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Correction: The Editor's apologies to Graça Filipe, whose name was not spelt correctly in her article in the last issue #85

The masonry blast furnace at the Ferrería de Pacho ironworks in Colombia. At the top of the 9 m pyramid was a terrace around the chimney and the charge door of the furnace. A bridge connecting it with iron ore, charcoal and chalk store. See page 6.

MEMBERSHIP NEWS

HELP OUR NEW MEMBERSHIP SYSTEM

Dr Miles Oglethorpe, TICCIH President

Welcome to the latest *TICCIH Bulletin*. Since the last issue, we have been continuing to prepare for the transfer of our membership system on to a new platform. This means that in the New Year 2020, when your subscription renewal is due, you will have the choice of opting into our network. We urge you to do so. This will provide you with access to information on colleagues and their associated expertise and interests across the world, cated pyrometallurgical operations in vogue in this part of world before the industrial revolution in the West, a process which is still basic to all high temperature distillation and condensation operations. (Craddock et.al. 1985).

Zawar mining and smelting technology apparently pre-dates other high temperature pyrotechnologies across the world. Acknowledging this, the American Society of Metals (AMS) declared Zawar as an Historical Landmark, placing a plaque at Hindustan Zinc Ltd at Zawar in 1989:

At this site are preserved the zinc retort distillation furnaces and remnants of related operations. The technical sophistication and application of scientific principles are unparalleled elsewhere in the medieval period. The element of standardization and mass production foreshadow the industrial revolution. This is the earliest example of high temperature distillation operations... The operation first supplied zinc for brass making used for fine instrument making in Europe, a forerunner of the Industrial Revolution.

The archaeo-metallurgical importance of Zawar has been described by H.V. Paliwal, K.T.M. Hegde, A.K. Biswas, Paul Craddock, Lynn Willies and L.K. Gurjar in various research papers and also by J.S. Kharakwal in his 2011 book titled Indian Zinc Technology in Glob.

COLOMBIA

THE PACHO BLAST FURNACE EXCAVATION

Roberto Lleras and Luzed Moreno, archaeologists

The oldest ironworks in Colombia, the Ferrería de Pacho, was almost completely destroyed about a century ago, despite its importance as a landmark in the industrial history of the country marking the beginning of industrial metallurgy in Colombia.

Its history can be traced back to the early years of independence from Spain. The new republic, Nueva Granada (afterwards Colombia), found itself deprived of the Spanish steel and iron which had been imported under a monopolistic regime during colonial times; local production seemed the logical option. The German mineralogist Jacob Wiesner was granted a license in 1814 to explore the countryside around Pacho, northwest of Bogotá: he found iron deposits and managed to smelt a few samples of iron in a rudimentary furnace. In 1822 the government authorised the constitution of a company to exploit the mines. The Ferrería was built north of the village in a site with easy access to the mines, the road to Bogotá and two rivers that provided abundant water power. In 1827, Egea, Daste y Cía took control over Wiesner´s plant and brought in a team of foreign technicians. In 1833, they asked ironmaster Medardo Merlin to build a blast furnace, a task completed in 1837; however, the furnace broke down. Robert Bunch took over the direction, repaired the furnace, built a puddling furnace and managed to sustain a stable production of good quality products for a few years. However, the operation of the steelwork suffered much from the low market demand and the competition of imported British steel. In 1857 Bunch died and decay began; then there were successive closures, re-openings and, despite some efforts, final closure in 1879.


The outside of the workshop ca 1930.

Prior to our archaeological intervention, about half a dozen historical studies and a limited archaeological survey of the Ferrería had been carried out. There is also an illustration from 1858 and several photographs, taken around 1930, that are extremely useful. As we were working within a restoration project we aimed to provide as much information as we could about the internal operation of the steelworks, right from the moment when the raw materials arrived until the finished products were delivered, including all the auxiliary systems and processes. We also intended to contribute information that could be useful for restoration.

The Ferrería de Pachois complex was organised along a functional axis whose nucleus is the blast furnace, a rectangular based pyra-

The blast furnace during restoration.

midal structure built of stone and bricks. On the front and lateral façades there are openings under stone arches. The pyramid rises to a height of 9.39 m where a terrace, surrounding the smokestack, offers access to the charge door of the furnace. Access to the terrace was possible through a bridge connecting it with warehouses where iron ore, charcoal and chalk were deposited; abundant remains of which were found during the archaeological digs. It seems that the bridge had some sort of rails along which wagons could run. The warehouses, the bridge with its rails, the wagons and the mills where the materials were crushed have disappeared. Only part of the buttresses that held the bridge remains. The ventilation system of the blast furnace included a network of tunnels through which air, heated by a central fireplace, circulated; inside the tunnels an iron pipe conducted pressurized hot air that was pumped into the furnace through nozzles located at both sides of the structure. Air pressure was obtained from a wooden piston operated by a large waterwheel that was used also to move a hammer and possibly other devices, such as the mills used to crush raw materials; only part of the water inflow structure, drainages and the buttresses of the wheel remain.

The main frontal arch of the furnace shelters the discharge structures of the furnace; the slag extraction door with a stone channel that conducted the molten slag to a space where it was left to cool and be removed and, further down, the vent through which molten pig iron was extracted from the furnace. For unknown reasons, the lower part of the structure had been buried right after the furnace was shut down, so that it was not visible even in the photographs taken in the 1930s. Large quantities of slag and pig iron were found outside the furnace; the most striking find, however, was a large block of pig iron that completely filled the crucible of the furnace, indicating that it was not discharged when shut down.

Adjacent to the blast furnace was the rectangular workhouse, a building, 16 x 12 m, with thick stone and brick walls of which only the foundations remain. Inside, we were able to recover the foundations of a heavy structure, partly visible in an original photograph, probably an ensemble of winch and hammer used to handle and work large chunks of cast iron taken out of the puddling furnace. The puddling furnace was located adjacent to the east wall of the workhouse; it had the highest smokestack in the plant; again, only the foundations remain. Nevertheless, the excavation provided a clear picture of the spatial relation of the blast furnace, the puddling furnace and the winch-hammer ensemble, allowing us to understand the processes that lead from raw materials to partially laminated cast iron bars and plates. Additional historical and photographic evidence helped us to understand other features of the workhouse; it was a single floor structure with a Spanish style tile roof with a large opening to allow the heat and gases produced by the furnaces to escape.

Mechanical energy from the main waterwheel was taken inside the workhouse by means of pulleys, belts and levers. A second smaller waterwheel was located downhill, on the drainage channel that came from the main one. It seems probable that another building, whose foundations are near the second waterwheel, housed a roller laminating machine mentioned in old documents. There was also another smokestack at the side of this building, possibly an auxiliary furnace used to heat bars and plates prior to rolling. A fourth smaller smokestack, not yet found in archaeological digs, may have corresponded to a forge, also mentioned in documents. Blacksmiths here produced many types of small products for households and farms.

When completed the research and restoration project will provide local people, students and tourists with an archaeological park where the early history of industrial metallurgy in Colombia will be exhibited and explained. The site is now protected and registered in the national record of historic monuments.

Contact the author

TURKEY

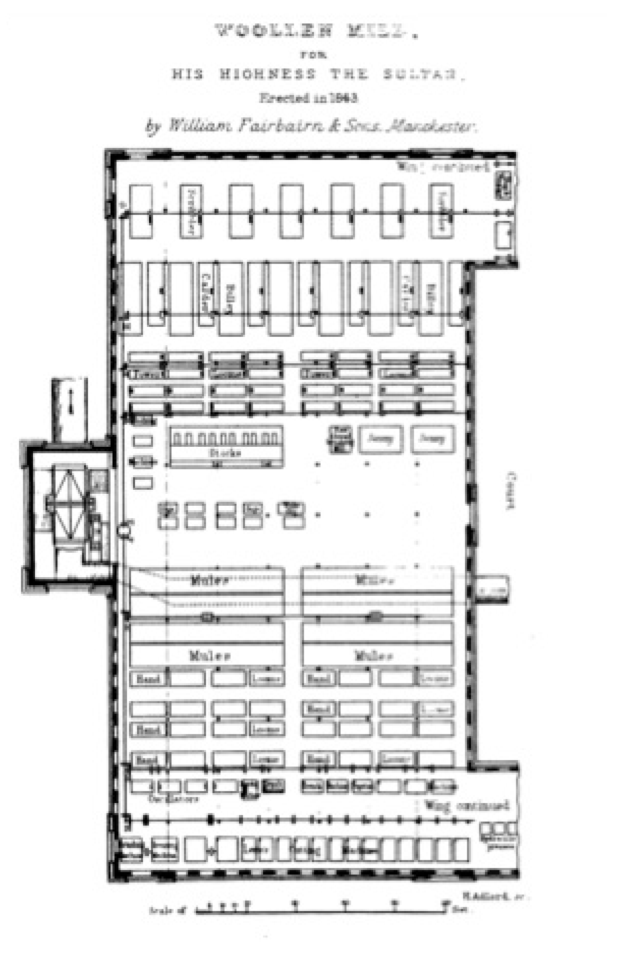
KARTEPE BROADCLOTH FACTORY

Ferda Özparlak Şahin, High Urban Planner, Kartepe Municipality

Kartepe is a town in northern Turkey along the Silk Road route between Europe and China, near the Black Sea. This town is home for a broadcloth factory which is very important example of industrial heritage. It was founded in 1844 to develop a broadcloth industry for Ottoman Empire under order of Sultan Abdulmecit. The leading English factory engineer Sir William Fairbairn moved to Istanbul and designed the engineering project for the factory, and manufactured the waterwheel which provided the power to the machinery. The architectural project was prepared by Garabet Balyan, the architect of such famous buildings such as the Dolmabahce Palace and Cıragan Palace in Istanbul. All the machines in the factor were bought by Ohannes Dadyan from England.

The Broadcloth Factory is one of the earliest examples in which iron construction was used in an industrial building. In fact, this factory is the first textile factory in which a water mill and a steam engine were used together in the Ottoman Empire period. This factory is quite unique in different ways, as a very rare example of the development of industry in the Ottoman Empire, and because Garabet Balyan was involved in the design.

In Fairbairn's classic Treatise on Mills and Millwork he mentions that in wool factories, it has been observed that there are revolu-



A section and plan of the main building with the layout of the spinning machinery showing the water wheel and line shafting. The illustrations are from Fairbairn's *Treatise on Mills and Millwork*, Part 2, 2nd Edition, 1865. Thanks to Mark Watson.