Castles, Cannons, Casemates
An historical survey of the fundamental change of military architecture in the 15th and 16th centuries

V. SCHMIDTCHEN

Summary

The discovery and further development of fire-arms in the 14th to 16th centuries influenced the social, economic and politic conditions of that period in an equally important fashion as the conventional and nuclear armament race between East and West does today. Among other elements, military architecture is one of the major subjects of interest when considering the transition phase between Middle Ages and Modern Times.

The evolution from the first heavy "bombards" of the 14th century to the quite well organized siege-artillery of the 16th century caused fundamental changes within the sphere of fortification works. Most of the walls and towers of medieval castles and the defences of medieval fortified towns no longer were a match for the new and powerful fire-arms of the bombard-type, used by besiegers.

The different types of medieval fortifications only had to face the medieval arsenal of mechanically operated engines of war such as battering-rams and stone-throwing catapults and trebuchets. The projectiles "fired" by these various types of stone-throwing devices hit the walls and towers of the strongholds after a high-angle trajectory, whereas those fired by a heavy piece of ordnance - and until 1450 these too only used stone balls for ammunition - reached their target on a nearly flat trajectory, provided the target lay within a suitable range of 300 to 500 meter. The balls fired by cannon struck the objective at approximately right angles and with a considerably higher power of penetration.

In the 14th to 16th centuries, successful sieges all over Europe made it clear that this new type of military threat necessitated a reaction in the field of defensive architecture. The possibility to withstand this menace depended on several factors, among them the topographical location of the stronghold, capital, workers, materials and - most important - the skill of the engineers responsible for the work. Only a few castles could be reinforced in a suitable way, but most of the fortified towns were able to undertake an extensive remodelling of their defenses. The basic need was to strengthen the walls and towers against the increased striking and penetration capacity of the cannon-balls and to obtain larger spaces on top of the defences to assemble one's own batteries.

We have to distinguish two phases. The first saw the remodelling of the medieval defences, the second the construction of bastioned fortifications with earthwork-enbankments and ditches. All this resulted in a succession of various historical types of bastioned fortresses (e.g. Old-and New-Italian, Old and New-Dutch ; etc., including the various later modifications by Coehoorn, Rimpler, Vauban, Montalembert, etc)., until the effective New Prussian ring fortresses of the 19th century appeared. This ultimately led to the culminating point represented by the 20th century Maginot Line and Atlantic Wall.

Résumé

La découverte et le développement des armes à feux du 14e au 16e siècle ont influencé le contexte social, économique et politique de cette période d'une façon tout aussi profonde que ne le fait de nos jours la course aux armements conventionnel et nucléaire entre les pays de l'Est et l'Occident. L'architecture militaire constitue un des thèmes de recherche majeurs de la période de transition du Moyen Age aux Temps Modernes.

L'évolution des premières bombardes lourdes du 14e siècle à l'artillerie de siège bien organisée du 16e siècle a entraîné des changements fondamentaux dans le domaine de la fortification. La plupart des murs, des tours des châteaux médiévaux et des défenses des villes fortifiées médiévales ne constituaient plus un obstacle sérieux pour les nouvelles et puissantes armes à feux du type de la bombarde, utilisées par les assiégeants.

Les différents types de fortifications médiévales ne devaient faire face qu'à l'arsenal des engins de guerre mécaniques tels que les béliers, les catapultes et les trébuchets. Les projectiles de pierre lancés par ces différents engins frappaient les murs et les tours des places fortes à la fin d'une trajectoire haute, tandis que ceux tirés par une pièce d'artillerie lourde - qui jusqu'en 1450 utilisait aussi exclusivement des boulets de pierre en guise de munition-arrivaient au but après une trajectoire presque plane, dans le cas où l'objectif se situait à une portée valable de 300 à 500 mètres. Les boulets tirés par le canon frappaient l'objectif sous un angle presque droit et possédaient une force de pénétration sensiblement plus élevée.

Du 14e au 16e siècle, une série de sièges réussis à travers l'Europe démontrait que ce nouveau type de menace militaire nécessitait une adaptation de l'architecture défensive. La possibilité de résister à cette menace dépendait de facteurs tels que la position topographique de la place forte, le capital disponible, les ouvriers, les matériaux et - plus important - la compétence des ingénieurs responsables des travaux. Seuls quelques rares châteaux pouvaient être renforcés de façon adéquate, mais la plupart des villes fortifiées étaient en mesure d'entreprendre une réorganisation extensive de leurs défenses. La première mesure était de renforcer murs et tours contre la force d'impact et de pénétration accrue des boulets de canon et d'élargir l'espace disponible au sommet des défenses afin de pouvoir y assembler des batteries.

Cette réorganisation se fit en deux phases : la première voyait la réorganisation des défenses médiévales, la seconde la construction de fortifications à bastions avec levées de terre et fossés. Tout ceci menait à une succession de différents types historiques de places fortes à bastions (ex : le Vieux et le Nouvel Italien, le Vieux et le Nouvel Hollandais, etc., y compris les différentes modifications ultérieures apportées par Coehoorn, Riompler, Vauban, Montalembert et d'autres), jusqu'à l'apparition - au 19e s. - du système des cercles de places fortes du nouveau style prussien. Ceci aboutit enfin au point culminant, représenté au 20e s. par la Ligne Maginot et le Mur de l'Atlantique.

In the first half of the 14th century, a sound never heard before marked the end of a European era which we commonly call the Middle Ages. This sound was the report of the first fire-arms such as hand-guns and cannons. As happened in all previous periods of the history of mankind, a number of inventions within the sphere of military technology and their further development contributed to bringing that phase to an end and heralded a new era : the Modern Times. The rise of fire-arms, their multiple uses in military action (sieges and battles) and their continuous improvement have marked those 200 years of transition between the Middle Ages and Modern Times (1350-1550) over and above purely military matters.

Apart from the close links with political aspects and situations which military inventions and the development of military technology always have, they also had consequences on the level of social and economic conditions. During the above-mentioned transition period, the technical progress reflected by the development of fire-arms did not only lead to a complete change of opinion on strategy and tactical formations : it also resulted in an expanding market for the raw materials needed for the production and for the use of these new weapons (iron to forge the guns; copper and thin to cast them; salpetre, charcoal and sulphur; brimstone to make the gunpowder).

Because of continual experimentation, the skills needed for the production of guns progressed steadily. This continu technological progress and the experience it brought with it entailed the necessity of a division of labour and hence also of a certain degree of specialisation. So on the one hand, some "experts" advanced from the status of simple craftsmen - blacksmiths or casters - to that of manufacturers of what were not only the most modern but even the ultimate weapons of the time. Such men were courted by kings and emperors and were richly recompensed.

On the other hand, many formerly independant craftsmen lost their status and became dependent workers. Through this division of labour, the manufacturing process became more efficient, but the workers themselves normally had to concentrate only on one or two parts of the whole process, and

with that "specialisation", they lost a lot of their former qualification. As they were concerned with mostly simple and thus easily taught details of the process, the workers of a gun-foundry, a forge or a gunpowder-mill quickly became interchangeable.

Similarly, we have to consider the question of armament from more than one angle. The armament race to achieve military superiority - required to promote one's own political aims - is not an invention of our times. A lot of money has always been needed to achieve the striking capacity necessary to forge ahead with one's own plans. From this point of view, it is hardly surprising that most of the knights - the formerly much admired military professionals, heroes of the crusades and idols of legendary tales - lost their importance as dreaded feudal warriors, being the representatives of the medieval art of warfare. They usually depended on the agrarian produce and income of their feudal tenures. With the late medieval economic crisis in Europe, they quite literally lost the ground under their feet. This economic decline was, however, but the first step on the way down : it was soon followed by relinquishing the ideals of knighthood, by taking service as mercenaries in the so-called free companies in France and Italy, or by becoming robber barons.

Some, however, understood that within the framework of the noticeable decline of medieval European society - the so-called "Autumn of the Middle Ages" (Huizinga) - they had a chance as service-men to the powerful sovereigns of the rising territorial states or as captains of the yeomanry of the big and rich cities, which derived their political importance from their economic power (e.g. trade, or as sovereign rulers of territorial states with feudal rights on the exploitation of natural resources, such as silver and copper mining, minting, etc...).

There are many instances of the numerous and diverse consequences of the rise and development of fire-arms, but in the following part of the present contribution, I will consider only one particular aspect of the subject : the reaction in the field of defensive architecture to the new type of military threat created by the fire-arms.

During the last decades of the 14th century, the situation in any given military conflict including sieges of castles or fortified towns changed completely. Those were the days when the besieger for the first time had the possibility to bring into action heavy guns : the so-called bombards, wrought-iron cannons of fairly enormous dimensions, capable of

firing stone balls with a weight of 100 to 700 lbs. From one day to the next, most of the existing fortified places - which had been built to face nothing more than the battering-ram or the impact of projectiles from medieval stone-throwing devices (catapults, trebuchets) - became no match for these bombards. The various types of medieval stone-throwing engines of war slinged the projectiles (stones) in a high-angle trajectory. In contrast, the stone-balls - till 1450 stones were the only type of ammunition, used also by the heavy guns - fired by bombards reached targets within a suitable range (from 300 to 500 meters) on a nearly flat trajectory. These balls struck the walls, towers or gates of the fortification at approximately right angles and with considerably higher penetration power. A direct hit from a bombard not only had the advantage of a better point of impact (the projectile hitting the wall at right angles); it also had the greater power of a missile put on trajectory not by mechanical tension or torsion but by the controlled explosion of gunpowder within the canon.

In the 15th century, a number of successful sieges throughout Europe made it clear that the defenders simply had to devise new ways to strenghten their protection against this new type of military action. The most striking proof of that was the fall of Constantinople on May 29th, 1453 : it resulted from the cannonade the town was subjected to by the huge Turkish bombards, which were now cast in bronze. To the minds of all military experts of the time, Constantinople - with its 12 meter high and 5 meter thick walls - was reputed to be the strongest fortress in the world. So one can easily imagine how shocked the West was when the news was heard.

Meanwhile, technological development went on, leading to better guns and to a new type of ammunition, the iron ball. The major disadvantage of the stone-firing heavy bombards which constituted the early siege artillery of the 14th and 15th centuries was their lack of mobility. Transporting these guns was not, however, the only problem. To get them into a correct firing position in front of a besieged stronghold, these bombards had to be placed on the ground and anchored there by means of a bracing system of wooden beams in order to absorb the recoil. Therefore, these bombards always were subject to the threat of a quick sally by the besieged.

In the first half of the 16th century, the master-gunners realized that iron has nearly three times the specific gravity of stone. So smaller-sized cannons intended to fire iron balls could be forged in iron or cast in bronze while still maintaining the same striking power or even augmenting it. Moreover, such cannons could be mounted on a wheeled gun-

carriage which improved their mobility. The iron ball offered an additional advantage : it now became possible to forge or cast large numbers of such projectiles to standard sizes; it thus also became possible to build up a sufficient stock of ammunition for cannon of the same calibre.

The possibility to withstand this new menace depended on several factors, among them the topographical position of the stronghold, capital, workers, materials and the skill of the engineers supervising the work. On the Continent, only a few of the castles could be reinforced in an adequate way. Nearly all those located on a plain lost their military significance, even if they had a moat; indeed, such a moat might impede a battering-ram, but it did not provide any protection against gun-projectiles.

Until the late 16th century, only those castles located on top of a hill or in a mountain area (mountain forts) and reinforced with additional defenses could still serve as strongholds (e.g. the Hohkönigsburg in the Vosges region). Most of the fortified towns, however, were able to undertake extensive remodelling of their circumvallation. The first requirement was to consolidate the weaker points of the defenses, such as the walls, the gates and even some of the towers. But when trying to assess the effort which smaller towns and bigger cities made to withstand the threat of the powerful guns of possible besiegers, we should also take into account a few other important factors, such as the number of fighting men available for the defense of the walls and the morale of the citizens.

The inhabitants had a duty to engage themselves in keeping up the urban defenses in peacetime and - in case of war - to serve either on the fortifications or as members of the urban levy present on the battlefield. Morale depended on the degree of conviction that defense was necessary. There is a difference between the strict loyalty of the attendants of the noble Lord of a castle on the one hand and the often strongly diverging interests of the members of an urban community on the other. Thus, it could occur that the majority of the citizens felt surrender to be the best protection against the possibly quite bad consequences of a siege.

Numerous municipal authorities therefore tried to reinforce the defenses of the town in such a way that the latter negative attitude did not get a chance to develop. This means that they spent enormous efforts to strengthen their

fortifications, with the intent both of deterring the possible aggressor and of averting the not unimaginable situation of an internal discussion on surrender. Looking at the 15th and 16th century town defenses, we have to distinguish two phases. The first is that of the remodelling of the existing medieval defenses; the second is that of the building of bastioned fortifications with earthwork-embankments and with dry or fordable or floodable ditches. The aim was to improve the resistance capacity of the defenses while at the same time gaining space on top of the fortifications in order to be able to assemble one's own guns.

In the absence of a better technical solution, the first step was to make the walls thicker and the towers stronger. Thus for instance, Robert de la Marche decided to build 6 meter thick walls at Hasbain Castle; so did the architects who constructed the angle turrets of the Naples Castle; the Count of St. Pol ordered a keep with 10 meter thick walls to be build at Ham Castle, etc.

A more progressive solution was linked with reinforcing the medieval defenses. Earthwork-embankments were raised against the inner or the outer side of the walls. As a result, the top of the defenses grew broader and - after the former (often wooden) wall passages had been removed - it provided enough room to assemble one's own garrison-batteries. The architects first thought that an embankment put up against the inner side of the wall provided additional protection, such earthworks possibly becoming an obstacle when and if the besiegers' artillery breached the wall. Throughout the 15th century, however, practical experience in fact demonstrated that when the wall was breached, the inner embankment tumbled into the breach thus providing an easy way of ascent for the assaulting troops.

Therefore, the architects engaged in reinforcing town defenses - where, in contrast to most castles, they had more room ro build up new fortification elements - preferred embankments raised against the <u>outer</u> side of the walls, at the frontage subject to attack. This type of earthwork-embankment really provided additional protection against the besieging artillery, because the earth absorbed the kinetic energy of the projectiles and reduced their penetration capacity to practically zero. Under those circumstances, breaching the walls became nearly impossible.

Another possible way to arrive at reinforcing medieval defenses was to incorporate existing "fausse-brayes" or "shot-traps". Medieval town defenses as well as a few castles had a barbican consisting of the space between the lower fausse-braye and the higher shell-keep. In the Middle Ages, this space often was used as a bear-pit. It was not all too difficult to reinforce this defense system : one simply dug a deep ditch immediately in front of the fausse-braye and filled in the barbican with the spill which had thus become available. This provided not only a better protection for the old circular wall but also a suitable platform for one's own guns. If a fausse-braye did not exist, such a rampart had to be constructed. In that case, an additional ditch generally separated this rempart from the circular wall. The fausse-braye ran parallel to the latter, jutting out at the gates where it formed a kind of bulwark. Such bastion-like bulwarks then made flanking fire possible.

Ditches played a role which gradually and continuously grew more important. This was particularly true in the case of the urban defenses. They constituted obstacles which the besiegers had to take seriously, especially when those moats had the additional protection offered by a kind of casemates with embrasures, located between the above-mentioned bulwarks and the gates in the circular wall. Such casemates not only provided a covered passage-way for the defenders if the latter wanted to reach the outer defenses safely : as flanking units armed with a few light guns, they also made it possible to enfilade the moat from both sides. In the 16th century, such flanking units were constructed in the form of so-called caponiers, even if a passage-way was not required. During that period, they developped into an improved component of the different systems of fortification works typical of the Modern Times.

The besiegers first had to eliminate these caponiers before they could try and assault the main ramparts. Thus, the defenders gained additional time to take their own precautionary measures.

In spite of all the rebuilding and reinforcing of the existing fortifications, however, the basic structure of medieval military architecture - with its main components of moat, wall and towers - essentially remained the same throughout the 15th century. Using fausse-brayes and bulwarks, one did succeed in creating a line of defense in front of the main defenses, but the still visible high towers and circular wall - which remained vulnerable to the besiegers' artillery precisely because of their height - now became the weaker points of the stronghold.

In contrast to what happened in Italy and in France, the architects working in the Holy Roman Empire did not want to abandon the old defensive principle of the superelevation. Only through reducing the height of the towers and walls when constructing new defenses in front of the stronghold could the defenders hide the main defensive components from the sight of the besiegers and therefore also from their artillery.

From the medieval castle and urban defenses to the 16th century bastioned fortress and ranging over the different types of design such as Old and New-Italian and Old and New Dutch (including the various modifications), the whole evolution of military architecture was no more than a step-by-step process which closely followed the development of the guns, from the first heavy bombards of the 14th century to the siege artillery as an autonomous military branch in the 16th century.

This slow development is explained by the fact that all the efforts spent in planning and constructing new fortifications basically were nothing more than reactions to the successive new threats presented by a succession of new and better guns. In this respect, we should not forget that the art of printing was invented around the middle of the 15th century : before that time, a broad and widely spread transfer of knowledge was impossible. The diffusion of new ideas and of new solutions to commonly experienced problems always and at all times depends on the nature and quality of the information media. If suitable ones are not available, diffusion is bound to be poor. So it understandable that the first book on the art of fortification was not published before the mid-16th century. Before, ideas and inventions were communicated from father to son, from master to student.

As a result, the first phase of modern fortification work was characterized by the well concealed and private knowledge of a few famous architects such as Leonardo da Vinci, Francesco di Giorgio Martini, Alphonso Adriano, Carlo Theti, Francesco Marchi, Michele Sanmicheli, Niccolo Tartaglia, Bonaiuto Lorini, the Pasqualini brothers, Daniel Speckle and others. The newly built forteresses made this know-how more common and this explains why for nearly a century, we can only identify some modifications, realized on the basis of attempts at copying the visible and recognizable design of the existing strongholds. Even those major 17th century architects and engineers such as Coehoorn and Vauban only added a few new details to the existing system of defense, without, however, really changing the structural components. Real qualitative progress

cannot be pointed out before the end of the 18th or the early 19th century, when the effective so-called "New Prussian ring fortress" with its detached forts came into being. This structurally new type of fortification was not only the result of the unavoidable architectural reaction to the highly developped modern artillery with its new types of cannon and shells; nor did it evolve only as the result of the appearance of new materials such as steel and later also concrete, used for the construction of the new forts. It also resulted from other new principles of warfare, which took into account the wider range of the guns and applied new notions such as spaces under fire-cover and camouflage. The culminating point of this development-being at the same time a step backward - was eventually reached in our times with the Maginot-Line and the Atlantic Wall.

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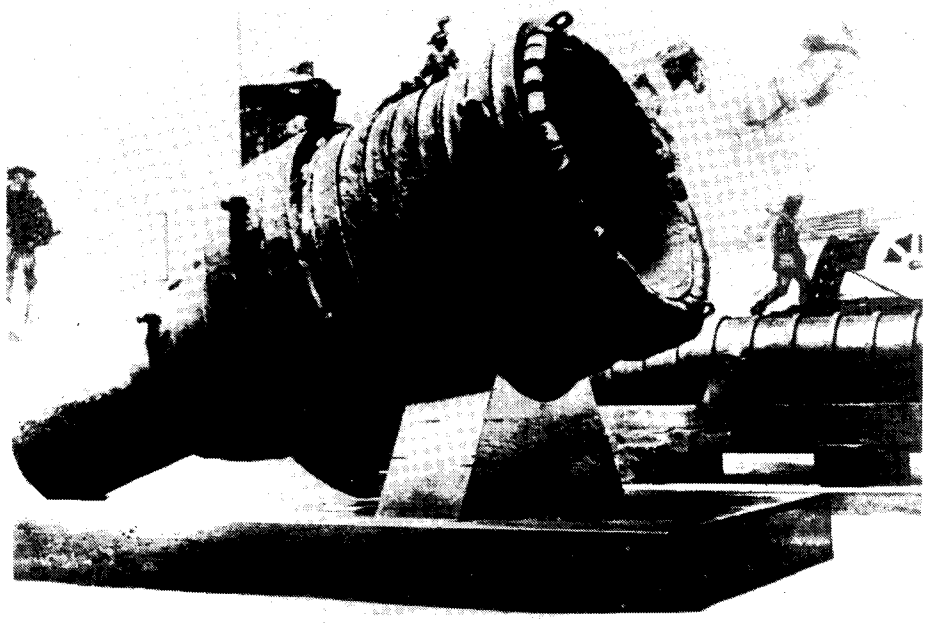

FIGURE 1

The "Pumhart von Steyr" 15th century. Giant stonethrowing bombard. The stone projectile had a diameter of 80 cm (Heeresgeschichtliches Museum, Vienna).
Le "Pumhart von Steyr" 15ème siècle. Bombarde géante à boulets en pierre. Le diamètre du projectile mesurait près de 80 cm. (Heeresgeschichtliches Museum, Vienne).

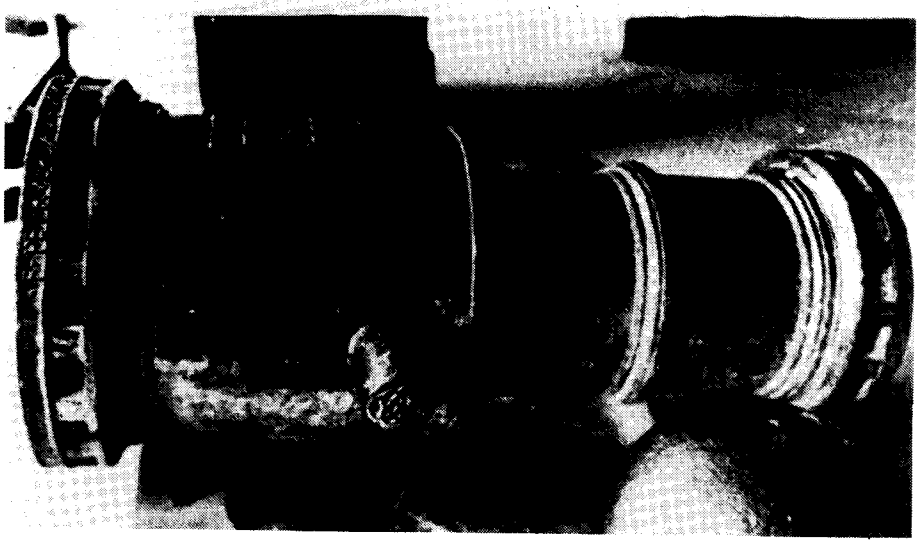

FIGURE 2

Bronze stone-throwing mortar. The order of the Knights of Saint John, Rhodos. Ca. 1480. Measurements: total length: 190 cm; length of the chamber: 80 cm; diameter of the cannonball: 45 cm; weight of the cannonball: 124 kg.
Mortier en bronze à boulets en pierre appartenant à l'ordre des Chevaliers de Saint-Jean, Rhodes. Ca. 1480. Dimensions: longueur totale: 190 cm; longueur de la chambre: 80 cm; diamètre du boulet: 45 cm; poids du boulet: 124 kilos.

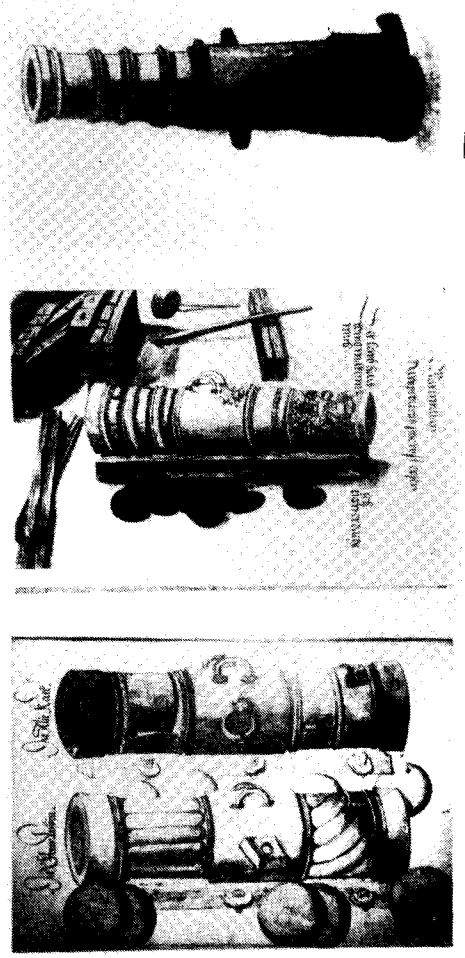

FIGURE 3

Top: bronze cannon with tapering barrel, end of the 15th century (CIM 222). Middle: cannon called "Der Löwe" (The Lion), belonging to Emperor Maximilian I; cast ears and decoration (Cpy 10.854). Bottom: heavy bronze cast siege guns, part of the artillery belonging to Emperor Maximilian I (CIM 222).
En haut: canon en bronze avec tube rétrécissant, fin du 15ème siècle (CIM 222). Milieu: canon appelé "Der Löwe" (Le Lion), appartenant à l'Empereur Maximilien I; anses et décorations fondues (Cpy 10.854). En bas: lourds canons de siège en bronze, faisant partie de l'artillerie appartenant à l'Empereur Maximilien I (CIM 222).

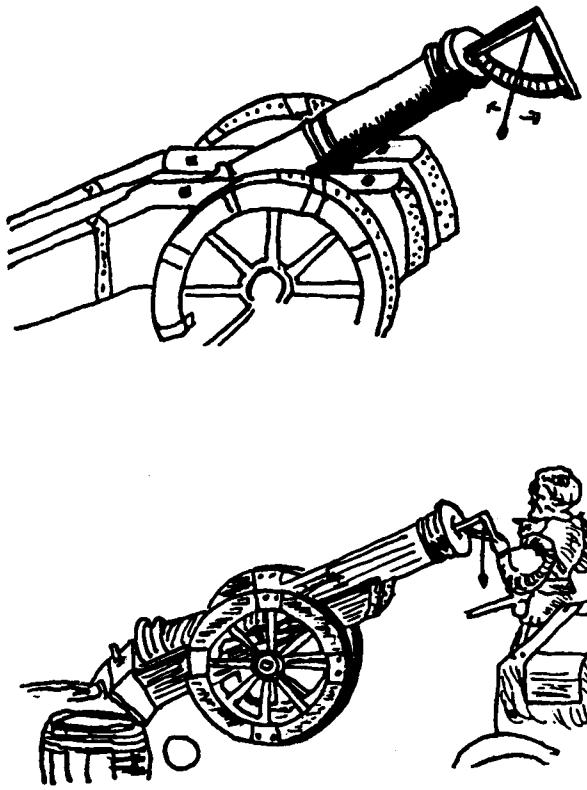

FIGURE 4

Top: canon with quadrant, used to measure the elevation of the gun (drawn after an example in I.V. Hogg, A History of Artillery, *London, 1974). Bottom: gunmaster measuring the elevation of the barrel by means of a double quadrant (drawn after an example given by Ryff, 1574; see F. Klemme,* Technik. Eine Geschichte ihrer Probleme, *München, 1954).*
En haut: élévation avec quadrant, utilisé pour mesurer l'élévation du tube (dessin d'après un exemple donné dans I.V. Hogg, A History of Artillery. *London, 1974). En bas: maître d'armes mesurant l'élévation du tube à l'aide d'un quadrant double (dessin d'après un exemple donné par Ryff, 1574; cf. F. Klemm,* Technik. Eine Geschichte ihrer Probleme. *München, 1954).*

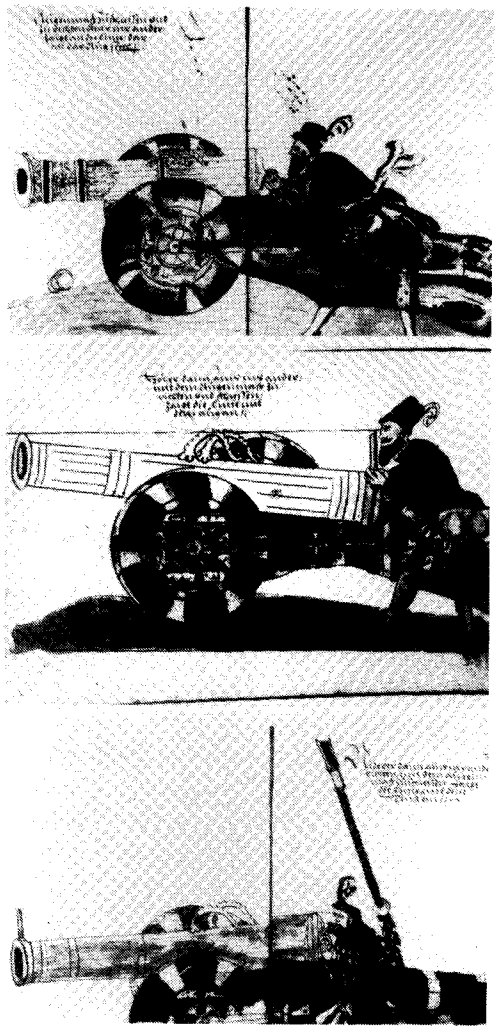

FIGURE 5

Top: aiming a cannon for a direct shot at a nearby objective; the gunmaster aims by looking along the highest points of the barrel (at the gummouth and at the back of the gun) (Cpy 10.952). Middle: aiming at a distant objective by means of a handspike (Cpy 10.952). Bottom: aiming a cannon at an objective which lies lower; the gunmaster uses a spike at the gunmouth and holds a loading stick (Cpy 10.952).
En haut: pointer un canon pour un coup direct contre un objectif proche; le canonnier vise le long des points les plus élevés du tube (a l'embouchure et à l'arrière du canon (Cpy 10.952). Milieu: pointer contre un objectif éloigné à l'aide d'une règle à main (Cpy 10.952). En bas: pointer contre un objectif situé plus bas; le canonnier utilise une règle montée sur le tube à l'embouchure du canon et tient un chargeur à la main (Cpy 10.952).

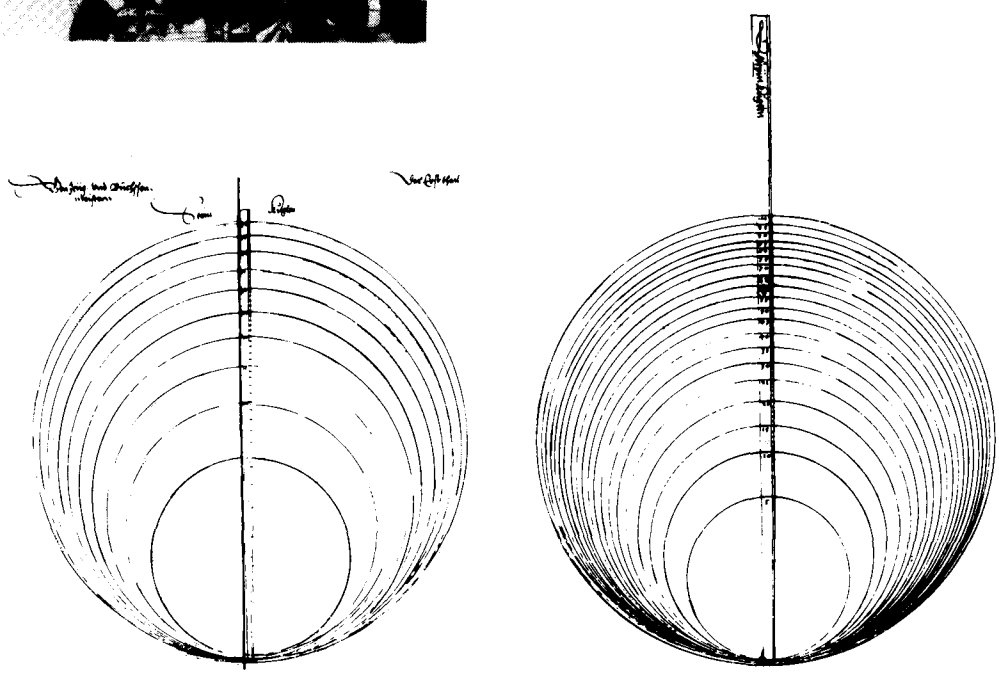

FIGURE 6

Stone (left) and lead cannon balls (right) drawn at the same scale in an artillery manual written about 1570 by Leonhart Fronsperger (Cpy 10.866).
Boulets en pierre (à gauche) et en plomb (à droite), dessinés à une même échelle dans un manuel d'artillerie rédigé vers 1570 par Leonhart Fronsperger (Cpy 10.866).

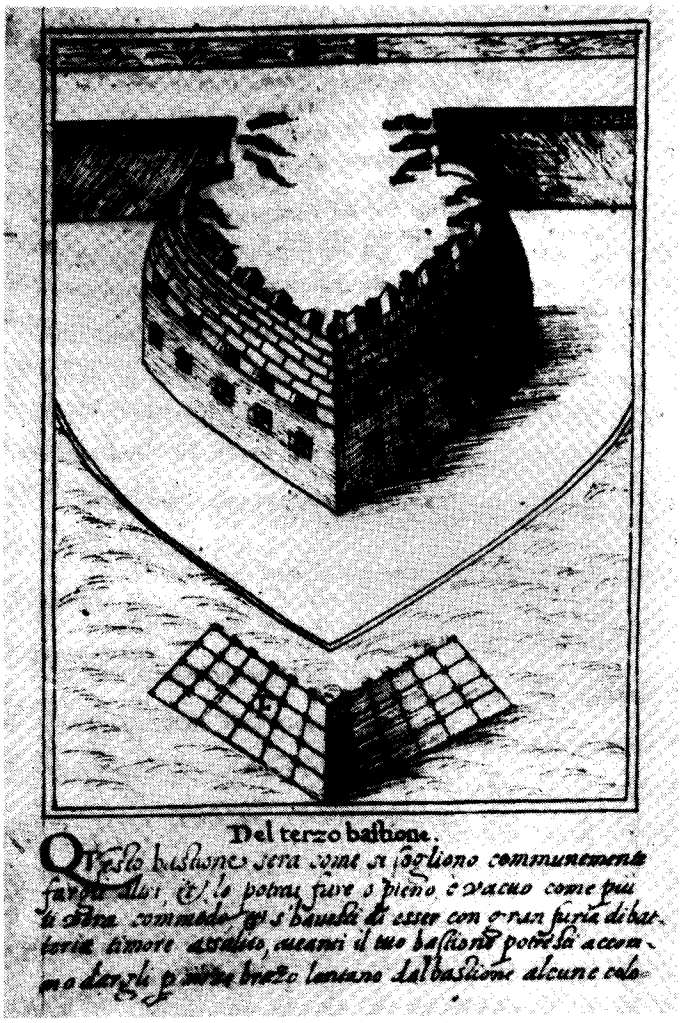

FIGURE 7

Italian bastion (ca 1550); heart-shaped and with casemates (Cpy 10.866).
Bastion italien (vers 1550) en forme de coeur et avec casemates (Cpy 10.866).

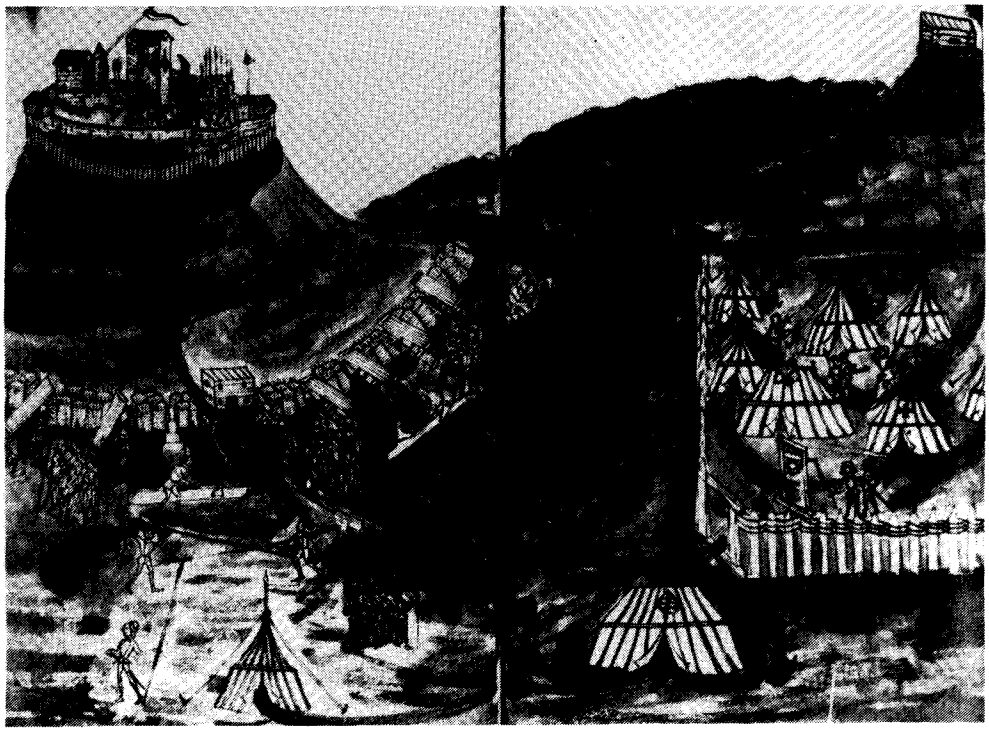

FIGURE 8

Siege of a strongly fortified hill-fortress at the end of the 15th century (Cpg 126).
Siège d'une forteresse de hauteur vers la fin du 15ème siècle (Cpg 126).

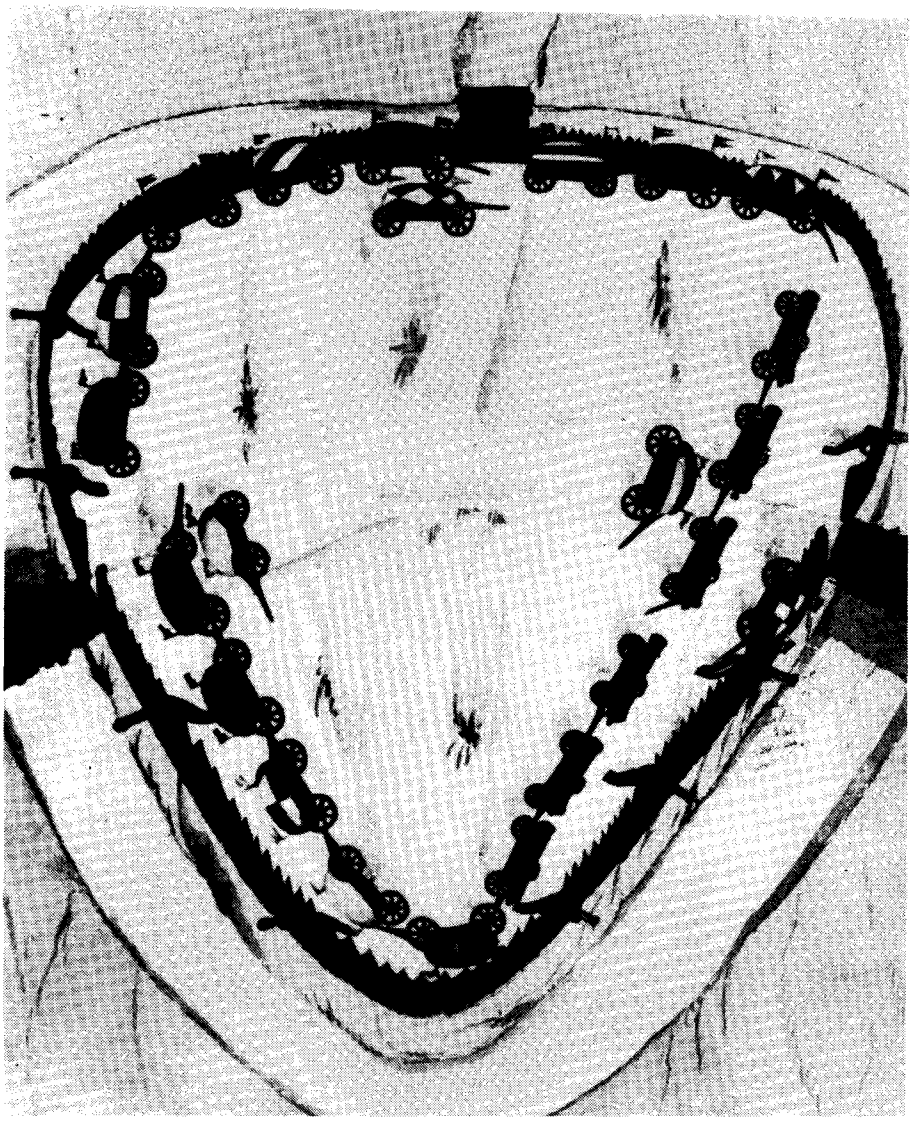

FIGURE 9

Field encampment with palissade. 16th century. The heavy artillery is loaded onto wagons while the fieldguns are used for the defense of the camp (Cgm 8143).
Camp de campagne avec palissade. 16ème siècle. L'artillerie lourde est chargée sur des chariots tandis que l'artillerie de campagne est utilisée pour la défense du camp (Cgm 8143).