I'm not a robot

Technology Civilization flourished continuously in China from about 2000 bce, when the first of the historical dynasties emerged. From the beginning it was a civilization that valued technological skill in the form of hydraulic engineering, for its survival depended on controlling the enriching but destructive floods of the Huang He (Yellow River). Other technologies appeared at a remarkably early date, including the casting of iron, the production of porcelain, and the manufacture of brass and paper. As one dynasty followed another, Chinese civilization came under the domination of a bureaucratic elite, the mandarins, who gave continuity and stability to Chinese life but who also became a conservative influence on innovation, resisting the introduction of new techniques unless they provided a clear benefit to the bureaucracy. Such an innovation was the development of the water-powered mechanical clock, which achieved an ingenious and elaborate form in the machine built under the supervision of Su Song in 1088. This was driven by a waterwheel that moved regularly, making one part-revolution as each bucket on its rim was filled in turn. The links between China and the West remained tenuous until modern times, but the occasional encounter such as that resulting from the journey of Marco Polo in 127195 alerted the West to the superiority of Chinese technology and stimulated a vigorous westward transfer of techniques. Western knowledge of silk working, the magnetic compass, papermaking, and porcelain were all derived from China. In the latter case, Europeans admired the fine porcelain imported from China for several centuries before they were able to produce anything of a similar quality. Having achieved a condition of comparative social stability, however, the Chinese mandarinate did little to encourage innovation or trading contacts with the outside world. Under their influence, no social group emerged in China equivalent to the mercantile class that flourished in the West and did much to promote trade and industry. The result was that China dropped behind the West in technological skills until the political revolutions and social upheavals of the 20th century awakened the Chinese to the importance of these skills to economic prosperity and inspired a determination to acquire them. Despite the acquisition of many techniques from the East, the Western world of 5001500 was forced to solve most of its problems on its own initiative. In doing so it transformed an agrarian society based upon a subsistence economy into a dynamic society with increased productivity sustaining trade, industry, and town life on a steadily growing scale. This was primarily a technological achievement, and one of considerable magnitude. The outstanding feature of this achievement was a revolution in the sources of power. With no large slave labour force to draw on, Europe experienced a labour shortage that stimulated a search for alternative sources of power and the introduction of laboursaving machinery. The first instrument of this power revolution was the horse. By the invention of the horseshoe, the padded, rigid horse collar, and the stirrup, all of which first appeared in the West in the centuries of the Dark Ages, the horse was transformed from an ancillary beast of burden useful only for light duties into a highly versatile source of energy in peace and war. Once the horse could be harnessed to the heavy plow by means of the horse collar, it became a more efficient draft animal than the ox, and the introduction of the stirrup made the mounted warrior supreme in medieval warfare and initiated complex social changes to sustain the great expense of the knight, his armour, and his steed, in a society close to the subsistence line. Study how a series of gears in a waterwheel translates a stream's energy to a millstoneBefore the Industrial Revolution, power came from three main sources: humans, draft animals, and water.The ingenuity people used in harnessing waterpower can be seen in this medieval-style mill. The waterwheel is turned by a stream and is connected to a shaft that leads into the building. At the other end of the shaft is a gear. The connection of a series of gears translates the power from the stream to a shaft that drives a millstone, which grinds flour from grain.(30 sec; 1.84MB)See all videos for this articleEven more significant was the success of medieval technology in harnessing water and wind power. The Romans had pioneered the use of waterpower in the later empire, and some of their techniques probably survived. The type of water mill that flourished first in northern Europe, however, appears to have been the Norse mill, using a horizontally mounted waterwheel driving a pair of grindstones directly, without the intervention of gearing. Examples of this simple type of mill survive in Scandinavia and in the Shetlands; it also occurred in southern Europe, where it was known as the Greek mill. It is possible that a proportion of the 5,624 mills recorded in the Domesday Book of England in 1086 were of this type, although it is probable that by that date the vertically mounted undershot wheel had established itself as more appropriate to the gentle landscape of England; the Norse mill requires a good head of water to turn the wheel at an adequate grinding speed without gearing for the upper millstone (the practice of rotating the upper stone above a stationary bed stone became universal at an early date). Most of the Domesday water mills were used for grinding grain, but in the following centuries other important uses were devised in fulling cloth (shrinking and felting woolen fabrics), sawing wood, and crushing vegetable seeds for oil. Overshot wheels also were introduced where there was sufficient head of water, and the competence of the medieval millwrights in building mills and earthworks and in constructing increasingly elaborate trains of gearing grew correspondingly. The sail had been used to harness wind power from the dawn of civilization, but the windmill was unknown in the West until the end of the 12th century. Present evidence suggests that the windmill developed spontaneously in the West; though there are precedents in Persia and China, the question remains open. What is certain is that the windmill became widely used in Europe in the Middle Ages. Wind power is generally less reliable than waterpower, but where the latter is deficient wind power is an attractive substitute. Such conditions are found in areas that suffer from drought or from a shortage of surface water and also in low-lying areas where rivers offer little energy. Windmills have thus flourished in places such as Spain or the downlands of England on the one hand, and in the fenlands and polders of the Netherlands on the other hand. The first type of windmill to be widely adopted was the post-mill, in which the whole body of the mill pivots on a post and can be turned to face the sails into the wind. By the 15th century, however, many were adopting the tower-mill type of construction, in which the body of the mill remains stationary with only the cap moving to turn the sails into the wind. As with the water mill, the development of the windmill brought not only greater mechanical power but also greater knowledge of mechanical contrivances, which was applied in making clocks and other devices. With new sources of power at its disposal, medieval Europe was able greatly to increase productivity. This is abundantly apparent in agriculture, where the replacement of the ox by the faster gaited horse and the introduction of new crops brought about a distinct improvement in the quantity and variety of food, with a consequent improvement in the diet and energy of the population. It was also apparent in the developing industries of the period, especially the woolen cloth industry in which the spinning wheel was introduced, partially mechanizing this important process, and the practice of using waterpower to drive fulling stocks (wooden hammers raised by cams on a driving shaft) had a profound effect on the location of the industry in England in the later centuries of the Middle Ages. The same principle was adapted to the paper industry late in the Middle Ages, the rags from which paper was derived being pulverized by hammers similar to fulling stocks. Meanwhile, the traditional crafts flourished within the expanding towns, where there was a growing market for the products of the rope makers, barrel makers (coopers), leatherworkers (curriers), and metalworkers (goldsmiths and silversmiths), to mention only a few of the more important crafts. New crafts such as that of the soapmakers developed in the towns. The technique of making soap appears to have been a Teutonic innovation of the Dark Ages, being unknown in the ancient civilizations. The process consists of decomposing animal or vegetable fats by boiling them with a strong alkali. Long before it became popular for personal cleansing, soap was a valuable industrial commodity for scouring textile fabrics. Its manufacture was one of the first industrial processes to make extensive use of coal as a fuel, and the development of the coal industry in northern Europe constitutes another important medieval innovation, no previous civilization having made any systematic attempt to exploit coal. The mining techniques remained unsophisticated as long as coal was obtainable near the surface, but as the search for the mineral led to greater and greater depths the industry copied methods that had already evolved in the metal-mining industries of north and central Europe. The extent of this evolution was brilliantly summarized by Georgius Agricola in his De re metallica, published in 1556. This large, abundantly illustrated book shows techniques of shafting, pumping (by treadmill, animal power, and waterpower), and of conveying the ore won from the mines in trucks, which anticipated the development of the railways. It is impossible to date precisely the emergence of these important techniques, but the fact that they were well established when Agricola observed them suggests that they had a long ancestry. Relatively few structures survive from the Dark Ages, but the later centuries of the medieval period were a great age of building. The Romanesque and Gothic architecture that produced the outstanding aesthetic contribution of the Middle Ages embodied significant technological innovations. The architect-engineers, who had clearly studied Classical building techniques, showed a readiness to depart from their models and thus to devise a style that was distinctively their own. Their solutions to the problems of constructing very tall masonry buildings while preserving as much natural light as possible were the cross-rib vault, the flying buttress, and the great window panels providing scope for the new craft of the glazier using coloured glass with startling effect. Ancient China gave us a bunch of inventions that still shape our lives. From everyday tools to ideas that helped build entire civilizations, their impact sticks around.Some of the most important inventions include paper, printing, the compass, gunpowder, and porcelain.These discoveries werent just practicalthey changed how people traveled, communicated, and built societies. Honestly, your life is influenced by these ancient Chinese inventions more than you might guess.Learning about them makes you appreciate how technology and knowledge spread. Its kind of wild to see the connections between old and new tech.Key TakeawaysAncient Chinese inventions shaped daily life and society in ways we still see.Their discoveries pushed science and technology forward.These inventions sparked new tools and ideas that stuck around worldwide.Foundational Inventions that Revolutionized CivilizationA lot of what you use today has roots in ancient China. These inventions made life more practical, helping people navigate, communicate, and trade over huge distances.Paper and Its Global ImpactPaper showed up during the Han Dynasty, around 100 BCE. Suddenly, writing got easier and cheaper compared to using silk or bamboo.You use paper all the timebooks, notes, even letters (if youre old-school like that).Later on, Chinese inventors came up with movable type printing. That made it way easier for books and ideas to spread. Early Chinese workshops built printing presses that inspired later inventions elsewhere.Paper also helped with keeping records and ideas safe. Thanks to this, your access to knowledge just kept growing.The Invention and Uses of the CompassThe compass started out during the Warring States period. People first used it for feng shui and land directions, but eventually it helped with navigation at sea.You probably dont think about it, but this magnetic tool lets you travel the world. Chinese sailors used the compass to explore far-off waters, which boosted trade along ancient routes.This invention was a game-changer for global commerce. Ships could cross oceans, opening up new trade possibilities for everyone.Silk Production and Cultural ExchangeSilk production began long before the Tang Dynasty but really took off during that era. Silk became a hot commodity, connecting China to Central Asia, Europe, and way beyond.By making silk in workshops with skilled hands, China set up a trade network that shared not just goods, but ideas and culture too. The Silk Road made the world a little smaller and a lot more interesting.Silk influenced fashion, commerce, and even diplomacy. You might be surprised how many things today trace back to this ancient industry.Scientific and Technological AdvancementsAncient China made advances that changed how people fought wars, shared information, and grew food. These inventions touched everything from military tools to farming techniques.Gunpowder and Military InnovationGunpowder popped up during the Tang dynasty, but its military use really took off in the Song dynasty. At first, it powered simple weapons like fire arrows and bombs.Later, it led to grenades, rockets, and early guns. Warfare changed a lotarmies suddenly had explosive devices instead of just bows and arrows.The Han dynasty started the chemical experiments, but later dynasties turned gunpowder into a force on the battlefield. Its a stark reminder of how tech can shift power.Movable Type Printing and Knowledge DisseminationMovable type printing came about during the Northern Song dynasty, building on woodblock printing. Suddenly, text could be printed faster and in bigger batches.Books and documents got more accessible. Scholars, officials, and merchants could share information more easily.This was a big step toward mass communication. It helped government, culture, and sped up science, literature, and education.Advances in Agriculture and Food ProductionAgricultural innovation was a big deal during the Han and Tang dynasties. Better irrigation and crop rotation boosted food supply.Hemp cultivation gave strong fiber for rope and clothpretty handy for farming tools and daily life. Wine production improved, too, which mattered socially and culturally.More efficient farming meant China could feed bigger cities and armies. That helped drive economic growth.Technological Marvels and Daily Life InnovationsAncient Chinese inventions made travel and daily life better. These advances grew trade, explored nature, and shaped habits.They influenced cultures far outside China, too.The Wheel and Its Role in TransportationThe wheel became important during the Warring States period. It made moving goods and people across China smoother.Horses could pull carts with wheels, making long trips faster. Traders hauled more silk and pottery to markets.The wheel also sped up military movement during wars. By the Song Dynasty, wheels showed up in farming tools and water systems.Its wild how one invention can change so much, not just travel.Hot Air Balloon: Early Aerial ExplorationThe Chinese played with hot air balloon models way before powered flight. Who knew, right?They made simple balloons from paper and silk. Sometimes, these floated over battles to watch enemies or send messages.It gave armies a view from above, which was pretty clever. Studying how hot air rises shows the early Chinese curiosity about flight and nature.These early models paved the way for future aerial inventions, even if true flight was still centuries away.Tea Culture and Social ImpactTea really took on a life of its own during the Song Dynasty. It wasnt just a drinkit shaped how people connected and interacted.You might stumble into a tea ceremony, and honestly, theyre about more than just sipping. They were a way to show respect, break the ice, or even seal a friendship.Tea farming had started earlier, but under Song rule, it exploded in popularity. Suddenly, there were new jobs in the fields and a buzz of trade, both within China and beyond its borders.It wasnt unusual to spot tea at home or at lively public gatherings. Its influence stretched into art, poetry, and even the way people thought about life.Even now, teas woven into daily routines in so many countries. Funny how something as simple as a cup of tea can leave such a lasting mark.You might be surprised to learn that many everyday items and important technologies have their roots in ancient China. From tools that changed how societies developed to innovations that revolutionized travel and communication, these inventions have had a lasting impact on the world.Understanding these ancient inventions helps you appreciate how they shaped modern life and influenced global progress. Exploring their origins offers a fresh perspective on history and shows how creativity and problem-solving have been driving forces throughout time.PapermakingWhen you think about writing or drawing, papermaking is one of the most important inventions from ancient China. It made communication and record-keeping easier for everyone.Your books, maps, and even money today owe a lot to this early Chinese invention. You can learn more about how papermaking started in China and its uses on the page about paper in ancient China.The CompassThe compass is one of the most important inventions from ancient China. You might be surprised to learn it started as a south-pointing chariot, a device to help guide direction.By around 1040 C.E., the magnetic compass as you know it was developed. It helped travelers and sailors find their way more easily, making navigation much safer. Learn more about the history of the ancient Chinese compass.GunpowderYou can thank ancient China for discovering gunpowder in the 9th century. It started as a search for life-extending elixirs but quickly became a key military tool.Gunpowder led to inventions like early rockets, bombs, and cannons that changed warfare. Its impact is still felt in many ways today.Learn more about its history and uses in Song Dynasty China.Woodblock PrintingWoodblock printing first appeared in China around the 7th century. You can learn how it involved carving text and images into wooden blocks, which were then inked and pressed onto paper.This method allowed you to produce books more quickly than writing by hand. If you want to explore its history, check out the development during the Tang and Song Dynasties and its impact on printing technology.For more details, see the information on woodblock printing in Tang China.Movable Type PrintingIf youre curious about printing, movable type was a big step forward. Invented in the 11th century, it used individual characters made from clay or metal.You might notice it wasnt widely used in China because whole-block printing was easier. Still, movable type laid important groundwork for printing technology. Learn more about early printing methods from this Printing & Movable Type Song Dynasty China.The WheelbarrowThe wheelbarrow first appeared in China during the Han dynasty, around 100 CE. You can imagine how it helped people move heavy loads with less effort.A famous figure named Zhuge Liang improved it for military use, making it easier to transport supplies. If you want to learn more, check out this article on the history of wheelbarrows.The Horse CollarThe horse collar was a big help for your work with horses. It allowed the animal to push with its shoulders instead of choking itself when pulling heavy loads.This invention made it easier to carry weight using fewer horses, saving effort and improving farming efficiency. The horse collar dates back to ancient China by at least the 5th century, showing its importance early on. Learn more about the horse collars origin.The Moldboard PlowThe moldboard plow transformed farming by turning over soil efficiently. If youve ever wondered how ancient farmers prepared their fields, this invention made the work easier and improved crop growth.You can trace its origins back to China around 500 BC, where it helped farmers follow hills contours to reduce soil erosion. Learn more about the impact of the moldboard plow in ancient China.Paper MoneyYou might be surprised to learn that paper money was first invented in ancient China around 806 AD. It started as letters of credit, helping merchants trade across long distances without carrying heavy coins.By the Song dynasty, this idea evolved into official government-issued notes, making transactions easier for everyone. You can explore more about the origins of Chinese paper money and how it changed trade.Cast Iron CannonsYou might be surprised to learn that cast iron cannons were first developed in ancient China. By the 5th century BC, the Chinese had mastered cast iron technology, allowing them to create durable weapons.Later, during the 12th and 13th centuries, early metal cannons appeared, marking important advancements in warfare. You can explore more about the history of these innovative weapons through the detailed accounts of History of cannons and their archaeological finds in Gansu Province.LandminesIf you think landmines are a modern invention, you might be surprised to learn they originated in ancient China. Back in the Song Dynasty, these early explosives were used to defend cities from invaders.You can explore how China developed landmines with mechanical ignition devices during the Ming Dynasty. This innovation laid the groundwork for future explosive technology you see today. Learn more about the history of landmines in China.Rockets Using GunpowderYou might be surprised to learn that rockets were first developed in ancient China using gunpowder. This invention allowed early military engineers to create solid-propellant rockets for warfare.These rockets combined an arrow with a gunpowder tube, making them an early form of missile technology. You can explore more about the origins of these innovative weapons in the history of gunpowder and rockets of ancient China.SeismographYou can thank ancient China for one of the earliest earthquake detectors. The seismograph was invented by Zhang Heng in 132 CE.This device could sense tremors from far away, alerting people to possible danger. If you want to learn more about this invention, check out the Chinese seismograph. Ancient China held leading positions in many fields in studyingnature in the world. Besides thefour great inventions :paper-making, printing, gunpowder and the compass, Ancient China contributed countless other inventions to the world, How many other Chinese creations do you know? Below is a list of the 20 inventions created by ancient Chinese and some may surprise you.1.Paper Making (105 A.C)The invention of the paper greatly affects human history. Paper already existed in China since 105 A.C, however, a eunuch named Cai Lun (ca. 50 AD 121) made significant innovation and helped make widespread adoption. His advanced paper-making technology then spread to central Asia and the world through the Silk Road.2. Movable Type Printing (960-1279 AD)Woodblock printing was already a widely used technique in the Tang Dynasty(618 to 906 A.D). However, this kind of printing tech was expensive and time-consuming. Until the Song Dynasty (960-1279), a man named Bi Sheng (9901051) invented movable type printing, making it quicker and easier. He first carved individual characters on pieces of clay and then harden them with fire. These movable type pieces were later glued to an iron plate to print a page and then broken up and redistributed for another page. This kind of printing tech rapidly spread across the Europe, leading up to the Renaissance, and later all around the world.3. Gunpowder (1000 A.D)Gunpowder was invented by Chinese Taoist alchemists at about 1000 A.D. when they tried to find a potion to gain human immortality by mixing elemental sulfur, charcoal, and saltpeter. It is generally believed that gunpowder spread to Europe during the Mongol expansion of 1200-1300 A.D.. The interesting fact is that Chinese used this discovery mainly for firecrackers while Europeans created cannons and guns and dominated China in the mid-1800s.4. Compass (1100 A.D.)A compass is a navigational instrument that shows directions. The compass was invented by Chinese between the 2nd century BC and 1st century AD. It was first used in Feng Shui, the layout of buildings. By 1000 AD, navigational compasses were commonly used on Chinese ships, enabling them to navigate. Arab traders sailing to China might learned of the the tech and brought it to the West, and this became an very important factor of the success of Age of Discovery.5. Alcohol About (2000 BC1600 BC)The inhabitants of the Arabian peninsula were widely believed to be the first brewers. However, in 2013, a 9000-year-old pottery found in Henan province revealed the presence of alcohol, 1000 years before Arabian. Alcohol is known as Jiu in Chinese and is often used as a spiritual offerings to the Heaven and the Earth or ancestors in ancient China. Study shows that beer with an alcoholic content of 4% to 5% was widely consumed in ancient China and was even mentioned on oracle bone inscriptions of the Shang Dynasty (1600 BC1046 BC).6. Mechanical Clock (725 A.D.)The worlds first mechanical clock Water-driven Spherical Birds was invented by Yi Xing, a Buddhist monk in 725 A.D.. It was operated by dripping water which powered a wheel that made one revolution in 24 hours. Hundreds of years later, the inventor Su Song developed a more sophisticated clock called the Cosmic Empire in 1092, 200 years earlier than the mechanical clock was created in Europe.7. Tea Production (2,737 BC)According to old Chinese legend, tea was first discovered by Shennong, Chinese Father of Agriculture, around 2,737 BC. In the Tang Dynasty (618907) tea became a popular drink enjoyed by all social classes. Cha Jing (or The Book of Tea), written by Lu Yu in the Tang Dynasty, explicated ways to cultivate tea, tea drinking and different classifications of tea in details. The book is considered as the worlds first monograph about tea. And the worlds oldest and largest living tea tree can be found in Lin Cang, China, about3,200 years old.8. Silk About 6,000 years agoSilk, one of the oldest fibers, originated in China asearly as 6,000years ago.The earliest evidence of silk was discovered at Yangshao culture site in Xiaxian County, Shanxi Province, China. where a silk cocoon was found cut in half, dating back to between 4000 and 3000 BC.Chinese peoplemastered sophisticated silk weaving tech andclosely guarded secret, and the West hadtopay gold of the same weight for the silks. In ancient times the silk was averyimportant item made in China and for many centuries businessmen transported this precious item from China to the West, forming the famousSilk Road.9. Umbrella (1,700 years ago)The inventions of umbrella can be traced back as early as 3500 years ago in China. Legend has it, Lu Ban, a Chinese carpenter and inventor created the first umbrella. Inspired by children using lotus leaves as rain shelter, he created umbrella by making a flexible framework covered by a cloth.10. Acupuncture (2300 years ago)The oldest Chinese medicine book Neijing, also known as The Classic of Internal Medicine of the Yellow Emperor, shows that acupuncture was widely used as a therapy in China much before the time it was written. Besides, various kindsof acupuncture needles were discoveredin the tomb of Prince Liu Sheng who died around200 B.C. This is a further proof that acupuncture were already in use in China more than two thousand years ago11. Iron smelting (1050 BC256 BC)Archaeological evidence revealed that iron smelting technology was developed in China as early as 5th century BC in the Zhou Dynasty (1050 BC256 BC). During The Spring & Autumn and Warring States periods (776-221 BC) China went into a flourishing period for iron smelting. In the Han Dynasty (202 BC220 AD) central government monopolized the iron smelting, seeing remarkable development.12. Porcelain (581 618 AD)Porcelain is a great invention of ancient China. The earliest porcelain emerged in Shang Dynasty (16001046 BCE) and matured during the Tang Dynasty (618-906). During the Song Dynasty (9601279), porcelain production technology reached an unprecedented height due to its focus on shape and the tactile experiences of the glaze. Chinese porcelain was highly prized in the world and many artworks had beenintroduced to the Westthrough the Silk Road.13. Earthquake Detector (132 A D)According to court records of the later Han Dynasty, a seismograph was created by the brilliant inventor Zhang Heng (78-140 AD) in 132 AD. Its function is to determine the direction of an earthquake. In 138 AD, this instrument indicated an earthquake occurring in Longxi a thousand kilometers away. It was the first time that mankind to detect an earthquake. Modern seismographs only began development in 1848 in Europe.14. Rocket (228 A. D.)China is hometown of rockets, ancient Chinese inventors created rockets by applying counter-force produced by ignited gunpowder. According to history, in 228 A.D. the Wei State already used torches attached to arrows to guard Chencang against the invading troops of the Shu State. Later theSong Dynasty (960-1279) had adapted gunpowder to make rockets. A paper tube stuffed with gunpowder was attached to an arrow whichcan be launched by a bow. This kind of ancient rockets and improved ones were widely used in military and entertainment activitiesin China.15. Bronze (1700 B.C.)The skill of produce bronze wasmastered by ancient Chinese by 1700 B.C. The Shang Dynasty (16001046 B.C.) and Zhou dynasties (1046-256 BC) brought China into the Bronze Age and the making of bronze wares reached its peak in this period. Bronze was mainly used to make weapons, bronze tools and ritual vessels at that time. Compared to counterparts in other regions of the world, the Chinese bronze wares stand out for their inscriptions and delicate decorative patterns.16. The Kite (About 3, 000 years ago)The kite was developed around 3,000 years ago by ancient Chinese. The earliest kites were made of wood, called Muyuan (wooden kite). In early times kites were mainly used for military purposes such as sending a message, measuring distances, testing the wind and signalling. Over time kite flying developed into playthings and kite flying is now enjoyed worldwide.17. The Seed Drill 3500 years agoThe seed drill is a device that plants the seed into soil at a uniform depth and covers it. If without this device farmers had toplant the seeds by hand, resulting in waste and uneven growth. According to records, the Chinese using of seed drills can be dated back to the 2nd Century BC. The device made farmers job easier and highly improved the agricultural output in China.18. Row Crop Farming 6 Century BCIn other parts of the world, farmers still scattered seed onto the fields randomly. While ancient Chinese started planting crops in rows from the 6th century BC. They planted individual seeds in rows, thus reducing seed loss and making crops grow faster and stronger. This technology was not used in the western world until 2200 years later.19. Toothbrush 1498 in ChinaThe bristle toothbrush was invented in 1498 by Chinese who made toothbrushes with coarse horse hairs attached to bone or bamboo handles. It was later brought to the new world by Europeans.20. Paper Money 9th century A.D.Paper money were first developed by the ancient Chinese, who started usingfolding money at the end of the 8thor beginning of the 9thcentury AD. Paper billswere originally used as privately issued bills of credit or exchange notes. A merchant could deposit his cash in the capital, receiving a paper exchange certificate which he could exchange for metal coins in other cities.Actually Chinese are responsible for countless inventions that have helped shape the world history. Without these inventions bythe ancient Chinese, the humankind would have taken more centuries to develop to the current phase. Do you know any other influential Chinese inventions? Please share with us by adding comments below. The Segmental Arch Bridge, though less well known than many of the other items on this list, is an important engineering feat. The segmental arch design, which used an arc smaller than a half circle, used less material and made stronger spans that stood up to damage better than a full semicircular arch. For example, the Zhaozhou Bridge was built during the Sui Dynasty and is the oldest all-stone example of this bridge type. At over 120 feet in length, it held the record for the largest arch of its kind at that time. This design was well ahead of others and influenced later bridge building around the world. Acupuncture, one of Chinas most famous medical practices, began by at least the 2nd century BC. This healing method uses thin needles in specific points on the body to even out Qi or life energy. In fact, doctors in ancient China believed illness happened when this energy was uneven. As a result, it was thought that acupuncture helped even out the energy and helped the body heal. Even today, people still use it, and it has been shown to help with pain relief and treat different health issues. The Chinese Materia Medica, or Shennong Bencao Jing, is a medicine guide that was written around the first century AD and lists hundreds of plants and how to use them. Ancient Chinese herbal doctors used these herbs to keep people healthy and stop disease. This approach to health looks at the body, mind and environment to find an effective cure and has influenced modern integrative and preventive medicine.The ancient Chinese were innovative and determined. They met their daily needs by creating and innovating some of the most important and long-lasting items in history.Ancient Chinese inventions date back to the Paleolithic period, and the Chinese were always ahead of their contemporaries when it came to inventing valuable things.They have given us the four greatest inventions in the world the compass, gunpowder, paper, and printing, but the list doesnt stop there.Here are the top 18 (including two from the medieval period) most famous Chinese inventions:Before the invention of paper, people used different materials like wood, stone, and bone to write on. Around 2200 BC, the Egyptians discovered a type of reed called papyrus which could be used to write on by overlapping thin strips that had been soaked in water. The world paper was derived from papyrus.Paper was invented in ancient China around 105 AD during the reign of the Han emperor He Di by Tsai Lun (or Chai Lun), an official of the imperial court. However, a recent archeological survey indicates that paper had already been invented 200 years earlier and was used by the ancient Chinese military.Tsai Lun used the bark of the mulberry tree and pounded the fibers into a sheet. Later, he discovered that the quality of the paper could be improved by adding hemp and old fish nets to the pulp. Soon, paper became the new writing material, and it only took a few years before it was widely in use all over China. Later, paper was brought to the rest of the world via the Silk Road.The invention of silk dates back to the fourth millennium BC during the Neolithic period. Apart from clothing, silk was widely used in a variety of sectors including writing, fishing, and for musical instruments. Silk was dominantly used by emperors and high-class society but later it spread to the rest of the population. During the Han dynasty (202 BC220 AD), silk became more than just a commodity. It was used as a reward for a worthy Chinese citizen or government official.Silk became an important part of the Chinese economy. Japan and the Middle East started cultivating silk around 300 AD and the Crusades brought the concept of silk production to Western Europe. This resulted in an economic boom and Chinese silk started to decrease in value and exports. However, China dominates the luxury silk market today.Tea was discovered in ancient China by the Chinese emperor Shennong in 2737 BC. Shennong liked to drink hot water. One day during a march he and his army stopped to rest and his servant prepared some boiling water for him. A brown leaf fell into the water and the water turned brown. The servant presented it to the emperor, he drank it and found it refreshing.During the Han dynasty, tea was used as a medicine, and it was used as a drink on social occasions from the Tang dynasty (618907 AD). Tea was prepared differently in ancient China than it is today. Tea leaves were processed and compressed into cake form.The dried teacake known as brick tea was ground in a stone mortar. The powder from the teacake was then boiled in a kettle, or hot water was added to it. It was then served as a hot beverage. White tea (compressed tea) was produced during the Tang dynasty, and it was harvested in the early spring when the tea leaves were still silver needles.The Chinese were ahead of the rest of the world in producing silk, and they used this silk to make kites, adding a resilient and lightweight bamboo framework to high tensile strength silk. Chinese philosophers Lu Ban and Mozi documented the first kite in ancient China in the fifth century BC.By 549 AD, paper kites were being used to carry messages for rescue missions. During the medieval period, the Chinese used kites to test the wind, measure distance, and for military communication.See also:Top 10 Astonishing Ancient Chinese Mythology StoriesThe Babylonians in ancient Mesopotamia invented single tube drills around 1500 BC, but these never reached Europe or Asia. Chinese farmers generally planted seeds by hand which was time-consuming and ineffective. Most of the seeds never germinated because of pests and the elements. The ancient Chinese found an alternative to this problem.During the Zhou dynasty, they discovered the seed drill that allowed However, it wasnt until the second century BC that they invented a multi-tube iron seed drill that helped them to produce food on a larger scale.The Chinese developed drilling technology to extract brine from beneath the earths surface. It was developed in the landlocked province of Szechuan, around 1,200 miles from the sea, in order to get salt from boreholes.Deep drilling borehole technology slowly improved, and the ancient Chinese were finally able to extract natural gas from the boreholes. The gas was carried by a bamboo pipe to its destination and then used as fuel.By the 11th century, the Chinese were able to drill boreholes over 3,000 feet deep. The same technology was used to drill the first petroleum well in California in the 1860s.Porcelain was not a sudden invention, and an ancient form of porcelain existed during the Shang dynasty (1600 BC1046 BC). It was perfected during the Tang dynasty and was exported to the Middle East.During the Song dynasty (9601279 AD), the manufacture of porcelain became highly organized and reached new heights. By the time of the Ming dynasty (13681644 AD) porcelain was being exported to Europe, Africa, and Asia via the Silk Road.The Chinese considered south their cardinal direction, and the original compass was created by the Chinese using a lodestone to point south. This was called the south pointer. A lodestone is a type of mineral magnetite that aligns itself with the earths magnetic field.The ancient Chinese discovered that a suspended lodestone could turn freely and would point towards the magnetic poles. During the Han dynasty, it was mainly used for geomancy and fortune telling. In the 11th century, during the Song dynasty, the Chinese figured out that the lodestone, which was primarily being used as a divination tool, could also be used to indicate a direction for travelers.In the book Shorter Science and Civilization in China, Volume 3 written by Joseph Needham, it is stated that the Chinese began to use the compass for navigation between the 9th and the 11th centuries.An archeological survey in 2002 at the Lajia site of the Qijia culture discovered some ancient noodles made of grains from millet grass. The 50cm-long yellow strands of noodles are predicted to be 4,000 years old.Prior to this period, the earliest noodles were thought to have been eaten during the Han dynasty. There was a huge controversy over whether the Arabs, the Italians, or the Chinese first invented them.See also:Top 10 Traditional Ancient Chinese FoodsThe consumption of beer began in ancient China around 9,000 years ago during the Neolithic period. They used rice, hawthorn, honey, and grapes to make the beer.The four to five percent alcoholic beer was made popular by Yi Di and Du Kang of the Xia dynasty. Various bronze vessels preserved from the Shang dynasty indicate that they had once contained alcohol.During the Paleolithic period, the Chinese used arrowheads made of stone for fishing and hunting. During the Neolithic period, conflicts began to arise among different groups and the Chinese started to modify their farming and fishing tools into deadly weapons. During the Shang and Zhou periods, bronze smelting was perfected to create different weapons as well as tools for farming.An Iron Age began in ancient China during the Zhou dynasty (1050 BC256 BC) and iron was used to create weapons, farming tools, and household products. During the Han dynasty private iron making was abolished, and the state began to monopolize the iron smelting industry.The Chinese used different techniques for creating iron and steel weaponry. Their innovative techniques led to the rapid growth of the iron and steel industry in China. They invented various casting processes to produce crude iron, cast iron, wrought iron, tempering, and wrought steel that put them way ahead of other civilizations at that time.There is archaeological evidence of wheelbarrows in ancient China from the Han dynasty, as seen in Huis tomb murals and brick tomb reliefs. However, the invention of the wheelbarrow can be credited to prime minister Zhuge Liang (181234 AD) of Shu Han sometime between 197 and 234 AD. Liang created the wheelbarrow to carry military weapons and to move injured and dead soldiers from the battlefield.There were two types of wheelbarrow that were common: the front-wheeled wheelbarrow and the centrally mounted wheel. The centrally mounted design didnt require a huge amount of energy to pull the wheelbarrow, the total weight being distributed equally between the wheels and pullers. This made it convenient to use and these wheelbarrows were used mainly by builders, soldiers, traders, and farmers.See also:There is archaeological evidence that acupuncture was practiced in ancient China from the Paleolithic period. Different materials such as stone knives and bamboo or bone needles used as instruments of healing have all been excavated in China.Acupuncture was revolutionized during the period of Huang Di, the Yellow Emperor (26972597 BC). The earliest book of Chinese medicine is the Nei Jing and was written around 305 BC204 BC. It consists of a dialogue between Huang Di and his physicist Qi Bo about the whole spectrum of the Chinese medical arts.In 132 AD, Zhang Heng (78139 AD) of the Han dynasty invented the first seismograph called Houfeng Didong to measure the movements of the earth and seasonal winds. The seismograph was an urn-like instrument made of copper with a central pendulum.The eight dragons on the surface, each one holding the copper in its mouth, point out the eight different directions: east, south, west, north, southeast, northeast, southwest, and northwest.When there was an earthquake, the dragons mouth that was closest to the earthquakes source opened and the ball dropped into the mouth of the frog, producing a sound. This let people know the direction of the earthquake.The Great Wall of China was built by the first emperor of China, Qin Shi Huang (260210 BC) to protect the country from northern invaders. The 5,500-mile-long wall was built by slaves, criminals, and peasants.It is estimated that millions of people worked to build the Great Wall over a period of 1,000 years. Most of the Great Wall that we can see today was built during the Ming dynasty. Glutinous rice flour was used as a binding material to bind the bricks.The Silk Road was an ancient trading route used by merchants, traders, and city dwellers linking Asia to the Mediterranean. The history of the Silk Road can be traced back to the Han dynasty.The name Silk Road came into existence due to the lucrative silk industry that exported silk all over the world. The Silk Road was 6,400 miles long and considered an important development, enabling the silk industry to flourish.Chinese Inventions During the Medieval Period:The first chemical explosive known as a gunpowder or black powder was made from sulfur, charcoal, and potassium nitrate (saltpeter). Gunpowder wasnt a sudden invention. The Chinese had used saltpeter since the middle of the first century AD in various medical treatments.Gunpowder was invented during the Tang dynasty in the 9th century, but it wasnt until the Song dynasty in the 11th century that the first recorded formula was documented. The Chinese used gunpowder and gunpowder-based weaponry as a military defense.A major revolution in the history of printing came after the invention of movable clay type printing by Bi Sheng (9901051) during the Northern Song dynasty (9601127). The printing process consisted of four stages: making the types, composing the text, printing, and retrieving the movable types. Later, in 1298, it was re-invented by Wang Zhen during the Yuan dynasty.He produced 100 copies of the Nong Shu or Book of Agriculture using more than 30,000 wooden movable types. The book consists of over 60,000 Chinese characters. Metal movable type printing was invented during the Jin (11151234) and Southern Song (11271279) dynasties in the 12th century. It was mostly made of bronze and was used to print money.Ancient Chinese inventions revolutionized many industries that we take for granted today. Without paper, there would be no books, without the compass, traveling would have been curtailed, without printing, there would be no paper money.The Chinese also invented lots of other things during the medieval period, and that is why two very important inventions from this period have also been included. The world would be a very different place without these ancient and medieval Chinese inventions. Picture your morning: You grab a match to light your stove, pour tea into your favorite cup, and jot down a quick note on paper. In those first five minutes of your day, youve already used three ancient Chinese inventions. But thats just the beginning. From your umbrella to your credit card, Chinese ingenuity from thousands of years ago shapes how we live today. Page 2 Picture your morning: You grab a match to light your stove, pour tea into your favorite cup, and jot down a quick note on paper. In those first five minutes of your day, youve already used three ancient Chinese inventions. But thats just the beginning. From your umbrella to your credit card, Chinese ingenuity from thousands of years ago shapes how we live today. A bronze Chinese crossbow trigger mechanism with a butt plate (the wooden components have since eroded and disappeared), inlaid with silver, from either the late Warring States period (403256 BC) or the early Han dynasty (202 BC AD 220)Part of a series on theHistory of science and technology in ChinaList of discoveriesList of inventionsFour Great InventionsBy subjectAgriculturesericultureAlchemyArchitectureclassic gardensbridgesAstronomyCalendarCartographyCeramicsCoinageMathematicsUnits of measurementTraditional medicineherbologyMetallurgyMilitarynavyPrintingSilk industryTransportnavigationBy eraNeolithic and early Bronze AgeHanTangSongYuanPeople's Republicagriculturespacevte China has been the source of many innovations, scientific discoveries and inventions.[1] This includes the Four Great Inventions: papermaking, the compass, gunpowder, and early printing (both woodblock and movable type). The list below contains these and other inventions in ancient and modern China attested by archaeological or historical evidence, including prehistoric inventions of Neolithic and early Bronze Age China.The historical region now known as China experienced a history involving mechanics, hydraulics and mathematics applied to horology, metallurgy, astronomy, agriculture, engineering, music theory, craftsmanship, naval architecture and warfare. Use of the plow during the Neolithic period Longshan culture (c. 3000c. 2000 BC) allowed for high agricultural production yields and rise of Chinese civilization during the Shang dynasty (c. 1600c

that in 1232, as the Mongol general Subutai (11761248) descended on the Jin stronghold of Kaifeng, the defenders had a "thunder-crash bomb" which "consisted of gunpowder put into an iron container... then when the fuse was lit (and the projectile shot off) there was a great explosion the noise whereof was like thunder, audible for more than a hundred li, and the vegetation was scorched and blasted by the heat over an area of more than half a mou. When hit, even iron armour was quite pierced through."[73] The Song dynasty (9601279) official Li Zengbo wrote in 1257 that arsenals should have several hundred thousand iron bomb shells available and that when he was in Jingzhou, about 1,0002,000 were produced each month for dispatch of ten to twenty thousand at a time to Xiangyang and Yingzhou.[74] The significance of this, as British sinologist, scientist, and historian Joseph Needham states, is that a "high-nitrate gunpowder mixture had been reached at last, since nothing less would have burst the iron casing."[75]Borehole drilling: By at least the Han dynasty (202 BC 220 AD), the Chinese used deep borehole drilling for mining and other projects; The British sinologist and historian Michael Loewe states that borehole sites could reach as deep as 600m (2,000ft).[76] K.S.Tom describes the drilling process: "The Chinese method of deep drilling was accomplished by a team of men jumping on and off a beam to impact the drilling bit while the boring tool was rotated by buffalo and oxen."[77] This was the same method used for extracting petroleum in California during the 1860s (i.e. "Kicking Her Down").[77][78] A Western Han dynasty bronze foundry discovered in Xinglong, Hebei had nearby mining shafts which reached depths of 100m (330ft) with spacious mining areas; the shafts and rooms were complete with a timber frame, ladders and iron tools.[79][80] By the first century BC, Chinese craftsmen cast iron drill bits and drillers were able to drill boreholes up to 4,800 feet (1,500m) deep.[81][82][83] By the eleventh century AD, the Chinese were able to drill boreholes up to 3000 feet in depth. Drilling for boreholes was time-consuming and long. As the depth of the holes varied, the drilling of a single well could take up to nearly one full decade.[77] It wasn't up until the 19th century that Europe and the West would catch up and rival ancient Chinese borehole drilling technology.[78][83]Breeching strap: The breeching strap traces its roots back to the Chinese invented breast-strap or "breastcollar" harness developed during the Warring States (481221 BC) era.[84] The Chinese breast harness became known throughout Central Asia by the 7th century,[85] introduced to Europe by the 8th century.[85] The breeching strap would allow the horse to hold or brake the load as horse harnesses were previously attached to vehicles by straps around their necks as previously designed harnesses would constrict the horses neck preventing the horse from pulling heavier loads.[86] The breeching strap acted as a brake when a cart tries to run forward when moving downwards on a slope and also make it possible to maneuver the cart in the reverse direction.[86][87]Brine mining: About 500 BC, the ancient Chinese dug hundreds of brine wells, some of which were over 100 meters (330 feet) in depth. Large brine deposits under the earth's surface were drilled by drilling boreholes.[77] Bamboo towers were erected, similar in style to modern-day oil derricks.[88] Bamboo was used for ropes, casing, and derricks since it was salt resistant.[89] Iron wedges were hung from a bamboo cable tool attached to a lever on a platform constructed atop the tower. The derricks required two to three men jumping on and off the lever that moved the iron wedge pounded into the ground to dig a hole deep enough into the ground to hit the brine.[88][89]Bristle toothbrush: According to the United States Library of Congress website, the Chinese have used the bristle toothbrush since 1498, during the reign of the Hongzhi Emperor (r. 14871505) of the Ming dynasty (13681644); it also adds that the toothbrush was not mass-produced until 1780, when they were sold by a William Addis of Clerkenwell, London, England.[90] In accordance with the Library of Congress website, scholar John Bowman also writes that the bristle toothbrush using pig bristles was invented in China during the 1490s.[23] Bonnie L. Kendall agrees with this, and adds that a precursor existed in Ancient Egypt, in the form of a twig frayed at the end.[91]Chinese river ships from Along the River During Qingming Festival, by Zhang Zeduan (10851145), Song dynastyBulkhead partition: The 5th century book Garden of Strange Things by Liu Jingshu mentioned that a ship could allow water to enter the bottom without sinking, and the Song dynasty author Zhu Yu (fl. 12th century) wrote in his book of 1119 that the hulls of Chinese ships had a bulkhead build; these pieces of literary evidence for bulkhead partitions are confirmed by archaeological evidence of a 24m (79ft) long Song dynasty ship dredged from the waters off the southern coast of China in 1973, the hull of the ship divided into twelve walled compartmental sections built watertight, dated to about 1277.[92][93] Western writers from Marco Polo (12541324), to Niccol Da Conti (13951469), to Benjamin Franklin (17061790) commented on bulkhead partitions, which they viewed as an original aspect of Chinese shipbuilding, as Western shipbuilding did not incorporate this hull arrangement until the early 19th century.[94][95]A late 10th century grey sandstone and celadon-glazed pitcher from the Song dynasty (9601279); the spout is in the form of a fenghuang head.The endless power-transmitting chain drive from Su Song's book of 1094 describing his clock tower[96]The Xuande Emperor (r. 14251435) playing chuiwan with his eunuchsA hand-held, trigger-operated crossbow from the 2nd century BC, Han dynasty[97]A 15th-century Ming dynasty (13681644) woodblock print of the Water Margin novel showing a game of cuju football being playedCandidates gathering around the wall where the civil service examination results are posted. This announcement was known as "releasing the roll" (). (c. 1540, by Ming dynasty painter Qiu Ying)Candle clock: Candle clocks have been used in China since at least the 6th century AD. The earliest reference of a candle clock is in a poem by You Jiangu, from about AD 520.[98]Cannon: The earliest known depiction of a cannon is a sculpture from the Dazu Rock Carvings in Sichuan dated to 1128;[99] but the earliest archaeological samples and textual accounts do not appear until the 13th century. The primary extant specimens of cannons from the 13th century are the Wuwei Bronze Cannon, dated to 1227; the Heilongjiang hand cannon, dated to 1288; and the Xanadu Gun, dated to 1298. Only the Xanadu gun contains an inscription bearing a date of production, so it is considered the earliest confirmed extant cannon. The Xanadu Gun is 34.7cm long and weighs 6.2kg. The other cannons are dated using contextual evidence.[100] The oldest representation of a bombard can be found in the Chinese town of Ta-tsu. In 1985, a Canadian historian, Robin Yates, saw a sculpture on the wall of a Buddhist cave temple, depicting a demon holding a hand-held bombard. The muzzle seems to have a blast and flames coming from it, which some believe is proof of a super gun. Yates examined the cave and believed the drawings dated from the late 12th century.[101]Cast iron: Confirmed by archaeological evidence, cast iron, made from melting pig iron, was developed in China by the early 5th century BC during the Zhou dynasty (1122256 BC), the oldest specimens found in a tomb of Luhe County in Jiangsu province; despite this, most of the early blast furnaces and cupola furnaces discovered in China date from after the establishment, in 117 BC, of the state iron monopoly under Emperor Wu (r. 14187 BC), during the Han dynasty (202 BC AD 220); Donald Wagner states that a possible reason why no ancient Chinese bloomery process has been discovered is that the iron monopoly, which lasted until the 1st century AD, when it was abolished for private entrepreneurship and local administrative use, wiped out any need for continuing the less efficient bloomery process, which continued in use in other parts of the world.[70][102][103][104][105] Cast iron is comparatively brittle and is not suitable for purposes where a sharp edge or flexibility is required. An important Chinese innovation was the development of malleable iron in the 4th century BC, which enhanced the mechanical properties of cast iron through an annealing process.[106] Furthermore, Wagner states that most iron tools in ancient China were made of cast iron in consideration of the low economic burden of producing cast iron, whereas most iron military weapons were made of more costly wrought iron and steel, signifying that "high performance was essential" and preferred for the latter.[107]Celadon: Named after a pale-tinted spring green colour, Chinese archaeologist Wang Zhongshu (1982) asserts that shards having this type of ceramic glaze have been recovered from Eastern Han dynasty (25220 AD) tomb excavations in Zhejiang; he also asserts that this type of ceramic became well known during the Three Kingdoms (220265).[108] Richard Dewar (2002) disagrees with Wang's classification, stating that true celadonwhich requires a minimum 1,260C (2,300F) furnace temperature, a preferred range of 1,285 to 1,305C (2,345 to 2,381F), and reduced firingwas not created until the beginning of the Northern Song dynasty (9601127).[109] The unique grey or green celadon glaze is a result of iron oxide's transformation from ferric to ferrous iron (Fe2O3 FeO) during the firing process.[109] Longquan celadon wares, which the archeologist Nigel Wood at the University of Oxford writes were first made during the Northern Song, had bluish, blue-green, and olive green glazes and high silica and alkali contents which resembled later porcelain wares made at Jingdezhen and Dehua rather than stonewares.[110]Censer: The earliest known censers can be traced back to the Warring States period in the mid-fifth to late fourth centuries BCE. In modern Chinese, the term for "censer" is xianglu (, "incense burner"), a compound of xiang ("incense, aromatics") and lu (, "brazier; stove; furnace"). Another frequently used term is xunlu (, "a brazier for fumigating and perfuming"). Initial designs of Chinese censers, typically crafted as a round, single-footed stemmed basin, are thought to have evolved from ritual bronzes, such as the dou sacrificial chalice.Chain drive, endless power-transmitting: The Greek Philon of Byzantium (3rd or 2nd century BC)[111] described a chain drive and windlass used in the operation of a polybolos (a repeating ballista),[112][113] "but the chain drive did not continuously transmit power from shaft to shaft and hence they were not in the direct line of ancestry of the chain-drive proper".[114] A continuously driven chain drive first appeared in 11th century China. Perhaps inspired by chain pumps which had been known in China since at least the Han dynasty (202 BC 220 AD) when they were mentioned by the Han dynasty philosopher Wang Chong (27 c. 100 AD),[115] the endless power-transmitting chain drive was first used in the gearing of the clock tower built at Kaifeng in 1090 by the Song Chinese politician, mathematician and astronomer Su Song (10201101).[116][117][118]Chopsticks: The Han dynasty historian and writer Sima Qian (14586 BC) wrote in the Records of the Grand Historian that King Zhou of Shang was the first to make chopsticks out of ivory, in the 11th century BC; the oldest archaeological find of a pair of chopsticks, made of bronze, comes from Shang Tomb 1005 at Houjiazhuang, Anyang, dated to about 1200 BC. By 600 BC, the use of chopsticks had spread to Yunnan (Dapona in Dali),[119][120] and Tv Province by the 1st century.[121] The earliest known textual reference to the use of chopsticks comes from the Han Feizi, a philosophical text written by writer and philosopher Han Fei (c. 280233 BC) in the 3rd century BC.[122]Chuiwan: Chuiwan, a game similar to the Scottish-derived sport of golf, was first mentioned in China by Song dynasty writer Wei Tai (fl. 10501100) in his Dongxuan Records ();[123] it was popular amongst men and women in the Song dynasty (9601279) and Yuan dynasty (12791368), and it was popular among urban men in the Ming dynasty (13681644) in much the same way that tennis was for early urban Europeans during the Renaissance (according to Andrew Leibs).[124] In 1282, the writer Ning Zhi published the Book of Chuiwan, which described the rules, equipment, and playing field of chuiwan, as well as included commentary of those who mastered its tactics.[124] The game was played on flat and sloping grassland terrain andmuch like the tee of modern golfhad a "base" area where the first of three strokes were played.[125]Civil service: During the Han dynasty (202 BC 220 AD), the xiaolian system of recruiting government officials through formal recommendations was the chief method of filling bureaucratic posts, although there was an Imperial Academy to train potential candidates for office and some offices required its candidates to pass formal written tests before appointment.[126][127][128][129] However, it was not until the Sui dynasty (581618) that civil service examinations became open to all adult males not belonging to the merchant class (although civil service examinations was a path to social advancement in Imperial Chinese society to candidates regardless of wealth, social status, or family background) and were used as a universal prerequisite for appointments to office, at least in theory.[130][131] The civil service system was implemented on a much larger scale during the Song dynasty (9601279), when an elite core of dynastic-founding and professional families lost their majority in government to a broad strata of lesser gentry families from throughout the country.[132][133] The civil examination system was later adopted by China's other East Asian neighbors Japan and Korea.[134] The imperial examination system attracted much attention and greatly inspired political theorists in the Western World, and as a Chinese institution was one of the earliest to receive such foreign attention.[135] The Chinese examination system was introduced to the Western world in reports by European missionaries and diplomats, and encouraged the British East India Company to use a similar method to select prospective employees. After the initial success in that company, the British government adopted a similar testing system for screening civil servants in 1855.[136] Other European nations, such as France and Germany, followed suit. Modeled after these previous adaptations, the United States established its own testing program for certain government jobs after 1883.Co-fusion steel process: Although British scientist, sinologist, and historian Joseph Needham speculates that it could have existed beforehand, the first clear written evidence of the fusion of wrought iron and cast iron to make steel comes from the 6th century AD in regards to the Daoist swordsmith Qiwu Huaiwen, who was put in charge of the arsenal of Northern Wei general Gao Huan from 543 to 550 AD.[137] The Tang dynasty (618907) Newly Reorganized Pharmacopoeia of 659 also described this process of mixing and heating wrought iron and cast iron together, stating that the steel product was used to make sickles and Chinese sabers. In regards to the latter text, Su Song (10201101) made a similar description and noted the steel's use for making swords.Coke, fuel: By the 11th century, during the Song dynasty (9601279), the demands for charcoal used in the blast and cupola furnaces of the iron industry led to large amounts of deforestation of prime timberland; to avoid excessive deforestation, the Song dynasty Chinese began using coke made from bituminous coal as fuel for their metallurgic furnaces instead of charcoal derived from wood.[138][139][140]Color printing: By at least the Yuan dynasty, China had invented color printing for paper. British art historian Michael Sullivan writes that "the earliest color printing known in China, and indeed in the whole world, is a two-color frontispiece to a Buddhist sutra scroll, dated 1346".[141]Counting rods: Counting rods are instruments used for performing calculations, which uses a grid of cells to represent a decimal position system. Each digit (09) appears as a tally of rods with red rods designated as positive numbers and black rods designated as negative numbers.[142] Archaeological evidence of counting rods dates from the 2nd century BC.[143] The earliest pictorial depiction of counting rods appears on Warring States period ceramics excavated in Dengfeng in Henan. The oldest surviving counting rods are bamboo rods discovered in a Han dynasty tomb at Fenghuangshan in Hubei, which dates from the reign Emperor Wen of Han.[144] The first explicit textual description of counting rods is recorded in the Book of Han, compiled by Ban Gu from about AD 60; but there has been speculation about textual references as early as the 3rd century BC. For example, one passage in the Tao Te Ching mentions that "a person good at shu [calculations] does not use bamboo tallies and bamboo slips."[142]Crossbow and repeating crossbow: According to British art historian Matthew Landruss and Gerald Hurley, Chinese crossbows may have been invented as far back as 2000 BC;[145][146] Anne McCants, an American historian at the Massachusetts institute of Technology, speculates that they existed about 1200 BC.[147] In China bronze crossbow bolts dating from as early as the mid 5th century BC were found at a State of Chu burial site in Yutaishan, Hubei.[148] The earliest handheld crossbow stocks with bronze trigger, dating from the 6th century BC, comes from Tomb 3 and 12 found at Qufu, Shandong, capital of the State of Lu.[97][149] Other early finds of crossbows were discovered in Tomb 138 at Saobatang, Hunan, dated to the mid 4th century BC.[150][151] Repeating crossbows, first mentioned in the Records of the Three Kingdoms, were discovered in 1986 in Tomb 47 at Qinjiazui, Hubei, dated to about the 4th century BC.[152] The earliest textual evidence of the handheld crossbow used in battle dates from the 4th century BC.[153] Handheld crossbows with complex bronze trigger mechanisms have also been found with the Terracotta Army in the tomb of Qin Shihuang (r. 221210 BC) that are similar to specimens from the subsequent Han dynasty (202 BC 220 AD); crossbowmen described in the Han dynasty learned drill formations, some were mounted as cavalry units, and Han dynasty writers attributed the success of numerous battles against the Xiongnu to massed crossbow fire.[154][155]Cuju (football): The game of football known as cuju was first mentioned in China by two historical texts; the Zhan Guo Ce (compiled from the 3rd to 1st centuries BC) and the Records of the Grand Historian (published in 91 BC) by Sima Qian (14586 BC).[156] Both texts recorded that during the Warring States period (403221 BC) the people of Linzi city, capital of the State of Qi, enjoyed playing cuju along with partaking in many other pastimes such as cockfighting.[156] Besides being a recreational sport, playing cuju was also considered a military training exercise and means for soldiers to keep fit.[156]Cupola furnace: An American anthropologist, Vincent C. Pigott, of the University of Pennsylvania, states that the cupola furnace existed in China at least by the Warring States period (403221 BC);[157] Donald B. Wagner writes that some iron ore melted in the blast furnace may have been cast directly into molds, but most, if not all, iron smelted in the blast furnace during the Han dynasty (202 BC 220 AD) was remelted in a cupola furnace; it was designed so that a cold blast injected at the bottom traveled through tuyere pipes across the top where the charge (i.e. of charcoal and scrap or pig iron) was dumped, the air becoming a hot blast before reaching the bottom of the furnace where the iron was melted and then drained into appropriate molds for casting.[158]Ceramic models of watchtowers from the Han dynasty (202 BC 220 AD) showing use of dougong bracketsA giant drawloom for figure weaving, from the Chinese Tiangong Kaiwu encyclopedia published by Ming dynasty encyclopedist and scientist Song Yingxing in 1637Antique drilling rigs in Zigong, ChinaDental amalgam: Dental amalgam were used in the first part of the Tang dynasty (618907 A.D.).[159] Evidence of a dental amalgam first appears in the medical text Hsin Hsiu Pen Tsao written by Su Kung in 659, manufactured from tin and silver.[160] Historical records indicate the use of dental amalgam earlier.[160] The composition of an early dental amalgam was published in the Ming dynasty, and a text written by Liu Wen Taiin 1505 states that it consists of "100 shares of mercury, 45 shares of silver and 900 shares of tin."[160]Diabolo: Archaeologists theorize that Diabolos (or Chinese yo-yo) originated from Chinese spinning top. In Hemudu Excavation, wooden tops were excavated. To extend the spinning time of the tops, whips were used to spin them. It was believed that poet Cao Zhi in the Three Kingdoms period had composed the poem "Rhapsody of Diabolos ", making it the first record of Diabolo in history. However, the authenticity of the poem requires further research and proof. By the medieval Tang dynasty, Chinese Diabolo became widespread as a toy. A Taiwanese scholar Wu Shengda argues that records of Diabolo only appeared during late Ming dynasty Wanli period, with its details well recorded in the book Dijing Jingwulue, referring to Diabolos as "Kong Zhong" (simplified Chinese: ; traditional Chinese: ; pinyin: Kng zhong; lit. 'Air Bell').[161][162] The first mention of a diabolo in the Western World was made by a missionary, Father Amiot, in Beijing in 1792 during Lord Macartney's ambassadorship, after which examples were brought to Europe,[163] as was the sheng (eventually adapted to the harmonica and accordion).[164][165]Dominoes: The Ming dynasty (13681644) writer Xie Zhaozhe (15671624) initiated the legend that dominoes were first presented to the imperial court in 1112.[166] However, the oldest confirmed written mention of dominoes in China comes from the Former Events in Wulin (i.e. the capital Hangzhou) written by the Yuan dynasty (12711368) author Zhou Mi (12321298), who listed "pupai" (gambling plaques or dominoes) as well as dice as items sold by peddlers during the reign of Emperor Xiaozong of Song (r. 11621189).[166] Andrew Lo asserts that Zhou Mi meant dominoes when referring to pupai, since the Ming author Lu Rong (14361494) explicitly defined pupai as dominoes (in regards to a story of a suitor who won a maiden's hand by drawing out four winning pupai from a set).[166] The earliest known manual written about dominoes is the Manual of the Xuanhe Period (11191125) written by Qu You (13471433).[166] In the Encyclopedia of a Myriad of Treasures, Zhang Pu (16021641) described the game of laying out dominoes as pupai, although the character for pu had changed (yet retained the same pronunciation).[166] Traditional Chinese domino games include Tien Gow, Pai Gow, Che Deng, and others. The thirty-two-piece Chinese domino set (made to represent each possible face of two thrown dice and thus have no blank faces) differs from the twenty-eight-piece domino set found in the Western World during the mid 18th century (in France and Italy).[167] Dominoes first appeared in Italy during the 18th century, and although it is unknown how Chinese dominoes developed into the modern game, it is speculated that Italian missionaries in China may have brought and introduced the game to Europe.[168]Dougong: A dougong is a building bracket which is unique to Chinese architecture. Since at least the Western Zhou dynasty (c. 1050771 BC), they were placed between the top of a column and a crossbeam to support the concave roofs of beam-in-tier buildings which were archetypal of Chinese architecture.[169] Each dougong is formed by double bow-shaped arms (, gong) supported by a wooden block (, dou) on each side.[169] Dougong were also used for decorative and ceremonial rather than entirely pragmatic purposes of support, such as on solid brick pagodas like the Iron Pagoda built in 1049. The Yingzao Fashi building manual published in 1103 by the Song dynasty (9601279) official Li Jie featured illustrations and descriptions of dougong.[170]Drawloom: The earliest confirmed drawloom fabrics come from the State of Chu and date from about 400 BC.[171] Most scholars attribute the invention of the drawloom to the ancient Chinese, although some speculate an independent invention from ancient Syria since drawloom fabrics found in Dura-Europas are thought to date from before AD 256.[171][172] Dieter Kuhn states that an analysis of texts and textiles from the Han dynasty (202 BC 220 AD) proves that the figured fabrics of that era were also crafted with the use of a drawloom.[173] The drawloom was certainly known in Persia by the 6th century AD.[171] Eric Broudy asserts there is virtually no evidence of its use in Europe until the 17th century, and the button drawloom was allegedly invented by Jean le Calabrais in the 15th century.[174] Mary Carolyn Beaudry disagrees, stating that it was used in the medieval Italian silk industry.[173]Drilling rig: The technique of percussion drilling for oil and gas originated during the ancient Chinese Han dynasty, when percussion drilling ("churn drilling") was used to extract natural gas in Sichuan province.[175][176] Iron bits were fastened to long bamboo poles, which were centered within a bamboo derrick. The poles were repeatedly hoisted, using cables woven from bamboo fiber. With the assistance of levers, very heavy bits could be raised, of sufficient weight to percussively bore through rock when repeatedly dropped.[175] Han dynasty oil wells were about 10 meters deep; by the 10th century, depths of 100 meters could be achieved.[175] By the 16th century, Chinese oil prospectors were using percussion drilling to create wells over 2000 feet deep.[176] A modernized variant of the technique was used by American businessman Edwin Drake to drill Pennsylvania's first oil well in 1859, using small steam engines to power the drilling process.[175]Escapement, hydraulic-powered (use in clock tower): The escapement mechanism was first described for a mechanical washstand by the Greek Philon of Byzantium who also indicated that it was already used for clocks.[177] An escapement mechanism for clockworks was later developed by the Buddhist monk, court astronomer, mathematician and engineer Yi Xing (683727) of the Tang dynasty (618907) for his water-powered celestial globe in the tradition of the Han dynasty polymath and inventor Zhang Heng (78139), and could be found in later Chinese clockworks such as the clock towers developed by the military engineer Zhang Sixun (fl. late 10th century) and polymath inventor Su Song (10201101).[57][118][178][179][180][181] Yi Xing's escapement allowed for a bell to be rung automatically every hour, and a drum beaten automatically every quarter-hour, essentially a striking clock.[182] Unlike the modern escapement which employs a suspended oscillating pendulum resting and releasing its hooks on a small rotating gear wheel, the early Chinese escapement employed the use of gravity and hydraulics.[183] In Su Song's clock tower, scoop containers fixed to the spokes of a vertical waterwheel (which acted like a gear wheel) would be filled one by one with siphoned water from a clepsydra tank.[184] When the weight of the water in the scoop filled to an excess, it overcame a counterweight that in turn tripped a lever allowing the scoop to rotate on a pivot and drain its water.[184] However, as the scoop fell, it tripped a coupling tongue that temporarily pulled down on a long vertical chain, the latter yanking down on a balancing lever which would pull upward on a small chain connected to a locking arm, the latter lifting momentarily to release the top arrested spoke before coming back down to repeat the entire process over again.[184] It should be pointed out that the Chinese intermittently working liquid-driven escapement had "only the name in common" with the true mechanical escapement of medieval European mechanical clocks of the 14th century onwards, which worked instead with weights, producing continuous but discrete beats and that derived from the Greek and Roman verge mechanism (alarum) device of earlier mechanisms.[185]Exploding cannonballs: The Huolongjing military manual compiled by the Ming dynasty military official Jiao Yu (fl. 14th to early 15th century) and the Ming dynasty military strategist and philosopher Liu Bowen (13111375) in the mid 14th century described the earliest known exploding cannonballs, which were made of cast iron with a hollow core packed with gunpowder. Jiao and Liu wrote that when fired, they could set enemy camps ablaze. The earliest evidence for exploding cannonballs in Europe date from the 16th century.[186][187] The Huolongjing also specified the use of poison and blinding gunpowder filled into exploding shells; the effects of this chemical warfare were described thus: "Enemy soldiers will get their faces and eyes burnt, and the smoke will attack their noses, mouths, and eyes."[188]An illustration of a bronze "thousand ball thunder cannon" from the 14th-century Ming dynasty book Huolongjing. The cannon is an early example of medieval mobile battlefield artillery.[189]The field mill in the Chinese book Yuanxi Qiqi Tushuk Luzui (Collected Diagrams and Explanations of the Wonderful Machines of the Far West), by German Jesuit Johann Schreck and Wang Zheng, 1627The 'divine fire arrow screen' from the Huolongjing. A stationary arrow launcher that carries one hundred fire arrows. It is activated by a trap-like mechanism, possibly of wheellock design. "Angler on a Wintry Lake", painted in 1195 by Song dynasty painter Ma Yuan, featuring the oldest known depiction of a fishing reelChinese flamethrower from the Wujing Zongyao manuscript of 1044, Song dynastyAn illustration of a fragmentation bomb from the 14th century Ming dynasty text Huolongjing. The black dots represent iron pellets.Tiger tally of Western Han periodField mill: In the Yezhongji ('Record of Affairs at the Capital Ye of the Later Zhao Dynasty') written by Lu Hui (fl. 350 AD), various mechanical devices are described which were invented by two Later Zhao (319351) engineers known as Xie Fei, a Palace Officer, and Wei Mengbian, the Director of the Imperial Workshops.[190] One of these is the field mill, which was essentially a cart with millstones placed onto the frame; these were mechanically rotated by the movement of the cart's terrain wheels in order to grind wheat and other cereal crops.[191] A similar vehicle these two invented was the "pounding cart", which had wooden statues mounted on the top which were actually mechanical figures who operated real tilt hammers in order to hull rice; again, the device only functioned when the cart was moved forward and the wheels turned.[191] The field mill lost its use in China sometime after the Later Zhao, but it was invented separately in Europe in 1580 by the Italian military engineer Pompeo Targone.[192] It was featured in a treatise by the Italian engineer and writer Vittorio Zonca in 1607, and then in a Chinese book of 1627 (concerning European technology) that was compiled and translated by the German Jesuit polymath Johann Schreck (15761630) and the Ming dynasty (13681644) Chinese author Wang Zheng (15711644), although by then it was considered by the Chinese to be an original Western contraption.[193]Finery forge: In addition to accidental lumps of low-carbon wrought iron produced by excessive injected air in Chinese cupola furnaces, the ancient Chinese also created wrought iron by using the finery forge at least by the 2nd century BC, the earliest specimens of cast and pig iron fined into wrought iron and steel found at the early Han dynasty (202 BC 220 AD) site at Tieshengguo.[194] Pigott speculates that the finery forge existed in the previous Warring States period (403221 BC), because there are wrought iron items from China dating from that period and there is no documented evidence that the bloomery was ever used in China.[195] The fining process involved liquifying cast iron in a fining hearth and removing carbon from the molten cast iron through oxidation.[194] Wagner writes that, in addition to the Han dynasty hearths, believed to be fining hearths, there is also pictorial evidence of the fining hearth from a Shandong tomb mural dated to the 1st or 2nd century AD, along with a hint of written evidence in a Daoist text from the 4th century AD, Taiping Jing.[196]Fire arrow: One of the earliest weaponized forms of gunpowder was the fire arrow which received its name from the translated Chinese term hujin (), which literally means fire arrow. In China a 'fire arrow' referred to a gunpowder projectile consisting of a bag of incendiary gunpowder attached to the shaft of an arrow from the 9th century onward. Later on solid fuel rockets utilizing gunpowder were used to provide arrows with propulsive force and the term fire arrow became synonymous with rockets in the Chinese language. In other languages such as Sanskrit 'fire arrow' (agni astra) underwent a different semantic shift and became synonymous with 'cannon.'[197] Fire arrows are the predecessors of fire lances, the first firearm.[198]Firecracker: The predecessor of the firecracker was a type of heated bamboo, used as early as 200 BC, that exploded when heated continuously. The Chinese name for firecrackers, baozhu, literally means "exploding bamboo".[199] After the invention of gunpowder, gunpowder firecrackers had a shape that resembled bamboo and produced a similar sound, so the name "exploding bamboo" was retained.[200] In traditional Chinese culture, firecrackers were used to scare off evil spirits.[200]Fire lance: The fire lance was a proto-gun developed in the 10th century with a tube of first bamboo and later on metal that shot a weak gunpowder blast of flame and shrapnel; its earliest representation comes from a painting found at Dunhuang.[201][202][203] The earliest confirmed employment of the fire lance in warfare was by Song dynasty forces against the Jin in 1132 during the siege of De'an (modern Anlu, Hubei Province),[204][205][206] where they were used to great effect against wooden siege towers called "sky bridges": "As the sky bridges became stuck fast, more than ten feet from the walls and unable to get any closer, [the defenders] were ready. From below and above the defensive structures they emerged and attacked with fire lances, striking lances, and hooked sickles, each in turn. The people [i.e., the porters] at the base of the sky bridges were repulsed. Pulling their bamboo ropes, they [the porters] ended up drawing the sky bridge back in an anxious and urgent rush, going about fifty paces before stopping."[207] The surviving porters then tried once again to wheel the sky bridges into place but Song soldiers emerged from the walls in force and made a direct attack on the sky bridge soldiers while defenders on the walls threw bricks and shot arrows in conjunction with trebuchets hurling bombs and rocks. The sky bridges were also set fire to with incendiary bundles of grass and firewood. Li Heng, the Jin commander, decided to lift the siege and Jin forces were driven back with severe casualties.[207]Fireworks: Fireworks first appeared in China during the Song dynasty (9601279), in the early age of gunpowder. The common people in the Song era could purchase simple fireworks from market vendors; these were made of sticks of bamboo packed with gunpowder,[208] although grander displays were known to be held.[209] Rocket propulsion was soon applied to warfare, and by the time of the mid 14th century there were many types of rocket launchers available.[210]Fishing reel: In literary records, the earliest evidence of the fishing reel comes from a 4th-century AD[211][212] work entitled Lives of Famous Immortals.[213] The earliest known depiction of a fishing reel comes from a Southern Song (11271279) painting done in 1195 by Song dynasty painter Ma Yuan (c. 11601225) called "Angler on a Wintry Lake", showing a man sitting on a small sampan boat and casting out his fishing line.[214] Another fishing reel was featured in a painting by the Yuan dynasty painter Wu Zhen (12801354).[214] The book Tianzhu lingqian (Holy Lections from Indian Sources), printed between 1208 and 1224, features two different woodblock print illustrations of fishing reels being used.[214] An Armenian parchment Gospel of the 13th century shows a reel (though not as clearly depicted as the Chinese ones).[214] The Sancai Tuhui, a Chinese encyclopedia published in 1609, features the next known picture of a fishing reel and vividly shows the windlass pulley of the device.[214] These five pictures mentioned are the only ones which feature fishing reels before the year 1651 (when the first English illustration was made); after that year they became commonly depicted in world art.[214]Flamethrower, double piston and gunpowder-activated: Although the single piston flamethrower was first developed in the Byzantine Empire during the 7th century,[215] the 10th-century Chinese flamethrower, or Pen Huo Qi, boasted a continuous stream of flame by employing double piston syringes (which had been known since the Han dynasty) spouting Greek fire which had been imported from China's maritime trade contacts in the Middle East. It was first used in battle 932 during the Five Dynasties and Ten Kingdoms period (907960), and the earliest illustration is found in the early Song dynasty military manuscript Wujing Zongyao of 1044, which also described the device in full.[216][217] Unlike the Greek model which employed a furnace, the Pen Huo Qi was ignited by an incendiary gunpowder fuse.[216]Flare: The earliest recorded use of gunpowder for signalling purposes was the 'signal bomb' used by the Song dynasty Chinese as the Mongol-led Yuan dynasty besieged Yangzhou in 1276.[218] These soft-shelled bombs, timed to explode in mid-air, were used to send messages to a detachment of troops far in the distance. Another mention of the signal bomb appears in a text dating from 1293, requesting their collection from those still stored in Zhejiang.[218] A signal gun appears in Korea by 1600. The Wu I Thu Phu Thung Chih or Illustrated Military Encyclopedia written in 1791 depicts a signal gun in an illustration.[219]Folding screen: The folding screen is a type of furniture consisting of several frames or panels. Screens date from China during the Eastern Zhou dynasty period (771256 BC).[220][221] These were initially one-panel screens in contrast to folding screens.[222] Folding screens were invented during the Han dynasty (206 BC - AD 220).[223] Depictions of those folding screens have been found in Han dynasty era tombs, such as one in Zhucheng, Shandong Province.[220] During the Tang dynasty, folding screens were considered ideal ornaments for many painters to display their paintings and calligraphy on.[221][222] Many artists painted on paper or silk and applied it onto the folding screen.[221] The landscape paintings on folding screens reached its height during the Song dynasty (9601279).[220]Forensic entomology: The Song dynasty (9601279) forensic science book Collected Cases of Injustice Rectified published by the Song dynasty court judge, physician, medical scientist and writer Song Ci in 1247 contains the oldest known case of forensic entomology.[224] In a murder case of 1235, a villager was stabbed to death and authorities determined that his wounds were inflicted by a sickle; this was a tool used for cutting rice at harvest time, a fact which led them to suspect a fellow peasant worker was involved.[224] The local magistrate had the villagers assemble in the town square where they would temporarily relinquish their sickles.[224] Within minutes, a mass of blow flies gathered around one sickle and none other, attracted to the scent of traces of blood unseen by the naked eye.[224] It became apparent to all that the owner of that sickle was the culprit, the latter pleading for mercy as he was detained by authorities.[224]Fragmentation bomb: The use of fragmentation in bombs dates from the 14th century, and first appears in the Ming dynasty text Huolongjing. The fragmentation bombs were filled with iron pellets and pieces of broken porcelain. A heated mixture of salammoniac, tung oil, chin chih, scallion juice, and yin hsiu is poured into the bomb, coating the pellets. Once the bomb explodes, the resulting shrapnel is capable of piercing the skin and blinding enemy soldiers.[225]Free reed aerophone: The musical pipe organ employing metal piston bellows had a long history in the Western world, dating from the Hellenistic period. However, the Western pipe organ did not make use of the reed, which the ancient Chinese mouth organ employed. The latter instrument, called a sheng and made traditionally of bamboo pipes, was first mentioned in the Shi Jing of the Zhou dynasty (c. 1050256 BC). The Chinese sheng is considered the ancestor of the harmonica, harmonium, concertina, accordion, and all other reed organ instruments. A free reed organ was invented in the Arab world in the 13th century, and the German organ builder Heinrich Traxdorf (fl. 15th century) of Nuremberg built one about 1460. It is thought that the classical Chinese sheng travelled west through Russia during the 19th century, as it was described then in Saint Petersburg.[226]Fuse: Documented evidence suggests that the earliest fuses were first used by the Chinese between the 10th and 12th centuries. After the Chinese had invented gunpowder, they began adapting its explosive properties for use in military technology. By 1044 they were using gunpowder in simple grenades, bombs, and flamethrowers, all of which required a fuse to be lit before being thrown at the enemy.[227]Rock carving of a bodhisattva playing a guqin, Northern Wei dynasty (386534 AD)Gas cylinder: The world's first natural gas cylinders were invented in China during the medieval Tang dynasty where the Chinese drilled deep boreholes to retrieve natural gas and used airtight jointed bamboo pipes to collect and transport it for many miles to towns and villages.[228][229][230]Gas lighting: The ancient Chinese during the Spring and Autumn period made the first practical use of natural gas for lighting purposes about 500 B.C. where they used bamboo pipelines to transport and carry both brine and natural gas for many miles to towns and villages.[231][232][233][234][235]Gaussian elimination: The Chinese solved a system of linear equations. The rectangle of coefficients was reduced to triangular and then diagonal form, in a process identical to what Europeans would later call Gaussian Elimination.[236]Go (board game) (pinyin: wiq in Chinese): Although ancient Chinese legend (perhaps contrived during the Han dynasty) has it that the mythological ruler Yao came down to earth from the Heavens about 2200 BC carrying with him a go board and stone player's pieces, it is known from existing literature that the go board game existed since at least the 10th century BC during the Zhou dynasty (c. 1050256 BC) and was even mentioned in writing by ancient Chinese philosophers Confucius (551479 BC) and Mencius (371289 BC), although the latter two had a slightly negative opinion of it.[237][238]Goldfish domestication: In ancient China, various species of carp (collectively known as Asian carps) were domesticated and have been reared as food fish for thousands of years. Some of these normally gray or silver species have a tendency to produce red, orange or yellow color mutations; this was first recorded in the Jin dynasty (266420).[239] During the Tang dynasty (618907), it was popular to raise carp in ornamental ponds and watergardens. A natural genetic mutation produced gold (actually yellowish orange) rather than silver coloration. People began to breed the gold variety instead of the silver variety, keeping them in ponds or other bodies of water.[240][241] Goldfish were introduced into Europe during the 17th century, and into North America in the 19th century.[242][243] A bronze hand cannon from the Yuan dynasty (12711368), one of the oldest in the world; the oldest specimen dates from about 1288, when the first textual reference to the hand cannon appears in Chinese literature. A Sui dynasty (581618 AD) plough figurine pulled by a bullHand cannon: The bronze Yuan dynasty gun from Heilongjiang, which dates from about 1288, is a little over 0.3m (0.98ft) long and weighs 3.6kg (7.9lb). It has a small touch hole for ignition and an even bore except for the bul

Song military as a weapon. The troops would then fill the iron cans with refined oil and threw them toward the enemy troops, causing a fire effectively the world's first "fire bomb" The workshop was one of the world's earliest oil refining factories where thousands of people worked to produce Chinese oil powered weaponry.[329]Oil well: The earliest record of an oil well dates from AD 347, in China.[330] Petroleum was used in ancient China for "lighting, as a lubricant for cart axles and the bearings of water-powered drop hammers, as a source of carbon for inksticks, and as a medical remedy for sores on humans and mange in animals."[331] The earliest depiction of an oil well dates from AD 1762.[331]Paper cup: Paper cups have been documented in imperial China, alongside paper napkins. Paper cups were known as chih pei and were used for the serving of tea.[332] They were constructed in different sizes and colors, and were adorned with decorative designs.[332]Paper lantern: The paper lantern is a lighting device made of paper. Early lanterns in China were constructed with silk, paper, or animal skin with frames made of bamboo or wood.[333] One of the earliest descriptions of paper lanterns is found in records from Khotan, which describe a "mounting lantern" made of white paper.[333]Paper Napkin: Paper napkins, or chih pha, accompanied tea cups and were folded into squares. Textual evidence of paper napkins appears in a description of the possessions of the Yu family, from the city of Hangzhou.[332]Paper packaging: The first use of paper used in packaging was for treated mulberry barks in the early first of second century BC.[334]Pendulum: Han dynasty scientist Zhang Heng created a pendulum in the 1st-century for a seismometer. Its function was to sway and activate one of a series of levers after being disturbed by the tremor of an earthquake.[335]Percussion drilling: Ancient China's principal drilling technique, percussive drilling, was invented during the Han dynasty. The process involved two to six men jumping on a level at rhythmic intervals to raise a heavy iron bit attached to long bamboo cables from a bamboo derrick.[336][337][338] Utilizing cast iron bits and tools constructed of bamboo, the early Chinese were able to use percussion drilling to drill holes to a depth of 3,000ft. The construction of percussion drilling machines took more than two to three generations of workers.[339] The cable tool drilling machines developed by the early Chinese involved raising and dropping a heavy string of drilling tools to crush through rocks into diminutive fragments.[340] In addition, the Chinese also used a cutting head secured to bamboo rods to drill to depths of 915 m.[341] The raising and dropping of the bamboo drill strings allowed the drilling machine to penetrate less dense and unconsolidated rock formations.[340]Petroleum as fuel: The use of petroleum dates from ancient China more than 2,000 years ago. In I Ching, one of the earliest Chinese writings cites the use of oil in its raw state without refining was first discovered, extracted, and used in China in the first century BC. In addition, the Chinese were the first to use petroleum as fuel as the early as the fourth century BC.[326][342][343][344]Pig iron: The earliest pig iron dates from the Zhou dynasty. By the 5th century, archaeological evidence indicates that pig iron was melted to produce cast iron.[70] In Europe, the process was not invented until the late medieval ages.[345]Pinhole camera: The ancient Chinese philosopher Mozi (c. 470 BC c. 391 BC)founder of Mohism during the establishment of the Hundred Schools of Thoughtis the claimed author of the Mojing (perhaps compiled by his disciples) which described the pinhole camera.[346] The Mojing stated that the "collecting place" (pinhole) was an empty hole "like the sun and moon depicted on the imperial flags," where an image could be inverted at an intersecting point which "affects the size of the image."[346] The Mojing seems to be in line with the Epicurean theory of light traveling into the eye (and not vice versa like in Pythagoreanism),[347] since the Mojing states that the reflected light shining forth from an "illuminated person" becomes inverted when passing through the pinhole, i.e. "The bottom part of the man becomes the top part (of the image) and the top part of the man becomes the bottom part (of the image)."[346] In his Book of Optics (1021), Ibn al-Haytham (9651039) wrote of his experimentation with camera obscura, which was followed by Song dynasty polymath Shen Kuo (10311095), the latter who alluded that the Tang dynasty (618907) writer Duan Chengshi (died 863)in his Miscellaneous Morsels from Youyangdescribed inverted images of Chinese pagodas.[348]Playing cards: The first reference to the card game in world history dates from no later than the 9th century, when the Collection of Miscellanea at Duyang, written by Su E (fl. 880), described the Wei clan (family of Princess Tongchang's husband) of the Tang dynasty (AD 618907) enjoying the "leaf game" in 868.[349][350][351] The Yezi Gexi was a book on the card came which was allegedly written by a Tang woman and commented on by Chinese scholars in subsequent dynasties.[352] In his Notes After Retirement, the Song dynasty (9601279) scholar Ouyang Xiu (10071072) asserted that playing card games existed since the mid Tang dynasty and associated this invention with the simultaneous evolution of the common Chinese writing medium from paper rolls to sheets of paper that could be printed.[350][352] During the Ming dynasty (13681644), characters from popular novels such as the Water Margin were widely featured on the faces of playing cards.[352] By the 11th century playing cards could be found throughout the Asian continent.[353] Playing cards were some of the first printed materials in Europe, appearing by the 14th century (i.e. in Spain and Germany in 1377, in Italy and Belgium in 1379, and in France in 1381) and produced by European woodblock printing before the innovation of the early modern printing press by German inventor, printer, publisher and blacksmith Johannes Gutenberg (c. 14001468).[353]Pontoon bridge: The Zhou dynasty Chinese text of the Shi Jing (Book of Odes) records that King Wen of Zhou was the first to create a pontoon bridge in the 11th century BC. However, the British scientist, sinologist and historian Joseph Needham has pointed out that in all likely scenarios, the temporary pontoon bridge was invented during the 9th or 8th century BC in China, as this part was perhaps a later addition to the book (considering how the book had been edited up until the Han dynasty, 202 BC220 AD). Although earlier temporary pontoon bridges had been made in China, the first secure and permanent ones (and linked with iron chains) in China came first during the Qin dynasty (221 BC207 BC). The later Song dynasty (9601279 AD) Chinese statesman Cao Cheng once wrote a description of the early pontoon bridges in China.[354] During the Eastern Han dynasty (25220 AD), the Chinese created a very large pontoon bridge that spanned across the width of the Yellow River. There was also the rebellion of Gongsun Shu in 33 AD, where a large pontoon bridge with fortified posts was constructed across the Yangtze River, eventually broken through with ramming ships by official Han troops under Commander Cen Peng. During the late Eastern Han into the Three Kingdoms period, during the Battle of Chibi in 208 AD, the Prime Minister Cao Cao once linked the majority of his fleet together with iron chains, which proved to be a fatal mistake once he was thwarted with a fire attack by Sun Quan's fleet. The armies of Emperor Taizu of Song had a large pontoon bridge built across the Yangtze River in 974 in order to secure supply lines during the Song dynasty's conquest of the Southern Tang.[355]Porcelain: Although glazed ceramics existed beforehand, the author and historian Samuel Adrian M Adshead writes that the earliest type of vitrified, translucent ceramics that could be classified as true porcelain was not made until the Tang dynasty (618907).[356] The archaeologist Nigel Wood of the University of Oxford states that true porcelain was manufactured in northern China from roughly the beginning of the Tang dynasty in the 7th century, and true porcelain was not manufactured in southern China until about 300 years later, during the early 10th century [this sentence contradicts itself].[357]Pound lock: Indirect evidence suggests that pound locks may have been used in antiquity by the Ptolemaic Greeks and the Romans.[358] In China, although the one gate canal flash lock existed beforehand, the two-gate pound lock was invented in 984 by an official of Huainan and engineer named Qiao Weiyo, during the early Song dynasty (9601279), so that ships could safely travel along canal waterways having gated and segmented chambers where water levels could be regulated.[359][360] The economic and transport benefits of this innovation were described by the polymath official and inventor Shen Kuo (10311095) in his Dream Pool Essays.[359]Puppet theater, waterwheel-powered: The mechanical toys of Roman Egypt, especially the weight-driven puppet theater of Heron of Alexandria (c. 1070 AD), are well known and discussed by historians such as Beck, Prou, and de Rochas d'Aiglun.[361] In China, Zhang Heng (78139) wrote of plays with artificial fish and dragons, and a 6th-century text Xijing Zaji states that when Liu Bang (reigned as Emperor Gaozu of Han from 202 to 195 BC) came upon the treasury of the deceased Qin Shihuang (r. 221210) in 206 BC, he found an entire mechanical orchestra of 1m (3.3ft) tall puppets dressed in silk and playing mouth organs, all powered by pulling ropes and blowing into tubes.[362] As written in the Records of the Three Kingdoms, the engineer Ma Jun (fl. 220265)already associated with the differential gear system of the south-pointing chariotinvented a mechanical theater powered by a rotating wooden waterwheel for the entertainment of Emperor Ming's (r. 226239 AD) court.[362] With the waterwheel in motion, a number of mechanical puppets performed tricks, such as singing girls who played music and danced, other puppets who would beat drums and sound flutes when one puppet entered the scene, puppets dancing on balls, throwing swords, hanging upside down on rope ladders, etc.[362] Other mechanical puppets dressed as government officials did tasks in their offices, puppets dressed as laborers did jobs of pounding and grinding (trip hammer and millstone), while others watched cockfighting, all moving simultaneously.[362] Water-powered puppet theaters in the tradition of Ma Jun were created in later dynasties as well.[363]Raised-relief map (Terrain Model): The raised-relief map may have existed in China since the 3rd century BC, if the accounts in the Records of the Grand Historian (by Sima Qian, 91 BC) about Qin Shi Huang's (r. 221210 BC) tomb prove correct (if it is excavated).[283] It is known that Ma Yuan (14 BC 49 AD) created a raised-relief map in 32 AD made out of rice, a type of map described in detail during the Tang dynasty (618907) by Jiang Fang in his Essay on the Art of Constructing Mountains with Rice (c. 845).[364] Xie Zhuang (421466) of the Liu Song dynasty (420479) created a 0.93m2 (10.0sqft) wooden raised-relief map of the empire (showing mountains and rivers) which could be taken apart and pieced together like a giant jigsaw puzzle. The Song dynasty polymath Shen Kuo also created his own raised-relief map using sawdust, wood, beeswax, and wheat paste.[365][366]Restaurant menu: During the early Song dynasty (9601279), expanding trade and commerce brought money and people to the Song Chinese capital. The first restaurants sprang up and food like dumplings and noodles became available to the masses for a small price. Urban shopkeepers of the merchant middle class often had little time to eat at home, so they ventured out to eat at a variety of establishments such as temples, taverns, tea houses, food stalls, and restaurants which provided business for nearby brothels, singing-girl houses, and drama theaters; this along with traveling foreigners and Chinese who migrated to urban centers from regions with different cooking styles encouraged a demand for a variety of flavors served at urban restaurants, giving rise to the menu.[367][368]Revolving bookcase: Revolving bookcases, known as zhuanluntang, have been documented in ancient China, and its invention is credited to Fu Xi in 544.[369] Descriptions of revolving bookcases have been found in 8th- and 9th-century Chinese texts. Revolving bookcases were popularized in Buddhist monasteries during the Song dynasty under the reign of Emperor Taizu, who ordered the mass printing of the Buddhist Tripiaka scriptures.[369] An illustration of a revolving bookcase is depicted in Li Jie's architectural treatise the Yingzao Fashi.[369]Rockets: The first gunpowder-powered rockets were developed during the Song dynasty and by the 13th century. The Chinese rocket technology was adopted by the Mongols and the invention was spread via the Mongol invasions to the Middle East and Europe in the mid-13th century.[370] Rockets were used by the Song navy in a military exercise in 1245. Combustion rocket propulsion is mentioned in a reference to 1264, recording that the "ground-rat", a type of firework, had frightened the Empress-Mother Gongsheng at a feast held in her honor by her son the Emperor Lizong.[371] Subsequently, rockets are included in the military treatise Huolongjing, also known as the Fire Drake Manual, written by the Chinese artillery officer Jiao Yu in the mid-14th century. This text mentions the first known multistage rocket, the 'fire-dragon issuing from the water' (huo long chu shui), thought to have been used by the Chinese navy.[372]Rocket bombs, aerodynamic wings and explosive payloads: The first known rockets fitted with aerodynamic wings are described as the 'flying crows with magic fire' in the oldest strata of the Huolongjing (early-to-mid 14th century), compiled by Jiao Yu and Liu Bowen during the early Ming dynasty (13681644).[373] The body of the rocket was shaped like a bird (specifically a crow), packed with gunpowder, and made of bamboo laths forming a long basketwork frame that was reinforced with glued paper.[374] A decorative head and tail were attached to the front and back ends, and the wings were nailed to the sides.[374] Under each wing were two slanting rockets to propel the weapon; a main fuse was lit that ignited a fourfold fuse connected to each rocket and running through a drilled hole in the back of the bird.[374] The book then claims that the rocket, after being launched high into the air and aimed at encampments or enemy boats, automatically produced an explosion upon impact that could be seen from considerably long distances.[375]Rocket boosters: An illustration and description in the 14th century Chinese military treatise Huolongjing by the Ming dynasty military writer and philosopher Jiao Yu shows the oldest known multistage rocket with rocket boosters. The Huolongjing describes and illustrates the oldest known multistage rocket.[372][376] It was a two-stage rocket that had carrier or booster rockets that would automatically ignite a number of smaller rocket arrows that were shot out of the front end of the missile, which was shaped like a dragon's head with an open mouth, before eventually burning out.[372] This multi-stage rocket may be considered the ancestor to the modern YingJi-62 ASCM.[372][377] The British scientist, sinologist, and historian Joseph Needham points out that the written material and depicted illustration of this rocket come from the oldest stratum of the Huolongjing, which can be dated roughly to AD 13001350.[372] Solid rocket boosters finds its roots in the Chinese invented fire arrows invented during the medieval Song dynasty more than 1000 years ago, using gunpowder as solid rocket propellants. Gunpowder was packed into a bamboo case cylinder and an opening was created on the cylinders other end. As the gunpowder was ignited, it began to burn rapidly and created large amounts of gas that would rush out to create thrust.[378][379]Rocket launcher: The earliest rocket launchers documented in imperial China launched fire arrows with launchers constructed of wood, basketry, and bamboo tubes.[380] The rocket launchers divided the fire arrows with frames meant to keep the arrows separated, and were capable of firing multiple arrow rockets at once. Textual evidence and illustrations of various early rocket launchers are found in the 11th-century Northern Song dynasty text Wujing Zongyao. The Wujing Zongyao describes the "long serpent" rocket launcher, a rocket launcher constructed of wood and carried with a wheelbarrow, and the "hundred tiger" rocket launcher, a rocket launcher made of wood and capable of firing 320 rocket arrows.[381] The text also describes a portable rocket arrow carrier consisting of a sling and a bamboo tube.[382]Rotary fan, manual and water-powered: For purposes of air conditioning, the Han dynasty craftsman and mechanical engineer Ding Huan (fl. 180 AD) invented a manually operated rotary fan with seven wheels that measured 3m (9.8ft) in diameter; in the 8th century, during the Tang dynasty (618907), the Chinese applied hydraulic power to rotate the fan wheels for air conditioning; the rotary fan became even more common during the Song dynasty (9601279).[383][384] The first rotary fan used in Europe was for mine ventilation during the 16th century, as illustrated by German mineralogist and metallurgist Georg Agricola (14941555).[385]Rudder, stern-mounted and vertical axial: Lawrence V. Mott, who defines a steering oar as a rudder, states the ancient Egyptian use of stern-mounted rudders can be traced back to the 6th dynasty (23502200 BC).[386] Mott states that the method of attachment for rudders in the Arab, Chinese, and European worlds differed from each other, leading him to doubt the spread of the Chinese system of attachment by socket-and-jaws or block and tackle (versus European pintle-and-gudgeon invented by c. 1180 AD).[386][387] In regard to Mott's definition of a steering oar as a rudder, Joseph Needham, Richard Lefebvre des Nottes, K.S.Tom, Chung Chee Kit, S.A.M.Adshead, Paul Johnstone, and Sean McGrail state that a steering oar is not a rudder; the steering oar can interfere with handling of the sails (limiting the potential for long ocean voyages) and it was fit more for small vessels on narrow, rapid-water transport; the rudder did not disturb the handling of the sails, took less of the helmsman's energy to operate, was better fit for larger vessels on ocean travel, and first appeared in China.[77][387][388][389][390] Leo Block writes of the use of the steering oar in the ancient Mediterranean world (specifically in regards to the Phoenicians, 1550300 BC): "A single sail tends to turn a vessel in an upwind or downwind direction, and rudder action is required to steer a straight course. A steering oar was used at this time because the rudder had not yet been invented. With a single sail, a frequent movement of the steering oar was required to steer a straight course; this slowed down the vessel because a steering oar (or rudder) course correction acts like a break."[391] The oldest depicted rudders at the back of a ship, without the use of oars or a steering oar, comes from several ceramic models of Chinese ships made during both the Western and Eastern eras of the Han dynasty (202 BC 220 AD).[77][392][393][394] According to the scholars Zhang Zunyan and Vassilios Christides, there is literary evidence to suggest that the axial stern rudder existed in China since the 1st century BC;[395] Gang Deng asserts the first reference was made in the Huainanzi of the 2nd century BC,[394] and K. S. Tom says that the first clear reference is from the 5th century AD.[77] However, K.S.Tom points to the fact that all Chinese pottery models of ships before this Guangzhou tomb model show steering oars instead of a rudder, which he states is strong evidence for the rudder's invention only by the 1st century AD.[396] Jacques Gernet states that, although the Chinese had invented the rudder in the 1st century AD, it was not completely fixed to the sternpost of Chinese ships until the end of the 4th century.[397] The bulkhead ship design of the junk, which appeared roughly the same time as the rudder, provided the essential vertical components for the hinged axial rudder.[398] Deng points out that an Eastern Han (25220) model distinctly shows a rudder in its own, separate cabin, suggesting that helmsmanship had already become an established profession.[394] Tom and Deng state that, after the invention of the balanced rudder pivoted on an axis, the Chinese then innovated the fenestrated rudder by the Song dynasty (9601279), with deliberate puncturing and boring out of holes in shapes such as diamonds, which, according to Tom, made the rudder "easier to steer, reduced turbulence drag, did not affect efficiency and was hydrodynamically sound."[394][399]A replica of Zhang Heng's (78139 AD) seismometer that employed a pendulum sensitive to inertia of ground tremors; while placed in Luoyang in 133, it detected an earthquake 400 to 500km (250 to 310mi) away in GansuA depiction demonstrating the use of the Chinese stinkpot shown in the Trait sur les feux d'artifice pour le spectacle et pour la guerre by French pyrotechnician Jean-Charles Perrinet d'Orval, 1745A sancai-glazed horse statue from the Tang dynasty (618907) showing a rider's stirrup connected to the saddleThe Luding Bridge in Sichuan, an iron-chain suspension bridgeA Chinese Song dynasty naval tower ship with a Xuanfeng traction trebuchet catapult, taken from the Wujing Zongyao, 1044 ADHydraulic-powered trip hammers, from a Ming dynasty encyclopedia published in 1637 by Song Yingxing (15871666)An ornate bronze bell belonging to Duke Mu of Qin (d. 621 BC) from the Spring and Autumn period (722481 BC)Salt well: The Chinese have been using brine wells and a form of salt solution mining as part of their civilization for more than 2000 years.[89] The first recorded salt well in China was dug in the Sichuan province about 2,250 years ago. This was the first time that ancient water well technology was applied successfully for the exploitation of salt, and marked the beginning of Sichuan's salt drilling industry.[400] Shaft wells were sunk as early as 220 BC in the Sichuan and Yunnan provinces.[89] By 1035 AD, Chinese in the Sichuan area were using percussion drilling to recover deep brines, a technique that would not be introduced to Europe and the Western World for another 600 to 800 years. Medieval and modern European travelers to China between 1400 and 1700 AD reported salt and natural gas production from dense networks of brine wells.[89] Archaeological evidence of Song dynasty salt drilling tools used are kept and displayed in the Zigong Salt Industry Museum.[401] Many of the wells were sunk deeper than 450 m and at least one well was more than 1000 meters deep. The medieval Venetian traveler to China Marco Polo reported an annual production in a single province of more than 30,000 tonnes of brine during his time there.[89] According to Salt: A World History, a Qing dynasty well, also in Zigong, "continued down to 3,300 feet [1,000m] making it at the time the deepest drilled well in the world."[402]Seismometer: The Chinese polymath and inventor Zhang Heng (78139) of the Han dynasty (202 BC 220 AD) invented the first seismometer in 132, a large metal urn-shaped instrument which employed either a suspended pendulum or inverted pendulum acting on inertia (i.e. ground tremors from earthquakes) to dislodge a metal ball by a lever trip device; this ball would fall out of dragon-shaped metal mouth into the corresponding metal toad mouth indicating the exact cardinal direction of where a distant earthquake had occurred in order for the state to send swift aid and relief to the affected regions; several subsequent recreations of his device were employed by Chinese states up until the Tang dynasty (618907), when use of the device fell into obscurity, a fact noted by the writer Zhou Mi about 1290, during the Yuan dynasty (12711368).[399][403][404][405][406][407][408][409]Sky lantern: The Chinese military strategist, politician, writer, and inventor Zhuge Liang of the Three Kingdoms era is credited with its invention, and reportedly used it during military campaigns. According to the British scientist, historian, and sinologist Joseph Needham, sky lanterns have been used in China since the 3rd century BC.[410] In 1783, the French entrepreneurs and inventors Joseph-Michel and Jacques-Etienne Montgolfier took part in the first modern manned hot air balloon flight.[411]Snow gauge: The first use of snow gauges were precipitation gauges that was widely used in 1247 during the Southern Song dynasty to gather meteorological data. The Song Chinese mathematician and inventor Qin Jiushao records the use of gathering rain and snowfall measurements in the Song mathematical treatise Mathematical Treatise in Nine Sections. The book discusses the use of large conical or barrel-shaped snow gauges made from bamboo situated in mountain passes and uplands which are speculated to be first referenced to snow measurement.[267][412]Solid-propellant rocket: The medieval Song dynasty Chinese invented the solid-propellant rocket at a time when bows, arrows, and catapult-based projectile launchers were state of the art military technology in medieval Europe.[413] Illustrations and descriptions in the 14th century Chinese military treatise Huolongjing by the Ming dynasty military writer and philosopher Jiao Yu confirm that the Chinese in 1232 used proto-solid propellant rockets then known as "fire arrows" to drive back the Mongols during the Siege of Kaifeng.[414][415] Each arrow took a primitive form of a simple, solid-propellant rocket tube that was filled gunpowder. One open end allowed the gas to escape and was attached to a long stick that acted as a guidance system for flight direction control.[414][415]South-pointing chariot: Although the claim of Wei dynasty mechanical engineer and statesman Ma Jun (fl. 220265) that the south-pointing chariot was first invented by the mythological Yellow Emperor are dubious, his south-pointing chariot was successfully designed and tested in 255 AD with many later models recreated in subsequent dynasties; this device was a wheeled vehicle with differential gears that ensured a mounted wooden figurine would always point in the southern direction no matter how the vehicle turned, in essence a non-magnetic compass.[416][417][418] The Book of Song written in the 6th century states that the device was successfully reinvented by the mathematician and astronomer Zu Chongzhi (429500) during the Liu Song dynasty (420479).[419] The Japanese historical text Nihon Shoki, compiled by 720, states that the device was crafted and presented as a gift to Emperor Tenji (661672) on two different occasions (658 and 666) by the Tang dynasty (618907) Chinese Buddhist monks Zhi Yu and Zhi You.[420] The wheeled vehicle device was described in intricate detail in the historical text covering the Song dynasty (9601279), i.e. the Song Shi (compiled 1345); for example, it revealed the number of gear teeth on each mechanical gear wheel, the diameter of each gear wheel, and how these gear wheels were properly positioned.[421]Soybean oil: Chinese records from before 2000 BC mention the use of cultivated soybeans to produce edible soy oil.[422] Ancient Chinese literature reveals that soybeans were extensively cultivated and highly valued as a use for the soybean oil production process before written records were kept.[423]Soy sauce: Soy sauce in its current form was created about 2,200 years ago during the Western Han dynasty and was soon spread throughout East and Southeast Asia where it is used in cooking and as a condiment.[424][425][426][427] The condiment considered almost as old as soy paste a type of fermented paste (Jiang,) obtained from soybeans which had appeared during the Western Han dynasty and was listed in the bamboo slips found in the archaeological site Mawangdui.[425][426]Steel made from cast iron through oxygenation: The earliest known production of steel is a piece of ironware excavated from an archaeological site in Anatolia (Kaman-Kalehoyuk) and is about 4,000 years old.[428] Other ancient steel comes from East Africa, dating from 1400 BC.[429] In the 4th century BC steel weapons like the Falcata were produced in the Iberian Peninsula, and Noric steel was used by the Roman military.[430] The Chinese, who had been producing cast iron from the late Spring and Autumn period (722481 BC), produced steel by the 2nd century BC through a process of decarburization, i.e. using bellows to pump large amounts of oxygen on to molten cast iron.[194][431] This was first described in the Han dynasty (202 BC 220 AD) book Huainanzi, compiled by scholars under Prince Liu An (179122 BC). For steel, they used both quenching (i.e. rapid cooling) and tempering (i.e. slow cooling) methods of heat treatment. Much later, the American inventor William Kelly (18111888) brought four Chinese metallurgists to Eddyville, Kentucky in 1845, whose expertise in steelmaking influenced his ideas about air injection to reduce carbon content of iron; his invention anticipated the Bessemer process of English inventor Henry Bessemer (18131898).[432]Stinkpot: The stinkpot was an earthenware incendiary weapon, part of which was filled with sulphur, gunpowder, nails, and shot, while the other part was filled with noxious materials designed to emanate a highly unpleasant and suffocating smell when ignited.[433] The weapon was used in the 19th century during the Qing dynasty, where the British Admiral Sir William Robert Kennedy recorded the use of the stinkpot in 1856 during the Second Opium War in his book Hurrah for the Life of a Sailor Fifty Years in the Royal Navy. These incendiary weapons were wrapped in calico bags and were then hoisted in a basket to the truck of the mast.[434] When an enemy ship was alongside, one of the crew members would climb up the mast and primed the stinkpots with lighted joss sticks.[434] The stinkpots were then launched onto the enemy deck by cutting the rope by which the basket had been hoisted.[435] The ensuing noise, flying debris, and pungent smell it would create, would cause the enemy crew sufficient confusion and blow them into disarray.[433]Stir frying: Stir frying is a Chinese cooking technique used for preparing food in a wok. It originates from the Han dynasty, but did not fully develop until the Song dynasty.[436] Although there are no surviving records of Han dynasty stir frying, archaeological evidence of woks and the tendency to slice food thinly indicate that the technique was likely used for cooking.[437] It was not until the Ming dynasty that stir frying was popularized as primary cooking method of Chinese cuisine.[438] Stir frying was brought to America by early Chinese immigrants, and has been used for non-Asian cuisines.[439]Suspension bridge using iron chains: Although there is evidence that many early cultures had suspension bridges with cabled ropes, the first written evidence of iron-chain suspension bridges comes from a local history and topography of Yunnan written in the 15th century, which describes the repair of an iron-chain bridge during the reign of the Yongle Emperor (r. 14021424); although Ming dynasty (13681644) Chinese claims that iron-chain suspension bridges had existed since the Han dynasty are questionable, their existence in the 15th century is the earliest known anywhere.[440] K.S.Tom mentions this same repaired Ming suspension bridge described by Needham, and adds that recent research has revealed a document that lists the names of those said to have built an iron chain suspension bridge in Yunnan about AD 600.[441]Tangram: The tangram is a dissection puzzle consisting of seven flat shapes, which are put together to form shapes. The objective of the puzzle is to form a specific shape using all seven pieces, which may not overlap. The game is reputed to have been invented in China during the Song dynasty,[442] and was popularized in Europe and United States during the 19th century.[443] The word tangram is likely derived from two words, the Chinese word tang, referring to the medieval Chinese Tang dynasty, and the Greek word gramma, a synonym of "graph".[444]Tea: The tea plant is indigenous to western Yunnan;[445] it is thought that by the mid 2nd millennium BC, tea was consumed in Yunnan for medicinal purposes,[446] but the earliest physical evidence (discovered in 2016) comes from the tomb of Emperor Jing of Han, dated to the 2nd century BC.[447] Tea drinking was already an established custom in the daily life in this area as shown by the Contract with a Slave, written by Wang Bao in 59 BC,[448] the first source to mention boiling of tea.[449] This written record also reveals that tea was processed and used as a drink instead of a medicinal herb, emerged no later than the 1st century BC.[450] Early Chinese tea culture began from the time of Han dynasty (202 BC 220 AD) to the Northern and Southern dynasties (420589) when tea was widely used by Chinese gentry, but only took its initial shape during the Tang dynasty (618907).[451]Teapot: The teapot was invented during the Yuan dynasty, tea preparation in previous dynasties did not utilize a teapot.[452] In the Tang dynasty, a cauldron was used to boil ground tea, which was served in bowls. Song dynasty tea was made by pouring water boiled using a kettle into a bowl with finely ground tea leaves. A brush was then used to stir the tea. The innovation of the teapot, a vessel that steeps tea leaves in boiling water, occurs during the late Yuan dynasty. Written evidence of a teapot appears in the Yuan dynasty text, Jiyuan Conghua, which describes a teapot that the author, Cai Shizhan, bought from the scholar Sun Daoming. By the Ming dynasty, teapots were widespread in China.[452]Thyroid hormones to treat goiters: In 239 BC, Master Lu's Spring and Autumn Annals stated that where water is too light, people suffer widespread baldness and goiter.[453] It was not until the 1860 that French physician Gaspard Adolphe Chatin (18131901) linked goiter with the lack of iodine in soil and water; iodine was discovered in the thyroid gland in 1896 by German chemist Eugen Baumann, and thyroid extract was used to treat patients in 1890. The Tang dynasty (618907) physician Zhen Quan (d. 643 AD), in his Old and New Tried and Tested Prescriptions, stated that the thyroid glands taken from gelded rams were used to treat patients with goiter; the thyroid hormones could be swallowed in pill form (the body of the pill made from crushed jujube pulp) or as a solid thyroid gland with the fat taken off.[453] The Pharmacopoeia of the Heavenly Husbandman asserted that iodine-rich sargassum was used to treat goiter by the 1st century BC (Ge Hong, 284364, also suggested using a tincture derived from sargassum seaweed in about 340 AD),[454] a treatment later recorded in the Western World by Italian practrica Roger of Palermo in his Practica Chirurgiae of 1180 AD.Tofu: Although both popular tradition and Song dynasty philosophers like Zhu Xi (11301200 AD) credit the invention of tofualong with soymilk to Liu An (179122 BC), a Han dynasty King of Huainan, no mention of tofu is found in the extant Huainanzi (compiled under Liu An).[455][456][457] The earliest known mention of tofu was made in Records of the Extraordinary (Qingyi lu), which reported that tofu was sold at Qingyang (Anhui).[458] The earliest explanation of how to make tofu is found in the Bencao Gangmu, written by the Ming dynasty polymath Li Shizhen (15181593).[457] According to Liu Keshun (1999), Liu An's process for making tofu was essentially the same as today.[459]Toilet paper: Toilet paper was first mentioned by the Sui Chinese politician and artist Yan Zhitui (531591) in the year 589 during the Sui dynasty, with full evidence of continual use in subsequent dynasties.[460][461] By the mid 14th century during the Yuan dynasty (12711368), it was written that ten million packages of 1,000 to 10,000 sheets of toilet paper were manufactured annually in Zhejiang province alone.[460]Traction trebuchet: The earliest type of trebuchet catapult was the traction trebuchet, developed first in China by the 5th or 4th century BC, the beginning of the Warring States period (403221 BC); to operate the trebuchet, a team of men pulled on ropes attached to the butt of the shorter segment of a long wooden beam separated by a rotating axle fixed to a base framework, allowing the longer segment of the beam to lunge forward and use its sling to hurl a missile; by the 9th century a hybrid of the traction and counterweight trebuchet, employing manpower and a pivoting weight, was used in the Middle East, Mediterranean Basin, and Northern Europe; by the 12th century, the full-fledged counterweight trebuchet was developed under the Ayyubid dynasty of Islamic Syria and Egypt (described by Mardi bin Ali al-Tarsusi) and used in the Third Crusade; by the 13th century, the counterweight trebuchet found its way into Song dynasty (9601279) China via the Mongol invaders under Kublai Khan (r. 12601294) who used it in the Siege of Xiangyang (12671273).[462][463][464]Trip hammer: The ancient Chinese used pestle and mortar to pound and decorticate grain, which was superseded by the treadle-operated tilt hammer (employing a simple lever and fulcrum) perhaps during the Zhou dynasty (1122256 BC) but first described in a Han dynasty (202 BC 220 AD) dictionary of 40 BC and soon after by the Han dynasty philosopher and writer Yang Xiong (53 BC 18 AD) in his Fangyan dictionary written in 15 BC; the next stage in this evolution of grain-pounding devices was to apply hydraulic power, which the Han dynasty philosopher and writer Huan Tan (43 BC 28 AD) mentioned in his Xinlun of 20 AD, although he also described trip hammers powered by the labor of horses, oxen, donkeys, and mules.[465] After Huan Tan's book was written, numerous references to trip hammers powered by waterwheels were made in subsequent Chinese dynasties and in medieval Europe by the 12th century.[466] However, trip hammers were also attested by both literary (Pliny, Natural History 18.97) and archaeological evidence in fairly widespread use in the Roman Empire by the 1st century AD.[467][468]Tuned bells: The earliest complete set of tuned bells, sixteen in all, were found in Tomb 8 of Marquis Su of Jin at Qucun, southern Shanxi.[469] The tomb has been dated by AMS radiocarbon techniques to 815786 BC, during the period of the Zhou dynasty.[470] Of the sixty-four bronze bells found in the tomb of Marquis Yi of Zeng interred by 433 BC, forty-seven of them produce two notes with minor third intervals and sixteen produce two notes with major third intervals.Tung oil: The tung oil tree originates in southern China and was cultivated there for tung oil, but the date of cultivation remains unknown.[471] During the Song dynasty, tung oil was used for waterproofing on ships.[472] Tung oil is etymologically derived from the Chinese tongyou.[473] The earliest references for Chinese use of tung oil is in the writings of Confucius around 500 to 400 BC[474][475][476][477] The Chinese have used tung oil, also known as China wood oil, for at least 2500 years for building waterproof boats and paper parasols, wood finishing, wood waterproofing, caulking, inks and paints.[478]Chinese rotary fan winnowing machine, from an encyclopedia published in 1637 by Song YingxingThe one-wheeled Chinese wheelbarrow, from the Song dynasty painter Zhang Zeduan's (10851145) painting Along the River During Qingming Festival, Song dynasty.Well drilling: The earliest record of well-drilling dates from AD 347, in China.[479] Petroleum was used in ancient China for "lighting, as a lubricant for cart axles and the bearings of water-powered drop hammers, as a source of carbon for inksticks, and as a medical remedy for sores on humans and mange in animals."[480] In ancient China, deep well drilling machines were in the forefront of brine well production by the 1st century BC. The ancient Chinese developed advanced sinking wells and were the first civilization to use a well-drilling machine and to use bamboo well casings to keep the holes open.[400][481][482][483]Well-field system: The well-field system was a Chinese land-distribution method used from the ninth century BC (late Western Zhou dynasty) to about the end of the Warring States period. Its name comes from Chinese character (jng), which means 'well' and looks like the # symbol; this character represents the theoretical appearance of land division: a square area of land was divided into nine identically sized sections; the eight outer sections (; stin) were privately cultivated by serfs and the center section (; gngtin) was communally cultivated on behalf of the landowning aristocrat.[484]Wheat gluten: The earliest description of wheat gluten comes from 6th century China.[485] It was widely consumed by the Chinese as a substitute for meat, especially among adherents of Buddhism.[486] The oldest reference to wheat gluten appears in the Qimin Yaoshu, a Chinese agricultural encyclopedia written by Jia Sixie in 535. The encyclopedia mentions noodles prepared from wheat gluten called bo duo. Wheat gluten was known as mian jin by the Song dynasty (9601279).[485]Wheelbarrow: The earliest wheelbarrows with archaeological evidence in the form of a one-wheel cart come from 2nd century Han dynasty Emperor Hui's tomb murals and brick tomb reliefs.[487] The painted tomb mural of a man pushing a wheelbarrow was found in a tomb at Chengdu, Sichuan province, dated precisely to AD 118.[488] The stone carved relief of a man pushing a wheelbarrow was found in the tomb of Shen Fujun in Sichuan province, dated about AD 150.[489] And then there is the story of the pious Dong Yuan pushing his father around in a single-wheel lu che barrow, depicted in a mural of the Wu Liang tomb-shrine of Shandong (dated to AD 147).[490] However, there are even earlier accounts than this that date from the 1st century BC and the 1st century AD. The 5th century Book of Later Han stated that the wife of the once poor and youthful imperial censor Bao Xuan helped him push a lu che back to his village during their feeble wedding ceremony, about 30 BC.[488] Later, during the Red Eyebrows Rebellion (about AD 20) against Xin dynasty's Wang Mang (45 BC AD 23), the official Zhao Xi saved his wife from danger by disguising himself and pushing her along in his lu che barrow, past a group of brigand rebels who questioned him, and allowed him to pass after he convinced them that his wife was terribly ill.[488] The first recorded description of a wheelbarrow appears in Liu Xiang's work Lives of Famous Immortals. Liu describes the invention of the wheelbarrow by the legendary Chinese mythological figure Ko Yu, who builds a "Wooden ox".[82]Winnowing machine, Rotary fan: Contemporary to the rotary air conditioning fan invented by Han dynasty mechanical engineer Ding Huan (fl. 180 AD) is a pottery tomb model of a crank-operated rotary winnowing fan from the Han dynasty, used for separating chaff from grain.[491][492] The winnowing fan was first described by the Tang dynasty writer and linguist Yan Shigu (581645), in his commentary on the Jijiupian dictionary written earlier in 40 BC by Shi Yu; it was also mentioned in a poem by the Song dynasty artist Mei Yaochen in about 1060.[493] The earliest known drawn illustration of the winnowing fan comes from the Book of Agriculture published in 1313 by Yuan dynasty inventor and politician Wang Zhen (fl. 12901333).[494]Wrapping paper and paper envelope: The use of wrapping paper is first documented in ancient China, where paper was invented in the 2nd century BC.[495] In the Southern Song dynasty, monetary gifts were wrapped with paper, forming an envelope known as a chih pao. The wrapped gifts were distributed by the Chinese court to government officials.[496] In the Chinese text Thien Kung Khai Wu, Sung Ying-Hsing states that the coarsest wrapping paper is manufactured with rice straws and bambo

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