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XVII Congreso Internacional sobre Patrimonio Geológico y Minero

XXI Sesión Científica de la Sociedad Española para la Defensa del Patrimonio Geológico y Minero

Editores: Luis Mansilla Plaza
Josep Mª Mata Perelló

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A BOULTON AND WATT STEAM ENGINE FOR THE BUARCOS COAL MINE (CAPE MONDEGO, FIGUEIRA DA FOZ, PORTUGAL) IN THE EARLY 19th CENTURY

UNA BOMBA DE FUEGO BOULTON Y WATT EN LA MINA DE CARBÓN DE BUARCOS (CAPE MONDEGO, FIGUEIRA DA FOZ, PORTUGAL), A PRINCIPIOS DEL SIGLO XIX

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Resumen: En 1802, Bonifácio de Andrada e Silva, en sus competencias de Intendente General de Minas y Metales del Reino, paso a ocupar-se de las minas de carbón de Buarcos, situadas en el Cabo Mondego (centro de la costa occidental portuguesa) y parcialmente escavadas por abajo del mar vecino. Estas minas, que abastecían principalmente el Real Arsenal en Lisboa, estaban abandonadas hace algunos años en consecuencia de una inundación por las aguas del mar, les cuáles han destruido, en su grande parte, los trabajos mineros. Para un eficiente desagüe de la mina y pronta recuperación la producción, Bonifácio propuso la adquisición de una "bomba a fuego", un proyecto pionero por entre las minas portuguesas de la época. La escoja del gobierno fue para la conceptuada firma inglesa Boulton y Watt, que proporcionó una máquina, embarcada en el puerto de Hull en enero de 1804, trasladada a Portugal bajo escolta. Por circunstancias varias en particular una nueva inundación por las aguas del mar, la instalación de la bomba a fuego fue siendo adiada, y en cerca de 1814, ya estropeada, sus piezas fueran recogidas por el Arsenal. Todavía, es posible reconstituir en parte este proceso histórico, ya que se conservan en los archivos de la antigua manufactura Boulton and Watt, gran parte de los documentos que ilustran la adquisición a saber, el manifiesto de carga y los dibujos técnicos de la máquina a vapor.

Palabras clave: Bomba de fuego; Boulton y Watt; Cabo Mondego; Mina de carbón de Buarcos; Portugal.

Abstract: By 1802, as chairman of the General Intendancy of Mines and Metals of the Kingdom, Bonifácio de Andrada e Silva was charged of the coal mines of Buarcos located in Cape Mondego (west central Portuguese coast), and partly worked in the massif below sea-level. These mines, which mainly supplied the Royal Arsenal in Lisbon, were abandoned a few years before due to a massive seawater flood, which destroyed most parts of the mining works. For an efficient drainage of the mine and prompt recovery of production, Bonifácio proposed the acquisition of a steam engine, a pioneering project among the Portuguese mines of that time. The government's choice was the well-known British firm of Boulton and Watt, who provided a machine that was shipped, from the port of Hull in January 1804, and transferred under escort to Portugal. Due to *circumstances, including another seawater flood, the installation of the steam engine was delayed. By 1814 its components were damaged and it was transferred to the Arsenal. Nevertheless, it is possible to partially reconstruct this historical process, since a large part of the documents that illustrate the acquisition, namely the cargo manifest and the technical drawings of the steam engine, are still conserved in the Boulton and Watt archives in the United Kingdom.*

Keywords: Steam engine; Boulton and Watt; Cape Mondego; Buarcos coal mine; Portugal.

INTRODUCTION

By the first half of the 18th century thanks to the development in 1712 of the atmospheric engine by Thomas Newcomen (1664-1729), the innovative steam pumping technology was rapidly introduced throughout the British coal mining industry, and elsewhere in continental Europe. Newcomen's invention was soon modified by various engineers and the technology became more efficient and consumed less fuel. Steam, for example was condensed outside the cylinder, an idea patented in 1768 by James Watt (1736-1819). Eight years later Watt went into partnership with Mathew Boulton (1728-1809), a Birmingham industrialist, as a strategy to improve and adapt his invention for mines drainage, as well as other industrial purposes. In the following decades the firm of *Boulton and Watt* in Birmingham, became one of the most important builders of steam engines. Watt continued to improve the technology. For example, in 1782 he took out a patent for the double acting principle whereby steam was cyclically introduced and condensed on either side of the cylinder. This was followed in 1784 by a patent for a parallel motion, an innovation that ensured that the piston rod always entered the cylinder in a true vertical plane.

By 1800, there had already been installed in Britain more than a thousand steam engines, build by Boulton and Watt and other contemporaneous manufacturers, for example John Wilkinson at Wrexham, North Wales (Langton and Morris, 1986: 79).

Although relatively distant in the 19th century, Portugal had been made aware of those developments by diplomats and scholars who travelled abroad. Consequently, the Portuguese government soon became acquainted with the progress made in this field, and on the quality of Boulton and Watt's products, and so in 1802, they placed an order for a steam engine destined to drain the only active coal mine at Buarcos (Figueira da Foz), whose production was primarily destined to the Royal Army Arsenal in Lisbon.

Shipped from England in January 1804, the steam engine would be one of the first to operate in the country. However, it was never put into operation, which explains why there are scarce references about it in the literature, since the "steam revolution" in Portugal, according to Diogo (2003: 14) only began to impose itself from the 1820's. This was later than in neighbouring Spain, where steam power was introduced at the end of the 18th century, and was more generally used from the 1820's onwards (Gómez, 1994: 218-219).

BUARCOS AND THE INTENDANT OF MINES

The Buarcos coal deposits have been exploited since the 1770's, initially under the direction of the Lieutenant of sapper-miners José Nunes Figueiredo (Lima, 1956; Solla, 1970: 14) and then later on, from 1787, under supervision of the Colonel Bartolomeu da Costa from the Royal Arsenal, and his nephews the brothers Francisco and Rodrigo Raposo. The mine of Buarcos was located on the Atlantic seashore, near the western promontory of the Boa Viagem massif. The lignite coals are Upper Jurassic in age and together with limestones, marls and sandstones form part of the Meso-Cenozoic border of west central Portugal (Figure 1).

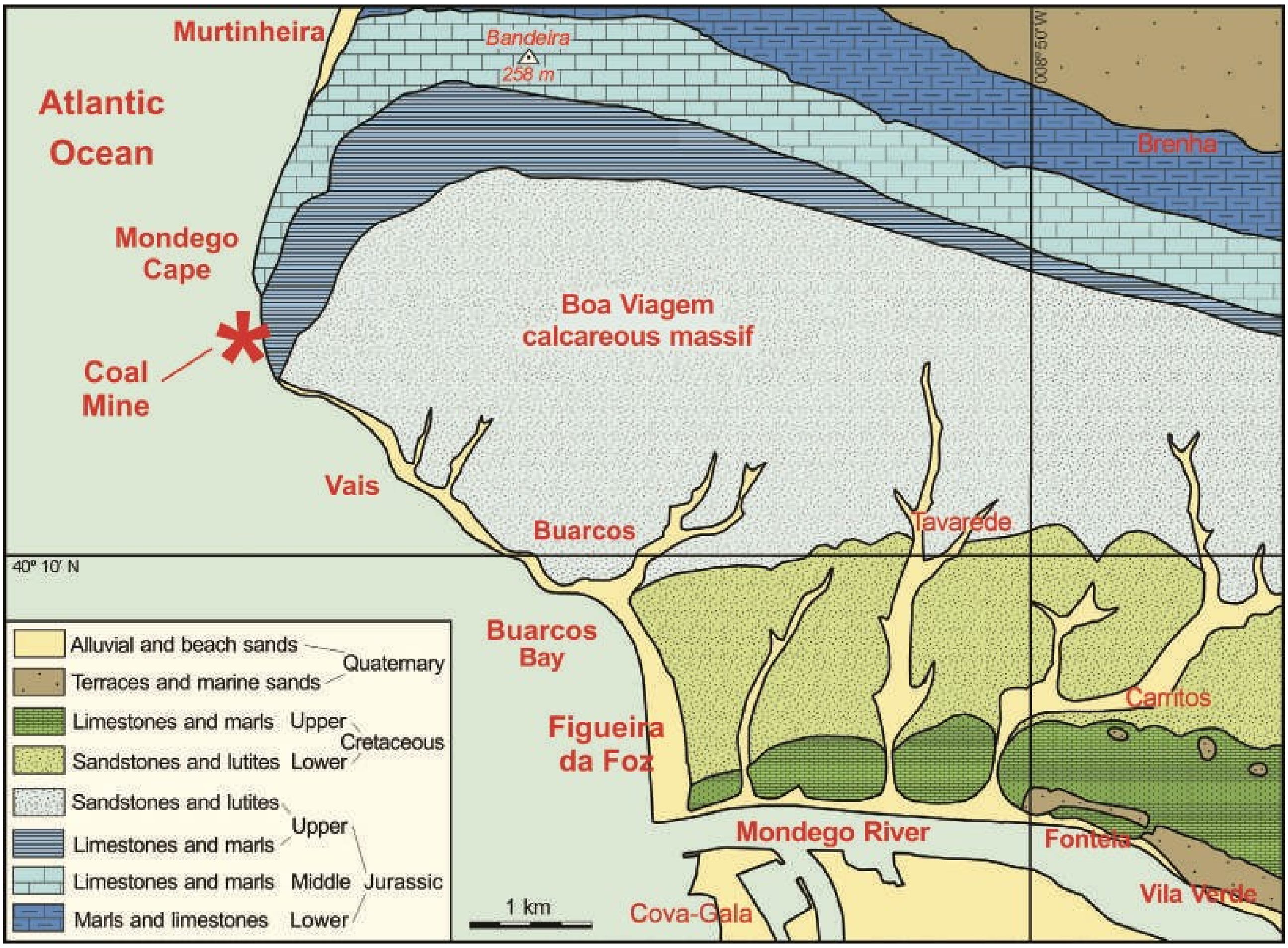


FIGURE 1. Location and geological setting of the Buarcos coal mine district. (Adapted from the Geological Map of Portugal, 1:25 000, 19-C Figueira da Foz).

The lignite coal worked at Buarcos is found in a succession of six coal seams interbedded within a 14 metres thick sequence of limestones and marls. (Andrade, 1813: 22-23; Sharpe, 1850: 162). This succession of lagoonal micritic laminated limestones, marly limestones and coal, belongs to the local "Carbonaceous Complex" Formation (Rocha *et al.*, 1981: 40), the lowermost Upper Jurassic unit (middle Oxfordian) of the Serra da Boa Viagem monocline structure, which dips approximately 40° S-SE, and is oriented to the Mondego river estuary. During the early phases of mining activity only the three lower coal seams were worked, as they were more productive due to their thickness. However, in the short-term the exploration was more concentrated on the thicker layer exposed in the middle of this group.

Domingos Vandelli, (1735-1816), naturalist and professor of the University of Coimbra, made the first study of the mining operations in the 1770's. Nearly half a century later Daniel Sharpe (1806-1856), a British geologist and merchantman who periodically worked in Portugal, and later became President of the Geological Society of London, undertook the first systematic study of the local geology, work that was continued by Carlos Ribeiro (1813-1882), chief engineer of mines for the State. These studies were followed by those of Paul Choffat (1849-1919), a Swiss geologist working for the Portuguese Geological Survey (Geological Commission of the Kingdom), and author of the first comprehensive geological map of the Boa Viagem and Buarcos ranges, as a complement of detailed stratigraphic studies carried on the Jurassic formations (1880).[1]

Vandelli's study of Buarcos coal demonstrated that it was not possible to use it for working metal because of its high sulphur content in the form of iron pyrites. However, it was possible to use it as a combustible in distilleries and in lime and ceramic furnaces (Vandelli. 1790: 434), a fact of which had been put to practical use with the installation of a glass factory and ceramic industries (tiles and bricks) close the mine, for local consumption of the coal.[2]

James Murphy (1760-1814), a British architect who widely travelled across Portugal at the end of the 18th century, publishing his impressions and images of the country, also referred to Cape Mondego's coal. He repeated Vandelli's observations and commented that the coal was not yet sufficiently bituminous, because the mine had not yet reached an adequate depth (Murphy, 1898: 43).

About 50 years later, during a decade of relative political stability, and technological progress allowed by the regime of the "Regeneration", Carlos Ribeiro had the opportunity to review in detail the coal mines of the country, including their stratigraphy, availability, and viability. He described the Upper Jurassic succession at Buarcos and confirmed the existence of the coal beds. At that time, only the second deepest coal seam (average thickness 1m) was being worked (Ribeiro, 1858: 215), and subsequently confirmed by Monteiro and Barata (1889: 305). Seam thickness was regarded as a limiting factor throughout the remaining life of the coal deposit.

FIGURE 2. José Bonifácio de Andrada e Silva (Santos, June 13, 1763 - Rio de Janeiro, April 6, 1838). (Reproduced from Coelho, 1877).

The fact that the coal produced at Buarcos was primarily destined for the Royal Army Arsenal became of concern to the Portuguese Government. It was clearly a matter that needed scrutiny. Consequently, a Royal Resolution was passed to create a special department, with the purpose to examine and supervise all the incipient country's mineral industry and the activity of the main state forges. This new department, named *General Intendancy of Mines and Metals of the Kingdom* (1801-1836), was created in May 1801, under the Chairmanship of José Bonifácio de Andrada e Silva (1763-1838), (Figure 2).

Bonifácio was a graduate in Laws and Natural Philosophy by the University of Coimbra. He had been full member of the Portuguese Royal Academy of Sciences since the 1800's, and besides his political influence, during this historical period, he was one of the Portuguese naturalists with the most international experience. He had spent the previous decade travelling all over Europe, as a Portuguese Government's fellow, attending chemistry and mineralogy courses in Paris, with le Count Fourcroy, Chaptal, Duhamel and Haüy, and in 1792-93, attended chemistry, mineralogy, metallurgy and geognosy courses at the Academy of Freiberg, Germany, where he was a disciple of Abraham

1 Étude stratigraphique et paléontologique des terrains jurassiques du Portugal. Le Lias et le Dogger au nord du Tage. *Memoires Section des Travaux Géologiques du. Portugal*, Lisbonne, XII.

2 This coal would later be classified as "bituminous coal" and not as a "pyrite lignite" (*Companhia ...*, 1880: 6), a classification closer to that attributed during the 20th century.

Werner, whose ideas profoundly marked his scientific career (Coelho, 1877: 8, 38). In the following years, Bonifácio also visited several mines and metallurgical centres of Central and Northern Europe. Focussing on mineralogy, he described several new species, and varieties of minerals, that gave him fame with his peers of other countries.

In view of his diverse and noteworthy curriculum, Bonifácio was also appointed as professor of metallurgy at the University of Coimbra (1801), a function that he performed in conjunction with the position of Intendant of Mines and Metals, with the aim of training technicians for the Royal workshops.

The published Royal Decree defined the mission of the Intendancy and the outlined the competence of its chairman (Charter of January 30, 1802). José Bonifácio was appointed to administer the Buarcos mine, which at that time had been temporarily abandoned, as a direct consequence of a disastrous flood that occurred in late 1798 when a large collapse of the mine workings beneath the sea allowed the sea water to inundate the mine, thereby destroying the workings. (Monteiro and Barata, 1889: 307).

Considering the extent of the damage, the possibility to leave the mine was first considered by the Intendant Bonifácio, but he finally decided to face up to the problems, considering that it was "*more fitting to amend and perfect than to destroy"* (Andrade, 1813: 21).

His main aim was a quick recovery of production. However, it was necessary to rebuild almost everything. He wasted very little time. The main shafts, excavated some years before by the brothers Raposo were repaired, and houses and warehouses were rebuilt, machines and tools obtained, new ventilation points were constructed, as well as new pumps for mines drainage. Debris was cleared from galleries and new ones driven (Guimarães, 1988: 30). Using his influence, he also invited local authorities to collaborate in the repair

FIGURE 3. Late 19th century panoramic view of the Buarcos coal mine and associated industries from postcard ca.1904 (authors' personal collection).

of the access road to the village of Figueira da Foz, where the maritime port to transfer the coal to Lisbon was located, ensuring its regular transport by boat.

Nevertheless, his biggest challenge was to solve the problem of the water flooding the mine. This water was been pumped out the workings, using manually operated pumps; however, the constant and unequal struggle to remove huge volumes of water from inside the galleries, only demonstrated the inadequacies of this method. Water constantly flowed into the works, not only through the many fractures and cavities in the limestones interbedded with the coals, that had connection to the surface, but also due to direct infiltrations from the nearby sea, where the mine shafts were sunk below the coastal cliffs of Cape Mondego (Figure 3).

Bonifácio was certainly aware of the main advances in steam engines for mines drainage, as he would have seen working examples during his visits to mines in Austria, Germany, Italy and Scandinavia, and knew that their effectiveness far exceeded the traditional manual pumping; certainly he would have heard about the engine ordered in 1786 for Almadén mercury mine. This was the first one to be installed at Spanish mines and was built by the well-known British industrialist John Wilkinson (1728-1808), according to the models designed by Boulton and Watt (Gómez, 1994: 217; Sobrino and Aparicio, 2005: 45). Convinced that this could be the best alternative for the Buarcos mine, Bonifácio suggested to the Portuguese government that such a steam engine should be installed there; this kind of machine could facilitate the removal of mine water, enable easy access to the coal seams without unnecessary interruptions, and would ensure a regular supply to the forges of the Royal Arsenal, and other customers.

During the first months of 1802 and after been proven his strategic utility for the necessities of the country, an order was placed with Boulton and Watt, in Birmingham for a steam pumping engine.

THE STEAM ENGINE

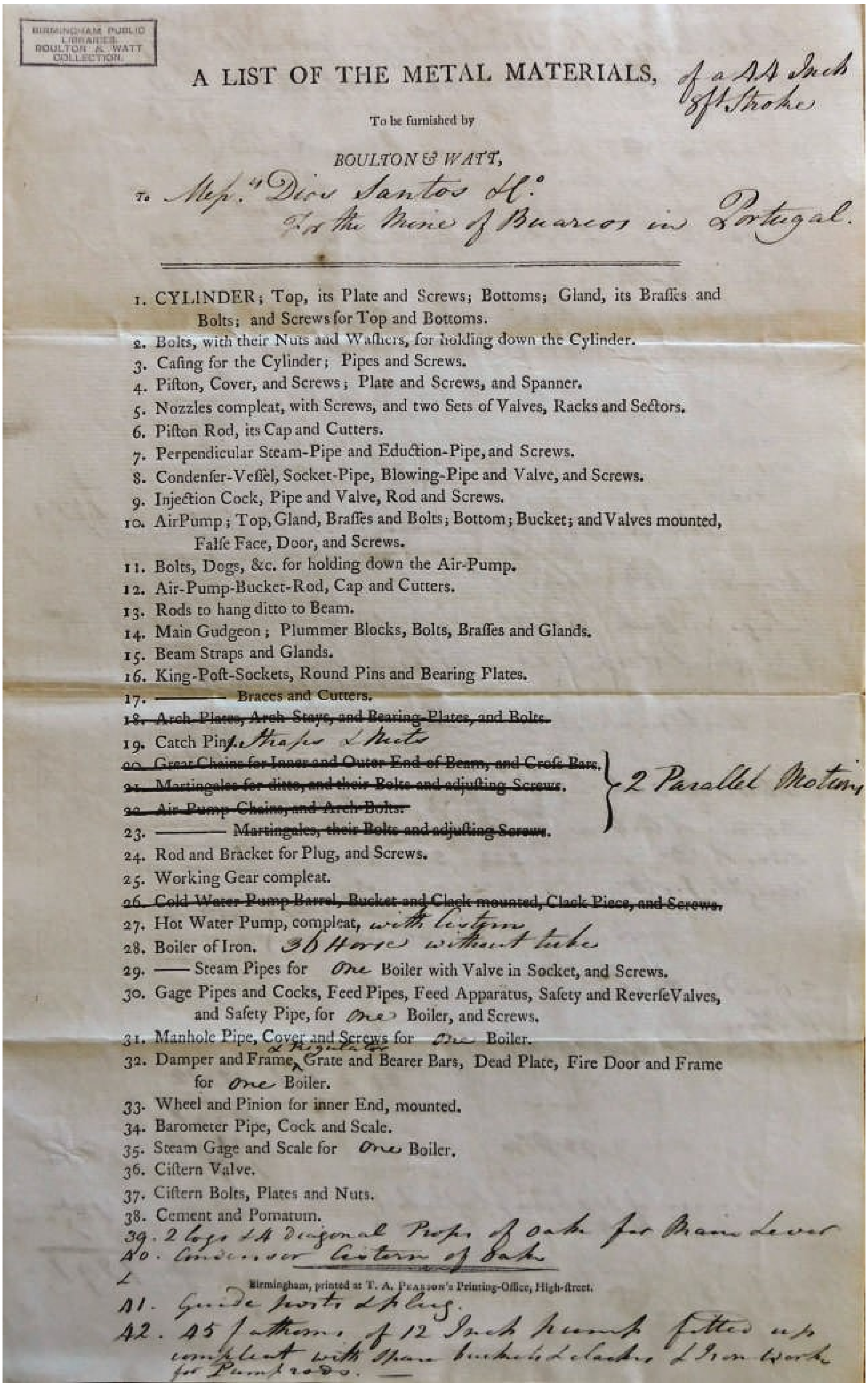
Contemporary records that include an estimate, as well as a shipping inventory and original engineering drawings for the Buarcos engine exist in the Boulton and Watt Archives, Central Library, Birmingham, England.

The estimate (Figure 4) dated 9th April 1803 is a quotation for an engine with a 44 inches (112 cm) cylinder and an 8ft (2.44m) stroke requested by Messrs. Dias Santos (believed to be London agents for the Portuguese Government), for the mines of Buarcos. The order also included an oak beam, a cistern, boiler and 45 fathoms (82.3m) of 12 inch (30cm) pump. As well as all the standard features, it is noted that the conventional great chains, that ran on an arc of timber construction at each end of the beam, and used to keep the piston rod vertical in the cylinder, and the pumping mechanism vertical in the shaft, had been replaced by parallel motion. This was considered a great improvement as the conventional chains were made from wrought iron and prone to breakage. The beam consisted of two logs. The boiler was to be transported in 36 pieces, without tubes, to facilitate putting it together, which presumably meant that the pieces would be riveted together at Buarcos.

Build into the quotation was an additional 33% for the buyer ‘being foreign.’ Overall the engine was estimated to weigh 28 tons and a carriage charge of £4 per ton was applied to the estimate.

The total estimated cost of the engine, including boiler and pumps, and carriage to London amounted to £2697, but this was rounded up to £2750 to ‘cover the trouble of instructing men, agency in London, etc, etc’.[3]

3 Documents from Boulton and Watt Archives, Library of Birmingham.



A LIST OF THE METAL MATERIALS, of a 44 Inch 8ft Stroke

To be furnished by

BOULTON & WATT,

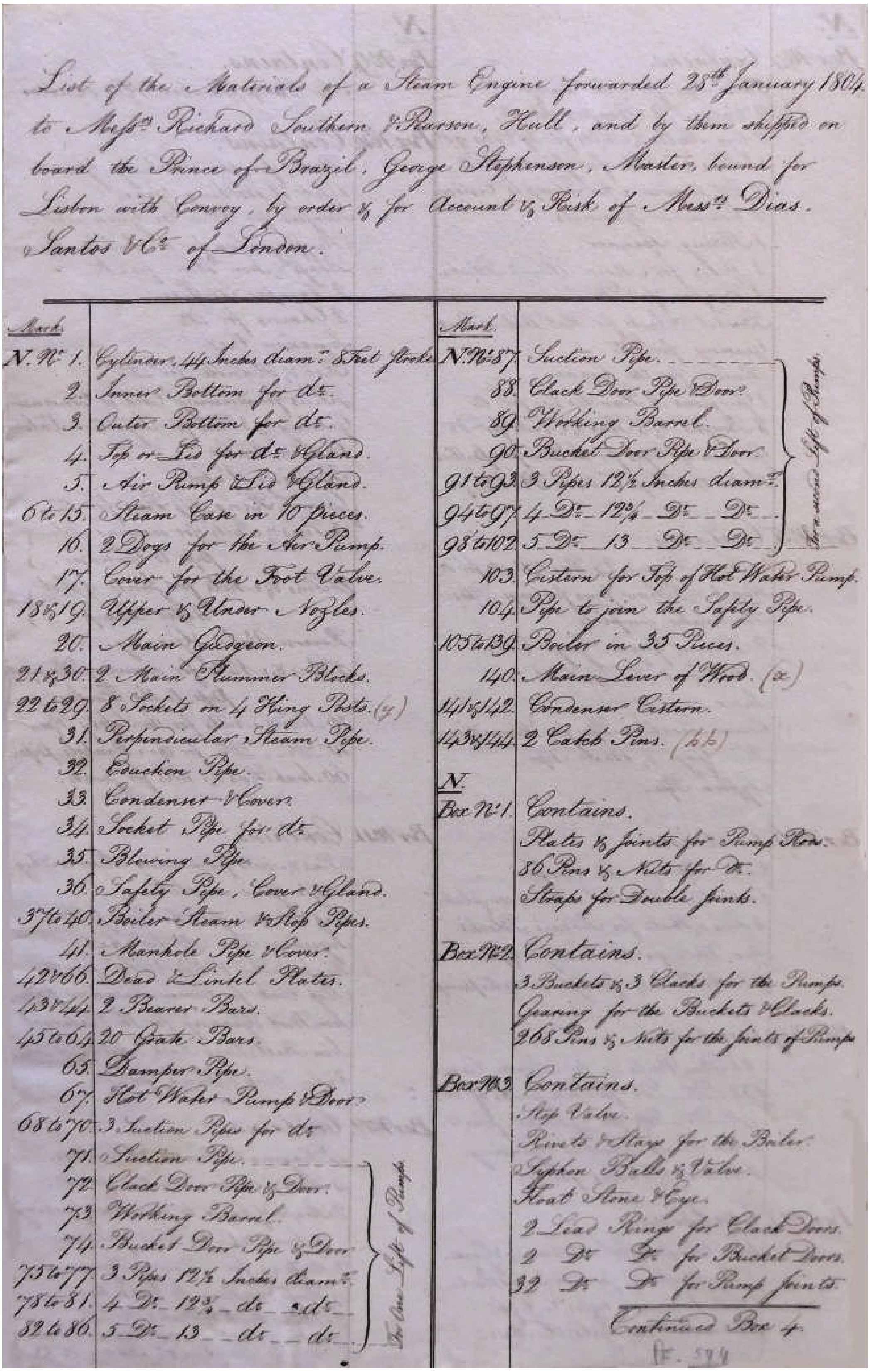
To Mess.rs Dios Santos & Co
For the Mine of Buarcos in Portugal.

1. CYLINDER; Top, its Plate and Screws; Bottoms; Gland, its Braſſes and Bolts; and Screws for Top and Bottoms.
2. Bolts, with their Nuts and Waſhers, for holding down the Cylinder.
3. Caſing for the Cylinder; Pipes and Screws.
4. Piſton, Cover, and Screws; Plate and Screws, and Spanner.
5. Nozzles compleat, with Screws, and two Sets of Valves, Racks and Sectors.
6. Piſton Rod, its Cap and Cutters.
7. Perpendicular Steam-Pipe and Eduction-Pipe, and Screws.
8. Condenſer-Veſſel, Socket-Pipe, Blowing-Pipe and Valve, and Screws.
9. Injection Cock, Pipe and Valve, Rod and Screws.
10. AirPump; Top, Gland, Braſſes and Bolts; Bottom; Bucket; and Valves mounted, Falſe Face, Door, and Screws.
11. Bolts, Dogs, &c. for holding down the Air-Pump.
12. Air-Pump-Bucket-Rod, Cap and Cutters.
13. Rods to hang ditto to Beam.
14. Main Gudgeon; Plummer Blocks, Bolts, Braſſes and Glands.
15. Beam Straps and Glands.
16. King-Poſt-Sockets, Round Pins and Bearing Plates.
17. ——— ~~Braces and Cutters.~~
18. ~~Arch-Plates, Arch-Stays, and Bearing-Plates, and Bolts.~~
19. Catch Pins, Straps & Nuts
20. ~~Great Chains for Inner and Outer End of Beam, and Croſs Bars.~~ } 2 Parallel Motions
21. ~~Martingales for ditto, and their Bolts and adjuſting Screws.~~
22. ~~Air-Pump-Chains, and Arch-Bolts.~~
23. ——— ~~Martingales, their Bolts and adjuſting Screws.~~
24. Rod and Bracket for Plug, and Screws.
25. Working Gear compleat.
26. ~~Cold Water Pump Barrel, Bucket and Clack mounted, Clack Piece, and Screws.~~
27. Hot Water Pump, compleat, with Cistern
28. Boiler of Iron. 36 Horse without tube
29. —— Steam Pipes for One Boiler with Valve in Socket, and Screws.
30. Gage Pipes and Cocks, Feed Pipes, Feed Apparatus, Safety and ReverſeValves, and Safety Pipe, for One Boiler, and Screws.
31. Manhole Pipe, Cover and Screws for One Boiler.
32. Damper and Frame, & Regulator Grate and Bearer Bars, Dead Plate, Fire Door and Frame for One Boiler.
33. Wheel and Pinion for inner End, mounted.
34. Barometer Pipe, Cock and Scale.
35. Steam Gage and Scale for One Boiler.
36. Ciſtern Valve.
37. Ciſtern Bolts, Plates and Nuts.
38. Cement and Pomatum.
39. 2 logs 44 Diagonal Props of Oak for Main Lever
40. Condenser Cistern of Oak

Birmingham, printed at T. A. Pearson's Printing-Office, High-ſtreet.

41. Guide posts & plug.
42. 45 fathoms of 12 Inch pumps fitted up compleat with spare buckets & clacks, & Iron Work for Pumprods.

FIGURE 4. Boulton and Watt: First page of the estimate for the Buarcos Engine dated 9th April 1803. (Reproduced with the permission of the Library of Birmingham, ref: Boulton and Watt MS3147/4/14).



List of the Materials of a Steam Engine forwarded 28th January 1804 to Messrs Richard Southern & Pearson, Hull, and by them shipped on board the Prince of Brazil, George Stephenson, Master, bound for Lisbon with Convoy, by order & for Account & Risk of Messrs Dias Santos & Co of London.

Mark
N. No 1. Cylinder, 44 Inches diam. 8 Feet stroke
2. Inner Bottom for do.
3. Outer Bottom for do.
4. Top or Lid for do & Gland.
5. Air Pump & Lid & Gland.
6 to 15. Steam Case in 10 pieces.
16. 2 Dogs for the Air Pump.
17. Cover for the Foot Valve.
18 & 19. Upper & Under Nozles.
20. Main Gudgeon.
21 & 30. 2 Main Plummer Blocks.
22 to 29. 8 Sockets on 4 King Posts. (y)
31. Perpendicular Steam Pipe.
32. Eduction Pipe.
33. Condenser & Cover.
34. Socket Pipe for do.
35. Blowing Pipe.
36. Safety Pipe, Cover & Gland.
37 to 40. Boiler Steam & Stop Pipes.
41. Manhole Pipe & Cover.
42 & 66. Dead & Lintel Plates.
43 & 44. 2 Bearer Bars.
45 to 64. 20 Grate Bars.
65. Damper Pipe.
67. Hot Water Pump & Door.
68 to 70. 3 Suction Pipes for do.
71. Suction Pipe.
72. Clack Door Pipe & Door.
73. Working Barrel.
74. Bucket Door Pipe & Door.
75 to 77. 3 Pipes 12½ Inches diam.
78 to 81. 4 Do. 12¾ do. do.
82 to 86. 5 Do. 13 do. do.
For One Lift of Pumps

Mark
N. No 87. Suction Pipe.
88. Clack Door Pipe & Door.
89. Working Barrel.
90. Bucket Door Pipe & Door.
91 to 93. 3 Pipes 12½ Inches diam.
94 to 97. 4 Do. 12¾ Do. Do.
98 to 102. 5 Do. 13 Do. Do.
For a second Lift of Pumps
103. Cistern for Top of Hot Water Pump.
104. Pipe to join the Safety Pipe.
105 to 139. Boiler in 35 Pieces.
140. Main Lever of Wood. (x)
141 & 142. Condenser Cistern.
143 & 144. 2 Catch Pins. (bb)

N.
Box No 1. Contains.
Plates & Joints for Pump Rods.
86 Pins & Nuts for do.
Straps for Double Joints.

Box No 2. Contains.
3 Buckets & 3 Clacks for the Pumps.
Gearing for the Buckets & Clacks.
268 Pins & Nuts for the Joints of Pumps

Box No 3. Contains.
Stop Valve.
Rivets & Stays for the Boiler.
Syphon Balls & Valve.
Float Stone & Eye.
2 Lead Rings for Clack Doors.
2 Do. Do. for Bucket Doors.
32 Do. Do. for Pump Joints
Continued Box 4

FIGURE 5. Boulton and Watt: Part of the Shipping Inventory for the Buarcos Engine dated 28th January 1804. (Reproduced with the permission of the Library of Birmingham, ref: Boulton and Watt MS3147/5/594)

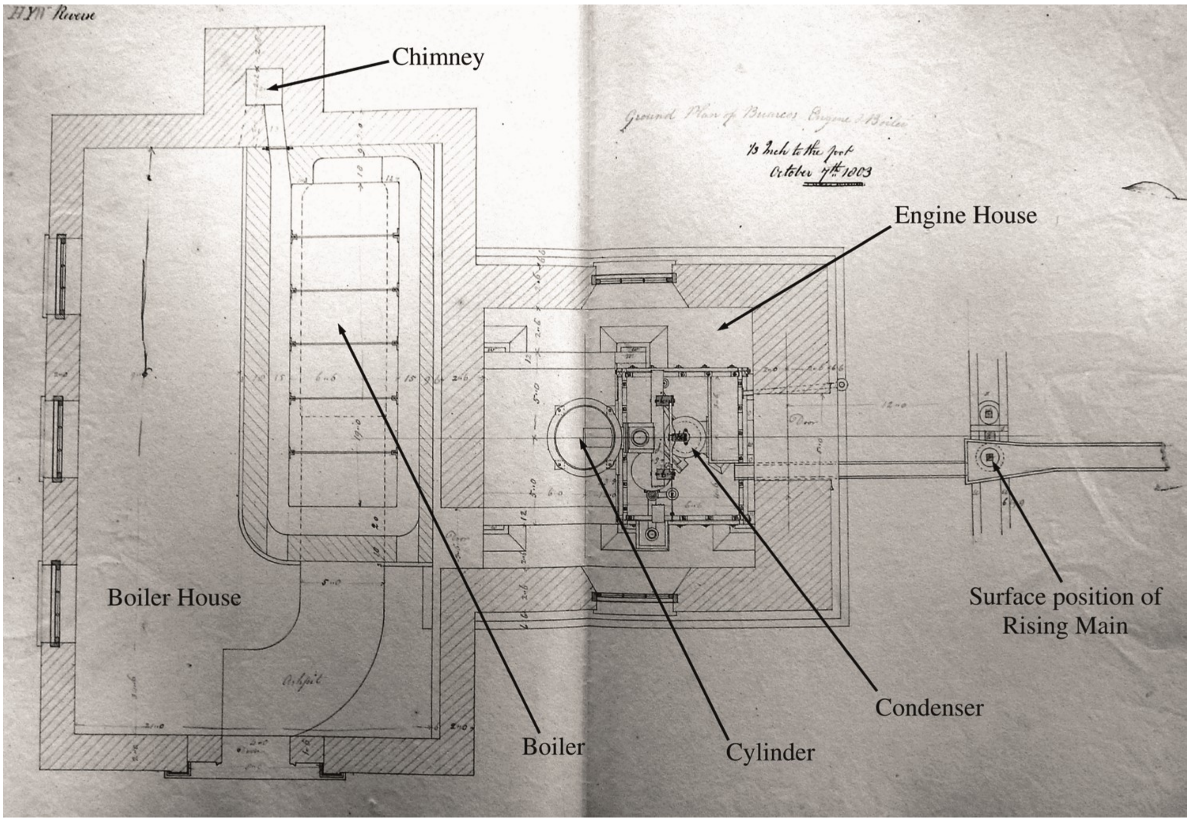


FIGURE 6. Boulton and Watt: Annotated Plan of the Buarcos Engine and Boiler Houses dated 7th October 1803. (Reproduced with the permission of the Library of Birmingham, ref: Boulton and Watt MS3147/5/594)

However, the engine did not leave England via London, it left the Soho Works, the Birmingham factory of Boulton and Watt, on the 28th January 1804 bound for the port of Hull (on the east coast of England), where their agents, Messrs. Richard Southern and Parsons supervised it's loading onto the Portuguese Naval frigate 'Prince of Brazil', part of an escorted convoy bound for Lisbon.

The detailed inventory (Figure 5) lists 144 parts (engine and pumps), transported in twenty-two boxes with a total weight of 54 tons. The engineering drawings are very detailed and include side and front elevations and plans of the combined engine and boiler houses, with the equipment installed (See Figure 6 for a plan of the engine and boiler houses). Other illustrations provide details of specific parts, for example, the cylinder and condenser arrangement, and the parallel motions. Additional drawings show the shaft pumping arrangement, with two lines of pump rods descending down the shaft from the end of the beam. The top and bottom length of pump rods were 137ft 6in (41.9m) and 275ft (83.8m), respectively. The total length of rising main pipe amounted to 279ft. (110.6m), offset halfway down the shaft by a cistern and launder.

There is no mention in any of the material seen in the Boulton and Watt archives that suggests that an engineer was included in the contract to supervise the in situ erection of the engine, or commission it.

AN UNFAVOURABLE CONJUNCTURE

The transportation of the engine to Portugal, and ultimately its erection at Buarcos, would have presented an enormous task. Once the engine arrived at Lisbon it would have been transferred to smaller vessels, as they were the only ships that could navigate through the shifting sand banks that filled the Mondego estuary, before finally reaching the port of Figueira da Foz. The unloading of the 22 boxes of machinery would certainly have been a time-consuming and expensive task. However, besides the questions concerning the financial resources, greater constraints to the success of this important and pioneering acquisition would also occur.

Firstly, to unpack and assemble the various machine components required specialized expertise even though everything was well documented in the shipping manifest and the very detailed engineering drawings. For this reason, it was probably usual for Boulton and Watt to send an engineer to supervise the erection of its engines, a service provided by the company but apparently not included in the price of its machines. Unfortunately, this does not appear to be the case for the Buarcos engine.

Secondly, in January 1804, while the transportation of the machine was being prepared in England, a new and enormous flood occurred at the mining complex. The result of the sudden opening of several fractures at the bottom of the so-called “old mine” that was excavated under the seashore, through which sea water invaded the galleries and inundated all the mine works (Andrade, 1813: 74-75) including the drainage system, the hand pumps and recently installed capstan. Bonifácio’s answer was to abandon the three Raposo’s shafts and sink a new one, a little further from the others and at a higher level (Mondego shaft). This action would eliminate sea water entering the mine working when weather conditions were stormy, the so called “new mine”.

Further problems ensued due to the tensions between France and Britain that led to the Continental Blockade decreed by the French Republic in November 1806, by which all ports of countries under French influence would have to be closed to English ships. This was an attempt to asphyxiate the economic strength of the Old Albion. Portugal however, did not join the blockade, and oscillated between British pressures to continue with their long-standing commercial relations, and the threats of France. French armies first invaded Portugal in 1807, and so began a devastating war that lasted until 1811, with the consequence that the Buarcos mine was abandoned (Serrão, 1992: 47). José Bonifácio didn’t stay immune to the Peninsular War, as he joined the Portuguese army and led a battalion of academics and students from Coimbra, fighting against the French armies (Serrão, 1992: 576).

Under this unfavourable conjuncture, where multiple difficulties arose from the mine flooding in 1804, together with years of political instability, Bonifácio’s involvement in conflicts, and an overall lack of economic resources, it was inevitable that there would be a long delay before the Buarcos engine could be erected.

Despite those major factors, it is also necessary to consider the possibility that José Bonifácio had lost interest in the engine. In fact, after the flood of 1804 the mining works had started to be developed in landward direction, thus clearly reducing the need for an effective mines drainage system, as mines water was now naturally flowing out of the mine through the new main gallery. Besides that, it is necessary to add that by 1810, the Royal Arsenal had rejected the coal from Buarcos arguing that it was of lower quality when compared with imported coal available in Lisbon, a fact certainly reflected in the level of production.

It is also apparent that the engine was also falling into disrepair, and by 1814, the government decided to send its parts to the Royal Arsenal, in Lisbon, where it was never put into use. Wilhelm Eschewege (1777-1855), a German engineer who had worked for the Portuguese Crown, appointed as Intendant of Mines in 1823,[4] is very critical of these facts, as reported in his extensive report on the situation of the Portuguese mines, delivered to the government in 1924.

4 Bonifácio had returned to his home land, Brazil, in 1819.

FINAL REMARKS

The Buarcos' Boulton and Watt fire (steam) engine, ordered by the Portuguese government, according to the suggestions of the 'Intendant of Mines and Metals of the Kingdom', Bonifácio de Andrada e Silva in the very beginning of the 19th century, was amongst the first to be imported to Portugal. It was a symbol of progress and modernity, once erected in the coal mine of Buarcos in Portugal. It was slightly smaller than the first Boulton and Watt engine on the Iberian Peninsula, at the Almadén mine, Spain. It had a cylinder diameter of 44 inches (Library of Birmingham), whilst the Almadén engine cylinder was 50 inches diameter (Sobrino and Aparicio 2005; 46). Nevertheless, the Buarcos engine had other advantages, for example it had parallel motions at each end of the beam that meant that it was less prone to disruption due to chain breakage.

Unfortunately, because of the circumstance detailed above it was never erected. This whole episode was undoubted a very costly, and time wasting experience for all parties concerned. Had the engine been erected and put into use it may well have had considerable influence on the development of the Buarcos coal deposit, and made the enterprise a viable concern, but circumstance did not permit that to happen. In 1803 the cost of the engine was estimated to be £2750, which in 2017 would equate to about €100,000.

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