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CHINESE METALLURGY. A HISTORICAL NOTE

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RESUMEN

Los chinos idearon y moldearon un gran número de campanas hechas de bronce, algunas de las cuales eran de enorme tamaño. Produjeron zinc y realizaron aleaciones de níquel siglos antes que los europeos.

PALABRAS CLAVE: China, metalurgia histórica, cobre, estaño, zinc, níquel.

ABSTRACT

The Chinese invented and cast an enormous number of bells made of bronze, some of them were huge. They produced metallic zinc and nickel alloys centuries before the Europeans.

KEY WORDS: China, historical metallurgy, copper, tin, zinc, nickel.

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INTRODUCTION

The ancient Chinese civilization was so well established that the last rulers of the Manchu Dynasty were so convinced of the superiority of the Chinese way of life. They refused to acquire anything more than the most superficial knowledge about the West. Imperial regulations even prohibited Chinese from travelling abroad and teaching their language to foreigners. They were unaware that social and technological revolution in Europe was producing traders and missionaries prepared to probe and settle the far corners of the world.

The Chinese are known of their discovery of silk, paper, and gunpowder. They developped magnificent porcelain because of the high quality clay deposits found in Kaolying, a locality near Beijing from which the mineral kaolin was derived. They also played an important role in developing mining and metallurgy. They used coal, zinc, and nickel before the Europeans. They cast large vessels from bronze. The trade routes were responsible for transmitting knowledge between China and the West. About 110 BC a Chinese explorer was sent by a Han ruler to report on Central Asia population. When the expedition returned, the emperor decided to establish relations with these countries. Since that time the so-called Silk Road was established as a caravan route through Afghanistan's mountains, bearing treasures from East to West, taking back other commodities in return. It started from Xian the ancient Chinese capital and ended at Antioch in Asia Minor and Tire (Lebanon) on the Mediterranean, crossing the Pair mountains and passing by famous places like Samarkand, Merv (Turkemanstan), Damghan, Ctesiphon (near present day Baghdad), and Palmyre. In addition, links were established with the Indus Valley civilization. The splendour of the Chinese court was noted by Marco Polo in the 13th century.

ANCIENT CHINESE UNIT OPERATIONS

The ancient Chinese utilized the lever principle for crushing ores (Fig. 1) and the water wheel to operate special bellows for blasting air in a furnace (Fig. 2).

COPPER

Bronze was used primarily for casting ceremonial temple vessels used in sacrifices to the gods of

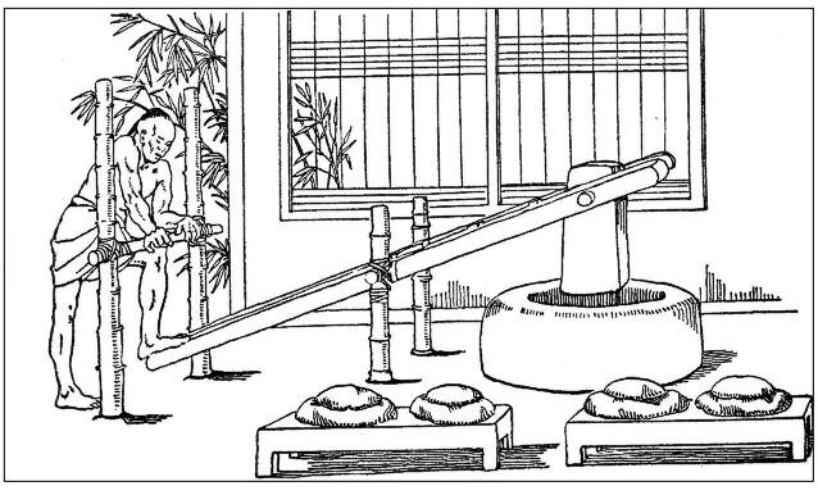

Figure 1. Crushing ores in ancient China using the principle of lever.

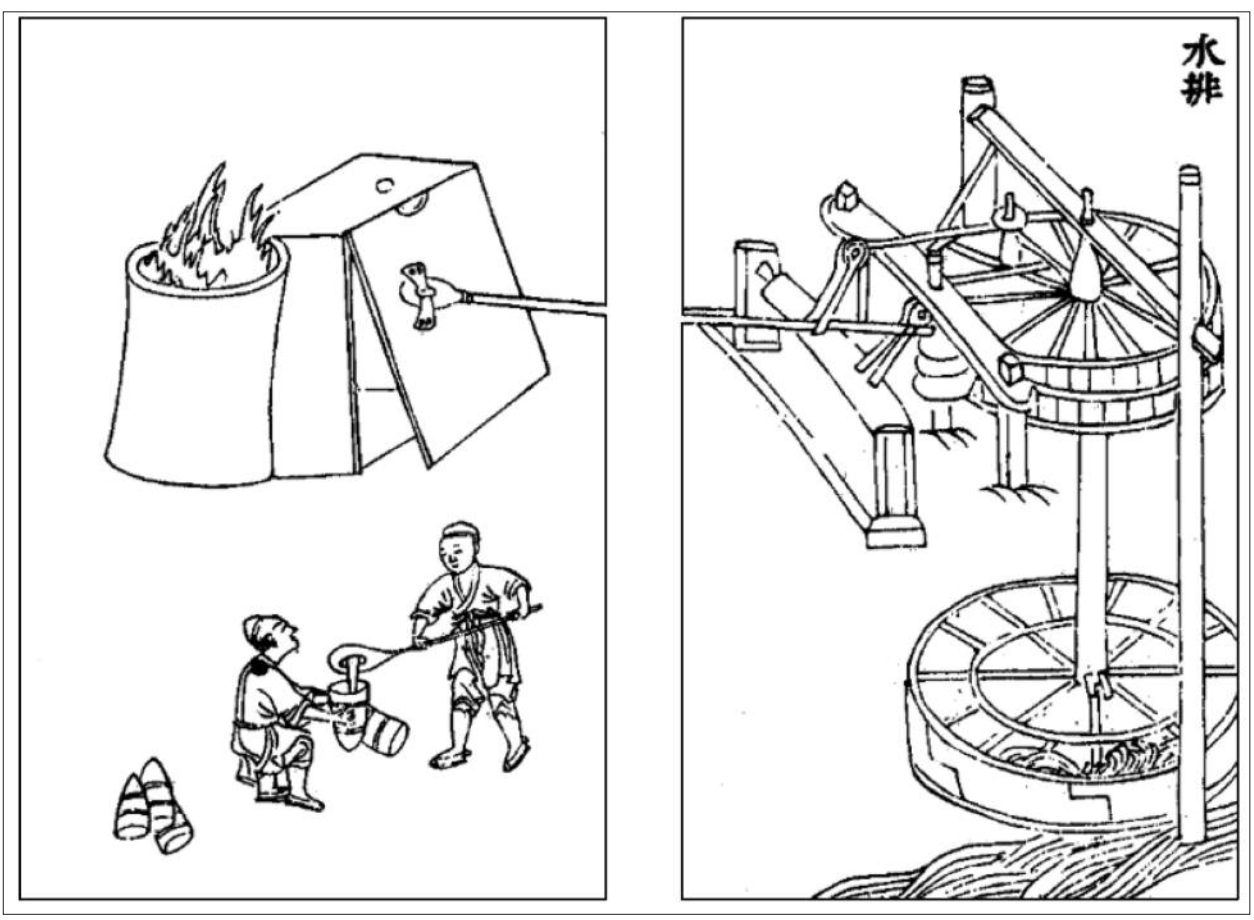

Figure 2. Water wheel was used to operate special bellows for blasting air in a furnace.

heaven, earth, the mountains, and rivers (Fig. 3). Typical analysis of the alloy is 80% copper, 15% tin, and 2% lead. It is most probable that bronze was made some considerable time before tin as an individual metal was isolated. It is also probable that tin ore was mixed with copper ore to give bronze. It needs not necessarily have been recognized at first that the tin ore was essentially different from the copper ore - all the knowledge required being a realization that an ore from a certain place, when added to copper ore, produced an improved form of copper.

Figure 3. Typical ancient Chinese bronze vessels.

Bronze objects were used in vessels for banquets, ceremonies, and noble funerals. Since bronze is a durable material resistant to cracks and breakage, it was used by kings to cast inscribed vessels honouring the ancestors who made great contributions to their nation or sovereign, serving as a reminder to later generations. The museums in Beijing, Shanghai, Wuhan, and other large cities are full of bronze vessels, bells, and statues. Some of these vessels are documented in a series of Chinese postage stamps (Fig. 4).

Bells are a Chinese invention. The Bell Museum was set up in the Great Bell Temple located on the western outskirts of Beijing, displays about 700 bells made of bronze, iron, and jade some dating from 1100 BC (Fig. 5). The museum illustrates the history of Chinese metal casting. The largest bell was cast on orders of a Ming Emperor who took power in 1403 after a coup. After feeling guilt of his misdeeds he hoped to divert public indignation by casting the bell. The bronze bell weighs 46.5 tonnes and its sound can be heard 50 kilometres

Figure 4. A collection of Chinese stamps depicting ancient bronze vessels.

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away. The bell was originally kept in the Imperial Longevity Temple. Shipping the bell from the foundry to the temple was a problem, since there was no vehicle that could handle it. A ditch was dug along the way, filled with water to make an ice route in winter. The bell was then placed on a huge sleigh and was hauled to its destination by oxen. In 1733 it was moved to the present site.

WHITE COPPER FROM CHINA

Centuries before the discovery of nickel by Axel Fredrik Cronstedt (1722-1765) in 1750s, nickel-containing alloys were in use by the Chinese. They had been making "pai thung" or "white copper" (40% Cu, 32% Ni, 25% Zn, and 3% Fe) which resembled silver in appearance and was used as currency (Fig. 6). This material appeared in Europe in small quantities in the late 1700s. A modified composition of the alloy was made in 1821 by the German medical doctor Ernest August Geitner (1783-1852). His alloy contained 55% Cu, 20% Ni, and 25% Zn which he called *Argentian* or *Neusilber*. By the 1830s, this alloy became known as *German Silver* and were produced commercially in both Germany and England in significant amounts. In addition to its silver color, this alloy was easy to cast and fabricate, was resistant to tarnishing, and was

Figure 5. Bell Museum, Beijing.

economical to produce. Since it cost only one quarter the price of silver, the alloy had obvious commercial potential as a silver substitute.

Figure 6. Chinese pai thung or white copper an alloy of copper, nickel, and zinc.

ZINC

It was from the China that metallic zinc became known to the West. The production of metallic zinc was described in the Hindu book *Rasarnava* which was written around 1200 AD. By 1374, the Hindus had recognized that zinc was a new metal, the eighth known to man at that time, and a limited amount of commercial zinc production was underway. From India, zinc manufacture moved to China where it developed as an industry to supply the needs of brass manufacture. The Chinese apparently learned about zinc production sometime around 1600 A.D. The book *Tien-kong-kai-ou* published early in the 17th century related a procedure for zinc manufacture. Calamine ore, mixed with powdered charcoal, was placed in clay jars and heated to evolve zinc vapour. The crucibles are piled up in a pyramid with lump coal between them (Fig. 7), and, after being brought to redness, are cooled and broken. The metal is found in the center in the form of a round regulus. Zinc production expaned and metal began to be exported to Europe by Dutch, Portuguese, and Arab traders.

Figure 7. Production of metallic zinc in China around 1600.

SUGGESTED READINGS

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