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On the Forts of to-Day

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even in peace time. We must look upon it as furnishing, too, the best opportunity to the Officer of inferior grade and to the non-commissioned officer for showing what they are made of, and as thus strengthening the spirit of martial enterprise throughout the whole Army, and, owing to the intimate connection between Army and people, throughout the whole nation."

Colonel v. Boguslawski concludes his remarks upon "Der kleine Krieg" with the foregoing words.

M. Devaureix, who is quite as much impressed with the importance of the subject as the German writer, has not as yet given us his views upon the training of partisans, which is to be regretted, as it would have been interesting to compare his opinions with those of Boguslawski. It is all the more disappointing as his last article in the "Journal des Sciences Militaires" of December, 1880, concluded with the following words:—

"Après avoir exposé toutes les considérations qui semblent militer aujourd'hui en faveur de la guerre de partisans, il nous resterait à rechercher quelles doivent être leur organisation et leur tactique de détail dans l'avenir. Nous réserverons cette double question pour une autre étude."

Although Colonel v. Boguslawski writes, of course, specially for the German Army, and although, much as we may admire German military institutions, we cannot help feeling that there is a good deal in them which is not applicable to our Service, yet it appears to me that there is nothing in his proposals as to "Training for Partisan Warfare," as far at any rate as I have quoted them, which might not be carried out with advantage in the British Army or in that of any other nation.—L. G.

ON THE FORTS OF TO-DAY.

By Major E. M. LLOYD, R.E.

THE adoption of extended order, which is the most marked change in tactical formations during the present century, is the most marked change in fortification also. Just as the thin veil of skirmishers has grown by degrees into the fighting line of infantry, so small advanced works have gradually developed into detached forts, and become the true fighting line of a fortress. And just as military discussion is no longer concerned with the application of the oblique order, but with the handling of companies and battalions in the fight, so it has drifted away from rival systems of fortifying an enceinte to the position and organization of forts. The cause in both cases is the same: increased effect of fire, and diminished apprehension of shock.

It was in field fortification, where there was no great inequality between the combatants, that continuous lines first went out of fashion. Successive improvements in small arms, such as the introduction of the flint-lock fusil, paper cartridges, the iron ramrod, and the socket-bayonet, made infantry stand less in need of a material obstacle to protect them against horse, and allowed of handier formations and greater mobility. Troops on the defensive could not afford to leave the whole benefit of this to their enemy, and restrict themselves to a passive defence. At Fultowa and Fontenoy the example was set of fortifying a position by a chain of redoubts, giving freedom of counter-attack; and the method rose in favour as time went on till its reputation was established by Torres Vedras and Dresden. In permanent fortification the movement in the same direction was necessarily more cautious. Vauban was blamed for the redoubts which he placed on the high ground east of Namur,

though they delayed the besiegers for a fortnight in 1695. Marshal Saxe, instead of such redoubts, wished to surround a fortress by a chain of masonry towers. Montalembert combined the towers with the redoubts, and proposed to secure Cherbourg from bombardment by a double chain, of which the outer works were 2,000—3,000 yards from the place, and 1,400—2,000 yards apart. But his critics confidently asked what was to prevent a besieger from sapping round and isolating them; for even "when redoubts and lunettes, provided with countermines and susceptible of a good defence, are at the foot of the glacis of a besieged fortress, one does not consider their communication with the place secure unless it is by an underground gallery."¹ Even such a gallery did not save the Queen's Redoubt, in front of Fort St. Philip, in Minorca, from being stormed in 1756, though it allowed the garrison to escape, to surrender with the fort next day. The surprise of Schweidnitz in 1761 increased the mistrust of outlying works. On the other hand, at Cassel, in the following year, "a simple earthen redoubt, 1,000 yards from the fortress, obtained all the honours of a regular siege. The besieger, after spending eleven days of battering and sapping upon this redoubt, at length ventured to assault it; the French, who were defending the redoubt, stood the assault for more than an hour, and at length, with the help of reinforcements from the place, repulsed it with great loss to the enemy."²

D'Arçon, afterwards a prominent figure among the French engineers, took part as a young Officer in the defence of Cassel, and laid its lesson to heart. In his well-known work, published thirty years later, he proposed the ques-

The Plate to Major Lloyd's article on "The Forts of To-day,"
will be issued with the July Number of the Journal.

morale of the garrison, and the activity of the defence. Troops, as he said, were always apt to lose heart and think of surrender as they watched their enemy occupying commanding points, tightening his grip round the fortress, establishing himself on the crest of the covered way, and opening a breach in the body of the place. Detached works, while hindering each of these steps, would also allow the men's courage to be kept up by frequent sorties without risk of their retreat being cut off; and if these sorties were combined with a vigorous use of countermines the defence might be prolonged indefinitely. His Cassel experience had taught him the importance of keeps in the interior of detached works, and of good flank defence for their ditches; and both of these are provided—the former by a loopholed circular tower, the latter by a counterscarp gallery—in the excellent type of work known as the "lunette d'Arçon," of which examples were to be found lately both at Metz and Strassburg.

The detaining value of detached works was exemplified in the two British sieges of Badajoz. The first consisted mainly of an unsuccessful attack on Fort San Cristoval; in the second more than a week was spent in the capture of the Picurina lunette. But the siege of Colberg by the French in 1807 furnished a more striking instance. Gneisenau, then only a Major, was sent there to direct the defence. In presence of the besiegers he threw up a field-

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² D'Arçon, "Considerations Militaires et Politiques sur la Fortification."

³ *Op. cit.*

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D'Arçon, afterwards a prominent figure among the French engineers, took part as a young Officer in the defence of Cassel, and laid its lesson to heart. In his well-known work, published thirty years later, he proposed the question, "not merely whether detached works should be allowed as an addition, that seems evident enough; but whether, supposing a simple enceinte is to be strengthened, one should not prefer these exterior dispositions to a multiplication of works accumulated upon the enceinte."³ He laid stress on their importance, as Montalembert had done, for protecting naval arsenals from bombardment, for which purpose they must be thrown forward a mile and a half or more. But he recommended them also for ordinary fortresses which would have little to fear from bombardment, and where they need be only about a quarter of a mile from the covered way. He built, not so much on the delay which their capture would impose, as upon their influence on the *morale* of the garrison, and the activity of the defence. Troops, as he said, were always apt to lose heart and think of surrender as they watched their enemy occupying commanding points, tightening his grip round the fortress, establishing himself on the crest of the covered way, and opening a breach in the body of the place. Detached works, while hindering each of these steps, would also allow the men's courage to be kept up by frequent sorties without risk of their retreat being cut off; and if these sorties were combined with a vigorous use of countermines the defence might be prolonged indefinitely. His Cassel experience had taught him the importance of keeps in the interior of detached works, and of good flank defence for their ditches; and both of these are provided—the former by a loopholed circular tower, the latter by a counterscarp gallery—in the excellent type of work known as the "lunette d'Arçon," of which examples were to be found lately both at Metz and Strassburg.

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work on the Wolfsberg, more than 1,000 yards in front of the covered way, to serve as the main pivot of an advanced line. Before it was finished it was stormed by the enemy, but it was recaptured before morning. The French then opened a systematic attack upon it, and after a siege of twenty-five days the work was surrendered, as it had been so much injured by that time that it was unfit to stand another assault. Three days afterwards a sortie was made and the garrison once more got possession of it; but it had to be abandoned next morning, after the gorge had been partially thrown open. Another sortie four days later was repulsed with serious loss, and from that time the defence had to be more passive; but in another fortnight, while the fortress still held out, peace was concluded.

The feebleness of small old-fashioned fortresses as ordinarily defended, repeatedly illustrated throughout the Napoleonic wars, had been brought out with special prominence in 1814-15; and after Waterloo, a strong current of opinion soon showed itself in favour of fewer and larger fortresses. Rogniat led the way in 1816, with a proposal to convert places of strategic importance into intrenched camps capable of receiving an army of 100,000 men by adding four forts, one on each side of the place, and a mile and a half from it. Four battle-fields would thus be presented to the enemy, each about three miles long, perfectly secured on the flanks, and strengthened by field-works in the centre. The problem of fortifying Paris gave practical interest to the question, and after twenty years of controversy between the advocates of detached forts and those of a continuous enceinte, it was decided in 1840 to provide both.

Meanwhile, in Germany, this solution was more promptly and unanimously arrived at. The most important fortresses on the Rhine, Cologne, Coblenz, Mayence, and Rastadt, were converted into intrenched camps by the help of detached works, and the same thing was done with Verona, Ulm, Olmutz, Cracow, and the places on the east frontier of Prussia; while at Lintz an intrenched camp was formed by a chain of towers without any interior enceinte.

The character of the German works and the principles on which they were planned were explained in a memorandum by General von Brèse, the designer of the works of Posen. When a position is to be fortified, the engineer, he says, makes choice of the most important points, and on these he places round or angular towers, forming casemated barracks of two or three stories, with a gun-platform on the top. These towers, secure in themselves against a *coup de main*, are sheltered from direct artillery fire by earthen ramparts in front of them, upon those sides on which an enemy could place batteries. Thus they form the keeps of works, sweeping the interior with musketry from their lower story, and the terreplein of the ramparts with artillery from their upper story, while the gun-platform on the top commands the country as a cavalier. The upper story can also be used for howitzers to shell the siege-works. The ditch in front of the earthen rampart is flanked by caponiers or counterscarp casemates; and, unless the work is exposed to fire on all sides, the gorge is closed merely by a wall, so that other works in rear may fire into it if it should be taken by the enemy. The Cologne works of this type were placed about a quarter of a mile in front of the enceinte, and rather more than that distance apart.

A chain of such works, General von Brèse argued, is not only cheaper in construction, garrison, and armament, than a corresponding length of bastioned enceinte, it opposes a resistance three or four times as great, since each work must be taken separately, and above all it gives every facility and support to the offensive strokes of the garrison.

¹ Extracts from this memorandum were given in the "Royal Engineers' Aide-Mémoire to the Military Sciences."

As soon as rifled artillery was introduced, it was seen that the great increase of range and accuracy made detached works at once more necessary and more effective than they had been hitherto, and they were employed on quite a new scale. In 1859, immediately after the peace of Villafranca, Verona was provided on the west side with an outer chain of forts, 2 miles in advance of the enceinte, and rather more than 1 mile apart. The new fortifications of Antwerp comprised a chain of forts which were similarly placed, but were of much greater size, having a crest line of nearly half a mile on the front and flanks, and an armament of 120 guns.

In the English defence works undertaken at the same time, they played a still more prominent part. "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," it was said, "to occupy them by continuous lines, which must be manned throughout their whole extent, and which fall if pierced at any one point."¹ The forts in some cases had to be thrown forward 3 or 4 miles, so that they must needs depend wholly upon themselves, without any support from an enceinte in rear. They were rather nearer to one another than the Antwerp forts, and had only about half the length of crest line. While of the same general type as the German forts, more care was taken to place their caponiers in such positions that they were not liable to be silenced by fire along the ditches they flanked.

In England, as before in France, the new fashion of fortifying did not meet with unanimous approval, in spite of the fresh arguments in its favour. Just as conservative soldiers, even after the Franco-German war, still refused to admit that "our two-deep line formation, so long regarded as a thoroughly British institution, must be looked upon henceforth as impracticable, and that the German skirmisher-swarm formation must take its place," so others ten years earlier refused to admit "that mere fort building is fortification," and asked for "a good wholesome wall and ditch which the enemy has to get through or over before he reaches his object." A very able Officer—Colonel Owen—tried to show that a continuous line, which "has been well and fully tried for thousands of years," is as cheap as a line of detached works; that it can be defended by fewer men and those men far less trained; that its defence is simpler and easier understood by Generals, by Officers, and by men; and that it appeals most to the patriotism of the citizens.

But his vigorous argument failed to win much support, and in the discussion which he started the weight of authority was all against him.² It was generally agreed that to guard a very extended line with a small force, the essential thing was to make sure of the commanding points. If these were strongly fortified and held, little was to be feared from an enemy pushing between them. Connecting lines would be of more or less value according to circumstances; but a simple continuous line of many miles would be as ill-adapted to passive defence by a mixed garrison as to active defence by an army of disciplined troops. As regards the relative expense, there was the broad fact that the enceinte of Paris, though of the simplest kind, without outworks and with an unrevetted counterscarp, had cost 25 per cent. more than the chain of forts, the perimeter of which was more than half as much again.

The real gist of the question is well brought out by one of Colonel Owen's illustrations. "When a farmer puts up a fence or a wall round his garden, he erects a fortification; and so long as fortification is a development of that one simple idea, everyone can understand it. When you put up a row of forts

¹ "Royal Engineer Professional Papers," vol. ix.

² "Royal Engineer Professional Papers," vols. xii and xiii. Another advocate of continuous lines has lately come forward, but only to follow in Colonel Owen's track. See "Occasional Papers of the Royal Engineers' Institute," vol. iv.

and say the enemy cannot pass through, it is asking the farmer to believe that the posts of his fence will keep out cattle without the rails." But the parallel shows how completely the engineer may lose sight of the tactician. The fence has to keep out the cattle by itself; but it is not the works, but the troops inside of them, that will have to keep out the enemy. The question is, how they will be best posted for that purpose: in a long thin line, or in compact groups? The armour must be made to fit the man, not the man the armour.

Colonel Owen took exception, not only to the open intervals, but to the closed gorges of the forts. He confidently asked whether, supposing an engineer had the time and means to strengthen further a place already fortified by a continuous line, he would intrench the salient points inwards, or in other words, convert them into forts. "Surely not," he said, "would he not rather make coupures in his own rampart, and retrench against the enemy those points most liable to be breached, or where from exceptional circumstances an escalade might be apprehended?" The course of the American Civil War was just at that very time throwing some light on this point. General Abbott, of the United States Engineers, in his remarks on the operations against Richmond, dwells particularly on the advantage derived from insulating the vital points of the line. "Our system of intrenchments at Petersburg," he says, "consisted in general terms of a system of field-works, each capable of containing a battery of artillery, and a strong infantry garrison. These works were closed at the gorge, were protected with abattis and palisading, were often supplied with bomb-proofs, and were located at intervals of about 600 yards, on such ground as to well sweep the line in front with artillery fire. They were connected by strong continuous infantry parapets, with obstacles in front." Early one morning, three Confederate divisions swept across the lines on either side of one of the weakest forts, joined in rear, and carried it; but they could take no others. As soon as daylight would permit, all the artillery that could be concentrated opened on the work which had been taken, and which the enemy still held. "No reinforcements could join him from his own lines, owing to this fire which swept his communications; his captured position was entailing deadly loss; our reserves were rapidly assembling, and finally, about 8 A.M., they made a charge which resulted in the recovery of our works, of all our artillery, and in the capture of over 1,800 prisoners."¹ The result was very different in some of the assaults upon the Confederate lines, where the works had open gorges, and such an extent of line was consequently occupied, that the assailants could not be driven out again.

What applies to field-works applies equally to permanent or provisional works. German engineers, from Von Brese to the present day, have laid it down that in most cases an enceinte will be best formed by placing works of the same general type as detached works upon the most important points, and connecting them with one another by simple lines; and this was the mode adopted in the bridge-head of Florisdorf, thrown up in 1866, to protect Vienna.

The varied siege experience of the Franco-German War brought out fresh reasons for extending the circle of defence of fortresses, both large and small, and consequently for relying more upon forts. The blockade of a fortified capital, like Paris, proved by no means so vast an undertaking as had been predicted. Instead of requiring five or six times the strength of the garrison, as Colonel Brialmont, for instance, had estimated, it was found that a garrison of 200,000 regulars and mobiles (besides national guards) could be securely invested by an army actually inferior to it in numbers, extended over a circuit of nearly 50 miles.

¹ Abbott, "Siege Artillery in Virginia."

The chief object of the new fortifications of Paris is to make such an operation more difficult in future by robbing the enemy of those commanding sites which proved so useful to him, doubling the length of his line of investment, and embracing large areas of camping ground and pasture. There are three principal masses of high ground, upon the north, the east, and the south-west of Paris. Possession of these masses is now secured by the new forts which form three separate camps, "three tactical centres," and are from 6 to 10 miles in advance of the enceinte. How far more formidable a work another siege of Paris would be, is fully recognized by the Germans themselves. A recent writer in the "Militair Wochenblatt" (August, 1880) points out all the difficulties of the task: from the extension of the works, their advantages of position, their excellent construction, and powerful armament, the circular railways which "give the Commander-in-Chief a freedom of action without a parallel in military history," and the immense resources of the city. "One cannot expect that, as in 1870, the French armies will disappear from the scene, but must rather assume that there will be time enough for a large army to be collected for the defence of Paris," especially when we consider the spider's-web character of the French railway network. While a continuous investment would be a gigantic task, he thinks it very questionable whether, as has been proposed, an effective blockade could be maintained by armies concentrated on different sides, and linked to one another by cavalry divisions. But "the defence of this vastest of all fortresses must be planned and executed upon a grand scale, and requires military genius of the highest order," and the doubt whether this would be forthcoming is the chief consolation which the writer offers to his countrymen. But, as the same writer adds, "it is not only round Paris that the observant German soldier sees the circle of defence growing wider and stronger; besides the new intrenched camps of Epinal and Belfort, Langres, and Besançon, the lines of La Fère, the fortified position of Rheims, the fortresses of Verdun and Toul, girdled with strong new forts, the fortified plateau of Haye, the permanent works which guard the Moselle near Nancy, and those which lie on the Meuse, upon the north-east frontier, the entry of an enemy in another direction is opposed by the intrenched camp of Dijon in the Côte d'Or, and by that of Lyons further south. If the above-mentioned works of defence and lines are only in part new creations, yet it is solely by the extension they have received, their solid construction and suitable armament, that they have become factors full of importance, which must be taken account of in those large calculations on which hangs the weal or woe of nations. One stands amazed when one considers that that same France which lay so low in 1871 is now able to call out much more than a million of men to defend their country, and that all the above-mentioned measures of defence have been carried out, with a silence quite unlike the French wont, and are now nearly finished."

What chiefly concerns us here in these defences is to notice the almost complete disappearance of those small fortresses for about 5,000 men, which, from Vauban's time down to 1870, stood like picquets extended along the French frontier. Instead of them we see a series of camp-fortresses¹ with barrier-forts between them. Montmédy is to be reduced, it is said, to the latter class; while Toul, Langres, and Verdun have been converted into camp-fortresses of ten times their former diameter. Toul proved very useful in 1870, blocking a main line of railway for six weeks, owing to the German inability to bring up a siege-train at that time; but, like Verdun, Thionville, and so many other places, it surrendered without waiting to be regularly besieged. The convergence of fire from all quarters, to which their small

¹ The Austrian term "camp-fortress" seems preferable to the German term "fort-fortress." One can speak of the component parts as camp-forts, instead of as forts of a fort-fortress.

radius exposed them, made defence hopeless. The long and successful resistance of Belfort was mainly due to the bold maintenance of outlying positions. Apart from the reasons that have been given already, the favouring of an active defence, the occupation of valuable sites, the protection of buildings from bombardment, and the enhancement of the difficulty of blockade; looking merely to the conditions of the artillery combat, rifled guns have made it all-important to enlarge the circle of defence, so as at any rate to escape reverse fire.

In some cases, as at Antwerp and Strassburg, the nature of the ground is likely to forbid complete envelopment, and there may be fair hope of reaping the full value of a strong enceinte by an obstinate defence at close quarters; but elsewhere, though it may be well to have some continuous obstacle to bar entry into the town which forms the heart of a fortress, it may be doubted whether it will be found worth while in future to create a siege-enceinte. What used to be said of the covered way—"covered way lost, all is lost"—may now be said with equal truth of the line of forts. That is the line which it is the most essential and easiest to defend, and nearly all the available resources should, therefore, go to reinforce it. The idea of the Prussian engineers of the last generation, that a fortress, like a spiral spring, should offer more resistance the more it is compressed, must be discarded as hopeless in presence of rifled artillery.

Some nucleus (*noyau*) is certainly desirable for every large fortress, but this may be not in its centre, but on its border line, like the citadels of former days; some particular region of marked natural strength or importance being constituted as an independent camp, defensible on all sides. The small camp first formed at Langres may be said to stand in this relation to the much larger camp since formed by the new forts to the north and east, two of which are 7 miles from the place.

General Brialmont goes further. He recommends that the plan of grouped camps which has been actually adopted at Paris should be the normal disposition for the fortification of a capital. He gives as a type three similar camps symmetrically placed on a belt nearly 6 miles wide, and lying at about the same distance outside the city. Each camp would be roughly about 14 miles by 6, and might be formed by ten forts—five upon the front, three on the gorge (towards the city), and one at each end. The intervals between the camps would be about 9 miles. He considers that though the cost would be greater than that of a simple line of forts, the defence would be much more protracted, and there would no longer be any necessity for a guard-enceinte round the capital, a thing most important to avoid with a vast and growing city like London.

"There is a bold and tactical air about this method of fortifying; holding the enemy off by threatening his flanks instead of barring his front. It looks at first sight like a larger application of the principles which have substituted detached works for continuous lines. But there is the all-important distinction that such works are assumed to be within range of each other, and that these camps are not. The combat is to be one of weeks and not of hours, so that the enemy can afford to push his way forward cautiously in the intervals upon a front of 6 miles, intrenching himself against flank attacks. Once within range of the capital it must fall into his hands, for any show of resistance would bring bombardment upon it. The defending army, if the war is not ended, will find itself cut in three, and its camps will be open to attack on whichever side the enemy may prefer. It may be said that the intervals would be occupied by field-works; but the comparative inadequacy of field-works, which is the ground for all permanent fortification, applies here as much as elsewhere. No doubt, with so extensive a circuit it would be well worth while to retrench some one part to serve as a citadel; but leaving one of these camps as it stands for this purpose, one cannot help thinking that the

half-dozen works which guard the rear of the other two camps would be better placed by pairs in the intervals." ¹

However well such a disposition may apply in a particular instance, such as Paris, where there was not only an enceinte for the city, but gorge forts for the camps ready to hand, it seems very questionable as a general type. As Brialmont himself points out in another connection:—"The action of a fort on the ground in front of the neighbouring forts will be greatest where the forts are in a straight line, or in one that is very slightly convex. One should avoid as much as possible, therefore, placing the forts in such a way as to form pronounced salients and re-entering angles."

With the exception of the works at Paris, the forts lately built have, as a rule, been placed within 3 miles of the enceinte. It has been recommended by Brunner² and Brialmont³ that this distance should be increased to 4½ miles, in order absolutely to preclude bombardment of the town. But the increase in cost of construction, and in the strength of garrison, involved by such an extension of radius has to be set against this advantage. Also, as the distance widens, the area of intervening ground unseen from either forts or enceinte, and affording shelter to an enemy who has passed between the forts, will become greater; in one of the new French fortresses there is said to be more than a square mile of such ground. Such an advance will sometimes be necessary, however, in order to see the ground in front better, as on the south-east side of Verdun (which is probably the fortress just referred to), where one of the principal forts is more than 4 miles from the enceinte; and occasionally it may even reduce the length of line to be defended, as in the Anthony position at Devonport.

It is beginning to be accepted as a principle that the distance of forts from one another, instead of 1 or 1½ mile, may be 2½ or 3 miles, if the ground is open; in other words, that it is enough for them to defend the intervals between them, instead of affording effective mutual support. This has been acted upon in many of the new fortresses, especially in France. Between the St. Cyr and Palaiseau Forts (on the south-west of Paris), which are more than 10 miles apart, it has been thought sufficient to provide two others. The country round Verdun is broken and wooded, and there eleven works have been made for a perimeter of 25 miles, the intervals varying from 1½ to 3 miles. One reason given for this wide spacing is to economize garrisons, and to avoid breaking up the defence into many fractions. But the duty of guarding intervals of 3 miles could not fail to be made lighter by the existence of storm-proof posts in the middle of them; and the writers who give their sanction to such long intervals (*e.g.*, Brialmont, Brunner, Von Bonin) assume some such small intermediate works, either permanent or provisional.

"It is well known," says a French engineer,⁴ "that in the fortresses as they now stand, both in France and abroad, the extent of the works has been limited by financial considerations; and, therefore, in most cases only the most important points round the fortress have been fortified, and the completion of the defences has been postponed till the time of need. . . . The Germans have placed the forts thrown up round Strassburg⁵ and Metz at average intervals of 2 to 4 kilomètres, as they consider those places to be too much in front line to allow the making of intermediate works to be put off till war breaks out: on the other hand, for the forts of their places in second line they have been satisfied with the intervals of 5 or 6 kilomètres adopted

¹ "Royal Engineers' Journal," March, 1874.

² "Défense des États," (1876), pp. 141, 143.

³ "Beständige Befestigung," (1876), p. 154.

⁴ "Étude sur la Fortification semi-permanente." Par un Officier du Génie. (1880.)

⁵ Strassburg has fourteen forts; those on the south and east are 4 kilomètres, but those on the north-west are only 2 kilomètres apart.

in France. This shows that they mean to throw up intermediate works there when needed, and that they admit the principle of mutual flanking at effective ranges, a principle which is equally admitted in France."

The projects for such intermediate works have, according to this writer, been already got out, but he estimates that 500 or 600 men would be occupied two or three months in making one, and reasonably urges, therefore, that France should follow the example of Germany, and build them in time of peace for her frontier fortresses.

But if it is desirable that they should be permanent works, one may further ask whether the maxim does not hold good here as elsewhere, that "a chain is no stronger than its weakest link," and whether—apart from peculiarities of site, which will continually give more importance to this fort, and less to that—it should not be the general rule to equalize the several links, instead of making them weak and strong alternately. "The garrison of a large fort consisting of 1,500, to 1,800 men, commanded by a Colonel, will usually have a better spirit and be more ably handled than that of a small fort consisting of 300 to 400 men, commanded by a Captain or a Major."¹ On this ground General Brialmont has always been the advocate of large forts, and prefers to reduce their number rather than their size; but whatever weight this argument may have against small forts, it must have much more weight against the still smaller intermediate works (intended for 50 or 60 infantry and 3 or 4 light guns, according to General von Bonin), which it is proposed to place in the wide intervals between the forts. The French engineers lean to Brialmont's views. The principal forts of their new camp-fortresses have infantry garrisons of 1,000 men and mount 36 guns on the ramparts. Some of the Paris forts mount 60 guns, while some of the isolated barrier forts mount from 80 to 100, and are constructed for 2,000 men or more. The German engineers lay less stress on size. They are satisfied in most cases with infantry garrisons of 500 men, and with 20 guns on the ramparts. When more guns are needed at any particular point, they can be placed in wing batteries, without enlarging the forts. If the Germans are right, forts may be placed at a mile and a-half apart without absorbing more than one-third of the entire garrison of the fortress, reckoning this, as is generally the case, at about 1,000 infantry per mile.

Passing now to the construction and organization of individual forts, it will be best first of all to borrow a general description of one of the new German forts,² such as those of Strassburg, to serve as a point of departure and comparison for others.

"The detached forts of the chain round a great place of arms are usually of lunette shape with very obtuse salients (130° to 145°), in order that the faces may escape enfilade, and also that their frontal action may be better, since they have to hold their own against the besiegers' batteries in the first encounter. The direction of the flanks depends on the position of the collateral works, but is, as a rule, nearly parallel to the capital. Assuming the forts to be a long way from the enceinte, their gorges may be closed by a line of rampart either of bastioned or of slightly re-entering trace.

"The size of the forts is proportioned to the part they have to play in the general system of defence. The faces will commonly be 75 to 125 mètres, the flanks 50 to 70 mètres in length, so that the perimeter of the forts will considerably exceed what it used to be, just as their present importance does.

"In a detached fort the use of the covered way is not so much to facilitate sorties, which can be made more conveniently upon the flanks, as to allow of keeping sentries outside the work up to the last stage of the defence; it can be replaced, therefore, by a simple patrol path, which on the gorge side

¹ "Défense des États," p. 143.

² Bonin, "Festungen und Taktik des Festungskrieges" (1878),

becomes a roadway to the wing batteries (*Anschluss-glacis*), and widens out opposite the gorge gateway into a place of arms, with a tambour and a block-house to guard the communication. By this arrangement of the covered way, together with admissible reduction in the width of the ditch, it becomes possible to screen the masonry escarp of the faces and flanks from the besiegers' indirect fire, provided it is limited to a height of about 5 mètres. Since this height in itself affords no sufficient security against assault, and the situation of the forts—usually on commanding ground—seldom allows of wet ditches, such security must be sought for by means of good flank defence for the ditches, and of a high revetted counterscarp, perhaps organized for countermines. The escarp of the gorge, not being exposed to the heavy batteries of the attack, will be utilized for shelter-casemates, and revetted to a suitable height.

"The double caponiers at the shoulders which were formerly used to flank the ditches of lunettes are no longer admissible, as they could be destroyed by the enemy's indirect fire on the prolongation of the ditches of the faces. They are usually replaced by a caponier at the salient, sweeping the ditches of the faces with artillery, and two single caponiers at the shoulders, on the prolongation of the escarp of the faces, sweeping the shorter flanks with musketry. If the gorge has been given a bastioned trace, casemated flanks furnish a low flank-defence for its ditch; if it has been simply broken inward, a caponier is required. All caponiers have posterns leading to them from the interior of the fort.

"The old reason for providing the escarp with a costly revetment wall, to bring the musketry fire as near as might be to the crest of the glacis, has no longer any weight with the new rifle; it is now thought better, therefore, for the sake of economy, to have an earthen slope for the escarp of the rampart of the faces and flanks, and to place a less substantial detached wall at the foot of it as the obstacle to assault.

"The command to be given to the rampart above the plane of site depends upon the formation of the ground in front, which should be overlooked as extensively as possible; it will seldom be less than 8 or 9 mètres. The greater penetration of the new siege guns requires that the thickness of the parapet should be increased to about 7 mètres. A less command will suffice for the gorge parapet; it is enough that it should cover the faces and flanks from reverse fire in case of assaults; and here, as the direct fire of heavy siege guns has not to be met, the thickness of the parapet may be reduced to 4 mètres.

"The rampart will from the first be organized for guns upon the faces and flanks. On the gorge it will be prepared only for musketry, but in the later stages of the defence it may be necessary to mount guns there also; and accordingly the terreplein must be made wide enough for them.

"The employment of casemated batteries for fire to the front has had to be given up; the bombproof gun-emplacements of masonry or timber which were formerly in use, can be used no longer, owing to the accuracy and destructiveness of the new siege artillery; it has been found necessary to sacrifice the howitzer fire upon the country which was to be furnished by the upper stories of casemated keeps, since such action of the keeps could not be reconciled with their own protection from indirect fire. But this protection has further required in most cases that the command of the interior of the work from the casemated keep should also be sacrificed, since if it was to fulfil its object in this respect it could not be shielded against an angle of descent of 10°. There was naturally great reluctance to abandon the casemated defences which had been thought so much of, and attempts were made to reinforce them by iron plating, as had been successfully done with ships-of-war. But the results of these attempts were not very satisfactory. The conclusion has had to be accepted that casemated defences are only to be

employed where, owing to the nature of the site, they can be protected even from indirect fire.

"The importance of the rampart as the main line of defence has become more distinctly marked, and has demanded better measures for securing its defensive powers. With this object the gun emplacements and roadways along the ramparts have been sunk lower, in order to get better cover; higher carriages have been adopted for the guns firing overbank to repel assaults; while indirect fire is chiefly contemplated from those which are intended for the artillery combat in case of a regular siege, since the deep embrasures that have been used hitherto cannot now be employed, on account of the accuracy of the new artillery. More complete traverse-cover has been given to guard against side shots; only one gun being placed between a pair of traverses on lines exposed to enfilade, and on other lines at most two guns. Secure receptacles for ammunition for immediate use have been made in the interior slope, or in the traverses; and the latter, being built hollow, with a sufficient thickness of earth over the masonry on the enemy's side, allow the troops on duty upon the ramparts, and even some of the lighter guns provided against an assault, to take shelter in them if the enemy's fire should be very heavy.

"The quarters for the garrison in general lie as a rule in a range of casemates along the gorge, which also contains the hospitals (essential for the self-dependence of the several forts), and in the basement, kitchens, stores, &c. For guards and other detachments held in readiness, casemates open to the rear and well provided with outlets are made under the terreplein of the faces; in case of need the space afforded by the posterns will either supplement these or serve instead of them. This space will also be sufficient to contain some of the stores which are not immediately required for the defence, and which ought to be sheltered from the enemy's fire.

"Each fort requires at least one main powder-magazine, completely in the heart of the rampart, and quite out of reach of the enemy's fire, and, according to its size, two or three shell-filling rooms, each with its own expense-magazine and the necessary storerooms for the several kinds of artillery ammunition. . . . These are placed under the terrepleins, and are connected by lifts with hollow traverses overhead, so that the made-up ammunition can be transported without risk from the enemy's fire almost to the very spot where it is to be used. Lastly, the increased effect of siege artillery imposes greater care about the communications. This is partly met by the larger use of traverses on the terrepleins; but with . . . detached works one cannot do without large capital, or central, traverses, which divide the interior of the work into separate portions, protect the several lines of rampart from indirect reverse fire, and at the same time allow a completely sheltered communication to be made between the gorge and the casemates under the main rampart. With very exposed works one may even go so far as to carry this covered communication right along the ramparts, and connect it by staircases with the hollow traverses on the terreplein, so that if the enemy's fire is heavy and convergent the open area of the work and the ramps to the terreplein need not be used at all for circulation."

Much of the above description would apply to any of the recently constructed forts, whether in Germany or elsewhere. The points which chiefly call for remark, and regarding which we find most difference of treatment, are:—

- (a.) The general shape of the fort,
- (b.) The provision of a keep,
- (c.) The disposition of the rampart armament and the mode of mounting it,
- (d.) The caponiers.

General Brialmont in his latest type (Planche II), as in the forts of Antwerp,

has preferred a single straight front, or head, to the two faces of the more usual lunette form. His objection to the latter is that they bear less directly upon the ground over which the besieger will advance, and that they are likely to be enfiladed from the salient towards the shoulders. When a work occupies a re-entering position in the general line, so that the prolongations of the front ditch cannot be taken up by the enemy, the straight trace has everything to recommend it. For one thing, its caponier may be placed at one end instead of in the middle, and will be able to defend also the adjoining flank, thereby saving a shoulder-caponier (as in the case of Fort Purbrook, a plan of which is given in vol. xii of this Journal). This will also allow such a trace to be adopted in cases where one only of the prolongations lies out of the enemy's reach. But Brialmont himself recognizes that the front must be broken outwards whenever the enemy could otherwise place batteries so as to breach the caponier by firing along the ditch. The forts of a camp-fortress must as a rule be salient works, and their saliency increases as the intervals between them are made wider. Even if the siege batteries are not strictly on the prolongation of the ditch, but 10° or 15° outside of it, their shot will still drop sufficiently after clearing the glacis to strike the masonry of the caponier. So far as the escarp line is concerned, therefore, it seems likely that as breaching by curved fire becomes more perfect the angle between the faces, instead of being increased to 180° , will commonly have to be made less obtuse than hitherto; and if this makes the fire of the two faces too divergent, or exposes them too seriously to enfilade in the opposite direction, some part of them must be traced independently of the escarp.

In some cases, as in the type given by Major Wagner, of the Prussian Engineers (Atlas, xviii, 20), secondary flanks are provided, firing to the right and left rear, so that the work fronts three-quarters of a circle, and the gorge is narrowed. In very salient positions such a form is imperative, and even for the ordinary forts of a chain it has the advantage that, when their neighbours have fallen, and the enemy pushes in through the gap, they themselves cannot so easily be taken in rear, and are better able to support a retrenchment line. But these secondary flanks are themselves so exposed to reverse fire, that they need to be protected by *parados*, or to be completely casemated. They help to hide the keep, when there is one, as in this instance, from the enemy's view; but that seems a questionable advantage, as they correspondingly restrict its action.

The new French and German forts have been made without keeps, on account of the difficulty already mentioned of making them effective for their purpose, and at the same time sheltering them sufficiently from curved fire. "They restrict the interior space," says Major Brunner, "and intercept the shells which fly over the parapet of the work, so that they are liable to be disabled along with it. Consequently their services are not always in proportion to their cost."¹ Another Austrian writer says: "Although keeps can be protected from curved fire in the same way as the main work, it must be remembered that the keep has usually no action upon the ground outside, and that if once the outer line of the fort is carried, the pushing forward of an attack step by step on the keep, though it presents difficulties and occupies men, causes no serious hindrance to the progress of the attack against adjoining works, or against the nucleus."²

But other writers still insist on their importance. "To renounce a keep," says Wagner, "would be as incorrect as to fight in the field without reserves."³ He endeavours to adapt the old Prussian type of keep to present conditions, retaining even the casemates for high-angle fire. Instead of over-

¹ "Beständige Befestigung," p. 89.

² Weeger and Geldern, "Befestigungskunst" (1873), ii, 36.

³ "Grundriss der Fortification" (1872), § 129.

lapping the gorge ditch, it must now be pushed forward into the interior of the work, and its escarp covered by an inner glacis. Its platform must not be given any command over the main rampart, but one or more iron turrets may be placed on it, to fire indirectly upon the country.

Brialmont maintains that "a keep is an indispensable work for every important fort which is either isolated, or in a salient position."¹ It is not really costly, for it furnishes the casemated cover which must needs be provided in some form, and by the additional security it gives, it may even allow of a reduction in the height of the main escarp and counterscarp. The space it occupies is useless for any other purpose, and it does not necessarily involve any enlargement of the fort. If properly constructed, instead of falling with the fort, it will impose a second siege on the enemy, and will meanwhile arrest his further advance; for, unlike Wagner, Brialmont makes it an essential condition that the keep should overlap the gorge ditch, and while screened from the front by the main rampart, should be able to command the country on either flank as well as to the rear. He dwells upon the value of the keep, not only in guarding a fort against sudden capture by assault, but also in supporting counterstrokes for its recovery when the enemy have got possession of it. With this contingency in view, he would make wide roadways across the gorge ditch and rampart, close under the guns of the keep, to allow the fresh troops to enter the work.

Since he wrote, a marked instance in support of his argument has been furnished by the storming of Kars. When the Russians had made themselves masters of Fort Kanly, the fire from its keep, a defensible barrack, obliged them to abandon the interior, and get cover outside the parapet. It enabled the Turks to reoccupy the work for a time, and when they had retired the keep still held out, until all the works on that side of the river had surrendered, and it was plain that further resistance was useless. It must be remembered, too, that Fort Kanly, like the other southern forts, had been vigorously bombarded with siege guns for a week before the assault.

The main problem in fort building—how to organize the ramparts and dispose the armament, so as to deal either with the converging fire of numerous siege batteries, or with sudden assaults by overwhelming forces—meets with widely different solutions. In most of the German forts, as already mentioned, reliance is placed chiefly upon the use of high carriages, and of massive and frequent traverses. There is only a single rampart, on which the heavy guns are mounted for indirect fire during the artillery combat, and which serves for infantry, or for the lighter guns firing overbank when the enemy comes near. In the French forts there are two ramparts, a lower one for infantry, and a higher one behind it for artillery, so that 600 rifles and about 30 guns can be brought into play at once. This arrangement is said to have been adopted also by the Germans in some of their latest works, but Brialmont condemns it because the infantry would suffer so much from shells bursting in the exterior slope of the rampart in their rear. He himself recommends an inner rampart for the heavy guns, but it is lower than the outer rampart, and screened by it from the enemy's view.² In large forts with keeps, this inner rampart should be broken into two halves, separated by the keep, which should flank them both in front and rear; in small forts it will form a continuous retrenchment or *parados* for the gorge parapet.

An interior battery of this kind has been adopted in the latest English type of fort (See § 292, Part I of the Woolwich "Text-book of Fortification").

¹ "Défense des États," p. 185.

² General Todleben carried out some experiments in 1875, which led him to the conclusion that, as indirect laying must in any case be largely employed in future, part of the armament should be placed behind the main rampart instead of upon it.

The crest is about 60 yards behind the outer parapet, and half a yard below it, and the exterior slope is very gentle, so that shells striking it may ricochet over the work. The outer rampart is intended only for musketry and field-guns, with a few heavy guns on Moncrieff carriages at the angles.

In the newest Austrian designs, given in the magnificent collection of details of military architecture recently published,¹—a collection to which one would much like to see some English parallel—we also meet with interior batteries, with their crest on the same level as the outer crest, or a few inches higher. In one case the battery forms part of a keep. The ends have a masonry escarp screened by an inner glacis, and they form orillons covering the flanks of the keep, which have a good view over the country upon the sides, and in rear of, the fort. The front has only a steep earthen slope, with an unflanked palisade at its base.

Iron turrets and shields have been made use of to some extent abroad for inland works as well as for coast batteries. The earliest turret mounted on land was on the keep of one of the Antwerp forts, and some of the new forts at Metz are provided with two turrets each. The cost has been brought down as low as 4,000*l.* for a two-gun turret; and Brunner points out that a fort with ten such turrets will even be cheaper than a fort for twenty unarmoured guns, on account of its much smaller size. But the uncertainty of artillery progress makes it unsafe to stake much on them, and so they stand on the footing of defensive luxuries, additions to works which are not dependent upon them, but for which no money is grudged. It is said that there are not more than a dozen turrets in the whole of the fortresses of Germany. They are chiefly to be used, according to Wagner, for giving protection from curved fire to heavy guns which are hidden from view, and are themselves to be laid indirectly, as on the keep of the fort referred to above.

In the French forts iron has been more largely used, shields being provided for several guns on the ramparts. Shields give a much more restricted field of fire than turrets, and their ports cannot be averted from the enemy when not in use; but they cost much less, and it is easier to increase their thickness if it should become necessary at any time, supposing that they are made of plates bolted together. It is a great drawback to the chilled cast-iron (Gruson's patent) which is now being so largely adopted abroad, both for shields and turrets, that it will hardly admit of any such subsequent strengthening.

"A great step will have been made," says Brialmont, "when some one has invented a disappearing carriage of simple construction and moderate cost, which will allow of fire over a parapet about 10 feet high." The Moncrieff counterweight carriage does not seem to be accepted abroad as satisfying the essential conditions. Looking upon this as too expensive and too liable to injury, but wishing to obtain its advantages of shelter and all-round fire, Count Geldern, of the Austrian Engineers, proposes to use lifting platforms working spirally in circular pits. He has given a design for a T-shaped fort, to mount six heavy guns in pits upon the head, and six field-guns on the flanks. Comparing it with an ordinary lunette armed with seventeen heavy guns and four field-guns, he shows that in most directions it will be able to bring more guns to bear, while in the cost of construction and in the strength of the garrison needed for it, there will be a saving of nearly 40 per cent. Apart from the question of the mechanism, this design, if not quite satisfactory for an independent work, has much to recommend it for a keep.

In the several types of forts that have been mentioned there is little difference as regards the flank defence of the ditch, with the exception of the one just noticed, in which counterscarp casemates are employed. All the others have

¹ "Sammlung von Constructions—Details der Kriegsbaukunst, lithographirt im k. k. t. und a. Militär-Comité." Wien, 1880.

small one-tier caponiers, placed where they are least exposed to fire along the ditch, sunk sufficiently to be sheltered from shots descending at 15° from the crest of the glacis, and projecting beyond the escarp only so far as will afford space for two guns or half-a-dozen muskets. The space necessary is more narrowly reckoned in some cases than in others, in order to lessen as much as possible the retirement of the counterscarp opposite the caponiers, which—unless the glacis is raised correspondingly—will make it easier for the enemy to breach the escarp there. A gun can be worked in a width of 9 feet, and a mitrailleur in less; and iron columns can be used, instead of brick walls, to carry the roof; so that the projection of the caponier may be reduced to about 20 feet. But that gives very little room for the detachments, and hardly admits of loopholes for musketry in addition to the gunports. A width of 13 feet (4 m.) for the gunrooms is more convenient, and has been adopted in the caponiers of the French forts. Iron caponiers have been provided for a few German works where it was not possible to screen masonry from curved fire. Apart from their greater resistance when struck, they can be better covered by the glacis, as their total height from the gun-floor need only be about 10 feet instead of 20 feet. With wide wet ditches like those of the Antwerp forts, iron, at all events in the form of shields, seems indispensable for the caponiers.

Mitrailleurs, if they can be relied upon not to get out of order, are more effective for flanking ditches than either guns or musketry; and they take up less space than guns, and require fewer men to serve them. The French have adopted for the new Paris forts a pattern of the Hotchkiss 5-barrelled revolving gun, which has a calibre of 1.57 inches, and fires a case-shot containing 24 hardened bullets of $1\frac{1}{4}$ oz. each. "The gun is sighted and fixed once for all in the caponier, so that, in a surprise during day or night, it is only necessary to turn the crank, and the gun will discharge 60 to 80 canister shots per minute, consisting of 1,500 to 2,000 balls."¹ The central caponiers of these forts have three gunrooms on each flank, and as their size exposes them to curved fire, the front walls of the gunrooms are masked by carrying the arches forward about 20 feet beyond them. The casemates in the head of the caponier are also extended laterally, and form orillons sheltering the flanks, so that the plan reminds one of the early Italian bastions.

Brialmont, while adopting "inimum caponiers" in ordinary cases, considers that forts intended to resist a systematic attack to the very last ought to have large caponiers with wide gunrooms protected by masks; and he would give them overlapping heads with acute salients, like those of the Antwerp forts, so that they can be flanked from the ramparts.

The heads of the French and German caponiers are unflanked, and defended only by their own loopholes, which in the case of the former are machicolated. There are counterscarp galleries opposite to them, but these are solely for countermining, and are not loopholed, according to Brialmont. As they have no underground communication with the fort, but open into the ditch, it is assumed—surely a very questionable assumption—that men would not stay in them, and that loopholes would be useful only to the enemy. No doubt any reverse defence is likely to fail sooner or later in case of a regular siege, but, as has often been remarked, a fortress has done its chief duty when once it has compelled the enemy to besiege it in form. With detached forts especially, it is assault that it is of most importance to be absolutely secure against; attempts on the caponiers—to blind the loopholes, blow in part of the walls, or smoke out the defenders, would be the accompaniment of any assault, and would largely influence its success; and it seems very desirable to supplement mere direct defence in some way, for the head as well as for the flanks.

¹ "Royal United Service Institution Journal," vol. xxiv, p. 287.

"A little while ago," says Colonel Muller,¹ "there was a general predilection for those modes of attack which promised to give escape from a regular siege. But this has lessened with discussion, and consequently the formation of rules for the conduct of the systematic attack has been recently taken up with zeal." Strenuous advocates of the more rapid methods are, however, still to be found. The second part of Major Scheibert's work, published in 1881, "*Die Befestigungskunst und die Lehre vom Kampfe*," is little else than a vigorous argument in favour of storming the new French frontier fortresses on the outbreak of another war.

In some way or other a place must be got possession of if it blocks the main artery upon which the very life of an invading army now depends, and this, he argues, ought to be done within three weeks from the beginning of hostilities. But the regular siege of a great modern fortress will occupy from three to six months—the duration of a war in these days. The fortress is at its weakest when the enemy first comes before it, and the more promptly and vigorously it is attacked the less are the chances of the defence. The garrison—sure, as Von Scherff says, to consist of second-rate troops—half organized and new to their work, will warrant bold measures against it. If the assailants wait to fortify an investment line, and bring up a siege train, each day's delay will improve the state of the garrison, and of their works. With an eye especially to Verdun and Toul (of which he gives sketches), he dwells upon the wide intervals between the French forts, and the impossibility of arming and fortifying these intervals, and of clearing away the masses of wood in their front and rear, in the fortnight which there would be for preparation before the German armies appeared. A certain French fortress (Verdun?) has a garrison of 29,000 infantry. Of these, 9,000 are required for the forts and enceinte, and 6,000 to furnish outposts and guard the intervals on the further side; leaving only 14,000 for the same purpose on the side attacked, or one man to 15 mètres. It would be an easy matter, he concludes, for the assailants to break through the intervals at once, especially under cover of night or mist, to establish themselves there firmly, and either push forward directly upon the town, or assault some of the more isolated forts at the gorge while attacking them at the same time in front. The front faces will have about 14 heavy guns and 250 infantry to oppose such an attack. To keep down their fire, 1,250 infantry can be hastily intrenched within 500 mètres, and can be well supported by field artillery. These ought to make it impossible for the gunners of the forts to serve their guns.

Escalade is not so difficult a thing, in his opinion, as people suppose. Caponiers are held in too much awe. It is quite possible to close upon them, and to blind their ports and loopholes; and besides, men when firing through loopholes in masonry are by no means themselves secure from fire, and their defenders, few and isolated, are likely to think more of their own safety than of their duty. But if escalade seems to be impracticable a lodgment must be made upon the glacis, and mining or heavy guns must be employed to get rid of the obstacles in the ditch.

From the point of view of the attack Major Scheibert's arguments, and the experience of recent sieges to which he appeals are very far from convincing; but from the point of view of the defence they are worth bearing in mind.

¹ "*Geschichte des Festungskrieges*" (1880).