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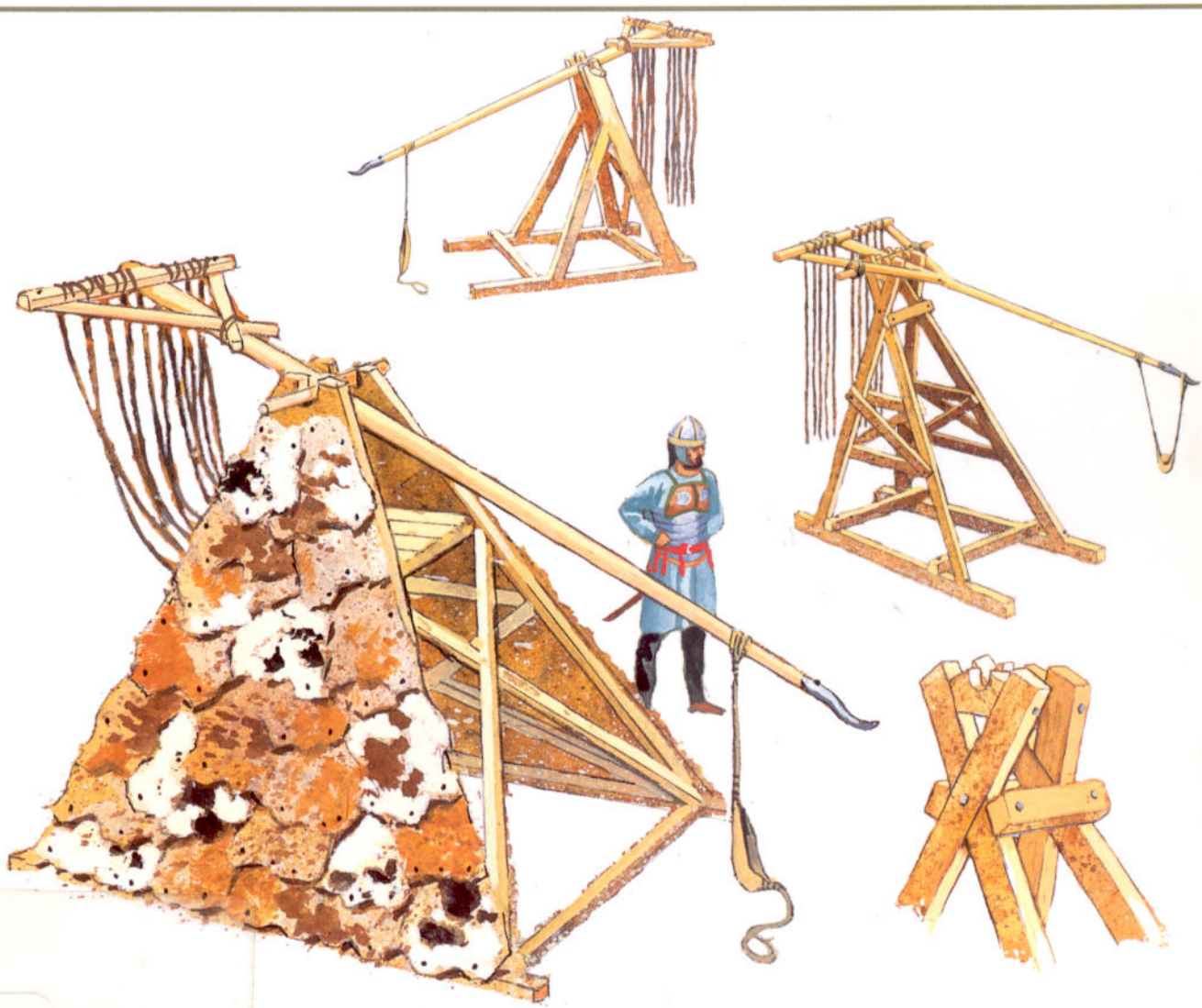
Medieval Siege Weapons (2)

Byzantium, the Islamic World & India AD 476–1526



avid Nicolle • Illustrated by Sam Thompson

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New Vanguard • 69

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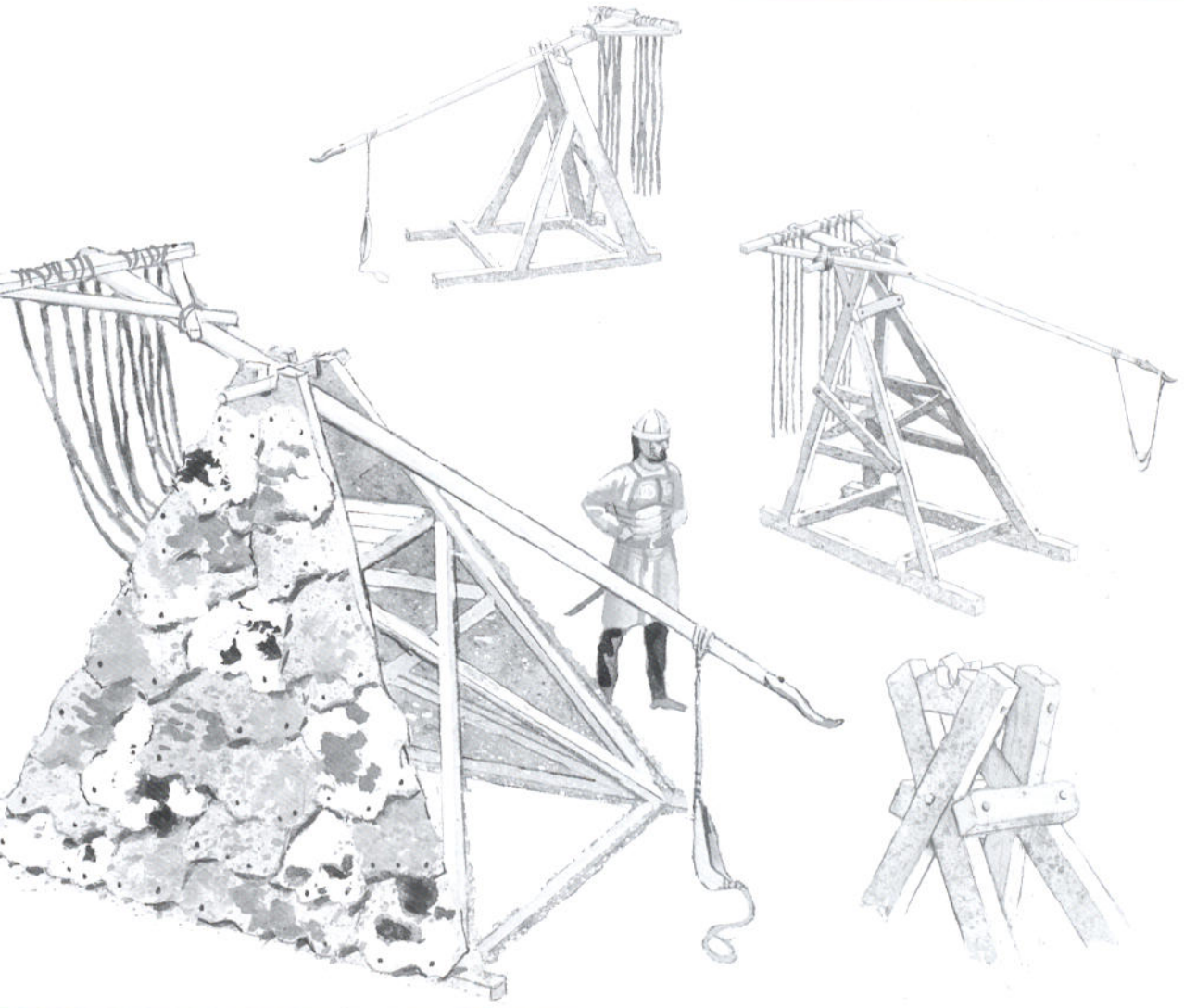

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Author's Dedication

For Melanie and Christian
"'By my faith,' cried he, 'yes, she is indeed my friend. It is a small matter to me now whether men slay me or set me free, for I am made whole of my hurt just by looking upon her face.'" (from *The Lay of Sir Launfal* by Marie de France, c.1175)

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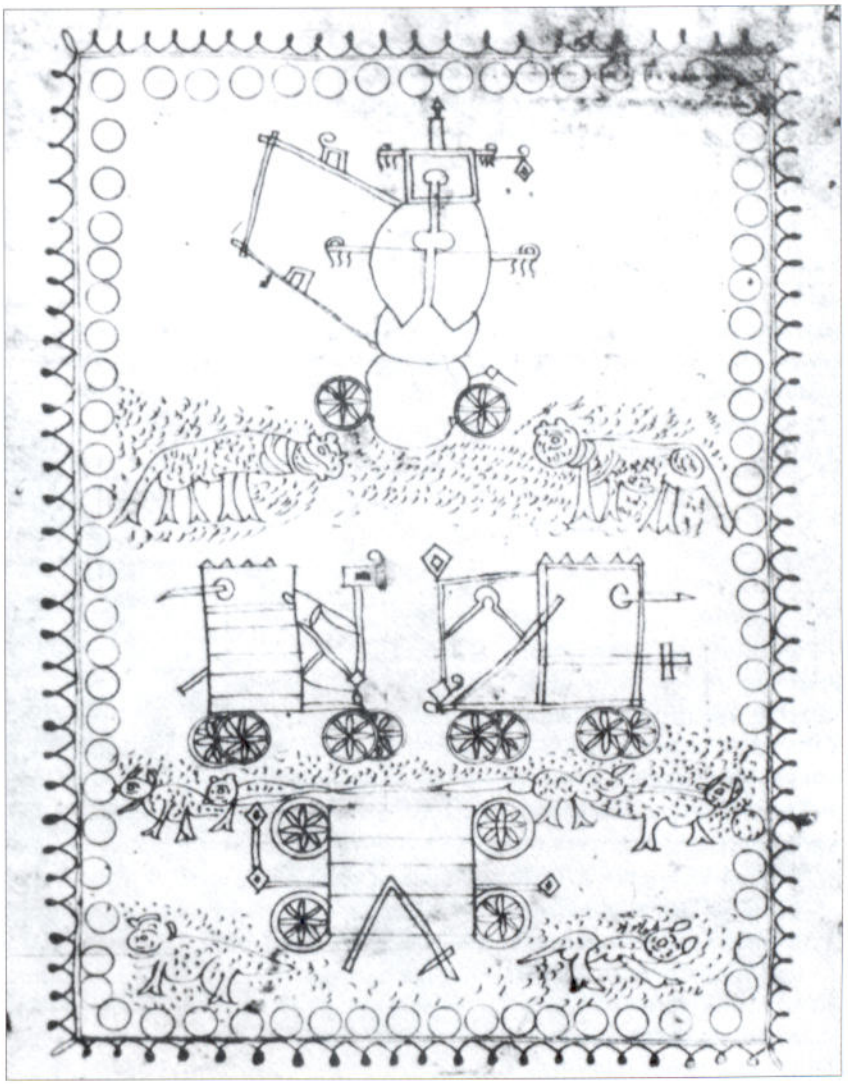
MEDIEVAL SIEGE WEAPONS (2) BYZANTIUM, THE ISLAMIC WORLD & INDIA AD 476–1526

INTRODUCTION

In the medieval Middle East it was widely said that 'Nimrod the King of Babylon' was the first person to construct a stone-throwing mangonel, and that the king learned the secret from the Devil himself. Complex siege machines had of course been known in this area for a very long time and civilisations that traced their roots to Rome, Greece, ancient Iran and even further back had traditions of effective siege warfare. The



Some early Byzantine military treatises are, like this example from the late 10th century, illustrated with almost childlike drawings. Yet this is in some respects more useful than more artistic manuscripts since its simple illustrations show the devices which Byzantine armies actually used, rather than the elaborate structures imagined by artists in Constantinople. The two objects in the centre seem to be wheeled, perhaps torsion-powered, engines to shoot large arrows. (*Treatise on Campaign Organisation and Tactics*, Vatican Library, Cod. Gr. 1164, f. 238v, Rome)

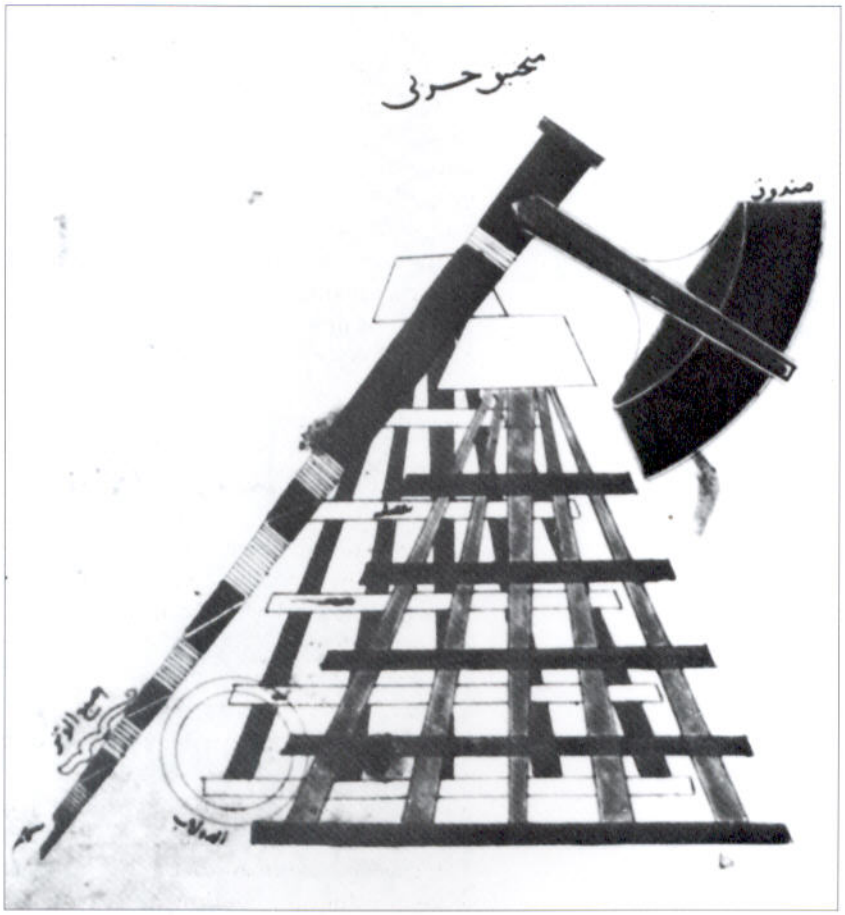
maggana or arsenal in Early Byzantine Constantinople included a library of military books and technical treatises while the rulers of rival Sassanian Iran had similar collections, as did the kings of India. Several of these ancient texts still exist, especially those used by the Byzantines, and fragments of Persian military manuals survive in medieval Arabic books, but unfortunately almost nothing remains of ancient Indian sources.

Competing Cultures – Shared Technologies

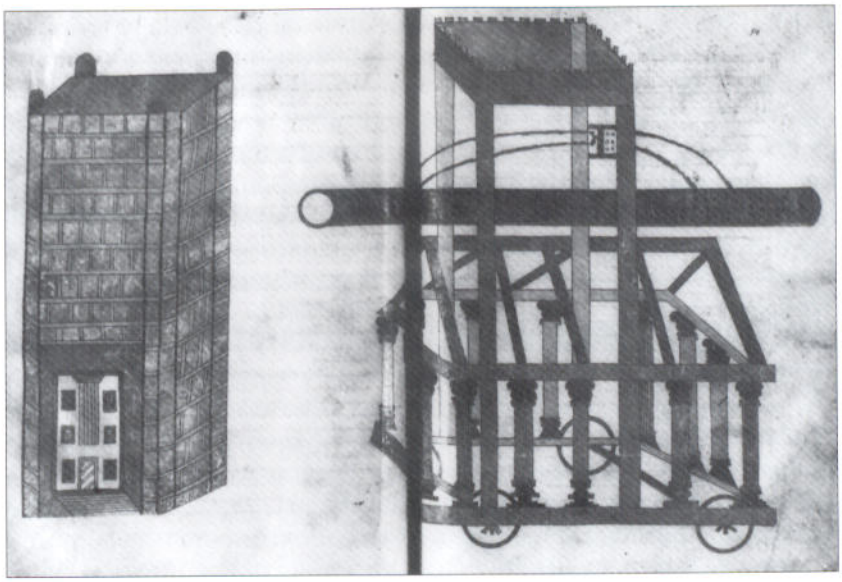
However, it would be wrong to see the siege technologies of the Middle Ages merely as a continuation of ancient traditions. In fact the medieval Byzantine and Islamic worlds witnessed dramatic advances in military engineering. The Mediterranean, the Middle East, Iran and to some extent India were opened up to Chinese technology which was often far in advance of that of the Graeco-Roman world. Furthermore Islamic civilisation introduced a more open-minded attitude towards technology in the civil and military fields. Medieval Christendom followed, and by the late Middle Ages Europe and the Islamic world had become 'machine-minded' cultures.

Muslims may have taken a lead but they also inherited highly sophisticated traditions of siege warfare. The final years of Sassanian Iran (late 6th to early 7th century AD), long the rival of Rome, were characterised by a defensive mentality which laid considerable emphasis on siege technology. This is said to have been learned from the West but it seems more likely that knowledge flowed in both directions. In fact early Byzantine siege warfare from the 5th to early 7th centuries AD was old-fashioned. Although the Christian Byzantine Empire possessed a highly respected military tradition which would soon influence the Arab Islamic caliphate, from the late 8th century onwards the Byzantines were probably learning more than they taught and the Byzantine reliance on guerrilla-style 'shadowing warfare' left little scope for complex siege machines.

Things changed in the 10th century when a revived Byzantine Empire returned to the offensive and Byzantine military technicians may have contributed to the development of the new



The mid-15th-century Arabic technical manual *Al-Aniq fi'l-Manajaniq* was made for use by Mamluk siege engineers and commanders. After showing how to erect the frame, mount the arm on the axle and attach the counter-weight, the book illustrates a *manjaniq harbi* or 'war mangonel' ready to shoot. (*Al-Aniq fi'l-Manajaniq*, Topkapi Library, Ms. Ahmad III 3469, f. 17v, Istanbul)



One of the finest Byzantine military manuals was made in the 11th century and is a collection of earlier texts. The section on ballistic machines is based on treatises by Athenios for war machines, Biton for catapults, Heron of Alexandria for portable devices, and Apollodoros of Damascus and Philon for throwing and assault devices. (Bibliothèque Nationale, Cod. Gr. 2442, ff. 58r-59v, Paris)

counter-weight trebuchet, though this is more likely to have been invented within the Islamic Middle East.

One of the most significant aspects of the early Islamic period was the way in which different military traditions were brought together. In fact the early Arab caliphate largely depended upon the siege technologies of conquered peoples, mainly Arabised Syrians, Greek Byzantines, Iranians and Turks. Consequently the Umayyad armies that attacked the Byzantine imperial capital of Constantinople used advanced siege engines and by the mid-8th century Caliph Marwan II had no fewer than 80 stone-throwing machines stored at Hims in Syria. The importance of specialist siege troops rapidly increased under the succeeding 'Abbasid caliphate, which had its capital in Iraq rather than Syria, with *manjaniqin* mangonel operators being stationed in all important fortresses and accompanying all major expeditions.

By the time of the Crusades in the 12th century, western Europe had reached a level of military sophistication such that Muslim military technicians found that the *Ifranj* or westerners were now worth studying. As a result, forms of stone-throwing engines called *Ifranji* or 'Frankish' were added to existing Arab, Persian, Turkish, *Rumi* ('Roman') or Byzantine machines. Not until the 14th century, however, did western European siege technology outclass that of the Byzantines, Muslims, Indians and other easterners. By then the Mongols had burst upon the scene, bringing with them much of the sophisticated siege technology they had learned while conquering northern China. But again the flow of ideas was not only in one direction, since the Chinese learned how to construct and use counter-weight trebuchets from Muslim siege engineers employed by the Mongols. Since Russia was conquered by the Mongols, it might have been expected that the Russians would emerge as experts in siege warfare. Instead, Russia's scattered and small cities meant that it was not fertile ground for advanced siege technology.

The situation in India is less clear. Earlier historians have tended to interpret references to terrifying siege weapons in early Indian epic texts too literally, leading some to claim that gunpowder was invented

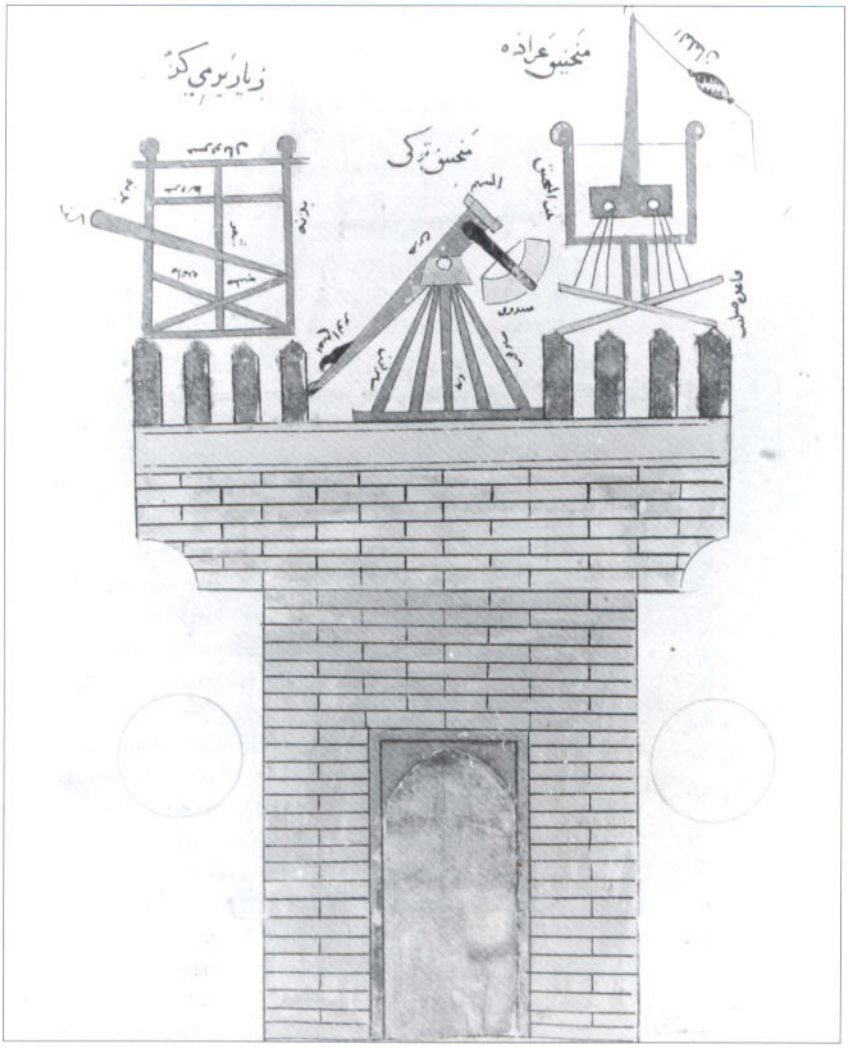
there. In reality India remained backward in siege technology, despite pre-Islamic India's sophistication in mathematics, metallurgy and chemistry. Perhaps this was because Hindu and Buddhist armies conducted warfare in a manner governed by religious taboos which inhibited the use of fire for military purposes. Further afield, in southern India, Sri Lanka, Burma, Malaya, and other parts of south-east Asia influenced by Indian civilisation, siege engines were rarely recorded, despite the fact that field fortifications and strongly entrenched stockades were a dominant feature of war in these regions.

STONE-THROWING MACHINES

Three basic systems were used to throw missiles at enemy fortifications. The first was torsion-powered, relying upon power stored in twisted skeins or ropes. The second relied upon the traction principle, using a beam-sling pulled by one or more men or women, and later by a counter-weight. The third system was essentially a large crossbow.

The Power of Twisted Skeins

Torsion-powered machines with one or two arms were known during the Roman period and were used extensively as the Roman Empire declined in the 4th–5th centuries. These included the seemingly wagon-mounted *carroballista*. The *Taktika* written by the Emperor Leo (886–912) also mentioned infantry with wagons carrying stone-throwing artillery now called *magganika alakia* or *elaktia*. As the weapon could swivel from side to side, a two-armed torsion machine is also more likely than the single-armed type previously called an *onager*. A century or so later the word *elakation* meant a windlass and in the 10th century it was associated with a weapon called the *chaero-maggana*. Perhaps these *magganika alakia* were, in fact, descended from the carriage-mounted, swivel-mounted, torsion-powered late Roman *carroballista* with



***Al-Aniq fi'l-Manajaniq*, or 'Elegance Concerning Mangonels', is by far the most comprehensive surviving manual on medieval stone-throwing machines. The manual was written in Egypt or Syria in 1462, but draws on lost earlier treatises. This illustration shows the three most suitable machines to be mounted on a fortified tower. On the right is a man-powered mangonel which is called a *manjaniq 'arradah*. In the centre is a counter-weight type now called a Turkish *manjaniq*. On the left is a single-armed, torsion-powered machine labelled as a *ziyar*. *(Al-Aniq fi'l-Manajaniq*, Topkapi Library, Ms. Ahmad III 3469, f. 63v, Istanbul)**

a windlass or similar mechanical spanning mechanism. The 10th-century Byzantine version could also shoot arrows as well as stones and perhaps incendiary grenades.

Clearly the complicated two-armed form of torsion engine had declined in significance during the Late Roman and Early Byzantine centuries while the single-armed *onager* or 'wild ass' became more important. Tactically the *onager* was much less flexible as it was extremely difficult to alter its aim, but it was simpler to construct and was more robust. The reappearance of two-armed torsion machines in the Islamic world does not necessarily mean that their use was learned from the medieval Byzantines since such technology could have been inherited from the Sassanian Empire and was already available in the ex-Byzantine provinces of the Middle East.

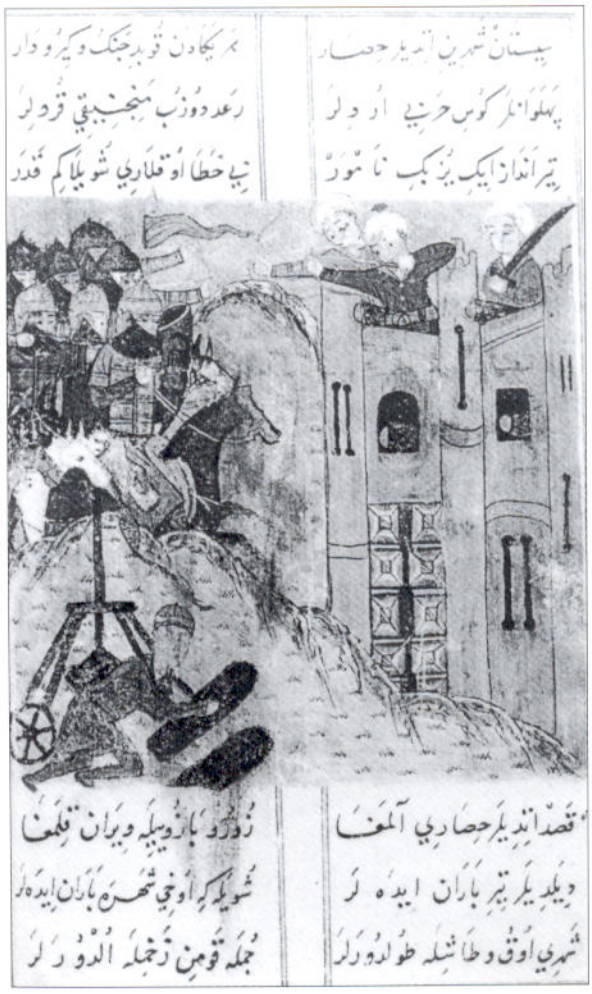
Variations on the term *ballista* also continued to appear in Byzantine sources, some of them again being mounted on wagons, while Greek and Arab sources make it clear that Byzantine *ballistas* were normally anti-personnel weapons used in both offensive and defensive siege operations. In the 11th century Heron of Byzantium's military manual stated that:

> The construction of the one-arm device will furnish those who wish it with theory about catapults [*xatapaltixion*], as it brings together much for long-range shooting with *euthytone* and *palintone* engines; that is stone-shooters [*lithobolos*] and missile-shooters [*oxubelesin*].

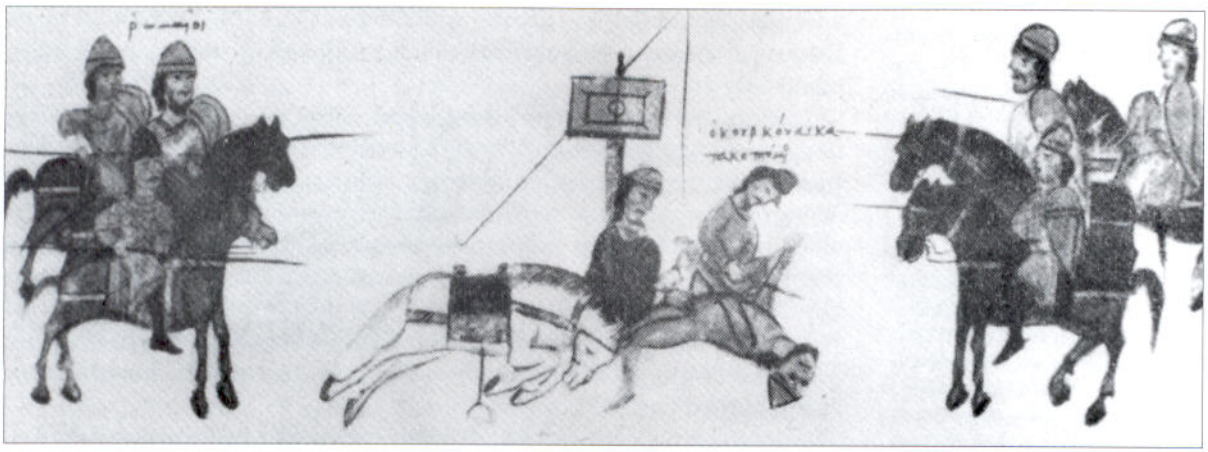
Perhaps this *lithobolos* was the single-armed machine previously known as an *onager*, and which was now spanned with a form of windlass. According to the notoriously archaic terminology of Byzantine military manuals, the Byzantines also continued to use animal tendons to make the twisted skeins which provided propulsive power, as the Romans had done.

How far medieval Russia made use of comparable machines is unclear. Russian terminology was particularly imprecise, with the words *prochnik* and *prasha* being used for various weapons. Nor are western European descriptions of Russian siege engines very helpful. At the Crusader siege of Dorpat (now Tartu) in Estonia in 1224, Russian troops helping the defenders use what Henry of Livonia called *paterells* to shoot glowing pieces of iron or pots of fire against the Crusaders' wooden siege tower. The name *paterell* and the fact that it was able to hurl very hot objects both suggest an onager-like machine.

Problems of terminology are even greater in early Arab-Islamic sources. The *'arradah* is widely assumed to have been a single-armed machine like the *onager*, since the name *'arradah* may come from an Aramaic word for a wild ass and the Latin



The Ottoman Turks continued to use stone-throwing *manjaniqs* after they adopted cannon. Here, in an Ottoman manuscript dating from the late 15th century, an artist includes two cannon and a sort of trebuchet in a siege scene while other guns protrude from the fortress walls. ('Alexander the Great attacks a fortress in Sistan', *Iskendername*, Institute of Oriental Studies, Ms. C. 133, f. 52b, St Petersburg, Russia)



Light forms of stone-throwing mangonel appear in Byzantine manuscripts to indicate that the event happened during a siege. Here, in a Byzantine-style manuscript from late 12th or early 13th century Sicily, a battle takes place outside the town of Dorustolon. The mangonel is mounted on a single pole and seems to have only one rope. (*Skylitzes History*, Cod. 5-3, N2, f. 169r, Biblioteca Nacional, Madrid)

name *onager* similarly meant a wild ass. But the image of a donkey kicking upwards could just as well apply to a beam-sling traction machine (see below). Furthermore, later medieval military manuals like *Al-Aniq fi'l-manajaniq* clearly show that, by then, the *manjaniq al-'arradah* was a man-powered beam-sling weapon, while a minority of scholars consider the *'arradah* had always been a small form of beam-sling weapon. It was used during the Prophet Muhammad's siege of Taif in Arabia in 630, a generation before the Muslim Arabs supposedly met the beam-sling *manjaniq* in central Asia. By then the *'arradah* had been used against and by the Arabs in northern Syria, Egypt, Iraq and Iran.

On the other hand, during the 'Abbasid Caliph al-Mutasim's siege of Byzantine Amorium in central Turkey in 838 his siege machines were each served by four men and were 'placed on carriages carried by carts', both of which suggest torsion-powered weapons. However, a few years later in the caliph's capital of Baghdad, the *'arradah* was said to need large quantities of rope, which suggests a substantial man-powered beam-sling traction device. Whether it was torsion or traction powered, the *'arradah* remained an important weapon throughout the Islamic world during the following centuries, especially in defence of fortifications when *'arradahs* were placed upon the walls, as is clearly described in several sources. For example the mid-11th-century Persian traveller Nasir-i Khusraw said of Tripoli in Lebanon that: 'along the battlements are placed *'arradahs* for their fear of the Greeks [Byzantines] who are liable to attack the place in their ships'.[1] The Muslims continued to use the *'arradah* during the Crusades and it seems to have been relatively easy to change the aim of these light weapons. Arabic and Latin or Spanish sources similarly state that *'arradahs* were used in North Africa and in the Islamic southern parts of the Iberian peninsula, frequently being placed on top of fortified towers. The Christian Spanish adopted the weapon but changed it to *algarrada* (from the Arabic *al-'arradah*).

In 13th-century Islamic northern India the scholar Fakhr al-Din, writing in Persian in his *Adab al-Harb* or 'Art of War', listed the *'arradah-i yak ruy* – simple or single *'arradah*; the *'arradah-i gardan* – rotating *'arradah*; the *'arradah-i khufta* – stationary *'arradah*; the *'arradah-i rawan* – fast shooting *'arradah*; and the *'arradah-i giran* – big *'arradah*. Fakhr

1 G. Le Strange (tr.), *Diaries of a Journey through Syria and Palestine by Nasir-i-Khusrau in 1047 A.D.* (London 1888; reprint Ann Arbor 1977), p. 7.

In later medieval Islamic art, the men operating siege engines are often shown as Arabs or Persians while the soldiers look like Turks or Mongols. Here the operator uses a mallet to release the trigger of a fully loaded *manjaniq*. ('The Sultan of Ghazna attacks a fortress', *Universal History of Rashid al-Din*, ex-Royal Asiatic Society)

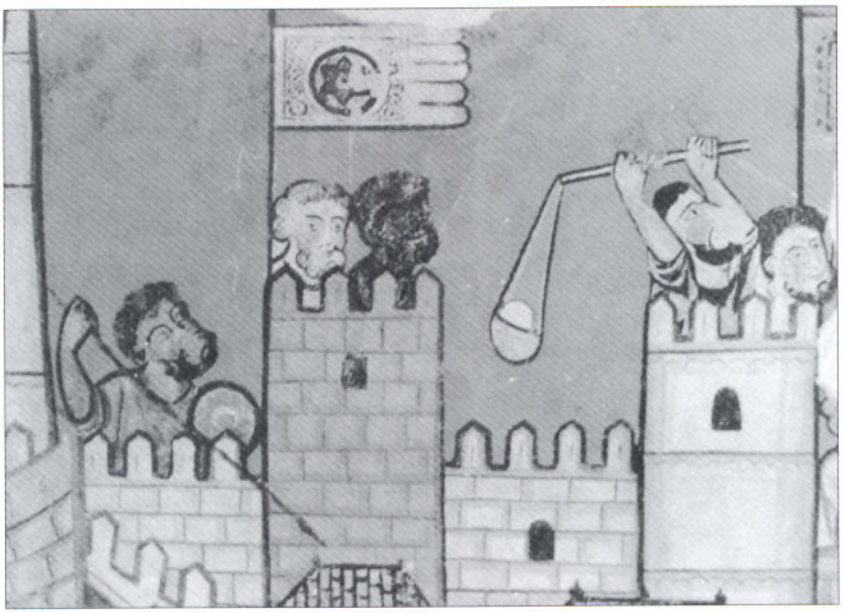
al-Din also mentioned another variation on the poetic image of a kicking donkey, when he wrote that a *khark* or 'little ass' was used by attackers to bombard a parapet and its defenders.

One type of Islamic siege weapon was clearly constructed on the torsion principle. This was the *ziyar*, whose name shared the same root as the word for the most tightly pulled string on a musical instrument. Its skeins or twisted ropes were made of animals' hair, silk or tendons. Used from at least the 12th century, it came in single- and two-armed forms. Saladin's men used ziyars during the siege of Acre by the Third Crusade. In the 13th–14th centuries it was used as far west as Morocco where one ox-cart could carry four, presumably small examples, of the *ziyar*. It could throw containers of semi-explosive incendiary material and the two-armed *qaws al-ziyar* or '*bow ziyar*' version could shoot very large arrows. Even in the 15th century the single-armed *manjaniq ziyar* was important enough to deserve a short chapter in the Egyptian *Al-Aniq fi'l-Manajaniq* technical manual.

The most detailed description of a two-armed torsion-powered siege weapon of the type known in Europe as an espringal is found in the manual called *Al-Tabsira*, written for Saladin by Murda al-Tarsusi, perhaps as early as 1169 when Saladin became *wazir* or 'prime minister' of Egypt. This *qaws al-ziyar* was based upon a wooden frame to which the twisted skeins were attached. Ordinary versions were probably mounted on pedestals like late Roman and Byzantine weapons, but the monstrous *qaws al-ziyar* described by al-Tarsusi had a frame which was over five metres across. It was probably an experimental version of an established weapon. The skeins were of mixed silk and horsehair while unseasoned oak was recommended for the frame (see Plate A), the draw-weight being an estimated one and a half tons. Without the windlass, which al-Tarsusi also described, the author maintained that 20 men were needed to pull back its bowstring and the missile it shot had a head weighing 2 kilograms.

The proportions of al-Tarsusi's huge weapons were probably comparable to those of a more normal *qaws al-ziyar*, but whether the ordinary weapon had bow-arms of composite construction is unknown.

This was almost certainly not the case with Roman and Byzantine types. The *qaws al-ziyar* which the Emperor Frederick II purchased in Acre in 1239 would surely have been a standard version, but in early 14th-century Morocco it took 11 mules to carry one dismantled *qaws al-ziyar*. A similar family of weapons in the 15th-century *Al-Aniq fi'l Manajaniq* was called a *kuskanjil*. One had three strings and two separate bow-arms each side, recalling the remarkable 'doubled bows' used in China and Indo-China (see New Vanguard 43: *Siege Weapons of the Far East (1) AD 612–1300*), so it might be significant that an unexplained siege weapon called a *kashkajir* was also mentioned in Fakhr al-Din's *Adab al-Harb*, written in India in the early 13th century. This mysterious *kashkajir* was also later mentioned by Saif al-Harawi in his history of the Afghan city of Herat.



The staff-sling was found almost everywhere from Europe to China and it was from this that man-powered beam-sling mangonel developed. Here it is used by a Muslim soldier defending the city of Majorca (now Palma) in the Balearic islands, as portrayed in a late 13th-century Catalan wall-painting. (Museo de Artes de Cataluña, Barcelona)

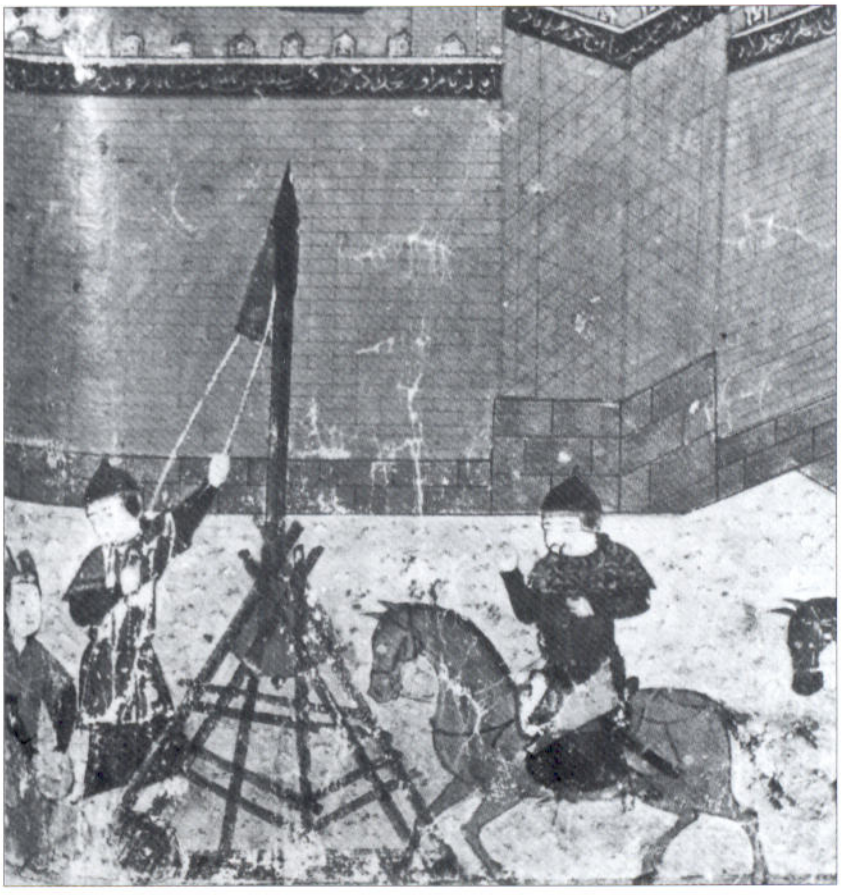
The Power of Teamwork

The beam-sling or traction form of stone-throwing siege engine was much more important in the Byzantine and Islamic regions during the Middle Ages, though the situation is less clear in India. The root of the Byzantine words *manganon*, *manganikon*, *magganika* and other variations, as well as Arabic, Persian and Turkish variations on the name *manjaniq*, was the Greek term *mangano*, which meant to crush or squeeze. At first the Byzantines used these words loosely and even in the late 9th century the Emperor Leo felt a need to explain the term by saying 'stone-throwing *magganika*, the so-called *alakatia* and *tetrareai*'. The Byzantines also used the descriptive term *petrabolos*, which simply meant 'stone-thrower', though even this was sometimes corrupted to *petrarea*. The *labdarea* seems to have been one such beam-sling engine, mounted on a lambda-shaped or inverted-V frame. Another was the *tetrareai* (see above), which had a four-sided frame, probably with a short horizontal piece at the top. In the 9th century these two forms were sometimes called the *triboloi* and the *tatreboloi* and they would have been synonymous with the Turkish and Arab forms of *manjaniq*.

The beam-sling stone-thrower was first recorded in China and the earliest clear illustration outside China was on a wall painting from the Transoxanian palace-city of Pendzhikent, dating from shortly before the Arab-Islamic conquest. However, the first detailed description of such a weapon comes from the Byzantine Empire, where it was used by Avar invaders descended from the Juan-Juan, who had been driven from their homeland north-west of China. The Chinese-influenced Avars used it during their siege of Thessaloniki in 597, where Archbishop John wrote:

These *petraboles* were tetragonal and rested on broad bases, tapering to narrow extremities. Attached to them were thick cylinders well clad in iron at the ends, and there were nailed to them timbers like beams from a large house. These timbers had slings from the back and from the front strong ropes by which, pulling down and releasing the sling, they propel the stones up high and with a large noise ... They also covered these tetragonal *petraboles* with boards on three sides so that those inside shooting them might not be wounded by arrows shot from the walls. And since one of these, with its boards, had been burned to a cinder by a flaming arrow, they carried away the machines. On the following day they again brought these *petraboles* covered with freshly skinned hides.[2]

The Byzantines, then, adopted this beam-sling stone-thrower enthusiastically, yet the sources still make it clear that they were primarily used against people and flimsy parapets rather than the much sturdier walls themselves. Though vulnerable to fire-arrows, counter-battery bombardment and sorties by the defenders, they could maintain an astonishing rate of fire and could drive defenders from their walls. When a Byzantine army invaded Syria in 1032 it bombarded the hilltop castle of Bikisra'il before storming the fortifications. Inside the Byzantine soldiers found 200



Most illustrations of mangonels in historical or literary works are unreliable and their scale is normally misleading, as in this picture of Mongol soldiers preparing to reload a *manjaniq* during their siege of Baghdad. It is a late 14th-century copy of Rashid al-Din's *Universal History*, made in western Iran. (Bibliothèque Nationale, Ms. Suppl. Pers. 1113, ff. 180v-181r, Paris)

2 K. De Vries, *Medieval Military Technology* (Peterborough, Ontario, 1992), pp. 133–34.

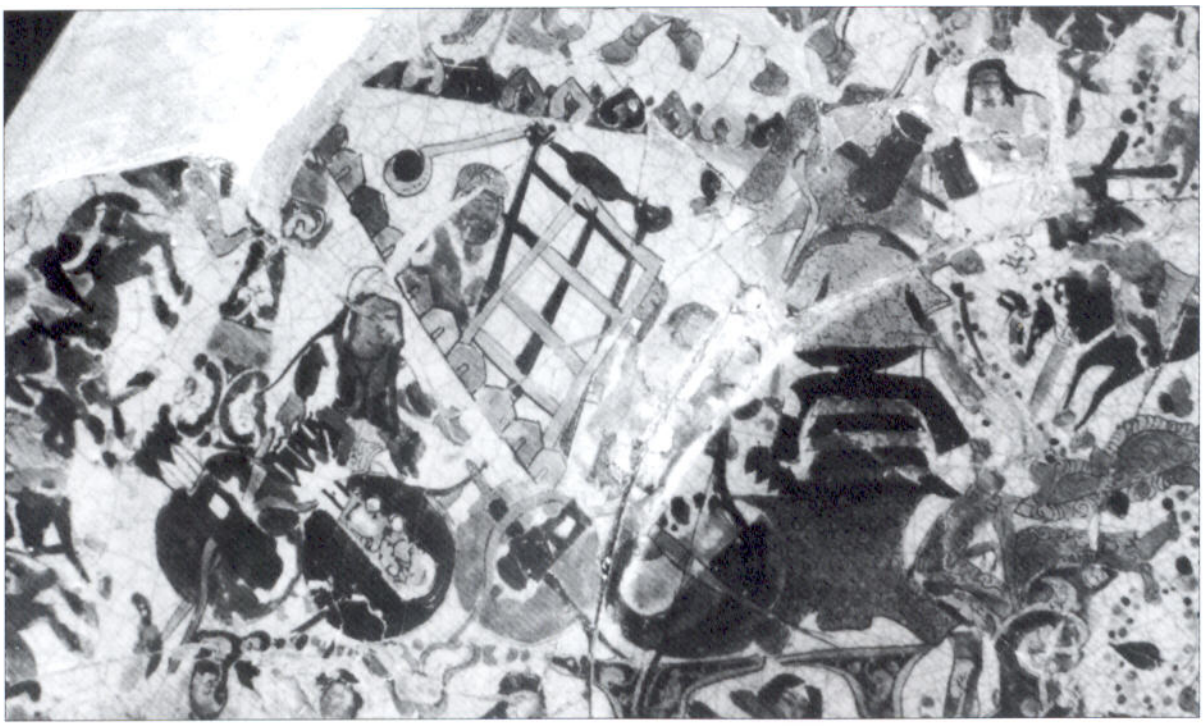
corpses, killed during the bombardment. The limitations of such machines continued to be made clear in later Byzantine sources. For example a Byzantine army attacked Anazarva in southern Turkey in 1137 but the defenders burned the Byzantine mangonels with heated missiles. So the Byzantines encased the supporting frames with mud-brick. Nineteen years later a Byzantine force tried to reconquer southern Italy but found their *petraboloi* mangonels had no effect on the city wall. Instead they:

> ... flung stones like a discus to fly high over the walls, and they caused them to fall within the city. As soon as they let go the first one, an old woman strutting in the city received the shot on her crown and it shattered her head and broke every bone of her limbs.

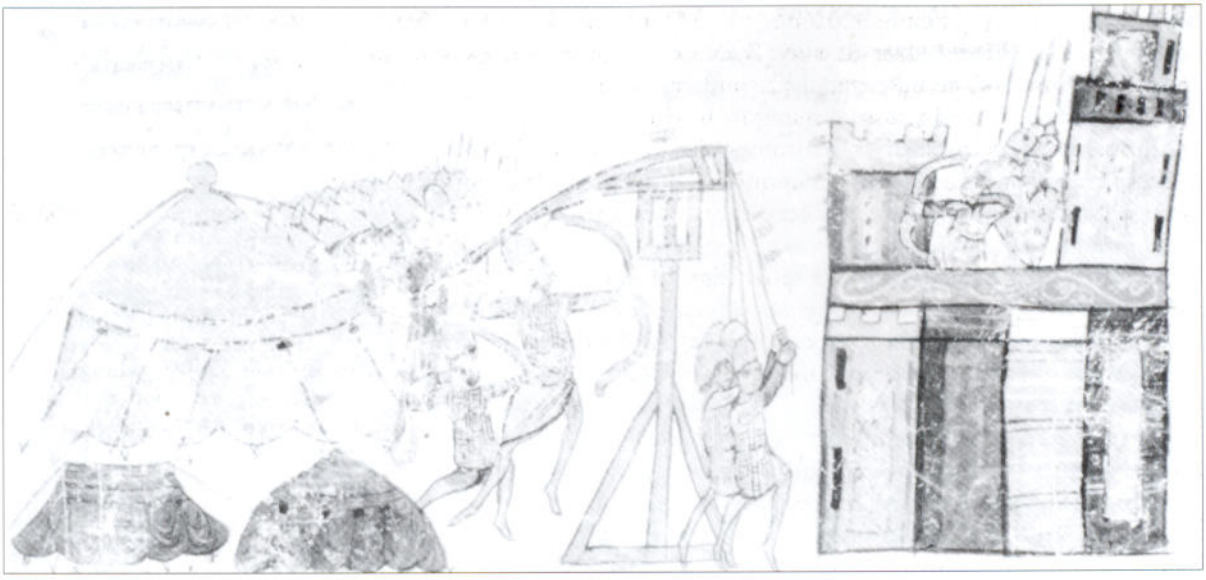
Perhaps because traction-powered machines were easy to construct and operate, beam-sling mangonels were undoubtedly used in technologically backward regions of the Balkans and Russia. Even so, when Russian troops in Estonian Tartu tried to use a beam-sling mangonel against the besieging Crusaders, it shot backwards and hit their own men. Nevertheless, the Russians continued to use what they apparently called a *porok* later in the 13th–14th centuries.

Whether beam-sling siege machines were used in India before the coming of the Muslims seems doubtful. Nevertheless, some historians have assumed that Indian *yantrapasana*, 'stones thrown by machines', were hurled by mangonels though the 'rods to throw stones' found in other Indian sources were probably only staff-slings.

The medieval Islamic world provides abundant and detailed information. Descriptions of *manjaniqs* being like sexually excited stallion horses or camels probably refers to the upward swing of the sling or the



The so-called Battle Plate was made in Iran in the early 13th century and illustrates an army attacking a fortress. On top of the tower there is a stone-throwing engine operated by the only man with a turban and beard. The siege machine itself is probably an inaccurately drawn single-armed torsion device. (Freer Gallery of Art, inv. 43.3, Washington)



A different small man-powered mangonel appears in another illustration from a late 12th- or early 13th-century Sicilian-Byzantine manuscript, showing Emperor Nicephorus Phocas attacking Mopsuestia in 965. The men pulling the ropes are fully armoured as apparently they are within range of archers on the enemy wall. (*Skylitzes History*, Cod. 5-3, N2, f. 151r, Biblioteca Nacional, Madrid)

way a stallion camel lets his tongue loll out. Nicknames such as 'The Bride' and 'The Long Haired One' reflect the numerous pulling ropes attached to the other end of the beam. Accounts of a siege of Mecca during a civil war in 692 include a description of how such a *manjaniq* was used. Here the 'shooter' tucked up his long robes, picked up a rock, placed it in the sling and then ordered the team of rope-men to pull. Later information indicates that the 'shooter' did not release his hold on the sling immediately but judged his moment against the tension of the 'pullers'. As a result an experienced 'shooter' with a disciplined team of 'pullers' could achieve astonishing accuracy especially when, as we know from written and archaeological evidence, the missiles were shaped to a specific weight.

Al-Baladhuri's account of the Arab siege of Daybul in what is now southern Pakistan in 712 describes how the Muslim commander, Muhammad Ibn al-Qasim, had a *manjaniq* called 'The Bride', which was operated by 500 men – probably an exaggeration. As al-Baladhuri wrote: 'There was at Daybul a lofty *budd* [temple or perhaps even a statue of the Buddha] surmounted by a long pole and on this pole was a red flag which unfurled over the city.' During the course of regular correspondence between Ibn al-Qasim and Hajjaj Ibn Yusuf, commander of Islamic forces in the east, Hajjaj advised that Ibn al-Qasim should:

> Fix the *manjaniq* and shorten its foot and place it in the east [of the budd]. You will then call the *manjaniq*-master and tell him to aim at the flag-staff … So he brought down the flag-staff and it was broken.[3]

This remarkable shot so demoralised the garrison that the city soon fell. Numerous other mentions of the *manjaniq* in Islamic sources of the 7th–11th centuries show that the weapon was used against defenders on a wall, parapets, buildings inside a fortification and against ships attempting to break a blockade. By the mid-11th century the *manjaniq* was so common that it was used as a way of describing something else, as

3 H.M. Elliot (ed. J. Dowson), *The History of India as told by its own Historians: The Muhammadan Period* (London 1867) vol. I, p. 120.

when Nasir-i Khusraw said that a *khashab* or lighthouse north of Basra, which helped ships navigate through the vast marshes of southern Iraq, was made of four large timbers 'like a *manjaniq*'.

The Middle Eastern *manjaniq* used an arm which was cut from a single piece of timber rather than consisting or numerous lengths of bamboo tied together, as in most Chinese mangonels. As a result Islamic types were heavier than the Chinese, which may in turn have encouraged the development of the counter-weight version. The earliest technical description of a *manjaniq* comes from Abu 'Abd Allah al-Khwarazmi's late 10th-century *Mafatih al-'Ulum* or 'Keys to Science'. This listed the elements of a *manjaniq* as the *kursi* 'chair' or supporting frame, the *khinzira* 'sow' or axle, the *sahm* 'arrow' or beam-sling which had an *istam* or piece of iron to which the sling was attached.[4] Other later sources indicate that the element to which the traction ropes were attached could similarly be of iron. By the mid-10th century the *manjaniq* came in several forms, some of which remain obscure, such as the *rutilah* or 'daddy long-legs' in Persian which was mentioned by al-Jahiz of Basra. It is believed to have thrown smaller stones.

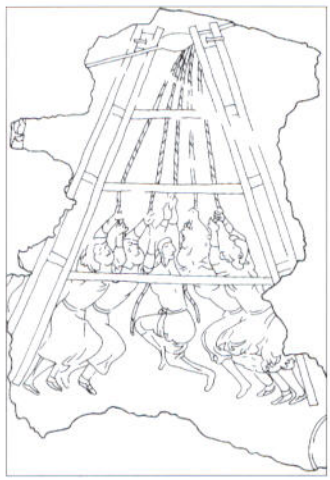
Man-powered *manjaniqs* continued to be used until the 15th century, despite the invention of a more powerful counter-weight *manjaniq* and the adoption of guns during the 14th century. Presumably the simplicity and reliability of the man-powered *manjaniq* meant that it remained useful as a high trajectory anti-personnel weapon. It was small enough to be mounted on top of towers and could be used from inside fortifications to provide 'indirect fire'.

The remarkable 12th-century Egyptian military expert al-Tarsusi again provided the most comprehensive description of early Islamic *manjaniqs*. There were, he wrote, four basic types: the Arab, Turkish, 'Frankish' or European, and the much smaller *lu'ab*. The Arab was the most accurate and reliable but was complicated to build. The Turkish was the easiest to erect, while the 'Frankish' incorporated features that seem to overcome problems inherent in the simple Turkish *manjaniq* (see Plate D). All *manjaniqs* powered by teams of rope-pullers apparently had a maximum range of around 120 metres – and it is worth noting that, like most artillery, *manjaniqs* had a minimum range (of about 80 metres) as well as a maximum range. The best wood for the beam-sling was cherry, although cedar would do. The axle and frame were best made of unseasoned oak, and there were several metallic elements, including an iron hook for the sling and iron nails for the frame. For a man-powered *manjaniq*, three-quarters of the arm should be on the sling side of the axle with one-quarter on the rope-pullers' side, while the ropes themselves should be of hemp.

The range of the lu'ab or smallest man-powered *manjaniq*, was less but, being mounted on a single pole, its arm could be moved side to side, enabling the operators to aim in any direction. Unfortunately al-Tarsusi considered this lu'ab so well known that it was not worth describing in detail, except to state that the arm was mounted on a *lafata* or 'turner' which was a rotating swivel as shown in several manuscript illustrations.

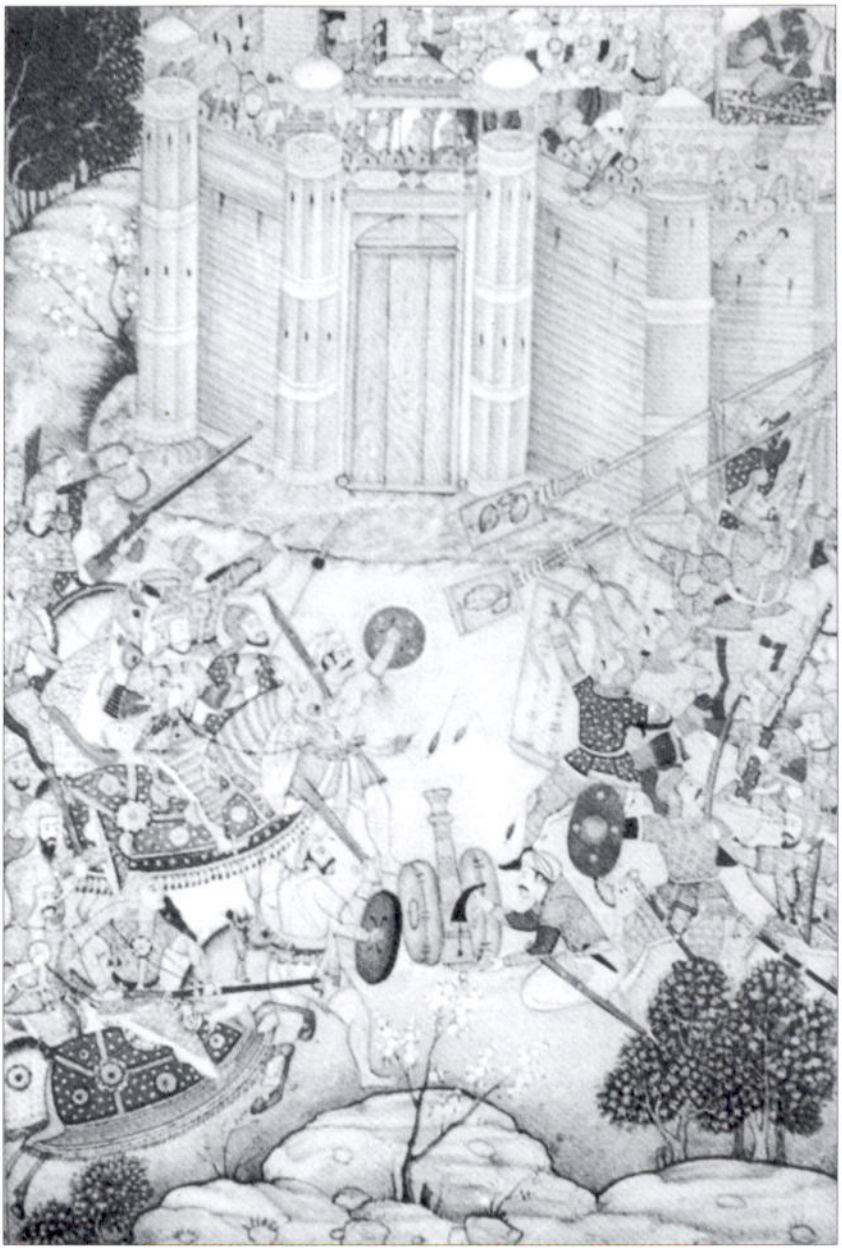
Terminology changed in the 12th–13th centuries when the main types of *manjaniq* were known as the *franjiyyah* (western European),

RIGHT. **By the late 16th century, stone-throwing machines had dropped out of use even in India. Nevertheless, they were sometimes still shown in manuscripts alongside cannon and muskets, as in this Mughul picture of Genghiz Khan attacking a fortress made around 1596. The *manjaniq* with a counter-weight consisting of large rocks lashed to a wooden board may not really have existed and the artist had probably never seen such antiquated machines. (*Genghiz Khan Nama*, National Library, Tehran)**



One of the most significant fragments of wall-paintings from the pre-Islamic Transoxanian city of Penjikent shows a team of men operating an early form of beam-sling stone-throwing mangonel. It is very similar to those already used in neighbouring China and probably dates from the very late 7th or early 8th century. The mangonel itself is of the type which would later be known as an Arab *manjaniq*. (via Hermitage Museum, St Petersburg)

4 D.R. Hill, *Trebuchets*, Viator IV (1973), pp. 100–01.

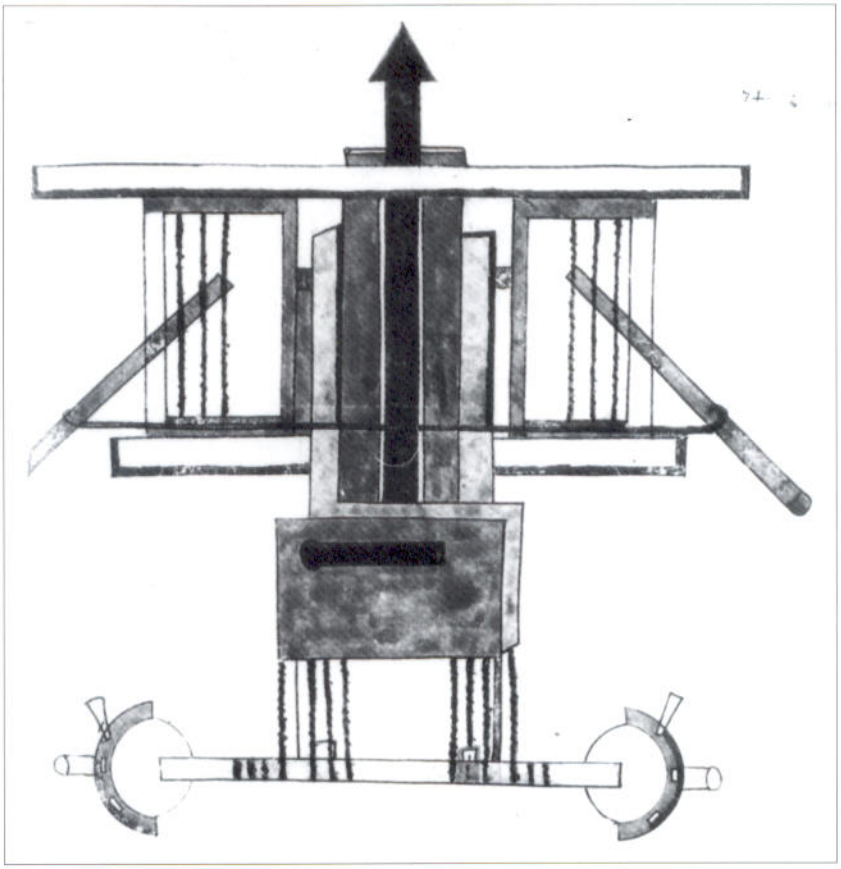


maghribiyyah (western Islamic), *qara bughawiyyah* (black bull-like) and *shaytaniyyah* (devilish). Of these, only the *shaytaniyyah* was still man-powered, being used against Crusader-held Damietta in Egypt in 1218. The terminology also changed in the eastern regions of the Islamic world where Fakhr al-Din's *Adab al-Harb* gave *manjaniqs* much the same names as those given to *'arradahs*. Here the *manjaniq al-'arus* was now a weapon which could shoot in any direction and was probably a larger version of the *lu'ab*. Others were the man-powered *manjaniq-i rawan* 'fast throwing mangonel', the 'devilish' *manjaniq div* which was probably the same as the Middle Eastern *shaytani*, and the *manjaniq ghuri* which had presumably been introduced by the Ghurid dynasty which ruled north-western India until 1215. Meanwhile the later medieval Islamic Indian *'arusik* was probably a smaller version of the *manjaniq al-'arus*. Some of these weapons continued in use well into the 17th century. According to the Mamluk treatise entitled *Al-Aniq fi'l-manajaniq*, the only man-powered mangonel still used in the 15th-century Middle East was called a *manjaniq sultani*. Like the remarkable double-counter-weight *manjaniq ifranji* (see below) it was a small weapon mounted upon a pole rather than a frame. Two sets of five ropes were tied to two iron rings attached to a splayed H-shaped piece of iron, itself fastened to the beam-sling arm.

The Power of the Counter-weight

The counter-weight mangonel or trebuchet is generally believed to have have been invented in the eastern Mediterranean region in the 12th century which is when the first certain evidence of its existence appears in al-Tarsusi's treatise written for Saladin. However, a careful reading of this

text shows that the author did not regard the counter-weight *manjaniq* as a new weapon. There is even circumstantial evidence to suggest that rudimentary forms of counter-weight *manjaniq* existed two centuries earlier. For example, the 20 'large' *manjaniqs* which defended Tarsus in the mid-10th century were accompanied by three mysterious *manjaniq h-r-ri*. Because the vowels of the word *h-r-ri* are unknown its meaning is unclear, but it could be rooted in the sense of 'free' or 'independent' – but independent of what? Perhaps of a team of rope pullers, in which case three of the Tarsus *manjaniqs* might have been early counter-weight forms. Or the word could be rooted in the concept of 'stony', and here it is worth noting that al-Tarsusi's counter-weight *manjaniq* – the earliest known – was powered by a net full of rocks.



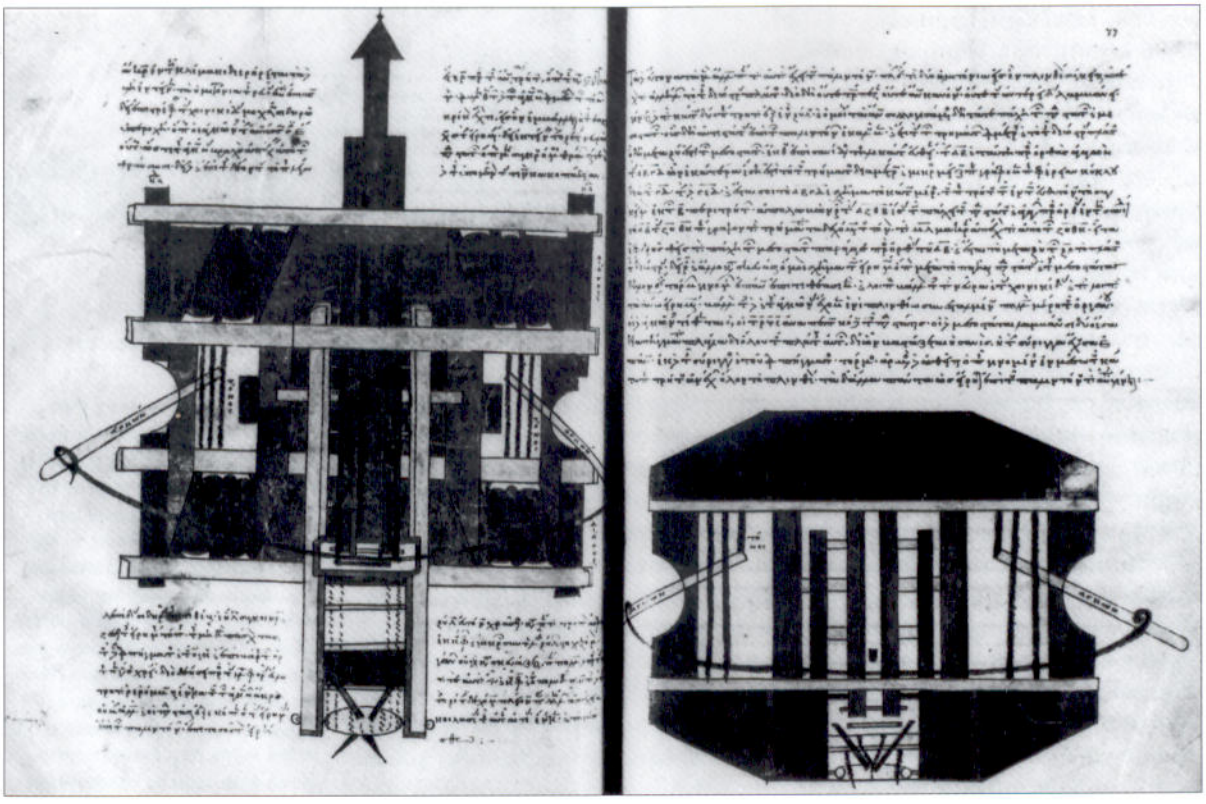
ABOVE AND RIGHT **A superb 11th-century Byzantine military manual shows some siege equipment in an archaic and fanciful way while other items, like these pictures of two-armed, torsion-powered weapons, are strictly technical. The first (above) shows the device with a winch mechanism. The second (right) shows a similar machine from both top and front, with a smaller winch or capstan. (Bibliothèque Nationale, Cod. Gr. 2442, ff. 74r & 76v-777, Paris)**

In 1089–90 a band of freebooters under Khalaf Ibn Mula'ib seized Salamiya in central Syria and then threw a respected local leader out of the citadel from a *manjaniq*. Surely this could only have been done with a counter-weight version? During the early 12th century Crusader invasions there were also a few occasions where the Muslims' petraries, as they were known in Crusader sources, breached the walls of Crusader-held fortifications, which is unlikely to have been possible with man-powered versions. In 1138 the Byzantines used notably powerful mangonels during their siege of the Syrian-Arab fortress of Shayzar where Usamah Ibn Munqidh recalled in his memoirs:

> These *manjaniqs* could throw a stone farther than the distance covered by an arrow, their stones being 20 to 25 *ratls* in weight [37 to 46 kilograms assuming a Syrian *ratl*]. One time they hurled a large millstone against the house of a friend named Yusuf Ibn Abi al-Gharib, may God's mercy rest upon his soul. This one stone destroyed the whole building from top to bottom.[5]

Furthermore these Byzantine mangonels opened a breach in the outer wall of Shayzar.

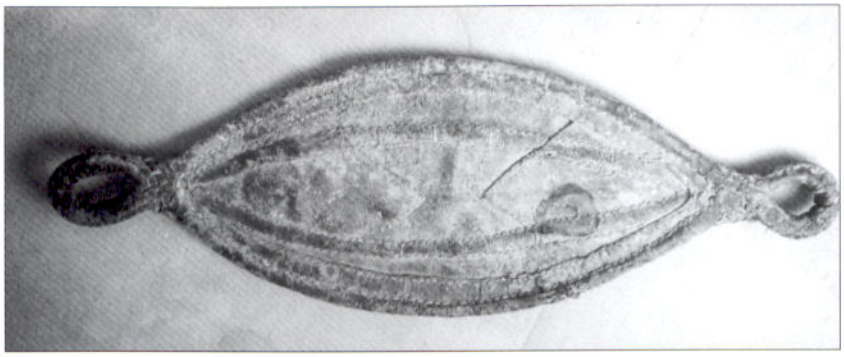
5 Usamah Ibn Munqidh (ed. H. Zayn), *Kitab al-I'tibar* (Beirut 1988), p. 105; or as translated by P.H. Hitti, *Memoirs of an Arab-Syrian Gentleman* (Princeton 1929; reprint Beirut 1964), pp. 143–44.



The first certain reference to a Byzantine counter-weight mangonel was 27 years later and during the Third Crusade's siege of Acre (1189–91) some mangonels were specifically described as being the counter-weight type.

In addition to writing about man-powered *manjaniqs*, al-Tarsusi described and illustrated what he called a Persian *manjaniq*. This had a supporting frame and a beam-sling identical to those of the Turkish *manjaniq*, except that the beam-sling had an iron ring at its lower end to which a netting bag, filled with rocks, was attached. As the supporting frame was no taller than that of the man-powered Turkish *manjaniq*, the bag would hit the earth as it dropped, so a hole or trench was excavated between the base-frame timbers, enabling the bag of rocks to complete its arc when the weapon was loosed. It was still a primitive machine and some problems resulting from its counter-weight system had yet to be solved. A pulley system to pull the beam-sling down, and thus raise the counter-weight, had not been necessary with the man-powered types as the weight of the tapering beam-sling was equalised on each side of the axle.

The new or experimental element in al-Tarsusi's Persian *manjaniq* was his inclusion of a *jarkh* or large crossbow (see below) into the release mechanism. This, like several other features in al-Tarsusi's book, seems unduly complicated and is not seen in later *manjaniqs*. His description of its function is also difficult to interpret but the pull of the crossbow string, when released at the same moment as the beam-sling itself, may have helped overcome any inertia in the counter-weight. As al-Tarsusi made clear in his text, this *manjaniq* could be operated by one man and could also throw a missile weighing 50 *ratls* – over 90 kilograms if the author was using Syrian measurements.



In the late 13th century the Mamluk Sultan Baybars ordered a major strengthening of Syrian fortifications in the face of the Mongol threat. Local military leaders had to maintain, at their own expense, those craftsmen who made and repaired siege weaponry. This mangonel sling made of leather and rope is the only one known to survive from the Middle Ages. It is approximately 45cm long and was found in the ruins of a Syrian castle along with various other items, including a reinforced hat decorated with the heraldic cartouche of Sultan Baybars himself. (Private collection)

The late 12th to early 14th centuries saw significant increases in the power, reliability, variety and above all the accuracy of counter-weight *manjaniqs*. They were often used in considerable numbers and could now breach walls by sustained bombardment; some early 14th-century mangonel stones found at Tlemcen in Algeria weighed 230 kilograms. The counter-weight *manjaniq* was similarly effective in defence, smashing an attacker's siege engines. In fact a revolutionary new style of fortification appeared in the early 13th century with larger, more closely spaced and more protruding towers serving as emplacements for counter-weight *manjaniqs*.

The *manjaniq qarabugha* (black bull-like) was first mentioned in this Turkish form, at Akhlat in eastern Turkey in 1229. Some scholars suggest that it had been modified to shoot large arrows, though how a beam-sling weapon would do such a thing remains unclear. The name is Turkish and it was given prominence in the epic *Destan* of Umur Pasha which, though written in the 15th century, was probably based on a lost earlier version. Describing the Turks' resistance to a Crusader naval assault on Izmir, the poet wrote:

> A Moor arrived, a black man [normally meaning an Arab in Turkish poetry], he built an amazing small *manjaniq*. He left no [enemy] boat, no tower; he broke all in pieces. It was impossible to count the Europeans he killed. The Europeans in the ships shot their mangonels, the boats advanced and threw rocks. But with his *manjaniq* the black man destroyed them all and broke the boats to pieces. See how many stones were thrown at the infidels by his *qara bughranug* (note this further variation of the term).[6]

By the time an Arabic-Turkish dictionary was written for newly recruited Mamluk soldiers in 15th-century Egypt, *manjaniq* was translated as *töp* – a word which was also used for early cannon! Written around the same time, but in Arabic, the Mamluk *Al-Aniq fi'l-manjaniq* supplies practical descriptions and illustrations of counter-weight *manjaniqs* despite the fact that these weapons were being superceded by guns. Its drawings indicate the relative lengths of each of the 26 pieces of timber used in the construction of the *haykal* or frame, plus two axles for the beam-sling and the counter-weight box which had replaced al-Tarsusi's net full of rocks. It then described how to mount the *sahm* or beam-sling arm on to the axle by sliding it up a wooden ramp, how to fasten the arm to the axle and slot the axle into the frame, and how to raise the arm so that the counter-weight could be attached. Next came the attachment of a winch to pull down the arm once its counter-weight was attached. A notched or slotted object was also fastened near the top

6 Enveri (ed. & tr. I. Mélikoff-Sayar), *Le Destan d'Umur Pasha* (Paris 1954), p. 114.

of the arm, perhaps making it possible to alter the spot where the sling was attached and thus vary the weapon's range. The following pages dealt with the counter-weight box and how it was fastened to the arm. Next came a description of the trigger mechanism, followed by the sling and associated elements, and finally some pages on what modern engineers might call 'small parts' and spares.

A short chapter in *Al-Aniq fi'l-manjaniq* dealt with the small *manjaniq ifranji,* which was mounted on a single pole and had two counter-weights which swung down on either side of the supporting pole. It was, in fact, similar to the two-box mangonels illustrated in the Italian Mariano Taccola's *De Machinis* of 1449 where it was labelled as a *brichola* (see New Vanguard 58: *Medieval Siege Weapons (1) Western Europe*).

Meanwhile in the Byzantine Empire there were comparable advances but no evidence of leadership in such technology, except that Emperor Manuel Comnenus may have been the first to react to the new counter-weight trebuchet by having massive new towers added to the northern end of the land walls of Constantinople in the second half of the 12th century. In central Asia the fortifications of Sultan Kala in the oasis of Mary (now in Turkmenistan) were rebuilt around this time but, instead of having massive towers added, the previously hollow walls were made solid and much thicker to resist the impact of the new counter-weight *manjaniq.* The Mongols who overran central Asia and Iran in the 13th century were soon using counter-weight *manjaniqs* in great numbers. They also recruited Muslim and even European specialists to operate these fearsome weapons as far away as China. Muslim artillerymen were similarly recruited by the rulers of southern Vietnam in 1282. When the Mongols invaded India they placed some *manjaniqs* on river rafts and had them hurl large pieces of waterlogged timber when rocks were unavailable. In 1299 the defenders of the Indian city of Ranathambhor used what was called a *sang-i maghribi* (western stone), which was probably a *manjaniq,* and in the 14th century the Moroccan traveller Ibn Battuta described *manjaniqs* aboard Indian Ocean ships throwing rocks and incendiaries. A coastal town in Malabar responded by using *manjaniqs* against transports that were attempting a beach landing.

Stone mangonel balls have been found in several Syrian fortifications. Some lay amongst the ruins where they had fallen. Others were still neatly piled ready for use by the defenders. They were clearly made to a number of carefully selected sizes, and a variety of these are now displayed in the citadel of Aleppo. (Citadel Museum, Aleppo)

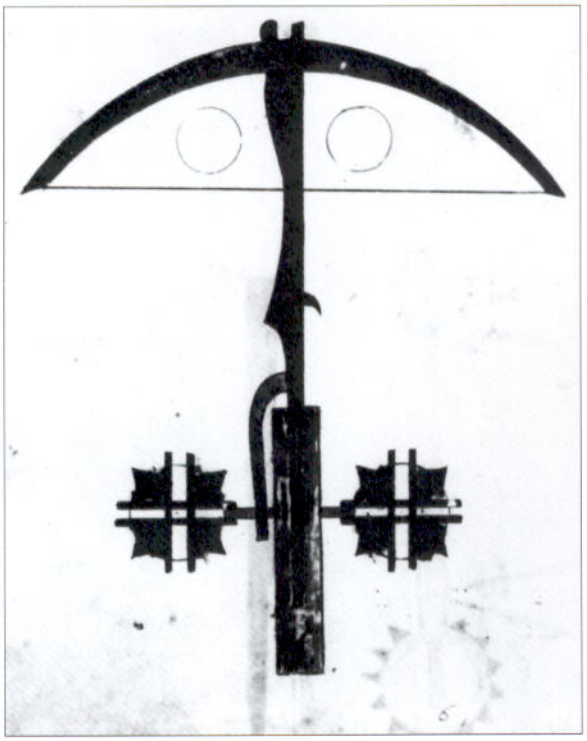
GREAT CROSSBOWS

The crossbow survived the fall of the Roman Empire and continued to be used in Byzantium and parts of the Islamic world. Furthermore it re-emerged as a weapon of war in these regions long before it did so in western Europe. The trigger system in these early medieval Mediterranean and Middle Eastern crossbows indicates that the technology had survived from Roman times rather than coming from China. Byzantine and medieval Islamic military crossbows were almost always associated with siege warfare but were not necessarily of the large form known in western Europe as great crossbows, despite sharing the same technology.

Some Byzantine weapons that were formerly interpreted as crossbows are now regarded as something entirely different. The *solenarion*, for example, was merely an arrow-guide. The *cheriomaggana* may have been an early crossbow but seems to have been small when compared with the *melalai toxcobolistrai meta trochilion* or 'large bow-*ballistas* with a pulley'. The latter were included amongst weapons required for an expedition to reconquer Arab-held Crete in 949 and may have been frame-mounted great crossbows shooting short but probably stout bolts called *muaz* or 'mice'. By the 10th and 11th centuries the only crossbows used by Byzantine troops may have been heavy weapons mounted on frames or pedestals. Most seem to have been capable of throwing stones as well as large arrows, and were operated by teams of men. Such weapons could also be mounted on warships as well as being used to attack or defend fortifications.

The oldest picture of a frame-mounted great crossbow is in an 11th-century Byzantine military treatise. The weapon is in a wooden tower or chassis. Two levers enable the structure to be turned and loaded. The bow appears to be of simple rather than composite construction and seems fixed to a vertical timber. However, the drawing is far from clear. Perhaps the artist was copying a picture of a weapon which no longer existed or perhaps he did not fully understand a new weapon.

Siege machines rarely appear in medieval or even early modern Russian illustrations. Nevertheless, this late 15th- or early 16th-century Russian manuscript offers one of relatively few pictures of great crossbows, here being used by a Mongol army attacking the Russian city of Vladimir. (State Archive of Historical Documents, Moscow)



Great crossbows are rare in Islamic sources. However, four illustrations are dedicated to the massive qaws al-'aqqar in *Al-Aniq fi'l-Manajaniq*. Some show the weapon with its spanning or stringing table frame while this shows it with a toothed winch. (*Al-Aniq fi'l-Manajaniq*, Topkapi Library, Ms. Ahmad III 3469, f. 81v, Istanbul)

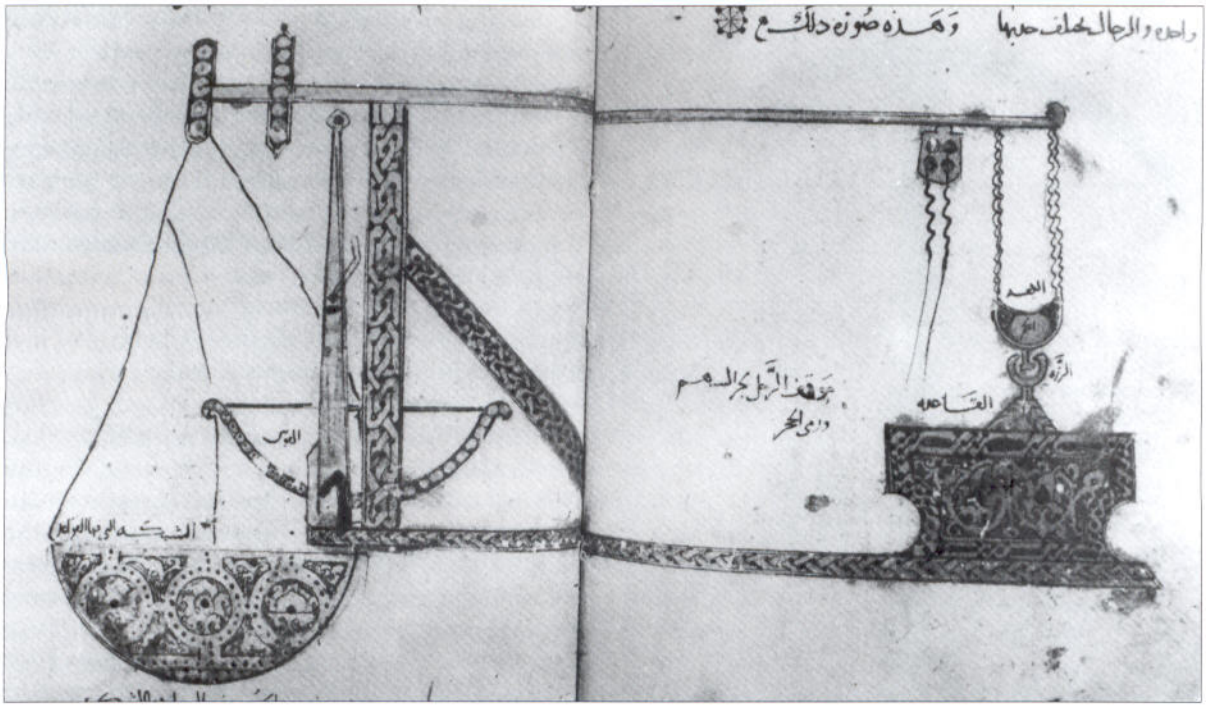
During the 11th century the Byzantines adopted another form of crossbow which they called a *tzangra*, *tzagra* or *tzarch*. These terms came from the Persian *zanburak* and *charkh* or its Arabic derivation *jarkh*. Within the Islamic Middle East the *zanburak* was a particularly heavy military crossbow used in siege warfare while the *jarkh* was a lighter weapon which was also associated with siege warfare. In neither case did the Byzantine terms reflect Western European influence. The Byzantines had adopted lighter crossbows by the 13th and 14th centuries, but Greek, Turkish and Crusader sources agree that heavy, perhaps frame-mounted, great crossbows continued to be used. Comparable weapons were used in the Balkans and Russia, though on a smaller scale. In mid-13th- to 14th-century Russia, for example, the word *samostrel* sometimes seems to have been used for a large siege crossbow or great crossbow, perhaps introduced by the Mongol conquerors, who themselves came across such weapons in Iran.

The arrow-guide was said to have been used by the Sassanian Iranians against the first Muslim Arab invaders in the early 7th century. Although this was not a crossbow it may have been what lay behind an otherwise unexplained statement in a Chinese source from 636 which noted that the Sassanian Persians 'have armour, halberds, dense arrays of swords, crossbows and [ordinary] bows and arrows'.[7] The real crossbow, called a *qaws al-rijl* or 'foot bow', was first mentioned in the Islamic Middle East in 881, when it was used by 'Abbasid troops against rebels in the marshlands of southern Iraq. The qaws al-rijl also defended the Islamic frontier city of Tarsus in the mid-10th century. Fatimid Egyptian marines paraded with their qaws al-rijl and more advanced *qaws al-rikab* (stirrup) crossbows a century later, but these were still hand-held weapons. The Fatimids' *qaws al-lawab* must have been a significantly more substantial crossbow as it shot bolts weighing five Syrian ratls (over 9 kilograms).

Meanwhile the Persian *charkh*, whose name indicates it was spanned by a windlass or a pulley, was another heavy weapon, probably rating as a giant crossbow. It was mentioned in Firdawsi's epic poem, the *Shahnamah*, written shortly before 1000 but might have been known earlier as the *Shahnamah* is itself the first major piece of medieval Persian literature to survive. One section of the epic described how the Persian ruler, arrayed his army against his Turkish foe:

> The warriors of Baghdad who were with Zanga [the Zanj?], son of Shawaran, were picked men of Karkh [a suburb of Baghdad]. He ordered them to take their place on foot with their *kaman charkh* [windlass bows], in front of the elephants. If two miles of mountains had been in their way, they would have pierced the rocks' hearts with their arrows. No one was able to withstand their shots.[8]

7 P.A. Miller (tr.), *Accounts of Western Nations in the North Chou Dynasty* (Berkeley 1959), p. 14.



The most remarkable illustration in al-Tarsusi's military manual is, in fact, the earliest known representation of a counter-weight mangonel or trebuchet. The text, however, clearly indicates that such machines had been around for some time before al-Tarsusi wrote his book. The mangonel shown here also incorporated a crossbow, probably as part of its trigger or release mechanism, but as the picture does not entirely agree with the text, this is not clear. *See also* Plate D. *(Al-Tabsira by al-Tarsusi*, Bodleian Library, Ms. Hunt 264, ff. 134v-135r, Oxford)

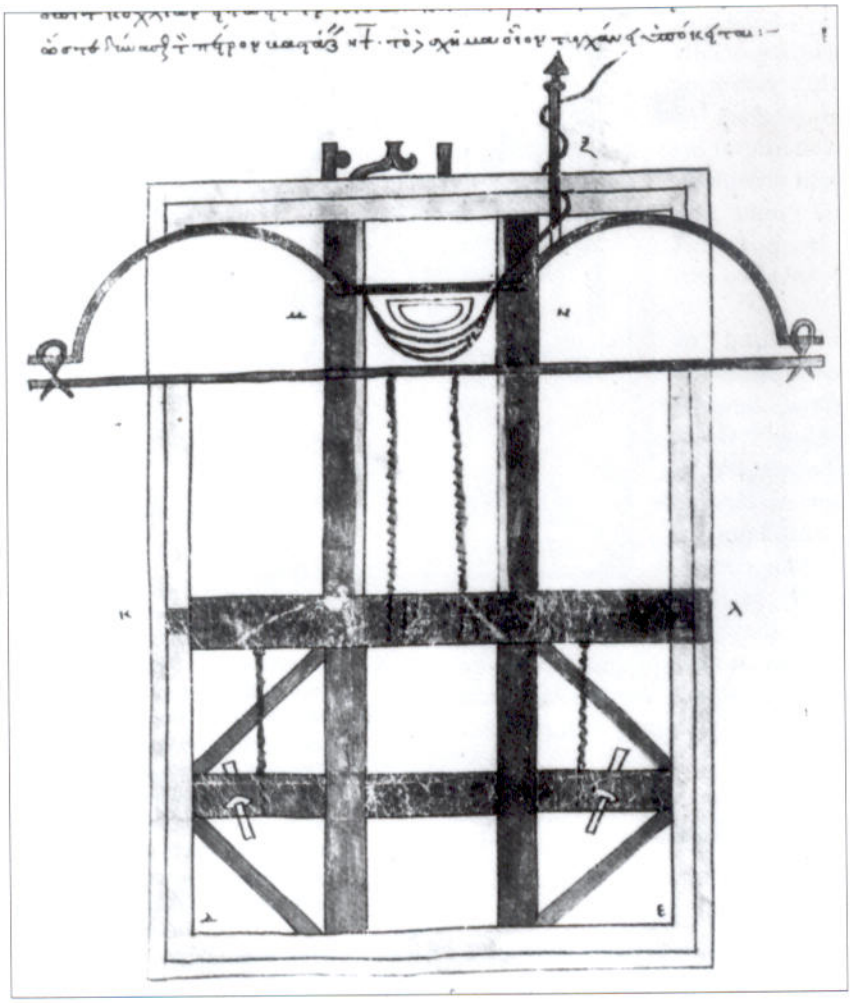
The Arabs subsequently borrowed the term as *jarkh* while the Turks did so as the *çarh*, and these heavy siege crossbows were used in the 12th and 13th centuries. The defenders of a castle near Diyarbakr killed so many of Zangi's troops that, after the place fell, Zangi ordered that nine captured *jarkh* crossbowmen have their thumbs cut off. Although the captives were forced to hang their jarkh crossbows around their necks, indicating that the weapons cannot have been so heavy, another 12th-century Persian source recorded that some charkhs could shoot arrows weighing half a kilogram to a distance of 900 metres.

In Egypt, al-Tarsusi had already stated that the *jarkh* and the *'aqqar* were not as powerful as the *qaws al-ziyar* torsion-powered weapon described above. They were, however, sufficiently large to be spanned by a *lawlab* pulley, screw or windlass or lever. Unfortunately the jarkh and *'aqqar* were amongst those weapons which al-Tarsusi considered too well known to require further description. Instead he devoted a page to a form of *qaws al-rijl* which had been modified to be able to shoot 'eggs' of incendiary material (see Plate G).

Fortunately a number of medieval Islamic composite crossbow staves, some of them large enough to rate as great crossbows, have survived. One from Syria has been carbon dated to between the mid-12th and early 13th centuries. Two other great crossbow staves from the citadel of Damascus are now in the Musée de l'Armée in Paris. One is of composite construction while the second is of wood, probably from a palm tree.

Only a small part of the mid-15th-century *Al-Aniq fi'l-manajaniq* concerns great crossbows, which were probably outdated by the time the work was written. All the illustrations are labelled as versions of the *qaws al-'aqqar*, with their spanning capstans or winches, and show how to

8 Firdawsi (ed. J.A. Vullers), Shahname (Leiden 1877–80), p. 1280; or as translated by A.G. & E. Warner, *The Shahnama of Firdausi* (London 1905), p. 147.



The great crossbows in this 11th-century Byzantine anthology of technical texts include a very complex form spanned by what appears to be a system of geared rollers or winches within the structure of the weapon. (Bibliothèque Nationale, Ms. Grec. 2442, f. 63r, Paris)

attach bowstrings to such powerful weapons. Some pictures that initially seem to show supporting frames actually illustrate the tables to which the weapons were attached while being strung.

The Persian *kaman-i zanburak* and Turkish *semberek* was called the *qaws al-zanburak* in Arab regions, and was used alongside the jarkh during Saladin's campaigns. According to the Mamluk officer Ibn Taybugha, writing around 1368, Persians and Turks used the *zanburak* while North Africans used the *laqshah* and Europeans used the jarkh. Furthermore he stated that the arrow for an *'aqqar* should weigh ten and a half dirhams (a third of a kilogram) while that for a *qaws al-rikab* or ordinary stirrup crossbow should weigh slightly less.[9] None really rated as great crossbows and perhaps the heyday of oversized siege crossbows had now passed.

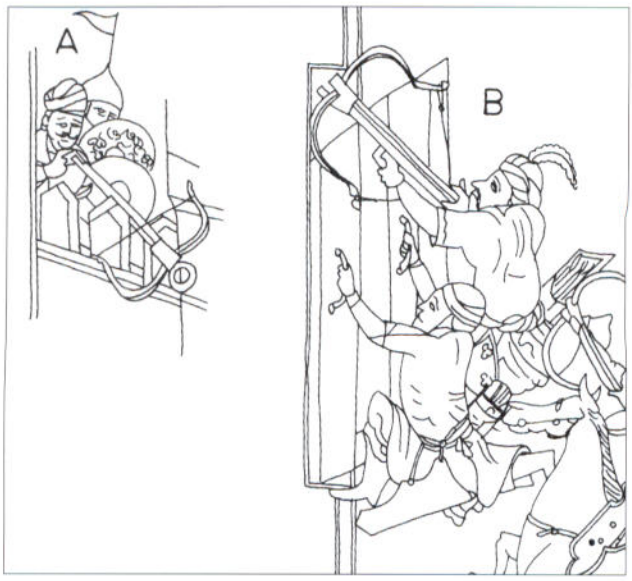
Things were even less clear in medieval India, although a chapter on siege warfare in the 13th-century *Adab al-Harb* does mention the *zanburak*, the *charkh* and the *nim charkh* or 'half *charkh*'. When Hülegu's Mongol army invaded northern India later in the 13th century it was said to have brought 3,000 *charkhs* from China, and even before this campaign the Mongols who attacked the Ismaili castles in northern Iran had at least one *kaman-i gav* 'ox bow'. This was supposedly a frame-mounted great crossbow operated by Chinese technicians and shooting large bolts whose heads were dipped in burning pitch. Furthermore this weapon was said to have a range of 2,500 paces! Hülegu's Mongol army subsequently used the *charkh kaman* and the *charkh andazan* or 'throwing crossbow', the latter perhaps throwing rocks or incendiary grenades.

In India the *charkh* continued to be used by Indian Islamic armies until at least the early 16th century when the *Babur-Nama* also referred to a siege weapon known as a *kaman-i-guroha*, which had a draw weight of 40 *batman* (about 280 kilograms) and the *taksh-andaz*. Both have sometimes been interpreted as exceptionally powerful great crossbows.

9 J.D. Latham & W.F. Paterson, *Saracen Archery* (London 1970), pp. 18–30.

Given the close links between Sri Lanka and some parts of south-east Asia, especially Burma, it is possible that the *yanta* or 'machine' which hurled light javelins or 'sharp pointed bamboo rods' in medieval Sri Lanka was comparable to the giant crossbows used in Indo-China. This *yanta* could also throw stones and was used by both Sri Lankans and the Javakas who invaded Sri Lanka in the 13th century.[10]

Some of the most experimental of medieval siege machines were based upon the oversized and multiple crossbow. Several attempted to increase the crossbow's notoriously slow rate of shooting while preserving its sometimes extraordinary power. Al-Tarsusi, for example, described and illustrated a multiple crossbow which, he maintained, had been constructed and which really worked (see Plate G). It has been suggested that the *charkh kaman* used in Iran from the late 12th century onwards was another multi-shot weapon which could be operated by one man, but the evidence for this is dubious. It was probably the 10th-century *kaman charkh* by a slightly different name.



Various crossbows appear in Islamic art but they are very rare in the eastern parts of the Muslim world. Two are, however, shown in a Persian miniature of Timur-i Lenk's siege of Izmir painted between 1470 and 1490. Of the many soldiers in the scene, only these crossbowmen wear turbans, probably indicating that the Persian artist regarded the crossbow was an Arab weapon. (*Zafarnama*, John Work Garrett Library of the John Hopkins University, Baltimore)

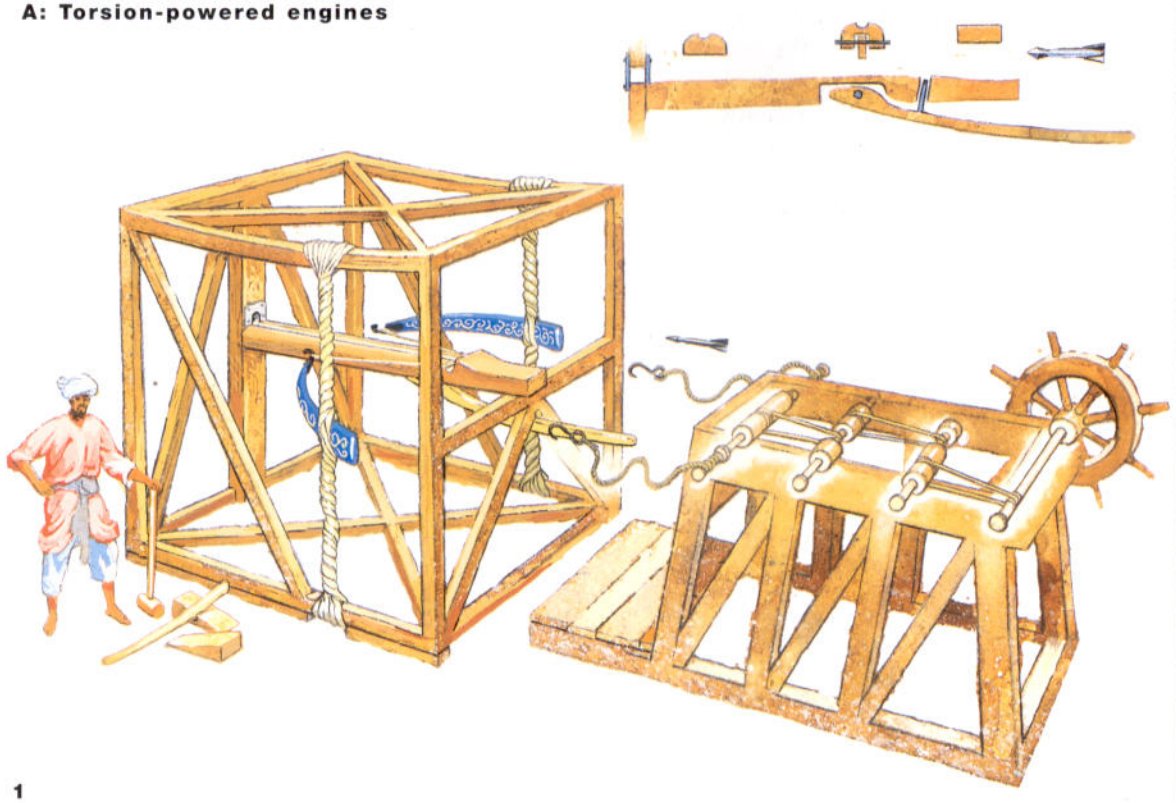
DROPPING, BURNING AND EXPLODING

Late Roman and early Byzantine military treatises refer to several devices to drop objects upon an enemy. For example, an anonymous 6th-century Greek manual advises defenders to raise a large stone 'with a suitable machine' mounted on their wall so as to drop the rock on the attackers' mobile protective shed or ram. This machine was to have a square base with wheels and one or two strengthening braces and side pieces 'inclining towards each other and connected by braces'. A central pole had another beam across it from which the missile was dropped by releasing several ropes.[11] Something similar was constructed by a Greek sailor named John who used a 'mast' to raise a small 'boat' beyond the wall of Constantinople during the Avar siege of 626. Inflammable material was placed in this tilting 'boat' and then dropped upon the attackers. When a Crusader army attacked Islamic Lisbon in 1142, one of the defenders constructed something similar, again using 'small boats' to tip incendiary material over a wooden siege tower which was only three metres from the wall.

Clearly a sailor's knowledge of ropes, pulleys and spars proved useful in several sieges, as in Ibn al-Qalanisi's account of the Crusader assault on Tyre in 1112. Here the attackers had a huge iron-tipped ram suspended inside the lower part of a siege tower. In response an unnamed Arab naval officer devised a system of iron hooks which were hung over the wall to

10 W. Geiger (ed. H. Bechert), *Culture of Ceylon in Medieval Times* (Wiesbaden 1960), p. 157.
11 G.T. Dennis, *Three Byzantine Military Treatises* (Washington 1985), p. 43.

A: Torsion-powered engines



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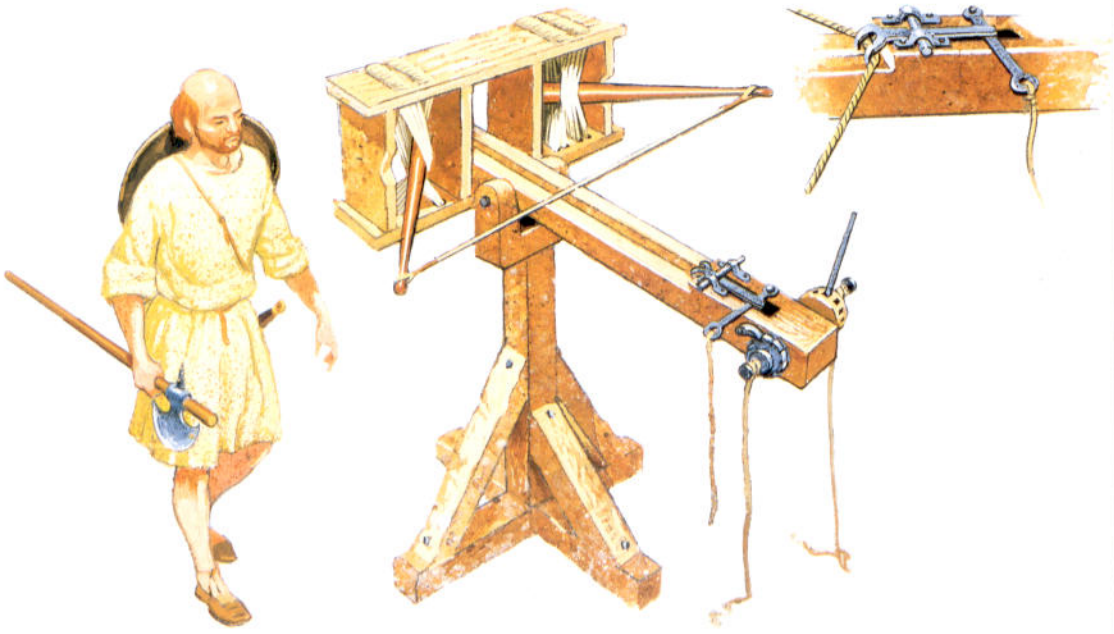
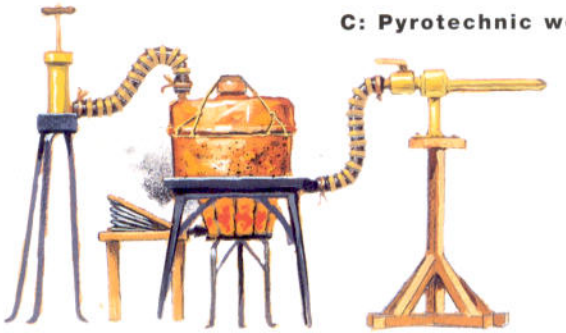


2

B: Russian wheel of fire in action, Tartu, 1224

C: Pyrotechnic weapons



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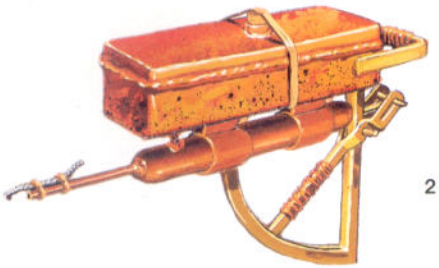

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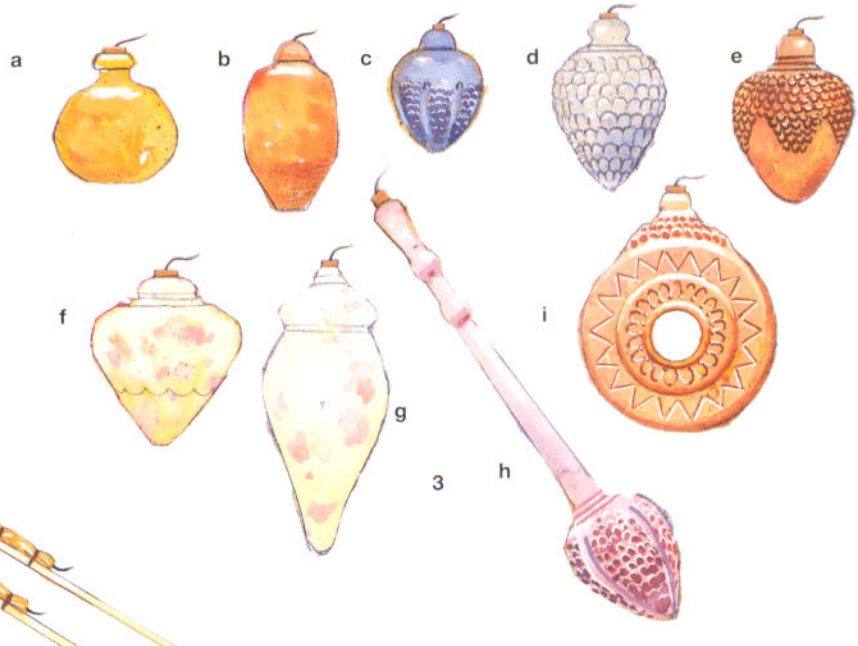
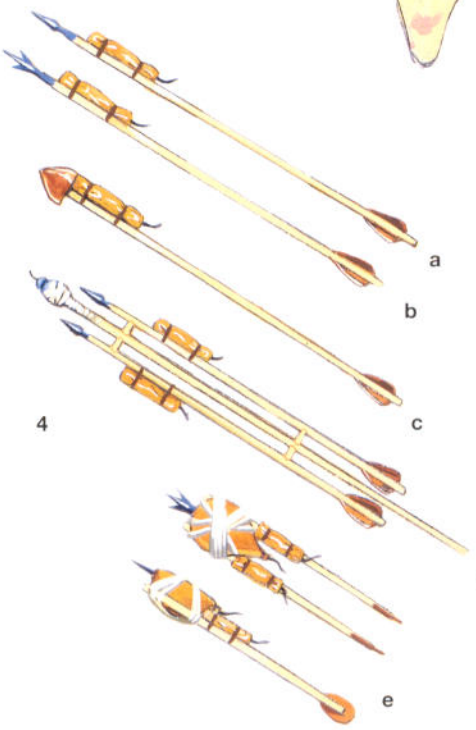




5

D: MANGONELS

KEY

1: 'Turkish-style' *manjaniq*

1 Wooden axle in iron sheath, lashed to beam-sling and slotted into summit of timber support frame.

2 Lateral frame lashed to end of beam-sling, with ten pulling ropes attached.

3 Support frame of roughly hewn unseasoned timber.

4 Leather sling on rope to beam-sling, plus rope loop to shallow iron hook on beam-sling.

2: Rumi or 'Frankish-style' *manjaniq*

5 More complex support frame of roughly hewn unseasoned timber.

6 Lateral frame with side-pieces attached to beam-sling beyond the axle, and with pulling ropes attached.

7 Well greased wooden axle in wooden slots on top of support frame.

8 Leather sling on rope to beam-sling, and with rope loop here shown over iron hook at end of beam-sling.

9 Detailed view of top of support-frame showing slots where axle of beam-sling would sit.

3: *Lu'ab* or swivel *manjaniq*

10 Single timber supporting pole.

11 Timber side-pieces, thrust into earth.

12 Hook carved from wood at end of beam-sling.

13 Wooden swivel supporting axle at top of main pole, enabling *lu'ab* to be swung side to side and aimed in any direction.

14 Lateral bar for pulling ropes, through which beam-sling and side-pieces are thrust.

15 Close-up view of axle lashed to beam-sling.

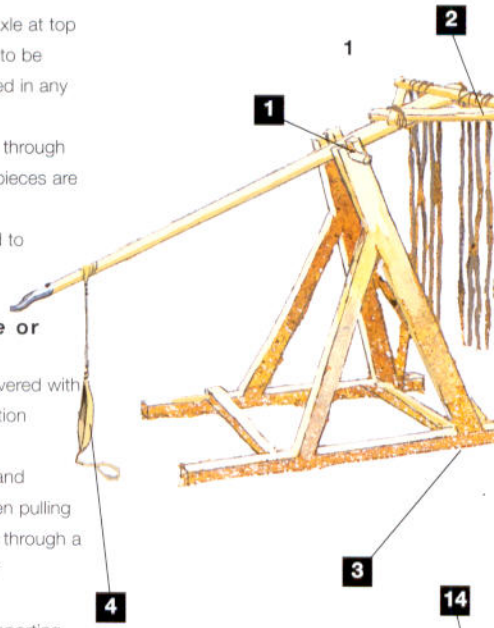
4: Byzantine *petrabole* or 'Arab-style' *manjaniq*

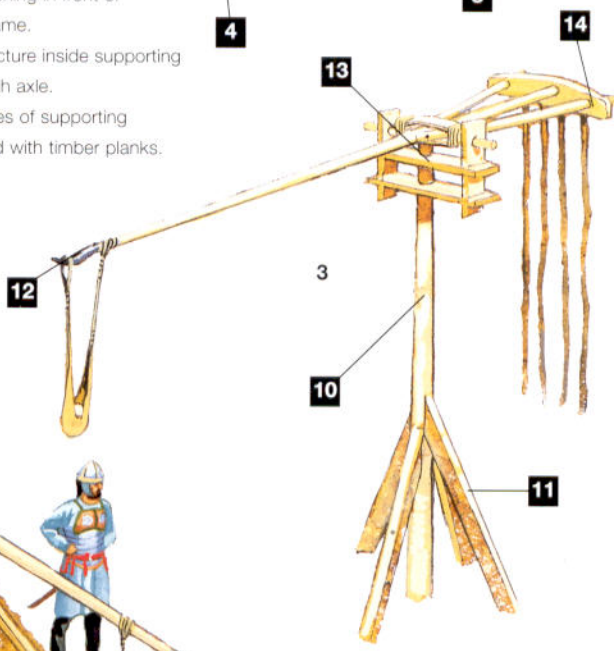
16 Exterior of support frame covered with fresh animal hides as protection against fire-arrows.

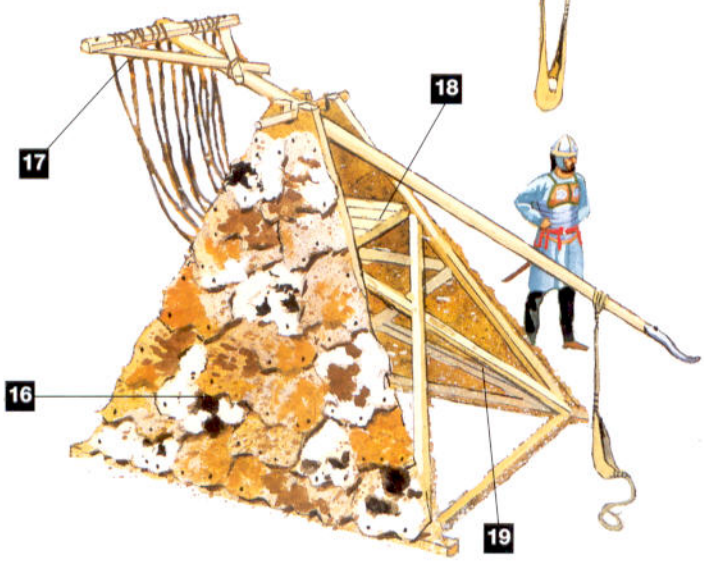
17 Lateral wooden bars nailed and lashed to beam-sling, with ten pulling ropes attached then running through a horizontal opening in front of supporting frame.

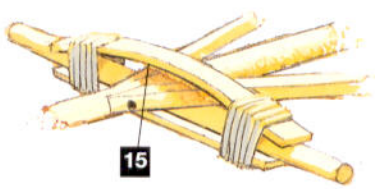
18 Roof-like structure inside supporting frame, beneath axle.

19 Front and sides of supporting frame covered with timber planks.





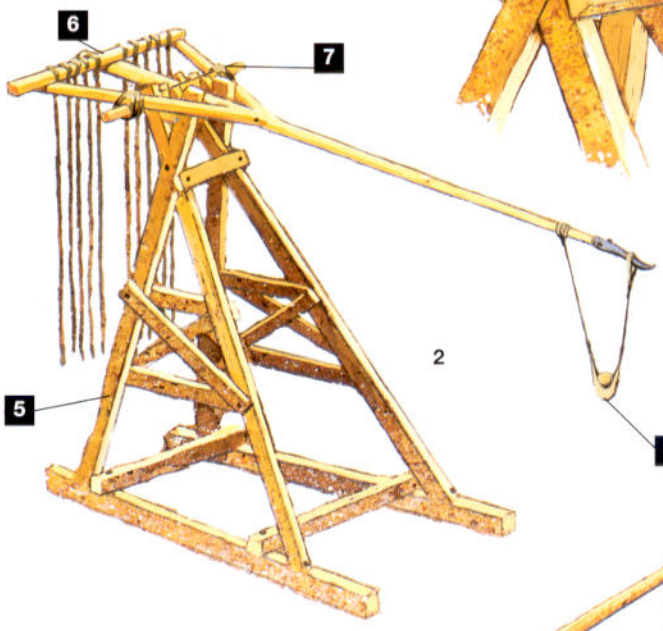




5: Earliest known form of counterweight *manjaniq* as described by al-Tarsusi

20 Longitudinal elements of timber base-frame partially sunk into the ground.

21 Hole in ground within base-frame, for lower arc of counterweight as it falls.



22 Pair of large iron hooks to take upwards strain on crossbow (24) when hook (23) is attached to lower end of beam-sling.

23 Long iron hook to go through ring in second iron band around front of beam-sling (27).

24 Large form of *jarkh* crossbow attached to front cross-timber of base-frame.

25 Counterweight consisting of a large rope-net filled with rocks.

26 Iron or bronze collar around lower end of beam-sling, to which ropes from counterweight are attached.

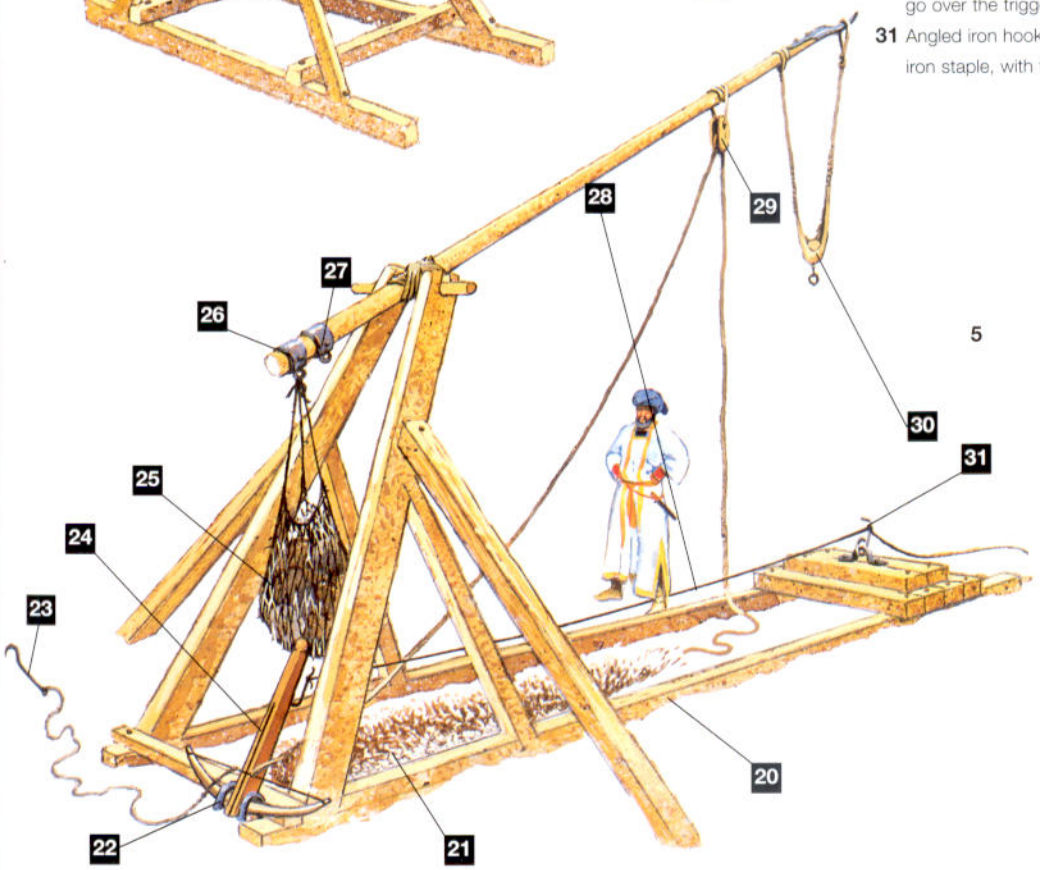
27 Second iron collar around beam-sling with ring for hook from crossbow.

28 Rope linking trigger hook of *manjaniq* to trigger of crossbow.

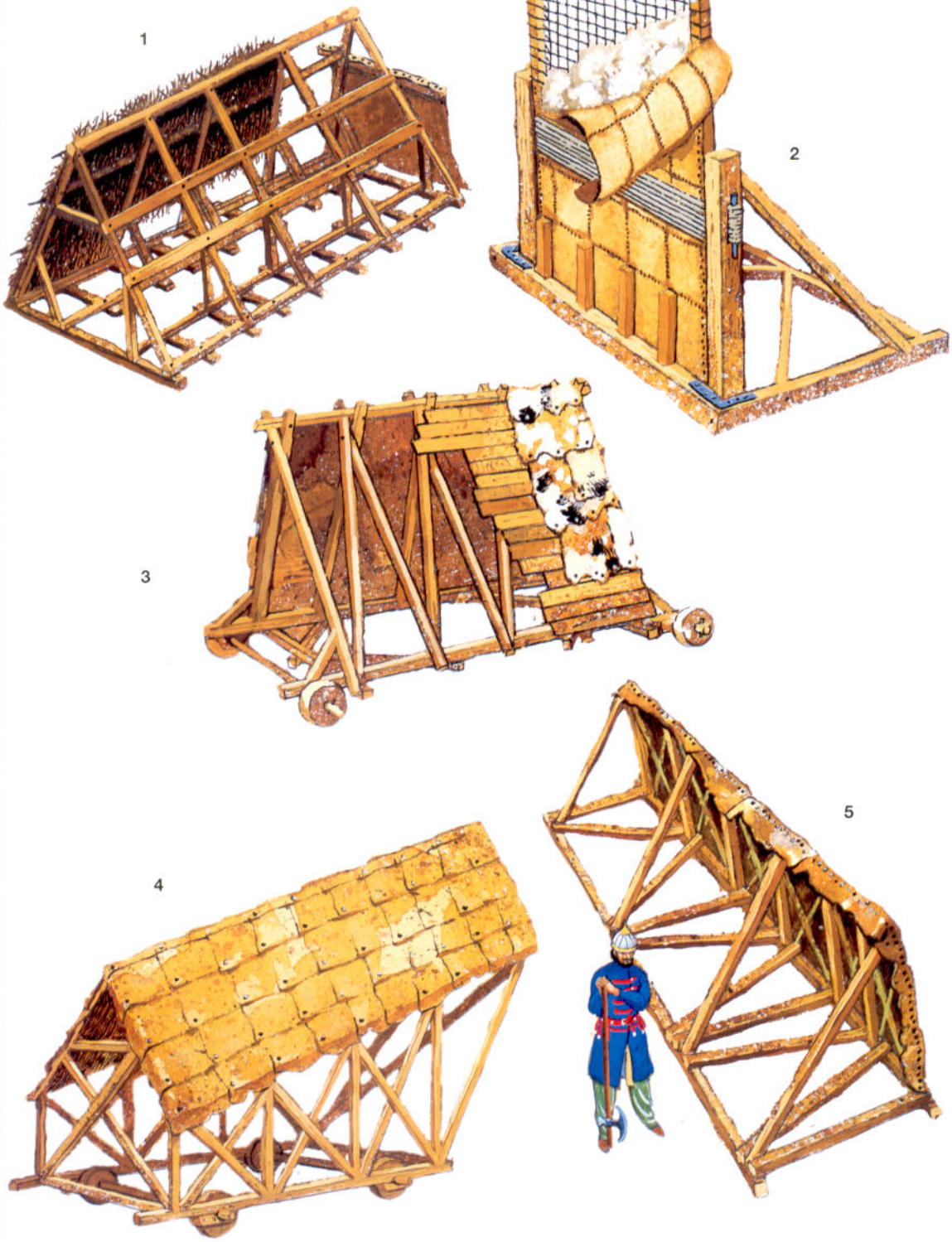
29 Wooden block and pulley tied to beam-sling, to enable operating to pull down beam-sling after shooting.

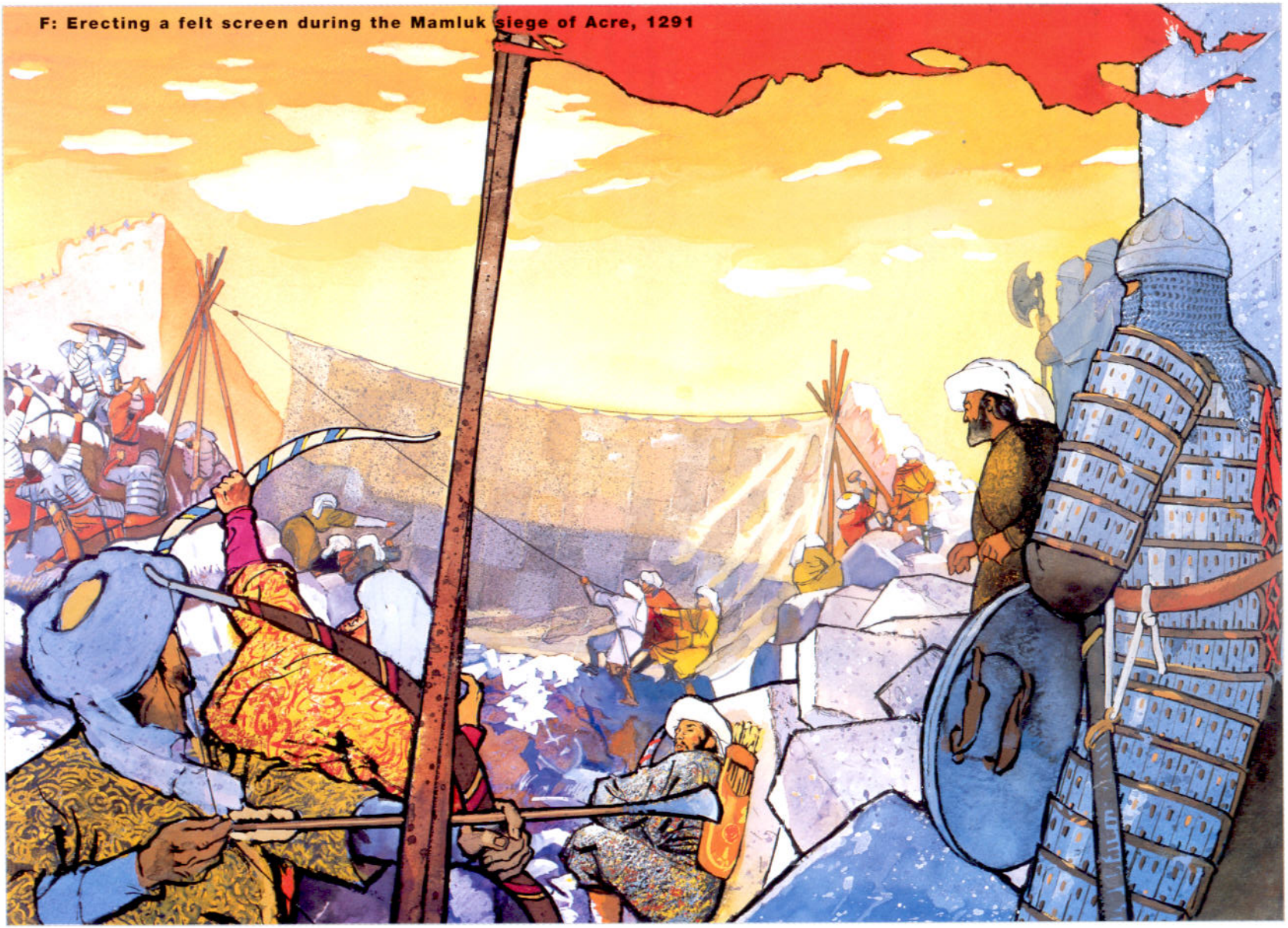
30 Leather sling with small iron ring to go over the trigger hook (31).

31 Angled iron hook attached to large iron staple, with trigger-rope attached.



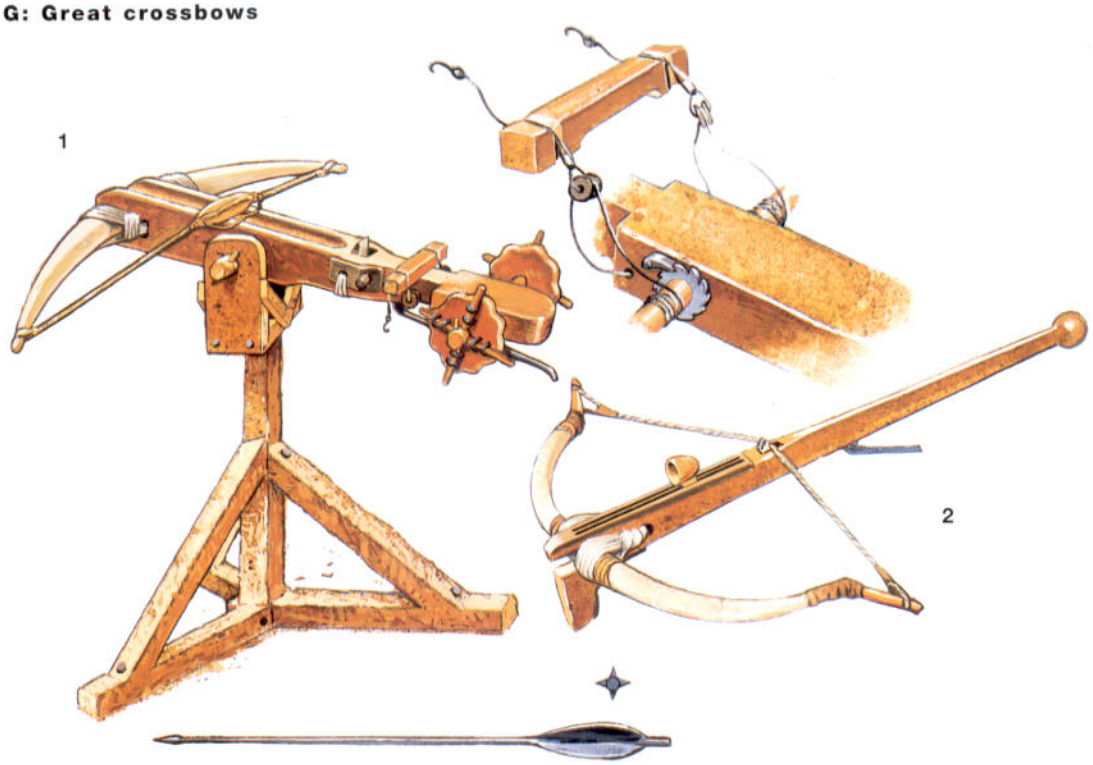
E: Protective sheds and screens

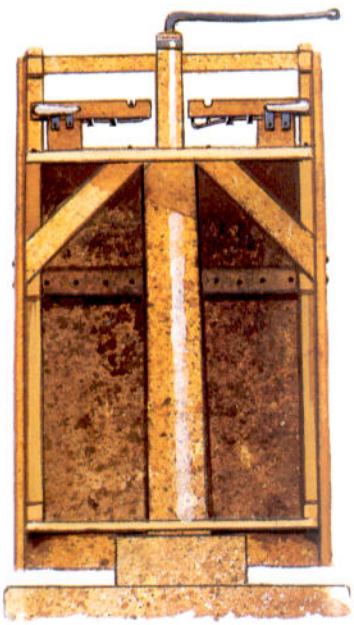




F: Erecting a felt screen during the Mamluk siege of Acre, 1291

G: Great crossbows





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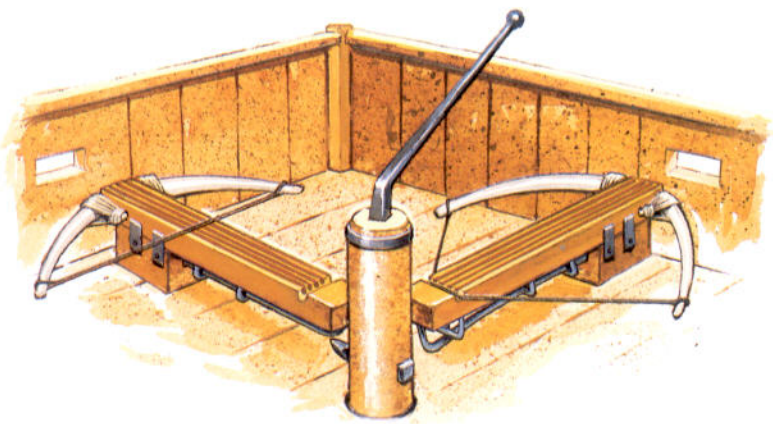
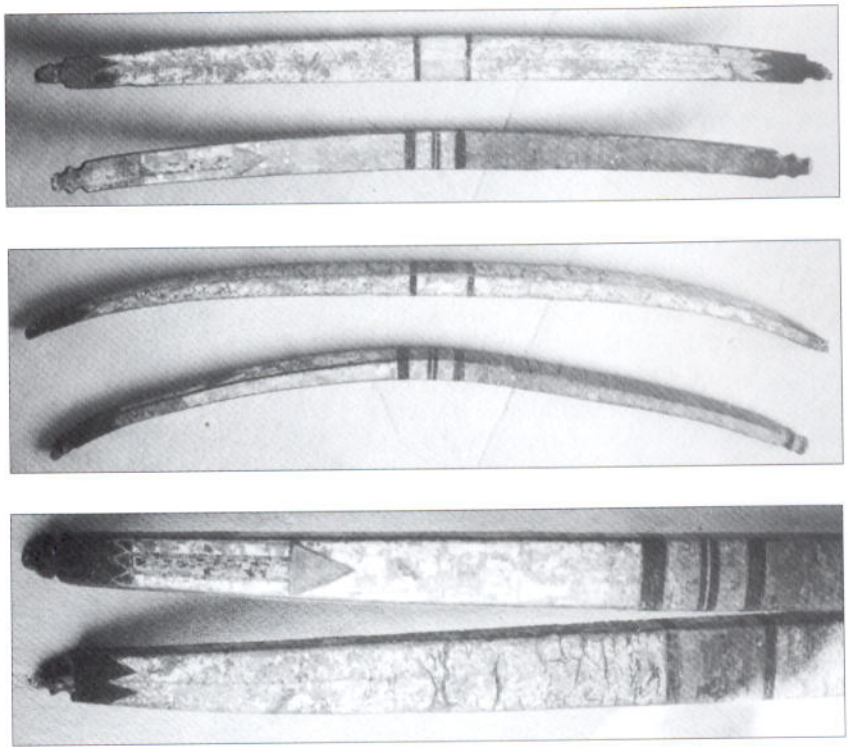




When a late 13th-century Arab historian mentioned 'crossbows made of the skins of dappled monkeys' he was probably referring to their surface decoration. These massive bows were part of two great crossbows used to defend a Mamluk castle in Syria where they were found and they date from the late 13th to early 14th century. (Private collection)

snag and deflect this ram. The same naval officer then constructed a sort of crane:

> A long beam of unseasoned timber was set up on the wall in front of the [enemy] tower. One top of it, forming a T-shape, was another beam 40 cubits [20 metres] long, swung on pulleys worked by a winch in the manner of a ship's main spar in the direction of whoever was operating the machine. At one end of the pivoting beam was an iron bar and at the other end were ropes running on pulleys, by means of which the operators could hoist buckets of dung and refuse and empty them over the Franks in the tower ... Then the sailor had panniers and baskets filled with oil, pitch, wood shavings, resin and cane-bark set on fire and hoisted up in the manner described to the level of the Frankish tower.[12]

By this means the defenders destroyed two siege towers. Similar skills were available in the Balkans, though they were not always used with such success. When the Byzantines attacked Hungarian-held Zemun in Dalmatia in 1165, the defenders tried to drop a massive rock upon Byzantine sappers attacking the base of their wall.

> Girdling it with wooden beams they fastened their ropes to the timber and drew it up to a wooden turret which they had constructed, projecting over the wall, to drop it on the Romans [Byzantines] from there. But when the stone reached the turret, the turret was unable to endure the weight ... Suddenly it broke and crashed to earth with many of the Hungarians.[13]

Similar devices were used in medieval India where large objects called *sataghni* were rolled or thrown onto the enemy, while in the later Mughul period stones dropped from a parapet were called *sang asiya*.

Fire Weapons

Fire weapons were far more highly developed in the medieval Byzantine, Islamic and Indian worlds than they were in western

12 Ibn al-Qalanisi (ed. & tr. H.F. Amedroz), *Bi Dhayl Tarikh Dimishq: History of Damascus* (Beirut 1908), pp. 179–80.
13 Kinnamos (tr. C.M. Brand), *Deeds of John and Manuel Comnenus by John Kinnamos* (New York 1976), pp. 181–84.

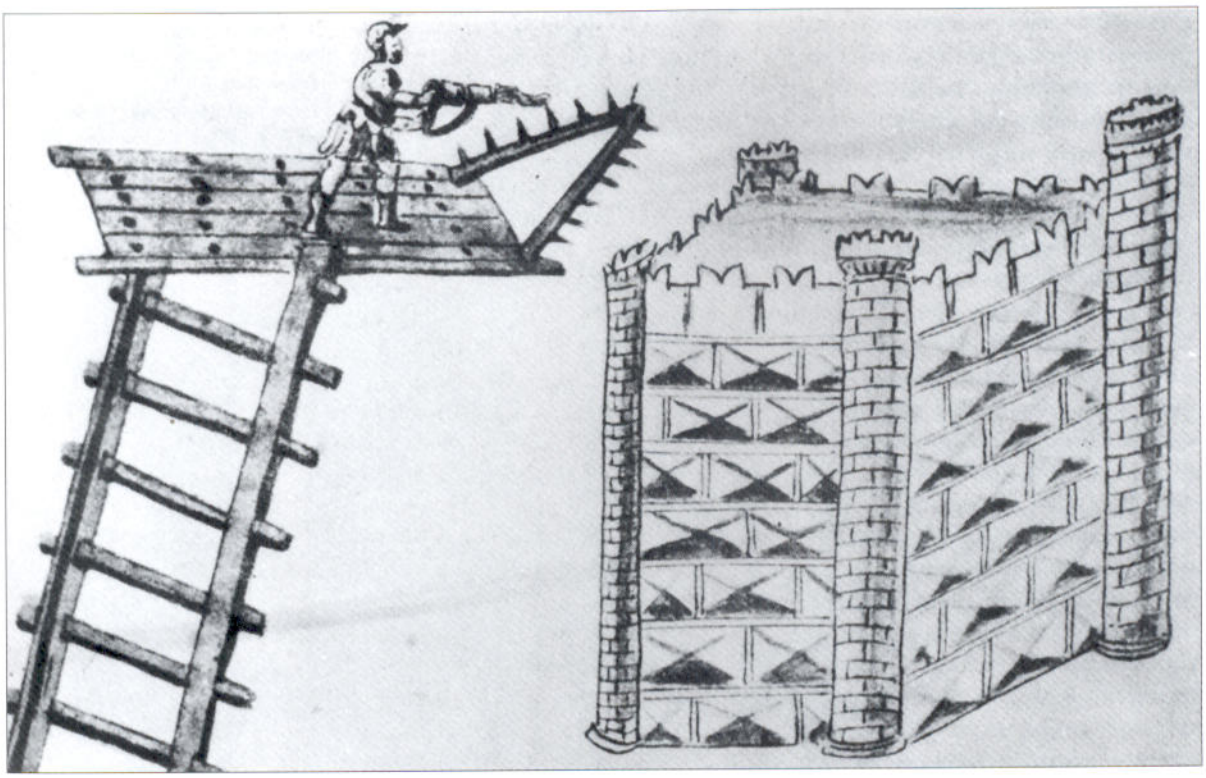
Europe. Of course oil was abundant, either as olive oil, pine resin, or more significantly in the form of naturally occurring petroleum deposits. Even in the 4th century AD the Persians used particularly advanced military pyrotechnics which could not be extinguished by water. Ammianus Marcellinus knew that the special ingredient was called naphtha but he thought this was a secret herb. The late Roman and early Byzantine armies also had effective incendiaries using resin, oil, bitumen and sulphur which could be attached to large arrows or hand-thrown javelins.

By the 6th century the Byzantines used fire-pots called *chouzia*, but the biggest chemical advance came in the 7th century with the invention of so-called Greek Fire which was credited with saving the Byzantine Empire from the advancing Muslim Arabs. In fact Kallinicos, the man credited with inventing what came to be known as Greek Fire, was a Syrian Christian architect who deserted the service of the Caliph around 673 and brought with him the latest knowledge of mixing and perhaps distilling crude oil with other ingredients. In the 7th century Greek Fire was mostly used at sea and certainly had a terrifying moral impact. Having lost the oil-fields of the Middle East, the Byzantines apparently got most of the primary ingredient from the Donbas region north of the Black Sea where crude oil oozed to the surface. It was probably gathered early in the morning or in winter before the more volatile elements evaporated in the sun. Once ignited, this mix of crude oil and other ingredients was notably difficult to extinguish and could even burn on the surface of the sea.

The next major advance was the development of syphons to project Greek Fire without unacceptable risks to the operators. Liquid fire shot through tubes was probably known by the later 9th century. However, the weapons were so complicated that the Bulgarians could not turn captured Greek Fire syphons against the Byzantines. The main problem was probably that Greek fire had to be heated before being ignited at the mouth of the syphon, and the distilled liquid had a low boiling point which could create an explosive mixture with air.

There is no agreement on precisely how a Greek Fire projector worked. The early forms were bulky and were apparently operated by a

The Byzantines used Greek Fire very effectively at sea, and the best illustration shows a man at the prow of a galley squirting fire over an Arab ship. Close inspection shows an additional object on the top of the fire-projecting tube. This was probably the ignition element or fuse known as a *warda* or 'rose' in Arabic sources. (*Skylitzes History*, Cod. 5-3, N2, f. 34v, Biblioteca Nacional, Madrid)



The following text from Heron of Byzantium accompanied this drawing of a Byzantine soldier with a Greek Fire syphon: 'If some of those standing on the assault-bridge with a hand-held swivel tube incendiary shoot fire into the face of the enemy, they will so terrify the defenders standing on the wall that the latter will quickly abandon their position.' (*Poliorcetica of Heron of Byzantium*, 13th-century copy of a 10th-century original, Vatican Library, Cod. Gr. 1605, Rome).

protocaraboi, a *siphonarii* and a *proreis* who heated, pumped and aimed the mixture (see Plate C). The Viking *Yngvar Saga* also described the vulnerability of the device; a fire-arrow which punctured a pipe causing the mixture to blow back into the faces of its operators.[14]

The Emperor Leo VI (886–912) maintained that the smaller hand-held fire projector was a recent invention. It probably used a more volatile mixture which could be ignited without preheating (see Plate C), while a smaller 'one-shot' incendiary blowpipe could even be used underground, as it was during a siege of Durazzo (now Dürres) in 1108.

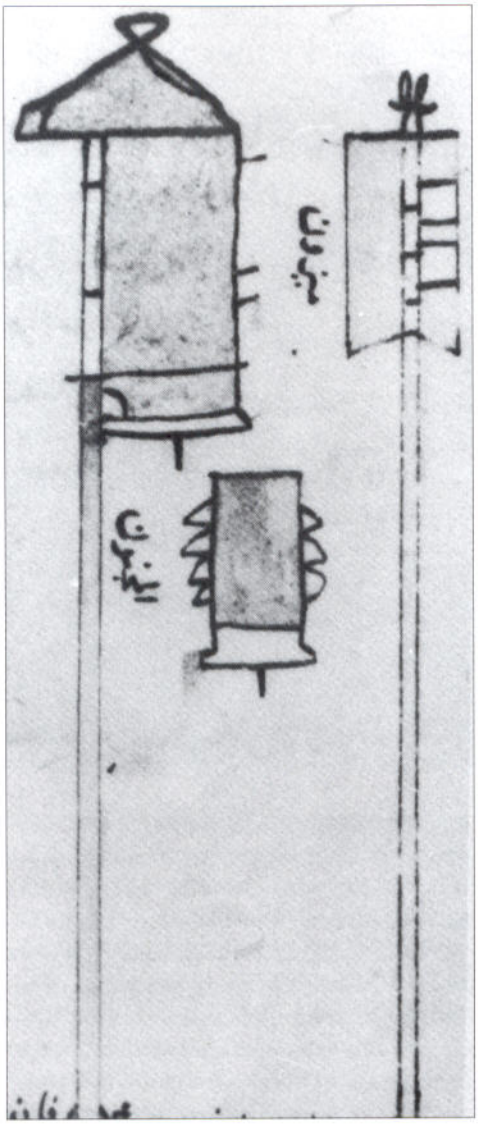
Once semi-explosive incendiary substances were developed, probably in the Islamic world rather than Byzantium, they apparently proved more effective or at least more versatile than the clumsy and unreliable Greek Fire syphons. Consequently all sides used them when they could, including the Byzantine Empire. In 1054, for example, a European mercenary in Byzantine service pretended to be an envoy and entered the camp of a Turkish army besieging Manzikert. Suddenly he produced 'three bottles of naphtha' which he threw against the enemy's siege machines before galloping back to safety. The fuses of these grenade-like weapons must already have been ignited and were perhaps hidden beneath the soldier's cloak.

The effectiveness of Islamic incendiary weapons against the Crusaders in the 12th and 13th centuries is well recorded. Of course the basic technology of Greek Fire came from the Middle East, as did most of its vital ingredients. Furthermore attitudes towards the practical application of technology for civilian and military purposes within the

14 J. Haldon & M. Byrne, 'A Possible Solution to the Problem of Greek Fire', *Byzantinische Zeitschrift*, 70 (1977), p. 999.

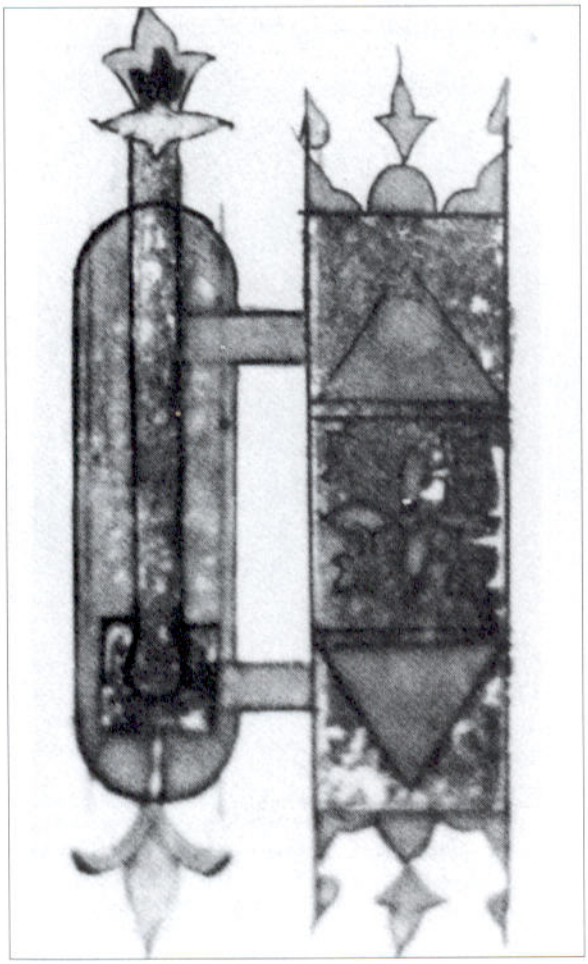
medieval Islamic world were closer to those of modern times than those of ancient Greece and Rome, so it is no surprise that Muslim chemists and technicians had outpaced their Byzantine contemporaries by the 10th century.

Simple bundles of burning reeds had been used in pre-Islamic Arabia but in the early 8th century Umayyad caliphate incendiary materials were assembled before a major siege campaign. Some non-Arab sources maintain that Muslims were using Greek Fire within a decade of the Byzantines doing so, especially at sea. They were certainly doing so in river warfare inside Iraq in the mid-8th century and the first indisputable reference to the use of *naft* or Greek Fire in siege warfare was during Harun al-Rashid's attack on Byzantine Heraclea (now Eregli) in 802. A later account of the same siege stated that rocks were wrapped in *naft*-soaked fabric then thrown by *manjaniqs*. A 12th-century source also described large clay pots containing *naft* that were covered in felt before being thrown. Hand-held *naft* grenades around the same time were thought to have been used against Indian war-elephants, while Sindi *naft* throwers rode in howdahs on the backs of four elephants during a caliphal parade to impress a Byzantine ambassador in 912. There was even one attempt to draw an enemy onto ground which had been soaked with *naft*.



A 14th-century manuscript from Mamluk Egypt illustrates two incendiary rockets called a *mizun* or 'balanced' and a *majnun* or 'mad'. (Sulëymaniya Library, Istanbul)

Knowledge of Greek Fire 'flame-throwers' was similarly available, and one 9th-century Latin account described the Muslims' use of such weapons at sea: 'The Saracens ... made a hearth on the bows of their ship on which they rested a vessel of bronze filled with the above [ingredients] and put fire under it.' The result was a great deal of smoke and the roaring of the bellows. Similar weapons had been used slightly earlier against a rebel-held castle in northern Iraq and during a civil war in 934 one army tried to use *naft* syphons in open battle. But the wind changed and blew the resulting flames back into their own lines.



Though highly stylised, this seems to be the only known medieval technical illustration of a *naft* or Greek Fire projecting syphon. It is described as a 'supplying container (fuel tank) with a copper *mizraq* (shooting syphon) beneath'. It is followed by another stylised illustration of a 'detached supplying container'. By the time this manuscript was made in 15th-century Mamluk Egypt the *naft* and Greek Fire syphon had been known for at least six centuries. (*Al-Aniq fi'l-Manajaniq*, Topkapi Library, Ms. Ahmad III 3469, Istanbul)

Variations on the word *zarraq* were now being used, and this, together with *naffata* and *mukhula* came to mean a flame-thrower. A virtually unknown Arab poet described such a *zarraqat al-naft* in the mid-10th century:

> It is a tube of yellow [brass or bronze] in the mouth of which there is a dribble of the same colour [to hold the ignition fuse]. When it comes to project it competes with the wind and rushes by just as quickly. When it makes wind it envelops men in a cloak of darkness [the smoke] like a protecting fortress. It has a tail [handle] which is like the tail of a pig standing on the head. When one pulls it [the handle] towards oneself, it releases its wind which strikes like a spear. Its spits lightning between two nights [the dark night inside the machine and the darkness of the smoke] and plunges into the battle naked for the most terrible vengeance. If one is targeted there is no escape, neither in surrender nor in retreat.[15]

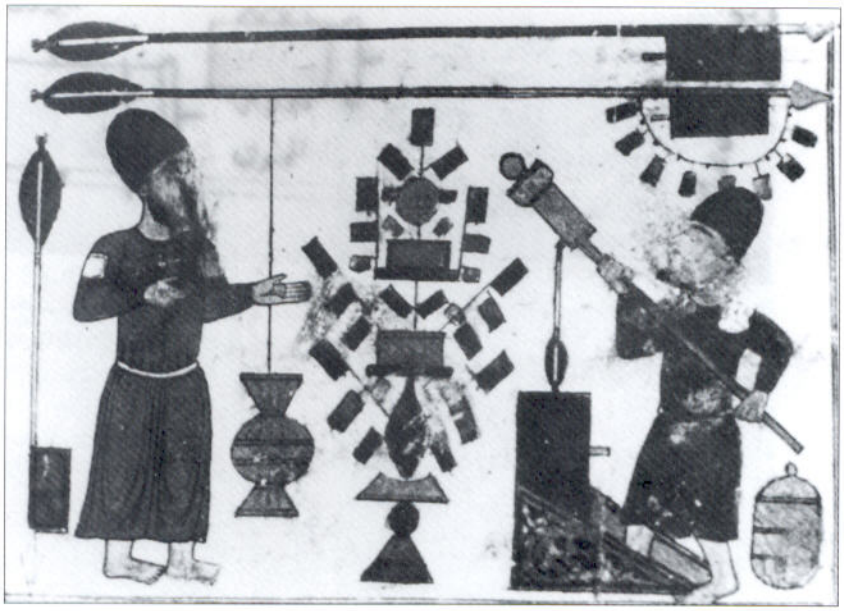
The 12th century scientist al-Jazari makes it clear that the *naft* syphon had non-return valves, while other Arabic sources show that the *naft* projector incorporated a small brass tank for the fuel. The resulting stream of oil-based liquid was ignited by a *warda* or 'rose' fixed to the top of the nozzle, this being a slow-burning fuse to produce a *'shihab* [shooting star] as long as a spear'.

This was the terrifying tradition of pyrotechnics which the Crusaders met in the Middle East. Their own chronicles, and those of their Arab opponents, state that various forms of incendiaries were used against Crusader siege machines and even against individual soldiers, while Crusader efforts to use comparable weapons largely failed. It has been suggested that an almost complete disappearance of wooden siege towers during the Crusades resulted from their being so vulnerable to *naft*. Furthermore, this virtual disappearance of suitable wooden targets may then have led to a decline in the use of *naft*, except in naval warfare.

This was not yet the case in the late 12th century when Saladin's garrison in Acre was besieged by the Third Crusade. *Naft* was so vital that Arab swimmers carried it into the harbour, past a Crusader naval blockade. The garrison of besieged Acre also included professional incendiary troops but their efforts were not at first successful, so the son of a coppersmith from Damascus offered to burn the Crusaders' siege towers. Eventually he was allowed to try, and his perhaps copper containers for *naft* were hurled by a *manjaniq*, burning the enemy's engines to the ground.

15 M. Canard, 'Textes relatifs à l'emploi du feu grégeois chez les Arabes', *Bulletin d'Études Arabes*, XXIV (Algiers 1946), p. 7.

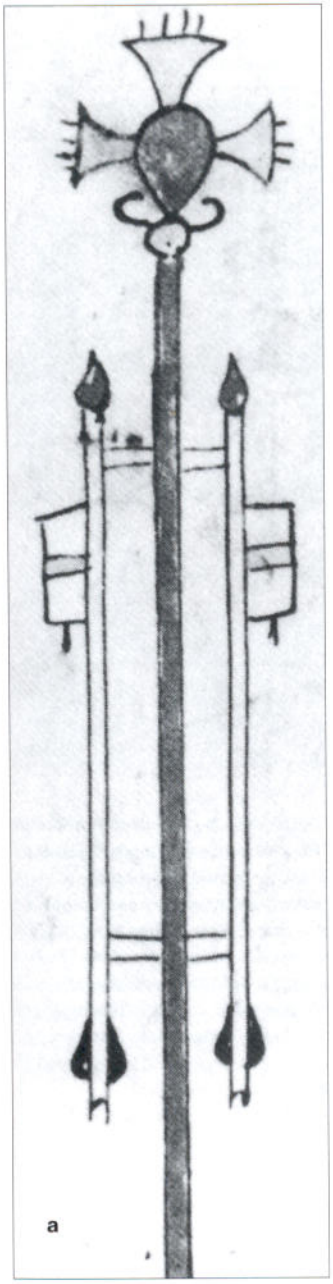
Meanwhile Iraqi incendiary weapons continued to be highly regarded. *Qidr 'Iraqi* or 'Iraqi pots' were shot from *manjaniqs* during the siege of Crusader-held Damietta in 1249; de Joinville describing them as 'like a big cask and having a tail [of flame] the length of a large spear'. They also exploded on impact, perhaps because they now contained primitive gunpowder. The purest Iraqi form of *naft* was called 'white', meaning a clear liquid, but some kinds of 'black' *naft* could be converted to 'white' by an oil-refining process. The result could be mixed with animal or vegetable fat, lime, resin and sulphur to make it adhesive like modern napalm. However it was saltpetre which made later types of *naft* so much more effective than early Greek fire. By the 10th–11th century there were already seven different ways of purifying saltpetre, and by the late 13th century there are said to have been ten times that number.

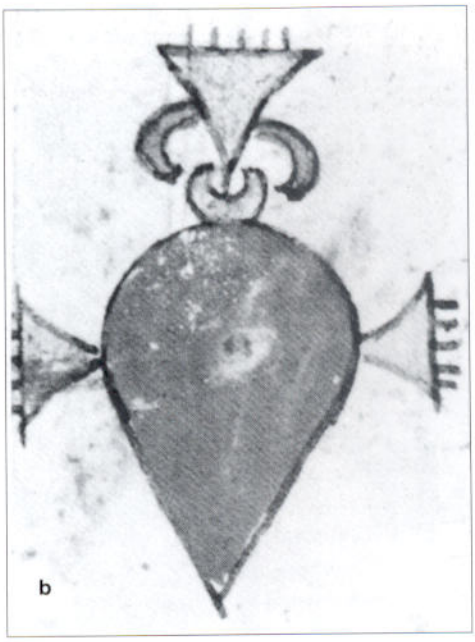


By the 15th century, when this illustration was added to a copy of an earlier training manual, Mamluk military texts included early forms of gun or hand-cannon as held by the man on the right. The picture also shows rockets and incendiary weapons using various forms of gunpowder. (Library of the Oriental Institute, St Petersburg)

Packets of perhaps explosive *naft* were described as being attached to arrows, javelins spears, even maces in 14th-century Arabic technical manuals, and there were several types of grenade (see Plate C). Two fire-arrows from the citadel of Damascus, now in the Musée de l'Armée in Paris, are made of iron with iron fins and small rings on their shafts, presumably for attaching packages of incendiary material. But these particular missiles also have large wooden plugs around their shafts, indicating that they were fired from early forms of cannon. In contrast the *siham khita'iya* 'Chinese arrows', which were known by the early 13th century, may actually have been primitive forms of incendiary rockets.

It is widely believed that incendiary weapons were highly developed in ancient India. Yet early Indian references are difficult to interpret and remain poetical rather than realistic. The only exception seems to be the *nalikastras* or 'missile barrels' which might have been incendiaries. In fact accounts of early Arab and Turkish invasions of north-western India seem to suggest that it was the invaders who made greater use of pyrotechnics, especially for frightening the war elephants on which Indian armies so often relied. Things may have been changing by the 11th century, and in the 13th century, when Fakhr al-Din wrote his *Adab al-Harb* for a Muslim ruler of northern India, assorted incendiary devices were probably in widespread use. These ranged from ordinary fire-arrows to the *atish kash ahnin* 'iron fire shovel' and the *tir-i atishin* which were perhaps 'containers of oil for burning'. The *kusht-anir* of a few years later may have been similar to the earliest Chinese gunpowder weapons which were, however, still incendiaries rather than guns.





Medieval Arab-Islamic technical texts include a variety of siege weapons using primitive gunpowder before the development of guns. Here, in a treatise written by Hasan al-Ramah in the late 13th century, two arrow-like rockets are attached to a rod with an incendiary warhead (a). Another simple drawing shows a grenade-like incendiary with three fuses (b). (Bibliothèque Nationale, Ms. Arabe 2825, Paris)

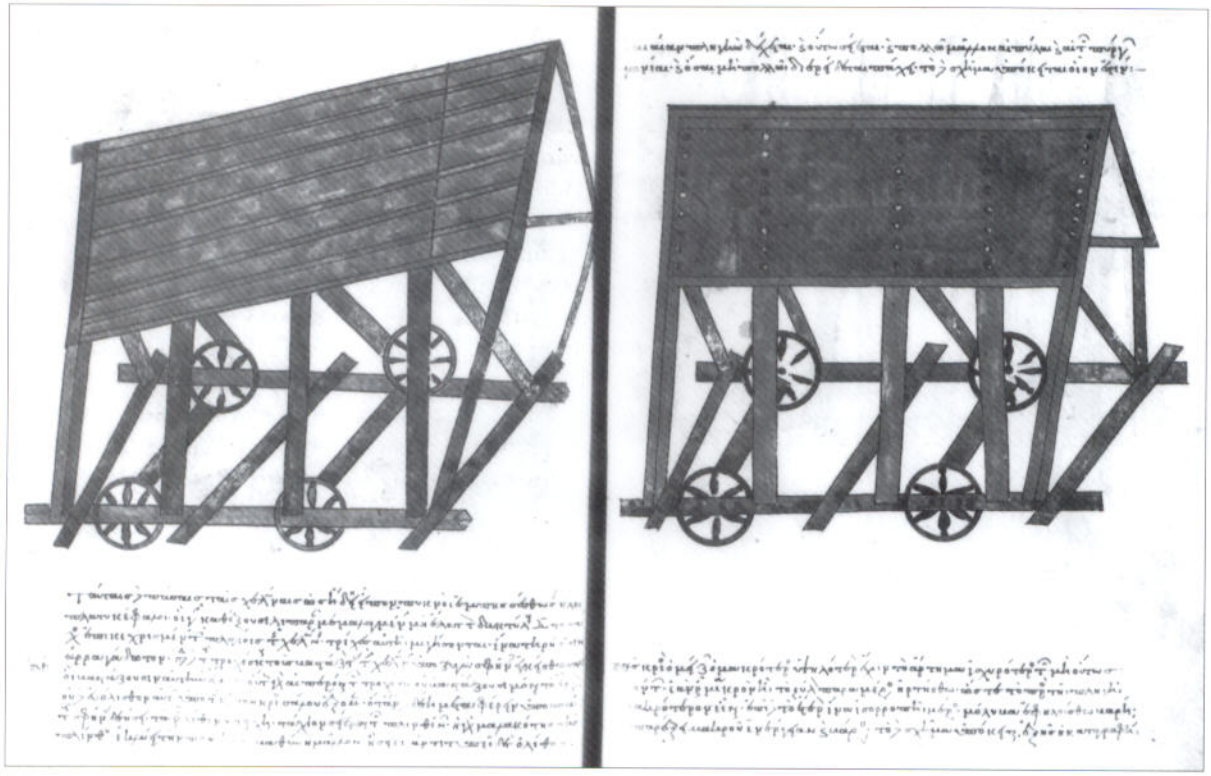
Despite their close links with China, the Mongols do not at first seem to have been noted for their incendiary technology. Later 13th- and 14th-century Mongol armies were, however, feared for their use of pyrotechnics in siege warfare. This probably had an impact upon Russia, where the *shereshir* is said to have been a metal container for incendiary material, probably thrown from a mangonel. Then there were the remarkable 'wheels filled with fire' which Russian troops in Tartu used against German Crusaders in 1224 (see Plate B).[16] Over a century and a half later Tamerlane made devices 'in the form of great wheels' during his siege of Izmir. These were made of wood and were rolled 'into the moat', though there is no indication they were set on fire.

Mobile Sheds and Shelters

Byzantine and Islamic armies made considerable use of a remarkable variety of temporary or movable shelters during siege warfare. These are also described in some detail in surviving sources. The Byzantine *chelonai* 'tortoises', for example, were wooden penthouses such as those used by earlier Roman armies. They came in various sizes, could be transported on carts and sometimes had their own wheels. However, by the mid-10th century the cumbersome 'tortoise' was widely regarded as old-fashioned. Smaller, more portable shelters called *laisai* of supposed Slav origin were now considered more effective by most Byzantine military theorists, at least when attacking smaller fortifications. They could be carried into position by a team of men but again came in a variety of designs and sizes, the smallest being little more than portable mantlets.

Information from Islamic sources is more varied. A *dabbabah* 'crawler', a protective shed covered with fresh cow-hides, was used during the Prophet Muhammad's siege of Taif in the early 7th century AD, but was nevertheless burned when red-hot iron bars were dropped onto it. Assorted *dabbabahs* continued to be used by Islamic armies throughout the medieval period. It could be fireproofed with iron sheeting and could have its own integral defensive tower, in which case it was sometimes called a *zahhafah*, which again meant 'crawler'. Other names for similar protections included the 10th-century *darajah* under which infantry could advance under fire, while the 14th century Turks

16 J.A. Brundage (tr.), *The Chronicle of Henry of Livonia* (Madison 1961), p. 225.

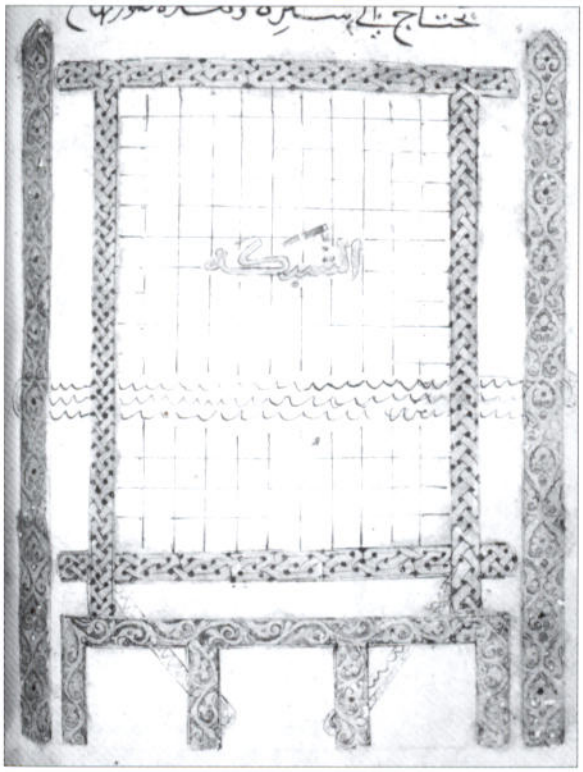


called their smaller infantry protections 'little frogs', perhaps because they advanced in short bursts or 'jumps'. The eastern Iranian or Afghan *karwah*, sometimes called a *garwah* in India, seems to have been similar to the smallest Byzantine-Slav *laisa*. It was covered in bullock hide over cotton padding.

Simple palisades or mantlets were known by various Arabic, Persian and Turkish names. The frequency with which these *mataris*, *jaftah* and *sitarah* are mentioned from the 7th century onwards indicates the sophistication of Islamic siege warfare. In Islamic India such devices were known as a *chapar*, *turah* and perhaps also included the obscure *dah mardah* or 'many men'. The *shabakah*, as described by al-Tarsusi in the 12th century, was a more complicated structure specifically designed to protect missile-throwing siege machines. Its frame not only absorbed the shock of enemy missiles, but could be tilted so that the machine it was protecting could shoot back. As such it appears to have been a precursor of the sort of movable screen placed in front of cannon during later medieval European siege warfare.

Occasionally the sources include very detailed accounts of otherwise little-known devices. Following the final siege of Acre in 1291 the Mamluk governor of Kerak, Baybars al-Mansuri, wrote his memoires called *Zubdat al-Fikra fi Tarikh al-Hijra*. These recalled how he had noticed that one of Acre's towers was so damaged by mangonels that it could be reached across an open space between it and the outer wall which the Mamluks had already captured. But this space was exposed to the defenders' crossbow fire. So Baybars took some felts and had his men stitch them into the shape of a long white cloud:

Mobile sheds to protect men attacking the walls of a fortified place ranged from simple structures to elaborate wheeled devices. The complicated types shown in an 11th-century Byzantine anthology of military treatises may not, in reality, still have been used. (Bibliothèque Nationale, Cod. Gr. 2442, ff. 84r-85v, Paris)



In his military manual al-Tarsusi suggested that a form of swivelling mantlet protect the large and complex *qaws al-ziyar*. It was designed to absorb the shock of missiles shot against the *ziyar*. *See also* Plate F. *(Al-Tabsira by al-Tarsusi*, Bodleian Library, Ms. Hunt 264, f. 141v, Oxford)

Between two posts opposite the damaged tower I place a pulley rigged with ropes similar to a ship's. There I hoisted the felt cloud into place like a dam. This was done under the wings of night unknown to the defenders of Acre who, when they arose in the morning and saw the screen, shot mangonels and arrows against it. When a stone fell into the screen the felt would slacken beneath it and break its thrust, and the crossbowmen could not penetrate it with arrows.[17]

Behind this screen Baybars' men filled the moat to make a causeway along which the Mamluk army successfully stormed the walls. The device was also remarkably similar to one described and illustrated in a work on siege warfare written for the French King Philip the Fair just over a century later.

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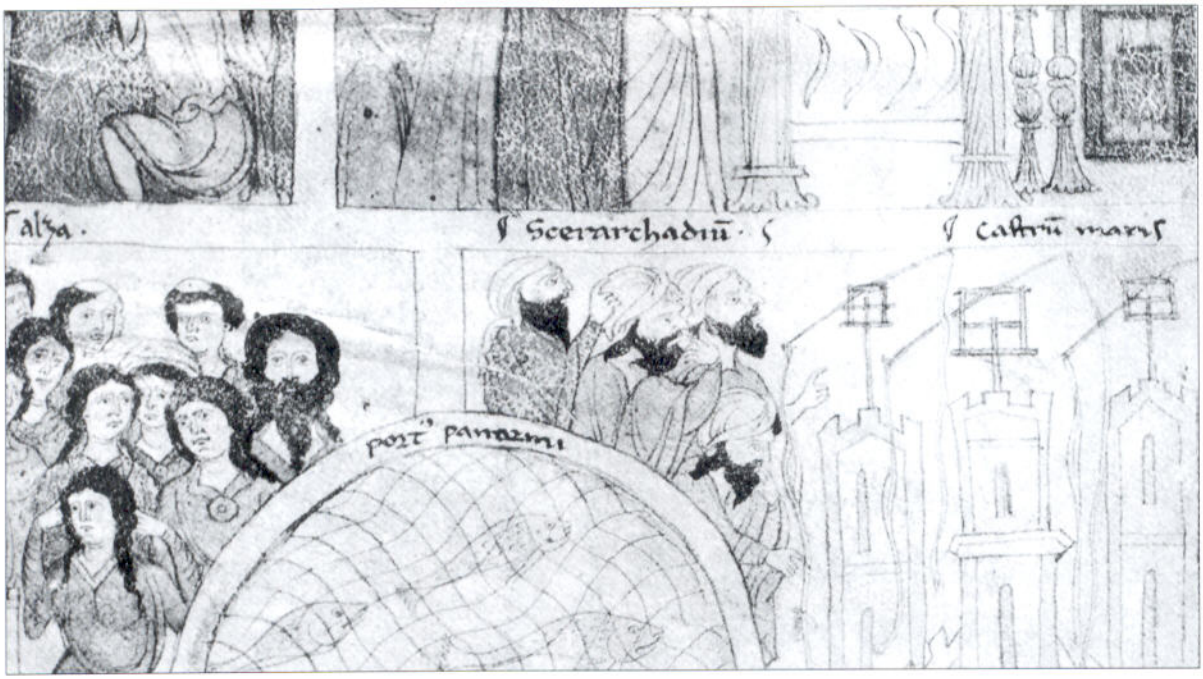
17 D.P. Little, 'The Fall of 'Akka in 690/1291', in M. Sharon (ed.), *Studies in Islamic History and Civilization in Honour of Professor David Ayalon* (Leiden 1986), p. 172.



Peter of Eboli's *Chronicle* of the fall of the Norman Kingdom was made in Sicily or southern Italy around 1200. Here a group of 'Saracens' look with apparent concern at man-powered mangonels, each mounted on a fortified tower. *(Chronicle of Peter of Eboli,* Ms. Cod. 120/11, f. 98r, Burgerbibliothek, Bern)

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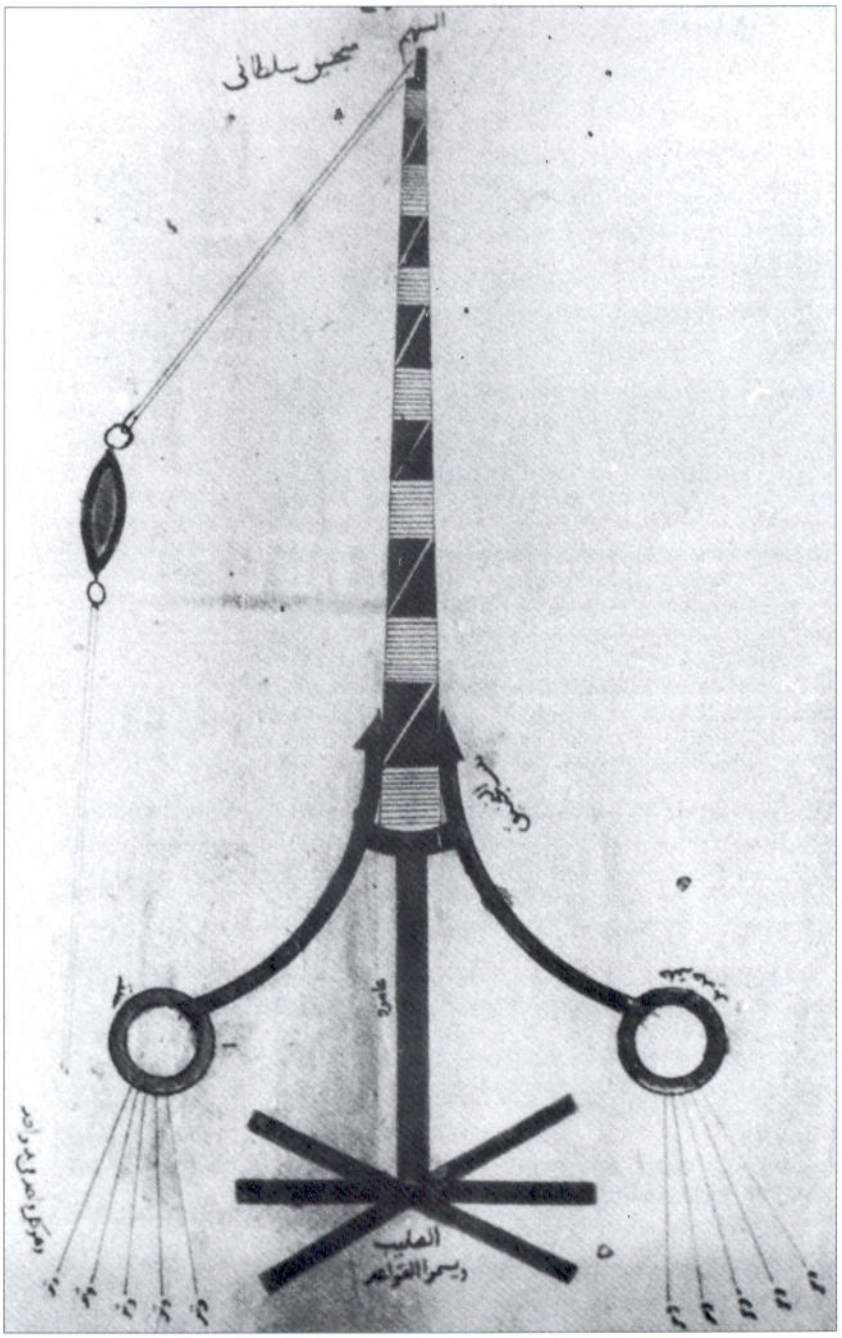


After describing how to construct the frames, counter-weights and axles of mangonels, the mid-15th-century *Al-Aniq fi'l-Manjaniq*, describes and illustrates four kinds of beam-sling arm. This is for a man-powered *manjaniq sultani* where the pulling ropes were attached to two iron rings. (*Al-Aniq fi'l-Manajaniq*, Topkapi Library, Ms. Ahmad III 3469, f. 40v, Istanbul)

COLOUR PLATE COMMENTARY

A: TORSION-POWERED ENGINES

1: The largest form of *qaws ziyar*, as described by al-Tarsusi

The frame of the *qaws ziyar* was made of unseasoned oak with half-butt joints and large iron nails. Each piece of wood was approximately one span (20cm) square while the vertical timber at the front was two spans across with bronze plates around both sides of an arch-shaped hole through which the arrow was shot. The horizontal stock down the centre of the *qaws ziyar* was again of unseasoned oak. Twisted skeins of mixed horsehair and silk were looped around the frame, their tension causing the arms of the crossbow-like structure to swing forwards. The arms themselves tapered from about 25cm to about 5cm and were of composite construction around a wooden core. In this reconstruction the bowstring of horsehair and silk has been pulled back to slot into a groove across the top of the stock. An oak trigger from beneath the stock pushed up a peg which forced the bowstring out of the groove to shoot.

Al-Tarsusi also described a winch that was used to span or pull back the bowstring against the massive thrust of the twisted skeins.

2: Byzantine *alakation* or *ballista*

The Byzantine *alakation* was probably a simplified version of a weapon common during the Roman period. Its heavy wooden frame could not easily be moved. However, the weapon itself could be aimed up and down and side to side. Like the *qaws ziyar*, the *alakation* had two separate bow-arms, in this case of oak, and the twisted skeins that powered the weapon were stretched across a wooden frame. Some Byzantine illustrations seem to indicate that these skeins ran through slots in the frame while the skeins themselves still seem to have been of animal tendons. Here a cross-shaped piece of iron with a claw is held in place by two staples nailed to the stock. An iron 'key' with a length of rope served as a release mechanism. The weapon itself was spanned by ropes and hooks from an axle with a wooden capstan wheel and capstan bar.

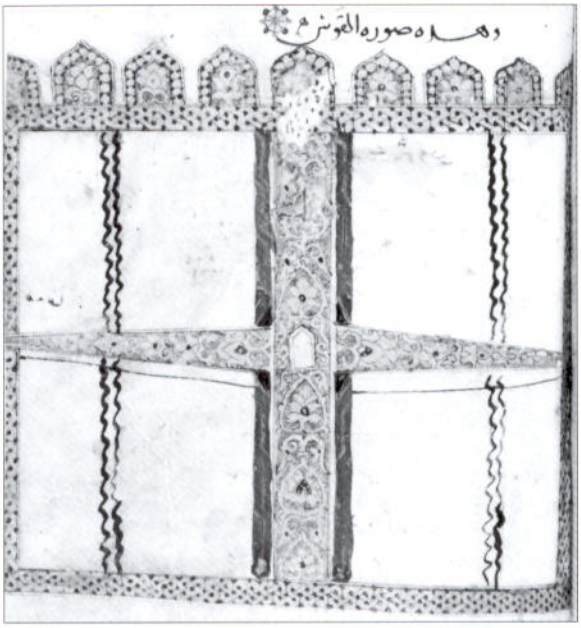
B: RUSSIAN WHEEL OF FIRE IN ACTION, TARTU, 1224

During the Crusader siege of Tartu in Estonia in 1224, the Estonians' Russian allies made large 'wheels filled with fire' which they rolled out of a gap in their already damaged defences towards the Crusader's largest wooden siege tower. But the Crusaders extinguished the flames and these extraordinary fire wheels failed. Devices known as 'thunder sticks' were similarly used in China, though they were not apparently ignited, so perhaps these weapons hint at eastern military influence upon Russia and its neighbours even before the arrival of the Mongols.

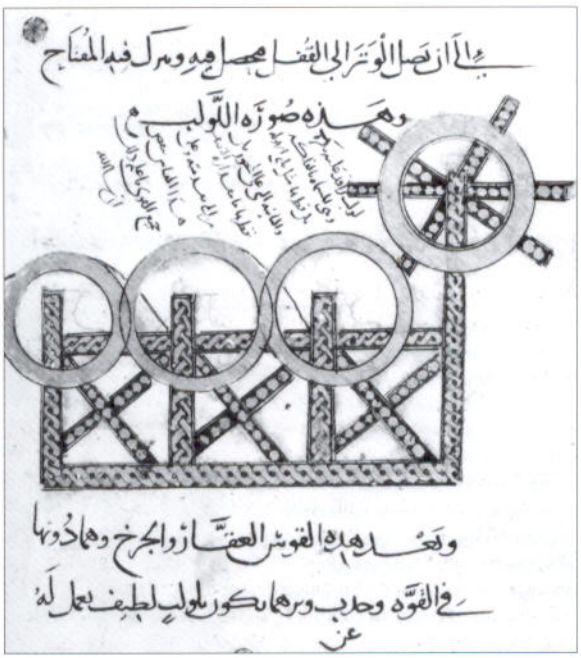
C: PYROTECHNIC WEAPONS

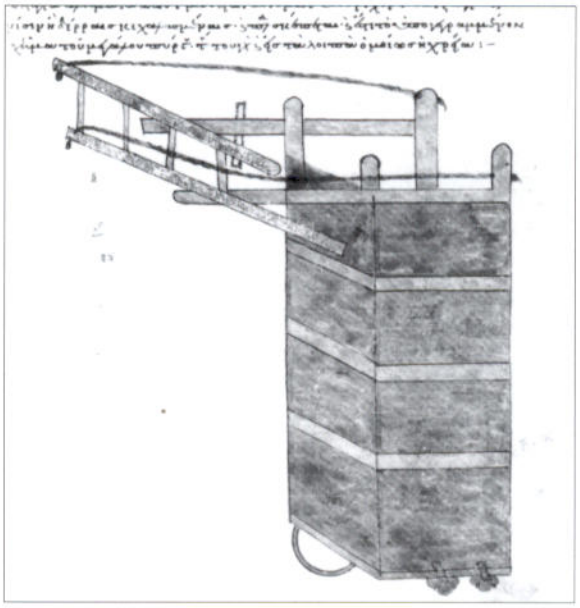
1: Greek Fire syphon

This hypothetical reconstruction is based upon written descriptions and one surviving illustration. A vertical brass pump provides air pressure via a bronze-bound leather hose to the main tank consisting of two pieces of copper soldered together. Underneath is a small brazier and a pair of bellows.



ABOVE AND BELOW **The most famous Middle Eastern military manual was written by Murda al-Tarsusi for Saladin in the later 12th century. Its illustrations are schematic and decorated, even including gold paint. The two pictures shown here show a *qaws ziyar* from the front (above), and a side view (below) of the multiple winch needed to span this fearsome weapon. *See also* Plate A. (*Al-Tabsira by al-Tarsusi*, Bodleian Library, Ms. Hunt 264, ff. 85r & 87v, Oxford)**





Several forms of siege tower appear in this 11th-century Byzantine anthology of military treatises, most being shown with wheels. Various types of ladder or ramp were added to their summits to allow attackers to get onto the enemy's wall. (Bibliothèque Nationale, Cod. Gr. 2442, f. 97r, Paris)

The brazier is believed to have contained flax, possibly impregnated with linseed oil. Another hose takes the heated incendiary liquid to a brass or bronze nozzle. There was presumably a tap to control the flow and at the front of the nozzle there was an ignition system consisting of a linen taper impregnated with sulphur.

2: *Naft zarraqa*

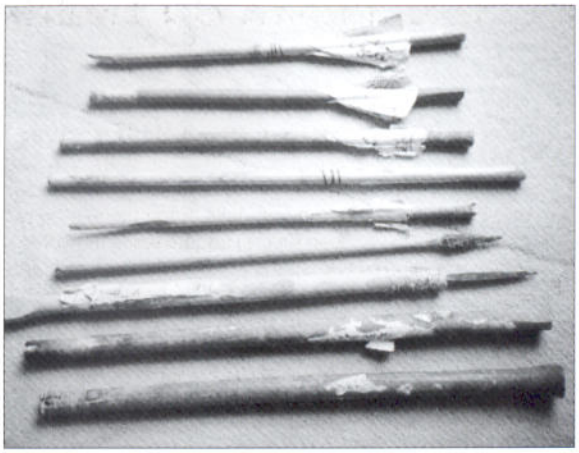
This conjectural reconstruction of a portable Greek Fire syphon is based upon a number of written descriptions, plus highly stylised illustrations in Byzantine and Islamic military manuals. An airtight copper 'box' containing inflammable liquid is mounted above a hand-held syphon. The inclusion of chemicals that would later be used in gunpowder probably meant it was no longer necessary to pre-heat the fuel. The pressure is here provided by a handle within a quarter-circle of brass or bronze, as indicated by a small Byzantine drawing.

3: Ceramic grenades

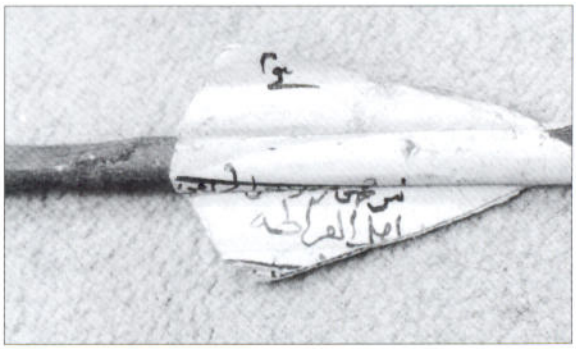
A few of these grenade-sized containers have been found to contain traces of burnt material and even primitive gunpowder. A–b: Two grenades from Fustat, Cairo, 12th century. C: Grenade from central Jordan, 13th century. D: Grenade from Abu Dhabi, 12th–13th century. E: Grenade from Burma, 12th–13th century. F–g: Grenades from Transoxania, 13th century. H: Grenade with a long ceramic 'handle' from Iran, 13th century. I: Ring-shaped grenade, perhaps to be attached to a javelin, 13th–14th century.

4: Incendiary missiles

The incendiary missiles used in the Byzantine, Islamic and medieval Indian regions included simple flighted javelins with packets of inflammable material tied to their shafts and various types of blades (a–b). Other javelin-like weapons



a



b

In addition to massive crossbow staves, an array of bolts and arrows (a) was also found in a Syrian castle. The bolts vary in size, weight and length but have the tapered tails which distinguishes a crossbow bolt from arrows. Some still have crudely made iron arrowheads and several still have flights made of paper (b). (Private collection)

appear to have been rockets, almost certainly indicating Chinese influence (c). A more elaborate and perhaps experimental weapon (d) consisted of two rockets attached to a third 'stick' with what might be an incendiary grenade in front, while a surface-skimming anti-ship 'torpedo' (e) must surely have been merely experimental. It consisted of a half-egg-shaped iron container attached to two wooden poles, the tails of which had leather 'rudders'; there were also rockets tied to the poles.

5: Hand-gun, late 14th century

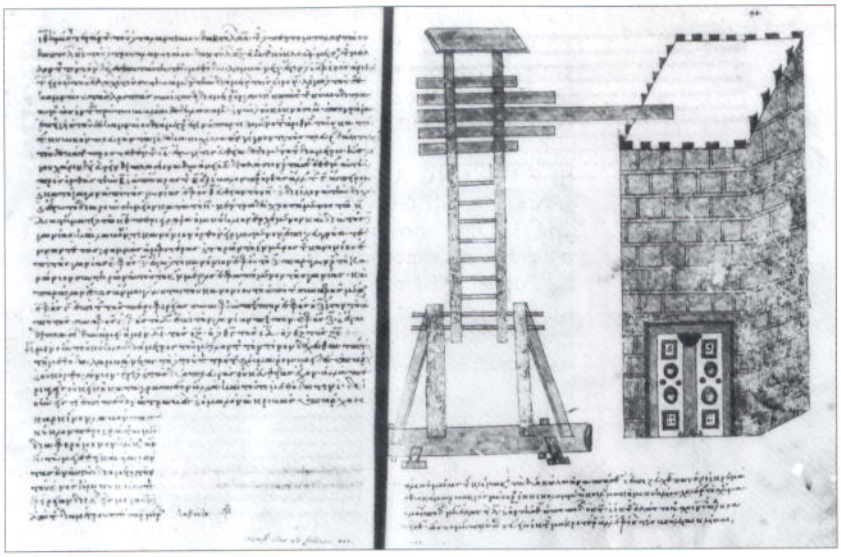
Unfortunately the very worn Arabic inscription on the rear portion of this medieval Islamic gun has yet to be interpreted. The massive late medieval iron arrow found in the citadel of Damascus, and now in the Musée de l'Armée in Paris, was probably fired from such a gun.

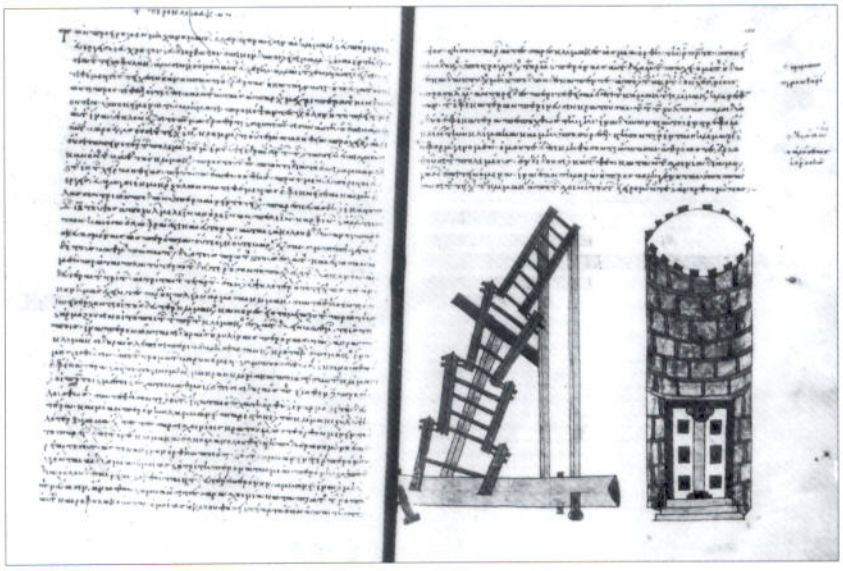
D: MANGONELS

1: 'Turkish-style' *manjaniq*

The Turkish *manjaniq* was simpler than the 'Arab' and had an open frame, but the rotating arm, axle and attachment for the ropes were the same.

2: Rumi or 'Frankish-style' *manjaniq*





In addition to mobile siege towers, this 11th century Byzantine anthology described ladders and platforms which could be raised and extended to enable attacks to be carried out. Some are very similar to the devices shown in similarly dated Chinese military manuals. (Bibliothèque Nationale, Cod. Gr. 2442, ff. 93r-94v & 99v-100r, Paris)

This was another simple open-framed weapon, except that the axle sat in a slot between the upright supports. A triangular frame for the pulling ropes also extended further up the arm and also rested upon the axle.

3: *Lu'ab* or swivel *manjaniq*

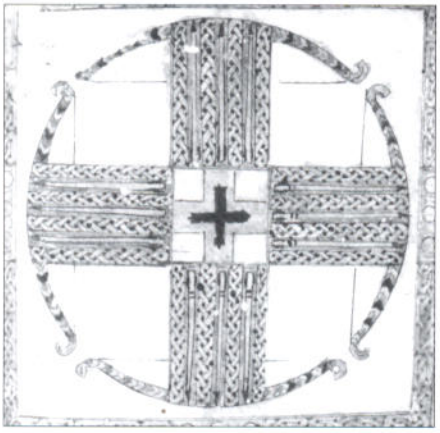
The *lu'ab* was the smallest man-powered mangonel and its smallest version could be operated by one man. An identical Byzantine version appears in several Byzantine manuscripts which illustrate a three-tiered structure at the top of the pole. This has been interpreted as a frame which allowed the arm to be turned horizontally, enabling the operator to change aim between shots.

4: Byzantine *petrabole* or 'Arab-style' *manjaniq*

Several sources state that the front and sides of the frame were covered with wooden planks and that there was a wooden roof. The exterior could also be covered in fresh animal hides as a defence against incendiary weapons. The axle again sat in deep notches, apparently held in place by the weight of the arm. In front of the arm was a wooden bar to which ten pulling ropes were attached. These presumably ran through a slot in the front of the weapon, since the pulling team was inside.

5: Earliest known form of counter-weight *manjaniq* as described by al-Tarsusi

The timber frame was the same as that of a Turkish *manjaniq* and was, like other Middle Eastern mangonels, made of unseasoned timber. A trench was dug inside the base-frame so that the counter-weight did not hit the ground. The arm of the weapon was made of a single piece of timber, probably roughly hewn pine, while the axle fitted into slots on top of the frame and was of well greased iron or bronze. As a counter-weight device this early weapon used a large net of hemp rope filled with rocks. A large *jarkh* crossbow was attached to the front of the frame by large iron hooks. Al-Tarsusi's text and drawing are difficult to interpret but it seems there was a pulley attached near the upper end of the arm with a rope which



Various countries tried to develop multiple-shot or repeater crossbows. The earliest description and illustration of such a weapon in the western world is in al-Tarsusi's treatise written for Saladin. *See also* Plate D. *(Al-Tabsira by al-Tarsusi,* Bodleian Library, Ms. Hunt 264, f. 94r, Oxford)

lowered the arm to raise the counter-weight and pulled back the crossbow-string. The crossbow must have been 'shot' just as the ring on the missile-sling was released from its hook. A further rope is mentioned in the text and has here been interpreted as a link between the release hook and the crossbow trigger.

E: PROTECTIVE SHEDS AND SCREENS

1: *Laisa*

The wooden frame is roughly made of unseasoned wood. The short timbers along each side are extended so that they can be used as handles to lift the entire structure. A matting or wickerwork screen is also nailed across the front entrance while interwoven branches form a protective roof (only one part is shown in this reconstruction), kept in place by longer horizontal branches.

2: *Shabakah*

The supporting structure is made of substantial timbers. Large iron pins lie against the main verticals to secure the flexible rope loops which support the protective frame and help it absorb the shock of blows. Ropes are woven across this frame, covered with felt sheets nailed to the screen, while the space between is packed with sheepskins.

3: *Dabbabah*

The Islamic *dabbabah* was a simple structure, covered with wooden planks and usually surfaced with fresh animal hides. Comparable shelters were used throughout the Middle East, the Byzantine Empire and probably India.

4: *Chelonas*

This Byzantine protection was similar to the Islamic *dabbabah* and technical manuals indicate that it came in a variety of shapes. The version reconstructed here was to be rolled against an enemy's wall or defensive ditch where the overhanging front would allow sappers to attack the base of a wall or fill a moat. The sides of the *chelonas*, here shown open, would normally be covered with timber.

5: Karwah

The eastern Islamic *karwah* was described as a frame covered with hides and padded with cotton waste. It could be carried and was also used in open battle. Here the cross-pieces are made of small branches which formed a shock-absorbent support for the padding, which was itself covered by an outer layer of bullock hides.

F: ERECTING A FELT SCREEN DURING THE MAMLUK SIEGE OF ACRE, 1291

The Mamluk governor of Kerak, Baybars al-Mansuri, described his experiences during the siege of Acre in 1291 in his *Zubdat al-Fikra fi Tarikh al-Hijra*. He recalled how, during the final phase of the siege of Acre, one of the Crusader towers was seriously damaged by mangonels, creating a gap between this tower and the main wall. But this was covered by enemy crossbows so that the Mamluks could not start filling the moat to reach the gap. One night Baybars had sheets of felt stitched into what he described as 'the shape of a long white cloud' which was then erected on a system of masts and ropes similar to those on a ship. Behind this screen Baybars and his men filled the moat to make a ramp which the Sultan's army used to storm the city.

G: GREAT CROSSBOWS

1: Frame-mounted *toxobolistra* or *jarkh*

Here a great crossbow is mounted on a sturdy wooden support which enables it to aim in any direction. The weapon itself is an enlarged version of an ordinary Middle Eastern crossbow with composite bow-stave. There is a broad groove along the stock because this weapon is intended to shoot stones or fire-grenades. Bronze plates on the sides of the stock strengthen a relatively weak point and provide an anchorage for a trigger. Wooden capstan wheels at the rear pull back a wooden block which slides along the top of the stock as the bow is spanned. It is possible that a very large all-iron bolt or arrow, like one found at Vladimir in Russia and shown here, might have been shot from such a weapon.

2: Crossbow to shoot 'eggs of *naft*'

Crossbows shooting small incendiary grenades were apparently used in Islamic siege warfare. Here the crossbow is a standard version used in the Middle East during the 12th century. The short trigger-arm also suggests that such crossbows were not particularly powerful. According to al-Tarsusi the weapon had a container 'like a coconut' which slid along the top of the stock where an arrow would normally run, seemingly on rollers.

G3: Multiple crossbows in a rotating tower, according to al-Tarsusi

This remarkable weapon was made, according to al-Tarsusi, but clearly was not widely used. Here the revolving wooden tower structure is shown with one side removed. Each crossbow shot through a hole in the outer skin and each crossbow shot four bolts. The crossbows were presumably removed from the tower to be spanned and in this reconstruction they have wooden beds to raise their triggers clear of the tower. The most complicated part of al-Tarsusi's machine enabled these crossbows to be shot in sequence, apparently by an iron crank which turned a central spindle. Perhaps this released a trigger under each crossbow to thrust up a peg or pegs, forcing the bowstring out of its spanning groove.

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The design, development, operation and history of the machinery of warfare through the ages.

Medieval Siege Weapons (2)

Byzantium, the Islamic World & India AD 476–1526

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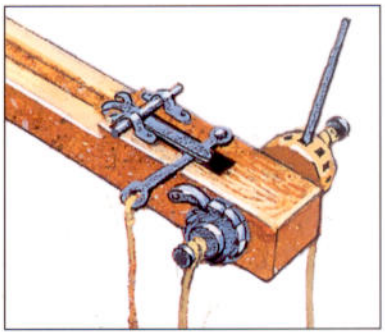
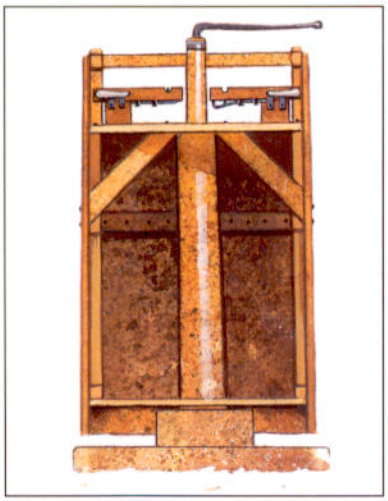


Unrivalled detail



Cutaway artwork

Photographs

The medieval period was one of the most inventive in military history when it came to non-gunpowder machine development. During this period, the pre-existing military-technological traditions from the ancient worlds were brought together. Three civilisations; Graeco-Roman World, Persia, India, and China, were primarily responsible for this evolution – the Late-Roman or Byzantine Empire, the Islamic World, and latterly the Mongol 'World Empire'. This book examines the resulting stone-throwing machines that used assorted power sources from torsion 'energy storage' systems, to manpowered and counterbalance sling devices, rockets and others.

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