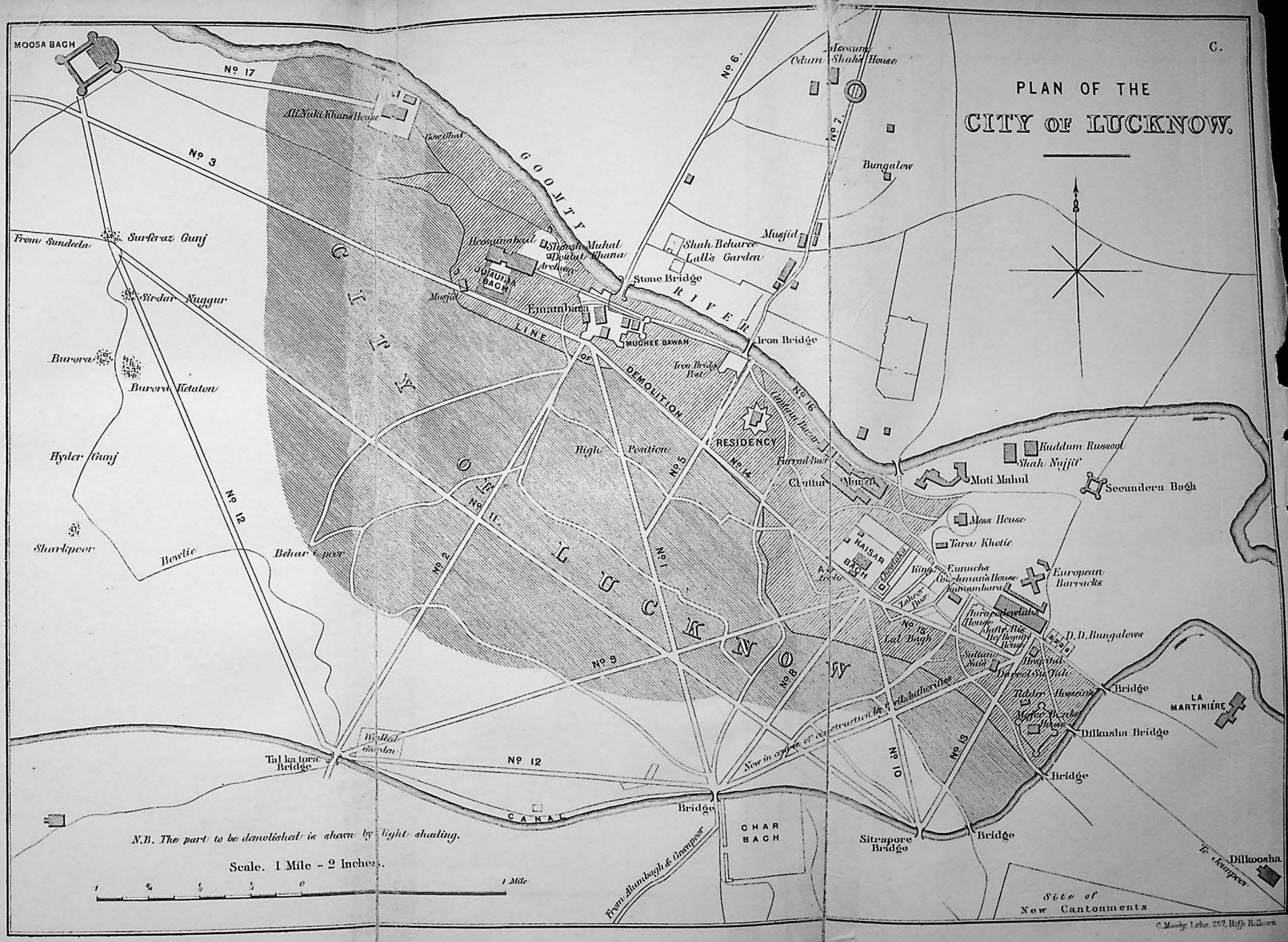
Scale for Plan.

C. Moody, Lithr. 257, High Holborn.

(SIGNED) W. A. GROMMELIN, MAJOR.
Chief Engineer, Oudh.

C.

PLAN OF THE CITY OF LUCKNOW.



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PAPER VI.

REPORT ON THE DEMOLITION OF A PORTION OF THE OLD BRIDGE AT ROCHESTER, BY THE ROYAL AND EAST INDIAN ENGINEERS, CONTINUED FROM JUNE, 1858, TILL ITS COMPLETION IN NOVEMBER, 1858, CONDUCTED BY CAPTAINS W. H. NOBLE AND A. W. DURNFORD, ROYAL ENGINEERS, AND BY LIEUTENANT L. CONWAY GORDON, INDIAN ENGINEERS, UNDER COLONEL SANDHAM'S DIRECTION.

The mining experiments for the demolition of Rochester Old Bridge, detailed in Volumes VII and VIII of the Royal Engineer Professional Papers, were continued from June till November, 1858, when they were completed, by Capts. W. H. Noble and A. W. Durnford, Royal Engineers, and by Lieut. Lewis Conway Gordon, Indian Engineers, under Colonel Sandham's direction.

The three central arches, Nos. 5, 6, and 7, and their piers IV, V, VI, and VII, (see Plan in Vol. VIII, Royal Engineer Professional Papers) were alone left standing, and the centreing and tramway on staging, for the removal of the central arch (No. 6) by manual labour, referred to in the description of the operations of 1857, in Vol. VII of the Professional Papers, being completed, mining operations were recommenced on the 14th of June, 1858, for the demolition of Nos. 5 and 7 Arches, and their piers, IV, V, VI, and VII, collateral to the central arch, in the following order.

Four 3-inch jumper holes were bored in the lower added portions* of Nos. 5 and 7 Arches, one in each voussoir, next the key-stone, having lines of least resistance of 9 in. to the soffits of the arches, which were each loaded with 1 lb. of powder, and one in each haunch, 1 ft. 6 in. in front of the faces of the piers, having l.l.r.s of 1 ft. 6 in. to the soffits of the arches, each charged with 1 lb. 12 oz. of powder.

Under the soffit of the upper added portion of No. 7 Arch a charge of 35 lbs. was suspended, beneath the central stone of the key-course, which consisted of three stones, upon a strong stage slung by chains, carrying a layer of filled sand-bags, on which the charge was placed touching the soffit of the arch, round which other filled sand-bags were built. A hole was also sunk into the voussoir on either side of the key-course, and another into one of the voussoirs of the right haunch, and these were loaded with 1 lb. and 3½ lbs. of powder respectively. These operations were commenced on the 7th of June, by removing the rubbish and loose masonry; and the holes were completed and loaded by the 17th, on which day the following explosions were made:

* This refers to the portions added to the original bridge, so as to increase the width of the roadway 6 feet at each side.—ED.

1st. The charges in the lower added portion of No. 7 Arch were fired simultaneously by the Voltaic Battery. The charges in the haunches, not having been lodged sufficiently deep in the voussoirs, acted on the spandrils of the arch; and, although the charge in the key-stone broke it up, it was not entirely displaced: a small fragment remained, which keyed the voussoirs, and the arch did not fall.

2nd. The charge of 35 lbs. suspended under the key-course of the upper added portion of No. 7 Arch was fired, and the central stone only of the course was blown out. It was not expected that 35 lbs., applied as above described, would destroy the arch, but it was thought that a larger charge would have been dangerous to the surrounding houses; charges had therefore been prepared, one in a 3-in. hole 5 feet deep in the right haunch, having an l.l.r. of 16 ft. 5 in. to the soffit, and loaded with 3½ lbs., and one in each of the central stones of the courses collateral to the key-course, each having an l.l.r. of 9 in. to the soffit, and each being charged with 1 lb. of powder. The priming wires of the two last mentioned charges were so much disturbed by the explosion of the suspended charge of 35 lbs. that they could not be fired, and the charge in the right haunch was fired by itself; the voussoirs were heaved up by the explosion about a foot, but they settled down again, somewhat irregularly, into their places. On the 18th June two charges of 2 lbs. each were lodged in openings between the 6th and 7th and the 7th and 8th voussoirs from the right-hand skewback; these charges were fired by Bickford's fuze, and brought the arch down completely. On the 19th June two charges of ¾ of a lb. were lodged in a similar manner in the lower added portion of No. 7 Arch, and exploded, producing an equally good effect.

3rd. In the main Arch No. 7, two rows of 3-in. holes had been sunk in the left haunch, four in one and three in the other, checkered, having l.l.r.s of 1 ft. 6 in. to the soffit of the arch, each loaded with 4 lbs. of powder; and two rows of six and five holes each, checkered, had been sunk in the courses collateral to the key-course, having l.l.r.s of 9 in. to the soffit, and each loaded with 1 lb. of powder; these were all intended to have been fired simultaneously by the Voltaic Battery; three charges however in the haunch and two in the crown failed; a great part of the arch was thrown down, and when the wires connected with the three unexploded charges in the haunch were re-adjusted and fired, the remainder of the arch attached to No VII Pier was brought down by them. There was still a large mass of the arch in a very disjointed state, hanging on to No. VI Pier, which fell by its own weight, unfortunately at low water, carrying away part of the stage formed to receive it, there being no body of water above the stage to break its fall. Large masses thus found their way into the bed of the river, and these were afterwards very ingeniously removed by passing chains under them in contrary directions, and then attaching the ends of these chains to the bow of a barge at low water: as the tide flowed, the chains became taut, and thus getting a firm grasp, the masses were lifted as the barge rose with the tide, and were carried off and deposited above low water mark.

4th. One 3-in. hole in each haunch of the lower added portion of No. 5 Arch, having l.l.r.s of 1 ft. 6 in. to the soffit, with charges of 1 lb. 12 oz., and one in the voussoir on each side of the key-stone, having l.l.r.s of 9 in. and charges of 1 lb. of powder in each, being fired simultaneously, produced perfect demolition.

5th. In the upper added portion of No. 5 Arch, three 3-in. holes were sunk in the left haunch, in one line, having l.l.r.s of 1 ft. 6 in. to the soffit, and charged with 1 lb. 12 oz. in each, and one hole was sunk in the centre of the key-stone, (l.l.r. 9 in. and charge 1 lb.). These were all fired simultaneously by the Voltaic Battery; the voussoirs were completely disjointed, and those at the haunch were much broken, yet the arch did not fall; many fragments of the broken voussoirs were forced out by crowbars, when the arch slewed out of the direct line very considerably, and it was afterwards easily thrown down by crowbars.

6th. In the original Arch No. 5, seven 3-in. holes were sunk into the left haunch, four in one row and three in another checkered, the l.l.r.s being 1 ft. 3 in. to the soffit, and each hole being loaded with 4 lbs. Two rows of 3-in. holes were also sunk in the collateral courses to the key-course, six in one row and five in the other, checkered; the l.l.r.s to the soffit were 9 in. and the charges 1 lb.: these were fired simultaneously by the Voltaic Battery, producing perfect demolition.

This completed the demolition of the arches, and the Piers IV, V, VI, VII, only remained to be destroyed. In the centres of the Piers IV and VII shafts 4 ft. square had been sunk for practice during the summer of 1857, nearly to the level of the starlings, but as staging existed only between Piers IV and V and Piers VI and VII, it was necessary, in preparing for the demolition of the piers, so to dispose the charges that any stones that might be thrown from the piers should fall in the direction of the stages; the object also was to shake only portions of the piers at a time, in order that the masonry might be removed into barges by hand; the shaft, therefore, in Pier IV was filled in to the level of the top of the cutwater, leaving a depth of 9 ft. 6 in. to the top of the shaft: at that level galleries were driven in the direction of the length of the pier, from the shaft, 7 ft. 6 in. long, at the end of which, as well as at the bottom of the shaft, charges of 13½ lbs. were lodged (being $\frac{1}{3}$ l.l.r. ^{2}, each charge having an l.l.r. of 7 ft. 6 in.) and the galleries and shaft were tamped up to the surface.

3-in. jumper holes were sunk in the centres of Piers V and VI; that in No. V was 9 ft. 6 in. deep, and the l.l.r. being towards the upper surface it was loaded with 10 lbs. of powder; and the other, in Pier VI, was 11 ft. deep, having three equal l.l.r.s, (one to the upper surface and one to each of the two faces of the pier), and was loaded with 16 lbs. of powder.

One side of the shaft in Pier VII had been cut away by hand, leaving the remainder of the pier almost in two distinct portions, near the centres of which two 3-in. holes were sunk from the upper surface, and loaded with very moderate charges; this pier was next to the only channel left open for the navigation of the river, which rendered it necessary that it should be removed by small blasts, to avoid the possibility of interruption to the navigation.

There was a small portion of the haunch of No. 5 Arch still attached to Pier V, in which three 3-in. holes were sunk 3 ft. deep, and they were loaded with 1 lb. of powder in each; these were fired on the 30th of June, 1858: two only exploded and little effect was produced; the charge in the centre of Pier V was then exploded; it shook and cracked the whole mass, and disjointed the cut stone masonry of the cutwaters without projecting a stone from its original bed.

The charge in the centre of Pier VI was fired on the 2nd July, and threw down the face towards Strood upon the stage below, producing but little effect in the direction of the central arch; after this explosion two 3-in. holes were

sunk in the masses that were left standing on each side of the centre of Pier VI, and one hole was bored in a sloping direction into the face left after the explosion of the central charge. In each of these a charge of $\frac{1}{32}$ l.l.r.^{3} was lodged, and fired by the Voltaic Battery. The effect produced was what was required, and the cut stone of the cutwaters and the rubble masonry was all removed by hand.

The charges in Pier No. IV had been prepared with hose and wires also, and they were fired simultaneously by the Voltaic Battery, but the effect was not so great as was expected. The rubble that was thrown down fell on the stage between Piers IV and V.

The loosened rubble masonry and the Bramley-Fall cut stone having been removed from Pier V so as to form a level surface, on the 7th July, four 3-in. holes were sunk in it, to a depth to give l.l.r.s of 7 ft. 6 in. to the faces of the pier and cutwaters: those were loaded with 13 lbs. $2\frac{1}{2}$ ozs. in each hole, and fired by hose on the 15th July: the masonry was completely disjointed and appeared to be a mass of rubbish.

Up to the 27th July the men were practised in blasting, using small holes and charges to break up the larger masses of masonry that had been disturbed by previous explosions, and also to loosen the masonry sufficiently for the contractor's men to load the barges without difficulty. At the above date a level surface having been again formed on Pier V, four 3-in. holes were sunk on the same plan as those referred to above, two of them, 9 ft. 6 in. deep, having l.l.r.s of 8 ft. 6 in. to the face of the pier, and the other two, towards the centering of the central arch, having l.l.r.s to the upper surface; these were not so deep as the others, the contractor having expressed a wish that some courses of voussoirs at the springing of the central arch should be left quite undisturbed, to form an abutment to the centering which supported the travelling crane used to remove the larger stones, and the charges were therefore reduced to about $\frac{1}{4\frac{1}{2}}$ l.l.r.^{3}, or 15 lbs. for those with l.l.r.s of 8 ft. 6 in., and to 10 lbs. for the other holes. These were all fired by Bickford's fuze, the greater effect was upwards, owing to the great space which the powder occupied in the holes; some of the stones were projected into the air, but the general effect was good. These explosions may be considered the last of importance, though the practice in boring and blasting was continued until November, by which time all the piers were completely broken up.

The operations extended over several months of the years 1857 and 1858, 2,151 men of the Royal and Indian Engineers were practised in mining and blasting in masonry, and, to the credit of the officers, non-commissioned officers, and sappers employed, it should be recorded that only two men were confined for irregularity throughout the operations. 2,458 lbs. of powder were expended, for which the bridge-wardens paid the Government 6d. per lb.

The remarks on the operations described in Vol. VIII, p. 68, may be referred to for further instruction, and an abstract of the charges and their effects is annexed.

H. SANDHAM, Col., Royal Eng.,
Director Field Instruction,
Chatham.

Date.	No. of Arch or Pier.	Position of Charge.	Charges. Number.	Proportion to L.L.R.	lb. oz.	L.L.R. ft. in.	Means of Firing.	Tamping.	Effect of Firing.	Effect of Explosion.
1859. 17th June	No. 7 Arch, lower added portion.	1 in each voussoir next the key-stone	2	2½	1 0	0 9	Voltaic Battery.	Chalk and Rubble.	Exploded.	Voussoirs disjointed, but did not fall.
		1 in each haunch.	2	¾	1 12	1 6				
"	No. 7 Arch, upper added portion.	Suspended under key-stone . . .	1	—	35 0	—	Bickford's Fuze.	Surrounded by sand bags.	Exploded.	The central stone only of the key-course blown out.
"	Ditto.	In right haunch.	1	1¼	3 8	1 5	Voltaic Battery.	Chalk and Rubble.	Exploded.	Voussoirs much disturbed, but the arch still remained
"	Ditto.	1 in each voussoir next the key-stone	2	2½	1 0	0 9	——	——	Not fired.	——
18th June	Ditto.	Right haunch. .	2	—	2 0	—	Bickford's Fuze.	Lodged in crack.	Exploded.	Complete demolition.
19th June	No. 7 Arch, lower added portion.	Right haunch. .	2	—	0 12	—	Do.	Do.	Do.	Ditto.
"	No. 7 Arch, main part.	Left haunch. . .	7	1¾	4 0	1 6	Voltaic Battery.	Chalk and Rubble.	Do.	The part of the arch attached to No. VII Pier fell at the explosion, and that attached to No. VI Pier fell later.
		Crown, on each side of key-stone.	11	2½	1 0	0 9	Do.	Do.	Do.	
"	No. 5 Arch, lower added portion.	Right haunch. .	1	2½	1 0	0 9	Voltaic Battery.	Do.	Do.	Complete demolition.
		Left haunch. . .	1	2½	1 0	0 9				
		1 on either side of key-stone . . .	2	2½	1 0	0 9				
"	No. 5 Arch, upper added portion.	Left haunch . .	3	¾	1 12	1 6	Voltaic Battery.	Chalk and Rubble.	Exploded.	Voussoirs disturbed, and those in haunch much broken, but the arch did not fall.
		Centre of key-stone	1	2½	1 0	0 9				

Date.	No. of Arch or Pier.	Position of Charge.	Charges. Number.	Charges. Proportion to L.L.R.	Charges. lb. oz.	L.L.R. ft. in.	Means of Firing.	Tamping.	Effect of Firing.	Effect of Explosion.
1859. 19th June	No. 5 Arch, main part.	Left haunch . .	7	2	4 0	1 3	Voltaic Battery.	Chalk and Rubble.	Exploded.	Demolition perfect.
		Crown, on each side of key-stone.	11	2½	1 0	0 9				
30th June	Pier No. IV.	1 in each end and one in centre. .	3	1/32	13 4	7 6	Do.	Do.	Do.	Demolition incomplete.
,,	Pier No. V.	Centre of Pier. .	1	1/96	10 0	9 6	Do.	Do.	Do.	Shook the whole mass into pieces, and disjointed the cut stones, without projecting one stone from its original bed.
2nd July	Pier No. VI.	Centre of Pier. .	1	1/32	16 0	11 0	Do.	Do.	Do.	Threw down face of Pier towards Arch 7; but little effect towards Arch 6.
,,	Ditto.	Centres of two end masses . .	2	1/128	—	—	Do.	Do.	Do.	Loosened stone to allow of its being moved by hand.
		In central portion left by explosion on 2nd of July.	1	1/32	—	—	Do.	Do.	Do.	Ditto.
15th July	Pier No. V.	In part left by the explosion on 30th of June. . . .	4	1/32	13 2½	7 6	Hose.	Do.	Do.	Stones completely disjointed
27th July	Ditto.	In part left by the explosion on 15th of July. . . .	2	1/128	10 0	8 6	Bickford's Fuze.	Do.	Do.	Effect good, but principally upwards.
			2	1/21	15 0	8 6				

PAPER VII.

Report on an Experiment made 6th April, 1859, in Breaching a Merlon of Masonry constructed in 1854, at Europa Point, Gibraltar.

Communicated by LIEUT. COLONEL OWEN, C.B., R.E.

The merlon was in Woodford's flank, distant 190 yards from the gun. The line of fire was at an angle of 70 degrees to the merlon.

The gun was a 68-pr. of 95 cwt., mounted on a carriage* intended for an 8-inch gun, and was fired with a charge of 14 lbs. of powder.

The masonry consisted of squared limestone, with vertical joints and horizontal beds; the stones were 1 foot in depth and averaged 2 feet in length: this, however, was only on the faces, the interior being made up with rubble. The quoins of the embrasures were of sandstone. The mortar was very bad.

The merlon was 5 feet 3 inches thick, and had a banquette in rear, the surface of which, as well as that of the soles of the embrasures at the necks, was 4 feet below the crest; and the length of the merlon was 15 feet 2 inches between the necks of the embrasures, and 10 feet between their mouths.

The first shot struck below the centre of the merlon, about 7 feet below the crest of the parapet, or about 5½ feet below the outer edge of the superior slope; penetrated 27 inches, and made an opening 3 feet wide by 2 feet high. Stones were shaken in their beds in a portion7 feet wide and 6 feet high, and the whole merlon was slightly shaken. The shot was broken into several pieces.

Second shot.—Penetration 22 inches. The general dimensions of the breach were now 3 feet 3 inches high, and 3 feet 9 inches wide. Shaking of masonry over the same surface as before considerably greater, but merlon still standing. It struck the next course of stones, or one foot lower than the first, and carried away a portion of the second course of masonry, counting from the sole of the embrasure. It did not increase the depth of the breach, but widened it.

Third shot.—Penetration unknown. Struck about 1 foot 6 inches below the exterior crest of the parapet; completely loosened the whole merlon, and drove it in about 4 inches in the centre, and 1¼ inches at the sides, but it remained standing nearly vertical, though a ruin. It was in such a state that a fourth shot striking at the same level would have gone right through. The splinters were trifling.

It must be observed that the first two shots struck below the merlon. Had they struck the merlon fair the second would have caused as much if not more damage than the third actually did.

We infer from this that one 68-pdr. shot will nearly ruin a merlon 5 feet 3 inches in thickness, and that a second will so far ruin it as to require great determination on the part of the gunners to continue to fight their guns†.

We, however, think that the parapet would have presented more resistance had the mortar been of better quality; far from having obtained any peculiar hardness, as expected by Sir John Jones, it was very friable, and had the appearance of having been imperfectly mixed.

* The carriage was fitted to receive the larger gun by raising the cheeks. The axis of the trunnions was 3 feet 10 inches above the platform.

† It may be useful here to draw attention to the fact that in the experiments made by the American Engineers, described at Page 16, of Vol. VIII. of this series, a *longer* wall, 10 feet high, but only 5 feet thick, and without any banquette, stopped several 128-pr. solid shot at a range of 114 yards.—Ed.

PAPER VIII.

Notes on the Escape of Smoke from the Casemates at Cliff-End Fort, after Firing from them.

By MAJOR GALLWEY, R.E.

As one of the disadvantages of casemates is commonly believed to arise from the smoke preventing the gunners working the guns after one or two discharges, the following notes may be interesting.

The casemates at Cliff-end Fort, at the Isle of Wight, were lately manned to ascertain the rapidity and facility with which the guns therein could be served. The day was very calm, and therefore favourable for the experiments.

The three tiers of casemates, as also the guns on the terreplein or roof, were manned, and an independent fire was kept up until 20 rounds per gun had been expended.

No. 1 of each gun had been previously instructed not to fire unless he could take aim prior to each discharge.

The result, so far as the interior of the casemates was concerned, was very satisfactory, there being little or no smoke inside.

The firing was occasionally delayed in consequence of the smoke not clearing away from the front of the casemates, which was owing to the calmness of the weather.

The guns on the terreplein ("en barbette") were the most unfavourably situated in this respect, as the smoke, rising slowly, unveiled the lower tier first, and so on. The drifting of the smoke to leeward was very slow.

This fact demonstrates the necessity of commencing fire with the *leeward* guns, and although it would be difficult to preserve such an arrangement for any length of time, especially during rapid firing, it is a point which merits attention.

The casemates at Cliff-end Fort are what may be termed "close" in comparison with similar structures open at the rear. Their dimensions are 33 feet long, 18 feet wide, and 10 feet 6 inches high.

A wooden partition, or bulkhead, is built across each casemate, forming a passage along the rear leading to the front portions, which are used as barracks, but these partitions were taken down when the guns were fired so as to afford free communication and as great a current of air as possible.

In the rear wall, opposite to each casemate, is a window 6 ft. 6 in. by 3 ft. Over these windows, and also over the embrasures, are ventilators communicating with the exterior.

The president and members of the Defence Commission and several officers of the garrison of Portsmouth were present at these experiments.

T. L. GALLWEY,
Major, Royal Engineers.

PAPER IX.

Account of a Mode of Purifying Water Contaminated by Lead, Contained in a Letter to the Inspector General of Fortifications From PROFESSOR FARADAY, F.R.S., &c.

Note by the Inspector General of Fortifications.

Having observed in the "Times" a letter from Professor Faraday, explaining a very simple mode of treating water that was contaminated by receptacles of lead in the neighbourhood of the sea (a matter of great interest at many military posts), I requested him to favour me with a note on the subject, with the addition of any simple practical remedies, if such there were, for the presence of lead in water arising from other combinations; and the following answer from that eminent chemist cannot be too generally promulgated and attended to among those who have charge of establishments on the sea coast.

Royal Institution, 7th Oct., 1859.

My dear Sir John,

I consider your request relating to the leaded water an honour, and in replying may add an observation or two to the original matter. The case at first was simply that of certain waters, which, having been collected from rain by roofs, gutters, pipes, or cisterns of lead, were contaminated more or less with the metal. All water so obtained has not been found thus affected, and there is much difference and uncertainty about the mutual action of lead and water in different cases. When rain water falls upon surfaces of lead it is apt to act on them, and the water thus contaminated, by standing exposed to air, generally clears itself from the dissolved lead, the metal separating as a carbonated precipitate, and falling to the bottom. But when the sea-spray has access to the leaded surfaces, the action of the rain water is such that the dissolved lead does not separate in this way, or if it does, only after a much longer time*. It is such water as this that I recommend to be treated with carbonate of lime. Enough whitening or levigated chalk is to be mixed with the fluid to make it of the consistency of good milk (though more will do no harm), and the whole is either to be filtered or to stand until clear. I have never yet found any sample of water poisoned as above that was not freed from the lead by this process; and from the actions that occur in the laboratory I have no doubt that if two or three pounds of such powdered chalk were put into a cistern, and stirred up occasionally after rain, it would keep the water free from lead.

* Professor Faraday, in his letter to the Editor of the "Times," stated that "the salt of the sea spray, which often reaches the roofs of buildings, even when they are half a mile or more from the shore, causes the rain water to dissolve a portion of the lead, which is larger or smaller under different circumstances, and at times rises up to a quantity injurious to health and poisonous."—Ed.

Now my consideration was entirely confined to cases of the above kind, and to the service of the Trinity House. I might say much more to you about the modes of testing for lead in water, so as to discover its presence, and, within certain limits, its proportion, and also about the clearance of lead from all domestic waters by filtration or otherwise, but I have always found that chemical practice was required to make such knowledge available, and that for that reason it was nearly useless in the hands of the public. When, too, a particular case becomes mixed up with the numerous cases that may be associated with it, I think it often disappears from view, and the whole are after a time forgotten. Hence I prefer adhering to the case of adulteration arising from the joint action of salt water, or sea spray, and lead; and I have the full confidence that if it arise at any of your military posts at home or abroad, no difficulty will be found in the effective application of the remedy.

I am,

My dear Sir John,

Your very faithful servant,

M. FARADAY.

To Sir J. F. Burgoyne,
&c., &c., &c.

PAPER X.

NOTES ON THE CHINESE INFERNAL MACHINES.

BY THE LATE LIEUTENANT THAINE, R.E.

Three descriptions of infernal machines were found in Canton.

The first consisted of a large cylindrical wooden tub, lined with tin, so as to be water-tight; its dimensions were: diameter, 3 feet 8 inches; depth, 1 foot 10 inches. At about three inches from the top there was placed a board divided by small pieces of lath in such a manner as to allow a great length of match to be laid on it; one end of this match passed through a hole in the board into the lower part of the tub, where the charge was placed, and the other end communicated with a small lantern-shaped water-tight wooden box, fastened to the side of the tub. The top of this box consisted of a cone of tolerably stiff painted canvass, sufficiently flexible, however, to be easily pressed down; a small iron rod, about three-quarters the length of the box, was fastened to the apex of the cone, and, on its being pressed down, dipped into an earthenware jar, placed at the bottom of the box.

The following seems to be the most probable way in which this machine was fired. The end of the match which communicated with the box was allowed to dip into the jar, which was partly filled with chlorate of potash, and also contained a glass tube filled with sulphuric acid. (Any other substances acting on each other in a similar manner to the two mentioned above would do instead.)

Then, on the iron rod being pressed down, it would break the tube, the acid would come into contact with the chlorate of potash, and the match would be ignited: or, possibly, the jar might be filled with sulphuric acid, and the chlorate of potash be contained in a bag, fastened to the end of the iron rod, and into this the match would pass.

Nothing was found which exactly indicated the way adopted. From the great length of match, however, it seems likely that the machine was meant to be used as a sort of fire-raft, to be brought to within a certain distance of shipping, then ignited, and allowed to float down with the tide amongst them, or else to be fastened quietly to the side of a ship, the match giving enough time for the men who brought it to escape.

The second machine was a strong wooden box in the shape of a frustum of a cone, and of the following dimensions:

Height	2 feet 6 inches.
Upper diameter	1 „ 5 „
Lower ditto	2 „ 0 „

It was divided horizontally into three compartments; in the upper the apparatus for firing was placed, the second contained the powder, and the third was filled with iron.

The apparatus for firing consisted of the lock of an old musket communicating with the charge below by means of a brass tube filled with powder, and connected with clockwork, which regulated the time at which the charge was fired. This was contrived in the following way:—the lock was slightly altered, so that the hammer would descend on a trigger being pressed up; this trigger was provided with a spring pressing it up, but was kept down by a lever catching on a stud; the long end of the lever, which was on the other side of the lock plate, was immediately under a weight working on a pivot, and supported by a spring; the end of this spring was connected, by means of a short piece of twisted wire, with a small tongue of metal working on a pivot on the clock case. On the great wheel of the clock there was a stud which, on its arrival at a certain point, caught in the tongue of metal, and, as the wheel turned, tightened the wire; the spring supporting the weight was thus pressed in, and the weight descended on the long end of the lever, disengaging the trigger: the hammer then descended and the charge was fired. The time required for a complete revolution of the wheel was four hours, and the stud could be adjusted so as to secure the ignition of the charge after the lapse of any particular time less than that period.

These machines were furnished with rings and staples, and a great number of buoys were found with them. Probably they were meant to be sunk near a place where ships were anchored.

The third machine consisted of a strong, wooden, water-tight box, shaped something like a boat. Its dimensions were :—

Extreme length.....	4 feet 0 inches
Shortest length.....	2 „ 4 „
Greatest breadth	1 „ 7 „
Depth.....	1 „ 10 „

It was divided vertically into three parts; the apparatus for firing was placed in the centre, and the powder in the two end compartments. The apparatus for firing consisted of three hammers and three nipples, fastened to a thick plate, which was firmly screwed down to the bottom of the box; each hammer was provided with a strong spring pressing it on the nipple, so that, to keep them cocked, their ends were caught on the edge of a thick brass plate, which made an angle of about 40° with the bottom of the box, and worked on hinges in such a manner as to allow of its being raised, but not lowered, beyond that point; a small projecting bar of the same metal was fixed to the end of this plate. A species of cylindrical bellows was also fastened to the bottom of the box; its top was supplied with two rings of metal working on two vertical iron rods, and a brass tube passed from the bottom of the bellows to the lid of the box. A stout bar of wood, of nearly the same length as the compartment, was at one end connected by means of thick twisted wire with the projecting bar of metal mentioned above, and at the other was screwed on to the top of the bellows. On the bellows being inflated the wooden bar was raised, and lifted up the metal bar and plate; but when the plate had been raised to a certain height, the hammers slipped off its edge, descended on the nipples, and fired the charge.

In some of the machines found, flint or matchlocks were used, but in either case the method of firing did not differ materially from that just described. It seems a little doubtful how the bellows were to be inflated. Probably they were filled to a certain extent with water (so as not to raise the plate, however), and then moored in the position they were meant to occupy; then, on a vessel coming into collision with one of these machines, it would force it under water, and the pressure of the water at the time of the ship's passage over the spot would be sufficient to determine an explosion before she was out of danger. The boxes are very strong, bound with iron, and furnished with four rings.

The whole of the infernal machines were in very bad order, and utterly unfit for use when first found, and it required a great deal of time to get them into anything like working order.

ROBERT THAINE,

Lieutenant, Royal Engineers.

PAPER XI.

Reports and Journals of the Operations against the Forts at the Mouth of the Pei-ho, or Tien-tsin River, in June, 1859.

By MAJOR FISHER, Royal Engineers.

Report to Colonel Wynne, C.R.E., by Major Fisher, R.E.

Her Majesty's Ship "Fury," off the Pei-ho,
2nd July, 1859.

Sir,—I have the honour to enclose for your information extracts from the Royal Engineer Journal, which will, I think, give you all the particulars of our operations against the forts at the mouth of the Pei-ho.

The attack, I regret to say, proved unsuccessful; the strength of the batteries is very great, and the nature of the shore is such as to have rendered the landing of a force on the day of the attack, in any position from which the works might be taken in reverse, impossible.

The mud banks near the mouth of the river run out to such a distance that I believe that for six miles north or south of the Pei-ho, a gun-boat would not be able to approach nearer the shore than four miles at low water.

This fact will I think explain the necessity, on this occasion, of landing in front of the batteries. Even had a more favourable spot existed, the state of the gun-boats would have prevented their assisting or supporting a landing.

The result of the assault was, I think, entirely unprecedented. The enemy reserved their fire until it proved most effective, and stood on our approach without flinching. The whole defence was conducted in a different manner to what I have seen, or (as I have been told) has ever been seen in China.

The men were carefully concealed from view, and there was no display of flags, beating of gongs, or any of the usual accompaniments of a Chinese fight. The guns which were dismounted by our fire were most rapidly re-mounted. Some were run back and traversed for loading under cover, and in every way the defence was conducted as well as could be done by the most skilled European force, the whole character of the affair (with the exception of the arrows) having that appearance.

The shot which I noticed were 8-inch, 42-pounders, and some of smaller calibre. There were also leaden and iron shot of 3 lbs. or 4 lbs. and grape.

I have much pleasure in bringing to your notice the behaviour of Lieutenants Longley and Maitland.

Lieutenant Longley was, I regret to say, very severely wounded in the thigh, whilst bringing up the ladders. but refused at that time to allow any of the men so employed to fall out to help him. I am glad to say that he is going on well now, but the ball is not extracted.

Lieutenant Maitland was very zealous in his duties, gallantly assisted and cheered the men under a heavy fire, and mainly contributed towards bringing three ladders up to the ditch. Four men out of seven were shot down at one ladder.

Corporals Veal and Chaplin, and Sappers Gibson and Way, distinguished themselves in this duty.

Sapper Cleghorn was particularly pointed out to me by Lieut. Balfour, R.N., who commanded the "Opossum" gun-boat, as having made himself conspicuous for his coolness in using his rifle when under a very heavy fire, two of his comrades having already been killed at his side.

It gives me very great pleasure to tell you that from more than one quarter I have heard complimentary mention made of the behaviour of the men.

It is also a subject for thankfulness that, considering the very dangerous positions of the Engineers during the entire engagement, the loss has not been heavier than it was, though it is to be regretted that the lot fell on three of the best men in my company.

I have the honour to enclose a list of the casualties, and a return of the wounded, also a copy of the memorandum which I addressed to Admiral Hope at his request, previous to the attack of the position.

With regard to future operations, I am of opinion that a repetition of an attack on these forts, in front, would be useless. It cannot be denied that the position is much too strong to be forced in this manner.

The strength of the booms renders it impossible for vessels to run through the fire so as to enfilade or take the batteries in reverse, as was done last year. But I believe that a landing place might be found either to the north or south, within about ten miles from the forts, as a river exists at that distance in both directions. That to the north I hear is fortified.

Having landed a good force I anticipate that there would be but little difficulty in marching to the forts and taking them by assault or even by siege, should it prove necessary.

Should the Admiral have a vessel available for the duty, I shall endeavour to reconnoitre the coast in both directions. It is his intention at present to send the Company of Royal Engineers to Hong Kong as our force is too much reduced for immediate operations. In that case, should there be an opportunity of surveying, I propose to send Lieutenant Maitland down in charge of the Company, and remain myself to make a reconnaissance.

I have the honour to be, &c.,

A. C. FISHER,

Captain, Royal Engineers, and Major.

Sir,—Since the above was written, Lieutenant Jenkins, Royal Navy, of Her Majesty's ship "Cormorant," came on board the "Fury" to recommend Sappers George Ostler and William Thompson, for gallant conduct and coolness on board that ship when under a very heavy fire. After Corporal Pennington had been killed, Sapper Ostler assumed the charge of the men and "behaved in such a manner as elicited the praise of all who saw him."

I have the honor to be, Sir,

Your obedient servant,

J. H. MAITLAND,

Lieutenant, Royal Engineers,

5th July, 1859.

To Colonel Wynne,

Commanding Royal Engineer in China.

Extracts from the Royal Engineer Journals during the North China Expedition, written by Major Fisher, Royal Engineers.

17th June.—Having arrived at the rendezvous the day before, I left the "Chesapeake" at 3½ A.M., with Admiral Hope, and went in Her Majesty's Ship "Fury" to within about 6 miles of the forts at the mouth of the Pei-ho, anchoring in four fathoms.

Went with the gun-boats "Plover" and "Starling" to the bar, and anchored outside of it, about three miles from the forts. The tide not suiting at this time (11 A.M.) for the gun-boats to cross the bar, Admiral Hope sent Commander Commerell and myself, accompanied by Lieutenant Williams, Royal Marine Artillery, to pull ashore in two gigs unarmed, and we found the river barred across in several places.

1st. A barrier of wooden piles had been commenced, but was incomplete and no obstacle.

2nd. A row of iron stakes about 25 feet high (see sketch) placed across the river about 20 feet apart, and arranged so that the tops were just covered at high water (the only time vessels can get over the bar to come in).

3rd. A cable or chain under water, with beams attached longitudinally to it, covered with iron hooks.

4th. A boom of timbers shaped like pontoons, about 15 feet apart, and connected with one another at the centre and each end by chains and ropes, like a pontoon raft without the superstructure.

5th. A large raft of timber in a mass.

The river here is about 400 yards wide, and the barriers are about 200 yards apart, and stretch almost across the river. The whole are under fire from the forts at ranges of from 200 to 800 yards.

The batteries immediately commanding the passage are as follows:—

On the right bank on the south side there is a long fort, composed of three bastions connected by curtains of about 150 yards long, and running almost north and south. There is a raised cavalier in rear of each bastion, mounting three guns firing through embrasures.

The whole work appears constructed of rammed mud and is neatly executed. The wall is battlemented, and about 15 feet high*, the guns firing through large square openings on the level of the ground. The rampart appears about 12 feet thick and the top of each embrasure is constructed of transverse timbers. These embrasures or ports afford the ordinary means of ingress and egress. Each embrasure is closed by a mat.

The cavaliers have a command of about 30 feet above the ground, and do not appear to be retired many feet in rear of the outer wall. Part of the ground in front of the fort is mud, and a portion has been reclaimed by dams, and is apparently divided into shallow ponds, now dry, probably for evaporating salt water. The ground in front of the works is thickly covered with short pointed stakes fixed in the ground.

The work is all new, and, I think, not entirely armed, as daylight could be seen through some of the embrasures.

These were all crowded with men looking at us, but no one could be seen on the top of the wall; possibly the banquette was not yet constructed†.

* Since ascertained to be higher.

† This wall was manned during the assault.

There is another fort below this, and apparently retired and out of the way; this would appear to suggest a landing-place and road to Tung Koo in that direction. There is also another fort higher up and on the same side.

On the left bank there is another fort, mounting fewer guns; it is opposite to the upper end of the main fort above described.

We pulled up to a jetty immediately above the 4th barrier, and attempted to land, but could not get beyond a lighter alongside, as a number of armed men came down and prevented us. We were unable to get hold of any mandarin or man high in authority, but we communicated with a man who said he commanded a local levy of troops. He told us that the barriers were against the rebels, so we warned him to have them removed in three days to a sufficient extent to allow us to pass, or take the consequences. He promised to report our arrival immediately to the proper authorities.

One of the gun-boats now came in close to the 2nd barrier and we returned.

We went to the shore again an hour after with a further message from the admiral; when, by pulling past by the jetty, and rounding the upper barrier, we succeeded in landing, before they could get round to prevent us, at an upper jetty.

The works appear to occupy the same sites as last year, but to be entirely of a different construction.

20th June.—Went into the river with Commander Bythesea and Lieutenants Longley and Maitland, R.E., and discovered a wet ditch about 30 feet wide running in front of the works. No. 4 boom had been increased about 50 feet, and chevaux-de-frise had been placed round the upper bastion. The Chinese appeared to be opening three embrasures in the outer wall of each bastion, but there does not appear to be room for guns between the base of the cavalier and outer wall.

An interview, of much the same nature as the last, took place, but I think the conduct of the Chinese was more rude. On jumping on shore I was nearly pushed back into the water.

21st June.—A bridge formed of spars was designed for crossing the wet ditch. One spar was to be laid across on each side, and then gratings were to be laid across and lashed to them. I thought that there would be a loss of time in getting the poles to proper distances apart, and also in lashing the gratings *; accordingly I suggested the following plan, but it was not adopted. Two pieces of timber were to be provided, with a piece cut out of each end so as to take the ends of the spars, to ensure their being at the proper distance apart. One of these to be placed on each bank of the ditch. Each grating to be provided with a fillet underneath to keep it in position. The saddle at each side of the ditch would ensure a proper position, and the gratings would then only require laying over.

Gave the admiral a memorandum of my opinion of the attack.

23rd June.—Naval preparations continuing.

24th June.—Started early in the morning (4 A.M.), went on board the "Opossum," and was put on board a junk about 1½ miles from the forts.

At night Captain Willes and Lieutenant Wilson, R.N., endeavoured to break the chains by firing charges of powder, and succeeded partially, but the opening appeared to be closed up before the attack. Two shot were fired at them after the explosion.

* Gratings are the coverings of hatchways, of which any number was procurable.

25th June.—At 4 A.M., sent the Royal Engineers off to the gun-boats, as detailed below, with orders to act as marksmen and fire into the enemy's embrasures, and in the event of landing, to join the party which might leave each gun-boat, or the boats towed by it, and attach themselves to the ladder or bridge parties, and form a company inside the works.

To Captain Willes's division: "Plover" (flag), "Opossum," and "Haughty."—Major Fisher, R.E.

To Captain Shadwell's division: "Banterer," "Cormorant," "Janus," and "Starling."—Lieutenant Longley, R.E.

To Captain Vansittart's division: "Forester," "Nimrod," "Lee," and "Kestrel."—Lieutenant Maitland, R.E.

Went myself on board the "Plover" and joined the admiral there.

All the forenoon was employed in getting the boats into position, an operation attended with great difficulty, as a strong tide was flowing all the morning; the channel is not more than 150 yards wide at low water, and it seemed hardly possible to keep the vessels from fouling. The admiral's intention was to form an echellon line across the river, having a mean range of about 800 yards. These vessels were to form a kind of battery of position, and to cover the attempts of the "Plover" and "Opossum" to force a passage through the barrier. At noon the positions were pretty well gained and the squadron "piped to dinner."

At about 2 o'clock the action commenced: the "Opossum" went ahead, made fast to the iron stakes, and removed two of them, by lowering a hawser over them with a slip knot, and then backing the vessel, afterwards laying down buoys to mark the passage. This being done the "Opossum" steamed into the space between the booms, followed by the "Plover." Immediately the masks fell from all the enemy's embrasures, and an extremely heavy fire was opened on the gun-boats. It was replied to by the different vessels and a violent cannonade ensued.

The "Plover" suffered the most; in a short time the greater part of her crew was disabled, and only one gun detachment was left. The Sappers assisted in working the bow gun. Lieutenant Rason, commanding, was killed; the Admiral was severely wounded, Captain McKenna, staff officer, was mortally wounded, and four men of the Royal Engineers were wounded by the bulwarks being knocked against them. Sapper Palmer was very severely wounded in both hips. Reinforcements were sent for, and the "Plover" had, after some time, to slip her cable and drop down to the stakes, where the action continued.

The "Opossum" fared better, as regarded her crew, though Corporal Andrews and Sapper Atkins, R.E., were killed, and others wounded on board of her.

Corporal Pennington was killed on board the "Cormorant."

At about 5 P.M. the forts appeared to be partially silenced, but the squadron was in a crippled condition. The "Kestrel" and the "Lee" were sinking, and more than one other was aground. It was determined to attempt landing the Marines and Naval Brigade to endeavour to carry the southern fort by assault. It was at this time about low water.

It was considered impracticable to attempt landing at the spot originally contemplated, as the fire from that part of the southern fort was comparatively unimpaired, and there were guns in the Northern Fort bearing on that spot which had not even been brought into action. There were no gun-boats to cover a landing there, and after the experience acquired of the cross-fire at the boom, on board of the "Opossum" and the "Plover," it was evident that boats

could not live there. Hence the only practicable spot, though very unfavourable on account of the mud to be crossed, was the South Bastion, where the greatest damage had been done, and where the fire from the vessels would prove most efficient in covering the landing and advance; accordingly the Marines and Seamen were sent for and towed up by two gun-boats and the United States' ship "Toey-wan."

There appeared, as might be expected from the lateness of the hour and the admiral's wounds, a certain want of method in the arrangement of the landing parties. I had taken the opportunity of urging upon the admiral and other superior officers the extreme importance of a very large party of skirmishers, who ought to extend and keep up a continuous and crushing fire upon the works, as the only means of enabling the bridges and scaling ladders to be taken safely to the front over such difficult ground.

But unfortunately so great was the excitement and emulation amongst the boats' crews that each strove to reach the bank first. As the boats grounded, many, in their eagerness, jumped out of the sterns, where the water rose above their pouches, and many threw themselves over-board before the boats grounded at all. The consequence was that the covering fire was but slight.

Having charged Lieutenants Longley and Maitland with superintending the bridges and ladders, I endeavoured to pick out the best ground.

We were exposed to a very heavy fire, but the spot appeared to be judiciously selected so far as that only six guns fired on us, though in the early part of the day this portion of the fort was strongly armed. The following were the guns which fired on us:—

1 on the extreme left at the South Detached Fort.
1 in the South Curtain.
1 in the South Bastion.
1 in the adjoining curtain.
1 in the right flank of the Centre Bastion.
1 in the North Fort.

The fire from rifles and jingalls was also very heavy indeed.

The extent of ground to be crossed was from 500 to 600 yards, and the details of it were as follows *:—

A mud flat about 400 yards wide, at which distance from the boats there was a row of stakes about 4 feet apart and 3 feet high. As these were probably intended to prevent the approach of boats at high water the fire appeared to be mainly directed on this particular spot. About 100 yards further there was a bed of reeds about 2½ feet high and about 40 yards in width. Beyond this was a ditch capable of being filled by the tide, about 20 feet wide, and at this time of course nearly dry: but in wading across it was found to be very deep in mud and extremely difficult to cross. The further bank of this gave a very welcome shelter after crossing the mud, and afforded excellent cover for skirmishers, but unfortunately almost all the rifles were more or less unserviceable, many men having fallen in the mud. Passing this bank a mass of wet clayey mud had to be crossed, and a dam to keep the water in the main ditch afforded a second admirable cover (a regular crowning of the covered way). The wet ditch was about 25 feet wide, without a bridge, and about 6 feet deep; over this the leading men swam, and they were again sheltered by the bank. About 60 officers and men gained this point.

* See Plan.

Here the ladders and bridges were anxiously expected†. Lieutenant Longley had already been very severely wounded within 100 yards of the work, whilst exerting himself in bringing them up. Lieutenant Maitland, with great gallantry and perseverance, by his example and his own exertions succeeded in getting three of the ladders up to this point, four men out of seven being shot down from the ladder which he was assisting to carry; however they were soon broken by men using them improperly in crossing the deep water.

These ladders had been made on board ship. The greater number of the ladders, having been lashed on the outsides of the gun-boats, were destroyed by the shot from the forts, and the men were all shot away from the bridges.

From the bank just described the wall appeared 20 yards distant, and the ground between was tolerably hard and covered with pointed stakes. There appeared to be no other ditch, but it is possible that there might be a narrow one. The sills of the embrasures were about three feet above the ground-line or berm.

A sharp fire was kept up all this time, and many were shot; however, with proper care, there was good cover, except from arrows which were fired rather vertically.

The want of dry ammunition was here most deplorable, as much damage might have been done to the enemy. Had a proper skirmishing taken place, the bridges and ladders might have been brought up, and success would have been certain. Even as it was the work might have been entered by a few men, through the embrasures, but without ammunition the position would have been untenable, and the measure, in my opinion, unjustifiable.

At the same time any movement of retreat would have proved wrong; a panic would have ensued, and the men, now under cover of the banks, would have been subjected to a heavy fire in returning over the mud. Accordingly it was determined to remain until dark, when, the tide having risen, boats would be sent to bring us off. An order from Captain Shadwell, R.N., came about the same time to the same effect.

At between 8 and 9 P.M. we crossed the wet ditch, so as to place it between us and the enemy, in case of their attempting a sortie, and remained with bayonets fixed. At about 10 P.M. the wounded men were removed with assistance; then those whose arms were entirely unserviceable, and so on by degrees, until all reached the water's edge, where they waded out to meet the boats, the water being so shallow as not to permit them to come close in shore. Nearly all were probably on board by about midnight.

Light balls were fired constantly, followed by volleys of musketry and an occasional round shot. Single shots were frequently noticed as fired at individuals and with effect. The fire on the whole was very precise.

26th June.—The men were gradually collected from the different boats and vessels, and put on board the junk, where we remained all day.

27th June.—On board the junk.—I moved out to Her Majesty's ship "Fury" at 9 P.M. and lay outside the bar.

4th July.—The order was received for Her Majesty's ship "Fury" to proceed to Shang-Hai. Major Fisher having determined to remain in the Gulf of Pechili, for the purpose of making such reconnaisances as would be useful in case of future operations in that quarter, he handed over the command of the 10th Company of Royal Engineers to Lieutenant Maitland, R.E.

† Two ladders had been brought up before we swam over the ditch.—J. H. M.

REPORT TO THE ADMIRAL'S SECRETARY BY MAJOR FISHER, ROYAL ENGINEERS.

Her Majesty's Ship "Fury," 28th June, 1859.

Sir,—I have the honour to report as follows, regarding what came under my notice during the operations on shore on the 25th inst., for the information of His Excellency the Commander-in-Chief.

At about 6½ P.M. the boats advanced for landing so as to put the Force on shore opposite the outer bastion of the south fort, which was the portion which appeared the most injured by the fire of the afternoon, and where the landing and attack would be best supported by the fire from the gun-boats.

Immediately on reaching the shore the boats were met by a heavy fire. However it appears that so effective had been our fire that only six large guns opened on the landing party; they were as follows:—

One in the outer or south bastion.

Two in the curtains on each side of this bastion.

One in the flank of the centre bastion.

One in the north fort which however did not fire many rounds.

One in the extreme south detached fort.

There was also a very heavy fire from jingalls and rifles all the time.

The extent of ground to be crossed was from 500 to 600 yards, and was composed of mud, usually about one foot deep, but with occasional holes; the general nature of the ground was as follows: first, an extent of mud for about 400 yards had to be crossed, after which there was a row of piles, at intervals of about 4 feet, and about 2 feet high. On this line the flanking fire appeared to be principally directed, the piles being probably placed there to prevent the approach of boats at high water, in which case the guns would naturally be so disposed as to increase the difficulty; inside the stakes was a mud flat perhaps 100 yards wide, and then a breadth of about 40 yards covered with rushes growing to a height of about 2½ feet.

The first great obstacle was a ditch about 20 feet wide, which appeared nearly dry, but, on wading through it, it was found to be about 4 feet deep in thick sticky mud, and was extremely difficult to get over.

Immediately in front of this was a small bank about 2 feet high which afforded a partial cover.

After passing this, a deep bed of mud had to be crossed, in front of which was a dam, which afforded considerable shelter, and was of great service as a breastwork and rallying place for the men.

The next obstacle was a wet ditch nearly six feet deep in water, over which, the bridges not having been brought up, and the ladders having been broken, we had to swim.

The farther bank of this ditch afforded cover to those who had succeeded in getting so far, and about sixty officers and men reached this point.

Between this and the bastion was a space of about 30 yards, apparently tolerably dry, and covered with sharp pointed stakes about 3 feet high, closely driven.

The front of the bastion, though there were three mats upon the face of it like mantlets, appeared to have no embrasures.

The sills of the embrasures in the curtain appeared to be about 3 feet above the berm, or ground line, but I could not see if there was a ditch in front of the work or not; if there was one it must have been very narrow.

The outer wall of the bastion and curtain appeared to be about 20 feet high, and the bastion itself about 35 feet.

On the Force approaching the shore, the men were too precipitate, and on the boats grounding, many jumped out at the stern, where the water was so deep as to wet their pouches. Many, I believe, jumped out before the boats grounded at all, and of course with the same result.

The anxiety of the men to advance, and the useless state of their rifles, was the cause of there being but little fire from those first landed, to cover the disembarkation of the others bringing up the bridges and ladders. Consequently the fire was very heavy on the men so employed, and it was with the greatest difficulty that three ladders were got up to the most advanced ditch, where eventually they were broken by the men trying to cross it along them in default of a bridge. Lieutenant Maitland, Royal Engineers, behaved with great gallantry in performing this duty, and by his example, and by personally exerting himself in carrying the ladders, he mainly contributed to their being brought so far under such very great disadvantages. Lieutenant Longley was unhappily wounded whilst employed in the same duty.

From our most advanced position I believe it would have been possible to enter the works at the point of the bayonet, had there been more men, and with effective arms. In that case I consider a successful result would have been certain, but, considering the paucity of our numbers and the total want of ammunition, I am of opinion that an attempt of the kind would have been unjustifiable, as it would have proved impossible to maintain a position within the works.

Having gained a comparatively secure position behind the bank, it was resolved to maintain it until the darkness should cover our retreat, and the high tide then flowing should enable the boats to approach to carry us off. Accordingly at about 10 P.M. the wounded were sent away with assistance, next those without ammunition, and so by degrees the whole Force reached the boats.

During the time we were near the bastion, the enemy fired light balls, and then volleys of musketry; they also used rifles, and, within a range of about 50 yards, bows and arrows. One man was killed by an arrow. The aim from the rifles appeared to be very precise, single shots were frequently noticed as fired at individuals, and generally with effect.

I am happy to state that on shore none of the men under my command were killed.

The total loss in the Royal Engineers during the day was three men killed and about sixteen wounded.

I have the honour to be, Sir,

Your most obedient humble servant,

A. C. FISHER,

Captain, Royal Engineers, and Major.

To J. W. M. Ashby, Esq.,

Secretary to His Excellency the Commander-in-Chief.

Report addressed to Rear Admiral Hope, C.B., on the Defences in front of the Forts.

By MAJOR FISHER, Royal Engineers.

Her Majesty's Ship "Chesapeake," 5th July, 1859.

Sir,—I have the honour to report as follows with regard to the defences of the Chinese in front of their works, as observed during the attack on the 25th ult., as well as the natural difficulties and obstacles which tended to increase the strength of the position.

The distance of the point at which the troops were landed, from the bastion against which the attack was directed, is about 600 yds. The nature of the ground generally is stiff mud nearly a foot in depth, with occasional holes interspersed, which are deeper and difficult to distinguish. In advancing towards the proposed point of attack, a flat of this nature, and about 400 yards in extent, had to be traversed. At this spot there is a long row of piles on which the guns appeared to be laid, as the fire was noticed as being particularly heavy there; and as the apparent shelter of these posts occurred after a heavy struggle through the mud, the troops were naturally inclined to pause there to take breath, and in so doing suffered considerable loss.

About 100 yards beyond the stakes there is a bank of low rushes, about 40 yards in width: this appeared to be about high water mark. Beyond this is a ditch about 15 feet wide and 5 feet deep, which is filled by the tide, and at the time of the assault was apparently nearly dry, the tide being low. However, on attempting to cross it, the bottom was found to be composed of very deep tenacious mud, which rendered it extremely difficult to cross. The rifles of the men who fell in crossing it got wet, and were rendered for the time unserviceable. About 20 yards in advance of this is another ditch, the intermediate space being deep and covered with wet mud. The advanced ditch is kept full at all times of tide, and has high banks. It is about 6 feet deep and 25 feet wide.

As it proved impossible to bring up the bridges under such a heavy fire, those men who crossed this ditch were generally unable to do so without wetting their arms and ammunition. The ladders which were brought up enabled a few to cross over dry. The banks of these ditches afforded fair cover from the enemy's fire.

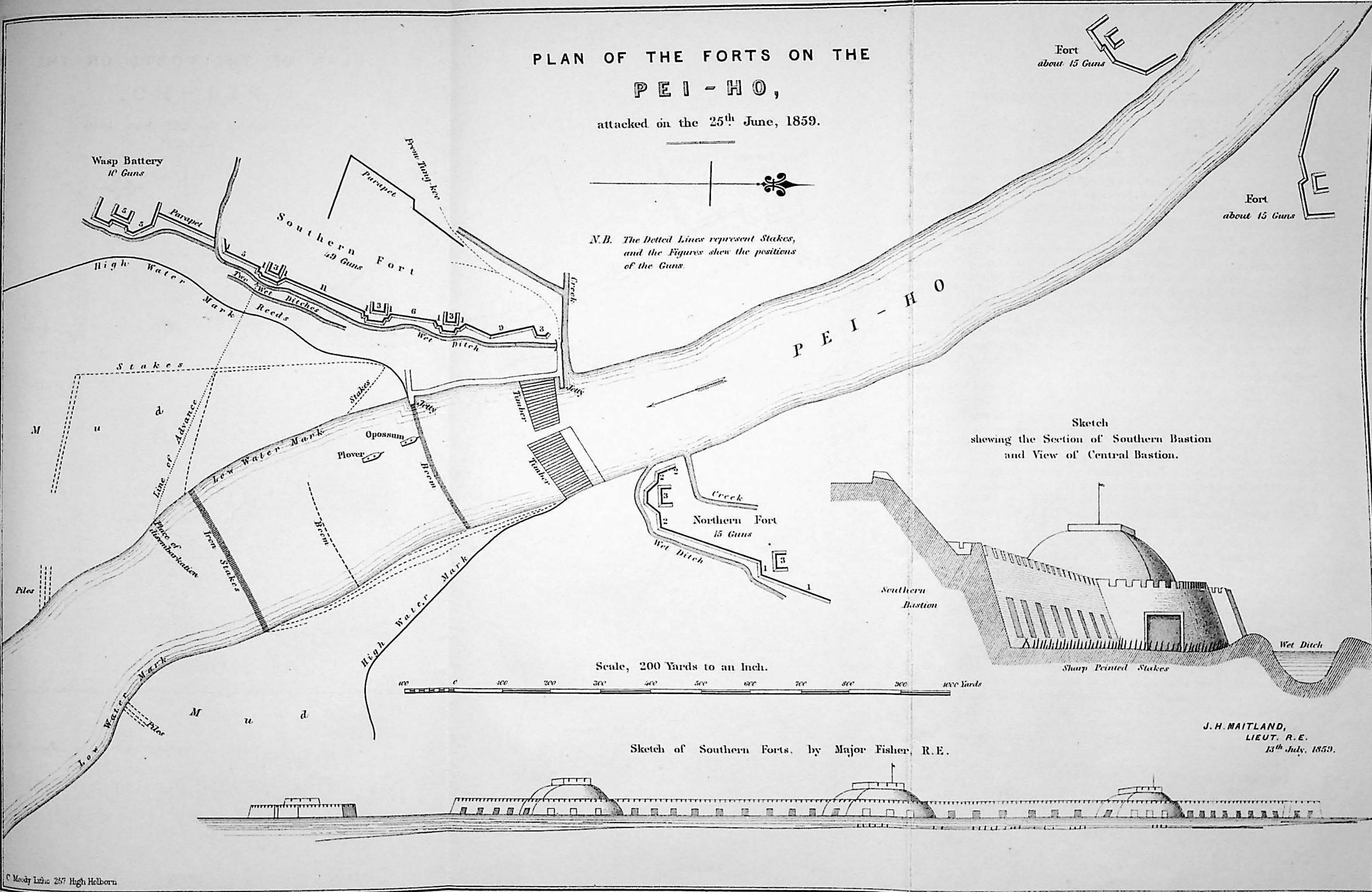
The distance of the last ditch from the outer wall of the bastion is about 20 yards, the intermediate space being closely covered with sharp pointed stakes about 2 feet high.

The curtain and outer bastion walls appeared about 22 feet high. The sills of the embrasures in the curtain are about 3 feet above the ground.

There did not appear to be another ditch in front of the work, but the obstacles created by the Chinese, as well as the difficult nature of the ground, must always render an assault of these works extremely difficult if they are properly defended.

I have the honour to be, Sir,
Your most obedient humble servant,
A. C. FISHER,
Captain, Royal Engineers, and Major.

To Rear Admiral Hope, C.B.,
Commander-in-Chief, &c., &c., &c.


PLAN OF THE FORTS ON THE
PEI-HO,
attacked on the 25th June, 1859.
Wasp Battery
10 Guns
Parapet
Southern Fort
49 Guns
From Tung-koo
N.B. The Dotted Lines represent Stakes, and the Figures shew the positions of the Guns.
Fort
about 15 Guns
Fort
about 15 Guns
High Water Mark
Two Wet Ditches
Reeds
Wet Ditch
Creek
PEI-HO
Stakes
Mud
Line of Advance
Jetty
Timber
Oposssum
Plover
Boom
Low Water Mark
Iron Stakes
Place of disembarkation
Piles
Northern Fort
15 Guns
Creek
Wet Ditch
Sketch
shewing the Section of Southern Bastion
and View of Central Bastion.
Southern Bastion
Wet Ditch
Sharp Pointed Stakes
Scale, 200 Yards to an Inch.
100 0 100 200 300 400 500 600 700 800 900 1000 Yards
J. H. MAITLAND,
LIEUT. R.E.
13th July, 1859.
Sketch of Southern Forts, by Major Fisher, R.E.
C. Moody Litho 257 High Holborn

MEMORANDUM ADDRESSED TO REAR ADMIRAL HOPE, C.B., AT HIS REQUEST, PREVIOUS TO THE ATTACK ON THE PEI-HO FORTS.

BY MAJOR FISHER, ROYAL ENGINEERS.

Her Majesty's Ship "Chesapeake," 21st June, 1859.

Assuming that the iron stakes have been removed*, and the second obstacle got out of the way, some of the gun-boats might get up as far as the upper bastions, and under cover of their fire the boom of floating timbers might be cut or blown up, and a way made for the gun-boats to ascend the river so as to see into the rear of the works.

The officers in these boats would see when a retreat was commencing, and might hoist a signal for the landing; and a signal having been made back that the troops were landing they would of course be very careful in their fire.

I think the fire from the gun-boats should be principally directed against the bastions, (the outer wall, as well as the high mounds) in order to destroy the fire of the guns in the flanks of these works, which rake the whole river and the front of the forts.

The two flanking guns on the extreme (enemy's) left should also be silenced.

In landing it would be desirable that the first men should immediately get under cover, and act as marksmen to cover the landing of the larger bodies, and the formation of the bridge, which should be the second operation.

After the landing of a portion of the Force† (say one half), howitzers might be found very useful in the works.

There is a good pier for landing, above the mass of floating timber opposite the extreme (enemy's) left, which might be made use of if the fire is subdued.

The north fort however fires on this point, and should be silenced. Some of the landing men of the storming party should carry axes, to cut down the chevaux-de-frise and stakes, so that there may be no delay in the storming party getting in. The powder-bag-men might be with these advantageously.

I think there would be no use for the ladders, as the embrasures afford a means of entering the works: however they might be left at the bridge if not required.

Of course great attention on the part of all the officers would be required in keeping together, and re-forming the men in the work so as to be ready to meet any attack from the reserve of the enemy, which, though unlikely, should not be disregarded.

It is possible that on our entering the work the enemy would abandon it immediately. If not the storming parties should go by companies to the right and left, those to *our* left being accompanied by the powder-bag-men, in case there might be gates in the rear of the high bastions.

I think it likely that the north fort would be abandoned on our taking the south one; if not one would be guided by circumstances at the time.

The fort on the south should I think be first completely disposed of, and a bridge, to cross the ditch, made from the materials of the fort: our temporary bridge would then be available for the work on the north side and the forts higher up the river.

A. C. FISHER,
Captain, Royal Engineers, and Major.

To Rear Admiral Hope, C.B.,
Commander-in-Chief.

* As had been already arranged.

† The work being supposed to be entered.

N.B. A short time before the action commenced on the 25th, the tide being very high, I suggested to Admiral Hope that during the firing of the gun-boats the troops might be landed near the enemy's right, and carry by assault that angle of the long fort, thereby turning the works. However Admiral Hope did not consider it advisable to alter his plans.

As this measure was one entirely dependent upon the state of the tide at the moment, and the hour of attack was uncertain, I did not originally propose it; the measures proposed on the 21st being independent of the tide, as there was a jetty at the contemplated landing place.

A. C. FISHER,
Captain, Royal Engineers, and Major.

PAPER XII.

Memoir of the late Lieutenant General Edward Fanshawe, C.B., R.E.

By GENERAL SIR JOHN BURGOYNE, Bart. G.C.B., &c.

There are officers who have rendered eminent services to the country, and whose value and merits are well known to the circle with which they have acted, but who, from fortuitous circumstances, did not take a part in those operations which have peculiarly attracted public notice, and who have consequently not participated in the honors and distinctions that have been accumulated on many of their more fortunate, though by no means more meritorious, brethren.

Such was the case of the late Lieutenant General Edward Fanshawe, of the Royal Engineers, who, for a period of between fifty and sixty years, devoted an enduring body and powerful mind to a zealous execution of his duties.

General Fanshawe, though engaged in many active services in the field, all of which he anxiously sought, and in all of which he distinguished himself, did not happen to be present at any of those particular scenes in the Peninsula, at Waterloo, or the Crimea, that have drawn so much deserved public attention. While, with the great mass of the army, field service may be entitled to the greatest degree of favour, the corps to which General Fanshawe belonged, that of the Engineers, requires exertions of another description, and the development of talents and professional acquirements which, for that branch of the service, are of far more value. For those, and the opportunities he had of applying them, General Fanshawe was very eminent.

His first commission was dated July 1801. In 1805, he served with the expedition under the command of Sir David Baird, at the capture of the Cape of Good Hope, which he left as a captain in 1806, with reinforcements for South America, and joined Brigadier General Sir Samuel Auchmuty, being the only officer of Engineers present at the siege and capture of Monte Video, when he obtained the flattering notice of the Commander, in general orders and in the public despatch. In the following spring he embarked from England with an expeditionary force under Sir Brent Spencer, against Spain, the object of which was entirely changed by the outbreak of the Spanish nation against the French.

In 1808, Lieut. General Sir Hew Dalrymple, Governor of Gibraltar, placed him on his staff, and took him with him to Portugal, where he acted temporarily as Military Secretary, and was engaged in a confidential manner in the negotiations for the evacuation of Portugal by the French; this first brought him into direct communication with the Duke of Wellington, who ever subsequently shewed much confidence in his judgment.

In 1809, he served during the whole period with the army in Walcheren, throughout the siege of Flushing, and in the destruction of the Arsenal there, when a strong report was made by his Commanding Officer in approbation of his exertions.

After different services in England, in 1821 he was selected by the Duke of Wellington to be member of a special military mission to the West Indies; and again, after the intervention of several special services, he was sent on an important confidential mission to Bermuda, to report on the defences and works at that place; again, in 1827, to Pembroke, and in 1828, to Canada.

On all these occasions his judgment and proceedings were considered so satisfactory that he was, from 1830 to 1850, actively engaged in the Office in London as First Assistant Inspector General of Fortifications, to regulate, revise and report upon all the proceedings in the fortification and barrack branches of the Ordnance Department.

In addition to the current business, which was arduous, and zealously attended to, he introduced many reforms and a systematic organization of the Department, which were most valuable.

In 1850, he voluntarily resigned his office, to the great regret of his superior officers and colleagues, and of the Marquis of Anglesea, Master General of the Ordnance, from an over-scrupulous conscientiousness and uprightness always found in him, and under a belief that he had passed a full period in the office, and that a change might be beneficial to the service.

During the reign of His late Majesty, he obtained the very moderate reward of the Companionship of the Bath.

Take him for all in all, we could hardly have to record services so prolonged, continuous and meritorious as those of the late Lieutenant General Fanshawe.

J. F. BURGOYNE,
General, Royal Engineers,
and Inspector General of Fortifications.

PAPER XIII.

Account of the Failure of the Escarp of the Right Face of Fort Elson, near Gosport.

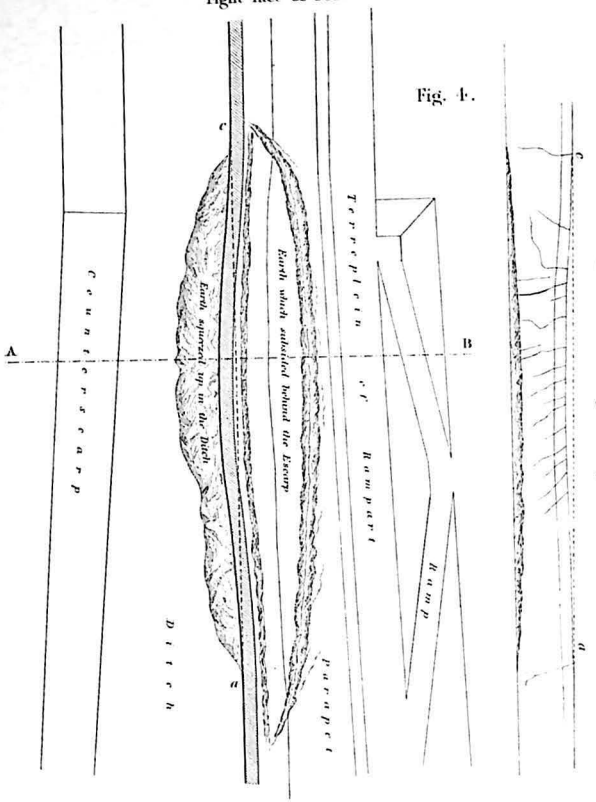
By MAJOR LOVELL, C.B., R.E.

Fort Elson is on the right of the advanced line of works covering Gosport. The soil on which it stands is clay, (red on the surface, and blue beneath, for a depth of 70 feet or more) intersected with layers of septaria in nodules, and with other layers of indurated clay, so hard that only with great difficulty could it be crushed in the rolling-mills of the brickmakers. There are also occasional patches of blue peat mixed with sand, very hard and firm when dry, but speedily becoming fluid on admixture with water. In places there is found, also, a peculiar kind of clay, known in the neighbourhood and in the Isle of Wight, as the "blue slipper," which is of a most treacherous nature, so much so that a contractor in the neighbourhood had met with such difficulty from it in some of his works, that he said "he could not even get it to lie *flat*." A few land springs were met with on the site of the fort, but they were not of any importance.

The ditch had been excavated to the depth of about 18 feet, and on the right face the escarp wall was completed to the section shewn in Fig. 1, and the parapet formed as far as shown by the dotted lines in Fig. 5; and it had remained in that state for about six weeks. On leaving the work on Saturday evening, the 1st May, all was safe; on the following Monday morning the foreman of excavators noticed that the bottom of the ditch was "uneasy," and in the evening the Clerk of Works reported that it was unsettled; but there was not anything to cause apprehension of an immediate failure. Next morning the wall had advanced into the ditch about 7 inches, and had commenced sinking gradually, which continued until about 5.30 p.m., when the sinking and advancing increased so rapidly that a number of men, who were removing the parapet, were obliged to cease work. The sinking and moving forward continued till about 9.30, p.m., when the wall had taken the position shewn in Fig. 5, from which it did not move. The wall at the centre of the bulge had then moved forward 6 feet 5 inches, and had sunk 2 feet 6 inches, forcing up in front of it a mass of earth 20 feet in width, and 3 feet 8 inches in height.

Plan, Elevation and Section of the Escarp of the right face of Fort Elson.

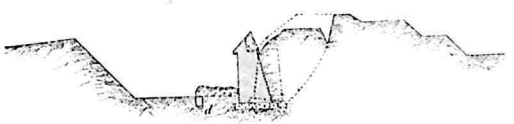
Fig. 4.



Elevation of Escarp, shewing the Cracks.

Section on A. B.

Fig. 5.



Scale, 60 Feet to an Inch.

0 10 30 40 50 100 Feet

d. Trench from which the pipes were removed.

N.B The dotted Line c a shews the original position of the Wall.

C. Moody Junior 257 High Holborn.

Fig. 1. Section of Escarp as originally built.

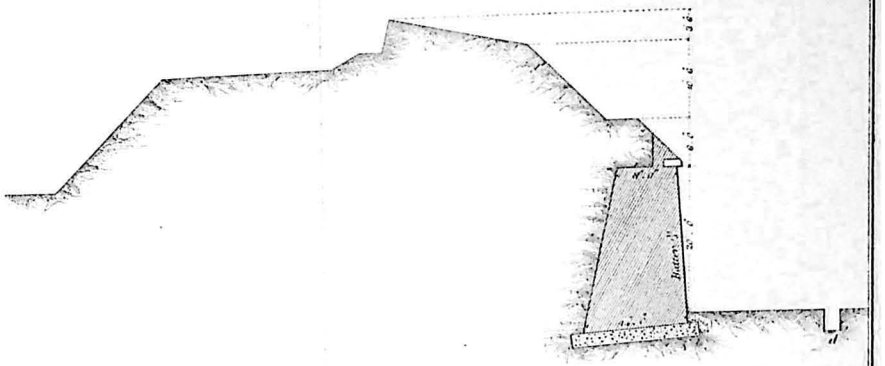
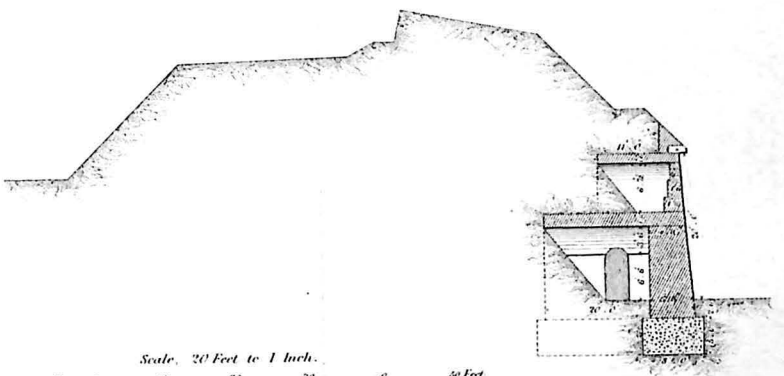


Fig. 2. Section of Escarp as rebuilt.



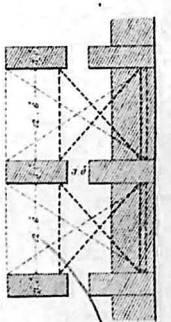
Scale, 20 Feet to 1 Inch.

0 5 10 20 30 40 50 Feet

N.B The thick dotted lines in the Plan shew the upper Arches, and the thin dotted lines shew the lower Arches.

Fig. 3.

Plan of Arches as rebuilt.



There is no doubt that the insufficient depth of foundation, considering the nature of the soil, was the reason of the failure, but the immediate cause of the rapid movement was that on the Saturday evening some drain pipes were removed, which had been laid in a trench in the centre of the ditch to carry off the water pumped out of the excavations for the foundations, and the water, being allowed to pass down the open trench, percolated into the clay forming the bottom of the ditch, which was then very dry and full of cracks, caused by the heat of the sun, and reduced the clay to a greasy state, so that it afforded an insufficient resistance to the thrust at the toe of the wall, which in consequence advanced, squeezing up the clay in the ditch until the trench, from which the drain pipes had been taken, was closed up; and as soon as this occurred the movement ceased.

The escarp has since been rebuilt according to the section shewn in Fig. 2, and stands perfectly well.

The treacherous nature of the soil is shewn by the counterscarp (which has an unrevetted slope of 45°) having failed in several places, even after having stood for more than a year.

J. W. L.

NOTE.—Some years ago I saw another remarkable instance of the movement of a wall, at one of the advanced redoubts at Posen, in Poland: it was built of brick, and loopholed, was 5 feet thick, and about 15 feet high, and was placed at the foot of the exterior slope of a rampart, so that no earth could press upon any part of it except on that close to its base; yet, from the soil being clay, like that at Fort Elson, the force exerted, after the rampart had been saturated with rain, was sufficient to move the whole of the wall of one face 4 feet forwards, retaining its vertical position and being apparently little injured.—ED.

PAPER XIV.

Notes on the Defence of Coasts.

By LIEUT. COL. BAINBRIGGE, Royal Engineers.

The following notes on the defence of coasts were prepared for the Cadets at the Royal Military Academy at Woolwich, and, some additions having been lately made to them, they may perhaps be of use to Officers of Engineers in considering that important subject.

The general application of steam power to ships has rendered coasts more exposed to sudden attacks than they formerly were, though it also affords the means of watching an enemy's fleets constantly, and of giving early notice of their movements.

No coasts can be efficiently protected by fleets alone, for a storm may disperse them, or the enemy, having made a feint to draw them away in one direction, may succeed in evading them and landing troops in another; and even large armies cannot prevent troops landing on a coast of great extent; but in a country where a good and complete system of railways exists they afford the means of rapidly concentrating troops at any point on the coast, and an enemy endeavouring to land may be checked long enough to allow of troops collecting in sufficient numbers to beat him before he is firmly established on shore. Time enough ought thus to be gained, so that, by means of telegraphic communications and fast steamers, information of the enemy's movements may be conveyed to the fleets, that they may unite and cut off the invaders from their supports.

Harbours and bays which would afford an enemy a secure landing at all times, if they could obtain possession of them and fortify them, require to be rendered defensible, especially those which also contain Dockyards and Arsenals, private building yards and stores, the destruction of which would cripple the resources of the country; and it is also very desirable to afford some protection to ports containing only mercantile shipping.

Various descriptions of works are required in different cases; for instance, small works secured against surprise and assault will be generally sufficient for the defence of an open coast of small extent, numerous powerful batteries will be necessary to prevent an enemy from entering important harbours, whilst chains of strong forts will be required to encircle Dockyards and Arsenals, so as to secure them against prolonged attacks and bombardments.

The circumstances under which the attacks may be made vary so much that it is difficult to lay down precise rules for this branch of fortification, but the following remarks have been extracted from various authorities, especially from

the articles by General Sir John Burgoyne and the late Lieutenant General Lewis, Royal Engineers, printed in former volumes of the "Professional Papers."

In making arrangements for the defence of coasts competent naval authorities ought to be consulted, so that an exact knowledge may be acquired of the description of vessels which could occupy particular positions, the course which they would take under various circumstances of winds and currents, and the depths of water in all directions, as well as all other particulars affecting their movements.

For the defence of open coasts it may at first sight seem desirable to place guns so that every part where a landing can be effected may be commanded by some of them; and some officers recommend that small open batteries should be placed at small intervals, and that enclosed works should be built in rear of these to command them, so that if the enemy land they cannot retain possession of the former nor take the latter without considerable delay; but this may require too great a number of works, and if many of them were to be constructed in such a manner as to be rendered secure against an assault the expense would be enormous.

Not many men besides the Coast-guard men, the Militia, and the Volunteers can be considered available for serving the artillery in such batteries, as nearly all the regular troops would usually be required for the fortresses and for the moveable artillery attached to the army defending the part of the country liable to invasion, therefore it would be useless to build a great number of these works; but perhaps in some cases heavy guns mounted on travelling carriages, and manned by Militia or Volunteers, may be available to be brought up to check the enemy in landing, in addition to those which can be permanently mounted in batteries; and places for such guns should be levelled beforehand at the commanding points, the excavated earth being formed into low parapets, so as to afford cover to them.

To support the Militia, or other troops engaged in resisting an enemy endeavouring to effect a landing, large bodies of troops ought to be kept in reserve, ready to be concentrated at the points attacked; and good roads and proper organization on the railways are indispensable to effect this object rapidly.

As there can seldom be means for building, arming, and manning batteries sufficient to command every part of the coast where troops can land, it is desirable to place the works so as to defend those particular parts from whence an enemy could most rapidly advance to the attack of points of strategical importance, or where they could most easily entrench themselves and secure the landing of their supports.

For the defence of harbours which might be useful to an enemy, and in which mercantile shipping could take refuge, numerous batteries would be desirable, which should be placed so as to command the entrances, and prevent an enemy outside from setting fire to the shipping or stores in them by means of either guns of long range, mortars, or rockets; and sometimes a small fort may be added on a commanding point, so as to allow of a prolonged defence, and prevent the enemy making use of the harbour, even if they succeeded in taking possession of the batteries which defend its entrance.

If a harbour contains a Dockyard or Arsenal, its defences must be such as to secure it not only against an attack from the sea, and against sudden bombard-

ments for the purpose of burning those establishments, (which are of vital importance to maritime nations for refitting their fleets), but also against prolonged sieges undertaken by large bodies of troops. As a security against bombardment from the land side, such a harbour should be enclosed by a chain of detached works, placed so as to render it necessary to take them before mortars or shell-guns can be placed within range of the establishments intended to be protected; and it must not be forgotten that the range of artillery has been so much increased that it will be necessary to enclose a very much larger space for this purpose than that which was formerly considered sufficient.

Before determining the points to be attended to in constructing coast defences it is desirable to consider closely the circumstances under which an enemy usually attacks them; and the disadvantages under which ships labour in contending with land batteries are thus stated by General Sir John Burgoyne, in the 1st number of the Corps Papers of the Royal Engineers, at p. 101.

"1. They are exposed to a fire which they can only return very imperfectly while taking up their position.

2. They must always be subject to more or less movement, which will affect the precision of their fire.

3. The men serving the guns on board have not such good means of judging their distances as those on shore.

4. A large proportion of shot and shells may strike a battery without doing any essential injury, whilst hardly any can hit a vessel without being very destructive.

5. They are susceptible of total destruction by red hot shot, and by incendiary means in general."

To this it may be added that if a ship's movements are entirely dependent upon paddles, propeller, or other machinery, a single shot may render her completely powerless by striking some part of it; and also that when there is much smoke the masts of ships are much more visible, and indicate their position much more clearly, than the flag-staffs of land batteries, which latter may indeed be removed altogether if required. On the other hand, if ships are provided with steam power, they have the advantage over land batteries of being able to move from one point to another, and thus, in some cases, of combining with other vessels to overpower each of the batteries opposed to them in succession. The application of steam power enables ships to venture into shallower water and into more favourable positions than sailing vessels could reach, and a single line-of-battle ship carries such a powerful armament that if her fire takes effect on a small battery, nearly on the same level, it is very likely to be silenced.

Ships which have their sides protected by iron plates will of course be much more capable of resisting the fire of batteries, but they cannot move so rapidly as other vessels; and batteries placed at a high level may be able to cripple them by means of a plunging fire directed upon their decks.

The late Lieut. General Lewis has stated that "no battery or batteries, however strong, can stop or prevent any ship of war or steamer entering a harbour when the navigation is free and the course nearly direct, *if she chooses her own time*; as examples—the conquest of Curaçao is one on a small scale, and the passage of the Dardanelles another upon the largest;" but the intro-

duction of rifled guns has now given a great advantage to the batteries, their long range enabling them to hit the ships much sooner than was formerly possible, whilst the motion of the latter must render the fire even of such guns, when afloat, much less accurate than that of guns ashore.

The principal rules to be attended to in constructing batteries in general are the following:

1. To avoid placing them so low as to be commanded by a ship (the fire of rifles and light ordnance from whose tops may perhaps henceforward have considerable effect), preferring a height of about 50 feet above the sea, and sites which are not too near deep water; and it may be observed that batteries at the level of 50 feet above the sea will not be struck by shot ricocheting from the water after being fired from a ship.

2. To avoid placing one battery directly in rear of another, and at a level only a little higher, for fear that the shot which miss the lower battery should injure that above.

3. To avoid, if possible, placing a battery close in front of a hill, rock, or building; as in that position shells which miss the battery, and would otherwise pass on without doing mischief, may be *caught* and explode so as to produce a very great effect upon its defenders.

4. To take care that the works are not placed so high as that the guns cannot be depressed enough to command the surface of the water thoroughly, and to bear in mind that the advantage arising from the shot which fall short ricocheting from the water and hitting ships may be lost if a work is more than about 50 feet above its level, unless the range is so great that the shot can strike the water at an angle not greater than 5° or 6°.

5. To form the parapets of earth 24 feet thick at top, wherever there is room, as they will be exposed to the fire of guns of the largest calibre, which are now carried even by gun boats; and if the guns are in embrasures, to place them at intervals of 21 feet, or even 30 feet, if there is plenty of space, so that it may be more difficult for ships to concentrate their fire on them; (indeed if the guns are on traversing platforms they cannot traverse fully with a less interval than 30 feet.)

6. Wherever the area available for ships to approach is considerable, the parapets should not have embrasures cut in them, but should be adapted for guns to fire over their crests, otherwise all the guns cannot be brought to bear effectually on a ship at the same time, which advantage cannot be counterbalanced by that of covering the gunners better by forming merlons; but when exposure to enfilade fire cannot be avoided the guns should be in embrasures. Dwarf traversing platforms, moving on racers raised to the required height on curved dwarf walls, are now ordered to be employed in barbette batteries, instead of the high traversing platforms.

7. To build the parapets of such heights as are proportionate to the relative levels of the battery and ships; for if the battery is but little above the sea, or *à fleur d'eau*, it may be necessary to make them more than 8 feet high, whilst, if it is on high ground, they need be only 5 feet high.

8. As the power of rapidly traversing the guns in coast defences is most important, every arrangement must be made to facilitate this by providing rings for tackles, &c.

9. To take care that the height of the sill of the embrasure, or parapet to be fired over, is such as to allow of the greatest required depression being given to the guns to be mounted in the battery.

10. To provide efficient means of preparing plenty of hot shot, or molten iron to be fired in shells, at the shortest notice, so that there may be every facility for setting fire to ships.

11. To construct secure powder magazines, an expense magazine for every 5 or 6 guns, and small rooms for preparing shells, &c., in each battery.

The following points should be kept in view in determining the positions and forms of batteries for the defence of *harbours*.

1. Since the great object should be to cripple ships whilst advancing to the attack, and before they can bring their broadsides to bear on the batteries, the latter should be placed so as to *enfilade* the lines of approach, and rake vessels at the earliest possible period; for even the loss of a spar may oblige a ship to anchor when not intended, and thus derange the position of all those following her.

2. To place the works so that if ships succeed in passing the outer ones they may encounter the fire of others inside, the effect of which would probably be more decisive from the ships having previously suffered from the fire which they had already passed through; and to construct some batteries on points or islands commanding the approaches to the mouth of the harbour as a check to an enemy's preparations for an attack.

3. To trace the longer batteries so that they cannot be enfiladed, or, if this is impossible, to construct very solid traverses, or even casemates, to cover the guns in them: the enfilade fire of ships is however much less efficient than that of land batteries, and is not much to be feared unless a battery is so low as to be commanded by the horizontal fire of a ship.

4. To arrange the batteries so that no single work can be attacked by a number of ships at the same time, without also exposing themselves to be raked by other batteries. It is therefore desirable to consider well how each battery will bear upon the positions which the ships are likely to take up for the purpose of silencing other works, and to place some guns so as to bear upon ships which may have got into the harbour, and threaten to take the outer works in reverse.

Separating the batteries to a certain extent gives them advantages over ships, and in consequence of the increase lately obtained in the range of artillery, by the introduction of rifled guns, more sites may be advantageously occupied by artillery than was formerly the case, as ships can now be hit by guns on shore long before the latter are distinctly visible from them, and they may be much crippled before they can effectually return their fire; but when the works are very much scattered it is often difficult to secure them against an enemy landing out of range and attacking them in rear.

It will sometimes be desirable to construct a line of works, armed with very powerful guns, upon heights at some distance in rear of the coast line, as at Gibraltar, to obtain the advantage of a second tier; and guns so placed are not easily silenced.

All batteries should be secured if possible against assault in rear as well as on the other sides, by enclosing them with wet ditches or with palisades or

loopholed walls; and these must be well covered by a glacis, or, if they are constructed at the gorge, they may be protected by the parapet of the work itself.

Guard-houses are required in each work, and Napoleon I. ordered that all important batteries should have square towers built at their gorges, as keeps, to prevent an enemy retaining possession of the batteries if they succeed in entering them; but the machicoulis galleries of his "model towers" are so slight that they would be easily knocked down even by the fire of field-pieces, and the parapets of machicoulis defences in such buildings should be 3 or 4 feet thick, and should rest on massive arches. To protect a guard-house against the fire of ships it is desirable that it should not rise above the level of the crest of battery, security against assault being obtained by forming ditches round it, building it in the form of a cross to afford flanking fire, and placing it so as to defend the gorge of the battery.

Every part of the enclosure of each important battery should be flanked, and it is necessary that the kaponiers, or other flanking works, should be well covered against the enemy's artillery fire, in order that, even if an opening is made in the enclosure, it may be difficult to enter by it, in consequence of the flanking fire being preserved intact.

When a battery must be placed so that it is commanded by ground outside of it accessible to the enemy if they land, it is necessary to build its gorge enclosure high enough to screen the interior from their fire; and Sir John Burgoyne states that even if it is thus so high as to be liable to arrest shells and cause them to explode or drop within the work, this is the lesser evil of the two. In works liable to be bombarded, splinter-proof traverses will be required between every pair of guns and the next, which will also be of use in defilading them against reverse fire.

It will of course be useless to add enclosures and flanking defences to batteries unless there are likely to be infantry enough to man them, and in some cases mere earthen batteries provided with small defensible guard-houses may be sufficient, the gunners being thus enabled to retreat into the latter if the work is assaulted; and perhaps they may be able even to prevent the guns being spiked by maintaining a steady fire of musketry from the guard-house, but if the loop-holes in it do not command every part of the battery and the enemy have time to turn the guns round to bear upon the guard-house, it cannot hold out long.

The use of *masonry* for scarps and parapets cannot always be avoided in coast defences, as they are sometimes required to be placed in positions where the wash of the sea would destroy earthen works, or where considerable advantages may be gained by constructing casemated batteries having several tiers of guns, for instance, on a pier-head or a site from whence a narrow channel can be enfiladed, when the concentration of guns bearing upon one line is very desirable, and also on rocks or shoals of small dimensions. Experience shows also that the constant motion of ships prevents their fire from being concentrated upon portions of the walls, as that of land batteries is, so as to effect a breach, and especially if their surfaces are curved, as in the case of the celebrated Martello Tower on the coast of Corsica, which resisted the fire of a line-of-battle ship and

frigate, though it was only armed with one gun; and this circumstance led to the construction of many such round towers for the defence of the coasts of England and Ireland.

If casemates are adopted, it is desirable to leave them quite open in rear, to allow the enemy's shot to pass through without knocking off splinters from the walls; and care must be taken to make them wide enough to give ample room for working heavy guns. In some cases the parapet at the front of the casemate, as well as that of the platform above, may be constructed of earth instead of masonry.

Embrasures formed in masonry should be as narrow as possible externally, only just allowing room for traversing the guns, so that there may be but a very small opening for the enemy's shot to enter: and this will be secured by mounting them on traversing platforms, moving on iron racers placed in arcs the centres of which are only about 3 inches in rear of their muzzles. It has been proved by numerous experiments that if these racers, instead of being flat, are rounded at the top, and the trucks of the traversing platforms have their tires hollowed to fit them, in order to stop the recoil of the platforms on firing the guns, the *iron pivots*, hitherto required for retaining the platforms, may be omitted, which will lessen the difficulty experienced in narrowing the external openings of embrasures.

It appears desirable to strengthen the cheeks of masonry embrasures by the insertion of masses of wrought iron, cast iron having proved too brittle, and experiments are now being made in order to determine the best mode of construction: in the mean time the Report of General Totten, of the United States Engineers, of which extracts are given in the 8th Vol. of this Series, may be referred to for information on this subject.

There must be plenty of room for depressing the guns, and elevating them for very distant fire, when necessary, otherwise the masonry will be injured by their explosion; they must be carefully traced, so that the guns, when mounted, will have the proper lateral range, and care must be taken to construct the piers inside so that the platforms may traverse without difficulty. There must also be proper means for mounting and dismounting the guns in casemates, viz., strong rings fixed in the arches, &c.

PAPER XV.

Description of a Modification of Wheatstone's Rheostat, Manufactured by Messrs. Elliott, and invented by Mr. Becker, of the same Firm.

By CAPTAIN SCHAW, R.E.

The use of the Rheostat, in connection with the explosion of charges of gunpowder by voltaic electricity, has been described by Captain Ward, R.E., in his valuable paper on the application of the voltaic battery to military purposes, which was published in Vol. IV. of this series.

This instrument is also useful in experiments connected with the working of the electric telegraph; but for the latter purpose, as the resistance opposed to the passage of the current of electricity is much greater, and feebler currents are required than are necessary for heating the platinum wires so as to ignite gunpowder, the details of the rheostat must be varied, and the wire must be longer, thinner, and made of a metal possessing inferior conducting powers than would be required in an instrument intended for experiments relative to the explosion of gunpowder. The principle, however, is the same in both cases.

The form of rheostat invented by Professor Wheatstone, and described in Captain Ward's paper above alluded to, has some practical disadvantages, which have been so ingeniously overcome in the new form of the instrument devised by Mr. Becker, of the firm of Elliott, Brothers, No. 30, Strand, London, that I requested him to furnish me with a drawing and description of it for publication in the Professional Papers, in order that any of the officers of the Corps who may be engaged in electrical researches may know where the best form of this instrument is to be obtained.

The inconveniences which have been experienced in using the instrument in its original form at the Establishment for Field Instruction, at Chatham, are as follows, viz.:—

1. The expansion and contraction of the wire makes it slacker in warm weather than in cold; and in consequence of this it gets loose on the insulating cylinder, and the convolutions of the wire "ride" one on another, and thus interfere with the accuracy of the experiments, unless great care and watchfulness be observed.

2. If the handle be turned in the wrong direction at any time (a mistake which has frequently occurred, the wire is loosened on the cylinders, and much time is lost in re-adjusting it.

3. It is necessary to change the handle from one cylinder to the other whenever the wire is to be wound on to the insulating cylinder, or wound off it and on to the conducting cylinder.

4. To increase or lessen the resistance rapidly, it is necessary to wind a considerable length of wire on to one cylinder from the other, an operation occupying some time, and tending to wear out the instrument.

All these inconveniences are eliminated in the modified rheostat designed by Mr. Becker, the wire being wound on an insulating cylinder, and permanently fixed there in a spiral groove sufficiently deep to hold it firm, even when expanded to the greatest length which it will attain at ordinary atmospheric temperatures, while the current of electricity may be made to pass through a longer or shorter length of the wire, by an arrangement which will now be described.

AB is a cylinder of alabaster, serpentine, or other convenient insulating material, mounted at the ends in brass sockets, furnished with pivots, which turn in brass uprights fixed in a wooden stand. Motion can be communicated to the cylinder by means of the crank and handle *f*. On the surface of the cylinder is cut the thread of a screw, the number of turns of the screw, together with the diameter and length of the cylinder, depending upon the use to which the instrument is to be applied. A wire is wound on the cylinder in the groove, which is not deeper than half the diameter of the wire, so that the wire projects and forms a male thread of a screw on the cylinder. The diameter, length, and metal of the wire depend, like the size of the cylinder, upon the degree of resistance to the passage of electric currents which it is desired to obtain; but a thinner wire than No. 30 wire gauge is not suited to this modified form of rheostat.

Parallel to the large cylinder *A B*, is placed a metal rod *d e*, fixed on springs at *d* and *e*, which press it towards the large cylinder. A small wheel *c* works on this rod, which serves as its axis, and on which it is free to slip easily from end to end.

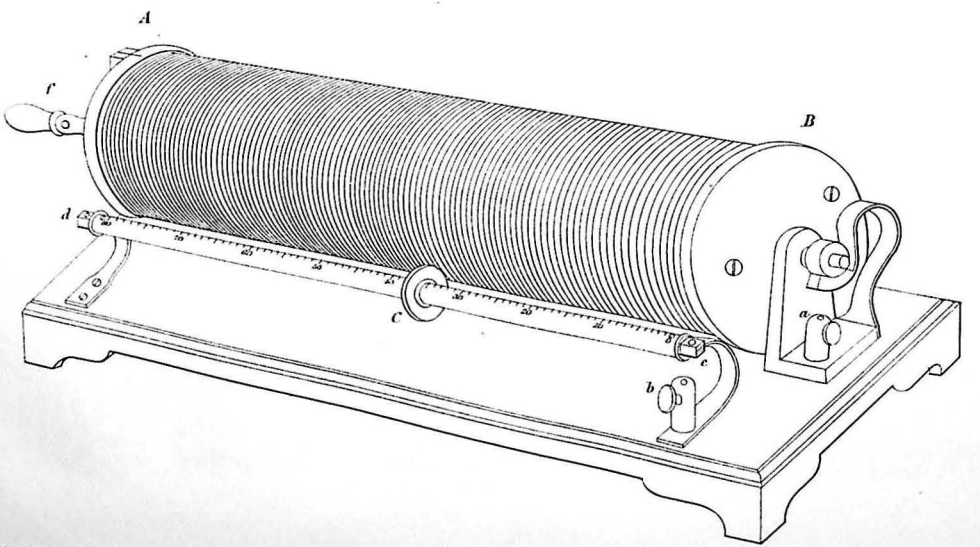
On the edge of the small wheel a groove is cut to fit the protruding wire wound on the large cylinder, against which it is pressed with a moderate force by the springs at *d* and *e*. As the cylinder is made to revolve by means of the handle *f*, the projecting wire acts like a screw upon the grooved wheel, and moves it gradually along the metal rod, which is divided so as to indicate the number of revolutions of the cylinder *A B*. The brass mounting at *A* is graduated to tenths, and indicates by an index hand the fractions of a revolution. At *a* and *b* are two binding screws, by means of which the instrument is introduced into the electric circuit under examination; *a* is in connection with the end nearest *B* of the wire wound on the cylinder *AB*; *b* is in connection with the metal rod *d e*, and through it with the wheel *c*, which may be brought into contact with the insulated wire at any point of its length between *A* and *B*, thus obliging the electric current to pass through a greater or less length of the wire as may be desired.

Should it be necessary to vary the resistance quickly, and to any considerable amount, the rod *a b* may be pressed back by hand, and the wheel *c* moved to any position and adjusted again to the wire on the cylinder *A B*, thus avoiding the necessity for screwing the wheel along the rod for a long distance by the revolution of the large cylinder.

H. SCHAW,
Captain, Royal Engineers.

Chatham, 3rd April, 1860.

IMPROVED RHEOSTAT.



PAPER XVI.

Account of the Siege of Plymouth by the Royal Army in 1643, Accompanied with Notes by CAPTAIN E. F. DU CANE, R.E.

The accompanying contemporary account and plan of the siege of Plymouth, (called "the most considerable strength in the kingdom,") during the Civil War, appears for several reasons sufficiently interesting to be worthy of reprinting in the Professional Papers.

This record conveys much information as to the modes in which our ancestors attacked and defended places, and has considerable historical interest attached to it; the localities referred to in it are well known to many of the officers of the Corps, and there may be something to be learnt from the long and active defence made by the little garrison of Plymouth, with the aid of the earthworks they threw up for the purpose.

It is worthy of notice that some of the points recommended by the Defence Commission of 1859 to be taken up, are the same as those which were occupied by defensive works in the year 1643; and this shews that, notwithstanding the alteration that has taken place in our mode of warfare, the consideration of warlike operations carried on so long ago as these may not be altogether unprofitable.

The circumstances of the war in these parts, previous to the time when this narration commences, as briefly extracted from Clarendon's History, the Rushworth Collection, and other sources, were as follows:—

The Committees of Parliament had gained an ascendancy in Devon, even before the battle of Edgehill (23rd October, 1642), but the Royalist party was stronger in Cornwall. The Parliament, determining to subdue Cornwall, sent their forces from Dorset and Somerset to join those of Devon at the end of 1642, and the Earl of Ruthen, a Scotchman, Governor of Plymouth, advanced with them into Cornwall, followed by the Earl of Stamford with a reserve. At Bradock Down they were defeated by Sir Ralph Hopton; and Ruthen, flying to Saltash, fortified himself and brought up a large ship to assist him, but was again driven back, and had to fly in a boat over the Tamar into Plymouth, leaving all his ordnance, &c., behind him.

In May, 1643, the Earl of Stamford marched again into Cornwall, but was beaten at Stratton, and fled to Exeter. The Cornish army having then joined Prince Maurice in the operations in the adjoining counties, still left the Parliament stronger in Devon, for while the Earl of Stamford possessed Exeter, and Colonel Ware held Tiverton, for Parliament, a few Royalists only, under command of Sir John Berkeley, were posted three miles from Exeter, and a small force under Colonel Digby was despatched to the north of Devon. Yet these two prevented the Parliament from communicating with Plymouth, or harassing "faithful Cornwall."

The garrison of Plymouth was now strongly reinforced from the fleet under the Earl of Warwick, and in August, 1643, resolved to join with the garrisons

of Barnstaple and Bideford to relieve Exeter; but they were defeated at Torrington by Sir John Digby; and Prince Maurice coming at the same time to Exeter turned the scale of affairs in the county so much that the towns on the North Coast submitted to the King, and Colonel Digby, with 3,000 horse and 800 foot, marched to Plymouth about the middle of August, to blockade it.

On the 4th September Exeter surrendered to Prince Maurice, who, after staying there some time, went and sat down before Dartmouth; and it was thought that he committed a great error in not advancing immediately to Plymouth, which was then full of distraction and jealousy.

Clarendon thus describes that town:—"It was a rich and populous corporation, being in time of peace the greatest port for trade in the West, and, except Bristol, then more considerable than all the rest. There was in it a castle very strong towards the sea, with good platforms and ordnance; and little more than a musket shot from the town was an island with a fort in it, much stronger than the castle."

During the absence of Sir Jacob Astley the Captain, the Mayor and Corporation had got the castle and island into their own possession. Parliament committed the care of the fort and island, which were looked upon as the security of the town, to Sir Alexander Carew, while the Mayor commanded the castle and the town, about which "was cast up a line of earth, weak and irregular."

This brings us to the period when the narrative commences, namely, during Prince Maurice's siege of Dartmouth, which lasted till the 6th October.

E. F. D. C.

A TRUE NARRATION OF THE MOST OBSERVABLE PASSAGES IN AND AT THE LATE SIEGE OF PLYMOUTH, FROM THE 15TH OF SEPTEMBER, 1643, UNTILL THE 25TH OF DECEMBER FOLLOWING, &C.

After Colonell Wardlaw, Commander-in-chiefe, and Colonell Gould, with the 600 men, shiped at Portsmouth about the 15 of September, for the reliefe of this towne, had stopt in Torbay, and finding Dartmouth besieged, left 100 men there for the strengthning of that garrison, we arrived at Plymouth the last of September, (which towne had been blockt up by horse so that no provision was brought in from the countrey for six weeks before) and having refreshed our men, and mounted some 150 of them on horseback, the enemy having only one regiment of foot (besides their horse) lying before us at their quarter at Plymstoke, and keeping a constant guard at Howe, close under Mount Stanford, consisting of about three hundred foot and a troop of horse, which fort they intended first to assault: about nine dayes after our arrivall, the eighth of October, we put over some three hundred men before day in boats, to Mount Stanford, and at breake of day fell on and surprised the enemies' guard at Howe; took Captaine Slowley, one Ensigne and fifty-two common souldiers, prisoners, two colours, and three barrels of powder, and put the rest to flight, with the losse only of two men of our side: about the same time we secured some malignants in the town, and sent up three of them to Parliament.

By this time the enemy had taken Dartmouth, and was on his march with his whole army to sit downe before us; and we received intelligence that the enemy kept a guard of two troops of horse at Knocker's hole, about two miles from our workes; the fifteenth of October we sallied out with our horse and two hundred Musquetiers, surprised that guard, and had taken twenty or thirty prisoners; but about sixteen of our horse pursued the rest, that fled so fast that their orders for retreat could not overtake them, engaged themselves too farre, and returning loaden with prey and prisoners, other troopes of the enemy comming from their quarters on Rowborrow Downe, to answer the alarme, met with our pursuers and took them all, save only Major Searle, who charged thorow them and escaped. Lieutenant Chasing, with fourteen more, were taken, and after escaped out of prison, and returned to us, save only two or three.

And now the enemy, being setled in his quarters, at Plymton, Plymstoke, Causands, Buckland, Tamerton, &c., with an army consisting of five regiments of horse, and nine regiments of foot, brought overland from Yalme thirteene fisher boats, into Plunket Mills Bay, over against Prince Rock, with an intention, as we conceived, to land men on Catdowne in the night, which they did not attempt, but set on Mount Stanford in good earnest: and the twenty one of October, in the night, they raised a square work within pistoll shot of our Fort of Stanford, on the north-east side, and from thence were drawing of a line with halfe moones to surround the said fort, thereby to hinder our reliefs from coming unto it. To prevent which, the same day we fell on the enemy in their new worke they had raised, with all the disadvantage on our part that possibly could be imagined, exposing our open naked bodies to an enemy within a strength, and assisted by their horse, who much annoyed us, we having none of our horse to assist us, nor could have, the sea being betweene us and them: after long skirmish and diverse repulses, at last we got their halfe moone, and after three houres hot fight, their close worke, and in it Captaine White and fifty other prisoners: in which work we put a guard that night of thirty musquetires, commanded by an ensigne; by whose treachery or cowardize, the enemy falling on that night, the said guard quitted the worke to them, without giving any alarme to the Fort, for which he was shot to death shortly after: which cost us a new labour the next day, with farre greater difficulty and danger than before; the enemy having of their horse and foot ready to second their guard in their new regained worke, which yet we againe made ours, after the losse on our part of Captaine Corbet, who was shot in the forehead as wee fell on upon their work; and three other of our captaines were also wounded this day and the day before; and wee had in both fights some twenty men killed, and above one hundred wounded, of whom many are since recovered. The enemy lost six commanders, whose names were concealed from us, and many men, besides those taken prisoners.

After we had gained the enemie's worke the second time, we slighted it,* but to prevent the like approaches, in regard Mount Stanford being a small worke, and very untenable of itselfe, much losse to keepe so large a circuit of ground as it was built to defend, we were necessitated to draw a line of communication both on the east and west side of the worke, to maintaine a long ridge of ground, with halfe moones at each end of the line, which we defended divers

* *i.e.* demolished.

dayes with extraordinary duty to our men, and divers skirmishes with the enemy, till the third of November, when the enemy planted their batteries within pistol shot of our forts; and on the fifth of November battered our worke with two hundred demy cannon and whole culverin shot, besides other smaller cannon that continually played on us, and flanked our line from Ofan Hill, whereby breach was made in the fort at severall places, and the lieutenant and some gunners at the fort slaine: the breach we repaired in the night, thickning the rampart as much as the smallnesse of our work would admit, and strengthened the weakest places with woolsackes. The next day they continued their battery till noone, with too much successe, yet so as no considerable breach was made, which day the enemie, whether they had intelligence of the want of provisions and ammunition in the fort, about one of the clock fell on horse and foot on our halfmoons and line, where we had reasonable guard; but tired with eight daies duty and long watching, after an hour's skirmish were enforced to retreat from the half moon and breast work, and were taken by the enemie's horse who came on the backs of them.

The Captaine of the Fort having but seven men, of thirty six, left to manage the gunnes, seeing himself thus surrounded by the enemy, whereby no reliefe of provisions or ammunition could be brought him from the towne, and upon examination finding but two barrels of good powder and a small quantity of case shot with him, and no provisions, and having held off the enemy some two houres, and given a signe to the towne by hanging out a wist, that he was in distresse, and no reliefe came; and the townsmen, for some reasons which you shall hear anon, being unwilling to go over, and Collonell Gould's regiment being those that were tired, and put to the retreat, unfit to encounter the enemie's whole army that were fresh and victorious,* the Captain yeilded the fort on composition about four of the clock, upon conditions that he should march off with colours flying, matches lighted, bullet in mouth, and a demy culverin, the best in the worke, with bagge and baggadge; and that the enemy should exchange all the prisoners they had taken of ours that day, being about fourtie, for the like number of their prisoners with us, which the next day was effected accordingly; but we are unwilling to let the world know by whose treachery, at least neglect, this fort was lost, for want of convenient quantities of ammunition and provision.

While the enemie was busie about Mount Stanford, we had begun to raise a worke upon Howstart, where our men retreated after they were beaten from Mount Stanford, which, being unfinished, and the same wearied men enjoyned to keep it till the morning (for we had no other, the townsmen refusing to go over) possessed with feare of the enemie's horse, quitted that place also, which the enemy soon after seized upon, and have there built a fort and divers batteries to hinder shipping from coming into the harbour, and others to shoot into the town, and at our windmill on the Hoe. But, notwithstanding, they have done no harme to any ship or boat that hath passed in or out for these two monethes past, nor hath any shot, of the many hundreds they have sent into the towne, from thence, done the least hurt to man, woman, or childe, (except one woman hurt in the arme with a stone) and but little to the houses, save that they shot off one vane of the windmill, which was presently new grafted; so that by

* This occurred on the 4th November.

experience we find that the losse of Mount Stanford was the wonderfull providence and goodnesse of God towards us, which, had we kept, we must necessarily have lost the best of our strength in the defence of it, and having lost it, we finde small dammage by it, our ships being beaten out of Catwater before we lost Mount Stanford by the enemie's cannon planted at Ofan, and by a batterie under Mount Edgecombe on the other side, from riding between the iland and the main, so that we were faine to take Mill Bay for sanctuary: nay, rather the losse of that was infinitely advantagious unto us, in the neerer uniting of our small strength for the defence of the towne, and the offering an opportunity to us to seize upon the fort and island, the most considerable strengths in the kingdome, which then were utterly destitute of provision, ammunition, or anything else necessary for the defence of them, of which neglect, and the authors of it, account may be given to the Parliament in due time; for in the very instant of the losse of Mount Stanford, while all men stood in doubt of the issue, Colonell Gould, by order from Colonell Wardlaw, Commander-in-chiefe, tooke possession of both those places, and afterwards setled stronger garrisons with store of provision and ammunition of sorts in the said fort and island. The securing whereof, and, at the request of the well affected of the towne, of four deputy lieutenants in them, of whose unfaithfulnesse to the State the townsmen had great suspition, we have found since to have been a most effectual means, under God, to preserve the towne. For these persons and places being secured and victualled, the towne, which before was altogether divided and hartlesse in its defence, now grew to be united with a resolution to sticke by us in the defence thereof, partly out of fear, knowing that the fort and iland would be goades in their sides, if the towne should be lost, but especially from their assurance of our reall intention to defend the towne to the last man, by the securing of those four deputie lieutenants whom they suspected, and by the many asseverations and resolutions of the officers that they would, when they could defend the towne no longer, burn it to ashes, rather than the enemies of God and his cause should possess it, which resolution of theirs they confirmed, by joyning with us in a solemne vow and covenant for the defence of the towne, a copie whereof is annexed to the end of this relation.

The enemy thus possessed of Mount Stanford, accounting now all to be his owne, sends a trumpet to us with a summons, a coppie whereof also followeth at the end, which was answered by silence.

The same day Mount Stanford was taken the enemy made an attempt upon Lypson worke, but was repulsed with losse.

The eleventh of November, a party of horse and musquetires were commanded out to Thorne hill to guard in wood and hay; but they transgressed their order, and pursued some of the enemie's horse to Knocker's hole, killed a captaine and some common troopers, and tooke some prisoners; but, staying too long, drew the maine body of the enemie's horse upon them, and Major Leyton, striving to make good their retreat, was taken in the reare, after he had received five wounds.

And now the enemy, having refreshed his men, and having secured his now gotten purchase, about the sixteenth of November, sits downe on the north side of our towne, we in the meane time being busied in mending up some hedges that were formerly pulled downe betweene the workes, the only line of

communication we yet have, scarce defensible against the stormings of horse; yet such places we must now resolve to defend upon equal terms with the enemy, for the workes are at such a distance each from other, and the grounds so uneven, that an enemy may in some places approach within the workes, without any molestation by them.

On the the twenty-eighth of November the enemy planted his battery against Lypson worke, but could not approach within musquet shot to batter our worke, in regard of a deepe valley betweene, by reason whereof, after three days battery, they did little execution on our worke.

About this time, one Ellis Carkeet, a malignant mariner, was accused and laid fast, for tampering with Roger Kneebone, the chiefe gunner at Maudline Worke, to blow up the said worke, the powder roome being buryed in it, and he having the keyes, which was discovered by the said Kneebone after he had concealed it diverse dayes, God not suffering his conscience to give him rest till he had revealed it. Upon the apprehension of Carkeet, two notorious malignants, Henry Pike, a vintner, and Moses Collins, an attorney, conceived to be privie to his treason, fled to the enemy, and upon the third of December, being the Lord's day, the enemy, as is credibly informed) guided by these two renegadoes, with foure hundred musquetires, three houres before day surprized our guard at Lary point, and in it three peeces of ordnance. The worke is but a halfe moone, and the guard there placed only to give the alarme, if the enemy should approach Lary Point over the sands when the tide is out. By which meanes the enemie, comming on under Lypson worke (being a false variable ground to them by reason of its steepness) and comming on the back of our guard, easily surprized it.

The alarme being given to the towne, and one hundred and fifty horse and three hundred musquetires at break of day, ready to fall on upon the enemie that were possest of our worke, which the enemy at Mount Stanford perceiving (for we fell on upon the south side of the hill that was from the enemie's view), gave the maine body of the enemie, that was at Compton all in armes, a warning piece; upon which, Prince Maurice, and all the gallantry of their armie, with five regiments of horse and four of foot, (having in the night made their way with pioneers) advanced under protection of their owne ordnance, and a hedge which they possest, where we usually had our centries, and where since we have built a worke under Lypson, to the assistance of those who in the night had surprized our guard.

We were in hope to have beaten off the enemie before their seconds came up; and with horse and foot falling resolutely on them, met with strong opposition, and Captaine Wansey, a gallant man, charging at a gap which formerly he knew to be open, but now made up by the enemie, was unfortunately slaine; which made our horse give ground, and both horse and foot after to an absolute rout for three fields together; at which time some of the enemie's horse mixt themselves with ours, and came within pistoll shot of the wals and were killed or taken. When a stand being made upon the height of the hill above Lypson worke, and fresh men being drawne from severall guards, our men being encouraged, we held our ground for foure houres. During which time, our ship at Larypoint, seeing our guard there taken, entertained a parley with the enemy, and so stood newters till we had beaten the enemy to a retreat, for

which some of them are in question for their life. The enemy likewise sent a trumpet to Lypson worke to summon it, and was answered with the cannon after the trumpet was commanded to depart. And wee having gotten a small drake planted in the crosse way discharged it foure or five times on the enemies horse with good execution; and giving a signe by the sound of a drumme, when our severall commanded places should fall on, the enemy began to give ground, and some two hundred musquetires of the trained bands of the towne being come to our assistance, and a party of some sixty musquetires sent about to play on the backes of the enemies, was no sooner perceived by the enemie but he commanded a retreat, which was followed so close by us that it was little better than a hasty flight; for, retreating most part over the Lary, and not the same way they came on, their reare gard of horse, of about one hundred, being cut off from their way of retreat, were forced into the mudde, betweene Lypson Worke and Lary point, and the horse were almost all taken or drowned when the sea came in, some of the riders crawling through the mud, hardly escaped; many of the enemy were killed in their retreat by our horse and foot, and by the ship at Larypoint, who then grew honest againe.

Of prisoners we tooke a Captaine-Lieutenant of horse, and one Langsford, a priest, that was a captaine, and some thirty common souldiers, and thirteene barrels of powder, two teames of horses with furniture, by which they were drawing up our ordnance against us. Of ours, the enemy took in our first retreat Captain-Lieutenant Roe, Lieutenant Upton, Ensigne Crocker, and Francis Rolles, ensigne, and about forty common men, besides Captain Wansey, and about twelve more killed, and a hundred more wounded, of whom some are since dead. Colonell Gould had one horse killed under him, and another shot, but he was mercifully preserved.

The Lord showed himselfe wonderfully in our deliverance, in that, when the enemy had gotton a ground of advantage, and were tenne to one against us, yet was pleased by our handfull to drive them backe another way than they came. For had the enemy possest the ground that they had gotten that night, the next day they would have been masters of all Catdowne, and then we must have quitted our outworks as unuseful to us, and have betaken ourselves to the towne walls, which then were not fully finished, and could not long have been defended. The same day the enemy with horse and foote assaulted Penny-comequick workes, and were repulsed with much losse.

The enemy being thus repulsed, suffered us to be quiet (as his usual manner was) for 15 or 20 daies after; in the meane time, gathering up his routed troopes, save that one night he fel on upon a work we were raising under Lypson, called in the mappe Lypson Mill worke, for the prevention of the enemie's incursion againe that way, and partly slighted it, our guard there quitting it without a shot, from which they were suddenly beaten again, and the work reedified. It were endlesse to acquaint you with the severall light skirmishes that daily past betweene us, sometimes about our cattell that straged without our works, at other times to passe time by bravadoes and ambuscadoes made by our guards to entrappe the enemie. And now the enemy, finding his battery against Lypson, and his intent to possesse himselfe of Lary point successelesse, he takes about and beginnes to make his approaches against

Maudlin worke, we in the meantime thickning that worke within to make it proofe, and finding their batteries planted within musquet shot of our worke, we planted a platforme close by Maudlin worke, and drew out a demy cannon which was taken in a prize that was going to the rebells in Ireland, to counter-batter against them, intending to have planted another, if it had been needfull. Upon the eighteenth of December, the enemy began to batter, but by reason of our counter batterie which played constantly into their worke through their ports, whereby their men could not stand safely by their ordnance, we having the advantage in playing downe into them from a commanding ground, the enemy in two days time could do no good with his batterie; but on Wednesday night, the twentieth of December, through the carelesnes of the captaine of that guard, that set out centries perdue, it being a wet and darke night, the enemie raised a square worke with the helpe of a corner of a field, within pistoll shot of Maudlin worke, almost in a direct line between that and Pennicomequick, which, if they had held, might have cut us off from the reliefe of that worke, &c.

Thursday in the morning, the twentyfirst day of December, as soone as it was discovered, the ordinary guardes there, being some threescore men, fell on in hope to have regained it without any more helpe; but found their worke guarded with two or three hundred men, and so were faine to retreat until supply came from the towne. And then about nine of the clock in the morning, having horse and foot in readinesse, we fell on upon their worke, and received the repulse twise, once after we had gained the worke: but our men heartned with the assistance of some fresh men, and backt with most of the strength we could make, fell on, tooke, and slighted the enemie's work, took prisoners a captaine, Prince Maurice's trumpet, and some few others more, and killed that day neer a 100 men; there were taken of ours by the enemy, Lieutenant William Harwar and two more, surrounded by the enemie's horse in one place, and as many in another: we had twenty men killed in the place, whereof Ensigne Grimes was one, and some fourscore wounded, whereof Ensigne Samuel Horte and some others are since dead. Upon the enemies' retreat we could hardly disswade our souldiers from falling on their workes to gaine their Ordnance: but we had too few men to adventure upon so hasardous a designe.

The next day we could see the enemy preparing to draw off their ordnance, and on Christmas day, the twentiefive of December, in the morning, they drew off their guards from about us, being the same day that Prince Maurice promised his souldiers they should be in Plymouth.

That day, Thomas Basset, Major Generall to the enemy, called to an officer of ours that was in their worke, and told him that he thought God fought against them, and said, if he could be convinced that he was not in the right, he would hang himselfe at his doore erre he would take up armes again in that quarrell.

The next day after the enemy rising from before us, part of two of our workes fell downe, which might have indangered the losse of them, if they had continued their seige.

The enemy now quarter at Tavestock and Plymton, to refresh their men, and to recruite for a fourth seige; and for the present they blocke us up from pro-

vision, having driven all the country before them of all sorts of cattell, so that we cannot subsist long unlesse store of all sorts of provisions be sent us.

But if we may have a considerable supply of men, money, armes for horse and foot, sent us with speed, by God's assistance we may be able to take the field, for all the country is inclined to us, which opportunitie we hope the Parliament will not neglect.

One remarkable passage of God's providence to us we must, with all thankfulnesse remember and acknowledge, that after the towne had been a long time strictly besieged, and no fresh victuall, either flesh or fish, could be had, whereby the poore people were grievously punished, there came in an infinite multitude of pilchards, into the harbour within the barbicon, which the people tooke up with great ease in baskets, which did not only refresh them for the present, but a great deale more were taken, preserved and salted; whereby the poore got much money: such a passage hath not happened before.

We cannot forget the humanity of the good women of Plymouth, and their courage in bringing out strong waters, and all sorts of provisions in the midst of all our skirmishes, for refreshing of our souldiers, though many were shot through the cloathes.

We cannot omit to set downe also how that in few dayes after our first arrivall here one Sampson Hele, Esquire, came in a message to this towne, from the Prince, to perswade the yeelding of it. But, coming without drum or trumpet, for his offence hee was perswaded to yeeld us two thousand pounds for the payment and clothing of our souldiers, without which wee could not possibly have subsisted so long.

The enemie's word in this last fight was, "The towne is ours," and our word was, "God with us."

We had upon the losse of Mount Stanford a day of humiliation, and upon God's deliverance of us at Larypoint, a day of thanksgiving, and another since the siege was raised.

The chiefe commanders before us were Prince Maurice, the Earles of Marleborough and Newport, the Lord Mohun, Lieutenant Generall Wagstaffe, Major Generall Bassett, Sir Thomas Hele, Sir Edmund Fortescue, Sir John Grenvile, Sir Richard Cave, Sir James Coburne, Sir John Digby, Sir Peter Courtney, Sir William Courtney, and divers other considerable persons, many of whom, as well as of the common souldiers, are since either dead or desperately sicke.

Attested under the hands of:—

William Gould, Colonell; Michael Serle, Lieutenant Colonell; Will. Layther, Lieutenant Colonell; Nathaniel Willis, Serjeant Major.

Thomas Hallsey, Samuel Bertch, Gabriel Baynes, William Wotton, Henry Plumley, William Hill, Thomas Hughes, Robert Northcote, Henry Potter, Humphroy Barton, Thomas King, George Hamilton, Will. Owen, Captaines.

Here ends the old journal, but there is a manuscript containing an account of the proceedings of the defenders from the time of the raising of this siege up to the latter part of the following April, of which the following is an extract:—

"From the 25th December, 1643, till the 26th January, 1644, fortifications were still continued, many hundred hedges without the works were pulled down, decayed and ruined outworks repaired and new built, breastworks were run

from work to work, and two new works made and two repaired that fell 25th December. Three miles of ground were now fortified, and the enemy's works were pulled down."

Almost every week sorties were made on one part or other of the enemy's quarters (extending from St. Budeaux to Plympton), which were also in some cases defended by breastworks, and great use appears to have been made of the strong hedges common in this part of the country, as defences, the enemy being described as being "beat from hedge to hedge.

In April, Colonel Martin, the Governor, defeated Sir R. Grenville at St. Budeaux with great loss.

The Earl of Essex marching down into the West in July, 1644, Prince Maurice retired before him into Cornwall, and thus Plymouth was relieved. The King however soon afterwards followed; and in September entirely broke up Essex's army, he and Lord Roberts escaping to Plymouth, where the latter remained in command.

The King on his return determined "to look upon Plymouth," but "having sent a summons to the town, he received a rude answer to it, for the Earl of Essex had left Lord Roberts as Governor in the town, a man of sour and surly nature, a great opiniâtre, and one who must be overcome before he would believe that he could be so."

The tradition is that the King, with his suite, frequently came as near as to Townsend Hill, whence they were regularly driven away by cannon shot, and that hill is sometimes called "Vapouring Hill" in consequence.

These overtures being refused, and several fierce assaults given to the town being of no effect, Sir Richard Grenville was left to blockade it, an operation which he appears to have conducted in a very negligent manner, as it was said that "his farthest guards were never nearer the town than Lord Hopton's head-quarters the day he came thither," and he himself lived at his seat at Buckland Monachorum, 8 miles from Plymouth, where it was said that he built himself a large riding school out of materials supplied for building huts for his soldiers.

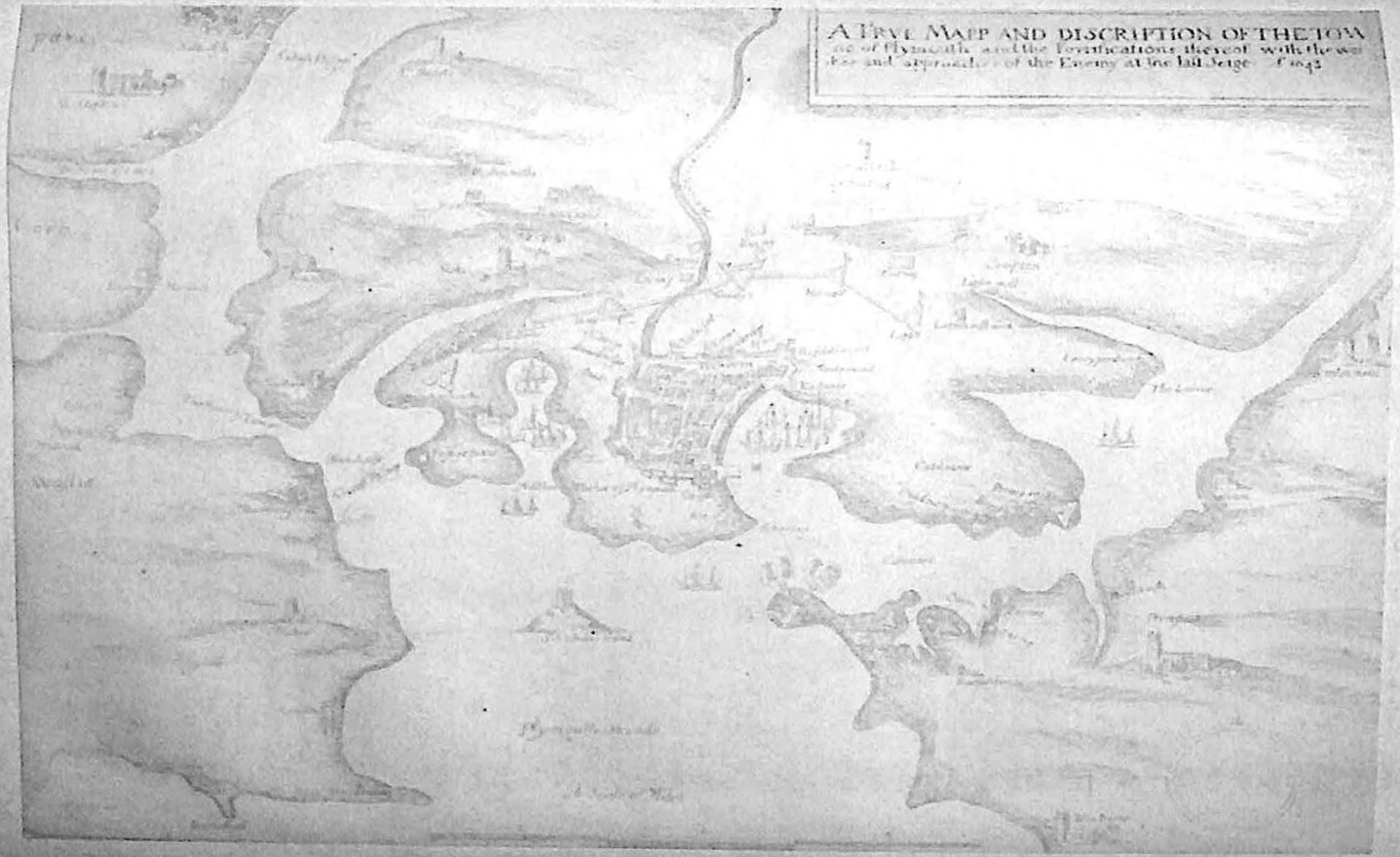
On the 10th January, 1645, having then a force of 6,000 men, he assaulted the works, and took four of the principal ones; but the garrison rallied and he was repulsed.

This blockade lasted till the 10th January, 1646, when the victorious march of Fairfax into the West entirely broke the King's forces, and led the way to the termination of the war in the year 1646.

The sites of the works shown on the plan are said to have been as follows, and they could be traced not many years ago:—

New works	At Eldad.
Penycomquic works ..	On the site of the Northernmost house in Bellevue Place, near St. Michael's Terrace.
Mawdlyn Fort	Behind North Hill House.
Holiwell Fort	(From description) near where Plymouth new prison now stands.
Lipson Fort	Farther along the same feature as the last.
Lcerie Point works ..	On Little Saltram Farm.

E. F. D. C.


A TRVE MAPP AND DISCRIPTION OF THE TOWN
ne of Plymouth, and the Fortifications thereof with the we
ke and approaches of the Enemy at the last Seige 1643

PAPER XVII.

Remarks on Fortification, with especial reference to Rifled Weapons.

By CAPTAIN H. TYLER, R.E.

It is now well established that musketry fire can be accurately employed against troops at a distance of upwards of a quarter of a mile, and that it is thoroughly efficient at a range of half a mile.

It is also ascertained that rifled cannon, loading at the breech, easily served by a small number of men, and easily transported, will throw elongated projectiles five miles, and that these projectiles may be made to strike with certainty an object 6 feet square at a range of two miles.

The most interesting, as well as the most important questions, which the military engineer is required, under these circumstances, to discuss, are,—

1st. What will be the effect of such weapons upon existing fortifications?

2nd. How can fortifications be best adapted to the employment of such weapons?

3rd. How can fortifications be constructed to resist most effectually the effects of such weapons?

In considering the first of these questions, we naturally divide existing fortifications into two classes, of which the bastion and the caponier are the principal representing elements. The French engineers still advocate the bastioned outline, modified by the Count de Pagan and others from those of the Italian and Dutch engineers. The German engineers, whose views have obtained more favour in Europe, prefer the polygonal outline and central caponier of Montalembert. The detached wall and countersloping glacis of Carnot have also been employed by them; and they have made use, to a greater extent than the French, of bomb-proof barracks, and casemated batteries.

The relative advantages of the bastioned, or the polygonal trace; of the revetted, or unrevetted counterscarp; of the detached wall, or of various descriptions of escarp revetments; of a greater or less amount of casemated fire,—have been warmly discussed; and at least one important result has followed, from which *we* have derived much benefit—that a vast deal of information has been diffused upon the subject.

But, amidst these discussions, the French and Germans have shewn by their practice that they are agreed, at all events, upon one point. They have both, to some extent, in their larger constructions, abandoned the use of outworks; and they have adopted extensive systems of detached works, arranged, according to circumstances, in front of their original enceintes, or their main lines of defence.

In the fortifications of Paris, the French have adhered to the bastioned trace, both in the continuous enceinte by which the city has been surrounded, and also in the advanced forts, which have been placed on the outside of that enceinte. But at Lyons they have, in the case of some of their detached forts, evinced a leaning towards the principles which the Germans have adopted in such works; and at Grenoble they have made use extensively of casemates à l'Haxo.

In the numerous fortresses which the Germans have constructed, or modified, since the peace of 1815, they have shown, as I have said, a decided preference for the polygonal trace. They have employed bomb-proof masonry caponiers for the defence of their ditches, either attached to, or detached from, the body of the place; either with detached walls and counterguards, as at Coblentz, or with counter-arched revetments, as at Germersheim; either with dry ditches, as in most of their fortified places, or with wet ditches, as in the bridge-head at the latter place. The fire from the principal caponiers, along the main ditches of the polygonal fronts, is not directed outwards towards the country to so great an extent as that from the flanks of the bastioned systems; but the flanking defences of the ditches of the ravelins are directed outwards to an equal extent in both systems.

The parapets from which flank defence is principally derived are liable, in the bastioned systems, to be enfiladed, taken in reverse, or ruined by distant fire before their own fire is brought into play. And even the low casemated fire, which is employed for the same purpose in the German system, is liable to be silenced, wholly or partially, by the effect of distant fire, whenever the prolongations of the ditches can be taken up by the artillery of the besieger. The flanks of the bastioned systems, as well as the caponiers of the polygonal systems, are also liable to be destroyed from the counterscarp of the opposite salient, in all cases in which flank defence is afforded by a defensive fire directed outwards towards the country.

Setting aside the masonry towers of Lintz, and those which surround the fortifications of Verona, the following are briefly the principles on which the different advanced forts of the German works are constructed:—Such outlines are selected as are best adapted for the particular situation, or purpose, to which they are to be applied. The ditches are flanked by bomb-proof caponiers, or bastionets, or by escarp or counterscarp galleries. A bomb-proof building is constructed at the gorge of each work, to form a citadel, as it were, for its secondary defence, and an additional safeguard against surprise. The gorge is made less strong than the front, (generally of exposed brick-work or masonry,) in order that if the work were captured by an enemy it might not be of material advantage to him.

It will not be necessary to say more here on the subject of the German works. Many of them are described in the different numbers of the Professional Papers, and in the Aide-Mémoire to the Military Sciences; and others in the publications of different continental writers. It must be remembered that those which are best known to us were designed and constructed before there appeared to be any probability of the introduction of rifled cannon into extensive use; and I may point out why they are not well fitted, in some respects, to resist the effects of such weapons, without impugning the judgment or professional skill of their

authors, in so far as the increased powers of those weapons are concerned. But it must be admitted that in many cases their masonry is too much exposed to artillery fire, to enable them successfully to contend even against the artillery of past times; and that there are grave defects in their construction, at the same time that many of the *principles* which have been employed are undoubtedly of high merit. It is plain that the increased length of the faces, curtains, or lines of the polygonal systems, will often be disadvantageous, now that they can be enfiladed with more effect, from greater distances, and with increased precision, by means of rifled weapons.

The relative effects of round, or elongated projectiles, upon different materials, at different distances, has yet to be thoroughly and accurately determined; but the increased momentum of the elongated shot at the longer ranges is undoubted; and the *path* of the missiles discharged from rifled cannon is far more certain, both in elevation and horizontal direction, at such ranges, than that of the spherical shot and shell hitherto employed. This increased momentum, and this greater accuracy, will hold good, though not to the same extent, in the case of missiles projected with reduced charges at higher, as well as with those fired with full charges at lower angles of elevation; and even if it be found useful, for particular purposes, to sacrifice momentum, by reducing the length of the projectiles, in order to obtain a curved trajectory, the accuracy of fire will still in some measure be retained. It is probable, therefore, that in firing at unseen objects, as in the case of the Carnot wall, in the Woolwich experiments of 1824, or in that of the casemate in the more recent experiments made in Germany, rifled ordnance will have considerable advantages over smooth-bored guns.

It is not so important, indeed, as it appears to be to some at first sight, that we should ascertain the precise effects of the weapons that have already come into use, before discussing these questions. In designing fortifications, we must now consider, not so much the exact results that artillery projectiles have up to the present time produced, as those which they may reasonably be expected ultimately to achieve, when the science of artillery has approached to the highest degree of perfection of which it is capable. The great stride, from smooth-bored to rifled artillery, has certainly been made; and we cannot expect much more from gunpowder and iron than has recently been accomplished; but still there are further adaptations to be carried out, and a great deal of information has yet to be acquired. One form and size of shot is best adapted for the destruction of thick iron plates; another description of missile will be found better calculated to destroy masonry at short ranges; a third will be preferable at longer ranges; a fourth for ruining earthen parapets; and so forth.

But, in any case, it cannot be doubted that the increased accuracy, and facility for employment, of rifled artillery, combined with the greater momentum at long ranges of their elongated projectiles, and the superior capacity of their shells, will greatly augment the destructive effects of *distant* artillery fire, on the one hand; and it cannot be expected that there will result, on the other hand, so great an advantage from their employment at short ranges.

It is evidently in the attack and defence of fortresses, more particularly, that the greatest changes will occur in consequence of these improvements in the means of destruction.

In field operations, a difficulty will be more or less felt, in obtaining, at the moment when it is required, the exact range of moving objects; and this will be, to some extent, a bar to the accurate use of musketry and artillery at long ranges, even in the hands of veteran troops. For such operations, a trajectory as flat as can be obtained is more peculiarly required.

In the course of a siege, a state of affairs altogether different exists. The besiegers are required to throw up their works upon ground well known to the garrison; and it will be in future vastly more difficult for them to construct those works, not only by daylight, but by night also, when proper means of artificial illumination are employed, at a moderate distance from a fortress, as long as the garrison is on the alert, and is able to fire upon them. The fire of rifled musketry, and that of the lightest artillery, employed by the besieged, from rifle pits, and from suitable positions in the neighbourhood of the place, will suffice to check the besiegers most materially in their progress, and will compel them to commence operations at far greater distances than those at which it has before been considered desirable to break ground.

As the siege works advance, besieged and besiegers will be firing at each other from day to day, at distances accurately ascertained, from behind their parapets and mounds of earth; and then the greatest advantages will be derived from the use of accurate fire at long ranges. The improvements in musketry and light artillery will tell principally in favour of the besieged; those in heavy artillery in favour of the besieger. As long as the besiegers are without cover, they will labour under greater disadvantages than before, in carrying on any works in the immediate neighbourhood of the place; but they will be able to establish batteries, in convenient situations, at greater distances from it; and, whilst almost unseen themselves, to support their more advanced workmen by the fire of those batteries, at the same time that they commence the destruction, which it is their object ultimately to effect, of the permanent works of the garrison.

The disadvantages of the besiegers will decrease in proportion to the amount of injury which they can effect in those permanent works, and to the progress which they can make in the construction of their own trenches and batteries; and they will increase in proportion to the extent of the area occupied by the besieged, and to their activity in employing the fire of temporary works, scattered over that area, in support of their permanent defences. When once the besiegers establish themselves firmly within range of the place, they will be enabled, in some measure, if they possess the requisite preponderance in numbers and resources, by the use of a converging fire on particular points, to prevent the besieged from repairing their permanent works, or from constructing additional ones; and they will, themselves, in that case, benefit most by the improvements that have been made in modern weapons, according to the extent of their means, compared with those of the besieged.

Any fire, whether from infantry or artillery, on either side, at other than very long ranges, must in future be kept up from behind well constructed works. The more the besiegers can keep down the fire of the garrison the better will they be able to advance their own works; but, in order to keep down that fire, they must first ruin the defences of the place, when these are suitably constructed with reference to modern means and weapons.

In considering the question of a moderate garrison, it is evident that an extensive range of destructible batteries, or of batteries of which the fire would be easily silenced, will, in future, be of less avail for defensive purposes than a limited extent of batteries of superior construction, whose fire, being more difficult to silence, would be longer available. And it is also evident that as a garrison increases in numbers, so may a greater force of artillery be employed by it with advantage. To accommodate the defence to different sized garrisons, there will be required, therefore, a smaller number of guns, placed in casemates of the most secure form, and in positions defensible by the more limited garrison; at the same time that opportunity is afforded for the employment of a greater number of guns, in intermediate works of a more temporary character, but in positions equally well protected from any sudden attack of the enemy.

One most material difference that will occur in the conduct of future, as compared with that of past siege operations, will probably be found, then, in the preliminary struggle of distant fire between the besiegers and the garrison. When once any portions of the defences of the garrison are ruined, the besiegers will have a greater facility than before for keeping their fire under, at those particular points; but so long as these defences are practically available, so long will the progress of the besiegers be more difficult than it was before.

These being, briefly, the general results that are to be expected, I will proceed to consider, in a more detailed manner, the actual effects that will be produced by rifled cannon.

The penetration of elongated projectiles, as far as it has been tried, into different substances, but particularly into earthworks, appears as yet to have somewhat disappointed those who expected very great things from it; and there are good reasons why this should be so, more especially when these missiles are employed at long ranges. The longer the shot, or bolt, and the more rapid the rotation imparted to it, the more it is inclined to retain throughout the whole of its flight, including its descent, the angle of elevation at which it is projected from the gun; and the resistance of the atmosphere tends to increase rather than to diminish the angle which is thus formed between its path and its axis. The inclination of its axis to the horizon when it strikes, for instance, an earthen rampart, and the rotation that it possesses when it does so, are both obstacles to it, if penetration be desired; and they together tend, with the present mode of rifling, to cause it to turn upwards, and to the right, instead of proceeding in a direct course through the earth. These disadvantages may perhaps be counteracted in some measure, though at the sacrifice of range and momentum, by decreasing the length of the projectiles employed for such a purpose; or they may be modified by weighting them in the front; and they will, no doubt, be more than compensated by the increased accuracy of fire that will be obtained. But many improvements in these respects have yet to be effected; and we can only now come to certain conclusions, as to what may be reasonably expected to be the ultimate result of such improvements, and as to what should be provided against in the construction of future works.

We can see clearly that slightly inclined slopes of earth are those which may be most advantageously opposed to these weapons, when they shall have been perfected to the utmost, as well as at the present time. We may fairly conclude that all defences constructed according to methods hitherto employed, will

ultimately be more easily ruined, at considerable distances, by the fire of rifled cannon than by that of smooth-bored guns; that the earth of parapets and ramparts placed at an angle of 45° will be more easily blown away by the more accurate fire of their shells; that exposed masonry will be knocked to pieces with greater facility by their solid shot; and that much, even, of the masonry which is not exposed to view from the exterior, will become more liable to be destroyed from a distance in consequence of their introduction into use.

I have already briefly alluded to the experiments tried against unseen masonry, the first at Woolwich, in 1824, described by Sir W. Denison at page 38, Vol. II, of the old series; the second in Germany during the last few years, described by Lieutenant Colonel Bainbrigge at page 42, Vol. VII, of the new series of the Professional Papers. In the former well-known case, a practicable breach, 14 feet wide, was made in a Carnot (detached) wall, from distances of 400 and 500 yards, in 6 hours, by 1,400 rounds from 8-inch and 10-inch howitzers and 68-pr. carronades. In the latter, a front wall of a casemated guard-house, 5 feet thick, constructed at the gorge of an earthen work, was ruined for practical purposes, by 400 shells filled with lead, fired from 8·4-inch howitzers, at a distance of 530 yards. In the former case, as related by Sir Howard Douglas, the gunners had no further aid or assistance than they would receive at an actual siege. In the latter case, the earth on the casemate was visible to them from the battery, and they had the advantage, which they certainly would not possess on actual service, of being informed by telegraph of the effects of their shot after each round.

Now, supposing that each individual shot or shell which strikes unseen masonry, under these circumstances, will only in future do the same amount of damage as the missiles which were employed in these experiments, still it may be expected that, the fire being far more accurate, both in horizontal direction and in elevation, the desired effects will be produced with greater facility, and with less expenditure of ammunition. In the Woolwich experiments, only one-quarter of the shells, and one-fifth of the shot, took effect. In the German experiments, only 34 shells out of 112, fired during the first two days, struck the front wall of the guard house, though that wall was 15 feet high and 39 feet long. In future, we may expect that hardly a shot would fail to produce some effect under similar circumstances; and a sanguine artillerist might perhaps even venture to assume that gunners practised in such firing, would be prepared to commence with one end of the wall of an unseen building, and to ruin it by degrees as they proceeded towards the other end, knowing with tolerable certainty the effects that they were producing. At all events, it will be readily admitted that, upon the whole, increased means of destroying unseen masonry under such circumstances will be acquired; and that it will not now be desirable to expose the masonry employed in fortifications, even to this description of fire, when the means exist of more effectually protecting it.

It has always been considered, and it no doubt is under certain circumstances, a great advantage to be able to increase the length of the *lines of defence* of a fortress. This facility is held forth as one of the improvements of the German system: and the shorter fronts of the bastioned system were put forward by Montalembert as amongst the principal of their defects. The power of still further increasing the lengths of lines of defence, in consequence of the increased range of rifled weapons, is now also hailed by some as one of the greatest

benefits to be derived from the recent improvements in musketry and artillery. But it must be remembered, that the more the lines of defence are lengthened, the more is the work that protects them, whether bastion-flank, or caponier-face, laid open to the distant fire above referred to, and that the longer those lines of defence are made, the more will faces, flanks, or polygonal fronts, be exposed, frequently, to enfilade, ricochet, or reverse fire, which will now be available from much greater distances than formerly. Anything that would cover or protect the German caponiers from the effects of distant batteries, would mask their fire, in the same manner that the employment of a tenaille in the bastioned system prevents the flanks of the bastions from defending the ditch by means of guns placed in low casemates. And there are only two modes of getting over this difficulty—either by making the caponier or flanking works indestructible, or else by directing their fire inwards, or towards points from which they cannot be attacked.

Looking now to a profile of a bastioned system without outworks in its front, it will be observed, that if it be desired to protect the escarp from the distant fire of improved guns, it will be necessary to sink it to a lower level, and to deepen the ditch in which it is placed. The higher the counterscarp by which it is protected, and the narrower the ditch containing it, the greater will be its security from such fire. It is probable, that, with the present profiles, a practicable breach could not be formed by the distant fire of rifled cannon; yet, the escarp would doubtless receive considerable damage from the besieger's missiles, and a portion of the parapet would be brought down, partly in consequence of the damage thus done to the escarp, and partly from the effects of the shells pitched into it. If the escarp wall were only of sufficient height to ensure safety against escalade to begin with, and if the parapet were only thick enough to be proof against shot and shell in the first instance, then they would not be sufficiently high or thick after they had been subjected to a certain amount of distant fire; and the fortress would be in a worse condition than before, more or less, according to the extent of the damage which it had thus received.

It is true that by retiring the rampart from the top of the escarp, and leaving room between the two for a "chemin des rondes," partial relief from these difficulties is obtained, inasmuch as the fall of the escarp does not then necessarily bring down the rampart, and the rampart itself becomes less liable to be injured in the manner referred to; and any wall on its summit, forming a parapet to a "chemin des rondes," would so easily be knocked to pieces that the cost of its construction can only be considered in most cases as money thrown away. M. Choumara argues, indeed, that such a work ought to be constructed, because it would be destroyed on the part attacked only, and would remain uninjured on other parts of a fortress. But, in truth, the side attacked is hardly that on which it is least required; and it is clearly the duty of the engineer, more particularly now that increased facilities for destruction by means of distant artillery are afforded, to employ such works as are difficult to destroy, rather than any which are intended to fall as soon as the besieger shall think proper to establish a battery against them.

The countersloping glacis, and the detached wall, adopted in some cases by the Germans, are evidently, when considered with reference to rifled cannon, a

step in the wrong direction. The former tends to lay the escarp, or detached wall, still further open to the effects of distant fire; and the detached wall itself is more easily destroyed by that distant fire than a revetment wall, particularly when the latter is built *en décharge*.

The portions of the enceinte which flank the central caponiers of the polygonal systems are more or less liable to be similarly affected by the distant fire of rifled guns, as, in fact, are all the other flanking works of the bastioned and polygonal systems which have an outward direction. The works which flank the ditches of the ravelins are practically unprotected from the description of fire referred to, inasmuch as the opposite counterscarp is separated from them by the whole length of those ditches; and so on, with regard to all flank defence provided upon the principles which are now mainly adopted.

It will be unnecessary to refer to them more in detail in this place. Enough has been said to establish with reference to actual constructions another of the principles involved, which is, that all flanking fire directed outwards towards the country, from masonry casemates below the surface of the ground, or from earthen parapets above the surface, is more or less liable to be prematurely silenced by the effect of distant fire from rifled cannon.

With regard to the Maximilian towers employed in Germany, a word or two will suffice. They have been practically tested in the experiment recorded by M. Allard,* and found wanting. A battery of guns, mortars, and Congreve rockets, which was established at 300 yards from one of these towers, completely disabled it in five hours, the shells having penetrated into the tower, the gun carriages having been broken up, and the platforms having been disorganized. They are without flank defence; and they are not likely to be imitated by us when defence against a *land attack* is required. At the same time it may be added that some of our own Martello, and other towers, which have been a good deal looked down upon, and depreciated in public estimation, would, if they were armed with rifled cannon, and protected by earth work, become exceedingly valuable, as permanent batteries, to be used against an enemy's *shipping*, and as keeps to earthen works thrown up around them. And if they were judiciously defended by counterscarp galleries, well covered with earth, they would then be secure against any description of sudden assault.

The detached works to which I have referred, have some of them many defects, when considered with regard to the increased accuracy of modern weapons. The masonry redoubts or guard-houses in their interior, as shown, for instance, in plan in Plate 5, and in section in Plate 7, at page 54 of the 2nd volume of the Old Series of the Professional Papers, would, as will be at once seen by referring to those figures, be liable, some more and some less, to destruction from distant artillery; and they would therefore become almost useless for the purpose for which they are intended. The caponiers and counterscarp galleries shown in figs. 2, 3, and 4, of the above Pl. 5, would, in like manner, be liable to be ruined from a distance before they were wanted for use; and the works, themselves, would not, after their redoubts and flanking works were thus destroyed, be in a state to resist assault. An exception may, however, be made in the case of the fort given at Pl. 3, in the work before referred to, of M. Mangin, in which there

* Mémoire sur la Fortification Polygonale construite en Allemagne depuis 1815, par A. Mangin, p. 127.

is shown a caponier at the salient, firing inwards, in addition to two which are constructed to fire outwards. The former could not be thus reached by distant fire from the front, and is not, therefore, open to the objection here stated. But the flanks of this work, as well as those of the other works above mentioned, might be taken in reverse from a distance; and a serious disadvantage will thus arise whenever they may be required for use against rifled guns.

In considering, then, the general effects of the fire of rifled cannon upon existing fortifications, we find that, when it has arrived at the greatest degree of perfection of which it appears now to be capable, they will be principally:—1. The more easy destruction by distant fire of earthen parapets and ramparts. 2. An increased facility for destroying from greater distances all masonry that is seen, and much that is not seen. 3. The greater liability of all flanking fire, as hitherto most commonly employed, to be silenced before it is required for the purpose for which it is established. 5. A greater facility for the use of enfilade and reverse fire from long ranges. And to these may be added;—6. A vastly improved means of distant bombardment, by which a garrison may be annoyed, its cover overthrown, its provisions and munitions destroyed, and its stores and materials burnt or annihilated, whenever these are exposed to the fire of the besieger.

So little has yet been said with regard to the ricochet of rifled projectiles, that I may perhaps record with advantage the result in this respect of an experiment made by Mr. Whitworth, with the first brass howitzer which he bored out in the form of an hexagonal spiral. I was favoured with an opportunity, as many others were at the time, of seeing a bolt of great length fired from that howitzer, and of watching the action of its ricochet under advantageous circumstances. Retaining in its course the angle of inclination to the horizon at which it left the mouth of the piece, it struck first with its hinder part when it reached the ground. It then bounded up again at a smaller angle of inclination than before. After striking in this manner for several times, its head came first to the ground; and it then turned over and over for some distance, until its momentum was exhausted. This is probably the mode in which all elongated projectiles will be found to ricochet, though in a modified form, according to their shape, and according to the spiral of the bore from which they are fired. It is stated that they generally fly to the right after striking the ground. They will not certainly bound so high, or so far, or so regularly, as spherical shot; but they will often be more destructive, on account of their *closer* ricochet, as it may be termed, when they are used against an enemy's troops, or against his works.

I will now proceed to consider how fortifications can be best constructed, so that they may resist the effects, and be adapted to the employment of such weapons.

It has been seen that the escarp revetment, or the detached wall, which is employed to secure a fortress from assault, partly by its height, and partly by means of the flanking fire established for its protection, must be more hidden in future, if immunity from the distant effects of rifled cannon is to be secured. It also appears that instead of an earthen counterscarp, or counter-sloping glacis, a revetted counterscarp, higher than before, must be placed in greater proximity to such walls, to protect them from these effects of distant fire. It is clear that, to obtain protection from weapons of increased range, it will be necessary to

enclose more extensive areas; and that if either of the systems hitherto adopted, of escarp walls or detached walls, be employed, greatly increased expense will necessarily be incurred.

At the same time, as has been stated or implied, a more ample supply of bomb-proof accommodation for men and materials, more substantial ramparts and parapets, and more effective cover for the guns and gunners, will all be required. And these will also involve increased expense. The same may be said with regard to the communications, which will be longer between the different detached forts, and between these and the lines of defence behind them; and which must be both secret and secure to the besiegers, and unavailable, when seized, for the purposes of the attack, if they are to be of use in future operations.

In their recent works, the German engineers are stated to have had recourse, extensively, to the use of countermines, attached, not only to their main works, but also under the terreplein and in front of their advanced works; and this is by no means the least important part of the principles which have been adopted. When there exists a judicious system of countermines in front of a work, the besiegers must, of necessity, make an attack by means of mines, and speaking generally, they will thus be reduced to a minimum rate of advance. If there are no counter-mines to oppose their progress, then they can in average soil advance by mining, say in 12 days, from their 3rd parallel, (or from the position in which that parallel was formerly supposed to be placed) to the ditch of the work attacked; whereas it has been estimated that it would occupy them from 40 days to two months to advance over that distance against a good system of countermines, properly defended.

Now that musketry fire can be used with such fatal effect, in the hands of trained men, at known ranges, against the besieger's workmen,—now that a very light piece of artillery, from any situation, and from almost any distance, will be able to arrest the progress of a sap worked above ground, it is certain that mining will be more resorted to by the besieger in the progress of his attack; and it cannot be doubted that engineers will be more disposed to resort to the use of countermines, as auxiliaries to the defence, in consequence of the increased facilities for the destruction of masonry and earthwork, which will be at the disposal of the besieger.

Subterranean works will, therefore, be more generally employed as rifled weapons come into more extensive use, and as, in the hands of more perfectly trained men, they are found to be more certain in their results. And the preparations to meet this contingency will again entail additional expense in the construction of fortifications.

There will, then,—to sum up these different requirements—be wanted in fortifications in future:—1. Ample bombproof accommodation, for men and materials of all sorts. 2. Numerous casemates for the service of artillery, and, frequently, means of protection from reverse fire. 3. Walls more perfectly hidden, and placed out of the reach, at all events of distant fire, as a protection against escalade. 4. Improved and more extensive means of communication, secret and secure for the besieged, but useless to the besieger. 5. Greater development of countermines, as the most effectual mode of delaying the enemy's attack under ground. 6. Facilities for maintaining a fire of musketry, and of

light artillery, to arrest his progress above ground, before he reaches the vicinity of such countermines. 7. Parapets and ramparts of the least destructible, and most easily repaired, description. 8. The occupation, in many cases, of increased areas, as a protection for interior works, or to enclose what would otherwise be commanding heights.

And the great problem to be solved is, how to obtain all these advantages with economy—not such economy as would deprive the works constructed of efficiency, which would not be economy at all—but such as will make fortification, so to speak, possible, and will afford to it a maximum of efficiency, at a minimum of expense.

In endeavouring to find the solution of this problem, I shall purposely avoid laying down anything that can be called a system. As is well known, systems have already been too much the bane of the science. Now, more than ever, *systems of fortification* must give way to *principles of construction*; and (if the word system be used at all,) to *systems of defence*. No two fortresses ought to be alike; but each work, and each collection of works, should be adapted to the purposes, strategetical and tactical, which it is intended to answer; to the means, pecuniary and material, at the disposal of the engineer; to the exigencies of its site; and to the circumstances of its topographical position.

Looking at the subject from this point of view, it will appear that there is still something to be derived from the principles of the bastioned trace; that some of the principles, again, which have been employed in the polygonal fortresses, are improvements which may be advantageously adopted; that other principles employed in these works are such as should be avoided; and that, finally, there are certain additional principles to be introduced, in order that economy and efficiency may be combined together in just mutual relations.

The principle of employing detached works, supporting each other, and resting, frequently, upon other works behind them, now very generally adopted, is evidently a true one, and one which must form the basis of all future fortification. Long range weapons are peculiarly well adapted for the application of this principle, on account of the facilities that they afford for efficient support, either between one work and another, or to advanced works, from the positions which can be advantageously occupied in their rear. This is the only principle on which a very extensive site can be efficiently and economically occupied.

Long continuous lines are more expensive to construct, are more difficult to defend, require larger bodies of troops to garrison them, are liable to be equally weak at all points, become useless when they are forced at any one point, and are devoid of that principle of mutual defence between one part and another which may now be so effectively employed. But there is an advantage, on the other hand, to be derived from the use of continuous lines, namely, that they do not present intervals, such as those between detached forts, through which an enemy may pass by stealth, under cover of darkness.

Except in very special cases, small *isolated* fortresses, to be manned by weak garrisons, will not, it is to be presumed, in future, be employed. It has been abundantly proved, and is admitted, that such works do more harm, as a rule, by abstracting strength from the army by which their garrisons are supplied,—by the necessity of operations to be undertaken for their relief,—and by the support which they afford, when captured, to an invading enemy, than they do good

in checking the progress of such an enemy. And what we have now mainly to consider is the question, either of a permanently entrenched camp, combined with a fortress, to act as a citadel in its rear; or of one or more lines of detached forts, constructed in a substantial manner, for the defence of a very considerable area.

One important desideratum in future works is that they should be perfectly defensible when manned by a comparatively small garrison, at the same time that they are capable of affording protection to a beaten army, and of enabling it to repose in security, and await the proper period for resuming offensive operations. A second is, that they should afford secure depots, in which bodies of troops and resources of all descriptions may be collected, and from which they may be drawn, or employed, in time of need. A third is that, in contra-distinction to the continuous lines above referred to, the capture by the besiegers of any portion of a line of defence should not occasion the loss of that line, but only of the point forced. A fourth is, that the besiegers should meet with increased opposition at every step, in order that they may lose confidence, and that the garrison may retain confidence, as the operations progress. A fifth is, that opportunity should be afforded for an active defence, so that, in proportion as the numbers and resources of the garrison are increased, in the same proportion should the difficulties of the besieger accumulate.

One of the most difficult questions with regard to detached works, and one upon which the least light has as yet been thrown, is that which refers to the best mode of connecting them, when it is desirable to do so, and of securing to them the advantage above alluded to, as being incidental to continuous lines,—of preventing an enemy from suddenly, or stealthily, passing through the intervals between them under cover of darkness. In some cases this is an object of the greatest importance, and I shall therefore refer to the means by which I conceive that it may be properly effected.

The object of connecting such works, as here contemplated, is, not to unite them for offensive, but solely for defensive purposes. The detached forts are supposed to be sufficient in all respects for the occupation of the position, and to possess all the means that can be relied upon, as a minimum, for its defence, with reference to the number of men, and the magnitude of the resources, available for the purpose. What is required is the application of a continuous *obstacle*, that shall fill up the interval between these forts in an efficient manner, and this *obstacle* should be defensible by the smallest additional number of men; should derive its defence, if possible, partly from the detached forts themselves, without interfering with their action; should answer the purpose of affording covered communication between these forts; should be out of reach of the enemy's artillery; and should be useless to the enemy if it is seized or passed. The modes hitherto generally proposed or adopted, for effecting such an object, have been, either the formation of rocky scarps when facility for applying them has been afforded, or else the construction of ramparts and ditches of the usual form, partaking more or less of the character of permanent works, according to circumstances, on ordinary sites. But a more advantageous method of providing such an obstacle in future will probably be by placing a counter-scarp, or sunken wall, in front of the detached forts, either to take the place of, or to be in addition to that which would be immediately connected with them; and

varying in height according to circumstances. In plates 2 and 3, such a sunken wall is shown in plan, disposed according to both the methods referred to; and the section in fig. 1, plate 1, exhibits the lowest counterscarp that could well be employed in such cases, with the highest that could be required in front of it. Where two counterscarps are employed, each should, of course, be made independently defensible against a coup-de-main. These sunken walls might derive flank defence, both from flanks constructed as parts of themselves and from the flanking redoubts of the detached forts; and they would be practically impassable to the enemy, while they could be crossed by their defenders, by means of temporary wooden ramps, to be used whenever they were required, at any particular points.

The main, or the advanced counterscarp, could only be taken by the slow process of gradual attack, in the course of which it would be blown in by the besieger's mines, if the besieger had the time and means to carry on his attack so far. It would hardly be worth the besieger's while, under any circumstances, as will be evident upon full consideration, to make his attack in this manner at any other part of it than opposite to one or more of the detached forts behind it; and at these points it should be further protected by a skeleton system of countermines, to be added to, as required, during actual operations. If the besieger did effect an opening in the space between any two forts, he would be unable to debouch from such an opening under the fire that would be directed upon it from both sides. He would not find any permanent fort directly in his front, against which to advance by trenchwork; nor would he be able to construct trenches against either of the forts commanding the opening, until the other was captured.

In considering the mode in which detached forts of moderate dimensions, scattered along a line of defence more or less extensive, should be constructed, it is evident that there are two conditions which they are principally required to fulfil, besides those which have been already enumerated. They should furnish: 1. A direct fire on the ground before them. 2. A cross-fire on the intervals between them. 3. A flanking fire for the support of each other.

A direct fire towards the front must be obtained, of course, from the ramparts which constitute the faces of these forts, and those faces must be inclined to each other at such an angle as the site demands.

The necessary cross fire, and flanking fire, has never been, and can still less now be, advantageously obtained from flanks with open parapets, attached, on either side, to the extremities of the faces. Any flanks which may be so employed will, in future, be more easily rendered useless than heretofore, by means of enfilade or reverse fire directed against them. When such flanks are casemated, there can then no longer be any danger from enfilade fire; but without the addition of screens at the rear of the casemates, there will still in many cases be a liability to annoyance from the effect of reverse fire.

Flanking fire has hitherto been principally obtained in all fortifications by one of three methods: either from an open rampart affording defence to a ditch, and commanding at the same time the country before it; or from casemates on the ramparts employed for these purposes; or else from low parapets, or masonry casemates, constructed for the defence of a ditch only. The objections to these methods are:—that the elevated parapets are liable to be ruined, or to have their fire silenced prematurely, and thus to be rendered unserviceable before

they come into use, for yielding that defence for which they are more especially constructed; that the casemates which are intended to serve for both purposes are also liable to be ruined by distant fire, and to be unavailable when they are most required; that low open parapets are exposed to a plunging fire from the glacis, or to vertical fire, and can thus be rendered untenable; and that the low masonry casemates, in caponiers, or other flanking works, while they are only available for the one purpose of defending the ditches, are yet in a position, when firing outwards towards the country, to be wholly or partially ruined, as has been seen, by the fire of distant artillery, whenever the prolongations of those ditches can be taken up by the enemy's batteries.

It has already been shown, and will presently be still further demonstrated, that it will be exceedingly advantageous, in future, to use counterscarp defences for the ditches. But it is now further desirable to devise some form of flanking works, which, not being exposed to destruction by direct fire, nor to annoyance from enfilade, reverse, or vertical fire, shall afford a cross fire over the intervals between detached works, and shall at the same time provide a flanking fire for the defence of the ditches of such works, in addition to that which is derived from their counterscarps.

These important results may all be obtained by the adoption of casemated flanking redoubts, such as are shown at Fig. 2, Plate 1, in section, and in Plates 2, and 3, in Plan. In Plate 2, they are shown in front of the faces of the detached forts, to which they afford a close flank defence. In Plate 3, they are placed behind those faces; and in this case each work is made to depend upon another for its flank defence, after the counterscarp in front of it has been blown in by the besieger. In the latter case, the flanking works would themselves be more protected; but their fire would be partially masked by the faces in front of them, unless they were of sufficient height to fire over those faces. They would, however, in this case, act as keeps to, besides being available for purposes of mutual support between, the detached forts. I shall refer, when speaking of the construction of ramparts in general, to a method by which those of the flanking works may be made, as well as those of the faces, comparatively indestructible.

The disadvantage which attends any method by which one work is made to depend partly upon another for flank defence, is now not so great as it was formerly, for two reasons. One of these has been already noticed, and is, that such defence can be more efficiently given by superior weapons; the other is, that perfect communication can in future always be maintained between one work and another, as well as between each work and the works in rear of it, by means of the electric telegraph. The use of telegraph wires between the different parts of a system of detached works, such as is now referred to, will at all times be invaluable. It will enable a commander to obtain information, to transmit orders, to combine his resources, in a manner, and with a celerity, that without it would be impossible. And it must also be remembered that the same wires which will serve the purpose of keeping up communication with a work as long as it can be maintained, or is required, will be equally useful for assisting to complete its destruction, when the time has arrived for such an operation.

Each of the flanking arrangements above referred to, and shown, respectively, in Plates 2 and 3, might be found advantageous under particular circumstances;

and some such combination of faces and flanks appears to be most suitable for application to extensive systems of detached works, constructed in a permanent manner; care being taken to make each fort, with its faces and flanks, independently defensible, whether it be placed behind a continuous counterscarp or not.

And the method here advocated is equally applicable to works with wet, and to works with dry ditches.

The notion has of late been too much gaining ground, and has notably been advocated in the case of the fortifications projected for Antwerp, that wet ditches without masonry revetments may be safely trusted to, for defence against surprise, or against sudden attack. But, looking to the danger of such ditches being drained, by the destruction of *batardeaux*, or by other means; to the risk of the water that they contain being diverted into another channel; to the difficulty of retaining detachments on the further side of them, and of guarding against surprise; and to the way in which these dangers and this difficulty will be increased in future, in consequence of the greater surface of the area to be enclosed, and the greater lengths over which such ditches will, when made continuous, have to extend; it appears hardly safe to trust to such means alone for the security of permanent works.

A very remarkable instance of the passage of a river, and of the storming of a town upon its banks, is related by Sir William Napier, in his History of the Peninsular War, and has been quoted by Lieutenant Colonel Bainbrigge, R.E., in the Aide-Mémoire to the Military Sciences.

Sir William Napier says, after referring to the ruin of the bridge at Tordesillas, during the retreat of the Duke of Wellington from Burgos, by the regiment of Brunswick-Oels, which was detached for that purpose:

"It was done in time, and a tower behind the ruins was occupied by a detach-
"ment, while the remainder of the Brunswickers took post in a pine-wood at
"some distance. The French arrived and seemed for some time at a loss, but
"very soon sixty French officers and non-commissioned officers, headed by
"Captain Guingret, a daring man, formed a small raft to hold their arms and
"clothes, and then plunged into the water, holding their swords with their
"teeth, and swimming and pushing their raft before them. Under protection of
"a cannonade, they thus crossed this great river, though it was in full and
"strong water, and the weather very cold, and having reached the other side,
"naked as they were, stormed the tower. The Brunswick regiment then
"abandoned its position, and these gallant soldiers remained masters of the
"bridge." The French account, as given in the work entitled "Victoires et Conquêtes des Français," differs slightly from the above, and is also worth quoting. It is as follows: "Les dispositions qui rendaient la reparation du pont
" d'une difficulté extrême donnèrent lieu à un beau fait d'armes: onze officiers
"et quarante sous-officiers et soldats, tant de la division Foy que des sapeurs du
"génie, s'offrirent pour passer le Duero à la nage. Ils se jetèrent, protégés par
"l'artillerie, et ayant réuni leurs armes et leurs gibernes sur une espèce de radeau,
"conduit par quelques nageurs. Parvenus sur la rive opposée, après avoir essuyés
"une vive fusillade, ils combattirent nus, enlevèrent la tour, et firent onze
"prisonniers. Cette audacieuse entreprise, proposée et dirigée avec tant de
"vigueur par le vaillant Capitaine Guingret, du 6me Infantere Légère, étonna
"tellement le regiment de Brunswick, placé à l'extrémité du pont, que, au lieu
"de venir attaquer cette poignée d'hommes intrépides, il se mit de suite en
"pleine retraite."

If such a feat could be accomplished, in crossing a river like the Douro, in the condition in which it is described to have been, with a single raft, how much more easy would it be to effect a passage across a comparatively narrow wet ditch, with careful preparation and superior means. A proper number of men, provided with a suitable costume, with swimming corks secured to their bodies, and with revolver pistols strapped on their heads, would really not run much risk in storming a work defended by a wet ditch only. The operation would be carried out in the dark by surprise; the requisite means would be taken for attracting the attention of the enemy to other points; and supports would be ready to follow them, upon bridges prepared beforehand for the purpose, as soon as they had secured, for the moment, the parapets and flanks defending the ditch to be crossed. A wet ditch considered in this light appears to be less safe than a dry ditch of the ordinary construction. It must at all times be far more difficult for soldiers to convey, and to employ, ladders for descending and ascending high walls, than for each man to carry on his person such corks as are necessary to provide him with a safe passage across the water. It is true that in very cold weather the project would hardly be a practicable one; but a fortress ought to be made safe against surprise in warm weather also. In such weather there would be no great difficulty in carrying out an attack of this description. The water would, indeed, afford material protection to the swimmers from the effects of the enemy's missiles if they were discovered; and they would have the whole surface of it at their disposal in crossing, instead, as in the case of a dry ditch, of being compelled to follow each other, down and up narrow ladders,—an operation which can never be expected to succeed when the walls are sufficiently high, when the men are exposed to a flanking fire from the place attacked, or when interior defences remain to be overcome after an escalade has been effected.

Under these circumstances, it would appear to be very desirable, in most cases, to add a counterscarp wall in front of any wet ditches that may be employed in future works. The advantages would thus be obtained of more perfect security against assault; of a place of safety for the garrison on the further side of the water, which is generally so much required; and a safe means of communication round the exterior of the work. In Fig. 1, Plate 4, there is a section to illustrate the mode in which this might be carried out.

It may be well, before proceeding further, to say something generally with regard to the possibility of obtaining those *impregnable* fortifications which have been so much talked and written about, and for which so many plans have been put forward. It can hardly ever be practicable to construct artificial works of limited dimensions, which shall be at the same time absolutely indestructible and unapproachable by an enemy possessed of proper means for besieging them. The resources at the disposal of the besieger are too great to justify such a supposition. What he cannot destroy by his artillery from a distance, he can work up to by degrees; and he can then either try the effect of mines, or of close artillery fire, or of both, at his leisure. But there are, no doubt, conditions under which impregnable works may be obtained, either in consequence of natural advantages, or by other means, which may be thus referred to.

A numerous, well found, and efficient garrison, occupying a good position, in an extended and well fortified area, capable of preventing perfect investment

by any number of troops that can be permanently employed in the attack, with means of reinforcement within reach, may be expected to make a resistance amounting to practical impregnability. If that garrison be in sufficient force, and have the necessary resources to enable it to oppose counter-approaches to an enemy's approaches, and counter-batteries to his batteries, to outflank his works as he constructs them, to make sorties as they are required, to keep up a constant fire of light artillery and musketry by day, and, with the aid of artificial illuminations, by night also, from suitable positions, upon any works which a besieger may attempt to construct,—then all progress on the part of the besieger will be rendered impossible, and a condition of impregnability will be obtained. An army would, under these circumstances, be able successfully to cope with superior numbers of its enemies by reason of the fortifications which it possessed, though it might not be able to stand before them in the field; and this is the utmost of which fortification can be theoretically supposed to be capable; though it may also—and this is commonly its more legitimate object—exercise an important influence upon the operations of war, by enabling an inferior force to *gain time*, when it is not in a position to risk an engagement with its assailants.

The nearer we can approach to these conditions the nearer shall we be towards obtaining impregnable works. And in order to render any particular works practically impregnable, it is necessary to approximate to these conditions, in proportion to the means that can be brought to bear upon the attack, to the time during which those means can be employed, to the number and nature of the garrison, to the material resources that can be afforded for the defence, and to the relative advantages and disadvantages of the parties expected to be opposed to each other, in position, in the nature of the soil, in the character of the troops, in the nature of their weapons, in their powers of supply, and in all other respects.

The next point to be considered is, what will be the best method of constructing the ramparts of defensive works in future?

There is wanted, as has been shewn, ample bomb-proof accommodation for men and material, secure from accurate distant fire. There is no better method of supplying this than by placing buildings under the ramparts, as has often been done before, to such an extent as will provide all the accommodation of this description that is required, either in continuous defences, or in those which are composed of detached works. With sufficient masonry above, as shown in Fig. 1, Plate 1, and with ample earthwork to cover the masonry, both above and in front, a work of the least destructible character is obtained. The wall at the back may be left exposed, when it is not open to reverse fire; it may be defended by a keep behind it, in the mode shown in Plates 2 and 3, and in section in Plate 1, so as to be secure against assault; and it can be destroyed when the work is taken, either by mines previously prepared for the purpose, or by the fire from a fort behind it, when there is one. Even if the enemy should make his way over the rampart, or get round to the rear of such a work, he would still be unable to possess himself of it. He would find, in the former case, a high wall to descend under a heavy fire, and, in the latter, two obstacles to overcome, in the barracks themselves.

Combined with this arrangement, as shown in the same figure, there may be constructed gun-casemates, for the use of artillery or musketry. These should

be exposed to a minimum of damage from the enemy's fire; they should afford the best possible shelter to the guns and the gunners, or to the sharpshooters, who might also make use of them; they should be well ventilated; and they should not render their defenders liable to damage from splinters.

In works like those shown in the figure referred to there will be found the means of fulfilling all these conditions. The vulnerable portion of a "Haxo" casemate is the masonry, or brickwork, of the arch above its embrasure. This part is protected by an iron plate, $4\frac{1}{2}$ or 5 inches thick, marked A; the plate being bedded in a frame-work of timber, built into the brick-work of the arch.

One of the most important problems of future fortification is the question as to how iron plates can be made use of in defensive works. If such plates are placed vertically, or nearly so, they can be destroyed by the fire of distant artillery; and it would be impossible to repair an embrasure thus plated, after it had been injured, during the progress of an attack. But by attaching the plates to the faces of the masonry, in a slanting direction, in the manner now proposed, the greatest degree of indestructibility is obtained; because it would be difficult to hit, and the enemy's shot would, when they struck it, glance harmlessly from it. The opening of the embrasure must be reduced to the smallest possible dimensions, and be provided with the best musket-proof shutters. This opening is surrounded with earth, above the plate, below, and in the cheeks of the embrasure. It may be lined with sheet iron gabions, both in front and at the sides. The only injury which the fire of the besiegers can effect in it is by blowing away the earth, by means of an accurate fire of shells, directed continuously on a particular portion of it; but it is constructed in the form which would best resist such fire, and which would enable any damage so sustained to be most speedily repaired.

Another point which has to be considered more in detail is the best means of hiding the masonry, and of placing it out of the reach of the enemy's fire. Masonry or brick-work are mainly required for two purposes in a fortress: 1° to provide barracks for the garrison, and storehouses for all sorts of materials; 2° to form walls that shall afford security against assault. Where escarp and counterscarp walls are used for the latter, in addition to those which are required for the former of these purposes, great expense must, of course, be incurred; but when, on the other hand, the masonry or brick-work necessary for the one purpose can be made to serve at the same time, either wholly or partially, for the other, or when the escarp or counterscarp wall can be dispensed with, then a certain amount of economy will be effected in each portion of the works, and a considerable saving on a whole fortress.

An escarp wall is weaker when it is built hollow, and is used for barracks, storehouses, or gun-casemates, than when it is built solid. It will be hardly desirable, in future, to employ hollow escarps in any case. Counter-arched revetments, which were invented by Speckle in 1589, might no doubt have been more used formerly with advantage; and they are probably the strongest form of escarp wall that can now be employed; but the destruction, even of these, is only a question of hours after the counterscarp has been blown in, or when once the enemy's artillery can be brought to bear directly upon them. And it becomes a serious matter for consideration whether escarps should be employed at all in future. Any other arrangement which would furnish equal security against

assault, with greater economy in construction, and better protection against distant artillery fire, would clearly be preferable to that which has hitherto been adopted, of an escarp, with or without a counterscarp. It will probably be admitted that the detached wall is not fitted for future employment; and it has been shown that even when an escarp wall is employed, a counterscarp wall is still required.

In the figures already referred to, marked No. 1 in Plates 1 and 4, there is shown a rampart sloping gently towards the foot of a counterscarp. By this arrangement the expense of an escarp is altogether avoided, and a rampart is obtained which possesses the utmost degree of indestructibility from distant fire. The principal counterscarp in Fig. 1, Plate 1, has a perpendicular height* of 30 feet, with a slope 10 feet long above it, and another, also 10 feet long, below it. It would require ladders upwards of 50 feet long for its descent; and it would, therefore, when properly flanked, be perfectly secure against escalade. Such a counterscarp may be disposed in plan, either as an indented line, or in the form of a *bastioned trace reversed*, as shown in the lower part of Plate 2. It may be made to afford, of itself, a perfect system of flank defence, so as to be secure, independently, against any species of assault. It might be, along the greater part of its length, a simple revetment wall, with a gallery behind it, such as has often been employed. The gallery would add to its strength; would supply a useful covered means of communication from one work to another; would be available when required for reverse fire; and would be a good commencement for countermines. But its flanking portions should be constructed somewhat as shown in Fig. 4, Pl. 4. They would thus give a fire of artillery and musketry upon the other points, besides completing the communication, and yielding the other advantages above referred to.

The designs given in these diagrams are, of course, only intended to illustrate the principles of construction now advocated, and not to be suited to any particular site. The actual dimensions would vary, both in plan and profile, as would, also, the shape of the works, their powers of supporting each other, and their distances apart, according to the circumstances of every case in which they might be applied.

It may be taken for granted, as a rule, that no attack will be made, or, at least, that no attack can be expected to succeed, upon any fortified works, unless there is an ultimate point of safety to be reached by the attacking party. For the siege of a bastioned fortress not supplied with interior defences, the object is, after a breach has been made in the escarp, to carry it altogether, by a coup-de-main; and there is wanting in the case of such a fortress the means of further defence after the main line of works has been penetrated.

* The accompanying diagrams have been drawn for a nearly flat surface. The slopes of the ramparts, and the distances of the counterscarps, would differ in practice according to the dispositions of the ground, and of the country to be *seen* in front. It would not be necessary in ordinary cases to adopt the extreme height of counterscarp which is here shown.

In some cases, the advantage of sweeping with artillery fire the whole slope of the *glacis-rampart*, from the embrasures to the foot of the counterscarp must be abandoned, and a steeper slope must be employed at the lower, than that at the higher part of it; but it will be advantageous to retain it in the form of one slope, wherever this can be done without making it steeper than is desirable.

The German fortresses and advanced forts, as well as some of the recently constructed French works, have been provided, to meet this difficulty, with defensible bomb-proof barracks, or guard-houses, and other means of secondary defence; and if the masonry of which these are constructed were in all cases safe from the effect of distant fire they would no doubt be of the utmost value, in the event of prolonged siege operations.

In the arrangement now proposed the same object is sought to be gained in a manner more suited to future operations, as they will be modified by the use of rifled weapons. Looking at the principal, or inner line of forts in Plate 2, and at the profile, Fig. 1, Plate 1, the assailants, after descending into the ditch by means of ladders, under a fire that could not be kept down, and part of which —that which proceeds from the counterscarp—could not be opposed, would have to advance towards the rampart, exposed to a reverse, as well as to a direct fire. They would then have to descend a second wall, by the same means and under similar difficulties. They would next have, either to mount the rampart of one of the detached forts, or to pass round to the rear of it. But wherever they turned they would find themselves exposed to a fire on all sides of them, from casemates into which they would be unable to penetrate. They would be helplessly shot down, without a chance of revenge or escape; and all retreat, over such obstacles, and under such a fire, would be impossible.

A very high wall is shown in the main counterscarp, Fig. 1, Pl. 1, to comply with the present belief as to what is required to render a fortress safe against assault. But if counterscarp walls, one behind the other, each affording fire from loop-holes that could not be opposed; each in itself impregnable, until destroyed by mines; and each entirely out of the reach of the enemy's artillery,—were adopted, then more moderate heights would probably suffice.

Counterscarp defences have not been hitherto as much depended upon as might for some reasons be expected, because they are liable to be destroyed by the mines of the besieger. If the salients of the counterscarp be the principal, or the only means of flank defence relied on for the defence of a ditch, the work becomes deprived of flank defence when the besieger has arrived at, and blown in, the counterscarp at those points.

This sort of reasoning shows that it is not advisable to trust at any time, if it can be avoided, to the counterscarp alone for flank defence; but it does not by any means prove that it is not desirable to employ, for as long a period as is practicable, a means which is so simple and so useful to the besieged, and which it is impossible for the besieger to oppose or destroy, by his musketry or artillery. It will evidently become now far more advisable to make use of this description of defence than it has hitherto been, on every account. The gradual progress of a siege, and particularly of the first operations of it, will, as we have seen, become more difficult to the besieger, in consequence of the greater range and accuracy of the musketry and light artillery of the garrison. There will therefore be an increased tendency to attempt the destruction of the defences as far as possible, by distant artillery fire; and then to deliver an assault during the hours of darkness, when the weapons of the besieged will be of less avail in opposing it. Against operations of this nature, there can be no better defence than that afforded by the counterscarp. Again, the accuracy of fire which will be at the command of the infantry and gunners of a garrison, and which can

be employed from all suitable positions in the neighbourhood of the permanent works, will render the progress of the besiegers above ground in the later periods of a siege more difficult, and will increase the tendency, as has already been noticed, to resort to mining operations. This last mode of warfare will be unaffected, when considered independently, by the introduction of rifled weapons; and would be facilitated on the part of the besieged, by the use of counterscarp galleries.

A great necessity, also, in a system of defence such as is here referred to, in which detached works form an important feature, as they will do in any fortifications that can in future be successfully employed, is, as I have already stated, "good communications." These should, as I have before pointed out, be as far as possible safe from the view, and from the fire, of the enemy; they should be easily accessible to the garrison; and they should be so contrived as to be of no use to the besieger as the attack advances towards the place, in the event of success on his part. The counterscarp galleries already described will often be of great use in these respects. In fine, there will be a general tendency in future siege operations towards an increased conflict with artillery fire during the more early, and a greater resort to mining operations during the later periods of the attack; and it is evident that for both of these contingencies the counterscarp is the work that must especially be relied on, for assistance and for security.

Any other communications that are required, as, for instance, to connect isolated advanced works, may be obtained by the use of galleries open to the rear, such as are shown in Figs. 2 and 3, Plate 2. When made open to the rear, they would be more easily entered at all points by the garrison, they would be rendered useless to the besiegers, and they would be less expensive to construct.

They should be more or less sunk below the level of the ground, according to the nature of the site; they should be indented, for flank defence; they should be closed at the rear, near the flank, or near any covered communications connecting them with works behind them; and they should be provided with musket-proof doors at those points. A sweeping fire would thus be afforded at intervals along the galleries themselves, and over the ground immediately behind them.

Galleries of this description might in many cases be advantageously used as a species of advanced counterscarp. They would afford a good means of retreat for the garrison, from temporary advanced parapets, or from rifle pits, or after being engaged in a sortie. And they would act as an obstacle, to prevent any sudden advance on the part of the besieger, upon the ground or works in their rear. Having once descended, and passed such a gallery, he would find himself exposed to fire from all sides, and his retreat cut off.

In fact, in a large circle of defence, enclosed by such a gallery, with forts at intervals, advanced works of the simplest form might be dispersed, in all advantageous positions, and of all shapes and sizes, behind it. And a strong garrison would be able to throw up any new batteries, or any rifle pits that they might require, from time to time, within its area, to impede the progress of their assailants, in comparative security from sudden attack.

While counterscarp defences will be the best that can be employed for permanent works, it must be admitted that they cannot be applied so well in all

cases to temporary works. They may, no doubt, be used with advantage, when time and opportunity occur, for the formation of temporary revetments, with timber, with gabions, or by other means. Where iron railings of a suitable description can be obtained, they may probably be placed in unrevetted ditches with great advantage. They could be easily applied; they would be difficult to surmount and destroy, when properly protected by a flanking fire from reverse galleries; and they would furnish an efficient and economical means of securing, against a sudden rush, any works of a minor description which it might be found necessary to throw up in large numbers in this country.

It will probably be better, in many cases, not to construct covered ways, as ordinarily used, or proposed, in front of the different works; but to substitute for them irregular parapets and rifle pits, of which the position can be altered at pleasure, employing the galleries above proposed to facilitate the advance or retreat of the garrison from any works that are in front of them, and to secure from sudden attack those that are behind them.

It will be in future almost, if not quite as necessary, to protect the works here proposed, as well as any other works, in many cases, from reverse, as from direct fire; and this will be one of the difficulties of fortification. It must be met by an extensive use of earthen screens, judiciously placed, where natural protection cannot be procured. But the engineer must now exercise more than ever the utmost circumspection in the selection, where he has a choice, not only of his general site, but also of the situation of each particular work which he may find it necessary to construct, as a part of his system of defence; and he must pay extra attention to the disposition of his works and the shape of his profiles, when he is compelled to occupy unfavourable sites.

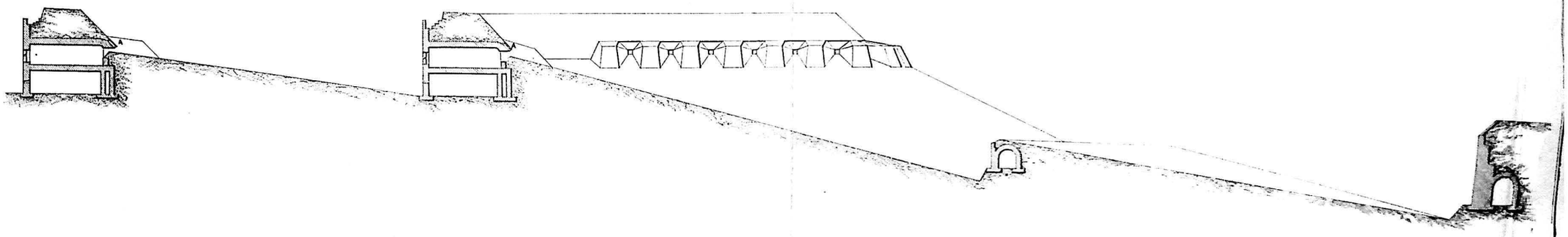
It will now be desirable, in conclusion, to sum up briefly the principles of construction that thus appear to be most suitable for adoption in future in permanent fortifications.

It will be necessary to occupy extensive areas, which will require long lines of works for their protection. Those long lines can be defended most efficiently, and most economically, by means of detached forts, scattered at suitable intervals, and in convenient situations, along the sites to be occupied. The advantage of continuous lines can be afforded to such detached forts, by the addition of a continuous counterscarp in front of them. Whether dry or wet ditches be employed, such a self-defensible counterscarp, higher in the one case, lower in the other, will be the best means of providing security against assault, of affording safe and secret communications, and of furnishing a commencement to countermines.

The greatest efficiency will be obtained in the construction of the detached forts, by providing gun casemates in their faces, for direct fire over the country; by uniting their flanks into casemated redoubts, for mutual support and flank defence, or by some similar arrangement; and by placing bomb-proof buildings under their ramparts, sufficient to furnish all the accommodation that is requisite for men and stores. The detached forts can best be rendered independently defensible, in a general way, by means of sunken walls, covered to the front, and open to the rear, before them and behind them; these walls being flanked by reverse galleries, in proper positions, as well as by the casemated redoubts referred to. To provide against the greater accuracy, the increased facility for

SECTIONS TO ILLUSTRATE PROPOSED PRINCIPLES OF CONSTRUCTION.

Fig. 1. SECTION ON A.B. Plate 2.



ENLARGED SECTION OF PORTION OF RAMPART.

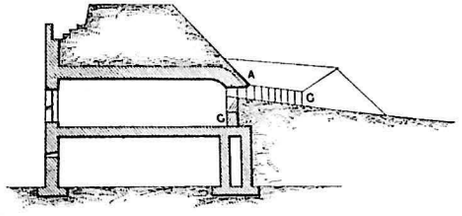
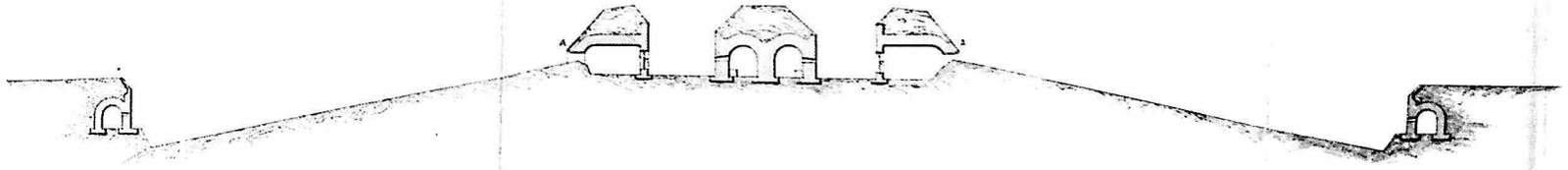


Fig. 2. SECTION ON C. D. Plate 2.



Scale for Enlarged Section

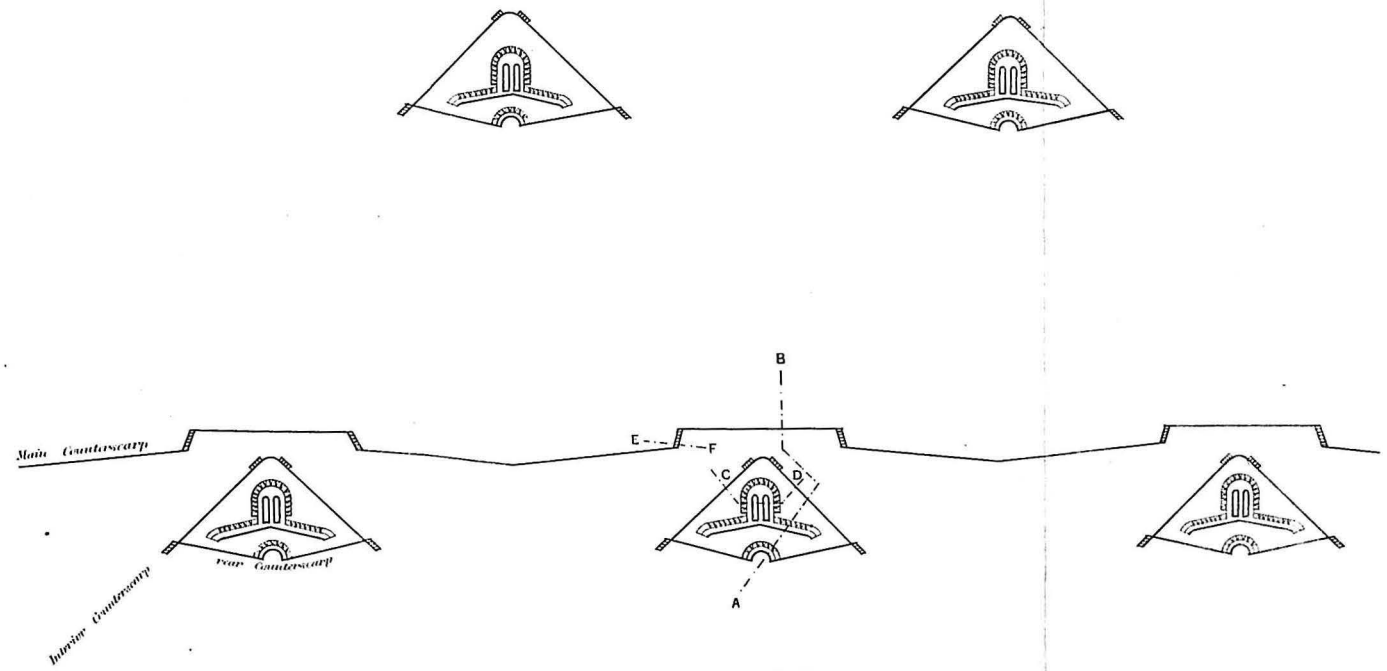
A.A. *Thick Iron Plates bedded on Timber.*

C. *Sheet Iron Galleries lining Front of Casemate and Cheeks of Embrasures.*

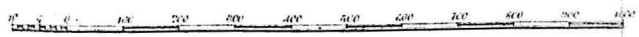
Scale for Figs. 1 and 2.

PLAN

SHOWING A METHOD OF APPLYING PROPOSED PRINCIPLES OF CONSTRUCTION IN THE DEFENCE OF A STRAIGHT LINE.

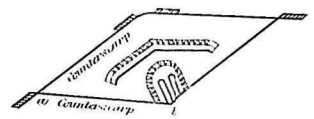


Scale of Yards.

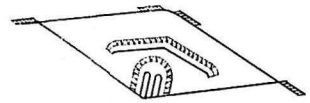


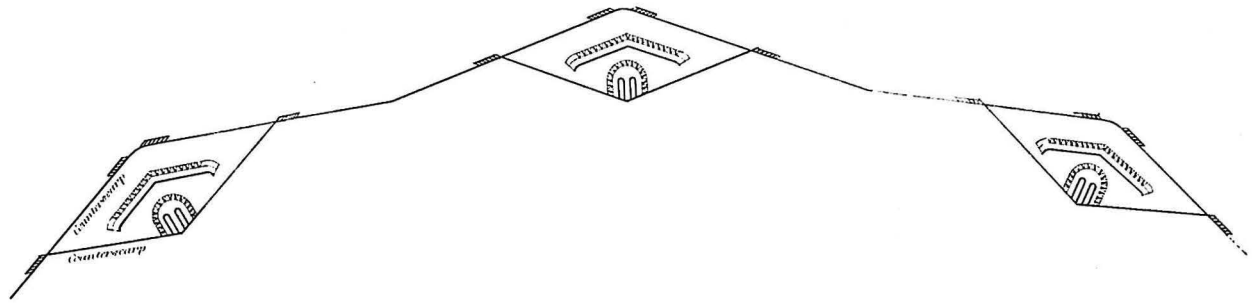
PLAN SHOWING DETACHED FORTS.

CONNECTED BY MEANS OF A SUNKEN OR COUNTERSCARP WALL, AND PRECEDED BY UNCONNECTED ADVANCED FORTS;
THE CAPONIERS BEING PLACED BEHIND THE RAMPARTS, AND SERVING FOR FLANKS AND KEEPS AT THE SAME TIME.



N.B. *The rear Counterscarp at a is sunk to a lower level than that at b.*

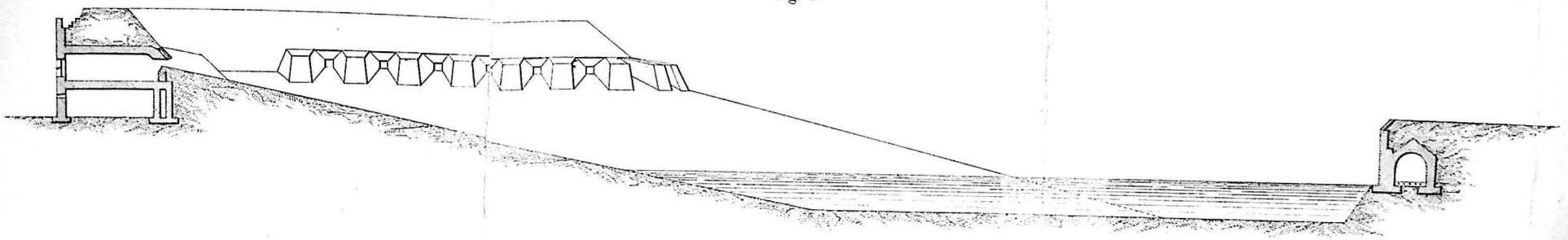




Scale of Yards.

SECTION SHOWING APPLICATION OF PROPOSED PRINCIPLES TO WET DITCH.

Fig. 1.



DESIGNS FOR AN ADVANCED COVERED COMMUNICATION OR CONNECTING COUNTERSCARP.

Fig. 2.

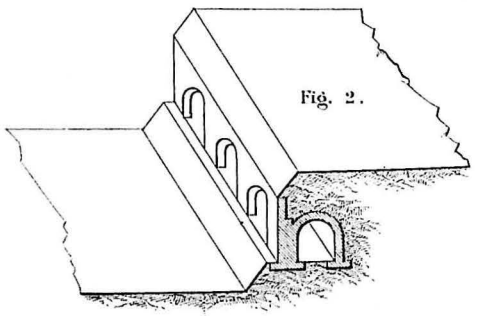


Fig. 3.

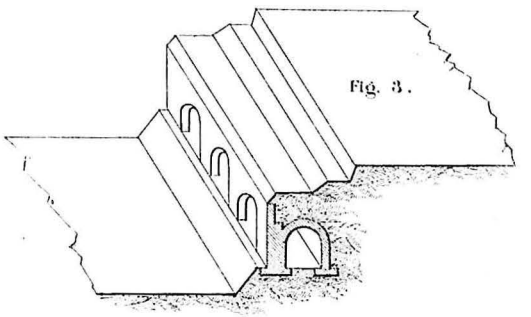
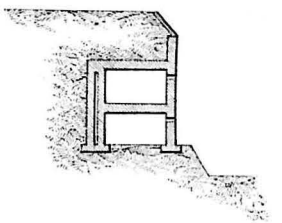


Fig. 4. SECTION ON E. F. Pl. 2.



Scale of Feet.

C. Moody, Litho. 257 High Holborn


106 + 04

employment, and, therefore, the more destructive effects of artillery fire, a higher degree of indestructibility, combined with facility for repair, in the works, in their ramparts, and in their parapets, must be obtained. As far as is possible, flat slopes of earth only must be presented to the front. Gun-casemates must be surrounded by such flat slopes of earth, and must be protected by slanting thick iron plates, bedded in timber, placed immediately above them, to cover their vulnerable points.

The detached forts, thus constructed and protected, must be considered as the permanent nucleus for the defence of a position. The power of resistance of the position can be indefinitely increased, according to the numbers and resources of the defenders. When these are small, the garrison will be more confined to their permanent works. When they are considerable, heavy artillery will be employed, principally in the detached forts or in positions in their rear, for the destruction of the besiegers' batteries; and light artillery and musketry, between them, behind them, or in front of them, in convenient situations for annoying his gunners and checking the progress of his works. But as no amount of fire above ground will be of avail against the besiegers' mines, skeleton systems of countermines must be prepared, in many cases, to meet his close attack.

When a position is prepared for defence in this manner, the degree of impregnability to which it will attain will vary, within certain limits, with the relation that exists between the means that can be spared for its defence and those that can be employed in its attack—of men, munitions, and materials, in proper proportions. It would appear, as far as can now be foreseen, that it will be by the application of the principles thus shadowed forth, and by varying the details for carrying them out, with the differing conditions of each particular site, that permanent fortifications may in future be constructed, which shall be, in proportion to their cost, the most secure against sudden assault, the least destructible, the most easily defended during an attack, the most tedious and harassing to besiege, the most difficult to get ultimate possession of, and the most useless when captured; which shall combine a facility for defence by a limited garrison, with a capability for more active operations as the number and means can be increased; and which shall unite the best means for defence against, and for the employment of the rifled guns and muskets that are destined to be employed in times to come. But the whole question is as yet completely in its infancy; and it is to be hoped that others will be induced to follow the course which has here been hazarded, of fully discussing it, not only with a view to the general advancement of the science, but also with the more practical object of affording assistance to those who are engaged in the difficult operations of designing and carrying out the extensive works that are about to be, or are being constructed, for the defence of this country.

PAPER XVIII.

NOTES ON PHOTOGRAPHY.

By CAPTAIN SCHAW, R.E.

Photography has now attained to a position of such acknowledged usefulness in reference to many of the arts and sciences in which the Corps of Royal Engineers are professionally interested that some notes on the subject may prove valuable to officers who have not had an opportunity of studying or practising it. So many excellent works however on photography have been already published that it would be quite superfluous for me to enter at length into the chemistry or describe minutely the manipulations of the art: it will be sufficient if I refer my brother-officers to the best works on the subject, and confine myself to such practical hints as may be likely to aid in the selection of good serviceable apparatus, and in using the apparatus to the best advantage under the varying circumstances, as regards climate, &c., in which officers may be placed. And as this beautiful art is as yet but in its infancy, it should be borne in mind by those officers who have had any experience in the working of photography in foreign countries that an account of the difficulties they have met with, and the means they have found most effectual in overcoming them, will be very valuable.

It is not probable that photography will ever be of much service on the field of battle or in cases where very great expedition is necessary. Success in photography depends upon the favorable combination of so many minute circumstances connected with the state of the weather and of the chemical agents employed, and also of the delicate apparatus, and of the manipulation, that it is not to be expected, in the present state of our knowledge of the art, that any good results should be obtained under the unfavorable conditions of hurry, dust, smoke, &c., inseparable from active military operations.

In reconnoitring hostile fortresses it is possible that photographs taken by means of some of the various "dry" processes may in some cases prove of service; but it is not probable that much assistance will be derived from photography in such cases on account of the exceedingly small scale on which distant objects are represented in a picture taken by means of the camera, even when the apparatus is of large size. And as the size of the apparatus increases, the difficulties connected with the practice of the art increase also in a very rapid ratio; it becomes also a more conspicuous object for the enemy's marksmen.

The uses to which photography has been found applicable in a military and scientific point of view, or to which it evidently may be made subservient, are briefly as follows, viz.:—

1. Obtaining exact records of the progress of public works in course of construction, which may take the place of those tedious "progress plans" too well known to most officers of the Corps; thus saving much valuable time and obtaining, with the minimum of labor and expense, absolutely truthful representations of the progress of the works.

2. Copying plans and maps, either on the same scale, or reduced, or enlarged. This application of photography, first made use of on an extended scale by Colonel Sir H. James, Director of the Ordnance Survey, has lately been perfected under his direction by Captain A. de C. Scott and Corporal Rider, R.E., in the new process of photo-zincography. Sir H. James will doubtless shortly publish full details of this most valuable discovery, which promises to be exceedingly useful to the Corps and to the public at large.

3. Obtaining minutely accurate pictures of architectural subjects of acknowledged excellence, to assist in designing new works and buildings; or of existing buildings to which additions or alterations are required, to enable the designer to adapt the new work to correspond with the old.

4. Preserving exact representations of failures in buildings from defective foundations or other causes, and thus possibly avoiding litigations with contractors after the defects have been made good.

5. Recording the effects of the explosion of gunpowder in different positions.

6. Recording the results of all sorts of experiments in mechanical constructions or new inventions, showing their success or failure and illustrating reports on the subjects.

7. Illustrating the methods of making military bridges, gabions, fascines, &c.

8. Showing the correct positions for soldiers in their various drills, such as rifle drill.

9. In surveying boundaries of different countries, photographs of remarkable natural features of the country, which may either occur in the boundary line or be visible from certain points in it, will tend to fix the positions of the line with great certainty.

10. Obtaining portraits of remarkable persons and costumes of foreigners.

For amateurs, photographs of scenes, places, and persons which have interested them in the different countries they may have visited, must, in after years, prove deeply interesting both to themselves and to others, and will well repay the trouble and expense incurred in obtaining them.

THE PHOTOGRAPHIC PROCESSES RECOMMENDED TO BE EMPLOYED.—Of all the numerous different processes by means of which sun-pictures have been obtained the one which has hitherto been found in every way the most satisfactory is the ordinary process of taking a negative picture on collodion, from which almost any number of positive prints on paper may be obtained. For very large pictures, where the rendering of minute details is not an object, the calotype or other process for taking negatives on paper may be preferred occasionally; but the very great difficulty of obtaining paper sufficiently *even* in texture and free from impurities, the long exposure in the camera which is necessary, and the still more tedious process of development required in all negative paper processes, together with the entire destruction of the picture resulting from the least failure in chemical cleanliness in the operations, have proved serious obstacles to success in this branch of photography. And even

the great advantages which it possesses in the lightness and portability of the material on which the negative image is formed, and the power of dispensing with the dark tent with all its paraphernalia when taking views at a distance from the dark room, have not obtained for it more than a very few supporters among the multitudes who now practice the "black art." I shall therefore not further allude to any of the processes for obtaining negative pictures on paper, except to the waxed paper process of Le Gray, which, slightly modified, appears to have given the most general satisfaction. Some of the pictures obtained from waxed paper negatives occasionally to be seen in our photographic exhibitions nearly equal collodion pictures in the clearness of the details and the beautiful gradations of half-tone. In hot climates, when the stock of collodion has been spoiled (an accident that will occur sometimes) it may be worth while occasionally to use waxed paper as the substitute for it. I have therefore appended a description of a waxed paper process which has been found to succeed very well at Bombay. It is from the pen of Mr. H. Stanley Crawford, Secretary to the Bombay Photographic Society, and was published in the Photographic News, Vol. I., No. 18, August 5, 1859.

The remaining processes may be divided into dry collodion, properly so called, and the honey and oxymel, metagelatine, and other processes where the sensitive surface is coated with some preservative solution which remains moist for a considerable length of time, and in which the plates must be exposed while the surface still remains moist. Although very exquisite pictures may be obtained at some distance from the operating room by means of the latter class of processes, yet the very great care necessary in avoiding dust, &c., render them quite unfitted for military purposes. Of the dry collodion processes, although many of them have given very excellent results in the hands of skilful operators, yet only two appear to have been worked with any degree of uniformity in pictures of large size. These are Taupenot's collodio-albumen process, and a process, described by Dr. Patterson in No. 94 of the Photographic Journal, where gum-arabic is the preservative agent. Two other dry processes deserve mention. 1st. "Fothergill's process" in which a coating of albumen is used over the sensitive collodion film, as in Taupenot's, but instead of being allowed to dry, as in that process, the albumen is washed off again. Many beautiful negatives have been obtained in this manner, but in general, when plates larger than the ordinary stereoscopic size are used, the results are far from satisfactory, mottled skies, streaks, and markings of various sorts being painfully common. The large quantity of water required in preparing the plates is also a decided objection to this process in many situations. 2nd. Dr. Hill Norris's process, in which gelatine is used for the preservative solution. This has produced some good pictures, even of a large size, when used by skilful and experienced operators; but here again the ordinary results seen in our photographic exhibitions are dirty-looking photographs very deficient in softness and half tones.

There remains therefore a choice between the collodio-albumen and the gum-arabic preservative processes. The first has had the longest trial, and it is beyond a doubt that by its means almost certain results may be obtained after some experience, by using great care and cleanliness; its drawbacks are:—

1st. A liability to blister, to be obviated by using a collodion specially prepared, and by extra care in cleaning and drying the plates.

2nd. The necessity of two nitrate-of-silver baths, one for sensitising the collodion surface, the other for the albumen, besides a bath of iodide of potassium which is generally recommended.

3rd. The large quantity of water required for the washing, as in Fothergill's process.

4th. The long time which must be expended in developing the picture.

Owing to these causes photographers have not used this process to any great extent.

The gum-arabic preservative process of Dr. Patterson appears to have fewer drawbacks than any other dry collodion process yet made public—it is simple and inexpensive, the manipulations are easily performed, very little water is required in preparing the plates, and the results appear to equal those obtained by means of wet collodion. But in this, as in all other dry collodion processes, the successful preparation of the plates requires that the strictest attention be paid to cleanliness, or the markings and spots before alluded to are certain to show themselves in development; with care however these difficulties will be overcome and it bids fair to be the best dry process yet discovered. The details are given in the appendix of this paper, being re-printed from the 95th number of the Photographic Journal.

The time of exposure in the camera appears to be about the same for all the dry collodion processes, viz., about six times that required for a wet collodion plate, under the same circumstances, and with a moderately quick working collodion; but in regard to rapidity of development, the Fothergill and gum-arabic processes have a considerable advantage over the others, requiring not more than twice as long as wet collodion, while plates prepared by the other dry collodion processes are usually very tedious in development.

As regards all the "dry processes," however, whether on paper or glass, where the tent is not taken into the field and the picture is developed either at the end of a tour or in the evening of the day on which the view was taken, there is so much uncertainty about the results, and disappointment occurs so frequently when it is too late to repair it by exposing another plate, that, with all its inconveniences, the wet collodion process is very much to be preferred. If a failure does occur (as it often will) in working with wet collodion, it is apparent at once, and the operator can try again, and generally by patience and ingenuity he will overcome his difficulties and not leave the subject he wishes to take a picture of until he has obtained a good negative.

The manipulations of the wet collodion process are so thoroughly described in "Hardwich's Photographic Chemistry" and in the numerous hand-books published on the subject that I need not notice them here; but pass on to describe the apparatus necessary.

THE CAMERA.—A good well-seasoned mahogany camera, brass-bound, with sliding body, is the most generally useful form; but, for portability, cameras are made to fold down flat by means of hinges in the sides, and these are much more durable than the still more portable form with an accordion body; the last mentioned form however is extremely light, and when provided with proper brass stays to prevent its being shaken by the wind, is sufficiently steady.

Accordion bodies are not to be recommended for hot climates, as insects eat the leather and destroy the camera. If the camera is required for copying

drawings, &c., full size, it should be made entirely of wood and be provided with an elongated front in order to remove the lens far enough from the sensitive surface; this front may be made moveable so that the camera may be used also for landscape and portraiture.

The three points essential in a camera, are—

1st. That it keeps out the light perfectly.

2nd. That it is firm and steady.

3rd. That the focussing glass and dark slide are so carefully adjusted that when the former is replaced by the latter the sensitive surface may occupy precisely the same position with reference to the lens that the roughened surface of the focussing glass had.

A failure in the 1st point will give *foggy* pictures, or pictures with dark spots recurring in the same place. A failure in the 2nd point will be fatal to the *sharpness* of the negative when there is any wind, as the camera will move and a number of images will be formed instead of one. If the 3rd point be not attended to the pictures must always be out of focus, however carefully they may have been focussed on the greyed glass.

The steadiest form of tripod-stand for a large camera is that in which there are three long screws which pass through the tops of the legs and through the metal triangular frame on which the camera rests. These screws can be tightened up and the stand made perfectly firm.

For a small camera the more usual form of tripod, in which the elasticity of the wood of which the legs are made serves to keep the two portions of each leg firmly pressed against the triangular top, is sufficiently steady, but legs which have a joint in the middle of their length are never steady.

It is of importance that the focussing glass should be of glass specially prepared for the purpose and very finely greyed, or it will be difficult to focuss correctly.

When working with paper a different form of dark slide for the camera is required from that suited for collodion on glass.

As regards the *size* of camera, it must depend very much on the expense which it is intended to incur; but it should be borne in mind that the difficulties of the manipulation and the weight to be carried increase rapidly with the size of the picture, and also that the quantity of collodion and other chemicals necessary must vary as the areas of the glass plates used.

Plates 10 inches by 12 inches, or 9 inches by 11 inches, are those usually employed by the photographers of the Corps, and for government purposes the size ought not, in my opinion, to be diminished; but for an amateur I should recommend a camera that will take pictures of what is called the whole plate size, viz., 8½ inches by 6½ inches, or even as small as 6 inches by 5 inches: and there should be a spare frame to fit in the dark slide to take plates 4¼ inches by 3¼ inches for portraits. Cameras are sometimes made *square*, so as to allow of the plate being used with its greater dimension either horizontal or vertical. This is useful in architectural subjects occasionally, but the same object may be obtained with greater portability (though at a sacrifice of convenience) by making the camera so that it can be fixed on the stand, either on its *bottom* or on its *side*.

The stereoscopic camera is preferred by some, and it has its advantages; but the larger single picture which may be obtained on a plate of the same area is

in most respects more satisfactory than the two small ones, and when viewed with *one eye* gives the same effects of solidity and distance so well that it appears to me very much to be preferred.

THE BATH for containing the nitrate of silver solution for sensitising plates is best made of gutta percha, enclosed in a wooden case with a top which screws on. The inside of the bath should be coated with shell-lac varnish, by dissolving shell-lac in methylated alcohol in the proportion of about 1 oz. of shell-lac to 6 oz. of alcohol, and pouring it into the bath and letting it flow all over the interior, when the superfluous liquid may be poured off, and the bath left to drain mouth downwards, until the lac has hardened, which will generally take place in about 12 hours. This precaution is necessary owing to the impurities which are frequently found in commercial gutta percha, and which decompose the nitrate of silver. The dipper should be of glass.

Glass baths in wooden cases are very good, but they are expensive, heavy, and very liable to fracture. The bath should be at least 1 inch deeper than the length of the plate to be immersed in it, to avoid spilling and to insure the plate being covered with the solution.

THE LENSES are the most important part of the apparatus; defects in the camera and even in the chemicals may be remedied more or less perfectly, but a bad lens is fatal, therefore I should not recommend economy in this particular.

For landscape photography the ordinary view-lens obtained from a good maker is as satisfactory as any; but in architectural subjects the distortion which is unavoidable in this form of lens is very annoying, especially in the vertical lines of buildings, which are invariably bent into curves.

For such subjects the new form of lens known as the "orthoscopic" or "caloscopic" lens is very useful, as it corrects the distortion above alluded to; it gives also a *flatter field* than the ordinary view-lens, that is, if the object to be copied be nearly in one plane, such as a drawing, the whole of it will be brought clearly into focus from the centre to the edge, which will be found to be impossible with the ordinary single view-lens, the image formed by the latter being on a curved surface while the surface on which it is received is flat.

In taking a view, however, in which there are objects at various distances from the camera, the orthoscopic lens is inferior to the ordinary view-lens, as it has not the same *depth* of focus, *i.e.* objects in the foreground and in the middle distance cannot both be sharply focussed, while the extreme distance is almost lost. By using a small stop or diaphragm with the ordinary view-lens, objects in the foreground and distance may both be photographed at the same time with considerable success.

The aplanatic lens, patented by Mr. Grubb, is said to combine in some measure the good qualities of both the before-mentioned lenses; the one which I have used however does not give straighter lines than the ordinary view-lens; but it is exceedingly convenient in some cases from having a very short focus and taking in a larger angular extent of subject than either of the other lenses. On the whole, for taking views, I should recommend both a Grubb lens and a caloscopic or orthoscopic lens for government purposes, and the former only, or even a good ordinary view-lens, for an amateur. For taking portraits there should always be a separate lens.

In portrait lenses the chance of getting an inferior article is very great if cheap makers be resorted to. Ross's are said to be the best. Grubb's are also very good. Those made by Horne and Thornthwait are also good and not quite so expensive. Doubtless many other makers produce equally good articles; but good lenses have a certain market value, and below that price the lenses must be inferior.

As the diameters of portrait lenses increase, so also do the difficulties of manufacture and the price, hence small portrait lenses to cover plates of from 4 inches by 3 inches to 6½ inches by 4¾ inches, and costing from £5 to £10, are to be preferred for amateurs. The French portrait lenses are cheaper than those of English manufacture, and if carefully selected are often very good.

Lenses are sold which by changing the positions of the glasses may be made to answer both for landscapes and for portraiture; but the unscrewing and refitting the glasses is very inconvenient, and there is always a risk of dropping the glasses and injuring them, moreover the action of these lenses is seldom perfect. The best are said to be those made by Jamin of Paris.

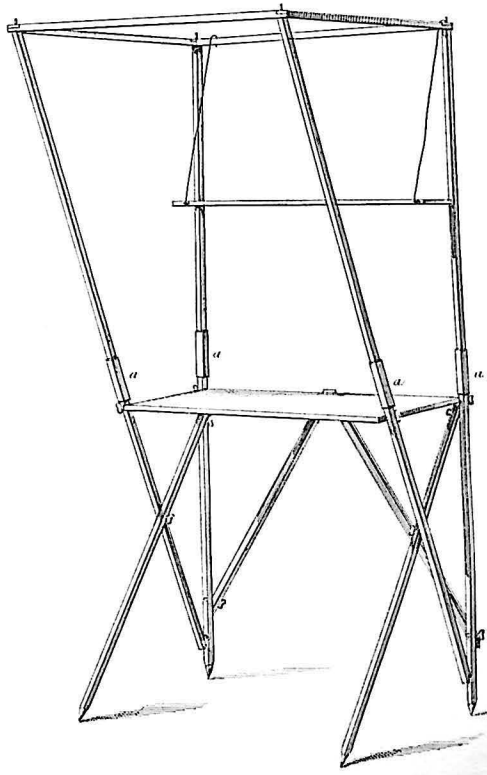
THE DARK ROOM OR TENT.—An operating chamber from which white light is excluded may generally be fitted up in any building with very little labour or expense. The conditions required are that it should be free from dust and draughts of air, that all white light should be excluded, but enough yellow or red light admitted to work by. The proper amount of yellow light may be obtained by means of yellow glass, or yellow calico, or a candle. The operating room should have a waste sink and a good supply of water, and for the latter a tap is very convenient. An even temperature of about 60° with a moderately dry atmosphere is best.

For a portable tent a simple frame-work of light wood, about 6½ feet high, supporting a light board for a table, about 15 inches by 30 inches, at 4 feet from the ground, with a covering thrown over all consisting of two thicknesses of yellow calico and one of black calico, is most convenient. An opening 1 foot square for a window should be left in the black calico, and an extra thickness of yellow calico may be substituted for it if the light be too strong. A very simple form of tent is described in Hardwich's Photographic Chemistry, page 261, but I should recommend that the covering should be allowed to fall down to the ground, and that it should have a double lap in front so as to allow the operator to get in without being tied into a bag. The form of frame for the tent used at Chatham, designed by Captain Fowke, R.E., is shewn in the annexed diagram. The long pieces have a joint and ferrule at *a, a, a, a;* and brass thumb-screws secure the table to these pieces.

PACKING AND TRANSPORT.—In taking photographs in the vicinity of Chatham we have found it convenient to pack all the materials required for a day's work in one box about 2 feet 9 inches by 1 foot 5 inches, by 10 inches deep, which is carried by two men by means of two poles; or light wheels may be fitted to the box as is done at Kensington by the Royal Engineers, and it can be drawn by one man where there are roads. As this box holds all the materials for a day's work with plates 10 inches by 12 inches, a much smaller box will suffice for an amateur using a camera for pictures 8½ inches by 6½ inches. On service or in most foreign countries it will be found more convenient to divide the apparatus between two boxes, which will be more manageable and may be slung on either side of a pack-saddle. The chemicals should be packed in one box with compartments, and

FRAME FOR

PHOTOGRAPHER'S TENT.



C. Moody, Lith. 257, Holborn.

the camera, plates, &c., in the other. The tent would form a third package, and might be secured conveniently on the top of a pack-saddle between the boxes. In travelling any distance it is best to pour off the bath and solution into a large bottle kept for the purpose, which should be impervious to light. A square gutta percha bottle, varnished inside with shell-lac, will be found very convenient for the purpose. For a short distance the bath may be carried by hand in its trough with the lid screwed down.

SUN-PRINTING.—Flat porcelain dishes are best for preparing sensitive paper for printing, and for toning the prints with chloride of gold; and pressure frames with *spring* backs are preferable to those where the pressure is applied by means of screws, as the irregular pressure of the latter frequently breaks the negatives. American clips are very useful for hanging up the paper to dry. In albumenising large quantities of paper for printing, it is much quicker to brush the albumen solution on with broad flat brushes of hogs hair (such as those used by house painters) than to float the paper on the solution in the ordinary way. The solution is brushed on evenly in one direction first, and the sheets hung up to dry; when dry a second coating is given, the brush being used in a direction at right angles to that at first adopted, and the paper is again hung up to dry. The operation requires care to avoid streaks or bubbles; but after a little practice it becomes very easy. It is best performed on a board rather smaller than the sheet to be albumenised; this prevents the brush from becoming contaminated with dirt, as it touches nothing but the surface of the paper. Amateurs are however recommended to purchase albumenised paper from respectable dealers.

A few gutta percha trays are very useful for washing prints, for fixing them, for catching the waste solutions when developing in a tent, and for washing collodion plates when preparing them for any of the dry processes.

The paper best suited for photographic printing, especially when the pictures are small, is that known as *negative* paper, and "Canson's" is generally considered the finest. The thicker sorts of paper, called positive paper, are sometimes useful for large subjects.

The glass recommended generally for collodion negatives is patent plate, which is very expensive. The best 16oz. sheet glass answers the purpose quite as well and is much cheaper.

The pneumatic plate holder is indispensable for plates larger than 8½ inches by 6½ inches, and it is very convenient for these or even smaller plates. The globe plate holder is a convenient form for small plates.

THE CHEMICALS required for photographic purposes, should be exceedingly pure, or the results will be generally unsatisfactory. It is recommended that they be obtained from makers of reputation, who devote their attention to this branch especially. We have dealt with Messrs. Thomas, 10, Pall Mall; Hopkin and Williams, 5, New Cavendish Street, Portland Place; or Burfield and Rouch, 180, Strand, London.

Two lists are appended to this Paper, the one giving the materials required for a year's supply for a photographer constantly employed on Government work; the other for a small equipment for an amateur working with plates 7 inches by 6 inches for views, and 4¼ inches by 3¼ inches for portraits.

For foreign stations more than usual care must be used in selecting the collodion, as it is a very unstable compound, and if not perfectly pure, and prepared

in the best manner, it rapidly becomes unfit for use. Mr. Hardwich's collodion, now manufactured by Messrs. Burfield and Rouch, bears a very high character; so also do those manufactured by Mr. Thomas, Pall Mall, London, and by Mr. Keen, of Leamington. The last named is specially adapted for the dry processes and may be obtained from any respectable dealer. At the Ordnance Survey Office, Southampton, pyroxyline has been obtained from Mons. Cappe, 4, Quai de Billet, Paris, and we have used the same here for a considerable time. At first it gave admirable results, but it has deteriorated by keeping, and latterly we have found it uncertain in its action. If pyroxyline be purchased, and made into collodion as required, the ether used must be carefully preserved from the effects of light and heat, or the collodion will rapidly assume a dark color on being iodised, and become insensitive and useless.

Upon the whole I should not recommend amateurs to attempt the manufacture of their own collodion, unless they are expert chemists. The substance is so very easily altered in its properties, that failures are almost certain to occur frequently, and it will be better and cheaper eventually to purchase the collodion from good makers. It will be well, however, to have two iodising solutions—one iodide of cadmium, the other iodide of potassium; these two iodisers are now sold with nearly all good collodions, and may be varied according to circumstances. The cadmium iodiser is very valuable in hot climates, as collodion there rapidly acquires the property of liberating iodine from iodide of potassium, when it gives weak pictures and requires long exposure. It will be best also to get collodion sent out in small quantities at a time; there will thus be less risk of the whole stock turning bad.

I have made no mention of the positive collodion process, because the negative process is so much to be preferred, that it is not worth while for an officer, who has other occupations, to waste his time upon it; and as the pictures cannot be multiplied, and are on such a heavy and fragile material as glass, they are useless for military purposes.

Some general directions, not found in most books on the subject, with reference to the process of taking negatives on glass, and printing positives on paper, may be useful in conclusion; but for full details of the process, with explanations of the chemical theory, and directions for overcoming all sorts of photographic difficulties, the reader is referred to the 5th edition of "Hardwich's Photographic Chemistry."

General Directions for Taking Negatives.—After having tried nearly all the various methods recommended for cleaning photographic glasses, we have not found any more convenient detergent than tripoli powder mixed with enough water to bring it to the consistency of cream. In applying this a small quantity is dropped on the plate, which is laid on a pad of blotting paper, and with a tuft of cotton wool the tripoli is well rubbed over the surface, and cleaned off with another tuft, the plate is then turned over and the other side, treated in like manner, and the edges carefully wiped; it is then examined to see if there be any scratch or flaws on either side, and the best side is selected for the collodion, the pneumatic holder is fixed to the other side and the surface is polished with an old silk handkerchief, or piece of wash-leather, the latter being rather preferable. A little methylated alcohol is often sufficient to remove a slight stain on the glass.

The bath should always be kept covered to preserve it from dust and light, a brown paper cap which will drop on loosely is most convenient in the operating room.

In very hot climates chemical changes proceed so rapidly that half a minute or less in the bath may be sufficient, although in cold weather from 2 to 5 minutes is generally necessary.

The plate should be well drained before putting it into the camera slide, and if this is done on the dipper over the bath a good deal of solution will be saved. A strip of clean blotting paper laid on the back of the plate near its lower edge, after it is placed in the slide, is a useful precaution, as it saves the slide from the corroding action of the waste solution which would otherwise run down into the groove at the bottom, and which also is a fruitful source of spots on the picture from the slide being shut down too forcibly and splashing up some of this liquid on to the plate.

The sooner the plate is exposed and developed the better, especially in hot weather, but in cool damp weather if the collodion gives a good thick creamy film it may sometimes be kept for half an hour or even three-quarters of an hour, and when the necessity of a very long exposure, as in photographing interiors, obliges such a course, it may be useful to re-dip the plate in the bath before developing; this practice is not however to be recommended as there is great danger of carrying some organic impurity into the bath, and so putting it out of order.

In developing an under exposed picture in which the details of the shadows appear very slowly, the development should be carried on as far as possible before adding nitrate of silver to the solution. If the picture be over exposed, on the other hand, it is best to fix it as soon as the details of the shadows appear, and, after well washing it, it may be intensified if necessary with pyrogallic acid and nitrate of silver.

When hyposulphite of soda is used for fixing (which I should generally advise in preference to cyanide of potassium) it is best to leave the plate for a while in a dish of water before intensifying it, as the least trace of hyposulphite of soda remaining on the film would cause a stain.

In cases when a sufficient supply of water for washing the picture after fixing is not procurable, cyanide of potassium may be preferable to hyposulphite of soda as it is more easily removed; but it must be used very carefully or the delicate half-tones of the picture will be injured.

A very excellent and durable varnish is made by dissolving white lac in alcohol, but it requires the aid of artificial heat to dry it rapidly or it will have a dull surface.

Good varnishes are sold composed chiefly of gum benzoin or amber dissolved in chloroform, which may be used without artificial heat and are therefore more convenient; they are however more expensive.

In photographing landscapes or architectural subjects a view-meter is exceedingly useful; it is a small hollow truncated pyramid of tin, constructed so that when applied to the eye the field of vision is limited to exactly what will be depicted upon the sensitive surface by the lens to which it corresponds. The best point of view may thus be selected without moving the camera from place to place. Full consideration should invariably be given to this important

particular, as the value of the finished photograph, as a picture, will mainly depend upon the taste and judgment displayed in selecting the point of view.

A moveable front to the camera is frequently of great use in regulating the amount of foreground in the picture without disturbing the horizontal position of the camera, which should always be carefully preserved, or the subject will be distorted into the shape of a pyramid, the vertical lines converging upwards or downwards according to the direction in which the camera is inclined.

In focussing, the principal objects should be most sharply defined, and in general a want of clear definition in the foreground will be more disagreeable than if the distance be slightly out of focus.

In judging the necessary time of exposure, which can only be done by practice, it should be remembered that the total amount of light which is thrown on the sensitive surface through the lens mainly influences the result. For instance a large building covered with ivy which occupies nearly the whole of the picture, would require a considerably longer exposure than a corner of a wall of the same building occurring in a portion of a well lit landscape, although the camera were at the same distance from the building in both cases. On the same principle the nearer the object to be copied is to the camera the longer will be the necessary exposure to produce a good picture.

In copying drawings, &c., with the elongated front, it is essential that the planes of the picture to be copied and of the sensitive surface be exactly parallel, otherwise distortion of the image will result. A small stop is necessary in copying drawings with the ordinary view-lens to overcome, as far as possible, the curving of straight lines into a barrel shape, which is the great defect of that form of lens. The curvature of the image (*i.e.* its being formed on a curved surface instead of a plane one as before mentioned) renders it impossible to focus the whole picture with equal sharpness, it is best therefore to focus on an annular ring midway between the centre and outside of the picture; by this means the whole picture is nearly in focus.

In portraiture, the grouping of the figures, the dress, and the background all require careful attention. A dark background gives generally the most pleasing effect, and the figure stands out better from the background when the latter is slightly out of focus. It is generally necessary, in photographing a single sitting figure, to point the axis of the lens somewhat downwards, so as to bring the focussing screen nearly parallel to the general direction of the figure.

Groups of figures may be taken successfully in a good light, with a single lens of short focus, using the largest aperture. A good portrait lens is however generally better for the purpose, as the necessary time of exposure is shorter. In using a portrait lens in such cases, the group should be arranged in a curved form, the figures on the outside being advanced towards the camera; and if two rows of figures are necessary those in the front row should be children or sitting figures, and the camera should then be pointed downwards, so as to bring all the faces into focus. Taste and judgment will be required to avoid stiffness in the grouping.

Animals must generally be photographed in the sunlight, when with a good portrait lens, and under favourable circumstances, from half a second to one second will be sufficient exposure; but the gradations of half-tone are seldom so

well rendered as when the object is placed in a more subdued and equally diffused light.

As a general rule the position to be preferred for the camera, with reference to the sun, is when the sun is behind the camera and shines upon the scene to be depicted; but cases frequently occur when it is necessary to reverse this position. When this happens, or when the reflection of the sun from water, or light coloured ground, is thrown upwards into the lens, it becomes necessary to shade the lens from such direct or reflected rays of the sun, and this may generally be effected by means of a focussing cloth or other dark material held in the necessary position.

It is also a very excellent rule to throw a focussing cloth over the body of the camera before raising the slide which exposes the sensitive surface, this prevents any rays of light reaching the plate through the slit in which the slide works, or through any other minute chinks which may exist in the camera.

Sergeant Church, R.E., when employed as a photographer in the very hot climate of Honduras, found it a useful precaution to put a wet cloth over the "chassis" (dark slide) when carrying it from the operating tent to the camera, and to spread this cloth over the camera during the time the plate was being exposed, this kept down the temperature and prevented the very rapid evaporation which would otherwise have dried up the surface of the plate before he could have developed it. He also found it a great assistance when water was near at hand to pour a few buckets-full on the ground before pitching his operating tent; this diminished the chances of dust spoiling the picture, and by producing an artificially humid atmosphere, the condensed moisture from the breath could be observed on the plate, so as to ascertain if it were clean, which cannot be done when the air is very hot and dry.

For preparing the nitrate of silver baths and most of the solutions used in photography, distilled water is necessary; but for the developing solutions good filtered rain water or river water will answer sufficiently well. If the water be brackish, or contains any chlorides in solution (as is the case in most hard waters) it will cause a precipitate of chloride of silver on the plate and interfere with the development. When it is difficult to procure better water it will answer if nitrate of silver solution be dropped in until no further milkiness results; but this is of course an expensive expedient.

For washing positive prints, ordinary hard water answers well, though river water, if procurable in sufficient quantity, is generally considered preferable.

Small defects in the skies or in unimportant parts of negatives may be painted out easily with indian-ink and a fine brush on the collodion surface before the negative is varnished; but after varnishing such touching out becomes more difficult.

Defective skies may sometimes be stopped out on the negative by taking a print and cutting it out carefully along the line of the horizon; the sky portion is then exposed to the sun and fully darkened and gummed to the back of the negative, but it is necessary to paint out the edge of the horizon on the collodion side to prevent any light getting round the edges of the paper. In general however it is best to shade out defective skies by a piece of pasteboard outside the glass of the printing frame, arched up from it so as to avoid a hard line;

and whenever shading out is resorted to, the printing must be carried on in the shade, not in direct sunlight, or a hard line of demarcation between the shaded and unshaded portions will result.

In conclusion I would recommend any one who wishes to excel in photography to study the chemical theory of the subject. Hardwich's Photographic Chemistry is generally accepted as the best work which has yet been printed: in it will be found every sort of information which the beginner or the more experienced photographer can desire.

The details of the best process for obtaining positive proofs on paper have however altered slightly since the last edition of that work was published. I have therefore introduced them in the appendix to this paper; the process there described was first published in No. 8 of the 1st Volume of the Photographic News, October 29, 1858, by a person signing himself "*θ.*"

This process has been practised at this establishment ever since, and has been found so immeasurably superior to the old method of toning and fixing in the same bath that no one who wishes to obtain pleasant tones, clear whites, and prints which may reasonably be expected to be permanent, should hesitate to incur the very little extra trouble which "Theta's" process involves.

Appendix.

Solutions for Preparing Paper for Printing.

Albumen.

White of egg	1 ounce.
Chloride of Ammonium	20 grains.
Distilled water	1 ounce.

When paper is floated on this solution it should remain in contact not more than one minute and a half if thin, or two minutes if the paper is thick. In warm bright weather the chloride may be reduced from 10 to 7 grains per ounce, and the silver in the sensitizing bath must be reduced in proportion (say 45 grains). If a very glossy surface be desired for small portraits, &c., more albumen should be used in proportion to the water, say 1½ oz. of albumen to ½ oz water.

Sensitizing Bath.

Nitrate of silver	60 grains.
Water (distilled)	1 ounce.

The paper to remain in contact with this solution five minutes.

In using albumenized paper prepared with 10 grains of chloride to the ounce of solution and a sensitizing bath of 50 grains of nitrate to the ounce, floating 10 sheets of paper 10 in. by 12 in. (on a 10 ounce bath) reduces the strength of the solution from 50 to 40 grains per ounce, and uses one ounce of the solution.

Therefore after sensitizing ten large sheets, 10 in. by 12 in., or 30 small sheets, 6 in. by 8 in., add 1 ounce of solution, of 100 grains to the ounce, to the bath to keep it up to the full strength. If the strength of the bath be allowed to fall too low the prints will be weak and mottled.

Solutions for Toning and Fixing Positive Prints by "Theta's" Process.

1st Bath.	Common water	30 ounces.
	Ammonia	1 drachm.
	Solution A.	
2nd Bath. (Toning.)	Carbonate of soda	125 grains.
	Common water	30 ounces.
	Solution B.	
	Chloride of gold	5 grains.
	Distilled water	30 ounces.
	Fixing Solution.	
3rd Bath. (Toning.)	Hyposulphite of soda	6 ounces.
	Common water	30 ounces.

Solutions A and B ought to be mixed in equal proportions immediately before being used, and only in sufficient quantity to tone the number of prints required. One grain of gold will tone about four 10 in. by 12-in. prints by this process. The proofs must be printed deeply, and the whole of the silver washed out in two waters before immersion in the ammonia bath in which they must remain *five minutes*. They are then to be washed in one water and removed to the *toning bath*, and left there till *very purple;* then washed again and placed in the fixing bath for about *fifteen minutes*. They are then washed as usual for twelve hours in running water and hung up to dry.

Dr. R. Patterson's Dry Collodion Process, Published in No. 94 of the Photographic Journal.

"The collodion used was strongly alcoholic, but with the usual iodising materials. The bath was 40 grs. to the ounce, with 20 minims of acetic acid to each ounce of bath. The plate, after being coated and sensitized and allowed to drip, is then to be placed in a given quantity of common water in a flat tray (38 oz. to a 16-in. by 14-in. plate) and thoroughly washed—washed in fact until we are satisfied that the water has acquired the same strength of nitrate of silver as the surface of the collodion has had left upon it. It is then to be properly dripped on clean blotting paper, and coated with a solution of gum arabic, made of a thickness that will readily go through ordinary filtering-paper.

"No further washing is now necessary; but the gum solution being allowed to run off, it is then to be put into a drying box and carefully dried by artificial heat.* The exposure is about the same as that of other dry plates. With an ordinary meniscus lens, and a 22-in. focus, a plate 16 in. by 14 in. took five minutes in good light. I have always developed with pyrogallic acid, 2 grains to the ounce, with formic instead of acetic acid, and my results have been invariably steady and good. I may remark that there seems considerable difficulty in getting good results from any dry process with large plates, and

* N.B.—A small quantity of chloride of calcium in a saucer in the box, or chest, in which the plates are placed to dry with their corners resting on clean blotting paper, will dry them very effectually if a proper tin box or oven be not available.

this doubtless arises from the greater difficulty in manipulation. Although, therefore every one must not expect to succeed at once in getting good negatives by the above process on large plates, any one will find that with plates of a smaller size, and carefully prepared, he may go into the country with the security that he will bring home with him as many good negatives as he has exposed plates."

N.B.—In working this process at Chatham we have used the ordinary pyro-gallic acid developing solution, with acetic acid instead of formic acid, which answered very well.

It is necessary to wet the surface of the collodion carefully with distilled or rain water before developing, and it is best to pour on the developing solution first without the addition of any nitrate of silver until it flows quite evenly over the plate, a few drops of nitrate of silver are then added and the picture quickly begins to appear and may be developed just as a wet collodion picture. As regards the quantity of water to be used in washing the plate before covering it with gum, the proportion here given, viz., 1 oz. to every 6 square inches of surface of the collodionised glass plate, is a good average quantity, but if the collodion be of a very porous nature, or it be desired to preserve the plates for an unusually long time, more water might probably be used with advantage to the keeping properties of the plates, though they would be less sensitive; less water might probably be used under circumstances the reverse of the above.

Account of the Waxed Paper Process as Practised Successfully in Bombay, by Mr. H. Stanley Crawford,

Published in No. 58 of the 2nd Vol. of the Photographic News.

* * * * "To wax paper, I shall give no particular formula, so many excellent modes having already been given, nearly all of which answer equally well here as in a cooler clime. For my own part I prefer purchasing ready waxed paper, thereby saving myself the inconvenience of a troublesome operation. In purchasing waxed paper, however, it should be carefully examined sheet by sheet; those free from conspicuous flaws should be selected, and while having the appearance of being thoroughly saturated with wax and quite transparent, they should present no shiny patches on the surface, but a uniform dull smoothness; should shining patches appear on paper in other respects good, the objection may be got rid of by carefully ironing the sheet between folds of clean bibulous paper.

"Waxed paper, whether in its plain state or iodized, should always be kept in a portfolio, and in as cool a situation as practicable.

"The iodizing solution I have found to answer best, is made as follows:—

"No. 1. In 20 ounces of distilled water dissolve 480 grains of iodide of potassium.

"No. 2. In 10 ounces of distilled water dissolve 96 grains of bromide of potassium, and then add 24 grains of chloride of potassium.

"No. 3. In 10 ounces of distilled water dissolve 10 grains of cyanide of potassium.

"No. 4. In 4 ounces of distilled water dissolve 5 grains of iodine.

"Mix solutions Nos. 1 and 4 together, agitate well and then add No. 2 solution to it and agitate well; finally throw in solution No. 3, and agitate well. This solution should be kept in a well-stoppered bottle covered from light, and will be of service till entirely expended.

"When required for use, this liquid should be filtered through white clean bibulous paper into a pan of good depth, and as many sheets of paper as are required may be immersed one by one in it; care being taken that no air bubbles adhere to the paper, either above or below, and that the liquid quite covers the whole mass of paper.

"The paper should now be allowed to soak in this solution from 6 to 10 hours, after which it may be taken out sheet by sheet and hung up in a cool place (not exposed to much light) to dry; when dry it should be carefully wrapped in clean paper, and placed in a portfolio till wanted, and, with ordinary precautions, may in this state be preserved good for months.

"The exciting solution is made thus:—In 24 ounces of distilled water dissolve 2 ounces of crystallised nitrate of silver; when dissolved, add glacial acetic acid 2½ ounces, and finally add 5½ ounces of alcohol.

"Filter before use into a pan larger somewhat than the paper to be excited.

"Into this solution immerse one sheet of the iodised paper (taking great care that no bubbles adhere) and allow it to soak for about 5 minutes, when it should be taken out, and if to be kept for several days, placed in a similar pan containing pure distilled water, rinsed in it for a minute or two, and then dried off between folds of clean bibulous paper, where it should be retained ready for use in the camera. As many sheets as are needed may thus be prepared one after the other, and when finished should be kept in a portfolio in a cool place, and most cautiously excluded from light.

"To give any accurate time for the exposure necessary in the camera is almost an impossibility, but with a 3-in. view lens, ⅛-in. opening, and our ordinary Indian light, five to six minutes would be about the time required by this paper for buildings, but for foliage or dark masses of architecture in shade, nine to twelve minutes would probably be better.

"It may not be out of place here to impress upon the mind of the novice the absolute necessity of the most strict caution not to allow the least ray of daylight to get at the sensitive paper when not under exposure through the lens to a view. Camera slides, no matter how carefully made, cannot thoroughly exclude our bright sunlight, and the only plan to ensure certainty is to wrap several folds of yellow cloth round the slides when not in use. Too much care cannot be bestowed upon these precautions.

"Paper made sensitive as above described may be kept, with the precautions advised, at least ten days with perfect confidence. I have worked with such paper 16 or 17 days after excitation, and found no appreciable diminution of effect, even in the time of exposure. It may also be kept several days after exposure in the camera before being developed. At the same time it is always advisable to use the paper as soon after excitation as possible, as involving less chances of failure in excluding mishaps which might intervene by the lapse of time. The same remark applies to the development, which in particular should, if practicable, be done within 24 hours after the exposure in the camera.

"The developing solution is made by filling a bottle quite full with hot distilled water, and throwing into it as much gallic acid as the water will dissolve; when it will dissolve no more the solution should be allowed to cool and settle, then the clear liquid may be poured into a clean pan, say to the depth of a ¼ of an inch. Into this the impressioned sheet is immersed and allowed to

remain for five or ten minutes. The picture rarely developes rapidly under this solution, there being so little free nitrate of silver left on the paper; it is necessary, therefore, to assist the development by throwing into it an ounce of the water in which the sensitive sheets were washed (which should be preserved in a bottle for this purpose); the picture will now rapidly develope, and from this moment the process requires very careful attention:—in the first place to check it at the point when all the details of the picture are properly out; and in the next, if the developing liquid show symptoms of browning (decomposition) which in this climate will speedily occur in gallic acid to which free nitrate of silver has been added, to replace it immediately with fresh; a neglect of this precaution may perhaps destroy what would otherwise have proved a good picture.

"The time that the process of development occupies varies so much that none in particular can be stated. However, a picture is seldom out in less than a quarter of an hour, and it may be 12 or 20 hours, if the exposure in the camera was too short a time; in the latter case particular care must be taken to renew the gallic acid solution, should it show symptoms of becoming brown.

"A picture should be allowed to go on developing so long as the whites or half-tones do not suffer, that is darken. When all the details appear distinctly visible, the sheet of paper should be held up between the eyes and a light; if the blacks in this position present a density impenetrable to light, the whites a clear transparency, and the half-tones a relative value, the operation should be stopped, the picture put into a pan of clean water and brushed on both sides with a soft broad camel's hair brush to remove any deposit that may have settled upon it; if allowed to remain thus for about half an hour, nearly all the acid will be washed out; it should then be passed through a fresh pan of water, and afterwards to remove the iodide, placed in a bath of cyanide of potassium, made as follows:—

Cyanide of potassium	80 grains.
Water	16 ounces.

Filter for use.

"This bath is preferable to one of hyposulphite of soda, inasmuch as it acts more quickly, is less bulky, and is safe in operation, for nothing can be more injurious in working than hyposulphite, the least contact of which is destructive to the exciting and iodizing baths.

"The cyanide bath is very energetic, and consequently the picture requires much attention when in it; for if left beyond the time sufficient to dispel the yellow iodide, it will, in continuing its action, reduce also the blacks—indeed, it would, if left for any lengthened time, entirely obliterate the picture.

"If a hyposulphite bath is preferred, the following will be found to answer well:—

Hyposulphite of soda	3 ounces.
Water	20 ounces.

Filter.

"When the iodide has thoroughly disappeared the picture should be washed for an hour in several changes of water (say four or five times) and in a good supply of water each time: it should afterwards be hung up to dry.

"When thoroughly dry, expose to the sunshine for a few minutes, and finally iron with a moderately heated iron; this operation renews the transpa-

rency of the paper, which, in its continued and repeated washing, is in general somewhat impaired.

"In conclusion, I have only to recapitulate and throw out a few further precautions. Adopt the utmost cleanliness in every stage of the operation. Use no chemicals but what are guaranteed as the best. In exciting, use in the dark room no more light than is sufficient to enable work to be done with comfort. Use fresh clean bibulous paper for blotting off the paper after exciting. Filtered or otherwise, let all the solutions be perfectly clear and limpid. Use the greatest care in preserving the excited paper from the least ray of light when not under exposure in the camera, and so till the picture is developed. Never use the gallic acid bath after it has browned at all; after fixation in the cyanide bath, wash thoroughly in water to remove every trace of that solution. The paper, in every stage—in its plain, iodized, excited, impressed, and completed state—should always be wrapped in paper and laid flat in a portfolio, kept in a cool place. In this climate, every camera for out-door work should have a thick yellow quilted cover, which both serves as a protector to the wood, and excludes white light which might gain admission by any barely perceptible flaw, and also assists materially in maintaining a cool atmosphere about the paper. The lens must of course be wiped occasionally;* perfect knowledge of the proper use of the various sized diaphragms can only be acquired by experience and practice, but, as a general rule, the smallest sizes, compatible with the amount of light available, should be used.

Account of a Mode of Waxing Paper.

Extracted from the Photographic News, Vol. II.

"A dish of block tin, without joints in the bottom, and one inch deep, is made to fit into another and larger vessel, also of tin, containing boiling water, which must be kept at the boiling point by any convenient heater. A cake or two of white wax is put into the waxing dish, and when it is melted, the sheet of paper is floated thereon. When the paper is saturated with wax, take it up and drain off as much as possible of the superfluous wax. Do the same with any number of papers. Then with a clean box iron,† iron them one at a time between from four to six thicknesses of blotting paper, until the blotting paper is saturated with wax; then iron between fresh blotting paper, which may require to be repeated. The second and third blotting papers of the first batch will do the first and second ironing of the second batch. Proceed thus until all are ironed, and appear (when held between the eye and the light) free from any opaque or shining spots, and perfectly clear and transparent.

"Another method of waxing paper is to place the paper on two or three folds of blotting paper; then as you pass the iron over the back of the paper with one hand, follow it closely with a piece of wax held in the other—the excess of wax being ironed out as before. I do not recommend this mode of waxing papers previous to iodizing, but it answers very well when one or two calotype negatives have to be waxed, and must do when the photographer is unprovided with a tray."

* This is best done with chamois leather—it is less liable to scratch the glass than silk.

† English photographers lay great stress upon the iron not being used too hot, a very hot iron spoiling the paper.

List of Articles Necessary for a Government Photographer (Columns A.); or for an Amateur Photographer (Columns B.)

Description of Articles.	Quantity A.	Quantity B.	Rate.	Amount A.	Amount B.
			s. d.	£ s. d.	£ s. d.
Best extra white sheet glass—10 in. × 12 in.	6 doz.	.....	1 3 per foot.	3 15 0	.....
11 in. × 9 in.	6 doz.	.....	1 2 „	2 17 3	.....
6 in. × 8 in.	6 doz.	.....	51 0 per gross	1 5 6	.....
6 in. × 7 in.	....	6 doz.	42 0 „	.....	1 1 0
4¼ in. × 3¼ in.	....	6 doz.	12 6 „	.....	0 6 3
Bath, gutta percha in wooden case with glass dipper.	2 (11″ × 13″)	1 (7″ × 8″)	17 6	1 15 0	0 10 0
Scales and weights, (glass pans.)	1	1	5 9	0 5 9	0 5 9
Funnels, gutta percha, two (nested).	4	2	1 6 per pair	0 3 0	0 1 6
Ditto glass	2 large.	2 small.	.....	0 2 0	0 1 0
Glass graduated measures (20 oz., 8 oz., 4 oz. and minim.)	2 of each.	.....	6 1	0 12 2	.....
Ditto ditto (4 oz., 1 oz., 1 dr.)	.....	1 set.	3 9	.....	0 3 9
Gutta percha bottles for cyanide and developer.	4 16-oz.	2 8-oz.	2 or 1s.	0 8 0	0 2 0
Pneumatic plate holders.	4	2	3 6	0 14 0	0 3 6
Spare tops for ditto.	4	2	1 0	0 4 0	0 1 6
Focussing cloths.	2	1	2 6	0 5 0	0 2 6
Dishes for sensitising paper. porcelain.	2	1	.....	0 7 6	0 1 4
Ditto for washing in, gutta percha (nested).	6	3	.....	2 5 0	0 7 0
Still and refrigerator for water.	2-gallon.	½-gallon.	.....	1 2 0	0 14 0
Portable bucket for water.	2	....	14 0	1 8 0	.....
Pressure frames for printing with spring backs.	4 (11″ × 13″)	1 (7″ × 8″)	.....	2 8 0	0 7 6
Spare glasses for ditto.	2	.....	2 0	0 4 0	.....
Ditto focussing glasses.	2	1	.....	0 3 6	0 1 6
Ditto glass dippers.	2	1	.....	0 1 4	0 0 9
Gutta percha square bottles for bath, &c.	2 (80 ozs)	1 (30 ozs.)	.....	0 13 0	0 3 0
Glaziers' diamond.	1	1	.....	0 17 6	.....
Pins, tape, tacks, and American clips.	an assortment.	an assortment.	.....	0 4 0	0 2 0
Hammer and screw driver.	1 of each.	.....	.....	0 2 9	0 2 9
View meters.	3	1	.....	0 6 0	0 1 6
Dark tent.	1	1	.....	4 0 0	1 10 0
Boxes for holding plates for 10 in. × 12 in.	2 doz.	.....	.....	0 12 0	.....
11 in. × 9 in.	2 doz.	.....	.....	0 10 0	.....
6 in. × 8 in.	2 doz.	.....	.....	0 7 0	.....
6 in. × 7 in.	.....	2 doz.	.....	.....	0 6 0
4¼ in. × 3¼ in.	.....	2 doz.	.....	.....	0 3 6
				£27 18 3	£6 19 7

Description of Articles.	Quantity A.	Quantity B.	Rate.	Amount A.	Amount B.
			s. d.	£ s. d.	£ s. d.
Brought over.	....	....	....	27 18 3	6 19 7
Thermometers.	2	1	3 0	0 6 0	0 3 0
Camera folding and expanding with elongated front, in mahogany, brass-bound, for 10-in. × 12-in. pictures.	1	....	....	10 10 0	.....
Ditto, with accordion body, for 11-in. × 9-in. do.	1	....	....	9 9 0	.....
Ditto, expanding Spanish mahogany brass-bound for 6-in. × 7-in. do.	....	1	....	.....	5 6 6
Spare camera back for 10-in. × 12-in. camera.	1	....	....	1 10 0	.....
Ditto ditto for 11-in. × 9-in. ditto.	2 {for paper & for glass.	....	....	3 5 6	.....
Ditto ditto for 6-in. × 7-in. ditto.	....	1 for paper.	....	.....	1 2 0
View lens by Ross for 10-in. × 12-in. pictures.	1	....	....	3 0 0	.....
Aplanatic lens (Grubb's) for 11-in. × 9-in. ditto.	1	....	....	5 0 0	.....
Caloscopic lens (Horne and Co's.) for 11-in. × 9-in. ditto.	1	....	....	6 0 0	.....
Portrait lens (Ross') for 8-in. × 6-in. ditto.	1	....	....	16 0 0	.....
Aplanatic lens (Grubb's) for 6-in. × 7-in. ditto.	....	1	....	.....	3 10 0
Portrait lens (Grubb or Ross') for 3¼-in. × 4½-in. ditto.	....	1	....	.....	5 0 0
Tripod stands.	2	1	....	3 0 0	1 1 0
Extra flanges for lenses, that they may be fitted to either of large cameras	4	....	....	1 2 0	.....
Boxes for a day's supply, fitted with compartments, lined with cork.	2	....	....	2 0 0	.....
Store box for apparatus.	1	1	....	2 10 0	1 0 0
				£96 10 9	£24 2 1
Add for chemicals, &c.	....	....	....	45 0 0	11 1 5½
				141 10 9	35 3 6½
D. D. 15 per cent for cash.	....	....	....	21 0 0	5 5 10
Say nett.	....	....	....	120 0 0	£30 0 0

H. SCHAW, Captain, Royal Engineers.
14th May, 1860.

N.B.—The prices of the chemicals are taken from the price-list of Messrs. Burfield and Rouch, 180, Strand, London; those of the apparatus from the price-list of Messrs. Horne and Thornthwait, 121, Newgate Street, London; or of Messrs. Bland and Long, 153, Fleet Street, London; and those of the glass from the price-list of Mr. P. Palmer, 118, St. Martin's Lane, London. The prices vary slightly from time to time; but the above are a fair average.—H. S.

List of Chemicals Necessary for a Year's Supply for a Government Photographer (Columns A.); or for a Year's Supply for an Amateur Photographer (Columns B.)

Description of Article.	Quantity A.	Quantity B.	Rate.	Amount A. £ s. d.	Amount B. £ s. d.
"Hardwich's" or other good negative collodion.	10 pints. 4 at a time.	2 pints. ½-pint bottles.	s. d. 16 0	8 0 0	1 12 0
Canson's negative paper.	6 quires.	1 quire.	3 0	0 18 0	0 3 0
Ditto ditto albumenized.	6 „	1 „	10 0	3 0 0	0 10 0
Ditto ditto waxed.	1 „	1 „	7 0	0 7 0	0 7 0
White blotting paper.	10 „	2 „	1 0	0 10 0	0 2 0
Swedish filtering paper.	6 „	1 „	1 3	0 7 6	0 1 3
Absolute alcohol.	40 ozs.	6 ozs.	0 4	0 13 4	0 2 0
Methylated ditto.	120 ozs.	30 ozs.	0 1	0 10 0	0 2 6
Sulphuric ether.	40 ozs.	6 ozs.	0 4	0 13 4	0 2 0
Glacial acetic acid.	120 ozs.	30 ozs.	0 4	2 0 0	0 10 0
Citric acid.	16 ozs.	3 ozs.	0 4	0 5 4	0 1 0
Pyrogallic acid.	8 ozs.	1½ ozs.	4 6	1 16 0	0 6 9
Gallic acid.	10 ozs.	5 ozs.	1 0	0 10 0	0 5 0
Protosulphate of iron.	2 lbs.	1 lb.	0 8	0 1 4	0 0 8
Nitrate of silver (pure re-crystallised).	4 lbs.	1 lb.	64 0	12 16 0	3 4 0
Liquor ammonia.	12 ozs.	4 ozs.	0 2	0 2 0	0 0 8
Carbonate of soda.	1 lb.	¼ lb.	1 6	0 1 6	0 0 4½
Iodide of potassium.	4 ozs.	1½ oz.	1 4	0 5 4	0 2 0
Bromide of potassium.	4 drs.	2 drs.	1 6 per oz.	0 0 9	0 0 4½
Chloride of potassium.	2 drs.	1 dr.	1 6 per oz.	0 0 4½	0 0 2¼
Iodide of cadmium.	2 drs.	1 dr.	1 4 per oz.	0 0 4	0 0 2
Cyanide of potassium.	2 lbs.	1 lb.	2 9 per lb.	0 5 6	0 2 9
Hyposulphite of soda.	36 lbs.	10 lbs.	0 5	0 15 0	0 4 2
Chloride of gold.	8 drs.	1 dr.	7 6	3 0 0	0 7 6
Chloride of ammonium.	2 lbs.	½ lb.	1 9	0 3 6	0 0 10½
Iodine.	2 drs.	1 dr.	1 6 per oz.	0 0 4½	0 0 2¼
Kaolin.	2 lbs.	½ lb.	0 9	0 1 6	0 0 4½
Gum camphor.	6 ozs.	2 ozs.	0 4	0 2 0	0 0 8
Gum arabic.	1 lb.	¼ ozs.	0 3 per oz.	0 4 0	0 1 0
Litmus paper.	6 books.	2 books.	0 6	0 3 0	0 1 0
Varnish (chloroform).	80 ozs.	12 ozs.	0 10	3 6 8	0 10 0
Tripoli powder.	2 lbs.	1 lb.	3 6	0 7 0	0 3 6
Cotton wool.	6 lbs.	2 lbs.	2 0	0 12 0	0 4 0
Shellac brown.	1 lb.	¼ lb.	1 4	0 1 4	0 0 4
Packing case and bottles.	....	....	....	3 0 0	1 10 0
				£45 0 0	£11 1 5½

PAPER XIX.

Observations Relating to the Works in Progress and Proposed for the Defence of the Naval Ports, Arsenals, and Dockyards.

By MAJOR JERVOIS, R.E., Assistant Inspector General of Fortifications.

1. The British Empire being dependant for its greatness upon the maintenance of its maritime power, it is scarcely possible to overrate the importance which must be attached to providing for the security of those establishments and naval ports where its men-of-war are constructed, sheltered, and refitted. It is, however, doubted by many whether this security should be obtained by the aid of fortifications, and whether we should not rather leave the naval arsenals and dockyards, with their harbours, to the protection of the fleet; or defend them against a sea-attack by floating batteries applied to that special purpose, and, supposing an enemy to have landed on our shores, by meeting him in the open field. In support of this view, it is argued that, the strength of our army being small, we should not "lock it up" in fortifications; but an examination of the circumstances of the case must show:—

2. First—That the fleet, which, in addition to keeping command of the channel, has its duties to perform in every part of the globe, cannot be confined to the protection of the naval ports.

Secondly—That for the defence of these places against an attack by sea, the first cost of floating batteries applied for the special purpose would exceed that of the fortifications requisite for the same object; that whilst the latter would last for centuries, the former would require renewal about every 30 years, would be comparatively difficult to man, and, owing to their unsteadiness and liability to capture, would be much less effectual, even supposing them to be on the spot just when and where required.

Thirdly—That in the event of an enemy having landed in force in the country, it would be impossible, with our small standing army, to detach sufficient bodies of regular troops for the defence of our naval arsenals, for even with the aid of such militia and volunteers as would be capable of joining in the line of battle, the strength of that army would but barely suffice to oppose the enemy in his advance upon the capital.* There are reasons both financial and constitutional why this standing army cannot be largely increased; we should therefore as much as possible render it disposable for operations in the field, by applying to those vital points which we cannot leave unprotected, fortifications of such a construction that the defence may be entrusted to irregular levies, assisted by a comparatively small proportion of fully disciplined soldiers. Instead of "locking up" troops behind fortifications, both the fleet and the regular army are thus in reality set free to act with greater vigour and effect.

* See the Paper by the late General Lewis, R.E., on this subject, accompanied by a plan, at page 125 of Vol. II of this Series, and also others by the same officer in Vols. IX and X of the old Series.—Ed.

3. But the Commissioners who have lately reported on the defences of the dockyards and arsenals having so recently considered the reasons for fortifying them, and their views being now before the public, it is unnecessary for me to enter further into this portion of the subject; I would rather refer to their report for arguments to demonstrate the advantage of applying fortifications to the protection of the great naval establishments, both as a means of turning our army and our fleet to the best account and of economising the national resources.*

4. The first point to consider in fortifying any one of the places in question is to provide against an attack by sea; for an enemy having command of the Channel for a very short period would be able suddenly to concentrate a fleet upon any one of our naval ports and arsenals, and such an attack would not be subject to the delays incident to the landing of troops in the country. On this account it would perhaps have been desirable that these observations should have been accompanied by a description, with drawings, of the casemated works and open batteries now in progress, and of those which it is proposed to construct at the several naval ports and arsenals. A set of plans, giving a general idea of these works, had indeed been prepared with the object of inserting them in this volume, but as one principal point relating to the casemated works, viz., the precise form of iron embrasure to be adopted, awaits the result of experiments which are just about to be tried before a final decision is arrived at, and as it is probable that information respecting the nature of the land defences would at present be more acceptable, it has been thought better to confine these remarks to the consideration of the latter, leaving the description of the nature of the sea defences for a future paper.

It will suffice now to make a few general observations upon this branch of the subject.

5. Wherever the nature of the site, its elevation above the sea, and other circumstances will admit of it, open batteries should always be adopted in preference to casemated works, and where practicable the guns should be placed at considerable intervals: there is no doubt whatever of the superiority of several dispersed open sea-batteries over one large work; but the adoption of the former principle is not always consistent with the security of the guns against an enemy landed for the purpose of taking them in rear; nevertheless, although the latter arrangement becomes on this account in most instances

* I should observe that the fortification of the capital, provided there were funds for accomplishing it, would rank in importance with that of the Dockyards and Arsenals, *on the land side*, but the great obstacle to establishing permanent works, for a defensive position round London, that would be of any value, is the large outlay that would be requisite owing to the extent to which it must be developed to get clear of suburbs which are rapidly increasing, and in the neighbourhood of which the land is very expensive. I was so strongly impressed with the advisability of the measure, that nearly two years ago I drew up a paper upon the subject, which was printed and circulated, proposing a scheme similar in principle to that advocated in the pamphlet published last year by Lieut. General Shaw Kennedy, although I proposed to take a more extended line, more especially to the southward of the Thames, than he contemplated. My estimate for the project was five millions sterling but subsequent consideration has led me to believe that this is under the mark. The estimate of £500,000, stated in the "Cornhill Magazine" of June, 1860, as the probable cost, even of the proposal contained in that periodical, would do little more than pay for two or three sites of the requisite size in certain situations.

necessary, single guns dotted about, and supported by the large work, may in some situations be advantageously placed in position, either permanently or at a time of expected attack.

Sea-batteries must be casemated—1st. When constructed on small sites, or on sunken rocks, shoals, or perhaps marshes, upon which either the circumscribed space or the great expense of foundations renders it necessary to build the battery in tiers, either in order to obtain the necessary amount of fire, or to make it of the requisite height.

2nd. When necessarily placed against the side of a rock or hill, it is desirable to arch the guns over to protect the artillerymen from the effect of shells bursting against the ground in their rear.

3rd. When at a low elevation, in a situation where a large ship can approach it within the range of grape shot, the battery would be liable to be silenced very soon if its guns were not secured in casemates.

6. In some batteries the gun casemates will afford sufficient accommodation, so as to render any other barrack in connexion with it unnecessary; but the general plan adopted in open sea-batteries, or in those which are only partially casemated, is to construct a fire-proof defensible barrack (not bomb-proof) at the gorge of the work, acting as a keep, and affording accommodation for the garrison, room for stores, provisions, and all accessories. In the construction of this barrack, care should be taken to avoid placing the buildings close in rear of, and exposed at a considerable height above, the parapet.

7. Before leaving the subject of sea-batteries, it may be advisable to mention the result of a late experiment at a work at Cliff End, one of the defences of the Needles Passage on the shore of the Isle of Wight. It has so commonly been stated that not a shot could be fired for many minutes after the first round from a casemated work, owing to the casemates being filled with smoke, that the Commissioners for Defence thought it advisable to test this question by actual personal experiment. The Secretary of State for War accordingly authorized the issue of 20 rounds of ammunition for each of the 27 guns in the fort, 21 of which are in casemates placed in three tiers, the remaining 6 guns being on the roof.

The work was fully manned and cleared for action, and the firing was carried on as quickly as possible, although of course it was less rapid than it would have been in the case of actual attack, owing to the guns not being shotted having to be run back by hand, and to the platforms and racers working stiffly from want of use.

It was found that the casemates were almost entirely free from smoke; and that no inconvenience whatever resulted therefrom. The wind, which was blowing *from* the fort, but so lightly that the smoke hung about the work for some minutes, had no sensible influence in keeping the casemates clear of smoke or otherwise: had the wind blown *against* the work, the interior of the casemates might not have been so clear, but a portion of the smoke would perhaps have entered the work and gone out through the rear windows and other openings; nevertheless the result of the experiment went to show that the working of the guns in a casemated fort can be carried on with perfect facility, more especially if the casemates are altogether open to the rear, which was not the case in this instance.*

* The details of this experiment are given at Page 46 of this volume.—Ed.

8. With these remarks we may for the present leave the sea-defences, and proceed to consider the protection of our dockyards and arsenals against the attack of a force landed in the country, either for the express purpose of effecting the destruction of one of these establishments by bombardment, or with a view to carrying such a design into effect in connexion with a general invasion of the country.

In the event of invasion upon a grand scale, an attack might be made upon one of the naval arsenals, either for the purpose of capturing and subsequently destroying it, or for the sake of the possession of the arsenal and port as a base of operations. But the most probable kind of attack is that which could be effected with the greatest rapidity, viz., a bombardment, more especially since the introduction of the lately invented rifled ordnance, the lightness, range, and precision of which afford much greater facility than previously existed for such an operation.

9. In selecting the position which it is intended to fortify, it is unnecessary to take up any ground beyond that which screens the point to be protected from view; but if there is no such ground within about 8,000 yards (which may now be considered to be the limit of bombarding range) of the place, and if, on weighing all these circumstances, it appears probable that an enemy, already landed in force in the country, would approach in that direction for the purpose of bombardment, then there is no alternative but to place the fortifications at about that distance, varying, of course, according to the nature of the ground.

10. Having determined the positions to be taken up, the next consideration is the mode in which they should be occupied, whether by continuous lines or by detached forts; if the latter, the points upon which works should be placed; the extent of the works, the general design, and the principles upon which the fortifications should be constructed, must then be considered; and the details have subsequently to be worked out.

11. When the extent of the positions necessary to be occupied, in order to protect the dockyards against long-range bombardment, is considered, it is evidently impossible to occupy them by continuous lines, which must be manned throughout their whole extent, and which fall if pierced at any one point. It follows that the ground must be taken up by establishing upon the principal points of the position detached works, mutually supporting one another, and each secure in itself; subsequently arise the questions, which will be again referred to, whether these works should be connected by lines, and whether they should be supported by an enceinte or by other detached works in their rear.

12. The points to be occupied by detached works will of course depend very much on the ground, which may often necessitate their being placed nearer to each other than would be required in flat and open country. But supposing the country to be clear and nearly level, or such as can be readily commanded by the fire of the works to the front and flanks, it will suffice to place the forts at central intervals of about a mile from each other. The intervals between the works, which themselves occupy some portion of the space, are thus commanded by musketry and grape shot at a range of about 700 yards; and the front of each work is well commanded by the artillery fire of the forts adjacent to it.

Plate 1 represents a position about 4,000 yards in extent, occupied by three forts. The left of the position is supposed to be secured either by an unassail-

able line of coast, a precipitous cliff, or other natural obstacle: if there were no natural obstacle, it would be necessary to construct works of defence, according to the nature of the locality and the probable nature of attack in that quarter, to prevent the position being taken in reverse. On the right flank is a river, on the opposite bank of which it may be supposed that a work, or a series of works, is to be placed for the defence of another line of country, along which an enemy might direct his attack. It is assumed that the formation of the ground is such as to render it advisable to construct the works upon the sites indicated at A, B, C.

13. The size of the forts is determined, in a great measure, by the features of the ground and by the conditions which the work is designed to fulfil. The degree of influence which each fort would possess, in the general defence of a line, is also an important consideration in deciding upon its extent; if occupying the key of a position, it will in most cases be proportionately large, whilst, if it only forms a connecting link between two principal works, it may be comparatively small. Again, the size of the work depends on the number of men which it is desired to place in it, and on the amount of artillery fire which it may be advisable to bring to bear in any particular direction. As regards this latter point, if the works are constructed so that they may be held by a small body of men, it is advantageous to provide an excess of guns rather than otherwise, for whilst there is no necessity for manning more guns at one time than the strength of the garrison will admit of, provision is thus made for casualties, and an opportunity, moreover, is afforded of bringing a heavy fire to bear on any particular point, if circumstances demand it. Again, on certain occasions it would be advantageous to bring all the guns into play; even although there were not a sufficient number of men to work them simultaneously, the whole might be loaded and pointed in any particular direction, and it would only be necessary to attach one man to each gun to fire it at the required moment; subsequently they might all be reloaded at any favourable opportunity, and another volley be fired as before.

14. As regards the number of troops to be provided for in the works, it will suffice to construct barrack accommodation in each for about half the entire garrison of the fort; for at a time of expected attack the space which is now afforded in soldiers' rooms, and in all the accessories to a barrack, will accommodate double the number of men for which the barrack is calculated in time of peace; but there should generally be sufficient cover in one of these detached forts for three times the number of men required to be on duty at one time, so as to allow of the usual reliefs.

15. In the planning of a work, however, considerations arise irrespective of the actual accommodation required for the garrison of that work at a time of expected attack. For defensive purposes only, it would suffice to provide low bomb-proofs to shelter troops and stores during a bombardment, but whilst constructing these bomb-proofs it is obviously desirable to turn them to good account for barrack purposes at all times, and this can be done without any great increase of expense, at the same time that additional accommodation for troops is provided.

16. On the whole, therefore, it will be found advantageous so to construct the bomb-proofs that they can be inhabited by troops in peace time, without doing

violence to sanitary considerations. Buildings provided within the work merely as barrack accessories, not having any reference to the defence, need not of necessity be bomb-proof.

17. It may be asked, why not provide, in each of the works, only sufficient bomb-proof cover to afford shelter for the garrison, without reference to the consideration of barrack accommodation, and construct ordinary barracks in rear of the line? But an examination of this question will lead to the conclusion that this arrangement would be more expensive in itself, whilst it would not be so satisfactory in a defensive point of view; moreover, the barracks in rear of the line would generally obstruct the reverse fire from the gorges of the works.

18. As regards the principles to be adopted in designing the forts;—when the main lines of fire required from the point on which it is proposed to construct a work have been laid down with reference to commanding the ground in its front and on either side of it, and when the ramparts have accordingly been approximately traced, it will be found in almost all cases that a fort with straight faces flanked by caponiers will adapt itself to the ground much better, and that it will be much more applicable in every other respect, than one of a bastioned trace. At the same time, if, under exceptional circumstances, it were found advisable to adopt the bastioned trace, either for the whole or for any one side of a work, there would be no hesitation in adopting that form. But generally, the disadvantages of bastioned works in such cases as are now under consideration, are: 1. That the usual size of the works will not suffice to admit of properly developed bastions. 2. The work will not accommodate itself to the ground. 3. The difficulty of bringing the fire of the several faces to bear in the directions required. 4. The interior space will be much reduced.

19. On these considerations it has been found advisable to adopt a polygonal trace, making the angles of the polygon of the rampart sufficiently obtuse to allow of the fire from one face taking up that of the face adjacent to it. Thus, by giving a proper direction to the embrasures, a converging fire can be obtained, if desired, at the same time that the country both to the front and flanks can be swept by the fire of the fort. Ground in front of a position which is either insufficiently seen, or not seen at all from one work, should be commanded from another.

20. Care should be taken, in laying out the faces of the rampart, to avoid as much as possible subjecting them to enfilade fire, and wherever they are necessarily subject to enfilade they should be well protected by traverses, which may be either of solid earth, or hollow, with places for side-arms and expense magazines within them, or casemated à l'Haxo, according to circumstances. On the flanks of a work, which are usually open to enfilade, it is of great importance to adopt the latter method, in order to ensure the fire across the intervals between the forts against being silenced.

21. It is to be observed that the Haxo casemate (see Plate 10) is much better adapted for the flanks than for the faces of a line of works; for in the former case they are not subject to direct fire, and the exposed portion of the masonry or brick-work is not liable to destruction, as is the case when perpendicular, or nearly so, to the batteries of the enemy. Mr. Fergusson, at page 66 of his "Treatise," has proposed a mode of meeting this objection, which however, scarcely

obviates the difficulty. Captain Tyler, R.E., has proposed to face this vulnerable part with iron; but the precise mode of applying it in these cases has yet to be determined. If, however, it be found,—and I see no reason why it should not be so,—that iron can be applied in the manner suggested, or in any other way, to the exposed portion of the Haxo casemate, the objection to placing these casemates facing the enemy would no longer exist, and it would be of great advantage to construct them at intervals along the front faces of a work as well as on the flanks. But although a fort may be constructed without them in the first instance, there would be no difficulty in adding them at any future period without much additional expense.

22. It will sometimes be found that if the ditch were throughout made parallel to the parapet, there would be a space in front of a fort which would be unseen from that on either side of it, and the mutual co-operation of the works with one another would consequently be imperfect;—moreover, there would be much difficulty in properly flanking a ditch with as many sides as there are faces to a rampart, where the latter was required to fire in several directions (see Plate 1). It is therefore desirable to consider the trace of the ditch, and consequently of the escarp and counterscarp, irrespectively of that of the rampart, wherever the conditions for the one do not accord with those for the other. This principle, of tracing the parapet independently of the escarp, is well known as having been advocated by Choumara and others.

23. The ditches should be flanked by bomb-proof caponiers, well hidden by the counterscarp, and so placed and constructed that an enemy could not silence their fire by batteries established on the prolongation of any particular face. Counterscarp galleries to flank the ditch are considered objectionable owing to their liability to be destroyed by mining; they are nevertheless very useful as places from which to run out countermines.

The caponiers should be constructed for light guns or howitzers, and not for musketry only, it being of great importance to have the power of sending a shower of grape and canister along the ditch; for a few muskets would not prevent the success of a determined assaulting party on a long face of a work; it is, however, advisable to provide loop-holes for musketry fire to be used simultaneously with the guns and during any interval that may occur whilst loading the pieces of Artillery.

It is for consideration whether it would not be advantageous to have a light breech-loading gun, which might also serve as a rocket tube, especially adapted for caponiers and flanking purposes generally, a tubular case fitting the bore, and constructed to hold the requisite number of rockets being provided if necessary.

The designs of the caponiers should be varied according to the requirements of each particular case (see, for instance, Plates 5 and 6). Fire-places are not shewn in the drawings, but they should always be provided in caponiers, so as to afford extra barrack accommodation in time of need, and in order that the men to work the guns may be on the spot when required.

24. In determining the section of the work, regard must of course be had in the first instance to the fire from the rampart sweeping the ground in its front, and commanding the covered way (if there be one); and it is desirable, if the height will admit of it, to place bomb-proof casemates under its front faces, in which position the garrison would be more secure than in any other part

of the work during a heavy fire. These casemates are constructed, as shewn in Plates 2 and 10, with an interval between them and the rampart, serving as a passage for ventilation, as well as for communication from the several rooms to the cook-houses, ablution-rooms, &c. This passage is lighted by vertical shafts through the rampart; abundance of window space is provided for the casemates, and the whole arrangement is such as to afford excellent barracks at all times. The parapets of the front faces are now usually made about 24 or 25 feet thick, and about 20 feet thick on the flanks.

25. In order to protect the escarp as much as possible from distant fire it is desirable that the ditch should be narrow, and, for the same reason, it should be deeper than it has hitherto been usually made. The width of the ditch should not be less than 45 feet, and the height of the escarp should be at least 30 feet to the level of the bottom of the exterior slope. The height of the escarp will however be increased by 7 feet, by adding a loop-holed wall, the top of which, on the front faces of the work, will be 6 feet, and on the flanks about 3 feet below the level of the crest of the glacis. Although portions of the wall of the "chemin des rondes" may be knocked away, the revetment of the escarp itself will be secure against the effects of distant fire; indeed it would be difficult to breach it even by a battery in the covered way.* The great object of the "chemin des rondes," in addition to the facilities which it affords for opposing escalade, and to the greater height it gives to the escarp at all places except perhaps at those against which an enemy's batteries may have been more especially directed, is to afford the means for re-forming the parapets which will be more especially subject to destruction, and the repair of which will be more difficult, since the invention of artillery of such accurate aim as is obtained from rifled guns. The defect of the "chemin des rondes" is that it affords a footing for an assaulting party which may have succeeded in reaching it; but this is not a sufficient reason for neglecting to obtain the other obvious advantages that arise from its adoption, and can be obviated in a great degree by providing flanking walls, which act also as obstructions to the passage round it.

26. It is desirable, both for economy of construction and to give a facility of constructing flanking galleries where required, that both the escarp and counterscarp should be constructed "on décharge," rather than as solid revetments.† The former is moreover the best for resisting the effects of breaching batteries. In cases where galleries are required, or when the nature of the soil renders it necessary, the earth is retained by an inner wall; where no galleries are wanted the earth may be left to fall at a slope of 45°. (See Plates 3 and 4).

27. One of the most important points for consideration in the construction of our works is that they should be defensible by a comparatively small number of

* Captain Tyler, R.E., has lately proposed a system of fortification, one of the objects of which is to obviate the evils attendant on the possibility of breaching the escarp; his plan, as regards this point, is very simple, for it consists in abolishing the escarp altogether, thus making a permanent and continuous breach, so that when the counterscarp is blown in, an assaulting party may walk up an easy slope and sit down on the rampart.—W. D. J. (See page 85 of this volume.)

† In order to diminish the cost as much as possible, the counterscarp revetments of the citadel at Ghent have been built *without any continuous wall*, a row of counter-arches only being employed to support the glacis.—Ed.

men. With this view they are provided with casemated keeps at their gorges, either circular or polygonal in plan towards the front, but always so as to give an equal fire over the whole of the interior of the fort, and projecting to a sufficient extent in rear to flank the ditches of the gorge, and to afford a fire of artillery, which cannot possibly be silenced, along the crest of the glacis of the adjacent works. This keep is usually provided with two tiers of guns, the upper on the terreplein, the lower in the casemates, both sweeping the interior of the fort and the front of the neighbouring one, as well as the ground between them. In a small work, where the keep would be too narrow to admit of a rampart on the roof, the top may be covered with earth, and the upper tier of guns suppressed. In some cases the keeps are constructed to bring a fire of artillery also upon the ground in their rear, so as to form a nucleus to a fresh position, supposing one of the works to have been captured. If the nature of the ground does not admit of an effectual artillery fire to the rear, if a second position could not be taken up in connexion with the work, or if there were other works in the rear sufficiently close to afford support, the rear walls of the keeps might be made weaker than those to the front. (For plans of keeps, see Plates 2, 7 and 8.)

It is of great importance that the casemates of the keep, and indeed all other casemates, if possible, should be constructed "en décharge," in order to secure the scarp against being breached, and, for the same reason, the part of it towards the front should be on a much lower level than the crest of the parapet of the work, only so much of that scarp being exposed as will admit of the guns in the casemates sweeping the interior of the fort.

28. The crest of the parapet of the keep should be somewhat higher than that of the work, so as to command the superior slope of the latter; but it should be observed that although the artillery fire from the roof of the keep may be directed against the distant batteries of the enemy, it is not intended that it should sweep the country immediately in front of its own work. The main object of the keep, as before stated, is, that the fort itself, as well as the line of works of which it forms a part, may be held by a small body of men; and it is conceived that it would be very undesirable to incur the additional expense that would be caused by raising it to such a height as to command the glacis of the rampart in its front, not to mention the defect of exposing masonry to the enemy's fire, as is the case in the German works in which the keeps have been so constructed.

29. The ditch of the circular portion of the keep may be flanked by a counterscarp gallery, from which underground communications may be made to the caponiers flanking the ditch of the work; in some cases, as for instance where there is a wet ditch, which would render the communications to the counterscarp gallery difficult, it may be found preferable to flank the keep by musketry caponiers. (See Plate 8.)

30. The gorge of the work may be closed by a wall with ditch and counterscarp, connecting the keep with the inner extremities of the flanks on either side. As this wall is not subject to artillery fire there is no necessity for protecting it against being breached, but there should be an earthen banquette in its rear, and it is desirable that it should be sufficiently thick to enable it to withstand the effects of chance shot fired with low charges and high elevation dropping over the parapet of the work. The wall at the gorge is generally preferable to a parapet, because the latter obstructs, to a certain extent, the fire from the keep upon the interior of the work.

NOTE.—I should have observed that mortar batteries may be placed at the salients of the works as shown in Plate 2, and Fig. 4, Plate 4.

31. A plentiful supply of water, either by means of tanks or wells, should be provided within each work, and there should be abundance of store and magazine accommodation.

32. It remains to be considered whether the detached works to which the foregoing observations refer should be connected by lines. To arrive at a decision upon this point it is necessary to bear in mind the circumstances of each position to which the works are applied. For the purpose of guarding against the bombardment of a place, or to prevent the works themselves being attacked by artillery in the rear, it would be unnecessary to connect them, for it cannot be supposed that an enemy would be able to pass between them, either by day or night, accompanied by the guns and supplies of ammunition necessary for effecting the operation. But if by a rush with infantry only between the works at night (for such a hazardous movement could not be effected by day), he might be enabled to turn the sea defences of a place, and so open a passage either for his fleet, or for the landing within the advanced line of defences of a hostile force, accompanied by artillery and ammunition, in sufficient strength to effect a bombardment, it then becomes necessary that there should be obstacles between the works. In some instances, where the spread of buildings or the cost of land in the vicinity of a place is very great, it may also be found preferable, on grounds of economy and convenience, to connect the works of an advanced position, in order to guard against a place being run into, instead of adopting the more correct principle of meeting such a contingency by forming an enceinte immediately covering the point to be protected.

33. With respect to the nature of the obstacle, it is conceived that a wall about 18 feet high, and well hidden in a ditch, is the best that can be adopted: there should be a parapet behind the ditch, which will afford a covered communication between the forts, but it is not intended that the connecting lines should be manned, excepting at those few points where flanks may be necessary owing to the ditch not being seen throughout from the main works.

W. F. D. J.

The following note with reference to the caponiers shown in Plates V and VI may be useful:—

Plate V., Figs. 1, 2, 3, 4. Caponier with three guns on each side and a platform for musquetry above, the latter formed by retiring the lower portion of the wall in such a way as to form machicoulis. Where space is available, this arrangement is preferable to that of a projecting gallery, on account of its allowing more head-room, and permitting the smoke to pass unobstructed to the roof of the casemate. The faces of the caponier are also seen from musquetry galleries in the escarp. One half of the front of the caponier is seen from a counterscarp gallery; the other half is seen by a collateral caponier, on the principle shown in Fig. 5, Plate 6. The disadvantage of this latter arrangement, for general adoption, is that it usually exposes the caponier and the escarp to be breached by the distant batteries of the enemy.

Figs. 5 and 6 show another arrangement of the same caponier, with an open space at the salient.

Figs. 7, 8, 9. Caponier with front seen by machicoulis only. The acuteness of the salient at which it may be desirable to place a caponier sometimes renders this arrangement necessary.

Plate VI., Figs. 1, 2, 3, 4. Applicable to a salient where the front of the caponier is seen from other portions of the work.

Figs. 6 and 7. Musquetry caponier carried up the full height of the escarp, and with two tiers of loop-holes.

Figs. 8 and 9. Caponier with two tiers of guns, applicable to a salient where the front cannot be seen from other portions of the work.

PAPER XX.

Remarks on the Journal of the Siege of Sebastopol.

By GENERAL SIR JOHN F. BURGOYNE, Bart., G.C.B., &c.

The Corps of Royal Engineers, naturally feeling deeply interested in all that concerns the Siege of Sebastopol, in which so many of its officers and men were engaged, will have remarked with regret certain articles on the Professional Journal of the Siege, in some of the periodicals of the day, severely censuring the manner in which the work has been got up, and the whole of the proceedings of the Corps itself.

Considering the part which I bore in the early operations, and that I was instrumental in inducing Major Elphinstone to undertake the laborious task of compiling the journal up to the period of my quitting the army, I feel bound to relieve him in the eyes of the Corps from much of the censure passed upon him, by the avowal that I had cognizance of the contents of each chapter, that I approved of them, and that I do so still.

There are few compilations of this nature, which when viewed as a whole after printing, and after hearing the remarks made upon them by others, will not suggest the reflection that improvements might have been made in them; but, in this instance, such improvements would certainly not affect the general character of the work.

On one point only do I feel very great regret—it is the profuse introduction of papers and memoranda written by myself during the course of the proceedings, which might be construed into an undue desire on my part to take a more prominent lead in the operations than I had any right or capability of doing. This error must have arisen from Major Elphinstone having had so many more of my papers in his hands than of those written by others.

With regard to the operations themselves, it is quite right, and most desirable, that they should be subject to the most ample comments and discussions; and those will carry most weight that appear to be written for the advancement of military knowledge, and not, as in some of these cases, manifestly as a vehicle for decrying individuals or distinct bodies.

The author of one set of the criticisms in question displays his essential motive in a deep spirit of animosity against the Corps of Royal Engineers. He commences with allusions to what he considers their many failures elsewhere, which are totally irrelevant and unfounded, and all of which must detract from the confidence, in the good faith at least, that might otherwise be placed in him.

Where such a tone exists we have to expect that all our defects will be diligently sought for, and it is satisfactory to find the attempt here to be so little effective; scarcely a criticism is offered to which complete refutation could not be given; a statement which must be taken, however, as a mere assertion at present, as this is not a fitting occasion for a minute discussion of the matters in question; but at least it will make the Corps aware that the parties implicated dispute the justice of the reflections on the several proceedings.

Many notes have been prepared for the purpose, on a first perusal of these censures; and no doubt opportunities will arise for using them in future discussions, when the merits of the operations of the whole war in the Crimea, and the various comments that have been made on them, will have to be considered.

J. F. B.

W. P. JACKSON, PRINTER, WOOLWICH.

Plate I.

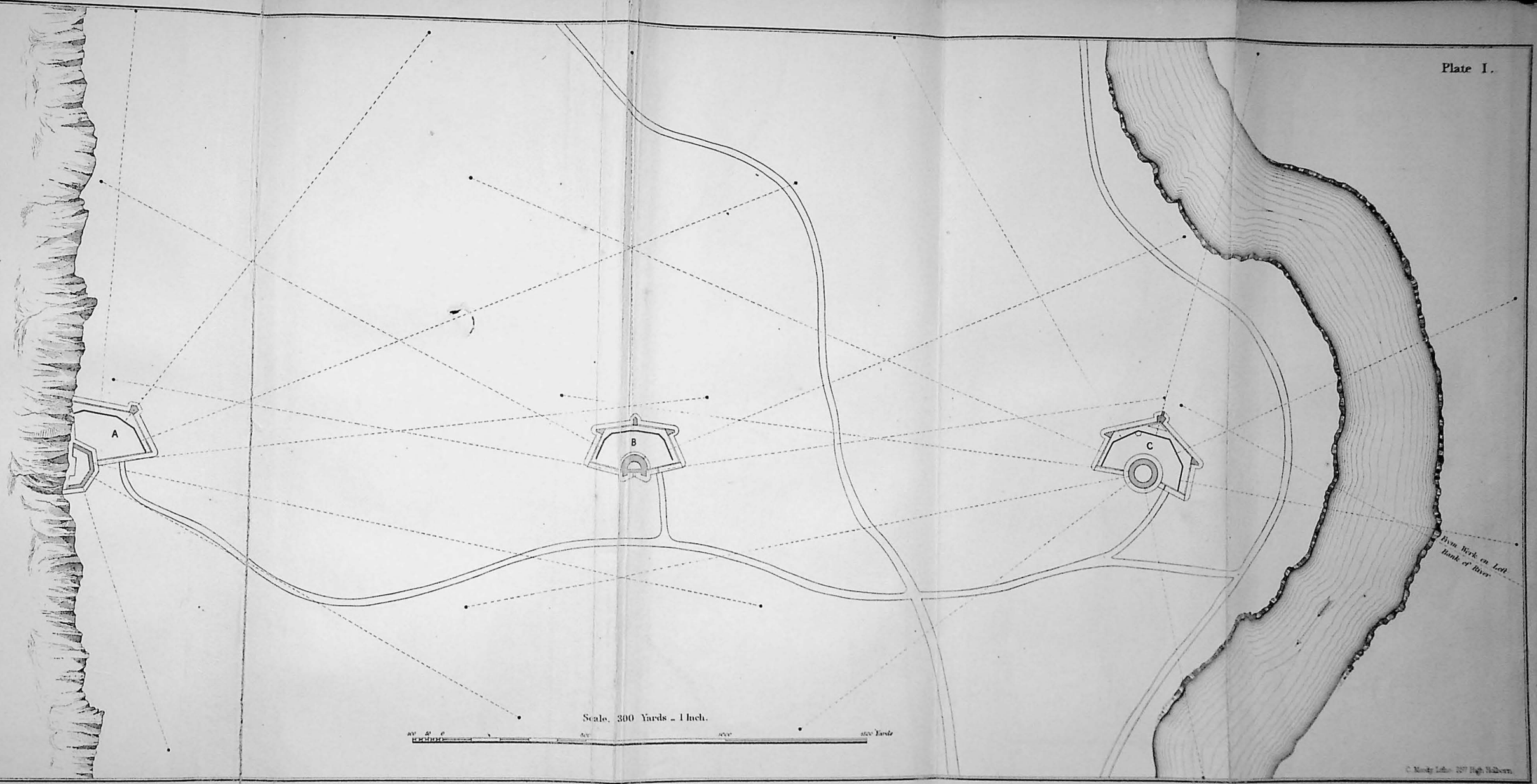

A
B
C
Bivn. Work on Left Bank of River
LINE OF UNASSAILABLE SHORE, PRECIPITOUS CLIFF OR OTHER OBSTACLE.
Scale, 300 Yards = 1 Inch.

Fig. 1.

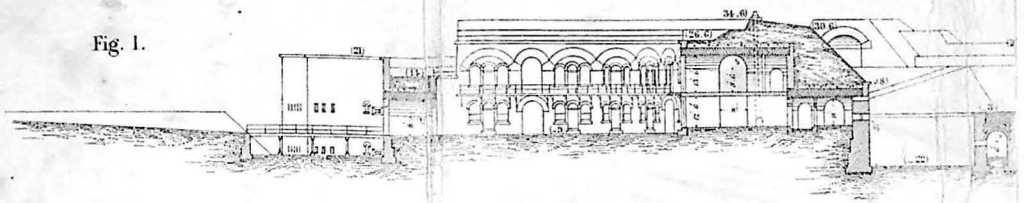


Fig. 2.

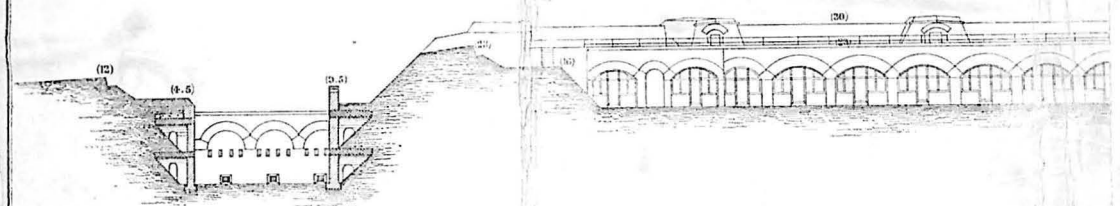
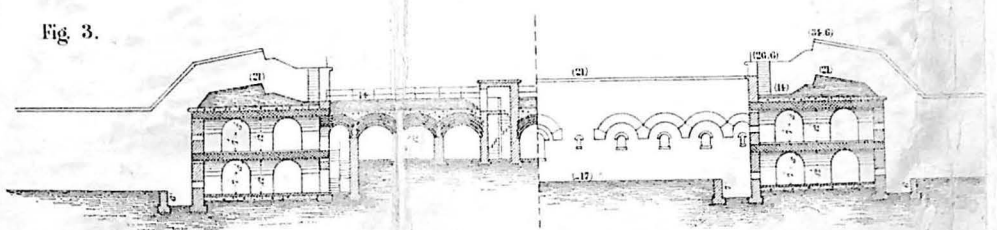


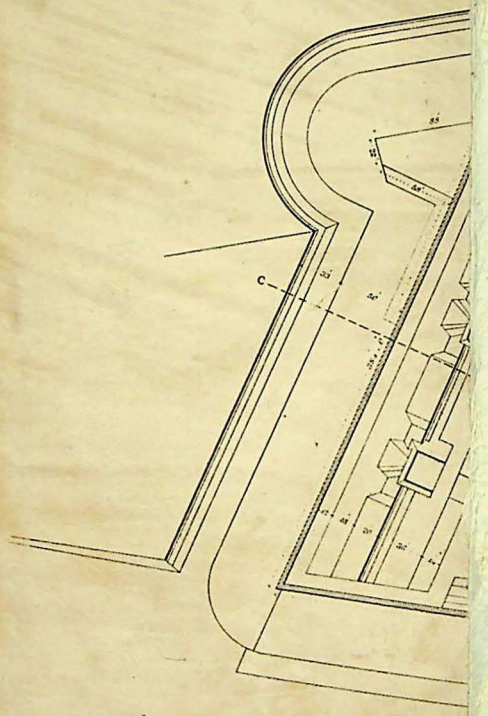
Fig. 3.



Section on Line E. F.

PLAN OF DETACHED FORT.

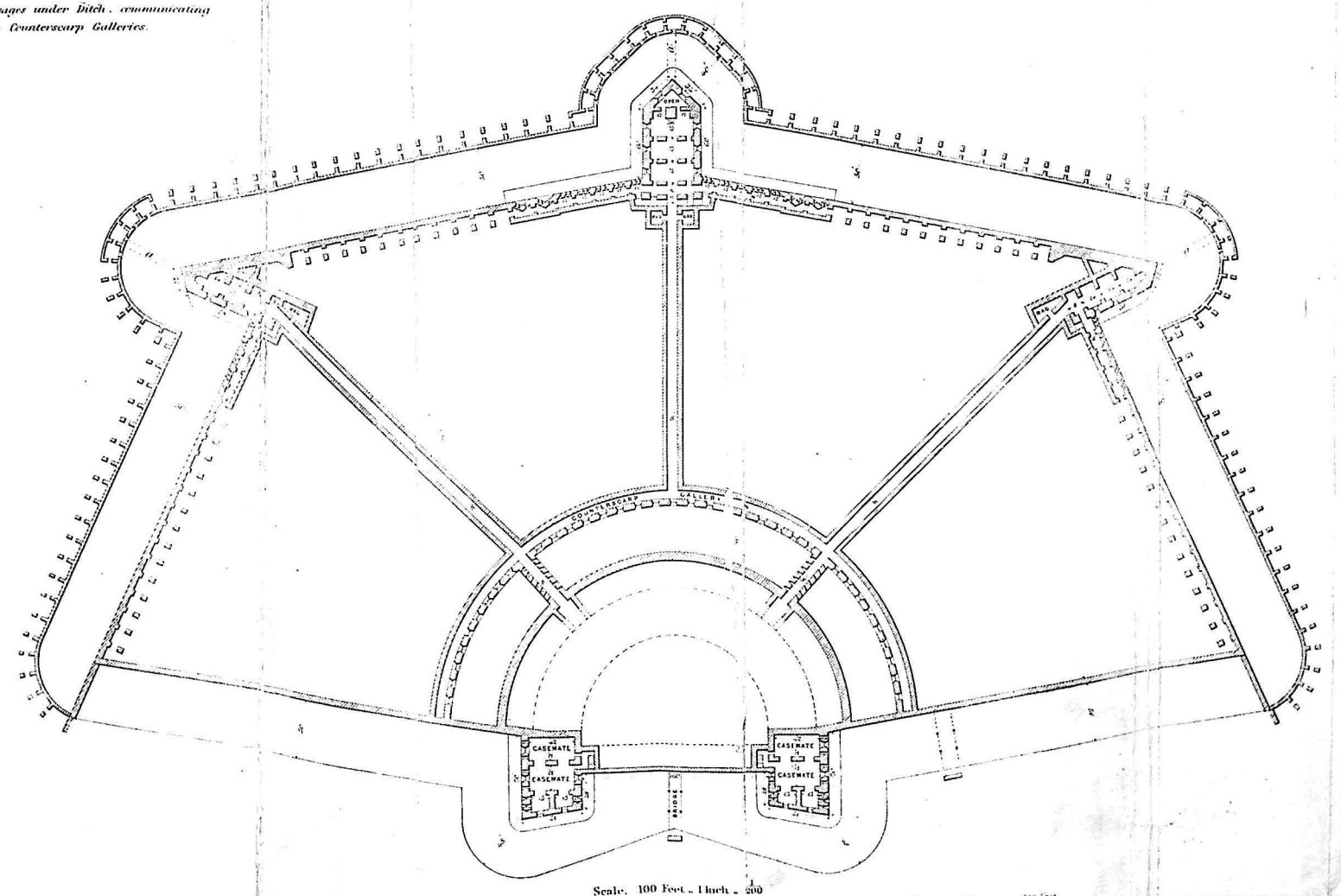
Embodying principles of Construction adopted in some of the Works now in progress for the Defence of Naval Arsenals & Dockyards.



HALF PLAN OF

PLAN SHEWING REVETMENTS, CAPONIERS, GALLERIES, &c.

a. a. a. *Passages under Ditch, communicating with Counterscarp Galleries.*

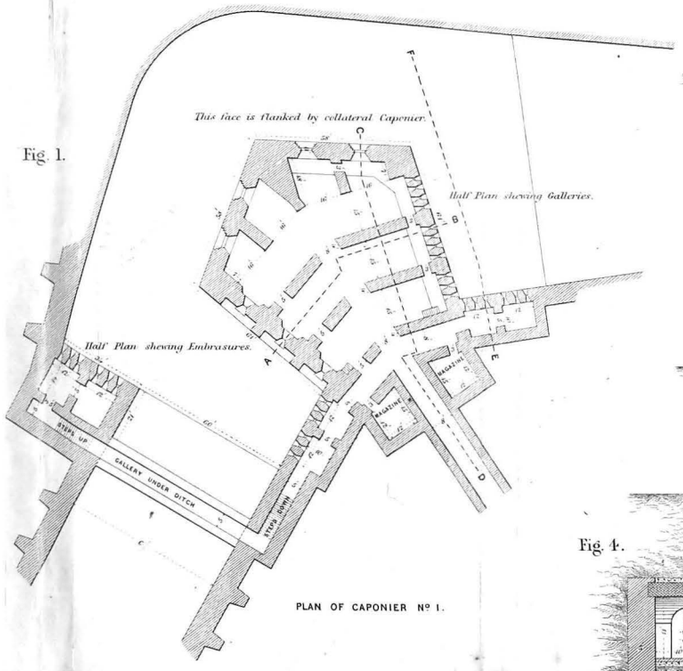


Scale. 100 Feet = 1 Inch = $\frac{1}{1200}$

Plate V.

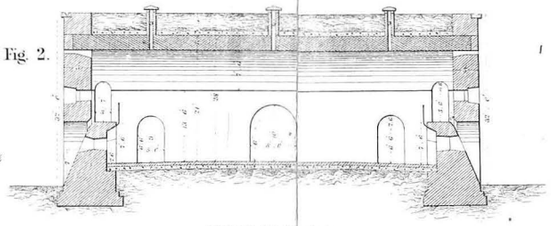
CAPONIERS.

Fig. 1.



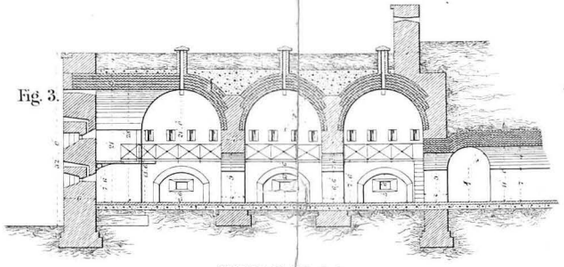
PLAN OF CAPONIER Nº 1.

Fig. 2.



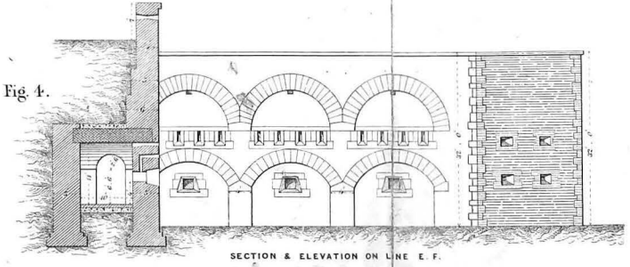
SECTION ON LINE A. B.

Fig. 3.



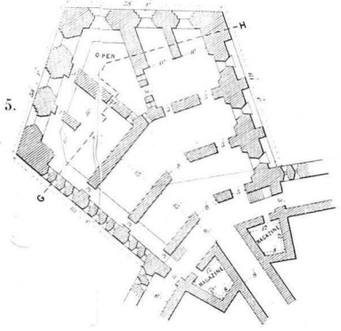
SECTION ON LINE C. D.

Fig. 4.



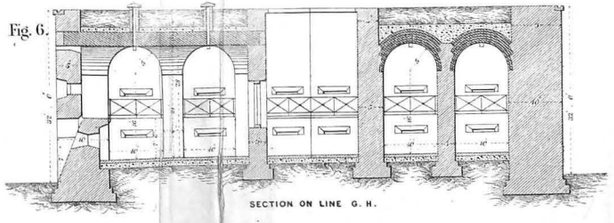
SECTION & ELEVATION ON LINE E. F.

Fig. 5.



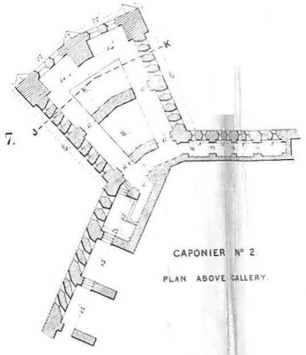
PLAN SHEWING ANOTHER ARRANGEMENT OF CAPONIER Nº 1.

Fig. 6.



SECTION ON LINE G. H.

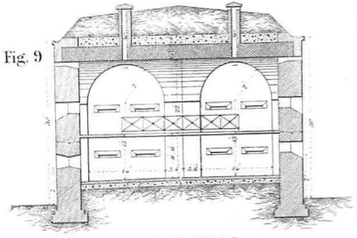
Fig. 7.



CAPONIER Nº 2.

PLAN ABOVE GALLERY.

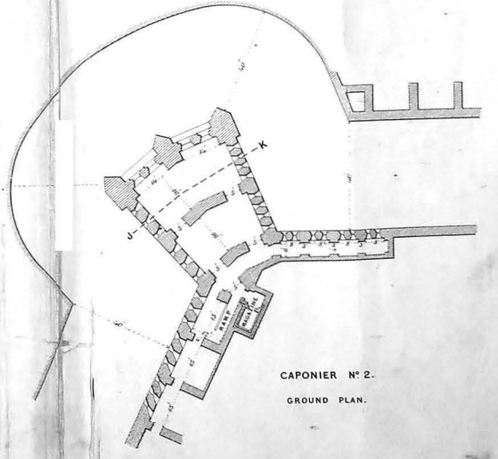
Fig. 9



SECTION ON LINE J. K.

CAPONIER Nº 2.

Fig. 8.



CAPONIER Nº 2.

GROUND PLAN.

Scale for Plans, 40 Feet = 1 Inch. 1/480

0 5 10 20 30 40 50 60 70 80 90 100 200 Feet

Scale for Sections, 20 Feet = 1 Inch. 1/240

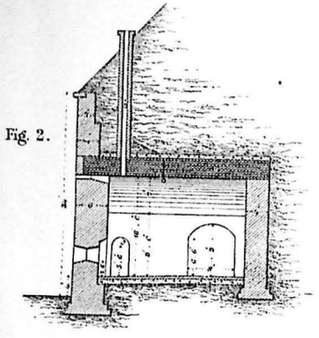
0 5 10 20 30 40 50 60 70 80 90 100 Feet

C. Mosley Litho 257 High Holborn.

Plate VI.

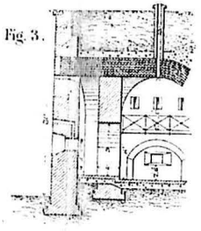
CAPONIERS.

Fig. 2.



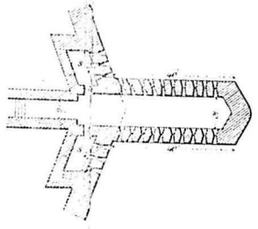
SECTION AT A. B.

Fig. 3.



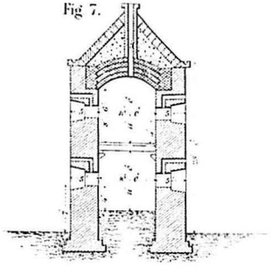
SECTION AT C. D.

Fig. 6.



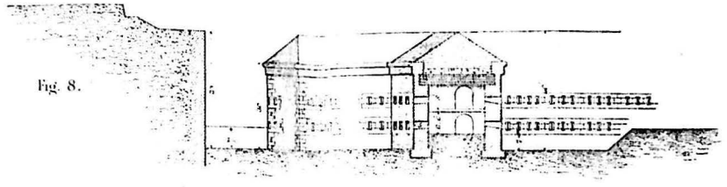
PLAN Nº 2.

Fig. 7.



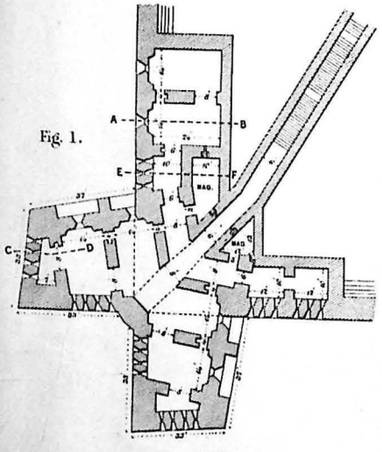
SECTION THROUGH CAPONIER Nº 2.

Fig. 8.



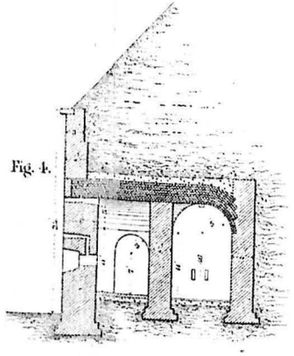
SECTION ON LINE A. B.

Fig. 1.



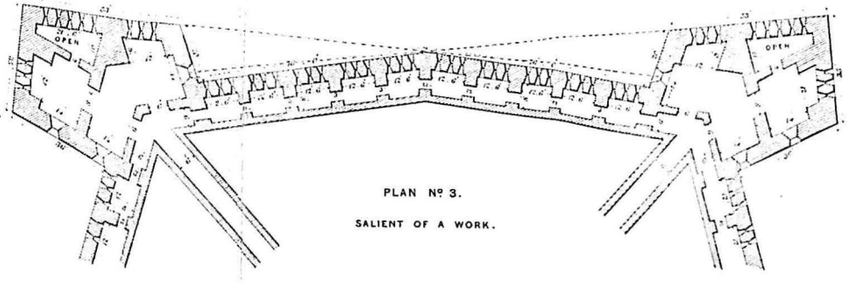
PLAN Nº 1.

Fig. 4.



SECTION AT E. F.

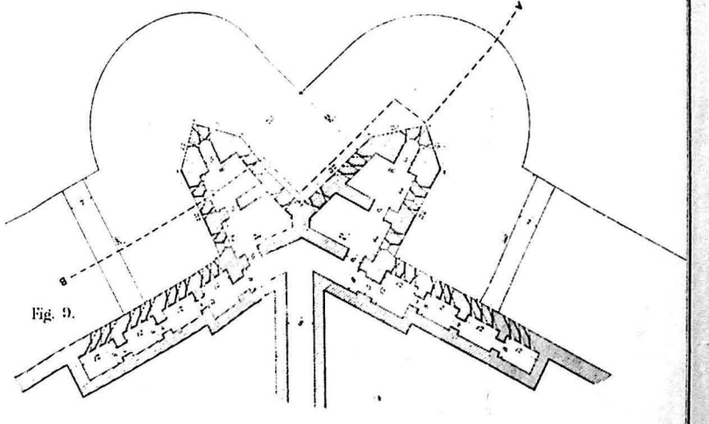
Fig. 5.



PLAN Nº 3.

SALIENT OF A WORK.

Fig. 9.



PLA OF CAPONIER

Nº 4.

Scale for Sections. 20 Feet = 1 Inch = $\frac{1}{240}$

Scale for Plans 10 feet Inch = $\frac{1}{120}$

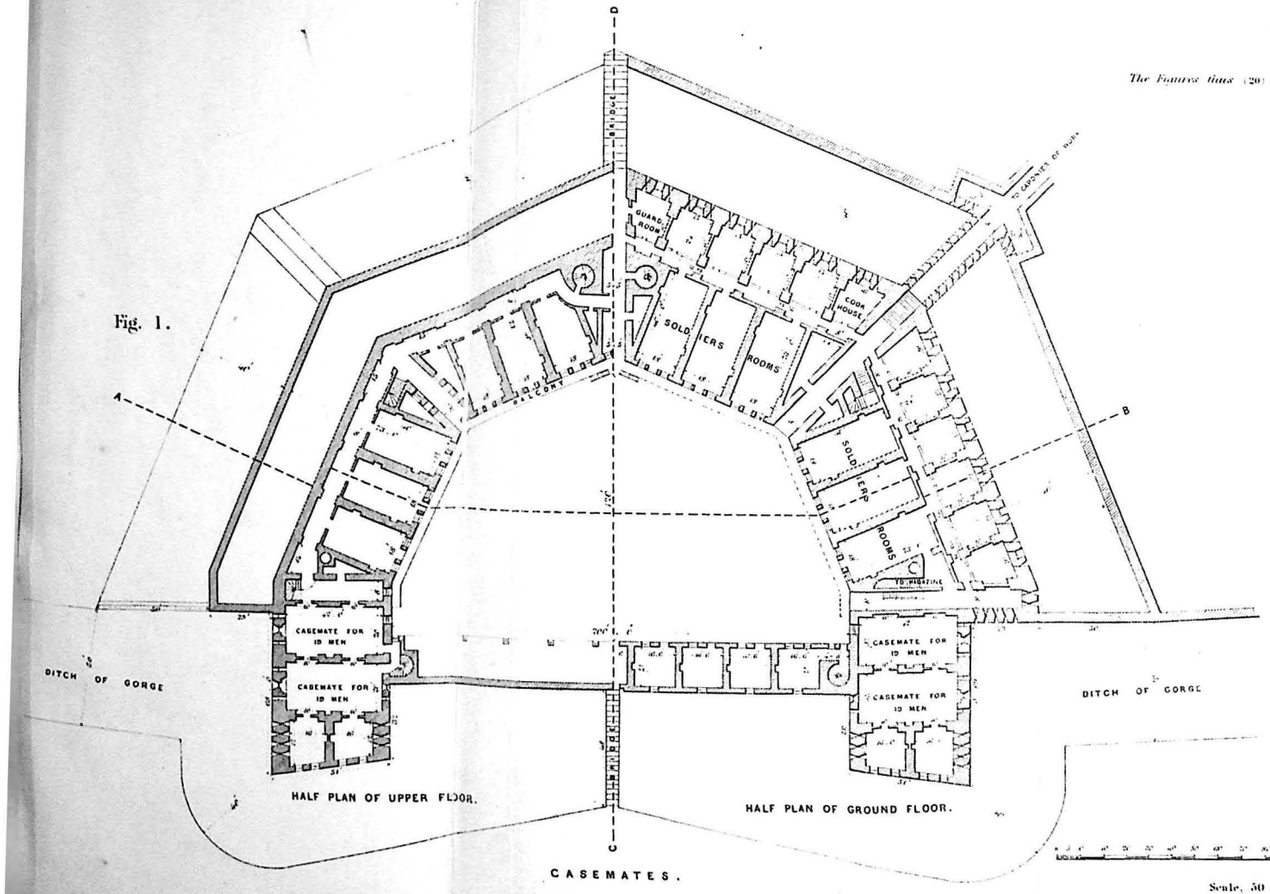
Plate VII.

CASEMATED KEEP IN CENTRE OF GORGE OF WORK.

(SHEWING POLYGONAL ARRANGEMENT)

The Figures thus (20) denote the height in feet above interior Area

Fig. 1.



Scale, 50 Feet = 1 Inch = $\frac{1}{600}$

Fig. 2.

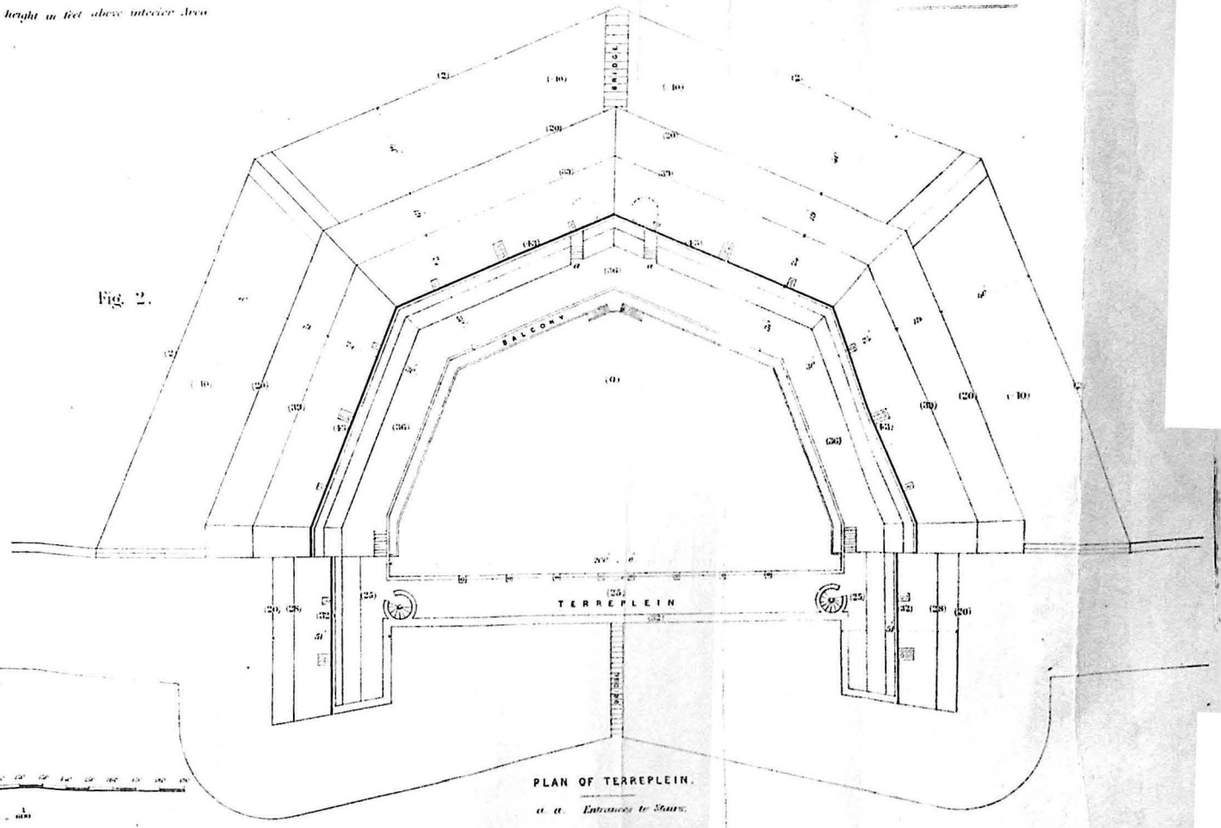
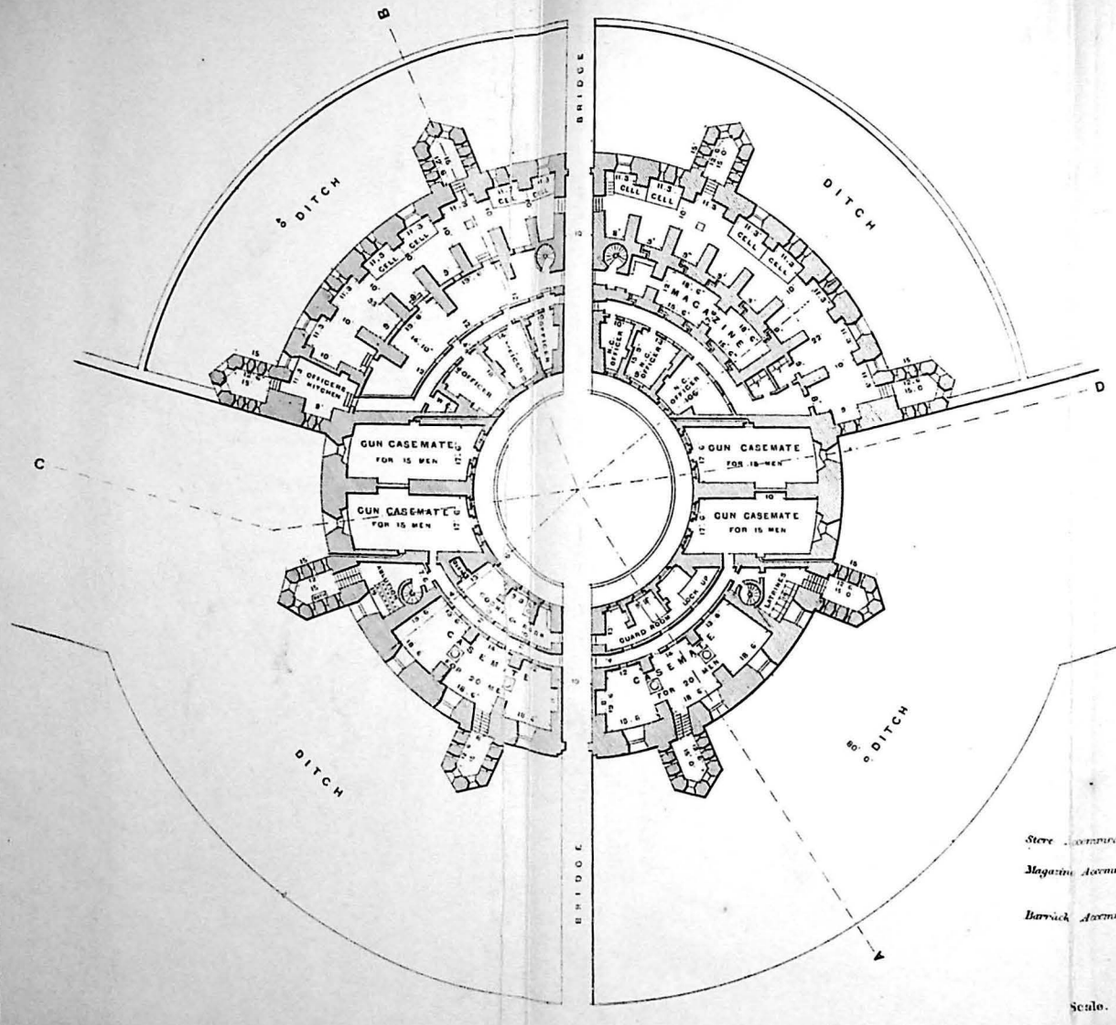
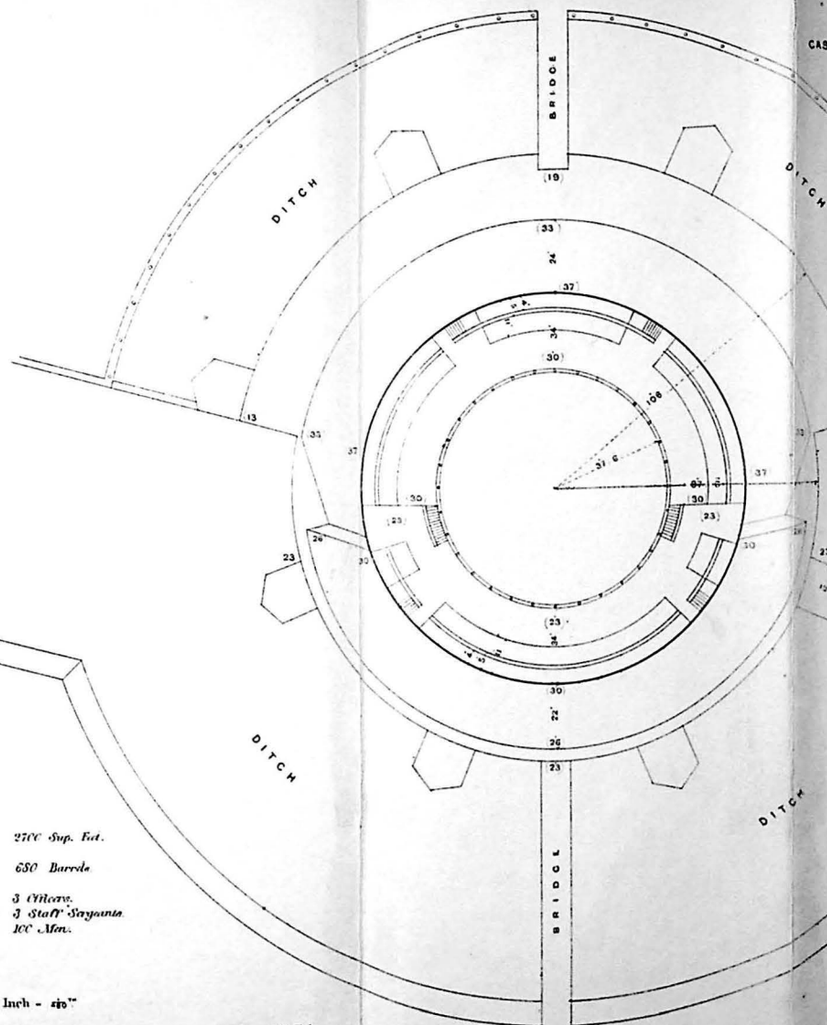


Plate VIII.

CASEMATED KEEP IN CENTRE OF GORGE OF WORK SHEWING CIRCULAR ARRANGEMENT.





Store Accommodation	*2700 Sup. Feet.*
Magazine Accommodation	*650 Barrels*
Barrack Accommodation	*3 Officers. 3 Staff Sergeants. 100 Men.*

The Figures thus (20) denote the height in Feet above interior area.

Scale. 40 Feet = 1 Inch = $\frac{1}{480}$

0 & C 10 20 30 40 50 60 70 80 90 100 200 Feet

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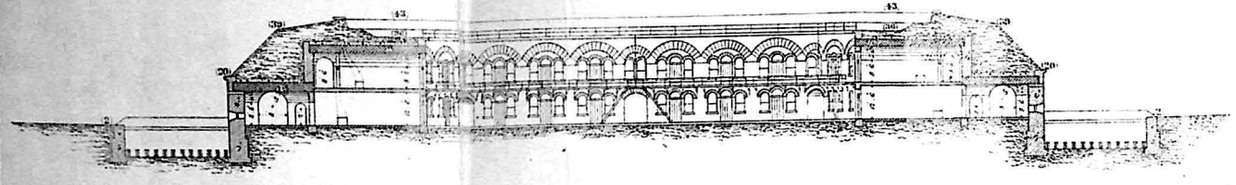
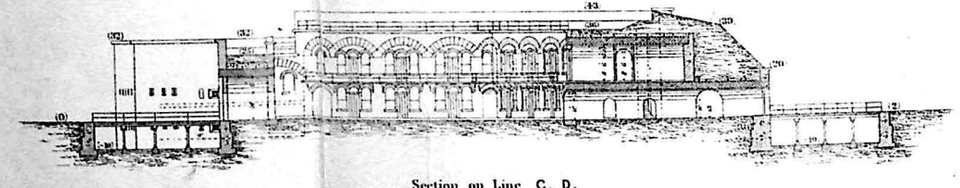
CASEMATED KEEP IN CENTRE OF GORGE OF WORK.

SECTIONS OF POLYGONAL KEEP.



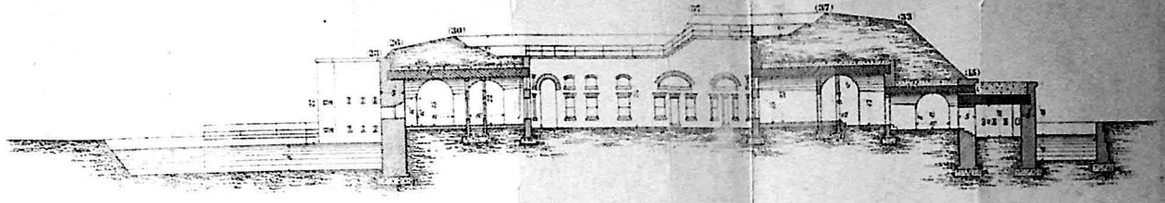
Section on Line A. B.



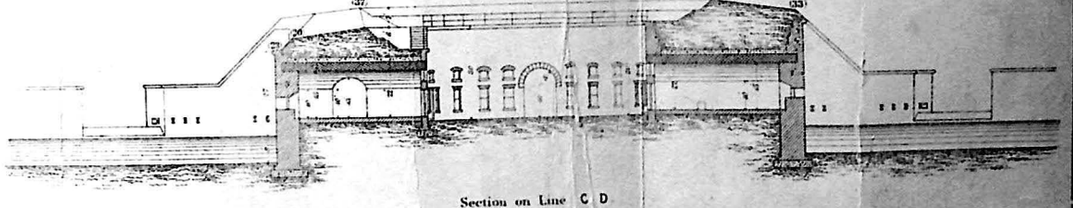
Section on Line C. D.

Scale 50 Feet = 1 Inch = 1/600

SECTIONS OF CIRCULAR KEEP.



Section on Line A B



Section on Line C D

Scale 40 Feet = 1 Inch = 1/480

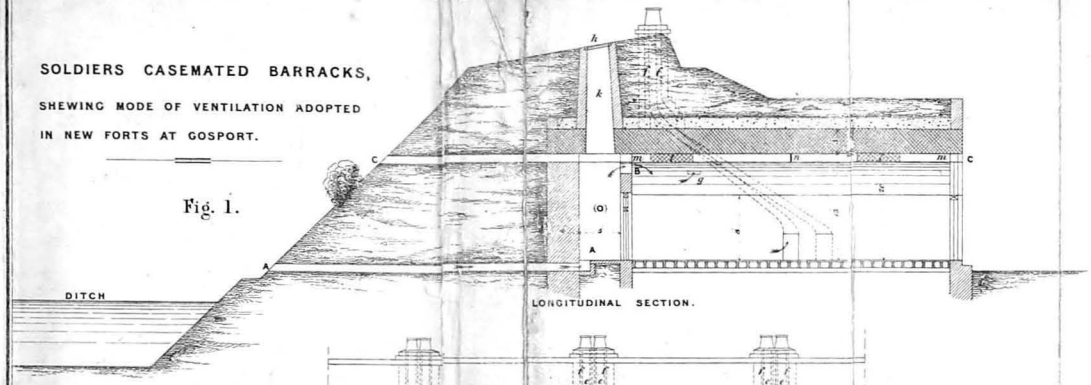
The Figures thus (30) denote the height in Feet above the Interior Area

C Moody Litho 257 High Holborn

SOLDIERS CASEMATED BARRACKS,

SHEWING MODE OF VENTILATION ADOPTED IN NEW FORTS AT GOSPORT.

Fig. 1.



REFERENCE.

- A. *Fresh air flues to passage, 12 × 6*
- B. *Openings to admit Fresh air to Casemates. (1.6 dia.r)*
- C. *Pipe for Summer Ventilation.*
- *e. e. Smoke Flues.*
- *f f. Ventilating flues.*
- *g g. Ventilators communicating with f f.*
- *h h. Window hung on a pivot.*
- *k. Shaft for light & air to passage.*
- *l. Perforated gratings in pipe.*
- *m. Valves to open & shut at pleasure.*
- *n. Division in length of pipe.*
- (O.) *Passage (to be warmed by Hadyn's Hot Water Apparatus.)*

Fig. 2.

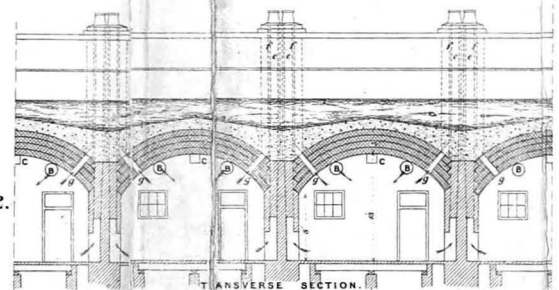


Fig. 3.

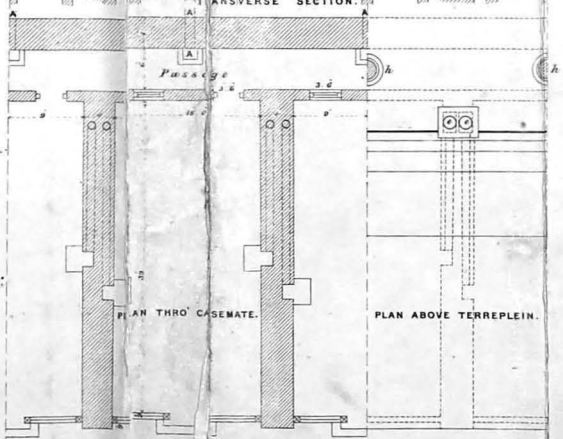
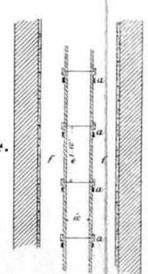
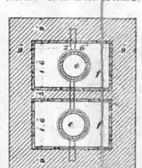


Fig. 4.



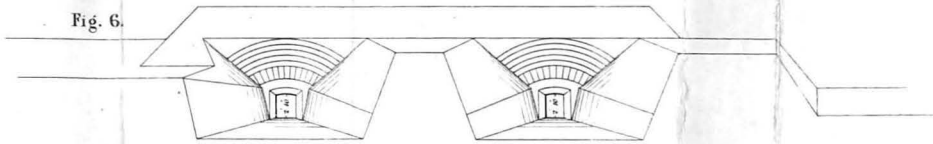
PLAN & SECTION
OF SMOKE & VENTILATING FLUES.
(a. a.) Cast Iron Collars.

Fig. 5.



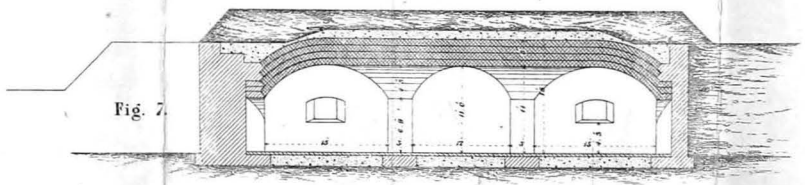
HAXO CASEMATES.

Fig. 6.



ELEVATION OF EXTERIOR.

Fig. 7.



SECTION ON A. B.

Fig. 8.

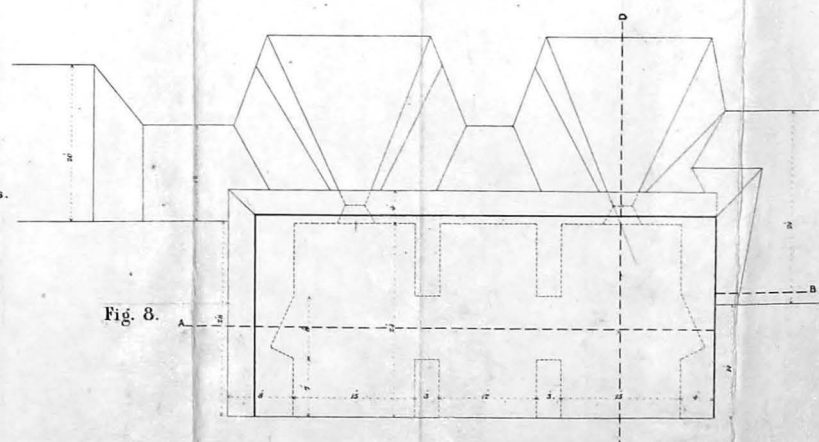
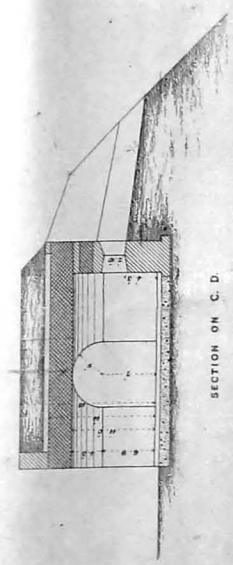


Fig. 9.



Scale 15 Feet = 1 Inch.

C. Moody Litho 281. High Holborn.