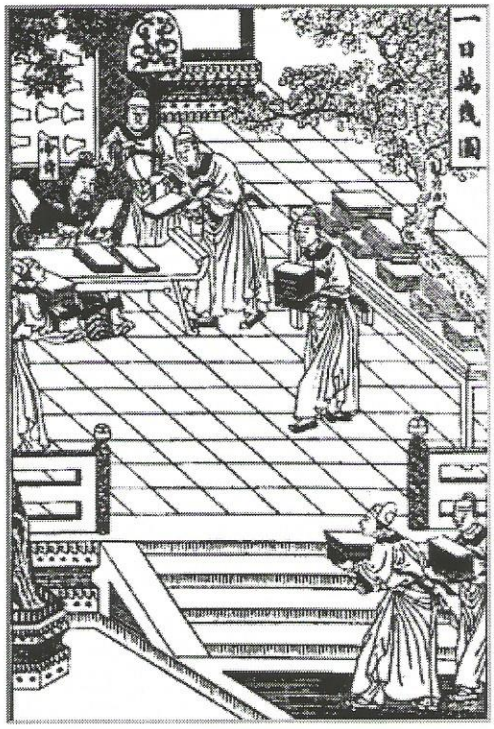

A 19th century depiction of the legendary emperor Shun who is going laboriously through files brought to him by assiduous secretaries.

The second great invention, which goes closely hand in hand with paper, was printing. Before printing was invented, knowledge could only be passed on my word of mouth, or by extremely expensive handwritten manuscripts. Not only was it expensive, but it was slow, and there was no guarantee each copy would be the same. As early as 2000 years ago, in the Western Han Dynasty (206BC-25AD) a form of printing had been developed. This was stone-tablet rubbing, very similar to brass rubbing in principle. It was used to spread Confucian knowledge and Buddhist sutras. Building on this idea, in the Sui Dynasty (581-618AD) there developed the practice of carving text on a wooden board, which was then covered in ink, and then it was printed page by page onto sheets of paper. This became known as block printing, and was very similar in concept to the Chinese seal. This technology produced the first ever book with a verifiable printing date in 868. It was a Buddhist sutra. This was nearly 600 years ahead of the first printed book in Europe.

During the Tang Dynasty (618-907) the technique spread across Asia, through Philippines, Vietnam, Korea and Japan.. But although it was a great advance, this block printing technology had a serious drawback. One mistake could ruin the entire block, and once used the block became useless, because it was unique. In the Song Dynasty (960-1279) a man called Bi Sheng had the idea of carving individual characters on small, identical square pieces of clay, which was hardened by slow baking. In this way the world's first ever movable type arrived. Once the printing was finished, the individual pieces were put away for future use. This new technology spread to Korea, then Japan and Vietnam, and later Europe. The next significant development of printing actually came in Europe, when Johann Gutenberg developed the movable type further by making the individual characters of metal. And so printing technology remained until the advent of the computer era.

Gunpowder

The third great Chinese invention is gunpowder. Everything from Guy Fawke's night fireworks to modern artillery shells owe their origin to this. Ancient necromancers searching for the elixir of everlasting life on behalf of the Emperor, discovered that mixtures of certain fuels and ores could, if mixed in the right proportions and heated, produce an explosion. This led in time to the discovery of gunpowder. In 1044 Zeng Gongliang wrote "The Collection of the Most Important Military Techniques", and in this text he recorded three formulae for gunpowder. Each was based on saltpetre (potassium nitrate), sulphur and charcoal. Joseph Needham identified these as the earliest formulae for what we now know as gunpowder. The formula for gunpowder reached the Arab world in the 12th Century and Europe in the 14th century. Common folklore states that gunpowder was first used for entertainment only, with fireworks, but the military potential was soon exploited. Indeed the earliest known illustration of a cannon dating from around 1127 was found in China, the time of the changeover from the Northern Song Dynasty to the Southern Song Dynasty. This was 150 years earlier than the cannon was developed in the west. The Song people also used gunpowder to make fire lances, or flamethrowers, and anti-personnel mines (for which we might be less grateful!). By the end of the Song Dynasty the Chinese had invented multi-stage rockets. In a way this could be seen as the idea behind the rocket, which put a man on the moon. Joseph Needham also suggests that the idea of an explosion in a self contained cylinder inspired in time the internal combustion engine.

So how did gunpowder move from East to West? Although the Song Dynasty was not particularly strong, its invention of gunpowder enabled the Chinese to repel the Mongols for decades. But eventually the Mongols were able to capture Chinese gunpowder makers and turn gunpowder back on the Chinese. The Chinese experts were employed in the Mongol army, and as the Mongols expanded their empire gunpowder went with them.

Compass

The fourth of the Great Inventions is the magnetic compass. Whilst mining for ores and producing copper and iron by smelting, the Chinese came upon a natural mineral, magnetite, which attracted iron, and also always pointed north if suspended. With development the round compass came into being.

The compass was probably invented in the Qin Dynasty (221-206BC) by Chinese fortune-tellers who used the lodestones to construct their fortune telling boards. But they eventually realised that the loadstones always pointed towards the north, and the compass really came into being. The first mention of the compass was in a book entitled "Dream Pool Essays" dated 1086 by Shen Kuo, in the Song Dynasty. This was a century earlier than the compass was