ELEMENTS

OF

FIELD FORTIFICATION.

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by their own fire, eſpecially when behind low and narrow parapets, as to be forced to abandon their works.

SECTION III.

Deſcription of the ſeveral Parts.

FIG. 1 and 2.† PLATE I.

Parapet.	Fraize.
Banquette.	Cheveaux-de-Frize.
Berme.	Trous-de-loup.
Ditch.	Abbatis.
Glacis.	Fougaſſes.
Second Ditch.	Inundations.
Palliſade.	

Of the Parapet and Banquette.

The parapet is the bank of earth ſurrounding the poſt to be defended, and ſerves to cover the troops and artillery employed for it's defence. The dimenſions of the parapet vary according to the nature of the ground, and the purpoſes for which it is conſtructed: it's breadth at the top, is from 2 to 18 feet; and it's height within, is from 4 to 10 feet.

† Fig. 1 and 2, Plate I. are referred to throughout this ſection, unleſs expreſſed to the contrary.

Parapets

Parapets of great elevation, give great command, are leſs expoſed to ſurprizes, and afford greater ſhelter to the men within. Parapets of little elevation, are leſs expoſed to the enemy's cannon, and the fire from behind them is more *razant* *, that is, more *grazing*: Mr. Vauban conſidered 6 feet as the moſt advantageous elevation, and fixed the greater at $7\frac{1}{2}$ feet. The thickneſs of the parapet varies much more than the height: when 2 feet broad at the top, it is capable only of reſiſting muſket ſhot; but when 18 feet, it is capable of reſiſting the ſhot of the larger cannon. Experience proves, that when the parapet is 3 or 4 feet broad at the top, it can reſiſt a three-pounder; when 4 or 5 feet, a ſix-pounder; and when 7 feet, a twelve-pounder: conſequently, when works are much expoſed to cannon, the ſecurity will increaſe in proportion to the greater thickneſs of the parapet; but when they are only expoſed to the attack of *ſword in hand*, the ſecurity will increaſe in proportion to the greater elevation of the parapet.

REMARK.

Parapets of great thickneſs and much elevation, that is, ſuch as have large profiles, will generally be found moſt advantageous; not only becauſe they afford ſecurity againſt all kinds of attack, but becauſe it is known that ſoldiers meaſure, by their eye, the obſtacles which an enemy has to ſurmount to come at them; and that their confidence is the greater, in proportion as the dimenſions of the works they are to defend are larger.

* There are two ſorts of fire, diſtinguiſhed by the names of *razant* or *grazing*, and of *fichant* or *plunging*: in the razant or grazing fire, the direction of the ſhot is parallel to the horizon, and conſequently deſtroys every thing within its range; and in the fichant or plunging fire, the ſhot being fired from a higher to a lower place, can only deſtroy what it meets near the point where it falls.

The

a file two deep is allowed: when cannon is uſed, 4 or 5 yards are allowed for every piece.

For the purpoſe of diſcovering the enemy in his approach, and of more effectually levelling at him, the top of the parapet is made ſloping towards the country. This ſlope is by ſome called *ſuperior talus*, and by others *plunge*; and it's direction is deemed the more advantageous, in proportion as it meets the horizon ſooner: in general it meets the counterſcarp.

Some engineers never allow this ſlope or plunge to have more than 2 inches for every foot in the height of the parapet, for fear of weakening too much the upper part of the parapet: thus, ſuppoſing the elevation of the parapet at AB, fig. 3, plate I. to be 6 feet, and that it has 6 feet alſo for thickneſs, the ſhot fired from behind ſuch a parapet with ſuch a ſuperior talus, will meet the ground at C, which is diſtant 12 yards from B, the ſpot the fire comes from. This proves, that at the exterior foot of every parapet, there is a ſpace, as CD, which cannot be defended by it; and this ſpace will evidently be the greater in proportion to the leſs ſlope of the ſuperior talus, and the greater height of the parapet.

From whence it follows, that in works which have no flanks, an enemy once paſſed the point where

where the direction of the ſuperior talus and the horizon meet, will be leſs expoſed as he approaches the parapet. This defect is an inſuperable objection to the uſe of works that have no flanks.

In proportion as the ſuperior talus has the greater or leſs ſlope, ſo the ſhelter againſt the direct fire will be the greater or leſs: the diſadvantages of the ſuperior talus having much ſlope, are, that it weakens the upper part of the parapet, and that the fire is more plunging. Mr. Vauban, by adding the glacis, not only diminiſhed the ſhelter againſt the direct fire, but obtained a more grazing fire.

The height of the parapet over the banquette not being ſufficient to cover the men in the act of firing, it is uſual for their ſecurity againſt the ſmall arms of the enemy *, to raiſe the interior part of the parapet with *ſacs a terre*, or ſacks made of ſtrong and coarſe cloth filled with earth. They are, in general, 2 feet in length, and 6 or 8 inches in diameter; and are placed in two rows one above another, with an interval between each in the lower row, ſufficient to receive the muzzle of the muſket: (ſee fig. 4, plate I.) this practice, though of conſiderable ſecurity againſt muſketry, will be of no ſervice againſt cannon, and in that caſe muſt be rather detrimental.

* This precaution might alſo ſerve to prevent the injuries to which flanked parts are liable, when the re-entring angle is not ſufficiently obtuſe. Formerly,

Formerly, the interior part of the parapet was often raiſed with ſmall gabions filled with earth, ſomewhat more than 1 foot in height, and in diameter 12 or 14 inches at the top, and only 9 or 11 inches at the bottom, fig. 5, Plate I. There is another ſort of gabion made uſe of to conſtruct batteries, much larger and higher, and of a cylindrical form. A gabion is a baſket open at both ends.

That the cannon may fire upon the enemy, it is uſual to cut openings in the parapet, called *embrazures*. The dimenſions of the embrazure depend, not only upon the nature of the ſoil, and the height and thickneſs of the parapet, but alſo on the caliber of the piece, the height of the wheels, and the conſtruction of the carriage.

The embrazure is cut ſloping towards the country, and within 3 feet of the horizon. The breadth of the embrazure within, is no more than is abſolutely neceſſary to receive the cannon; but that without, is from 7 to 9 feet. The confined breadth within, is given to keep under cover, as much as poſſible, both the piece and the men who ſerve it; and the extended breadth without, is given to obtain a wider view of the enemy in his approach.

The diſtance between two embrazures is from 12 to 18 feet from center to center, that that part of the parapet which ſeparates them, and is called *merlon*, may be ſufficient to reſiſt the enemy's cannon.

[In

[In plans drawn upon a ſmall ſcale, embrazures are repreſented by iſoſceles triangles, ſet off the diſtance from center to center between the embrazures, whoſe baſes turn towards the country. See *z*, fig. 1, 2, plate II.]

Cannon is ſometimes uſed without the help of embrazures, that is, the cannon is made to fire *en barbette*:* this, however, cannot be done, unleſs the carriage be ſo raiſed, as that the muzzle of the cannon ſhall be upon the ſuperior talus.

Becauſe the difficulty of forcing a parapet is the greater, as the exterior ſlope of it is the leſs; and becauſe the beſt and moſt adheſive earth cannot long ſupport itſelf at a height of 3 or 4 feet, unleſs formed with a ſlope of very gradual aſcent; it is uſual to force it to ſtand with a ſmall ſlope, by lining it with *ſods*, *faſcines*, *hurdles*, &c. The exterior ſlope of the parapet is called *ſcarp*, and is in general about the $\frac{1}{2}$ part of the height.

The interior part of the parapet is alſo lined, and even with more precaution than the ſcarp, with a view to obtain little ſlope, which is abſolutely neceſſary to enable the men within to ſtand and fire with eaſe: this ſlope, which, to be ad-

* So named by the French, becauſe the ball in its flight ſhaves the ſuperior talus of the parapet.

vantageous,

vantageous, ſhould be only about 1 foot, cannot, however, be leſs than 1 foot and $\frac{1}{2}$, when lined either with ſods or faſcines.

Of the Berme.

To prevent the earth of the parapet rolling into the ditch, a ſpace is generally left between the parapet and ditch, called *berme*. The breadth of it depends upon the nature of the ground, the dimenſions of the parapet, and the length of time for which the work is intended to remain.

Many conſider the berme to be advantageous to the enemy, ſuppoſing it rather to facilitate than retard the operation of forcing the parapet. This it certainly does, when the parapet has but little height and thickneſs; for the enemy once placed upon the berme, is upon an equal if not a ſuperior footing to the men within †. It is obſervable, however, that if there was no berme, a greater ſlope would be requiſite, not only for the ſcarp of the parapet, but alſo for that of the ditch.

† To ſupply this defect, M. De Saxe recommends the parapet to be of ſuch a height as that its ſcarp may have about 6 feet.

Of

Of the Ditch.

The trench dug up at the exterior foot of the parapet, is called *foſſé* or *ditch*. At the ſame time that it ſerves to furniſh the earth neceſſary for raiſing the parapet and banquette, it contributes to increaſe the difficulty of approach, which is deemed the greater, in proportion to the greater breadth and depth of the ditch. The dimenſions of it depend, however, not on choice, but on the dimenſions of the parapet and banquette: it's depth ſhould, if poſſible, never be leſs than 6 feet.

The ſlope neareſt to the parapet, is called *ſcarp*; and that oppoſite to the parapet, is called *counterſcarp*. The difficulty of the paſſage of the ditch, is greater, in proportion to the leſs ſlope both of the ſcarp and counterſcarp; but more particularly that of the ſcarp, and eſpecially when the ditch is of ſuch a breadth, as to force the enemy to leap into it to paſs it.

It is obſervable, that the ditch is generally cut or rounded off at the ſaliant angle of the counterſcarp, to prevent its being in that part eaſier of deſcent.

To determine the ſlope of earth, is, if not impoſſible, at leaſt exceedingly difficult; for it depends not only on the nature of the ſoil, which

is very various, but alſo on the height of the ſlope: when common earth is uſed, the baſe of the ſlope is generally recommended to be equal to the height; and when clay or loom is uſed, the baſe is taken equal to $\frac{2}{3}$ of the height.

That the direction of the ſlope of earth depends, not only on the nature of the ſoil, but alſo on the height of the ſlope, though of much conſequence, is however not generally underſtood.

If we ſuppoſe the particles of earth to have no adherence to each other, then the ſlope of earth muſt, like that of grain or ſand, have the ſame direction in every elevation: but, on the contrary, it is known, that the particles of earth are adheſive; and, conſequently, the earth will never require ſo much ſlope as it would do if deſtitute of adherence. Experience, indeed, proves, that earth ſupports itſelf for a while even without a ſlope, to a certain height, which, though but ſmall, is greater or leſs, according to the greater or leſs adherence of the particles, that is, according to the nature of the ſoil.

Now, if we ſuppoſe the tendency of diſunion (when deſtitute of adherence) to be in the direction of *a b*, fig. 3, plate I. and that the adherence of the triangle *a b c*, is barely competent to ſupport the earth; if the ditch is made twice as deep, it is evident, that the adherence of the triangle *c d e* will be only double the adherence of the triangle *a b c*, and that the weight of the triangle *c d e* will be quadruple that of *a b c*. If the ditch is made three times as deep, it is evident, that whilſt the adherence of the triangle *e f g* is only treble that of *a b c*, the weight of it will be nine times that of *a b c*; for figures are to each other in a duplicate ratio.

From

From whence we muſt neceſſarily conclude, that if in the firſt inſtance the adherence is barely competent to ſupport the earth, it cannot be ſo in the ſecond, and much leſs ſo in the third; that is, as is ſaid above, the direction of the ſlope of earth depends not only on the nature of the ſoil, but alſo on the height of the ſlope; and, conſequently, the ſlopes of the ditch muſt be greater, both according to the nature of the ſoil, and in proportion to the greater depth of the ditch.

From this it follows alſo, that the ſcarp of the ditch, when the parapet is to be raiſed immediately on the border of the ditch, muſt have a greater ſlope than when there is a berme; and further, that this ſcarp muſt have a greater ſlope, in proportion to the greater height of the parapet, and the leſs breadth of the berme. This proves, that the omiſſion of the berme will likely be productive of greater inconveniencies than the uſe of it.

Of the Glacis.

Becauſe the difficulty of the paſſage of the ditch increaſes according to its greater breadth and depth; many recommend raiſing the exterior borders of the ditch, one, two, or more feet above the horizon, in the form ABC: the direction of AB, is the continuation of that part of the exterior ſlope of the ditch below the horizon; and the direction BC, is generally the ſame with that of the ſuperior talus of the parapet. It is becauſe the ſlope BC is ſo great, that this work is called *glacis*.

The glacis, which is ſeldom added for the defence of very ſmall works, beſides increaſing the breadth and depth of the ditch, and diminiſhing the ſhelter againſt the direct fire, is particularly advantageous to works much expoſed to cannon; for it ſingularly ſecures the parapet; and the enemy is alſo ſingularly expoſed to the fire from behind the parapet, during his whole aſcent upon the glacis, and more eſpecially ſo at the inſtant when he endeavours to leap over or into the ditch.

REMARK.

This work was in much eſteem with Mr. Vauban, who introduced it to obtain a more grazing fire, and to diminiſh the ſhelter againſt the direct fire which every parapet neceſſarily affords, and that in proportion as it has the more height and the leſs ſlope.

Of the advanced or ſecond Ditch.

To increaſe the difficulty of approach, ſome recommend a ſecond ditch, which is in general ſo conſtructed as that its bottom may be in the prolongation of the glacis; that is, its greateſt depth is at the exterior ſide: hence the profile of it is a triangle.

Of

Of Paliſades and Fraizes.

As a ſecurity againſt ſurprizes, and to increaſe the defence, field works are ſometimes either *paliſaded* or *fraized*, and ſometimes both.

Of Paliſades.

Paliſades are ſtakes of ſtrong ſplit wood, of about 7 or 8 inches broad, 3 or 4 inches thick, and 8 or 9 feet long, of which 3 or 4 feet are ſunk into the earth. They are pointed both at the top and bottom; and that they may be of greater ſtrength, they are faſtened to a horizontal rail* within two feet from the top, and are generally placed ſo cloſe to each other, as only to admit the muzzle of a piece between them. Their greateſt diſtance from each other is never ſo great as to afford room enough to creep through them.

Paliſades are planted either *vertically* or *obliquely*: the oblique poſition is generally deemed the moſt advantageous, becauſe the paliſade cannot

* When ſome of the paliſades are only of ſufficient length to allow 3 or 4 feet to be ſunk into the earth, to ſtrengthen the whole range, it will be neceſſary to faſten them to two horizontal rails, one at the top and one at the bottom. The rail or rails are always oppoſite to the ſide of the enemy.

ſo

ſo eaſily be cut at the bottom, nor torn up with ropes. The poſition, however, depends more upon circumſtances than choice.

Paliſades fixed at a certain diſtance from the parapet, as at Y, to obtain the additional ſecurity againſt *hand grenades* *, ſhould be planted obliquely, ſo as to form an angle of 45 degrees with the country towards the enemy: this poſition will greatly increaſe the difficulty of cutting them, or tearing them up with ropes, if not render it impoſſible; they will be the leaſt expoſed to the enemy's cannon; and the difficulty of paſſing over them will not be leſs than if they were upright, unleſs many faſcines were at hand to place under them. The diſtance at which hand-grenades can be thrown, is from 25 to 30 yards.

But this practice of fixing paliſades is not generally approved, not only becauſe the paliſades, notwithſtanding their oblique poſition, are ſtill much expoſed to the enemy's cannon; but becauſe, when once they are forced, the enemy is at full liberty to advance in ſtrength, deſcend into the ditch, and attack the parapet in

* The hand-grenade, which is a hollow ball or ſhell, generally of iron, but ſometimes of tin, and *papier maché* of about 2½ inches in diameter; was firſt uſed in 1594, at the ſiege of Wachtendonche, a town near Gueldres. It is filled with very fine powder, and ſet on fire by means of a ſmall fuze driven into the fuze hole.

whatever part he likes beſt, which is ſingularly advantageous to him, eſpecially in works that have no flanks.

Paliſades fixed in the ditch juſt at the lower extremity of the counterſcarp, as at Z, ſhould be planted upright; for the difficulty of cutting them will be as great in this inſtance, as when planted obliquely, and that of paſſing over them much greater.

Paliſades fixed in the ditch as at X, fig. 3, plate I. ſhould be planted upright alſo. In this inſtance, however, they can be more eaſily cut than thoſe planted at Y or Z.

Paliſades fixed at the lower extremity of the ſcarp, as at W, fig. 6, plate I. generally form an angle of 60 degrees with the ground towards the enemy.

Paliſades fixed upon the berme, are generally planted obliquely: in this ſituation, however great their obliquity may be, unleſs the berme be much lower or the glacis much raiſed, the paliſades muſt be much expoſed to the enemy's cannon.

[In plans, paliſades are repreſented by dots or points.]

REMARK.

The generality of engineers are for fixing the paliſades into the ditch, in preference to any

other place, not only becauſe they are not expoſed to the enemy's cannon, but becauſe it ſurpriſes and obliges the enemy to ſtop at the very inſtant that he is moſt expoſed to the fire from behind the parapet. The top of the paliſades, whether planted upright or obliquely, ſhould never riſe above the exterior border of the ditch.

Paliſades planted in the ditch, may, however, ſerve as props to receive hurdles, over which the paſſage of the ditch may be eaſily made.

Of Fraizes.

Paliſades fixed in the parapet, are called *fraizes*. When the ſtakes are 9 feet long, 4 feet lie within the body of the parapet, and the remainder leans over the berme, rather inclining a little towards the ditch: this inclination is given to prevent grenades, &c. lodging upon them.

To ſtrengthen the fraize, the ſtakes are faſtened to two ſleepers, one of which lies upon the level ground, in the direction of the exterior part of the parapet; and the other, which is generally a ſtronger rail, lies within the body of the parapet, and diſtant from the firſt rail 3 feet: the ſtakes are ſufficiently cloſe to each other, when they

they do not afford room enough to creep through them.

The fraize, eſpecially when not expoſed to the enemy's cannon, is a great ſecurity to the parapet, as there is no forcing them but by cutting them, which cannot be eaſily done, even when the works have no flanks *, conſidering the poſition of the ſtakes, and the deſtruction which hand-grenades thrown from behind the parapet muſt neceſſarily make among the men employed in ſuch an operation.

REMARK.

The uſe of paliſades planted vertically, obliquely, and horizontally, to fortify the avenues of open forts, the bottom of ditches, parapets, &c. was antient even in antient times. It muſt, however, be confeſſed, that their conſtruction requires much time and attention, and is very expenſive unleſs in countries abounding with wood.

Of Cheveaux de Frize.

Cheveaux de Frize are ſo called by the French, from being firſt made uſe of in 1658, at the ſiege

* The fraize in the faces of works which have flanks, are apt to cover the men againſt the fire of the flanks.

of

of Groningen, a town of Friesland, to secure the avenues of the camp against the inroads of cavalry.

It consists of a piece of timber 10 or 12 feet long, and is either round, square, or cut into several more faces, through which a great many wooden pins are driven, of about 1 inch and $\frac{1}{2}$ in diameter, and 6 feet long, pointed at both ends, and often armed with iron †.

The most common use of the cheveaux de frize is to shut up and secure the entrance of the several works; but, like the palisade, it is deemed of most service when employed for the defence of the ditch, in which case cheveaux de frize are placed at the bottom of the ditch in a row, and fastened together with chains or cramp irons, (See B, fig. 8, plate I.)

[In plans, chevaux de frize are represented by a line expressing their length, through which lines cross each other, forming angles of 60 degrees each.]

† The Russians under Munich, and the Germans in their several wars against the Turks, were much indebted to the use of cheveaux de frize, for their security against the Turkish cavalry. The cheveaux de frize, during the latter campaigns of the Germans against the Turks, is said to have consisted only of a wooden pole of about 1 inch and $\frac{1}{2}$ in diameter, and 9 feet long, pointed and armed with iron at both ends. When required, it was sunk obliquely about 3 feet in the earth. At other times, it may serve for tent poles. What is become of this practice?

REMARK.

REMARK.

The practice of placing cheveaux de frize at the bottom of the ditch, was in much esteem during the wars in Germany of 1745 and 1756: M. De Saxe is for placing them on the berme.

Cheveaux de frize placed at the bottom of the ditch may, however, serve as a prop to receive hurdles, over which the enemy may cross the ditch.

Of Trous-de-loup.

Trous-de-loup are pitfalls in the form of an inverted cone, about 6 feet in diameter, and at least as much in depth, with one or more pointed stakes fixed at the bottom *. They serve to increase the difficulty of approach, and are mostly dug at some distance from the works, and sometimes also at the bottom of the ditch. See fig. 1 and 7, plate I.

When trous-de-loup are dug without the ditch, they are generally in 3 rows, chequer wise, that is, two of the rows are quite opposite to each other, and the third in the middle covers the interval of the other two. The distance between the first row and the ditch is about 5 or 6 paces,

* *Crow-feet* may be used in the place of stakes: crow-feet are four pointed irons, so made that whatever way they fall, one point is always uppermost. They are from 4 to 8 inches long.

and

and the earth dug out is ſpread looſe about them, and is ſometimes employed to raiſe the glacis.

When dug in the ditch they generally form but a ſingle row. They are deemed advantageous only in proportion to their greater depth, and their cloſeneſs to each other.

REMARK.

Theſe pitfalls, in the form of their conſtruction, have ſome reſemblance to the wolf-trap, from which they take their name; and, like that alſo, are lightly covered with large twigs, brambles, briars, and looſe earth, to conceal the place of their ſituation, and produce in the enemy all the terror and diſmay that ſudden plunges into danger never fail to excite.

Of the Abbatis.

An *Abbatis* is a defence raiſed before a redout, or other field work, to impede the enemy's approach. It conſiſts of hewn trees with the points of their branches turned towards the enemy; and to increaſe the danger and difficulty of forcing it, the trees are not only placed cloſe to each other, but the branches are ſtript of their leaves and twigs, ſharpened at the extremities, and interwoven one in another.

To prevent the enemy from forcing them aſunder to open himſelf a paſſage, the trunks of the

the trees are generally ſunk 3 or 4 feet into the earth *; and the principal branches that lie on the ground are faſtened down by ſtakes: trees of the middle ſize, and eſpecially fruit trees, are deemed moſt proper for forming an abbatis. When the trees in the neighbourhood happen to be very large, the larger branches will anſwer the purpoſe full as well as the trunks.

Fig. 1, plate I. repreſents the plan of an abbatis, *without expreſſing the earth dug out of the trench to receive the trunks.*

Fig. 8, plate I. repreſents its profile.

REMARK.

The abbatis is a defence univerſally known, and was probably one of the firſt in uſe, being mentioned by Herodotus, Thucydides, Xenophon, Polybius, and other ancient writers.

Mr. Folard conſiders the abbatis not only as the moſt formidable obſtacle to the approach of an enemy towards any work, but deems it of

* To receive the trunks, a trench is dug, in which the greater depth is towards the work; the profile of it is a triangle. The earth dug up is thrown towards the work; and when the trees are placed, it is generally made uſe of to fill the intervals between the trunks, and is alſo thrown over them in order to increaſe their ſolidity.

itſelf

itſelf a ſufficient fortification to ſecure a paſs or poſt. The earth taken out of the trench, if properly employed, may ſerve to cover the men.

Of Fougaſſes.

Mines that have for line of leaſt reſiſtance* leſs than 10 feet, are called *fougaſſes*. They are of the greateſt utility for the defence of the ſaliant angles and faces of works that have no flanks, and they require but little time for their conſtruction.

Mr. Santa Cruz conſiders fougaſſes to be as great an obſtacle as any that can be made uſe of to impede approach, on account of the dread with which their effects are known to impreſs the mind. Nothing diſconcerts and depreſſes men more, than to encounter danger againſt which they think neither their dexterity nor courage can afford them any ſecurity.

Of Inundations.

Among the ſeveral obſtacles to impede approach, that obtained by water is far from being deemed the leaſt advantageous: inundations, however, require much time and many precautions.

* *The line of leaſt reſiſtance* is the line drawn from the center of the place where the powder is lodged, perpendicular to the neareſt ſurface of the ground.

REMARK.

REMARK.

The uſe of paliſades, trous-de-loup, fougaſſes, and other obſtacles invented to impede approach, depend much upon the nature of the attack to which a work is expoſed. The two methods of attacking field works are with cannon, and with *ſword in hand:* when expoſed to the attack of cannon, the ſecurity of the poſt will depend much on the greater thickneſs of the parapet; and when expoſed to the attack with *ſword in hand*, the ſecurity will depend on the greater breadth and depth of the ditch, and the application of one or more of the invented obſtacles above mentioned.

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