III.—NOTES ON ROMAN AND MEDIEVAL MILITARY ENGINES, ETC.

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The warlike engines of ancient Rome would appear to have been the descendants of those shown on the granite sculptures of Persepolis. The Greeks employed them. Vastly improved engines were made by the famous Archimedes at Syracuse, during the reign of his relative, Hiero II., B.C. 270-216, but no particulars have been preserved. The engines he constructed were employed later, with great effect, when the Romans besieged Syracuse.

They were practically the same for attack and defence, and have been described by Vitruvius, Ammianus Marcellinus, Vegetius, and other writers; but what with the mistakes of the copyists, and especially the absence of any drawings explanatory of the text, or in fact any at all beyond certain monumental inscriptions which do not help us much, it is most difficult to differentiate or clearly understand them. The chroniclers almost all disagree with each other in many essential points, but it must not be forgotten that the writers who are most at variance chronicle quite different centuries in the history of the Roman world.

Industrious attempts have been made by several modern writers to reduce these descriptions to some clear system of mechanics; and with the assistance afforded by what is known of earlier medieval engines, all of which inherited their lines of action from Roman times, a considerable degree of success has been achieved in formulating the principles and details of construction.

The mechanical agencies employed in the working of Roman military engines may be described as 'tension' and 'torsion,' two principles often applied in combination for this purpose; and to these may be added, in the case of the onager, the use of the sling.

A summary of the conclusions of these authorities and of others would imply that the scorpion was a huge crossbow, with an added sliding plane for securing an accelerated action, and limited to

the throwing of darts; and that the catapulta and ballista were worked on the principle of tension, as represented in the use of the bow, but with added appliances for increasing the initial propelling force of the first cause of action, by means of bringing the agency of torsion into play, in order to secure an augmented power or double action; these energies being concentrated, so to speak, into one cumulative force, applied, in the case of the ancient catapulta for the throwing of large darts or javelins, and in that of the much larger (Roman) ballista for hurling stones 'weighing 360 pounds each, as well as javelins twelve cubits in length.'[1] Tacitus (*lib.* iii) says, in his description of a battle near Cremona between the armies of Vitellius and Vespasian, that the former had a ballista, belonging to the 15th legion, that threw enormous stones; and Josephus speaks of the Romans having a train of 300 catapultae and 40 ballistae at the siege of Jerusalem.

The principle of torsion was applied to these machines by providing them with a strong rectangular frame of hard wood, constructed in three compartments, firmly fixed on to a stand, which was also made very strong. Instead, then, of employing the energy represented by the simple bow, as supplied in the case of the scorpion or the crossbow, and assuming such arc or bow to be divided into four quarters, only the two outer quarters were used,[2] the two middle quarters being dispensed with, and in their place was the frame. The two inner ends of the outer quarters of the arc were firmly fixed in two upright shuttles with strands of twisted sinews (tormenta) which were held on the axis (sucula) in the middles of each of the outer compartments of the frame, so that the bending of this combination gave much more elasticity and propulsive force than was obtainable with the ordinary bow; thus, in fact, providing a recoil strong and forcible enough to project heavy darts to a distance of 250 yards, which is a longer flight

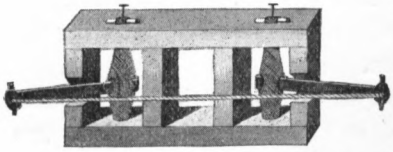


FIG. 1.—PRINCIPLE OF THE CATAPULT AND BALLISTA.

[1] Taking the Roman cubit at seventeen inches and four tenths this would make the missile over seventeen feet long, which is, to say the least, extraordinary.

[2] Procopius very naturally says that the longer these quarters were the more forcible the machine.

than was ever attained by the crossbow. A representation of this frame shown in a MS. of the tenth century, no. 17,339, in the National Library, Paris (fig. 1), will explain the principle at a glance.

This added movement, if it may be so described, is the one so laboriously worked out by Vitruvius, as applied to the catapulta and ballista. The difficulty in applying the details handed down by these authorities for reconstructing the engines lies mainly in the errors made in the original dimensions of the various parts by the copyists.

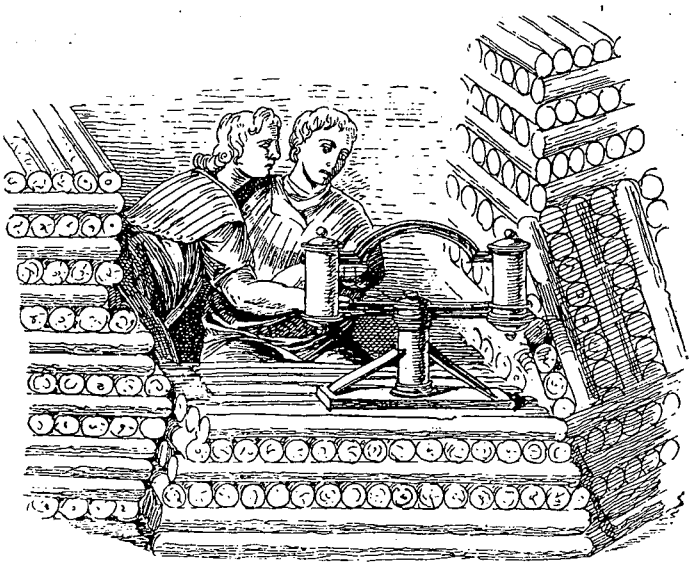


FIG. 2.—SOLDIERS WITH A BALLISTA (COLUMN OF TRAJAN).

Referring to the ballista Ammianus Marcellinus says that small windlasses were employed for pulling the cord into position, and this was doubtless the case with the catapulta also. The mechanism of the windlass was thus handed down to medieval times in its application for the same purpose in the case of the crossbow and other military engines. The main difference in the details of the two machines lies in the adaptation of the table or missile plane, in such a manner as best to bring the cumulative energy of the apparatus to bear on such widely different missiles as darts and stones.

A relief on Trajan's column (erected A.D. 113) depicts two soldiers working a ballista in the embrasure of a bastion. Other reliefs on the column show similar engines on corner towers, and others drawn by mules. These engines varied very much in size, and some were very

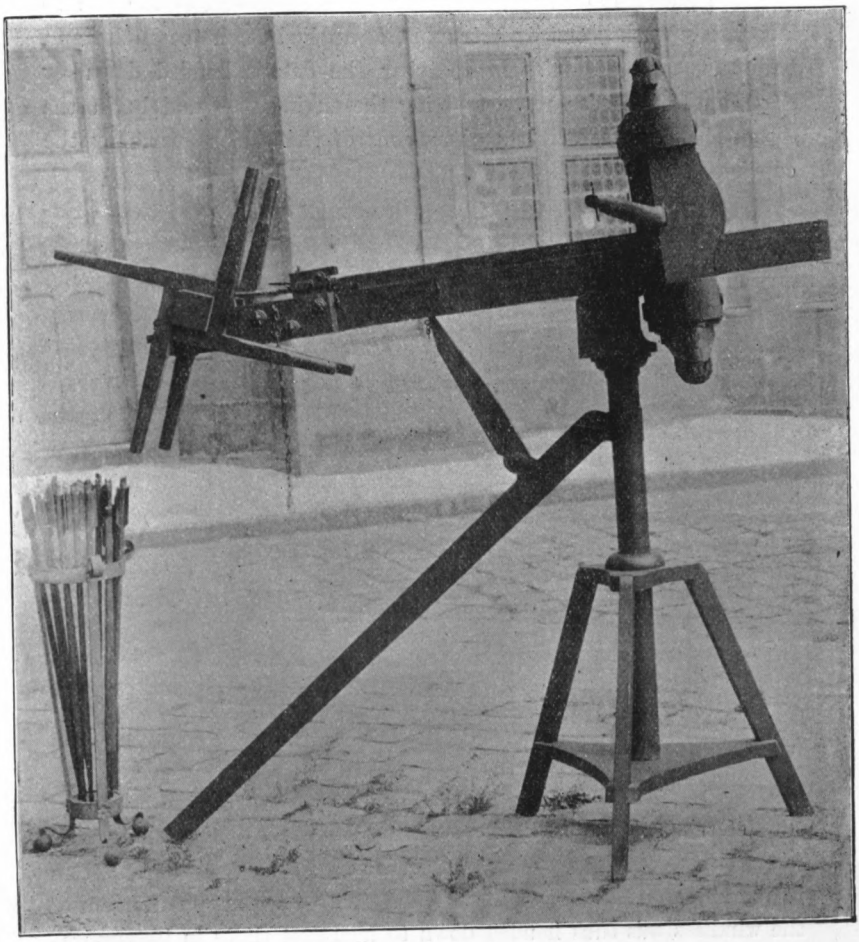


FIG 3.—MODEL OF A CATAPULTA (MADE AT MEUDON).

small hand-machines. Livy says that there were taken at the siege of Carthage 120 large and 200 small catapultae, and 33 large and 52 small ballistae. Athenaeus speaks of a catapult only one foot in length. The excavations at Ardoch, made in 1898, yielded 20 bullets of red

sandstone weighing from 6 oz. to $2\frac{1}{2}$ lb. each. The illustration (fig. 2) has been taken from Schreiber's *Atlas of Classical Antiquities*. All details are omitted; still the mere outline of the engine has proved of great assistance in helping out the written records in all attempts at reconstruction.

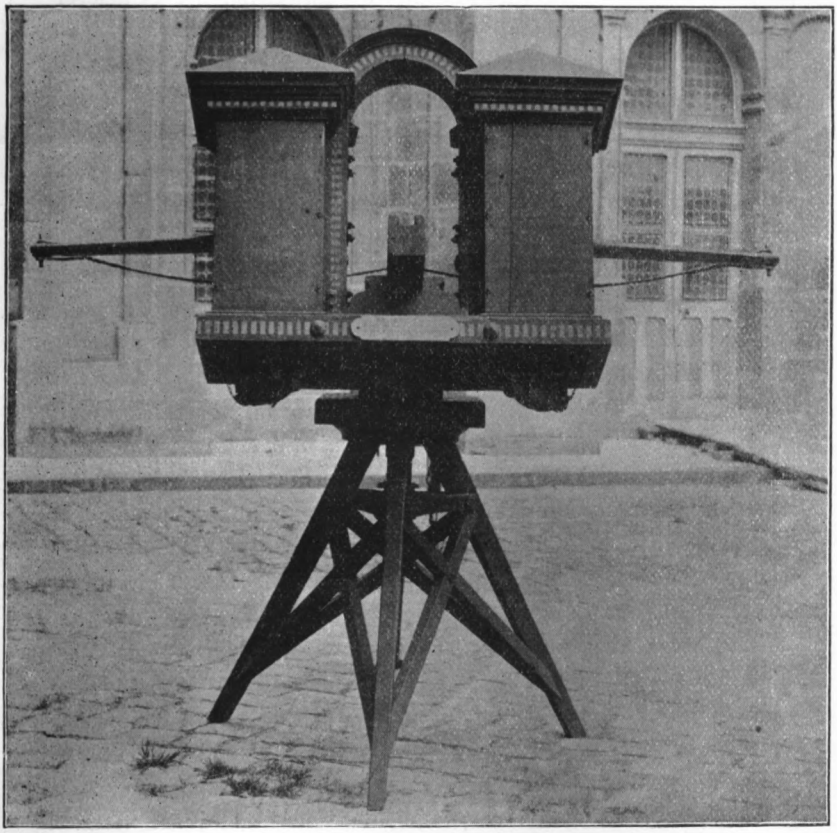


FIG 4.—MODEL OF A BALLISTA (MADE AT MEUDON).

Josephus writes of the terrible character of the stone-casting engines of the Romans at the siege of Jerusalem, when their missiles beat down the battlements of the sacred city, disabling similar engines on the walls, and thinning the ranks of the intrepid defenders. Stones were thrown the weight of a talent (about 100 lb.), and were carried two furlongs and farther. Figs. 3 and 4 give some idea of Roman catapultas and ballistas.

The onager doubtless took its name from the wild ass, suggested by its kick as represented by the recoil, and that the concussion must have been very great is obvious from the construction of the machine, which was worked on a system of torsion furnished by an adaptation of 'tormenta' or twisted cords manipulated by a lever[3] with an added sling, a form apparently much more effective for the hurling of heavy stones, rather than an impulse given by letting slip the cord of a bow, however augmented by auxiliary appliances; but, as will be seen later in these pages, it would seem that the form of torsion of the onager was not applied very long before Ammianus wrote concerning it, though, as already stated, he refers to the engine as 'formerly called scorpion,' which, however, could not well have been the case, as that machine was in all probability named after the reptile, as suggested by its form and sting. The onager had a great advantage over the ballista in point of strength, and was best adapted for throwing heavy missiles among masses of men, or into camps and towns, rather than for hitting smaller objects with precision; but it could not have had the same nicety of aim as the bow-fashioned engines, which discharged their projectiles point-blank, while those launched from the onager of necessity described a great parabolic curve. The motive power of both classes of machines must have been greatly affected by atmospheric changes and the weather generally. Fig. 5 gives some idea of the ancient onager.

The cords of these engines of antiquity were as much as eight inches thick, and made of the leg tendons of animals, or sometimes of women's hair, and the word 'tormenta' was the general designation given to the machines, as suggested by the twisting and untwisting of the coils, by means of which the propulsive force was applied.

It would seem that during the later centuries of the Western Empire the nomenclature of engines of war had got very much mixed, or that their names had become interchangeable. The same feature of uncertainty becomes even more pronounced in the records concerning them during the middle ages, when it was quite common to bestow pet or fancy names upon them, without any further designation.

[3] The children's skipjack affords a familiar illustration of the application of torsion.

While Vitruvius, who was an architect by profession, living in the Augustan age, and whose evidence has great weight and

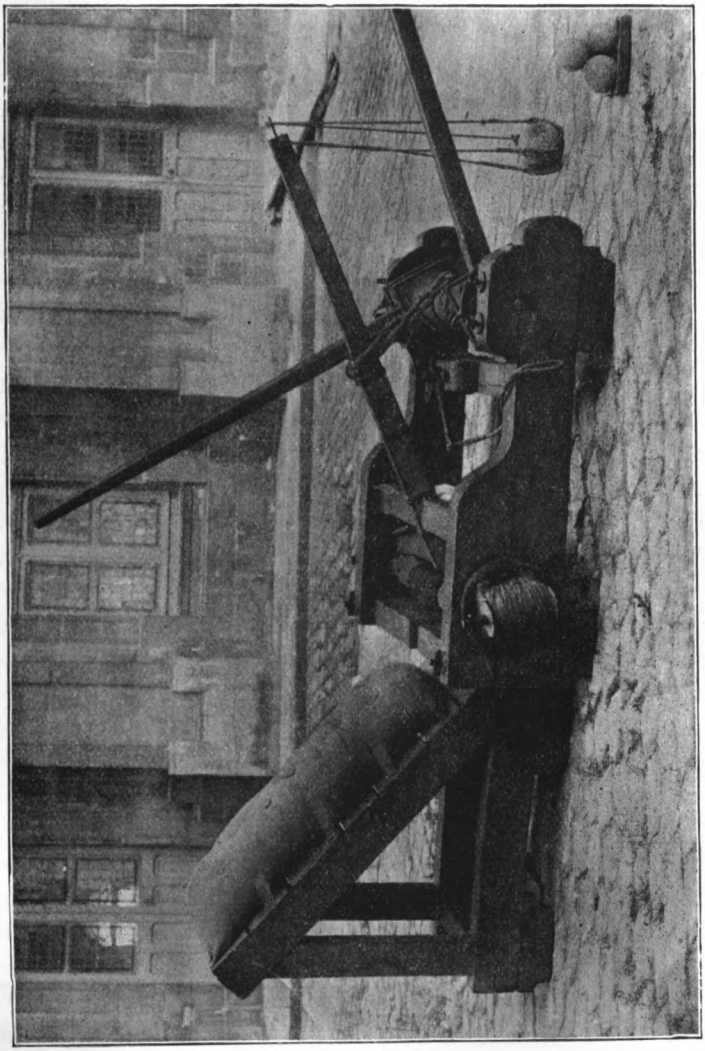


FIG. 5.—MODEL OF AN ONAGER (MADE AT MEUDON).

authority, speaks of the ballista as throwing stones and darts, missiles so very different in bulk and character, Ammianus Marcellinus,

the soldier and historian, writing in the reign of the emperor Constantius II. and Vegetius somewhat later,[4] refer to that engine as being used for darts only. The two last named chroniclers, however, wrote much later than Vitruvius, so it seems probable that the onager came first into vogue rather early in the fourth century. There is, moreover, no doubt, that the early Roman ballista shot stones and beams of wood as well as darts, for Polybius, born B.C. 202, makes mention of it in that sense. This testimony is early, but springing over to the other extreme in point of time, we find Procopius, the soldier secretary of Belisarius, who wrote in the sixth century of our era, stating in *De Bello Gothico* that the ballista of his day threw both bolts and darts; while Abbo, in his poem of the ninth century, says the same thing in connexion with the siege of Paris by the Vikings, *anno* 886. Mr. Grose in his *Military Antiquities* gives reproductions of the labours of Mr. Newton in working out models of the scorpion, catapulta and ballista, mainly based on the descriptions given of these machines by Vitruvius; and there may be seen at the Château de St. Germain-en-Laye eight most interesting and carefully constructed models of catapultae, ballistae and onagri, which were made at Meudon, under the direction of General de Reffeye, by order of the late emperor Napoleon III. As you see from the drawings exhibited to-night the first named engines (catapulta and ballista) differ somewhat from those worked out by Mr. Newton, but it must be remembered that considerable changes had taken place in the details of these engines from the times, say, of the emperor Hadrian to those of Constantius II., when the scorpion would seem to have dropped altogether out of use.

The materials for the figure of the onager on the drawing were taken by general Melville from the text of Ammianus and others, and the model of the same class of engine by general de Reffeye, as shown on fig. 5, was doubtless also arrived at from the same sources, in conjunction with the descriptions of Hero[5] and Philo; and it will be observed that the two models differ considerably, that of the English general being much the simpler of the

[4] Vegetius, 375-392 A.D., dedicated a treatise on the Art of War to the emperor Valentinian II.

[5] Hero of Byzantium.

two.[6] The photographs show the smaller details and appliances very clearly. The cushion arrangement for deadening the force of the recoil, is absent on general Melville's reduction. Figs. 3, 4 and 5 are reproductions from photographs of the machines made at Meudon, representing the catapulta, the balista and the onager respectively.

We will now assume that these ancient war engines were worked on the principles set forth, and we find them handed down to medieval times with similar looseness as to nomenclature, for the names ballista and catapulta were retained in the middle ages, but often applied to quite different engines from those of the Roman world bearing the names, and as time went on the confusion became greater and greater. An extreme instance of this confusing habit may be cited in the case of John de Monte Reggio, who refers to cannon as *tormenti* to shoot *sphæra tormentaria.*

In Dr. Bruce's *Roman Wall* we find reference made to two inscriptions found at BREMENIUM with the word 'ballistarium' mentioned in both. It expresses the platform on which a ballista or other warlike engine was stationed; and a portion of the rampart is as much as 28 feet thick, and heavily buttressed, near where the inscription was found. At BORCOVICUS a number of roughly hewn stones, weighing from one to one and a half hundredweights each, for feeding military engines, was found. The form of these stones is roughly a cone flattened at one end which is sharply cut; and the find is all the more interesting and important as it explains in some measure how and where the action of the cord was brought to bear on the projectile for its discharge.

At BORCOVICUS on the north wall, west of the gateway, a short second wall of inferior masonry has been built, and the intervening space filled in with clay and stones, thus forming a platform within the outer wall on which an engine was placed. Doubtless this platform had been built up sufficiently high to enable the missiles to be discharged over the heads of the defenders on the wall itself. That some provision of this sort was usually made in all works of the kind is shown by Ammianus Marcellinus, who states in *lib.* xxiii. that the

[6] This machine was made at Gibraltar for use against the Spaniards, to reach places inaccessible to shells.

platforms for military engines were built contiguous to, rather than on a wall, and did not form part of it, for he adds that the concussion from the discharge was of such a nature as would have endangered the stability of the wall itself, had the machines been used directly upon it. This writer, though he does not exclude brick, mostly refers to cespiticious walls ('super congestos cespites vel latericios aggeres'), on which the force of concussion would act differently from what it would do on a wall of masonry, and his remarks specially apply to projections built against a wall. Fig. 2 shows how ballistas were stationed on corner bastion towers in Trajan's reign. These bastions rose no higher than the curtain. It is stated in the Bible, 2 Chronicles, xxvi. 15, that Uzziah 'made engines at Jerusalem, invented by cunning men, to be on the towers and upon the bulwarks, to shoot arrows and great stones withal.'[7] All medieval experience goes to show that even the trébuchet, hereinafter described, was used on stone towers, at Carcassonne for instance. It would seem, then, that the isolation of military engines on projecting bastion towers was the rule.

To the north of the east gateway at BORCOVICUS is a solid platform of masonry twenty feet square, which is also probably a ballistarium. Hyginus calls these platforms 'tribunaliae.' Stances are present along the walls of Silchester, especially near the gates.

The northernmost frontier of the Empire in Britain, the vallum in Scotland, a 'murus cespiticius,' also affords some suggestions as to tribunaliae, and a good many projectiles have been unearthed. This line of fortification was constructed during the reign of Antoninus Pius,[8] by Lollius Urbicus, and is believed to have extended from Caeriden on the Forth to Alcluyd on the Clyde. Only vestiges of the eighteen castella, built about two miles apart, remain, and the rampart, which is stated to have been twenty feet high,[9] is now only visible in reaches at a few places along the line; while the fosse, originally twenty feet deep, has been much filled up and almost obliterated in many places; indeed for miles, especially at the Clyde end, it is only traceable by the colour of the soil. Fortunately, the

[7] B.C. 840-811.

[8] In his third consulship—probably about 140 A.D.

[9] Judging from the base I cannot think it was ever so high.

surveys made by Gordon about 1726, and by Roy more than half a century later, when the works were in a much better state of preservation than they are at present, have been passed on to us.

The Scottish vallum, a wall of sods built upon a foundation course of stones, now popularly known as Graham's Dyke, but formerly Grime's Dyke, exhibits swelling projections along its entire course and, as far as can be seen from what remains of it, at somewhat regular intervals; and these projections are not built in the same layers with the wall itself, but are constructed conversely alongside of it, as in a manner is also the case at BORCOVICUS. These thickenings of the walls are undoubtedly the remnants of stances for military engines. It is uncertain whether these stances were built contemporaneously with the wall or not, and it may be that they were later additions to provide for the much greater recoil of the onager, and the way the sods are laid might seem to lend some colour to such a supposition.

Near to Polmont are distinct traces of the fosse, and a long and deep piece of it may be seen in the park at Callendar castle, which lies a little to the east of the town of Falkirk, though but few traces, either of the vallum or the causeway, are to be observed along this portion of the barrier, or in fact on any part of it where the ground has been turned over for the purposes of agriculture. At Rough-castle and Tentfield, a little to the west of Falkirk, the fosse, berm and vallum run along for a considerable distance in a fine condition of preservation; while the causeway is obviously represented in the present carriage road, running for a distance by their side. The fosse measures here 50 feet wide and 12 feet deep; the berm 18 feet broad; foundation of vallum 15 feet. Distance to public road, supposed to be the old military way, 50 feet. The stances for military engines are well marked. Farther on, at Elf hill, towards Castle Carey, the entire fortification, and the causeway, extend for a considerable distance in excellent condition: and here again the stances are in evidence. The extensive station of Rough-castle exhibits all its features, in respect to the external lines of fortification, in almost perfect preservation, excepting for the height of the converging vallum, which is however still considerable, and very clearly and continuously marked. Breaks in the line show its cespiticious

character; and it is remarkable that the process of attrition and denudation has been so very gradual. The gateways and main thoroughfares of the station are clearly marked. The luxuriant growth of bracken alone interrupts what would otherwise have presented a perfectly distinct outline of the entire works, which, however, must be very obvious at the seasons when this vegetation has died down. The berm, which is common to all fortifications of the kind, is sharply marked, and its use in connexion with military engines is very obvious—it enabled them to rake the fosse not only directly but obliquely as well.

This northern barrier is quite homogeneous, and presents none of the perplexities arising from the more varied, and perhaps double, character of the more pretentious sister line of fortifications farther south. I have been informed that a careful report of excavations on the line of the Antonine Wall has been prepared, under the auspices of the Glasgow Archæological Society, giving full particulars of the stances and their measurements; but I have not seen it, and the space at my disposal on this occasion will not permit of my going any further into that matter, which is, after all, only incidental to the subject of these notes.

In the museum at the Black Gate is the cast of a tablet inscribed to the emperor Antoninus Pius, recording the completion of three miles of the Scottish vallum. The little *Guide to the Castle of Newcastle* informs us that the original was taken to Chicago, but was destroyed in the great fire there.

When the Visigoths took possession of the southern provinces of Gaul in the fifth century, with Toulouse for their capital, they brought Roman methods and traditions with them, and these were handed down through this people to that very elastic generalisation of time, the middle ages. The military system and tactics of the Visigoths, which may be said to have been derived from the Romans, were, however, much modified by the Franks, who held greatly to their own more barbarous Germanic methods of warfare, in which courage and impetuosity were far more conspicuous than organization, continuity and tenacity; but military engines continued uninterruptedly on the old models, and so remained with variations, excepting in the adaptation of a system of counter-

poise for heavier engines, until a new departure took place in the introduction of the epoch-making bombard. It must not be supposed, however, that mechanical engines of war were at once superseded by cannon; on the contrary it was long before ordnance had advanced sufficiently, either in power or precision, to compete with the older engines for many purposes; and they continued to be used contemporaneously with them, both on land and sea, until the sixteenth century. The continuity from Roman to medieval times thus ran on far more unbroken lines than is often supposed; and much of what may have been lost to Europe during the interval was preserved by the Byzantine empire, and brought back again by the Crusaders from Constantinople, Egypt, Asia Minor and Palestine.

That period of reconstruction, not very happily generalized as the dark ages, furnishes us with but scanty records, for when Rome fell, the general scramble left little time or opportunity for the chronicler to record events, which moved then with great rapidity; and it was not before the European nations had, in a measure, become organized and consolidated that we are put into possession of fuller information concerning their doings. Still, there is ample evidence of the continuous use of mechanical engines, which are mentioned in accounts of the sieges of Rome in 537, Nismes in 637, and Paris in 885. In the *Capitulare Aquisgranense* of the year 813, the marshals of the forces of Charlemagne are enjoined to supply suitable stones for the 'fundibuli,' that is, machines with slings, probably onagri. The engines of these early times were much more rudely constructed than their Roman prototypes.

The early Norman castle was more an isolated seat of power, amidst hostile surroundings, rather than a place of refuge for the neighbouring vassals and serfs when menaced by an enemy; and it was practically impregnable as against the then means of attack, which consisted mainly in the use of the bore or the ram, besides occasionally 'sap and mine,' covered by archers; and it could hold out very often as long as the provisions lasted. Mining operations were but rarely resorted to in attacks on these strongholds, which were frequently built on rocky eminences, or on the high mounds previously occupied by the Anglo-Saxon 'burhs.' When fully garrisoned the defenders were able to concentrate their strength rapidly on any given point, and,

assuming the outworks to have been forced, the high and massive character of the donjon, which had no woodwork to set fire to, and which commanded not only the whole of the surrounding defences, but beyond them, defied all attempts at a coup-de-main or escalade. The fencing in of towns by stone walls, which involved the defence of a great frontage, began to be more general after the second crusade, and it was then that military engines, with the use of war-sheds, towers, etc., once more commenced to play a great part in the reduction of fortified places, and this state of things continued until the manufacture of cannon and gunpowder had passed out of their rude and experimental stages.

We notice first in the records of the thirteenth century that special corps of 'gynours' or 'ingegneors' were attached to armies, not only for the construction of warlike engines, but also to work them, and they had charge of the military train.

Groping among old Latin records for differentiating these machines is a difficult and unsatisfactory quest, but medieval literature is worse again in the hopeless inaccuracy and confusion of nomenclature and description. Very little information of a definite character concerning these machines reaches us from the dark ages, but what there is shows that early medieval engines continued to be worked on the Roman principles of tension and torsion. That of counterpoise, as represented by the trébuchet (catapult), first appears in the thirteenth century, probably very early. I have not found any pre-Conquest mention of large military engines in England, but they are referred to in Domesday Book. In spite of the numerous names for these machines in common use in the middle ages, there were practically only three, or at most four, types, but many varieties of these, differing somewhat in size and unimportant details; and these notes have been written with a view of differentiating them more clearly.

Froissart in his chronicles frequently alludes to military engines, but seldom by name. Indeed he usually refers to them in general terms, such as 'great machines were made for hurling rocks and darts,' and his mode of allusion is shared in, more or less, by all other medieval writers on the subject; and it is partly these references that have brought so many historians and lexicographers to imagine that the words 'catapult' and 'ballista,' as used in the middle ages, were interchangeable terms;

in fact, that either name could be applied to one and the same engine. It would seem that names were frequently coined for these machines, for Froissart in his account of the attack on the castle of Romorantin on the Sandre, mentions engines called 'aqueraux' to fire 'le feu gregois.' This name would seem to have originated in the special office or function to which the engine was applied; but there is no sort of suggestion as to its class or principles of construction It may possibly have been one of those elementary pieces of artillery in the form of a hollow tube made of brass or iron, something of the kind used by the emperor Alexius Comnenus, as described by his daughter and biographer the princess Anna Comnena in the *Alexiad*, for discharging 'le feu gregois' from his galleys; or a cannon —'canons jetant feu'—for throwing Greek fire, which was in use in the reign of Edward III., and which is referred to in these notes under the heading of 'Greek Fire'; but it is far more likely to have been an engine worked on the direct counterpoise plan, one like the trébuchet; and the Greek fire would in that case have been hurled into the beleagured castle enclosed in a barrel. Camden mentions machines he calls 'malleoli,' used 'in fiering buildings.' There is not infrequent mention in medieval records of these barrels of fire having been thrown by mechanical engines, or discharged by mortars, and their course is often pictured as that of a fiery dragon; but whether it was possible or not to apply fire at a vent before discharge can only be guessed at—old prints certainly depict the barrel as flying through the air with a tail of flame. The romances of chivalry abound with tales of encounters between knights errant and fiery dragons belching forth flames, and they possibly owe their origin to this cause, or to some other form of application of Greek fire. The *Codex Aureus* of Saint Gall, a MS. of the ninth century, figures a horseman carrying a dragon-like looking fish, vomiting flames, transfixed on the point of his lance.

We find warlike engines frequently confounded with each other in times removed but little farther back from our own than those in which they had only quite recently become obsolete. For instance, in Camden's[10] *Remaines Concerning Brittaine* the following passage occurs:—'the balister in violent shoting great stones and quarrels,

[10] Camden died in 1623, aged 73 years.

as also the catapultes'; and here we have no distinction whatever made between the two engines, at least as regards the missiles they discharged. But in Blount's *Antient Tenures* we find an item noted on page 92, 'a spindle full of raw thread to make a false string for the king's balister or crossbow.' This statement would imply that the medieval ballista was constructed on the principle of its *confrère* of the ancient world, and this is supported by Otto of Freising, writing in 1155, 'tormenti e balista quam modo,' etc. This passage also bears a clear allusion to the spindle, as applied to Roman catapultae and ballistae, already illustrated in these pages by the figure in MS. 17,339, in the National Library, Paris. Records of the twelfth century very often refer to ordinary crossbows as ballistae; and the first portion of the passage in Blount classes the smaller and larger engines together, but the allusion made to the false string shows that the ballista was meant.

There is some uncertainty as to the principle of the bricolle. Froissart says it shot darts,[11] presumably like the espringal (springaus), the balista de turno, and the falarica. Guiart, writing in 1297, refers to the 'springold' as throwing quarrels, feathered with brass. Camden in the *Remaines* writes, 'Mangonels, Trabucches and Bricolles, wherewith they used to cast milstones'; and further on in his work, 'some kind of Bricol it seemed which the English and Scotch called an Espringold, the shot whereof King Edward the first escaped sair at the siege of Strivelin [Stirling].' I think we may conclude that the bricolle, espringal, falarica and balista de turno were all worked on the combined principles of tension and torsion, after the fashion of the ancient catapulta and ballista. The springaus is several times scheduled in inventories of the thirteenth and fourteenth centuries that have come down to us. In *Accounts of the Constables of Dover Castle*, dated 1344, we have 'iij. springald magnas, and iij. parve springald,' etc. The name of the balista de turno sufficiently indicates its description. The same *Dover Accounts* (1344) schedules 'magna arbaliste ad turrm.'

The ribaudequin is a huge crossbow on a small platform sometimes moved on wheels and worked by tension only, constructed

[11] At the siege of what Froissart calls the town of Africa (Johnes ed., vol. x., p. 194.)

on the model of the ancient scorpion. It was fifteen feet in length, throwing javelins five feet long. A train of these engines, each drawn by a horse, formed part of the armament of John, duke of Burgundy, when he marched on Paris in 1411. The name would seem to be associated in some way with the free companies called ribauds.[12] The falarica, sometimes spelt phalarica, or trifax, is often mentioned as throwing fiery darts. This engine was used by the Saguntines, Livy tells us, when Hannibal besieged the city (B.C. 219). The shaft of its projectile was wrapped round with tow, steeped in oil, and smeared with sulphur and resin, then ignited, and the missile launched against the pluteus (the prototype of the sow or cat) and the stationary tower called bastille, the ancient musculus; and these beleaguering engines were frequently burnt by its agency. The falarica was worked on the lines of the ancient catapulta, great nicety of aim being required for its special work. The bible or beugle threw stones, and was probably a variety of the ballista.

The mata-funda may be classed among fundibuli, or sling-throwing engines (*funditor*, a slinger), as mentioned in *Capitulare Aquisgranense, anno* 813; and this machine was a form of the ancient onager.[13] The tricolle seems to have been another name for the bricolle, or the word misspelt by the copyist.

The mangon or mangona, with its diminutive mangonel (from which we probably have the word gonne, gon or gun), was worked by torsion. There are instances however of this name having been applied to machines where counterpoise was employed, but it was common enough to carry on the old names to new departures, thus causing great difficulty and perplexity to the historian.

The names of mechanical engines were sometimes handed down to cannon, for in a paper printed in *Archaeologia*, vol. xxx, concerning stone shot, mention is made of a survey of ships dated 25th January, 1575, in which is an inventory of shot carried on board the 'Eliza Bonadventure,' and one item is 'polished stone shot used for canon piriers,' clearly a name inherited from the *pierrier*, described later on

[12] In Pipe Roll, *Mag. Rot.* 27 Edw. III. the machine is mentioned as 'Ribaud.' *Archaeological Journal*, xix. p. 73.

[13] 'That murderous sling the matafund.'—Southey's *Joan of Arc.*

in these pages; and a piece of ordnance called a robinet is catalogued in a survey of arms, etc., in the Tower of London, *anno* 1547.

The mangona had its prototype in the onager of the fourth century. It is mentioned by name as early as 886, in connexion with the siege of Paris by the Danes, and could not therefore have been worked on the counterpoise plan, as that invention did not appear until much later. M. Paul Lacroix, in his *Arts in the Middle Ages*, gives a drawing of a mangona, copied from an illustration in MS. 7,239 in the National Library, Paris. This machine is worked on the principle of torsion, and the drawing is specially interesting as illustrating the smaller details and appliances, which the space at my disposal will not permit of particularisation. In *Piers Plowman* we find, 'sette Mahon at the mangonel, and mulle-stones throweth.' Simon de Montfort was killed at Toulouse in 1218 by a shot from a mangonel.

The cabulus mentioned by Le Breton as having been employed at the siege of Château Gaillard in 1204 was clearly a stone-casting engine. This is probably still another name for the onager, the more so as there is no mention of the trébuchet so early. Mangonéaux and pierriers[14] were used alike by the French troops and the opposing Egyptians in the luckless campaign of St. Louis in Egypt in 1250 for hurling great stones and Greek fire at the battle of Mansourah. The invaders had a train of eighteen of these engines, which were replied to by sixteen machines of the Egyptians, who succeeded in setting the cats and belfreys of the French army in flames.

A representation of a medieval engine of the onager type occurs on a fifteenth century miniature by Zeitblom, in a MS. in the library of prince Waldberg Wolfegg.

Coming now to the class of engines worked on a direct system of counterpoise, which first appears in the thirteenth century, either alone or in combination with a sling, we find a passage in Beaumont and Fletcher's *Bonduca*:—'Bring up the catapult and shake the walls,' which can only refer to a machine throwing great stones or bolts, and one doubtless worked on this system and not on that of the Roman catapulta; indeed the fact cannot be doubted that the ancient

[14] Pierriers are described in the next section, which is devoted to engines worked by counterpoise.

name survived but was applied to an essentially different engine in medieval times, and one much more powerful than the old catapulta, or even the onager and the medieval mangona, while the ballista of the middle ages continued being constructed on the lines of its Roman prototype.

Among the medieval engines worked by counterpoise, besides the catapult (trébuchet), would appear to be the pierrier, the calabres, thecoillard or cuillard, and the martinet. The trébuchet is certainly the medieval catapult under another name, the word catapult being also often used in a generic as well as a general sense; and the others named are all probably the same machine, with variations, more in size and the details of adjusting the counterpoise and projectile, rather than in any principle of construction. There is a reference in the ballad of the *Albigeois*[15] to the trébuchet, as throwing stones at the siege of Toulouse. The petrary or petraria is mentioned as being employed at the same siege, and also in the defence of Beaucaire about the same period, and we find it often alluded to, after the second crusade, as being used in casting Greek fire into fortified places, which was frequently done in barrels; and it would seem to have been the same machine as the 'aqueraux,' mentioned by Froissart as being employed for that purpose. It also threw rocks at the siege of Toulouse, and the Turkish pierrier is doubtless the same engine as the petrary, varying possibly somewhat from its English confrère. Aegidius Romanus (Colonna), in *De Regimine Principum*, calls all trébuchets 'petrariae,' and in fact all these machines were worked on the same principle. The tripantum also belongs to the same class. The coillart or cuillard is often mentioned in accounts of the campaigns of Henry V.; and it formed part of the armament of Alexandria.[16] Its probable derivation from *cuiller* or *cochleare*, a spoon, would connect it with the trébuchet or medieval catapult.

The robinet threw both darts and stones, and was in fact a survival of the Roman ballista; while the mate-griffon would appear to have been a slinging machine, or one using a sling in combination, like the onager.

[15] The Provençal poem of the crusade against the Albigenses.

[16] 'A Survey of Egpyt and Syria, 1422.' A MS. in the Bodleian Library.

We see frequent reference to these machines in the wars of the Saracens, in which military engines were freely employed ;[17] and this people doubtless became acquainted with them through their conflicts with the Byzantine empire. Even the Vikings had assimilated them, as seen in the records of Siegfried's siege of Paris (885-886).

It would appear that the system of direct counterpoise, especially in combination with a sling, answered better for propelling such missiles as large stones ; and it is certain that the great majority of engines for this purpose, like the trébuchet, especially in later medieval times, were worked by this method, while most of those constructed on the bow principle were much better adapted for propelling darts only.

Remains of medieval engines were found among the débris of the castle of Russikon in Switzerland, which was burnt down in the thirteenth century. These may be seen in the museum at Zurich, but they are of too fragmentary a character to help us much ; and the engravings in the *Walturius*, printed at Verona in 1472 and now in the Hauslaub Library at Vienna, serve only to make the question of identification more difficult ; indeed, most of the drawings of engines of the fifteenth and sixteenth centuries are fanciful and unworkable.

The late emperor Napoleon III., when president of the French Republic, had an engine constructed at Vincennes which he calls a trébuchet, after the model of one shown on an old carving, supposed to date from the reign of Edward II. The machine consisted of a beam, called a verge, turning on a horizontal axis, and supported upon uprights. A counterpoise, such as a box filled with stones, was fixed at one extremity of the beam, and on the other a sling which contained the projectile. A winch was often used to lower the verge for making ready. It was quite common to cast the projectile from a receptacle at the extremity of the verge, formed like a great hand or a spoon, but the addition of a sling more than doubled the range of the engine. This machine, constructed in 1850, has a verge about thirty-four feet long, the counterpoise being fixed at 9,900 pounds. After some preliminary experiments a 24-pound shot was hurled 191 yards in a great parabolic

[17] Lord Lyttelton in his life of Henry II. says, 'Saladin assaulted Ascalon with thirteen catapults.'

curve, a weight of projectile and distance of flight very much short of what has been achieved by some Roman and medieval engines; in fact, as shown, more particularly, later in these pages, we have a projectile for the trébuchet in the castle here weighing about 523 pounds.

There were several kinds of trébuchets, but the difference between them lay mainly in the adjustment of the counterpoise, which in one variety could be shifted up and down the beam for regulating the range as required. Another machine, besides having a fixed counterpoise at the base of the beam, had a small adjustable regulator as well. There is a medieval carving, in ivory, in the museum at Boulogne, representing one of those amorous contests between a knight and his 'fair ladye,' so characteristic of the literature of the troubadours. A portion of this carving, an illustration of which is given in fig. 6, shows a trébuchet charged with fully blown roses, and a knight in armour kneeling before the engine obviously with the intention of belabouring his fair foe with a shower of these fragrant missiles.

FIG. 6.—TREBUCHET (FROM A CARVING IN IVORY, FOURTEENTH CENTURY).

This machine is worked on the principle of counterpoise, somewhat in the manner described, but the basin-like receptacle for the missiles at the lower end of the verge is not adaptable for the addition of a sling. The upper end is heavily weighted, and as soon as the catch has been slipped, owing to the unequal balance, the missiles are hurled with great velocity among the foe. The illustration, fig. 6, has been reproduced from a wood engraving, which, though faded, gives a good idea of the machine, and is especially valuable as furnishing an almost unique representation of one of these engines

directly handed down to us from medieval times. The armour of the knight would indicate a date early in the fourteenth century of our era. This class of machine (à verge) continued to be used long after the introduction of cannon. The learned Jesuit, le père Daniel, says so, and there is plenty of evidence that they were often preferred to early cannon. The English version of the name in old chronicles is trypgette and trybget; and the machine is so referred to in a poem describing the siege of Rouen, *temp.* Henry V.[18] Missile engines used on ships were mounted on raised platforms.

Dr. Hodgkin wrote a poem in 1872, entitled *The Catapult*, suggested by a picture painted by Sir Edward John Poynter, P.R.A., a work full of power and inspiration, and the lines so faithfully describe the trébuchet (catapult) that I venture to give extracts from the poem here :—

This framework's strength supports the catapult;
Thus planned :—A beam upon a pivot poised
Has one end by a gathered weight of stones
Held down to earth; the other, high upreared,
Wears the resemblance of a clenched hand.

* * * * * * *

To drag this armed hand downwards for a space,
And counterwork the lever's loaded end,
Storing up all its strength for the recoil
The soldiers labour, straining at the winch,
That o'er the pulley drawn the tightening rope,
And slowly—slowly lowers the great hand.

* * * * * * *

The little cord which when the moment comes,
Shall loose the tackle, break the pulley's strain.

Among a wealth of interesting objects which ought to be properly catalogued, the society possesses a very important collection of sandstone projectiles in the castle here, a large proportion of which were found in 1898, when lowering the floor of the merchants' exchange on the Sandhill. They are all spherical, and may be roughly classed in three varieties. The greater number are accurately rounded, while others are more roughly chiselled, and the remainder are very roughly hewn, especially at the sides. The roughest balls were fashioned for the trébuchet and other stone-casting engines, while all the others are for pieces of ordnance, polished or finely chiselled for 'canon piriers,' and for 'fowlers' rough. These pieces were muzzle-loaders, while

[18] MS. No. 124 in the Bodleian Library.

cannon were breech-loaders. The former were used to propel stone shot with a low charge of powder. It was naturally superfluous to fashion balls for mechanical engines with any nicety, all that was needed being a reasonably true balance for their aim and flight. Holinshed states that Edward I. used at the siege of Strively (Stirling ?) catapault balls weighing from two to three hundredweights each.

The form of balls for military engines of the Augustan age, and somewhat later, has already been referred to.

I had one of the castle balls weighed by Messrs Pooley, and used it as a standard for approximating the weight of the others. It was somewhat chipped, so the perfect balls in the specification would weigh relatively somewhat heavier than the weights given below.

	Diameter. Ft.	ins.		Cwts.	qrs.	lbs.
6 stone shot... ...	1	6½	each weighing about	2	1	3
2 ,, ,, ...			rather smaller			
1 catapult ball ...	1	11½	weighing about	4	2	19
2 stone shot ...	1	7½				
16 smaller balls [19] ...	1	0½	to 1 ft. 1½ in. mean weight of each	0	3	4½
4 catapult balls ...	1	1	weighing each about	0	3	4½

There are also several broken balls of various dimensions. Two stone shot in the Tower of London are in diameter eighteen inches and two feet respectively; and both shot for cannon and projectiles for mechanical engines may be seen at Norham castle. The warder at the castle of Newcastle drew my attention to markings on some of the balls, such as parallel lines, a rose, horse-shoes, and crosses.

Cannon was employed in England certainly as early as 1338, as shown by an indenture between John Starlyng and Helmyng Legat, 'ij canons de ferr, sanz estuff, etc.,'[20] and the records of the war waged against the French by king Edward III. contain many references to their employment at sieges.

It will be seen later that the largest of the balls now in the castle of Newcastle was exceeded in size by projectiles for the heavier ordnance of a very early period.[21] It is quite possible

[19] Most of these are dressed for ordnance, a few roughly hewn.

[20] These cannon are mentioned as forming part of the armament of the war vessel 'Barnard de la Tour.'

[21] A cannon is stated to have been used at the siege of Tannenberg, a fortress demolished in 1399, capable of throwing a projectile 950 lb. in weight. It was named Faust Bucleae.

that some of the castle shot were discharged against the Scots in 1342 when king David of Scotland lay about Newcastle with a large army, and assaulted the town. One of the Froissart illuminations depicts the Scottish army before the town, and there is another in the series showing the battle close to the walls with queen Philippa present in person, but this is a mistake, for she came no farther north than York.[22] This was in the early days of ordnance, but king Edward had a siege train of cannon before then, and it is very likely that he armed the walls of Newcastle with the new artillery, the defence of that fortress being of such vital importance, more especially while the king was engaged on his French campaign, when England was greatly open to invasion, having been largely denuded of troops for home defence. The army raised to repel the Scottish invasion doubtless consisted mainly of raw levies.

That ordnance was largely employed before the Scottish invasion in the defence of fortresses as well as in their attack is clear from the line in Froissart, 'Those of Quesnoy let them hear their cannon.' This was when the French besieged the town in 1340, two years before the Scottish army appeared before Newcastle.

There are still a good many very early pieces of ordnance to be seen in the various museums and arsenals of Europe, with calibres ranging roughly from thirteen to twenty inches, but, as far as I know, no larger examples have come down to us.

Medieval records yield many examples of very large cannon, some of which had a graduated tube for the reception of variously sized balls. These records usually lack details, but there are not a few explicit statements concerning huge ordnance, which are described by Villaret (*tom.* xiv., p. 244). Froissart speaks of very large ordnance. Very early cannon were only capable of throwing shot describing a parabolic curve, with a radius of about three hundred yards; and this would be ample for throwing shot as far as the Exchange on the Sandhill.

Stone balls continued being used for a certain class of cannon as late as the seventeenth century. *The Surveye of the Queene her Ma^ty Shippes, taken and viewed by The Officer of The Ordnance*, 25th January,

[22] Newcastle was often a trysting place for the assembling of the English armies for the invasion of Scotland. A writ, dated 20th June, 1322, summons 'all bannerets, knights, esquires, and other men-at-arms to meet the king at Newcastle, on the vigil of St. James, to march against the Scots.'

1575, referred to in *Archaeologia*, vol. xxx., gives an inventory of the shot carried by the 'Eliza Bonadventure,' and in the specification is mentioned 'stone shot polished and for fowlers rough.' As already stated, the polished stone shot were for 'canon periers,' and this name is doubtless inherited from the mechanical engine, 'pierrière.' The rougher balls were for the pieces called fowlers. To judge from this inventory and other sources of information it would seem that the proportion of stone shot, as against balls of iron, in use towards the end of the sixteenth century, was about one in ten, possibly a little less. In a book preserved in the Tower, *Provisions and Recepts for ix years in the beginninge of Her Maties Raigne from* 1558 *to* 1567, stands 'Recepts from Anthony Rickman and Edward Caflyn, marchants, stone shott of sundrie sorts 204 score and 18.'

The longbow and the crossbow, though perhaps more generally classed as weapons rather than as warlike mechanical engines, still largely partake of the character of the latter.

THE LONGBOW.

The use of the bow is recorded almost to the extreme limits of history. There are representations of bows in the tombs of the kings at Thebes, some of them exhibiting a double curvature, while others are nearly straight. A bracer was worn by the ancient Egyptian bowmen, and their arrows, which had bronze tips, barbed or shaped triangularly, were drawn to the chest and also to the ear with the forefinger and thumb or the two forefingers, as in medieval times. Some of these bows did not exceed 22 inches in length, while others were three feet and over.

These weapons were used by the Persians, Ethiopians, Libyans, Chaldaeans, Scythians, Greeks, and Romans, and the bow of the Lycian Pandarus is related to have been made of ibex horn, with a double curvature, and strung with sinews. The same form occurs on the Trajan and Antonine columns, and we have it again on a relief in the Blackgate museum from BORCOVICUS. Another relief at the Blackgate, which was found at Jarrow, exhibits an archer closely following a stag. One formed of a single horn, stated to have been found in the Fens, Cambridgeshire, was exhibited at the rooms of the Society of

Antiquaries of London in 1870. It also had a double curvature, and was originally 42½ inches long. The old Tartar bow was of horn and strung with sinews. The Celtic equivalent is 'bua.'

Agathias, writing in the sixth century of our era (535), says that the Franks did not use the bow in warfare, but it is mentioned in two of the capitularies of Charlemagne.[23] Judging from the numbers of arrow-heads found, the bow was a weapon of the ancient Britons, and the Danes were expert at its use. In Lodbroc's *Death Song*, 'The flexible yew sent far the barbed reed.'

Turning to the Byzantine empire we find it recommended in Leo's *Tactica* as 'the easiest weapon to make and the most effective.'

On the Bayeux tapestry only a single bowman is seen among the Anglo-Saxon host, while several are shown in the Norman ranks; these bows are short and drawn only to the breast, and the arrows barbed.

The English archer became justly celebrated under the Norman kings, and it was first under them that the bow was lengthened and assumed great importance as a weapon of war. Richard I. was himself an adept with the long bow, but it was not fully appreciated in warfare before the reign of Edward I., when it began to be the dominating feature of the armament of England. In 1314, Edward II. levied a company of 'Northumbrian archers' for the invasion of Scotland. Harold was slain by an arrow at Hastings, and James IV. of Scotland met his death on Flodden field from the same cause.

Bowmen under the Norman kings wore a leather jacket, which was afterwards adopted by the French, and called *jacque d'Anglois.*

Part of the light cavalry of the thirteenth and fourteenth centuries consisted of mounted archers. The longbow was the leading weapon at Creçy, Poictiers and Agincourt, and it continued to be so in the English armies until the sixteenth century; but Flodden may be said to have been the latest battle won mainly by its agency.

In the reign of Edward I. 'a painted bow cost one shilling and sixpence, and a white bow one shilling.' These bows did not exceed five feet in length, as would appear from illuminations of the period, and would seem to have been about the same length at Creçy. See *Roy. MS.* 16G. vi. folio 116 in British Museum.

[23] *Capitulare Aquisgranense* and *de Villis Dominicis.*

The later length of the English longbow was about an archer's height, say between five feet six inches to six feet, with a bend of nine inches, and those made from the bough of a yew were preferred because of the very slight shrinkage of that wood in drying, and its comparative immunity from boring insects. But as yew trees were scarce bowyers were enjoined by Act of Parliament to make four bows of 'witch hazel,' ash or elm, to one of yew, and no person under seventeen years of age with certain exceptions, was permitted to shoot with a yew bow, under a penalty of six shillings and eightpence. This statute was repealed in Elizabeth's reign. The bowstring was either of silk or hemp, twisted or plaited, but always round where the notch of the arrow went; and a MS. account of the Merchant Taylors' Company of 1549 schedules 'a dossen Bowe stryngs, sixpence.' At the commencement of Elizabeth's reign 'a bowe of yeugh' was worth two shillings and eightpence, and arrows six shillings the gross. Roger Ascham, writing about 1550, says 'the arrow consists of the stell, the feathers, and the head,' and he adds that they were made of divers woods, but mainly of ash, oak or birch. The shaft was drawn by two or sometimes three fingers at the string, and always to the ear for moderate distances, but towards the breast when used at long ranges. The archer kept both eyes open, and looked only at the object aimed at, holding his weapon perpendicularly. He carried a sheaf of arrrows consisting of twenty-four at his belt, but when in action he laid down two or three at his feet, with the tips towards his left, so that he could take them up, one after the other, without losing his aim; sometimes he stuck them in the ground. The standard length was a clothyard shaft, feathered from the grey goose or peacock's wing, or plain at the base, and tipped usually with a sharp, but sometimes a barbed head; these tips were of iron pointed with steel. Chaucer writes 'a shefe of peacocke arrows bryght and kene.' The archer wore a leathern wrist-guard called a bracer, to avoid hurt by the recoil of the string. The arrow with feathers from a goose's wing was the 'broad arrow.' The plain pile (without feathers) was thought to penetrate better. Henry V. enacted that the sheriffs of counties were to take six wing feathers from every goose for feathering arrows. In 1522, these feathers cost 21d. for 1400; arrows of ash were preferred.

An ordinary English archer would rarely miss an object the size of a man at 250 yards, and he could discharge his weapon ten and even twelve times a minute. The extreme range of the bow for practical shooting was from sixteen to twenty score yards; in fact a *bowshot* seems to have been a term used to express a distance of 400 yards, and the minimum range for archery contests was usually set at 220 yards. There are instances recorded of an arrow's flight of between 500 and 600 yards, and a bow made of horn shot an arrow 480 yards at one of the meetings of the Toxophilite Society.

The form of the longbow of the fourteenth century was thick in the middle, narrowing towards the ends, and it was sometimes coated with paint. In the reign of Edward III., the sheriff of Gloucester was commissioned to procure 500 painted bows; the unpainted were called *white* bows. In the reign of Henry IV. it was made penal to sell bad bows.

The price of longbows was fixed by statute in the reign of Edward IV. at a maximum price of three shillings and fourpence each, a much higher price than they brought in the reign of queen Elizabeth; and in order to increase the number available, each merchant vessel carrying goods to London was compelled to bring a certain number of bows in proportion to the weight of the cargo carried; and there was a similar enactment in the reign of Richard III., when the importation of every tun of Malmsey wine was required to be accompanied by ten bowstaves, under a penalty of 13s. 4d., and all bowstaves over 6½ feet long were admitted duty free. A statute of Philip and Mary ordains that all temporal persons having an estate of a yearly value of a thousand a year and upwards are required to furnish the State with thirty longbows, thirty sheaves of arrows, and 'thirty steele cappes or skulls.'

German and Italian bows rarely exceeded five feet in length.

Archers carried one or two pointed stakes as part of their equipment for planting before them on the ground as a defence against cavalry, and as a protection from the various missiles of the enemy. Leadenheaded mallets also formed part of their equipment, and these were employed for driving in the stakes, and also to dispatch the enemy's wounded.

The longbow continued in use long after the introduction of hand-guns, but it was practically superseded by the harquebus early in the sixteenth century, when its repute as a weapon of war had been sometime on the wane, though it continued to have enthusiastic admirers for many years; but such is always the case during periods of transition. Henry VIII. was a skilful archer, and there were many enactments in his reign for the encouragement of the use and practice of archery. The bow undoubtedly had many advantages over the earlier forms of hand-guns, which were uncertain, cumbersome, inaccurate and dilatory in operation, in fact inefficient in every way; but in the reign of queen Bess they had so far improved as practically to oust the bow as a weapon of war, in spite of the constant efforts made to rehabilitate it. Still its use constantly cropped up again, for instance; when Charles I. quarrelled with his Parliament, the earl of Essex raised a company of archers for his service. Many trials between hand-guns and bows took place during the sixteenth and even the seventeenth century, most of which resulted in the triumph of the bow; nevertheless at last it ceased to be a military weapon and was relegated to the ladies and gentlemen's shooting matches. As late as 1792, a match took place at Pacton Green, Cumberland, distance a hundred yards, and the result arrived at was that the arrows hit the target sixteen times out of twenty shots, while the musket balls achieved twelve hits only. It is a curious fact that Benjamin Franklin proposed in 1776 to equip the colonial forces with the longbow.

Specimens of the English longbow are of the greatest rarity. The loss of a war vessel, the 'Mary Rose,' which sank off Spithead in 1545, furnished us with some actual specimens of that time. A couple of these bows are preserved in the Tower of London; they are 6 feet $4\frac{1}{2}$ inches long, and made of yew. Another is at Dover castle. There was a Northumberland crossbow still to the fore early in the present century, and the late Mr. Matthew Culley of Akeld, in a letter to our society, dated November 26th, 1814, wrote concerning it: 'This bow had long been used by the hereditary bowmen of Wark castle. It is described as having been formed of various-coloured wood inlaid together, and of great length and strength. From the joining of different sorts of wood valuable properties are derived, which are well known to mechanics, and more especially to builders. This weapon, so

dreadful in the hands of its ancient possessors, being no longer in request, was consigned to the children as a plaything.' I must say that I have not come across any other mention of bows made in such a fashion; but there were crossbows constructed of yew and whalebone in alternate layers.

THE CROSSBOW.

The Greek word for the weapon is γαστραφέτης, because it was pressed by the stomach against the ground when being strung. The Latin equivalent is 'arcus balistarius' or 'balista manualis,' and the weapon with its windlass is obviously inherited from the antique. Fig. 7 represents a Romano-Gallic crossbow and quiver from a relief on a 'cippus' in the museum at Puy,[24] but whether the weapon hybernated so to speak, from the fall of Rome to the tenth century, or that any mention of ballistae over that early period may have had reference to a hand weapon rather than to the mechanical engine of the name is uncertain. What would seem to lend colour to such a possibility is that in medieval chronicles a crossbow is often, nay usually, referred to as a ballista,[25] and this may have been the case also at an earlier period of history.

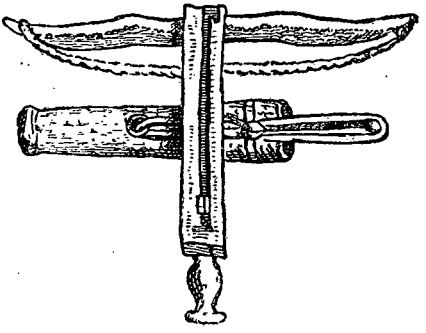


FIG. 7.—ROMANO-GALLIC CROSSBOW.

A soldier armed with a crossbow is shown on a vignette in a MS. of the tenth century in the National Library, Paris, and representations of the weapon occur in Anglo-Saxon MSS. of the eleventh century, and of the twelfth on some frescoes in the cathedral at Brunswick. The weapon does not appear in the Bayeux tapestry, though Guy of Amiens states that the Conqueror had 'balistantes' at Hastings, and these were perhaps as likely to have been crossbows as the larger mechanical

[24] Aymard, *Annales de la Soc. du Puy*, 1832.

[25] A Pipe Roll in the Public Record Office (Mag. Rot. 27 Edw. III.) gives some curious particulars concerning crossbows, and they are called ballistas over and over again. Henry V., as Duke of Normandy, confirmed the privileges of the *balistarii* at Rouen.

engines. Reference is made to the crossbow in Domesday Book in the mention of 'Odo the arbalister,' and Wace says that it was used in the chase in the eleventh century, both in England and Normandy.

It would appear that the use of the weapon was revived in England by Richard I., and in France about the same time by Philip Augustus for use in the second crusade; and we find Peter the Saracen making crossbows in England in 1205 for king John,[26] with wages at ninepence a day.

The princess Anna Comnena calls the crossbow a 'tzangara,' and mentions it as forming part of the armament of the crusaders late in the eleventh century; and that it was in use in the twelfth century is shown by a bull of pope Innocent II. in 1139,[27] which fulminates against its barbarity, and only sanctions its use against the heathen, meaning thereby all nations unconverted to Christianity. Such prohibitions, though renewed by Innocent III., were soon brushed aside, like others of a similar character, both before and since. It was partly owing to the first edict that the mortally wounding of Richard I., by a bolt from a crossbow, was looked upon as a judgment of God. Camden writes:—'It is reported by William Brito, that the Arcubalist or Arbalist was first showed to the French by our King Richard the first, who was shortly after slaine by a quarrel thereof.' Guillaume Guiart, writing towards the end of the thirteenth century, mentions the weapon as being in use at the battle of Haringues in 1297, and he adds that it was introduced into Normandy in the previous century by Richard I. of England. An illustration (*Roy. MSS.* 16 G. vi. fol. 336, in the British Museum), about 1330, shows crossbowmen clad completely in banded mail, with round bassinets, and surcoats to the knees. The crossbow was in constant use during the fourteenth century, when the Genoese, who had been sedulously devoting themselves to the improvement of the weapon and its practice since late in the twelfth century, made it a specialty, and the services of these mercenaries, who wore helmets, brassarts, greaves, and jackets with long sleeves, were in great request in all the wars of the period; it was, however, never a favourite weapon

[26] *Archaeologia*, vol. 58, p. 445.

[27] 29 Canon of the Sacred Council of the Lateran.

with the English, who used it mainly in the defence of fortified places. At the battle of Creçy the English army used the longbow, while the French king had a corps of six thousand Genoese crossbowmen in his pay, but these were of little avail against the English arrows, partly because of rain, alternating with brilliant sunshine, which blinded the Italian bowmen. The English archer could shoot ten to twelve arrows while the crossbowman discharged his two or three quarrels, for the winding up of the 'moulinet' or 'cranequin' was so slow; besides, he had to take a fresh mark and aim every time his crossbow was strung. The crossbow had, however, the advantage of a lower trajectory, but the longbow was much lighter and more portable, besides being more easily preserved from the action of damp than its crossbow confrère. In *Archæologia*, vol. 38, the baron de Cosson states that 'in 1302, William Conrad, bowyer of the Tower of London, supplied 2 lb. of wiseblase, 4 lb. of glue, 4 lb. of sinews of sea-dogs, etc., for ballistae and bows to the Prince of Wales,' and here we have a clear distinction made between the weapons. It does not appear that the extreme range of the crossbow has been accurately determined, but it certainly did not exceed 200 yards. The point-blank range was nothing like a hundred yards, probably in an ordinary weapon not over seventy. Part of the light cavalry of medieval times consisted of crossbowmen. In the *Accounts of the Constables of the Castle of Dover*, dated 1344, a variety of crossbows are mentioned: 'cxxxvj. arbalistas de quibus, xxxiiij. arbaliste de cornu ad duos pedes, et ix. de cornu ad unum pedem, et iij. magne arbaliste ad turrm.' The last mentioned item in the passage is probably the arbalete à tour or cranequin hereinafter described. It would appear from this that there were crossbows with two stirrups, as well as those with the usual one, but I have seen no other reference to crossbows 'ad duos pedes.' Soon after Creçy, corporations of bowmen were established in several French towns. In 1359, a company of 'arbalétriers,' 200 strong, was formed at Paris, and another at Laon in 1367, and the 'Confrérie d'Archers de la ville de Paris' obtained a charter from Charles VI. in 1411. Henry V. of England had only ninety-eight crossbowmen with him when he invaded France, and according to Juvenal des Ursins there were 4,000 crossbowmen in the armies of

the allies (English and Burgundians), for another invasion of that kingdom. The *Chroniques d'Angleterre*, written for king Edward IV., contains illuminations of arbalestiers, with their weapons.

The introduction of the pavise, a large shield propped up before the archer, was a great protection against missiles, and a miniature from Froissart in the National Library at Paris shows a crossbowman shielded in this manner.

The steel used in the construction of crossbows was of the strongest and most pliable kind. An enactment of the reign of Henry VII. forbade the use of the weapon, with certain reservations, under severe penalties. 'No man shall shoot with the crossbow without a king's licence except he be a lord or have 200 marks of land,' and in the sixteenth century it was mostly used in the defence of fortresses, or on ships; and similar prohibitions were enacted during the reign of Henry VIII. This perhaps accounts for a Tower inventory of arms, etc., *anno* 1547, containing only 'Crossbowe to shoot stone—oone.'[28] This would be a prodd most likely.

References are sometimes made, in the middle ages, to crossbows of horn,[29] but I am not aware of any specimens existing made solely of that substance, and these were probably composite bows of whalebone and yew in layers, this form of construction being designed for lending elasticity to the weapon. The fittings are of steel, iron, brass, ordinary bone and whalebone, and the weapons were sometimes coated with glutinous matter as a preservative against moisture. All these details may be seen among the numerous collections of crossbows. The projectiles are usually called quarrels, and are in great variety of form, but shorter and thicker than arrows for the longbow. Several specimens were found at Tannenberg, a fortress dismantled in 1399. The full complement for a crossbowman in the field was fifty quarrels—specimens are quite common in continental museums. Quarrels for the arbalest may be seen in considerable variety at Dresden, Berlin, etc. The stocks of pageant crossbows for the chase, which afforded great scope for ornamentation, were not

[28] *Archaeologia*, vol. 51.

[29] *The Accounts of the Castle of Dover*, dated 1344, mention 'arbaliste de cornu.'

only beautifully inlaid with bleached stag's horn,[30] ivory and mother-of-pearl, but often adorned with mythological, historic or biblical legends, carried out with rare elegance and finish, in fact presenting some of the choicest work of the 'Renaissance.' There are also barrel crossbows, and some with a pistol in combination. The crossbowman wore a brigandine or stuff tunic lined with strips of steel, besides his 'half-plates.' A picture in the National Gallery shows how the old stirrup crossbow was bent 'ad unum pedem.' The bowman places his foot in the stirrup, a cord is then fixed to the butt of the stock, the other end being attached to the waistbelt; the cord runs on a pulley, and the bow is bent by raising the body.

Early representations of crossbows on illuminations and miniatures are too small to show any apparatus there may have been for liberating the string; and the oldest form of lock of which there is any example is simply a long lever, working on a pivot passed through the stock. One portion of the lever is within the stock itself, while the other (the trigger) is outside. This lock was inadequate, for in order to obtain the necessary purchase to enable the end of that portion of the lever inside to turn the nut holding the string, for the discharge of the projectile, the protruding part necessarily stood so far out as to be much in the way, and was apt to go off when touched inadvertently. This disadvantage was obviated in later forms of locks by the substitution of a succession of small levers inside the stock, in place of the one piece; these were held in their places in the receptacle cut for them in the wood. By this means the angle of deflection of the trigger was much reduced when the mechanism was set for the release of the string.

The subsequent addition of a lock-plate permitted of a much more delicate mechanism; and the old long trigger was fixed on the stock as a guard for the protection of its short and much more effective successor.

THE ARBALEST, OR WINDLASS CROSSBOW (arbalète à cranequin).

This, the Genoese crossbow, is furnished with double cordage, and a set of pulleys (two) near the bottom of the stock, and another set

[30] We are indebted for the discovery of this interesting fact to Herr Max von Ehrenthal, late Director of the Historische Museum at Dresden.

(four) placed below the bowstring; these strong cords run along the pulleys, and the bow is bent by a small windlass, which is adjustable to the bottom end of the stock, while hooks, connected with the top pulleys, grasp the bowstring. As soon as the bow has been bent by the action of the windlass, the tackle is removed and is carried by the bowman slung from his shoulder. The top end of the stock is furnished with an iron stirrup, through which the archer thrusts his foot, in order to obtain the necessary purchase for bending the bow. The string is liberated by the action of a trigger, which sets free the catch holding it.

This type of bow was used at Agincourt, and it was greatly depended on in the defence of beleagured places. It was also called 'arbaleté à tour,' because the windlass, fixable to the stock, was sometimes embattled, like a tower, and it was named 'cranequin.' In Germany this was called the English windlass. The Agincourt form continued practically the same for centuries, indeed, up to early in the seventeenth century, when bows of this model were made at Malines, in Belgium, by a 'confrère de tir.' I have one of these Malines crossbows in my collection

THE LATCH CROSSBOW (arbalète à cric).

Latch is the English name given to the improved crossbow of the second half of the fifteenth, and to that variety used in the sixteenth century. It was bent by a windlass, with a rachet and long handle, of a much less complicated form than the cumbrous machinery of the 'cranequin.' The tackle is slipped on to the stock from the bottom, which passes through the thick hemp or iron ring or hoop attached to the windlass. Some of the latches used in fortress work were very heavy and unwieldy. The later forms of this bow are sometimes furnished with an elevating sight.

The earliest mention of the name latch, I believe, occurs in an inventory of the 'ordynaunce' and munitions, etc., taken in 1547, and in it are scheduled 'cross-bowes called latches.' There is a latch crossbow in my collection. The derivation of the word 'latch' has not been ascertained; possibly it comes from the latch-like handle.

THE GOATSFOOT CROSSBOW.

This horseman's weapon is light, and the apparatus for bending it is both prompt and simple. The stock, below a pin going through it, is firmly grasped by a lever consisting of two branches of unequal length, one of which grasps the string, while a downward movement

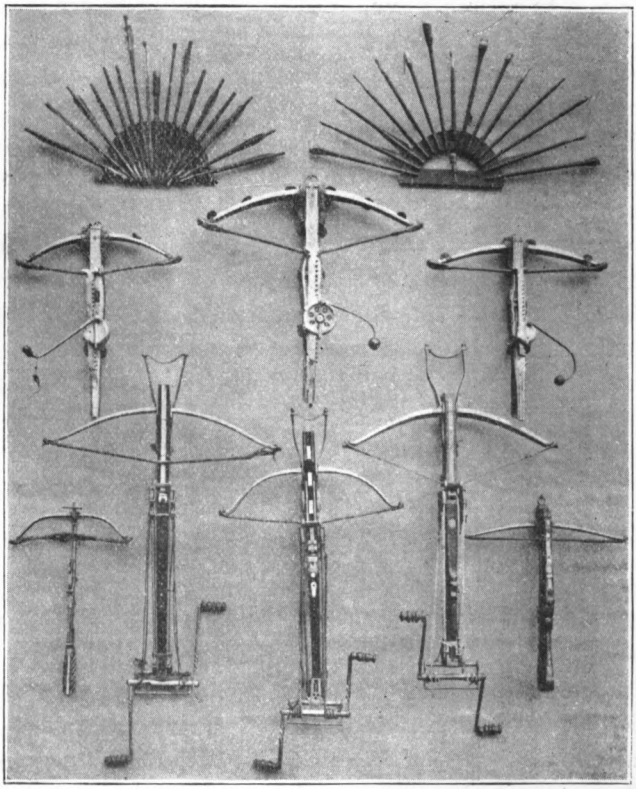


FIG. 8.—CROSSBOWS AND QUARRELS.

of the other and longer branch, draws the cord into position for the discharge. A specimen, dating about 1425, may be seen at Dresden.

THE PRODD CROSSBOW.

This bow is light, and was used in the chase. It shot principally pebbles, but also bullets. The French called it 'arbalète à jalet.' A

small prodd, in my collection, would seem to date from late in the sixteenth or early in the seventeenth century; and it is probably a similar bow to the one used for shooting game by queen Elizabeth at Cowdray. It takes its name from two upright pins of iron, placed at the tip of the stock, and across the top of these pins a thread is drawn, with a bead in the centre, which required to be brought into line with the notch observable on the top of the adjustable movement placed over the trigger for sighting purposes. The cord of this bow is double, and is kept taut by beads placed there for the purpose of leaving a cavity or resting place in which to place the pebble or bullet for discharge. This bow being light no windlass was required for bending it, and the arrangement for straining the cord into position was combined with the lock for its release.

Fig. 8 gives representations of the Arbalest, the Latch, and the Prodd.

THE SLING AND FUSTIBAL.

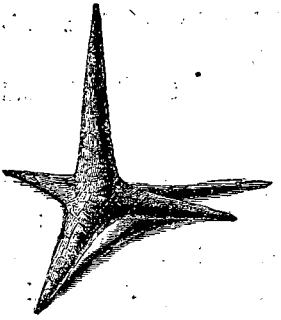
The sling is far too familiar to everyone to need description, and its ancient character is universally known. The ancient Egyptians used slings made of leather thongs; and the armies of Greece and Rome had their contingents of slingers (funditores). Vegetius recommends the slinger to cast with not more than one turn about the head. The excavation at Ardoch yielded 67 sling bullets of lead varying from $\frac{5}{8}$ to $1\frac{1}{2}$ inches in diameter; and at Hill-fort near Abernethy two sling bolts of burnt clay were unearthed. A great number of baked clay sling stones were found in a late Celtic crannog near Glastonbury in 1892. The sling was used at the battle of Navarete, where, Froissart says, 'they broke many helmets and skull caps, so that they wounded and unhorsed many of their opponents,' and as late as the siege of Sancerre, in 1572. At the Rotunda, Woolwich, are twelve sling stones of two sizes, viz., 2·35 and 1·7 inches in diameter. These stones came from Rhodes—they are pebbles covered with lead. A single slinger appears on the margin of the Bayeux tapestry—the weapon is being used by a peasant aiming at a bird. I saw it used in Egypt by boys for frightening birds from the bean fields.

The fustibal, or staff-sling, consists of a long pole, four feet in length, with a sling in the middle. An example is recorded in a

MS., which is attributed to Matthew Paris, in Bennett College Library, Cambridge, C. 5, xvi., and there is an actual staff-sling in the museum at Emden. It was wielded by both hands to cast stones, and used in the sixeeenth century for hurling grenades. The example at Emden was adapted for that purpose.

CALTRAP OR CROWSFOOT.

This, the Roman 'murex' or 'tribulus,' was a sharp point of iron standing upright, fashioned like a crow's foot. It was constructed so that one point always projected upwards, however thrown on the ground. They were strewn broadcast on the ground for the purpose of maiming horses in a charge of cavalry, or placed on a moat when filled up with fascines. The illustration shows a Roman caltrap discovered at Chesterford (*Arch. Jour.* vi. 21), and one has been found at Chesters (see *Proc.* iv. 170). Knightly spurs have been known to have been used for this purpose. The name is an abbreviation for cheval-trap. There are some specimens in the Rotunda, Woolwich, varying in height from 1·25 to 2·5 inches. An indenture of 16 Edward III. mentions 'j barelle cum mm.dcccc. calketrapp.'



Besides missile-casting engines there were many other agencies employed in the siege operations of Roman and medieval times, and a sketch follows of some of them. It will be seen that the middle ages inherited, in this direction also, almost everything from Roman times, which had, in their turn, borrowed greatly from still earlier empires and peoples.

The Romans made much use of the spade in warfare and owed a great part of their astonishing successes over numbers to its agency. The frequent scandalous panics and surprises recorded of several of the battles and sieges during the middle ages, and especially those in which the forces consisted mainly of the levies of the *ban*, were often attributable to a lack of the organised employment of this invaluable

adjunct in warfare. Its use was properly appreciated by Charlemagne, who enjoins a supply of spades with every military train.

A coup-de-main or an attempt at escalade was usually the first move made in the assault on a fortress, but when this failed it became necessary to sit down before, and closely invest, it. Military engines were then brought into play and wooden towers used, besides all the minor means, offensive and defensive (the latter by no means the least necessary),[31] employed by the besiegers in their operations, such as sap and mine, battering down the walls, casting fiery darts, filling up moats and ditches with fascines or rubbish, to enable the assailants to get near the walls to attack them closely. The moats when filled up were strewn with caltraps.

False brays (fausse braye) were used to keep the fosse clear, and to hinder the approach of military engines, sheds and towers, and especially to place difficulties in the way of mining. This defence is variously described as an outer barrier of a more or less permanent character, and as forts of the nature of barbicans. Probably it took both of these forms.

Medieval references to the 'warwolf' afford another illustration of the same name being sometimes applied to two totally different things. This machine would seem to have been made in the form of a harrow, and it was used as a second defence after a portcullis had been forced. Matthew of Westminster, however, refers to it as a stone-throwing engine, but going back to the sixth century of our era, Procopius in *De Bello Gothico* speaks of the warwolf as a machine for defending a gate, constructed on the harrow principle, and let down from a parapet on an attacking force. It is possibly the machine shown on one of the Froissart illuminations when 'the earl of Haynault takes and destroys Aubenton.' The herse would seem to have been a machine of this kind also. There may have been a stone-casting machine called warwolf, or the word was used as a sort of nickname[32] for an engine employed for that purpose, for Camden in his *Britannia* says,

[31] There are many disgraceful panics recorded in the history of the middle ages, when a large besieging force has been subjected to a successful sally from a fortress, and indeed it sometimes happened that the tables were turned and the investing force besieged within its own stockade.

[32] Nicknames and pet names, as already stated, were commonly given in the middle ages, to both mechanical engines and pieces of ordnance; and this is naturally a prolific source of difficulty in their identification.

'concerning these mangonels, petraries, trabucces, bricoles, espringolds, *and what our ancestors called the warwolf*, threw great stones with so much force as to break open strong gates.'

Among the engines used in attacking beleaguered places is the 'tolleno,' for lifting soldiers on to a parapet. This ancient machine was worked by counterpoise, and may have suggested the application of this principle to stone-casting engines, used in the thirteenth century. It was a beam and scales, in the form of baskets. One scale was weighed down, so that the other ascended to the level of a parapet.

The battering-ram or bosson (aries) is a heavy oak beam, or several beams spliced together, tapering towards the head, which was shod with iron, or sometimes tipped with an iron ram's head for breaching a wall; which was done by striking it near the bottom, continuously battering at the same place, so that the mortar fell out.

According to Ezekiel (599 B.C.), the king of Babylon used these machines to batter down the walls of Jerusalem (Ezek. xxi. 22).

The bore (terebrus) is much lighter than the ram, and pointed at the end, the object being to dislodge individual stones, and by degrees to make a large hole by picking out the mortar.

A ram is figured on an inscription at Nineveh, and there is an actual specimen of Roman origin in the Germanische Museum at Nuremberg, which is about a foot in diameter at the base, about eleven feet in length, and is still shod with iron. Plutarch refers to one used by the Romans in the Parthian war; and the engine is described by Vitruvius, who states that it was sometimes as long as 120 feet. Josephus mentions a ram, used by Vespasian, as being 50 cubits long (about 91 feet), with a head as thick as ten men. The battering ram was used by Wamba at Nismes in 673, and fig. 9 represents a relief

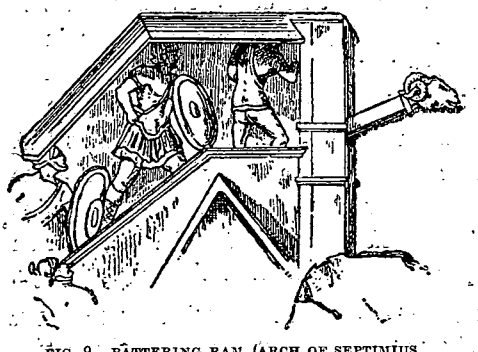


FIG. 9.—BATTERING RAM (ARCH OF SEPTIMIUS SEVERUS).

on the Arch of Septimius Severus, erected in 203 A.D. A vignette on a MS. of the tenth century, No. 17,339, in the National Library at Paris, shows it in operation suspended on a trestle, borne on wheels, and the engine was used at the siege of Exeter in 1067. There are frequent allusions to the engine up to the sixteenth century in the records that have come down to us. Froissart repeatedly mentions the ram, but it is generally difficult to say whether the bore or the battering ram is meant. The battering ram was often made available for the united energies of many men, and when suspended by ropes or chains in a sling or held by two perpendicular beams, its momentum was enormously augmented. It was also impelled on rollers or wheels and rapidly run forward to breach a wall, but its usual action was that of the pendulum, working only to the limits of the chain by which it was held suspended. Woolsacks or bags of hair were let down by the besieged from a parapet to deaden its effect, or wooden forks or triangles were lowered to catch the ram's head, so that it could not be drawn back again for another stroke. Sir Christopher Wren used the ram as an agency for the demolition of the walls of old St. Paul's.[33]

Another and more potent agency employed in all ages for breaching, was the mine, which was usually an excavation started from beyond the fosse and carried under the walls, the foundations of which were then propped up with timber and fired, after the hole had been filled with brushwood and straw for tinder; with the burning of the props the wall fell in and a breach was effected. This mode of offence was only available in cases where the walls were not built on the solid rock. Countermining was usually resorted to by the defenders as early as the eleventh century, or when this was omitted palisades were erected to cover the supposed place when the mine could be located. Various means were used for the detection of the slightest vibration under the walls.

Encounters under the surface of the ground in mining and countermining were not unfrequent. The siege of Melun, in 1420, is an instance; king Henry V. is stated to have been engaged in this encounter. Mining was also practised in the East. Gibbon, quoting

[33] There is a drawing in the *Pyrotechnie de l'Ancelot Lorrain*, and another in the *Walturius* of the Hauslaub Library at Vienna, of an engine with gear, constructed on the counterpoise plan, for battering down a wall. Note Demmin.

from a MS. of George of Sienna, states that mining with gunpowder began in 1480.

The 'sow' or 'cat,' the ancient 'cattus, pluteus or vinea,' an illustration of which, from the Arch of Septimius Severus, is shown in fig. 9,[34] is a movable shed on wheels, covered with raw hides to prevent its being burnt by fire cast from a parapet, and there are cases on record of these sheds having been plated with iron. It was often used as a cover for enabling a ditch to be filled up with rubbish or fascines in order to prepare a way for a wooden tower or other means of attack, and it sometimes contained a ram. The cat is mentioned by Guiart, anno 1295—'Un chat sur le pont atraire, etc.,' and one was employed a year earlier at the siege of Château Gaillard. These erections were also used by St. Louis in his Egyptian campaign in 1250, and there is constant mention of them in accounts of the sieges of the middle ages. This armed shed was often propelled on rollers, worked by levers, or by ropes and pulleys. John Sykes, in *Local Records*, when referring to the siege of Berwick by Edward II., in September, 1319, says, 'On the 13th the English employed a great machine called a sow, constructed for holding and defending men, who were moved in it towards the foot of a wall, in order to mine and sap its foundations. Devices were used to burn the machine, but by throwing a stone of vast weight from an engine, the sow was split and her occupiers dislodged.' This kind of engine was in use as late as the wars of the Commonwealth. Camden says, 'The Cathouse, answerable to the Cattus, mentioned by Vegetius, was used at the siege of Bedford Castle in the time of King Henry the third. The sow is yet usual in Ireland, and was, in the time of King Edward the third, used at the siege of Dunbarf, which when the Countesse, who defended the castle, saw—she said merrily, that unless the Englishmen kept their sow the better, she would make her to cast her Pigs.'

The 'testudo' (*testa*, a shell), the medieval 'tortoise,' was a movable wooden shed like the cat, but it contained a battering ram or a bore for attacking a rampart. The Antonine column at Rome furnishes an example of Roman soldiers extemporizing a testudo when attacking a fort. They placed their long cylindrical shields over

[34] The family of Cattus was in great variety in Roman times, and of various designations.

their backs at a sharp angle, with the ends of these mantlets resting against the rampart assailed, thus forming a sloping cover to work under and sap and mine, or otherwise to attack the fortress. The besieged are seen throwing down rocks and other missiles, but these roll down the inclined plain, presented by the sloping mantlets, without doing very much harm. Fig. 10 shows this arrangement in operation (column of Marcus Aurelius, erected 167-179 A.D.). The name was also applied to a close formation of soldiers, who placed their shields together so as to present an unbroken surface against the missiles discharged by the enemy. One form of tortoise was called a 'spur,'—it rather resembled the prow of a ship.

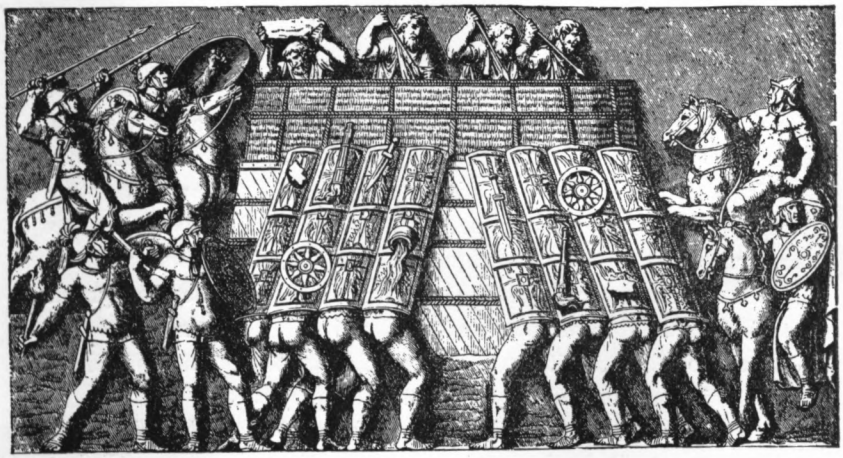


FIG. 10.—TESTUDO (COLUMN OF MARCUS AURELIUS).

The 'gate' is referred to in the ballad of the *Albigeois* as a cover for the besiegers 'faced with iron and held knights within it to push the gate vigorously and quick.' The besieged assail it with missiles, and cry 'Par Dieu! dame cat will never catch the rats.' This machine clearly belongs to the 'cat' family.

The 'belfredus,' 'berefreid,' 'beffroi,' or 'belfrey,' sometimes called 'chas chateilz' (cat castle), in contradistinction to the smaller cat, is a movable tower used for enabling bodies of soldiery to rush on to the walls of a fortress, with the object of taking it by storm. Marcellus used one of these towers, called *sambuca,* at the siege of

Syracuse; and Vegetius, in *De Re Militari*, calls it by the same name. This machine seems to have hybernated between the sixth and eleventh centuries, at least I do not know of any records concerning it during that interval. It was constructed in several storeys, the lowest being frequently supplied with a bore or a ram. There were intercommunications between the storeys by means of ladders or staircases, and the tower was high enough to reach or overtop the parapet of the fortress assailed. It was provided with a drawbridge for an assault in force, and the structure was rolled on wheels to the point of attack. It also was usually covered with raw hides as a protection against fire. An erection of this kind was used against Rome in 537, but we do not hear of it again before the eleventh century, when we find one in operation at the siege of Jerusalem in 1099, and a tower of the kind was burnt by Greek fire before Acre in 1190. A belfredus, built by order of Simon de Montfort, was employed at the siege of Toulouse, and as stated in the ballad of the *Albigeois*, already several times referred to, it was adapted to contain five hundred men. Belfreys were used by St. Louis, in Egypt, in 1250, and they were employed in every siege of importance. The last of these engines was constructed as late as the reign of Charles I., and it was captured by the Parliamentary forces. The great objection to the employment of this kind of tower was its great weight, which made it very difficult to roll over ditches filled up with light rubbish or fascines; and its size presented an excellent mark for projectiles.

Cæsar, in describing the siege of Marseilles, conducted by his lieutenant, C. Trebonius, refers to a stationary tower, called a musculus, built on the lines of the berefreid. The first storey contained a bore to knaw a hole, and hence the name of the tower. That storey having been completed, a floor was laid over it, and above this the walls, built of brick, were continued to a second, and then again floored, and so on to the top. The tower was placed under the walls of the fortress attacked. The only protection for the soldiers while building up the walls was afforded by their mantlets. This sort of tower was also used during the middle ages, and called 'bastille,' but it was not built of brick, like the Roman 'musculus,' but of earth, or wood, or stones without mortar. In Edouard Lehrischer's *Avranchin Monumental et Historique*, reference

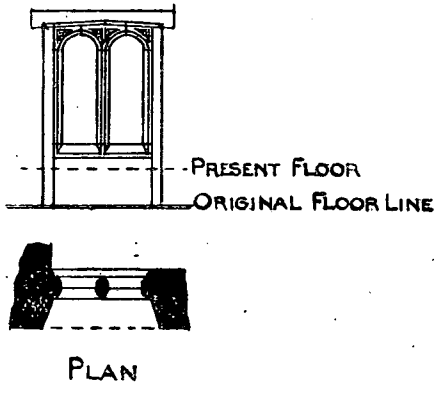
is made to bastilles as having been used at the siege of Mont St. Michel in Normandy.

'Mantlets' of hurdles (musculi), stuck in the ground or held over the body, provided an excellent cover for archers, or other combatants, beneath the walls of a fortress, for protection against Greek fire, boiling pitch, showers of stones, and the numerous other inflictions showered down from the battlements by the defenders, and they formed part of the archer's equipment in the field.

'Greek fire' played a great part in the warfare of medieval times, both by land and sea. It is stated to have been invented by a Syrian of Heliopolis, in 673, but Procopius mentions something of the kind in the preceding century, called 'Medea's oil.' Jesuit Petavius states, on the authority of Nicetas, Theophanes and Cedrenus, that it was invented about the year 660. Anna Comnena gives the ingredients, in the *Alexiad*, as bitumen, sulphur and naphtha, while others add pitch and gum to the mixture. The princess tells us in the *Alexiad* how it was discharged from a tube! and here we may be said to have the prototype of the hand-gun. An Arabian treatise of the thirteenth century, written by Hassan Abrammah, speaks of several ways of using Greek fire in the East—in grenades made of pottery or glass, thrown by hand; tow or hemp wrapped round staves and then dipped; poured, or squirted through tubes, or cast from military engines by means of arrows, javelins or barrels. The northern nations long regarded Greek fire as supernatural, and as the secret of its composition was most jealously guarded it was not before the second crusade that they acquired the knowledge of its component parts; but whether they were able to prepare it themselves in the East is not so clear. Philip Augustus brought some of it from Acre, and used it for setting fire to some vessels of the English fleet at the siege of Dieppe. It was employed in many ways, but its most fatal form of application was in setting fire to fortified towns, where the wooden houses of medieval times afforded it free scope, when inadequately guarded against by a sufficient covering of the roofs with raw hides and other means of protection. A mixture of vinegar, sand and urine was used to put out the flames. Barrels of Greek fire were cast into fortresses by various military engines as already described, and also by mortars; and it was freely employed by the

besieged in the destruction of military engines and movable towers, long after the introduction of cannon. The Sire de Joinville, describing its use in the *Hist. de St. Louys*, says "that in front it was of the bigness of a tun, and that the tail of it stood out 'comme un grant glaive.' It sounded like a thunderbolt, and looked like a great dragon." A treatise by MM. Reinaud and Favé, entitled *Du Feu Grégeois*, gives a recipe for its production, and other particulars; and in John Anderne's *Practica*, *temp.* Edward III., a clear distinction is made between 'Fewes Grégois' and 'Fewe Volant,' showing that both descriptions were in use in that reign; the 'fewe volant' being gunpowder. Froissart tells us that Greek fire was employed at the battle of Breteuil in 1356, the besieged being provided with 'canons jetant feu.' With the rapid improvement of ordnance, and especially that in the impulsive force of gunpowder, brought about greatly by its granulation, Greek fire, as well as mechanical engines of war, and the various contrivances for attacking and defending a fortress, at length became obsolete.

FURTHER EXPLORATION SHEWS THIS TO HAVE BEEN THE DESIGN OF WINDOW AT END OF SIDE CHAMBER



(See p. 65 *et seq.*)