= Early thermal weapons =

Early thermal weapons were devices or substances used in warfare during the classical and medieval periods (approx 8th century BC until the mid @-@ 16th century AD) which used heat or burning action to destroy or damage enemy personnel , fortifications or territories .

Incendiary devices were frequently used as projectiles during warfare , particularly during sieges and naval battles ; some substances were boiled or heated to inflict damage by scalding or burning . Other substances relied on their chemical properties to inflict burns or damage . These weapons or devices could be used by individuals , manipulated by war machines , or utilised as army strategy .

The simplest and most common thermal projectiles were boiling water and hot sand , which could be poured over attacking personnel . Other anti @-@ personnel weapons included the use of hot pitch , oil , resin , animal fat and other similar compounds . Smoke was used to confuse or drive off attackers . Substances such as quicklime and sulfur could be toxic and blinding .

Fire and incendiary weapons were used against enemy structures and territory , as well as personnel , sometimes on a massive scale . Large tracts of land , towns and villages were frequently destroyed as part of a scorched earth strategy . Incendiary mixtures , such as the oil @-@ based Greek fire , could be launched by throwing machines or administered through a siphon . Sulfur- and oil @-@ soaked materials were sometimes ignited and thrown at the enemy , or attached to spears , arrows and bolts and fired by hand or machine . Some siege techniques ? such as mining and boring ? relied on combustibles and fire to complete the collapse of walls and structures .

Towards the latter part of the period , gunpowder was invented , which increased the sophistication of the weapons , and led to the eventual development of the cannon and other firearms . Development of the early weapons has continued ever since , with modern war weapons such as napalm , flame throwers , and other explosives having direct roots in the original early thermal weapons . Fire @-@ raising and other destructive strategies can still be seen in modern strategic bombing .

= = " Fire and sword " = =

The destruction of enemy possessions and territory was a fundamental strategy of war , serving the dual purpose of punishment and deprivation of resources . Until the 5th century BC , the Greeks had little expertise in siege warfare and relied on a strategy of devastation to draw the enemy out ; they destroyed crops , trees and houses . Centuries later , the Byzantines recommended this strategy , even though they had developed siege technology .

Fire was the easiest way of harrying and destroying territories , and could be done easily and quickly by small forces . It was a strategy put to good use by the Scots during the Wars of Independence ; they repeatedly launched raids into northern England , burning much of the countryside until the whole region was transformed . King Edward II of England pursued one raiding party in 1327 by following the lights of burning villages .

The tactics were replicated by England during the Hundred Years ' War ; fire became their chief weapon as they laid waste to the French countryside during lightning raids called chevauchées , in a form of economic warfare . One estimate records the destruction of over 2000 villages and castles during one raid in 1339 .

As well as causing the destruction of lands , foods and belongings , fire could also be used to divert manpower . 13th century Mongol armies regularly sent out small detachments from their main forces to start grass fires and fire settlements as diversions .

Devastation by fire was not only used as an offensive tactic ; some countries and armies employed ' scorched earth ' policies on their own land to deprive invading armies of all food and forage . Robert I of Scotland reacted to the English invasion of 1322 by launching punitive and diversionary chevauchées into north @-@ west England , then retreating to Culross , burning as he went the Scottish lands which lay in the path of the English army . The English ran out of food and had to abandon the campaign . Kitchener employed scorched earth tactics to subdue Boer forces in South Africa when three years of warfare had resulted in a stalemate .

Such acts of aggression were not limited to wars against territorial enemies , but could form part of the strategies of conquest , subjugation and punishment of rebellion . Alexander the Great suppressed a revolt in Thebes , Greece in 335 BC , after which he ordered the city to be torched and laid waste . Alexander ordered (or allowed) a similar arson at Persepolis in 330 BC . It was a policy which was repeated throughout the period . William I of England , following his conquest of England in the 11th century , asserted his control of Northumbria by destructive campaigns throughout the region : " He ordered that crops and herds , tools and food should be burned to ashes . More than 100 @,@ 000 people perished of hunger " , reported Orderic Vitalis , a contemporary chronicler . It was a scene repeated the following century , during the anarchy of Stephen of England 's reign . Civil war erupted between Stephen 's supporters and those of the Empress Matilda , a rival claimant for the throne . The Gesta Stephani tells of the deeds of one of Stephen 's supporters , Philip of Gloucester , by describing how he " raged in all directions with fire and sword , violence and plunder " , reducing territory to " bare fields and dreadful desert " .

= = Techniques of use = =

At the simplest level , fire itself was used as a weapon to cause large @-@ scale destruction , or to target specific enemy positions or machinery . It was frequently used against siege engines and wooden structures . Incendiary weapons could be used to set fire to towns and fortifications , and a wide range of thermal weapons were used against enemy personnel . Some armies developed specialised " fire @-@ troops " . By 837 , many Muslim armies had groups of " naffatin " (fire archers) , and when the Mamluk Sultanate raised a fleet for an attack on Cyprus they had " nafata " , or firetroops .

= = = Simple fire @-@ raising = = =

The burning of enemy positions and equipment was not necessarily a complicated procedure , and many fires were set by individuals using common materials . When William of Normandy 's army besieged Mayenne in 1063 , they shot fire into the castle to panic the garrison , while two boys stole into the castle in order to start a fire within . The garrison surrendered .

Besieged forces would sometimes launch sorties in an attempt to fire the attackers ' camps or equipment . When Hugh Capet besieged Laon in 986 ? 987 , his troops became drunk one night , and Duke Charles 's men sallied forth and torched the camp , forcing Hugh to abandon the siege .

The besieged were not the only ones who might fire siege equipment ; when Frederick I Barbarossa abandoned his siege of Alessandria in 1175 , he burned his own camp and equipment .

However , like all weapons , fire @-@ raising had its own dangers . In 651 Penda of Mercia attempted to win Bamburgh Castle by building a pyre at its base from planks , beams , wattle and thatch . The wind changed direction and the fire blew back on Penda 's men , who had to abandon the attack . This fortuitous wind @-@ change was credited to Saint Aidan , who saw the smoke from the Farne Islands and prayed for the defenders .

= = = Throwing machines = = =

Various throwing machines were in use throughout the classical and medieval periods . Generally referred to as " artillery " , these engines could hurl , fire or shoot missiles and most could be used or adapted for throwing thermal weapons , by attacking and defending forces . Barrels , fire pots and other breakable containers of pitch , Greek fire , and other incendiary mixtures could be thrown ; other machines fired arrows and bolts , which could be ignited , or adapted to carry flammable mixtures . From the 12th century , Muslims in Syria were using clay and glass grenades for fire weapons , thrown by machines .

Most of the terms used for throwing machines were vague , and could refer to different engines , all of which went through changes and developments over the period . Among the most common were the ballista , mangonel and trebuchet . The ballista was similar in form to a crossbow , though much

larger , and used a string @-@ winding mechanism to fire a missile or bolt placed in a groove . Other giant crossbows were used throughout the period , and an " espringal " , based on the ballista , which threw large bolts , was developed in the 13th century . Torsion @-@ powered arrow firers had been used from 400 BC , and were adapted for stones . A mangonel had a wooden spoon @-@ shaped arm , to hold a stone or other projectile , which was manipulated under tension from a twisted rope . The trebuchet was an advanced development of the 12th or 13th century , which used a counter @-@ weight to power the throwing arm , and was the major siege engine until the cannon became widespread .

= = = In mining = = =

Forces attacking a castle of other strong fortification sometimes sought to undermine the foundations by digging " mines " or tunnels underneath them . Usually , such mining or digging machinery was protected by a tortoise (also called a cat , sow , or owl) : a covered shed on wheels , which shielded the miners from missile attack .

As the tunnels were constructed , they were generally supported by wooden beams and posts . Once the mine had been finished , the internal space was filled with combustibles , such as brushwood , firewood , resin , and other incendiary substances ; once ignited , these would burn the supporting props , causing the mine to collapse , bringing down with it the structures lying above . From the 15th century , gunpowder was also used , although the aim remained to burn the props .

Defenders might sometimes dig counter @-@ tunnels in order to reach the enemy 's mines and launch an attack ; frequently thermal weapons were used to drive the besiegers from the tunnels .

Rather than undermining a structure , some besiegers used borers to drill holes in the outer walls in an effort to destroy them ; such methods were more effective than rams on brick walls (which tended to absorb the shocks from the ram) . Borers differed in size and mechanism , but a typical machine was made from a log of wood , tipped with iron and supported and driven by windlasses or ropes . Once a series of holes had been bored along the length of a wall , the holes were typically filled with rods of dry wood , saturated with sulfur or pitch and then ignited . Bellows could be used to encourage a blaze .

= = = Fire ships = = =

Fire ships were used on several occasions throughout the period . In 332 BC Alexander the Great laid siege to Tyre , a coastal base of the Phoenicians . In order to bring his siege engines within range , Alexander ordered the construction of moles . The Tyrians responded by attacking the first mole with a large fireship , which destroyed it . A large horse transport ship was packed with cedar torches , pitch , dried brush and other combustibles ; above this were suspended cauldrons of sulfur , bitumen and " every sort of material apt to kindle and nourish flame " . This was towed to the mole , and lit by the Phoenicians before they jumped overboard and swam away .

Another example occurred during the 886 Siege of Paris , when the Vikings filled three warships with combustible material and pulled them upriver in a failed attempt to destroy the Franks ' fortified bridges . Fire ships containing straw and powder were also used during the Chinese Battle of Lake Poyang in 1363 .

= = = Other methods = = =

Often ingenious methods were developed for administering the weapons . The 10th @-@ century Olga of Kiev is reported to have tied burning tinder to birds which , when released , flew back to their nests in the hostile town and set them alight . Siege towers and ladders could be fitted with a long , narrow tilting beam at the top , gouged with a groove , so that hot oil and water could be poured down on the enemy defenders during an escalade .

During an attack , castle or fortification defenders could launch or pour the substances on the heads of attackers below . This could be done over the battlements , but also through purpose @-@

built holes such as machicolations and murder @-@ holes . Indian records suggest smoke and fire was used defensively within a fortress to confuse and disorient attackers ; iron grills could also be heated and used to block passageways . During night attacks , defenders could drop lighted bundles over the walls so the enemy could be seen ; Chinese and Muslim sources also describe the light gained by torches hung on the walls .

= = = Use against stone castles = = =

Stone castles were susceptible to fire , since they contained many combustible materials . In 1139 , Henry de Tracy forced the surrender of Torrington Castle by the simple expedient of tossing lighted torches through the keep 's loopholes .

Stone was also susceptible to intense heat , which would cause it to crack and collapse . Byzantine sources recorded the demolition of stone structures caused by placing clay pots of burning charcoal at the base of walls moistened with vinegar or urine , and the 6th century treatise by an engineer in Justinian 's army includes the lighting fires beneath the walls amongst its instructions for sieges .

Stone castles sometimes offered other inflammatory targets . During the Crusades , Muslim defenders frequently hung bundles of straw against their walls as buffers against stones and rams ; in turn , the Crusader archers would set these alight with fire arrows .

= = = Defence against thermal attack = = =

Defence from thermal weapons and fire attacks was usually water or other liquids such as urine ; hides were soaked and draped over vulnerable wooden hoardings and siege engines , and vats and barrels of liquid were collected and stored by defenders and attackers . Hides were hung in an overlapping manner so that any water would run down the whole structure to extinguish flames . Some thermal weapons (such as quicklime or oil) could not be extinguished or eased by water , in which case sand or earth could be used . Wooden structures were frequently soaked in alum to increase their fire resistance . The Romans covered their tortoises (mobile siege sheds) with raw hides packed with vinegar @-@ soaked seaweed or chaff , to serve as protection against regular and incendiary missiles . Throughout the period , sacks or nets might be filled with vinegar @-@ moistened chaff , seaweed or wet moss and hung on the exterior . The wooden siege engines of the Crusaders were vulnerable to attack from the Byzantine and Muslim fire @-@ weapons , so the troops inside siege towers kept stores of water and vinegar .

During the High Middle Ages , the majority of Poland 's castles were still made of wood , so uncut stone was frequently added to the front to improve their fire defences .

Both attackers and defenders needed to be prepared for incendiary and thermal attack . When the Athenians besieged Syracuse in 416 BC they lost many siege engines to fire . The Syracusan ruler Dionysius I must have taken note of this success , for when he laid siege to Motya in 398 BC he organised special fire " brigades " , who successfully doused the fires when his siege engines were bombarded .

During the First English Civil War , incendiary devices were used to raze city centers . Defenders in London were advised to combat the flames using milk , sand , earth , and urine . In Colchester , fires caused by hand grenades (the weapon was called " wildfire " by the combatants) were extinguished using wet clothes saturated in milk and vinegar .

= = Types of weapons = =

= = = Flaming arrows , bolts , spears and rockets = = =

Lit torches (burning sticks) were likely the earliest form of incendiary device . They were followed by incendiary arrows , which were used throughout the ancient and medieval periods . The simplest flaming arrows had oil- or resin @-@ soaked tows tied just below the arrowhead and were effective

against wooden structures . Both the Assyrians and the Judeans used fire arrows at the siege of Lachish in 701 BC . More sophisticated devices were developed by the Romans which had iron boxes and tubes which were filled with incendiary substances and attached to arrows or spears . These arrows needed to be shot from loose bows , since swift flight extinguished the flame ; spears could be launched by hand or throwing machine .

Flaming arrows and crossbow bolts were used throughout the period . Fifteenth @-@ century writer Gutierre Diaz de Gamez witnessed a Spanish attack on the Moorish town of Oran in 1404 and later described how " During the most part of the night , the galleys did not cease from firing bolts and quarrells dipped in tar into the town , which is near the sea . The noise and the cries which came from the town were very great by reason of the havoc that was wrought . "

Anna Komnene records that at the 1091 Battle of Levounion , lighted torches were fixed to spears .

The Chinese Song Dynasty created fire arrows - rockets attached to arrows and launched in mass through platforms , and later created rockets such as the huo long chu shui , a multistage rocket used in naval combat . Primitive rockets made from bamboo and leather were used by the Mongols , under Genghis Khan , but were inaccurate . However , the Fatamids used " Chinese arrows " from the 11th Century , which probably included saltpetre . The Mamluks experimented with a rocket @-@ powered weapon described as " an egg which moves itself and burns . "

A 2 @-@ metre @-@ long (2 @.@ 2 yd) iron crossbow @-@ bolt probably designed to carry a fire cartridge was found in a 13th @-@ 14th @-@ century castle in Vladimir , Eastern Russia . Such large machine @-@ thrown bolts were ideal for incendiary weapons . The Mongols used an " ox @-@ bow " machine to throw bolts which had been dipped in burning pitch , with a range of 2500 paces .

During the British Civil Wars (mid @-@ 17th century in Great Britain) , both the Parliamentarian and Royalist armies used various incendiary devices to attack enemies and destroy property that might be used for military purposes , according to historian Stephen Porter in Destruction in the English Civil Wars . The flaming arrow attack was used to set fire to buildings at a distance . An arrow with a flammable substance attached to the shaft , close to the tip , was shot from a bow or short @-@ muzzled musket . Such arrows shot from a musket had their feathers removed , to fit inside the muzzle , and were called fire @-@ darts . These devices were cheap to make and easy to prepare . Although used infrequently during the wars , the flaming arrows and darts proved to be destructive . The Royalists shot flaming arrows into the thatched homes in the suburbs of Chester causing extensive damage . Lyme Regis was partly razed using flaming arrows .

= = = Greek fire = = =

Greek fire was one of the most effective thermal devices , although it was extremely dangerous for the users . A combustible liquid , it could be shot from siphons or catapults , and it burst into flames on impact . First developed by the Byzantines in the 7th century , it was later used by the Turks during the Crusades , and was probably first used in Western Europe in the 12th century . Early experiments by the Byzantines in the 6th century used a mixture of sulfur and oil , which would have been terrifying if not destructive . Various versions seem to have existed , and the recipes were frequently kept secret ; experts today still debate the exact composition , although some recipes are known . It probably had regional variations ; the Islamic derivative was known as " naft " and had a petroleum base , with sulfur ; the Persian word for " petroleum " is ??? (naft) .

The combustible liquid could be shot from catapults , and would burst into flames on impact . Siphons , frequently of copper , were also developed , first appearing in the 10th and 11th centuries . The siphons could shoot a blazing stream , which a 10th @-@ century Mesopotamian source claimed could engulf twelve men . Mardi bin Ali al @-@ Tarsusi , who wrote a military manual for Saladin in the 12th century , suggested that " naft " could be placed inside blown eggshells , which could be thrown from horseback . From the 12th century , mouth @-@ blown tubes were developed for use in mines .

Similar petroleum and bitumen @-@ based incendiary mixtures had been known for centuries before the invention of Greek fire , but this new recipe created a blaze which was extremely difficult

to extinguish . It burned on water , and was used effectively in naval warfare , although it was primarily an anti @-@ personnel weapon rather than a ship @-@ burner . It remained effective at sea even after its use had declined on land after the 13th century .

The Greek fire recipes continued to be developed over the centuries , and by the High Middle Ages was much more sophisticated than the early versions . Saltpetre (also called " Chinese salt ") was added to the mixture in the Islamic world , and China developed a dry saltpetre mixture in the 12th century , which eventually became gunpowder . Both the Parliamentarian and Royalist armies used Greek @-@ fire @-@ like petroleum @-@ based incendiary devices known as " wildfire " during the British Civil Wars .

= = = Hot oil = = =

Oil of various kinds could be heated to high temperatures and poured over an enemy , although , since it was extremely expensive , its use was limited , both in frequency and quantity . Moreover , it could be dangerous and volatile . Since the smoke point of oil is lower than its boiling point , the oil was only heated and not boiled .

Pouring @-@ oil was used in historic battles , and Josephus described its use at Jotapata in AD 67 , saying " the oil did easily run down the whole body from head to foot , under their entire armour , and fed upon their flesh like flame itself . "

Oil was usually used to create incendiary devices . The Roman @-@ Byzantine armies of the 6th century created " fire @-@ pots " , oil @-@ based incendiary weapons which could be launched by hand or with ballistae . During the siege at Montreuil @-@ en @-@ Bellay in 1147 , a mixture of oils from nuts , cannabis and flax , was heated in iron containers , launched by mangonel , and burst into flames on impact . The Chinese made early grenades out of oil @-@ soaked hemp and cotton , which were ignited and thrown by mangonels .

Another use of oil can be seen in the naval battle of La Rochelle during the Hundred Years ' War ; the Castilians sprayed oil on the decks of English ships then ignited it by shooting flaming arrows down .

= = = Water , sand and other heated missiles = = =

Hot oil was considerably less common than boiling water or heated sand , which were cheap and extremely effective ; even " dust from the street " could be used . These would penetrate armour and cause terrible burns . Sand , especially , could work its way through very small gaps in armour . The Phoenicians at the Siege of Tyre (332 BC) dropped burning sand down on the attacking Greeks , which got in behind the armour and burned the flesh .

Such heated missiles have also been used in mining situations ; the 1st century Roman writer Vitruvius describes a counter @-@ mine dug above the attackers ' gallery by defenders at the siege of Apollonia . Piercing the floor between the mines , the Apollonian defenders poured down boiling water , hot sand and hot pitch onto the heads of their enemy . Other mixtures were more innovative ; the defenders at Chester in 918 boiled a mixture of water and ale in copper tubs and poured it over the Viking besiegers , causing their skin to peel off .

When Frederick I Babarossa besieged Crema , Italy in the 12th century , the defenders threw red @-@ hot iron objects down on them .

= = = Pitch , tar and resin = = =

Burning pitch was used on occasion ; the Mongols were known to fire containers of burning tar during sieges using catapults and trebuchets . Wheels could be covered in pitch , set alight , and rolled along ; this technique was commonly used during the Crusades . The besieged Carthaginians in Motya , 398 BC , set alight the siege engines of the attacking Syracusan forces under Dionysius I by dropping burning charred logs and resin @-@ soaked oakum ; however , the Syracusans were able to put out the fires .

Pitch was a base ingredient in many incendiary devices throughout the period . The Boeotians developed a fire machine , which they used against the Athenian wooden fortifications during the Battle of Delium in 424 BC . A cauldron of burning coals , pitch and sulfur was suspended at one end of a hollowed @-@ out log and bellows were fixed to the other end . A similar mixture was used 1700 years later by the Scots , when they dropped bales of wood , tar and sulfur by crane onto the English " sow " (a large protective shield covering the battering ram) at the 1319 siege of Berwick @-@ upon @-@ Tweed .

= = = Animal renderings and parts = = =

At the 1215 siege of Rochester Castle , King John ordered that fat from 40 pigs be used to set fire to the mines beneath the keep , which caused it to collapse , a cheap and effective technique in place of the more complicated mixture of sulfur , tallow , gum , pitch and quicksilver he had used in France the previous year . Animal fat was not uncommon as an accelerant ; in the 13th century French sortie @-@ parties would often be equipped with animal fat , straw and flax to use as fuel when setting fires amongst enemy siege engines .

There were some other intriguing uses of animal parts ; during the Siege of Paris in 886 AD , the Franks dropped bucket @-@ loads of a hot mixture of pitch (or oil) , wax and fish on the attacking Vikings ; the mixture got under the armour and stuck to the skin . Konrad Kyeser 's Bellifortis of 1405 describes a poisonous mixture of sulfur , tar and horses ' hooves . Other incendiary ingredients included egg yolks , and pigeon and sheep droppings .

Some documented uses of animals were not thermal or incendiary . Live insects were also used , to sting the enemy . 4th century BC writer Aeneas Tacticus suggested defenders should let wasps and bees into enemy mines , and jars of scorpions were sometimes fired during early bombardment in naval battles . In 189 BC Ambracia was besieged by the Romans , who dug mines under the walls . The defenders filled a clay jar with chicken feathers , which they then lit , using bellows to blow the acrid smoke down the tunnel ; unable to approach the pot due to defensive spears , the Romans were forced to abandon their works .

= = = Quicklime , sulfur and smoke = = =

The 15th @-@ century engineer Taccola recommended quicklime , although its use went back to ancient times , and might well have been a component of Greek fire . Quicklime reacts violently with water , and can cause blindness and burns . While quicklime was used in some naval battles , it does not appear to have been standard issue on board ships , due to the danger of the quicklime blowing back and burning the user .

Other substances smoked rather than flamed . Sacks of burning sulfur were effective at clearing enemy mines due to the toxic smoke produced . Any smoke could be used in small confines ; the Greek military writer Aeneas Tacticus recommended burning wood and straw to drive out enemy sappers by the smoke .

= = Gunpowder and cannon = =

The discovery of gunpowder was probably the product of centuries of alchemical experimentation . Saltpetre was known to the Chinese by the mid @-@ 1st century AD and there is strong evidence of the use of saltpetre and sulfur in various largely medicinal combinations . The impetus for the development of gunpowder weapons in China was increasing encroachment by tribes on its borders . The earliest known formula for gunpowder can be found in a Chinese work dating probably from the 9th century . The Chinese wasted little time in applying it to warfare , and they produced a variety of gunpowder weapons , including flamethrowers , rockets , bombs , and mines , before inventing firearms . European descriptions of gunpowder first appear in Opus Maius and Opus Tertium , written by the English philosopher Roger Bacon in the mid @-@ 13th century , although the mixture was not very effective . The composition of gunpowder varied throughout the period ,

and did not settle into the current ratios of saltpetre , sulfur and coal until the 17th century .

The years 904 ? 906 saw the use of incendiary projectiles called ' flying fires ' (fei @-@ huo) . Needham (1986) argues that gunpowder was first used in warfare in China in 919 as a fuse for the ignition of another incendiary , Greek fire . Initially , gunpowder mixtures were utilised through traditional engines and throwing mechanisms ; containers and grenades were thrown by mangonels and trebuchets , and explosive rockets and arrows were developed , along with gunpowder flamethrowers .

Like firearms , cannon are a descendant of the fire @-@ lance , a gunpowder @-@ filled tube used as a flamethrower ; shrapnel @-@ like material was sometimes placed in the barrel so that it would fly out together with the flames . In due course , the proportion of saltpeter in the propellant was increased to increase its explosive power . To better withstand that explosive power , the paper and bamboo of which fire @-@ lance barrels were originally made came to be replaced by metal . And to take full advantage of that power , the shrapnel came to be replaced by projectiles whose size and shape filled the barrel more closely . With this , we have the three basic features of the gun : a barrel made of metal , high @-@ nitrate gunpowder , and a projectile which totally occludes the muzzle so that the powder charge exerts its full potential in propellant effect .

Firearms remained in use in China throughout the following centuries . Meanwhile , gunpowder and firearms spread elsewhere very quickly . Gunpowder seems to have been widely known by the 13th century . The Europeans , Arabs , and Koreans all obtained firearms in the 14th century . The Turks , Iranians , and Indians all got firearms no later than the 15th century , in each case directly or indirectly from the Europeans . The Japanese did not acquire firearms until the 16th century , and then from the Portuguese rather than the Chinese .

In 1326 , the earliest known European picture of a gun appeared in a treatise entitled " Of the Majesty , Wisdom and Prudence of Kings . " On February 11 of that same year , the Signoria of Florence appointed two officers to obtain canones de mettallo and ammunition for the town 's defense . A reference from 1331 describes an attack mounted by two Germanic knights on Cividale del Friuli , using gunpowder weapons of some sort . Cannon were first used by the Muslims at Alicante in 1331 , or Algeciras in 1343 . The French raiding party that sacked and burned Southampton in 1338 brought with them a ribaudequin and 48 bolts (but only 3 pounds of gunpowder) . The Battle of Crécy in 1346 was one of the first in Europe where cannons were used .

However , early cannon were not very effective , the main benefits being psychological , frightening men and horses . Short barrelled , large @-@ calibre " bombards " were used up until the late 15th century in Europe , during which period they grew increasingly larger . In the mid @-@ 15th century , mortars also appeared . Various smaller weapons also existed , including the serpentine , ribaudequin and cropaudin . The powder was of poor quality and was used in small quantities ? to prevent explosion of the barrel ? so the effective range of these cannon was rarely more than 200 ? 250m .

The barrels of the cannon were forged or cast , and each gun generally differed in calibre and length . Early powder resembled a paste , and tended to burn slowly . Its composition varied in different geographical areas , the powder of Europe being quite different to that used in the Islamic world . The projectiles used were generally stone balls for bombards and mortars . Forged iron balls were used in smaller @-@ calibre cannon , and coated with lead to make them smooth . From the 15th century , cast iron balls were used , which caused great destruction . As they were denser than stone , even small balls could be destructive . Thus , cannon became smaller in calibre , and longer barrels increased the range .

= = Later development = =

The use of incendiary devices had decreased by the 14th century , perhaps due to the economic realities of war where it became increasingly important that captured castles and towns were undamaged . Moreover , fewer wooden engines and structures were employed in the battlefield after the late 13th century , perhaps because of the prior success of the incendiary weapons at

destroying them .

While the incidence of use dropped , towards the latter end of the Middle Ages the incendiary devices became more sophisticated , and the principle of wielding fire with sword remained present throughout the Early Modern and Modern periods ; improving technology merely allowed the process to become more efficient .

= = = The principle of fire and sword = = =

Fire itself remained a part of warfare . In his reminisces of the Peninsular War (1807 ? 1814) , a British soldier recorded that the French soldiers would " regularly burn to the ground every place they pass through . In following them we find each town and village a heap of smoking ruins . " During World War I , Leuven , in Belgium was " looted and burned in medieval fashion " , when German soldiers set fire to much of the town , destroying the library and other cultural buildings , and causing outrage around the world . Yet the tactic was not dispensed with . In World War II , firebombing with incendiary bombs was carried out by the Germans against Britain during the Blitz , and by the Allies against Germany and Japan . After one heavy raid on Tokyo in March 1945 , the resulting conflagration destroyed a quarter of the predominantly wooden buildings . Much as the Ancient Greeks before them , it was a strategy of devastation . Fire has continued to be used as a destructive measure in warfare . During the 1991 ? 1992 Gulf War , Iraq set fire to three @-@ quarters of Kuwait 's oil wells .

Fire remained an extremely successful weapon . During naval warfare of the Napoleonic wars , " the one thing most likely to destroy a ship was fire " . Sometimes the fires were merely a side effect of weapon technology . Early firearms proved incendiary in their use and could start fires . During the Peninsular War , both Talavera and Salamanca battlefields were wracked by tremendous grassfires , first started by the guns . At the Battle of Trafalgar , 1805 , the French ship Achille caught fire when musket @-@ flashes from her own men 's guns set fire to the tar and grease on the sail rigging ; the ship eventually exploded .

Smoke screens have continued to be used by attackers and defenders as a means of sowing confusion and hiding movements . During naval battles in the 18 ? 19th centuries , shots were sometimes fired early so a defensive screen was erected before the ships converged , to spoil the aim of the enemy .

= = = Development and continued use of weapons = = =

The major development of weapons in the early modern and modern periods occurred with firearms , which became progressively more efficient . Gunpowder settled into its standard ratio in the 17th century , and general ballistic technology improved . Initially , iron round shot replaced the earlier stone balls for cannon then , latterly , different types of shot were invented .

A carcass was a hollow projectile usually formed either by an iron cage of ribs joining two small rings or a cast iron ball with holes . A carcass was so named because the iron cage was thought to resemble the ribs of a body . A carcass was filled with a highly flammable mixture . Carcasses were used for the first time by the French under Louis XIV in 1672 .

For short range use against personnel , canister and the smaller naval grapeshot were popular during the 19th century ; it comprised smaller iron or lead pellets contained within a case or bag , which scattered on explosion . In 1784 , Lt Henry Shrapnel invented a spherical case @-@ shot , which was later named after him . The case was a hollow iron sphere which was filled with musket balls and was detonated by a gunpowder charge . Shot fired from cannon could be so hot that it scorched or set fire to materials that it brushed .

The incendiary liquids of the ancient and medieval periods were also developed , and have their modern equivalents . World War I saw the development of the flamethrower , a modern version of the Byzantine siphons , which used gas under pressure to squirt a mixture of inflammable oil and petrol , ignited by a burning taper . Similarly , the carcass projectile found new use in the Livens Projector , a primitive mortar that could throw a large canister of inflammable liquid (it was soon

used for poison gas instead) .

Technology improved throughout the 20th century , and the latter half saw the development and use of napalm , an incendiary liquid formed in part from naphtha , which was the main ingredient of the Arabic " naft " .

Flames continued to be used for defensive light until artificial lights were developed . At the Siege of Badajoz in 1812 , the French defenders flung down burning " carcasses " of straw so that the attacking British might be seen . Like the sieges of old , the British were met by incendiary weapons , but now these took the form of explosive grenades , mines and powder barrels as well as the enemy 's guns .

Specific weapons from the ancient and medieval periods continued to develop , and many have modern equivalents . Rocket technology , originally trialled by the Mongols , Indians and the Chinese , amongst others , was improved by the 19th century ; one example was the incendiary Congreve rocket , which had a tail , a fuse , and a powder charge (saltpetre , sulfur and carbon) inside a hollow shell . Grenades continued to develop , although still retaining some aspects of their medieval equivalents . The grenades carried on board British Royal Navy ships in the late 18th century and early 19th century were constructed from hollow cast iron , filled with gunpowder ; the fuse was a hollow wooden tube filled with combustible material . During World War I , grenades were still occasionally launched by ballistae .

The use of some weapons continued with little change . The Koreans used fire arrows against the Japanese at the Battle of Hansan Island in 1592 . At Trafalgar , in 1805 , the British ship Tonnant shot wads covered in sulfur , which set fire to the Algésiras . Fireships were used in later periods . In 1588 , the English sent fireships loaded with gunpowder , pitch and tar amongst the anchored Spanish Armada ; the Spanish fleet broke formation , setting them up for the later battle . The last battle under sail was the Battle of Navarino (1827) , part of the Greek War of Independence , during which fireships were utilised by the Turks .

Chemical warfare had been experimented with during the early period with sulfur , quicklime (calcium oxide) , and others , and developments continued . World War I saw many gases used , including the extremely effective sulfur mustard (mustard gas) .