\* The R.E. Institute is not responsible for the statements made, or opinions expressed, in this paper.

# PROFESSIONAL PAPERS

#### OF THE

## CORPS OF ROYAL ENGINEERS.

(FOREIGN TRANSLATION SERIES).

1897.

Paper V.

## MODERN FORTRESSES AND THEIR DEFENCE.

\* Précis" of Lecture delivered before the Military Society at Berlin on 6th November, 1895, by Captain Schroeter, of the German Engineers, and published in the "Militär-Wochenblatt."

SECOND LIEUTENANT J. CHARTERIS, R.E.

ALL RIGHTS RESERVED.

1897.

PRINTED BY W. & J. MACKAY & CO., CHATHAM. PUBLISHED BY THE ROYAL ENGINEERS INSTITUTE, CHATHAM. AGENTS : . W. & J. MACKAY & CO., CHATHAM.

Price, Ninepence net



[PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS. TRANSLATION SERIES.]

### PAPER V.

### MODERN FORTRESSES AND THEIR DEFENCE.

["Précis" of Lecture delivered before the Military Society at Berlin on 6th November, 1895, by Captain Schroeter, of the German Engineers, and published in the "Militär-Wochenblatt," made by Second Lieutenant J. Charteris, R.E.]

THE last 30 years form a most important period in the development of fortification and of fortress warfare. Two influences have given it this significance: first, as far as concerns the defence of countries, and thus, to a certain extent, with regard to strategy—the formation of alliances in Europe; and secondly, with reference to the shape of the works and to the attack and defence of single fortresses, the unexpected progress in the matter of armament, and especially of artillerv.

It is an advantageous and interesting study to trace the influence that the various political events of the last 30 years have exerted upon the development of fortification; but time imposes a limit; and in the present lecture the tactical considerations only in modern fortress warfare will be regarded. The object of the lecture is not to bring forward anything new, but to give to those whose duty does not bring them in contact with the study of fortification a general view of the present situation, and to arouse that confidence in fortresses which in many circles is wanting. F.S., 5. As regards artillery, two principal periods are to be distinguished.

(1). The introduction of rifled guns, and the development of low-trajectory fire and of the so-called indirect fire.

(2). The introduction of lengthened projectiles, of high-explosive charges, and of smokeless powder. Side by side with these changes appear the further development of long-range fire and increased accuracy in high-angle fire. In this period, the creation of mobile heavy artillery—field artillery and heavy siege train—exerted an important influence. It was possible to take account of these advances, either entirely or in part, in the erection of new forts, and the alteration of old ones from 1860—1885, e.g., Paris, Antwerp, Strassburg, Metz (before 1870), Cologne, Posen, Königsberg, Toul, Verdun and Belfort during the seventies, and the great Polish fortresses of Warsaw, etc., at the commencement of the eighties. This period is distinguished by the supremacy of the detached forts.

The general plan of a fortress of this type is well known; the following points are, however, specially characteristic. The forts were too far apart, according to present ideas; the intervals were not fortified except by isolated redoubts. The forts were defended by artillery, heavy and light, and by infantry, and were, therefore, intended to take part in both the long range and closequarters fighting. The real importance of these forts lay in defence against preliminary attack and the hampering of the preparations for a siege. They prevented by the mere fact of their existence the bombardment of the place itself; their heavy artillery forced the attacking party to content itself with blockade and preparations for siege works at a great distance; and as strong points secure from assault in a conflict at close quarters they made surprise attacks in force hopeless.

Two great objections are urged against forts of this type.

(1). In the event of a regular siege, the artillery duel was to be fought only from the forts.

(2). The forts are of too high a profile, too large, and placed at too great intervals, whereby on the one hand excellent targets are offered to the attacking artillery, and on the other hand the intervals are insufficiently swept by fire.

The first objection may apply to the giant forts of Antwerp designed by Brialmont, but does not apply to German forts in the seventies. In these latter forts the artillery fire was to be directed from intermediate batteries of low profile, although permanent works for this purpose date only from the eighties.

The high profile arose from the value given by artillerymen to direct fire of low trajectory from the forts; the great intervals are to be explained by the necessity, on account of the immoderately large extent of the line of defence, of saving both the expense of construction and the men, and the interval required also that the works should be large, and as far as possible independent.

At the same time, a grave defect attached to forts of this type when opposed to an organized siege attack, as was clearly shown in Paris in 1870–71. Here the forts, while capable of maintaining themselves against the enemy, suffered so severely from the bombardment that their power of active defence was seriously diminished, and they lost their importance as strong tactical points for flank defence. This weakness appears as soon as the enemy's artillery is in position, when the critical point of the defence passes from the forts to the intervals between them, *i.e.*, from the permanent works to the supplementary field or provisional works. At this stage of affairs the last-mentioned advances in artillery made their appearance (*i.e.*, elongated projectiles, high explosives and smokeless powder).

The effect of these innovations on fortifications was at first unfavourable, as the injurious results to defensive works became at once apparent, i.e., the possibility of systematic bombardment-not necessarily on a siege scale-and of the rapid destruction of this power of active defence was greatly increased. Siege artillery and field artillery coming into action at a great distance, and practically invisible, could with accurate fire and effective projectiles, put out of action the exposed guns of the fort and render the positions of the infantry untenable. The power of passive resistance, with the nature and strength of the materials then in use, and the method of applying them to the construction of a fort, was totally insufficient. This was, indeed, the "Storm and Stress" period of fortification. The literature of the period, deeply tinged with the bitterness consequent on the fierce conflict that raged in all ranks, reflects the interest excited, not merely in military circles, but in the lay press. Much of the literature is written with clever catch words, so that at a cursory reading it induces an opinion unfavourable to fortification, which disappears on closer study. All, but chiefly those not specialists in the subject, must read this literature with caution if they are to preserve their independence of judgment. Leithner, in his latest work, has described the difficult position of

those in authority, who had to choose a middle course between complete reconstruction of forts and leaving them as they were, without raising prejudices in the minds of the ignorant.

Those who object on principle to permanent fortifications have found no response in influential quarters ; no government, not even the most powerful, dare take the responsibility of doing away with fortresses. The alteration of old and the commencement of new works show how the question is regarded by European Governments. Among other authorities, Moltke says that large works, and chiefly those on great rivers, ensure freedom to manœuvre, and protect great commercial resources from the enemy.

A plan of purely provisional defence works is acknowledged to be impracticable, though mainly for technical reasons. A more pertinent question is whether provisional works are to be completed in time of peace, or only commenced, and immediately on declaration of war completed. Both plans are possible, and the problem awaits solution in the next great war.

Moltke expresses the opinion that fortresses not really in a tenable defensive condition, and in which the complicated machinery of the defence is to be improvised by hastily collected troops, with defective artillery, equipment and supply of provisions, and when the field of fire is to be cleared only on a retrograde movement of the first line, will, as far as we can see, speedily fall into the hands of the enemy and be of service to him alone.

The strategical aspect of the various systems of defence by fortresses—e.g., the distinction drawn between the system of central fortification in small states like Denmark, Belgium, etc., and the system of defence on a geographical basis, or by sections, which obtains in Germany, the system of groups—régions fortifiées—in Poland, the system of defence by lines of fortification as in France must be briefly passed over, to give space for the treatment of the tactical side of these questions.

The question of passive resistance has been decided in favour of the forts. In masonry, iron and sand the engineers have perfectly effective materials for the construction of forts. Cost is, therefore, the only limiting factor which prevents any required power of passive defence being given to a fort. It is important to remember that the cost of destruction of a fort, excluding that of providing, preserving, and transporting the guns, is from 3 to 5 times as large as the cost of construction. The necessity has been generally recognized of concealing the work as far as is compatible with a good range of fire, by making the works low, small and flat, and by avoiding steep slopes and sharp outlines.

The laity are often inclined to underrate the value of modern works, owing to the fact that forts are no longer of imposing appearance. But this property conceals an advantage of modern works in peace time which is not to be overlooked, inasmuch as the difficulty of obtaining accurate information about the forts is increased A decision has also been taken regarding armour. All countries—even Russia—have declared for its adoption. In the hands of private firms the improvement in the construction of armour has been such that it can now be made strong enough to resist all attacks. The objections to armour are its *cost* and the lack of *portability*. While the question of defence against artillery and of armour has thus been settled, the problem of defence against frontal infantry attack is still unsolved.

To defend with small armoured Q.F.'s is for many reasons impossible : to hold an open line of trenches makes great demands on the quality of the infantry. Even with masonry breastwork and casemates, in or under the parapet, the ideal of former systems is still far from being reached, in which the soldier ate and slept in his embrasure with his rifle under his arm. Leaving out questions of obstacles, mines, etc., and proceeding to more important tactical considerations, the necessity of great interior space, and, therefore, of the large diameter of the line of works, must be always kept in view. This necessity is caused by the desire of protecting the interior of entrenched camps and bridge-heads from bombardment, as well as the whole work from an enveloping siege attack. At the same time, the disadvantages of too extended forts are so great that it is to be recommended as a general rule only to make the diameter large enough to prevent an envelopment in force and a systematic effective bombardment, or even a cannonade of the fortress, and to clear sufficient space on all the exposed faces to bring into action all the artillery of the defence. For this a diameter of 12 to 14 kilomètres and a circumference 38 to 40 kilomètres in most cases will suffice. With regard to the disposition of the outer works, the chief means of defence, no serious attention is now paid to those adherents to the latest ideas of Schumann who desire pure and simple armoured works as found in the Seret lines. The errors of this system-defective defence against artillery at long ranges, entirely insufficient security from assault, diminished importance of the part played by infantry in the defence, difficulties of arranging

for the uniform conduct of the defence—are so evident that the above-mentioned practical application of the principle will probably remain unique. The proposal to substitute a continuous line of defence work (*i.e.*, an enciente) in place of the present girdle of forts has met with no general recognition, though some fortresses, *e.g.*, Copenhagen and Warsaw, bear the stamp of these ideas. The so-called old school, as represented by Brialmont, still holds the field as far as its fundamental principles are concerned. In the future, as in the past, forts will be considered as tactical points, free from assault, and as self-dependent caponiers sweeping the intervals, and the artillery duel will be conducted chiefly from open batteries in the intervals.

But while Brialmont remained true to the old form of forts, broad, deep, of high profile, and at correspondingly wide intervals, the opinion of the majority is in favour of small unimposing forts, answering more to the former idea of intermediate works, and small intervals. These intervals are prepared in time of peace for the artillery duel by means of concealed bomb-proof cover, roads of communication and masks.

Armour will be used with the most important guns of the defence, *i.e.*, those whose early destruction would have the most unfavourable effect on the conduct of the defence. Such are those which sweep the intervals and flank ditches—if they, as in the case of water ditches, can be easily attacked from a distance—certain light guns firing over the near foreground, and finally some of the long-range guns of the first artillery position. So far all are now agreed, but it is still an open question whether these last-mentioned long-range armoured guns are to be used in the forts themselves, or in intermediate and slightly retired batteries. This question is the more interesting as, under practical conditions, a decision has had to be taken regarding it by various States, and the decisions so taken have not been uniform. Very cogent reasons can be advanced on both sides.

Against the armoured forts and for the batteries, *i.e.*, for the principle of separating the system of defence against near and that against distant attack, it is urged :—

(1). The target offered both by the forts and the batteries is lessened.

(2). The separation suits the condition of field warfare.

(3). In the artillery duel the batteries attract less fire than the forts, and therefore remain longer intact.

(4). The forts are soon demolished, and the fighting power of the infantry is lessened by the moral effect of this.

For the forts and against the batteries it is urged-

(1). Batteries increase the number of permanent works, and, consequently, the number of troops required as a guard and for defence.

(2). Armoured batteries form an excellent objective for assaults in force and surprise attacks. To protect them from these attacks, either strong exterior protections are required, or they must be rendered secure from assault, and arrangements made for defence at close quarters.

(3). Forts will be bombarded whether the artillery is in them or not, and in all cases at such a range that the infantry could not take part in the defence.

If the forts do not take part in the artillery duel, the enemy will first attack with all his force and subdue the intermediate works. then proceed to destroy the forts ; if, on the other hand, the forts take part in the artillery duel, the enemy is forced simultaneously to attack them, and they relieve, therefore, the actually combatant batteries. The comparison with field warfare is not free from objection, as in forts also infantry must often engage before the artillery, and, besides, infantry and heavy armoured artillery in the forts do not come into action at the same time. To the lecturer it appears that forts with heavy armoured artillery, corresponding to the earlier form of fort, are more suitable in repelling attacks which are not on a siege scale, and in combatting siege preparations, than are forts which consist of mere strong points in the fight at close quarters, in conjunction with separate armour batteries.

It is difficult to decide, theoretically, which arrangement is more effective against attacks on a siege scale.

The lecturer's sympathies are with suitably modified Brialmont armoured fort, without desiring to exclude the use of armoured batteries in certain cases, *e.g.*, in commanding positions, in supplementing older fortresses.

The subject of surrounding the centre of the fortress with entrenchments is too long to enter into fully. The reasons advanced in favour of this course are so cogent that in many new forts the construction of a supplementary ring of entrenchments round the centre has been regarded as essential. Brialmont considers that even a provisional fortress should be provided with an entrenchment of this nature. A simple polygonal form of entrenchment, which would stop a surprise attack in force, is generally considered sufficient. In illustration of these remarks upon the present position of fortification, the following are characteristic traits of some modern works. The sketches which accompany them only claim to be accurate in cases where the works are open to all comers.

Foksani.—The defences of Foksani form the western of the three bridge-heads which block the route between the Lower Danube and the Carpathians, in the Seret lines. They represent throughout the system of the Schumann armoured parapet. There is no interior fortification defending the core. The sole defensive position forms a semi-circle 22 kilomètres long, at a distance of 5 to 10 kilomètres from the passages to be protected. It is composed of 70 batteries in the three lines, behind one another, at a distance of 400 to 500 mètres, and arranged radially in 5 sectors, each containing three groups ; in all in 15 groups.

The first line contains 40 batteries, in each 5 movable 3.7-c.m. armoured Q.F.'s in disappearing turrets.

The second line 15 batteries, in each 6 movable turrets for 5.3 c.m. Q.F.'s.

The third line contains the artillery for the artillery duel, 15 batteries, in each 1 armoured 12-c.m. gun, and 2 12-c.m. mortars.

The arrangement of a typical group is given in Fig. 2, Plate I.

The batteries are merely a line of low embankments with glacis. The line, while generally straight, is slightly broken or curved in certain places. There is a shallow ditch in front for wire entanglements. The armour and occasional concrete shelters are built into the parapet. There is no arrangement for a defence of flank or gorge.

Copenhagen.—The land defence works form the third of a circle,  $25\frac{1}{2}$ kilomètres long and of  $11\frac{1}{2}$  kilomètres radius. The Southern half of the sector is flat and open to view. Here the arrangements for defence consist of a line of defence 13 kilomètres long, broken only in one place, secure against assault and with good flank defence. Its peculiar character has earned it the title "Danish Profile" (Fig. 4, Plate I.). The line is for defence at close quarters and against artillery at long ranges. The actual position for the artillery in action is in the rear. In the Northern half the land is hilly and partly concealed from view. Here there are two lines of permanent forts. In the first line are 5 armoured forts or batteries, with intervals of 2 kilomètres, having great passive resistance, but no security from assault ; they are provided with the most diverse kinds of armoured artillery for near and long ranges. There is no infantry breastwork. The forts are small and invisible; they follow the shape of the ground, and form very unsatisfactory targets. In the second line  $(1\frac{1}{2}$  to 2 kilomètres in the rear of the first line) there are six permanent long-range batteries. Only one of these (the one at the extreme east of the line) is of the armoured battery type, secure against assault, like the forts of the first line. The remainder are open batteries, only partially provided with small armoured Q.F.'s for self-defence, and protected on their right flank, which lies towards the sound, by a large inundation. The artillery pesition is in this second line.

There is no interior defence of the centre of the fortress, but there is a continuous belt of inundation between the town and the outer fortifications.

Lättich-on-Maas (1888—1892) is an example of the Brialmont system of armour forts, similar to his latest works of 1895. The right bank of the Maas is very hilly, and the view is restricted; the left is a low-lying plain entirely open to view. The girdle of defensive works (12 in number) measures 48 kilomètres in length, the distance from centre of town is 7 kilomètres, from the suburbs is from 4 to 6 kilomètres, the interval between works varies from 2 to 6 kilomètres. There are 6 large and 6 small armoured forts (called *fortins* by Brialmont), of great passive resistance and very secure from assault.

For type of small fort (or fortin) vide Fig. 6, Plate I.

The small forts possess a weak armour equipment.

Their characteristics are -(1), the pointed triangular shape—in some cases a shallow redoubt type is found; (2), the relatively low relief; (3), a concrete counterscarp with reverse flanking arrangements; (4), heavy interior masonry work with long-range armoured eupolas; (5), infantry parapet with disappearing Q.F. turrets.

The forts differ from the *fortins* only in their size and in the more complete equipment of armoured artillery. Their garrison is 400, or from 200 to 250 men.

Verdun forms the left flank of the line of forts from Toul to Verdun; it is situated in hilly country, and is concealed from view. Only the east front of the work, thrown forward on the eastern slope of the mountains of the Maas, entirely commands the plain lying in front of it. The work is an example of the older form of French frontier fortress. It consists of an outer and inner circle of forts, and the old interior fortification with citadel. There are permanent intermediate works between the outer and the inner lines (e.g., Forts Louville and Tavanner on the right) and the posts of Chana and Des Sartelles on the right bank. The outer girdle of forts measures 48 kilomètres in length, the inner some 23 kilomètres; the greatest radius is about 10 kilomètres.

The outer girdle is composed of a line of forts with intervening works corresponding to the German intermediate works, groups of posts as infantry pivots with shelter trenches, and permanent batteries. The inner line is composed only of forts with connecting batteries and some isolated independent batteries. There are bombproof casemates in the intervals, chiefly underground.

Strassburg.—Example of the largest modern German forts. Circumference of fortress is about 40 kilomètres, mean radius 7 to 8 kilomètres. The interval between large forts is from  $1\frac{1}{2}$  to 6 kilomètres. The method of bringing works up to date, re-construction of forts, fortification of the intervals by small works, is well known.

Plate II. gives to a small scale the three largest fortresses in the world.

Bucharest is the most modern of these. The circumference is 78 kilomètres. There are 18 armoured and 18 intermediate batteries. The circumference of the inner fortifications, lately designed, is to be 25 kilomètres.

Antwerp, lately enlarged by a further advanced circle of forts, has a circumference of 90 kilomètres. The greatest radius is 17 kilomètres. The circumference of the former work, including inundation, amounted to 45 kilomètres, that of town defences to 15 kilomètres.

Paris, with its three advanced groups of forts, each containing 30 independent works, exclusive of small redoubts, has a circumference of 120 kilomètres. The inner lines are 55 kilomètres and the interior defences 32 kilomètres in length.

#### PART II .- THE DEFENCE OF MODERN WORKS.

The various points in the consideration of the question of defence will be taken in order as they would present themselves in the designing of every fort and every system of fortification. That is:--

I. How will attack be made?

II. By what means can the efforts of the attack be best combatted by the defence, *i.e.*, how is defence to be conducted ? III. What assistance is afforded for the conduct of the defence by the permanent outworks of a modern fort?

I. How will Attack be made?—Excluding blockades—a form of attack necessarily successful with sufficient troops and patience simple bombardment and surprise, which are hopeless with wellprepared modern forts, fundamental principles in the attack of fortresses are the same as in attack of field works—

(1). The defence of the artillery to be overcome by destroying the guns, or preventing their use.

(2). The defence at close quarters to be overcome by similar means, or by the destruction of the position itself.

(3). The position to be taken by assault.

These operations require time, but the plan which is the most thorough will in the long run prove the shortest.

The actual operations of the attack take place in the following order :—

(1). The placing in position in front of the fortress of the material for attack.

(2). The advance of the artillery, covered by infantry.

(3). The artillery duel.

(4). The advance of the infantry.

(5). The destruction of the capability for defence, by means of long-range artillery fire where possible, otherwise by the Engineers.

(6). The occupation of the defensive works.

(7). The assault on the interior of the fortress.

II. How is Defence to be Conducted ?—It is impossible to prevent the assembling of material for the attack before the fortress, but it may be rendered difficult by destroying all the roads—not merely radial, but also tangential—suitable for transport in a large area round the fortress.

Good information about the position of any works laid out by the attack will enable the defenders to open an early and effective fire when the conflict has commenced.

The advance of the enemy's artillery can be entirely prevented. Here lies the weak point in the attack and the opportunity for the defence of ensuring a successful issue to the conflict. According to Wiebe, this will be even more the case in the future than in the past. It is especially to be noted that even old, or defective modern, works can successfully engage in this operation if they have the necessary artillery and space for the development of its fire. It is generally acknowledged that accurate information can always be obtained by a carefully organized defence.

If, then, all the approaches to the fortress are kept under a systematic fire from the united artillery of the defence on the threatened side; if every attempt of the enemy to advance his artillery is nipped in the bud; if ammunition is freely expended during the night; if the movement of troops in the foreground is rendered difficult by obstacles, inundations, dams, the destruction of bridges, by demolishing and barricading the roads leading to places which can hardly be avoided by the attack, and which are themselves kept under fire, it seems almost impossible for the attacking artillery to be moved forward until the severe expenditure of ammunition has forced an unwilling economy on the defenders. This is the reason why the defence cannot and dare not forego the use of guns of large calibre, and of the longest ranges, of high-angle guns over very broken country, and of guns of large cone of dispersion over commanded ground. Heavy armoured guns, which are easily served and rapidly fired, are evidently here of the greatest use to the defence.

The conditions are different when a sudden surprise advance of heavy field artillery is to be expected from various directions, or when the arrangements for obtaining information break down. Nowadays great importance is laid on the first of these suppositions. This seems quite unwarranted in the case of armoured forts, and nearly so in the case of forts of older types. Heavy field artillery, while sufficient to attack fortifications of limited area, and useful in a siege attack as a support for the siege train, is not at present in a position to attack a modern fortress. Advance of field artillery and the providing of the ammunition for it would also be difficult after the preparations mentioned above have been made, and it would be always possible for the defender in case of necessity to strengthen his first line from the reserve or by field guns.

In the case of a breakdown of the arrangements for obtaining information, the defender would be forced to divide his artillery reserve among the most threatened sides and keep the foreground all round the fort under an increased and systematic fire. If the attack succeeds in opening a sudden fire, it will be, at all events, considerably superior at that point, and the possibility of rapid \_ reinforcements must be conceded.

The plan proposed seems more to the purpose than that of keeping the reserve artillery in inactivity. Such a case, so unfavourable to the defence, must, however, be regarded as quite out of the common, and can generally be traced to some omission in the plan of defence. Wiebe says that "the efforts of the attacking force would be directed to keeping the defender in ignorance of the date of the advance of the artillery and its direction, and then opening fire unexpectedly." This is a most difficult task, and almost impossible in the case of large fortresses, where complete investment is out of the question. With reference to the artillery duel, granting material of equal value to attack and defence, the question is, "Can the defence, in virtue of its peculiar advantages, counter-balance the numerical superiority and encircling position of attack so that the attack fails !"

It has lately been laid down as a principle, several times by various authorities, including Brialmont and Wiebe, that every improvement in firearms, even the introduction of smokeless powder, has been to the advantage of the defence. The attacking forces have first to get into a position to use their guns, and during this period act on the defensive, moving forward with many halts; the defenders, on the other hand, are already in the most favourable position. It must be admitted that these equalizing factors are of the utmost importance, and with skilful handling, combined with a certain amount of luck, are calculated to turn the balance to the side of the defence. The possibility of successful defence in old forts with unfortified intervals increases in newer forts with permanent intermediate works, and with armour amounts to a hopeful probability. The theory that the artillery duel will in future be of short duration seems erroneous; on the contrary, unless with conditions exceptionally favourable to one side or the other, it may well last till both sides have exhausted their resources without definite result. There is a great difference, of course, between the case of an isolated fort with some 30 guns resisting 48 attacking guns, and the case of 400 guns of the defence resisting 500 to 600 attacking guns. It must, however, be owned that a momentary victory of the defender's artillery could not have so decisive a result as the continued prevention of the attacking artillery's advance. The conditions of Sebastopol are not likely to occur again.

The silencing of the artillery of an old fort seals its fate. Even in what may be called "modernized" forts, the high profile and large 'targets force one to the opinion that under modern artillery fire the older parts, at any rate, of the works would soon be in ruins, and the utilization of the new works be rendered most difficult. The best modernized works are those with intermediate works capable of resistance, and with bombproof covers in the intervals. In the lecturer's opinion, the best course for the defender, after his artillery is silenced, is to retire to these works and leave only a guard in the forts. With armoured forts the task is far more difficult for the attacking force. Here there can hardly be any question of rapidly throwing forward infantry till all the armoured guns, heavy and light, whether in the forts or in batteries, have been silenced. The more difficult this task becomes for artillery at long ranges, the more necessary is it for the armoured defences to be destroyed either by surprise attacks in force at great loss, or by engineer works, even underground. This gives another reason why the armoured guns should be placed in positions as far as possible secure against assault. Even when the armoured guns have by some means been silenced there remains for the attack the task of preparing the works for assault. It is very doubtful whether this could be done against modern works solely by means of artillery. Very possibly it would have to be undertaken by a laborious and protracted engineer attack. The difficulty of such a course would perhaps cause the enemy to advance round the forts-which would be kept under by a strong force-overrun the intervals, and attack the forts in the gorge and the interior works at the same time. The possibility and, in certain cases, the expediency of such a course must be admitted. But it entails the attack being on such a large scale that the possibility of its advance being out-flanked is prevented, and that the defender is so weak in morale or resources that an energetic renewal of the resistance is not to be expected after breaking through the first line of defence. Military history teaches us that the chances of a successful assault, without a thorough preparation by artillery or engineers, are very small, and even with this preparation the result is and will remain doubtful. The question of what power of defence a fort has after its first line has been pierced is a much contested one, and one probably only to be solved by practice. Theoretically, the possibility of further resistance depends less on the nature and condition of the fortifications than on the strength and resources, chiefly artillery, which the defence can still bring up. It is a true principle of defence to oppose to the attack at one position everything available for the defence; and it is impossible to agree with those who think the proper system is to slowly retreat from one position to another. But the above principle does not demand that everything should be sacrificed when the uselessness of further resistance is

seen. The artillery lay stress on the difficulty of recognizing the right moment to withdraw the heavy artillery, and then of doing so in the face of the enemy's fire. Everything, nevertheless, that can be saved should be taken to the rear. The arrangements of the defence for a rapid advance of their artillery will serve also for a rapid retreat. The next tasks in a further resistance would be (a) to prevent the occupation of the conquered position by the enemy, and (b) to delay his advance against the interior works.

(a). The occupation of the work by the enemy is best prevented by retired batteries, which should be constructed at the same time as the forts, and by the demolition of all cover in the forts. This cover should be prepared for demolition even during construction. The batteries would be 1.5 to 2 kilomètres behind the position, *i.e.*, out of effective range of attacking artillery's position, but commanding the forts and the probable infantry battlefield. Old guns could be kept in reserve for the purpose. From this point of view a certain justification is given to type of fortress in two lines, as in *Copenhagen* and *Verdun*. The works of the first lines must be very strong, both against artillery attack and infantry attack, and the distance between the lines must not be more than 2 kilomètres.

(b). The advance against the inner line is best prevented by threatening the flank of attack by artillery positions, preferably armoured works. Flanking positions are especially useful when they are protected by difficult obstacles which compel the attack to make another artillery attack. The prospect of successful resistance may be summed up under the following short headings :---

(1). The taking up of position by the material for the attack may be delayed and rendered most difficult.

(2). A decisive advance of the attacking artillery may be prevented, and the attacker forced to take up the task of regular siege work.

(3). A modern fortress may be successful in the artillery duel, and thereby force the attack to operations requiring time.

(4). A modern fortress renders very difficult the task of the attacker, *i.e.*, the destruction of the capability of defence of the works attacked. The attack will probably be forced to an extraordinary expenditure of ammunition and difficult engineer operations.

(5). A modern fortress affords the greatest possibility of a severe resistance, even after the fall of a part of the defensive line.

History shows that after every advance in the material for attack, at first a resulting weakness in defence appears, but after the plans of fortresses and the methods of the defences have been altered to suit the new conditions, this discrepancy is done away with, and often the advantage finally lies with the defence. Von Müller says that in cases when formerly fortresses left to themselves had to surrender. on account of exhaustion either of supply or strength, now there is no such necessity. Also the attack, not being always possessed of unlimited resources, may reach a point of exhaustion where further advance is impossible. It is to be remembered, on the other hand, that all fortification is of the nature of a compromise between the ideal and various limiting influences, the chief of which is the cost. The nearest approach to the recognized ideal is only to be obtained by a careful consideration of the various measures, and by precedence being given to those of most importance. The chief object of fortification is to place in position a strong armament, combined with those arrangements which ensure the greatest effect for the artillery. To these arrangements belong the employment of Q.F. (i.e., quickloading guns) at least in the first artillery position, and preparations for the supply of ammunition and for observation. Secondly, measures have to be taken to preserve the guns in a serviceable state; this is chiefly a matter of cover. In addition, arrangements for infantry have to be considered. The chief task of the infantry is in the protection of the artillery and in the defence at close quarters. The more carefully the permanent works have been constructed, the fewer infantry are required, and the greater are the difficulties that confront the attack. The above measures refer to the actual fighting position. Finally, attention has to be given to those parts of the organization which will not necessarily take part in the action. Among other things, the question of cover for that part of the garrison not actually engaged, of the internal arrangements, of the interior defences, of other retrograde intrenchment cover for a retreat. Another important question, with regard to which the possible is far behind the ideal, is that of the strength and quality of the garrison. Here, however, another powerful factor, and one which it is impossible to estimate, comes in, viz., the personal influence of the commander and his officers.

The war of the future will doubtless afford great examples of conduct of fortress warfare. It is to be hoped that men like Gneisenau and Todleben may be forthcoming, who can use all the material available to the best purpose, and also inspire the garrison with their own indomitable spirit, and with a confidence in the defensive power of the works which in itself affords a great claim for success. It is the business of those who design fortresses to see to it that the confidence is not misplaced.







