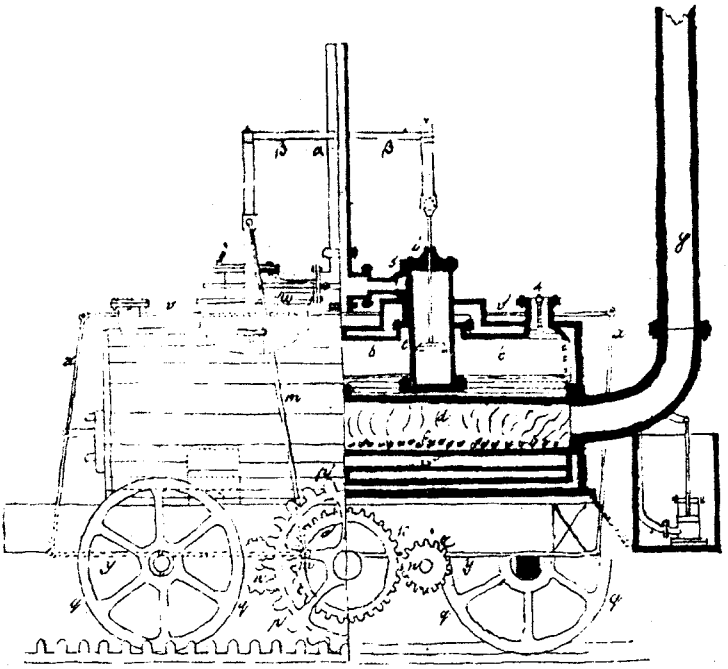
The First Steam Locomotives on the European Mainland

Mike Clarke

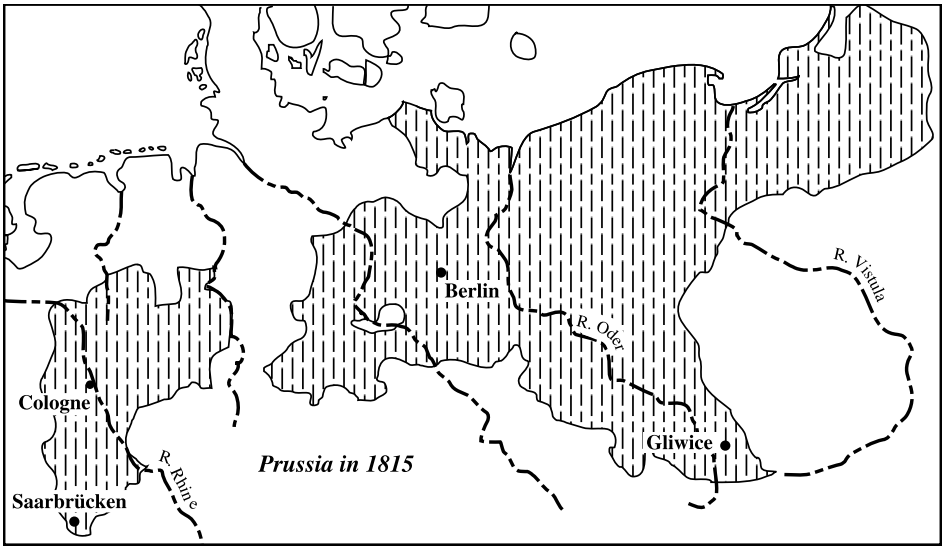


The First Steam Locomotive in Europe

The industrial development of Prussia was one of the main ambitions of Frederick the Great[1]. Unfortunately his homeland, Brandenburg, had few natural resources. So on coming to the throne in 1740 he immediately occupied Silesia, an area which was to become increasingly important for the supply of metal and coal. After several years of war, Austria relinquished control of the area in 1745 under the Peace of Dresden, the end of the Seven Years War in 1763 confirming Prussia's gain.

To further his aim of industrialisation, Frederick established a number of government departments with responsibility for economic and industrial development. They continued to influence the expansion of Prussian industry after Frederick's death in 1786, though there was increasing conflict between the centralised bureaucracy in Berlin and those working in the provinces. The Department of Mines and Ironworks, set up in 1768, was particularly involved with the development of industry in Silesia, the Mark (a Prussian area to the south of the Ruhr) and with that part of the Saarland taken over by Prussia in 1815.

In 1770 Frederick emphasised the importance of developing the Silesian coal field, but this was not done effectively until von Heinitz[2] was put in charge of the national mining office in 1777. It was he who encouraged his officials to visit



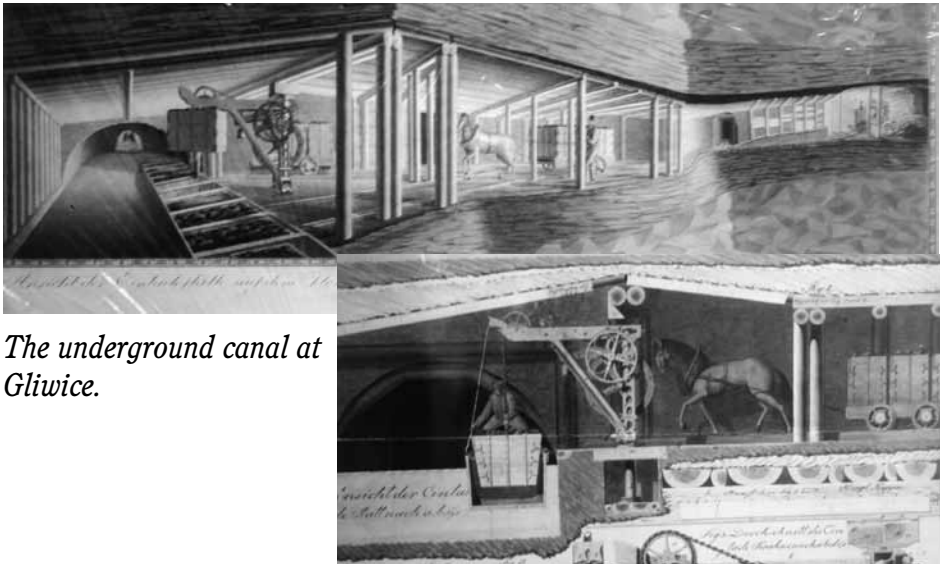
England[3], and for the next seventy odd years Prussian engineers would continue to visit Britain, and other countries, to view the most advanced technologies then available[4]. For example, as a result of his visit to England, Bückling set up first steam pumping engine in Prussia at Hettstedt (County of Mansfield) in 1785.

The industrial development of Lower Silesia started with the introduction of iron works in the Malapane area, to the east of Wroclaw (Breslau), in 1754. Upper Silesian industrialisation began with the discovery of lead and silver at Tarnowitz in 1784, following Frederick's approval for financing iron and metal working development in 1783. One of the Wilkinson brothers, possibly William, visited the works in 1786 at von Reden's[5] invitation and conducted experiments on the smelting of lead ore with coke. Two years later, in 1788, an English-built steam pumping engine was set to work.

The development of the iron and coal industry in Upper Silesia was further encouraged in 1790 when Heinitz authorised an increase in Silesian coal production. A coal mine at Zabrze, called the Queen Louisa Mine from 1811, was begun in 1795/6, but developed slowly. Coal was brought out of the mine by canal, in a manner similar to the coal mine at Worsley on the Duke of Bridgwater's estate near Manchester. Prussian engineers certainly visited Worsley, so the idea for the underground canal may well have come from there. Underground tramways linked the coal face with the canal, coal being loaded at the coal face into containers sitting on trucks. These were pulled along tramways by horse to underground canal interchange basins where cranes transhipped the loaded containers onto boats for carriage out of the mine.[6]

Coal from the mine was delivered to the Royal Ironworks at Gliwice (Gleiwitz), about three miles distant, which opened in 1794-6. During planning for the works, it was decided to use the latest British coke-firing technology, and von Reden, during a visit to Britain, asked John Smeaton to suggest a British engineer to help with the design and construction of the works. The man he proposed was John Baildon[7], the son of one of Smeaton's workers at Carron Ironworks. The name Baildon, a town to the north of Leeds, suggests that John Baildon's father had travelled north with Smeaton when he was organising the Carron Ironworks. The ironworks at Gliwice were built by Baildon, and two Prussian engineers, Wedding and Bogatsch, and were the first coke fired furnace in Prussia. Baildon also designed a boring machine for cylinders to be used at the works. In 1800 two cylinders were made for steam pumps at Tarnowitz, and cannon were made in Napoleonic War.

Initially coal was carried between Zabrze and Gliwice by road, but by 1806 the Klodnitz Canal had been built extending the existing underground canal about

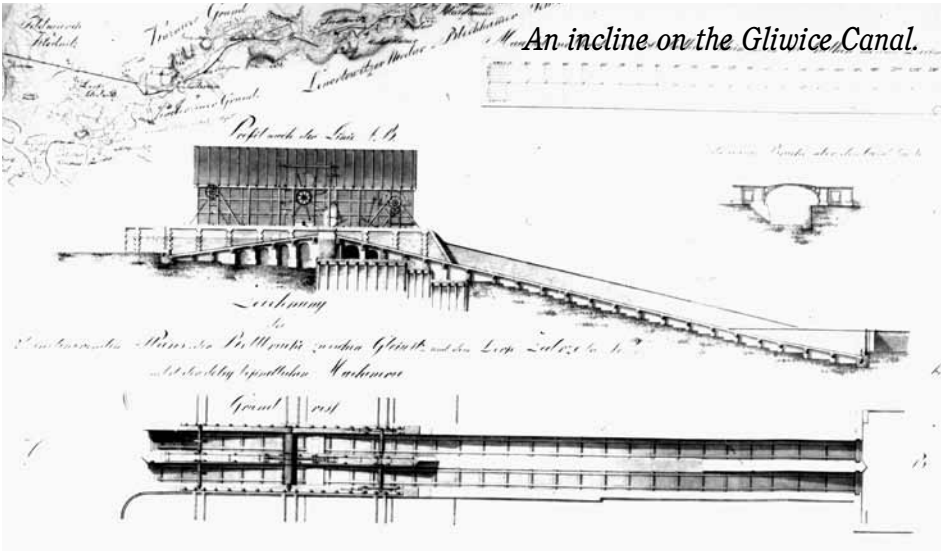


The underground canal at Gliwice.

three miles above ground. It served the iron works in Gliwice and was built to carry the small mine boats. They were originally 6.2 metres by 2 metres, but with the extension of the system to the iron works, were enlarged to 11.8 metres by 2.6 metres with a draught of about 0.9 metres. The new canal had to overcome a variation in level of 16.5 metres between the mine at Zabrze and the canal at Gliwice. To achieve this, two inclined planes were built, the upper with a fall of 11.5 metres, the lower of 5 metres. Important technical improvements to the design of these inclined planes were made during their construction[8].

Von Reden and Wedding had met William Reynolds and inspected the Shropshire Canal when they visited England, and we know that Smeaton had advised William Reynolds on the design of the inclined planes used on that canal, so it is no surprise that the original design for the Gliwice inclines was similar. A plan and section of the original scheme[9] shows that the boats would have been raised out of the water on a short incline at the upper level before being lowered down the longer incline to the lower level.

An incline where boats have to pass over a summit is really only suitable for small boats. For the new canal boats, 11.8 metres long, it would have been difficult to ensure clearance for the carriage as it passed over the summit. Shortening the wheel-base could make for instability or encourage distortion of the boat when it was resting on the carriage. This problem must have been in the mind of John Gilbert when he designed the underground incline on the Worsley mines canal system in 1797. To



An incline on the Gliwice Canal.

overcome the problem he built two locks, side by side at the top of the incline. A boat sailed into one lock, the upper gates were closed and the water drained off to allow the boat to settle onto a platform carriage. The lower gate could then be opened to allow the boat and carriage to descend. At the lower end, the boat and carriage would enter the water, the boat floating off the carriage[10]. Perhaps Count von Reden, Baildon and Wedding had kept in touch with developments in England, or perhaps they came to their own solutions for the design of the inclines on the Klodnitz Canal. Whatever happened, the design of the inclines on the canal were changed from ones similar to those on the Shropshire Canal to ones similar to that at Worsley.

Early canal inclines are of interest to the railway historian in that the point loading on the track would have been of the same order as those to be encountered with the introduction of steam locomotives. Problems with track failure must have been encountered, though the comparatively short length of track required for an incline would have made the provision of suitable support for the track much easier than for a conventional railway. Longitudinal wooden supports were the usual answer. Drawings of the Gliwice inclines exist[11] and show longitudinal cross-sections of the lock at the top of the plane and the chamber at the bottom. There are two scales on both drawings, giving measurements in both Prussian and English dimensions. Other archival drawings for the iron works have similar scales, suggesting that Baildon worked in both English and German units.

Both upper and lower inclines were in use from 1806 until 1828, but by then there were problems with the supply of coal. The reserves close to the canal adit were not as great as anticipated, and underground fires also caused problems. A long heading was driven towards Chorzow, but the cost of hauling the coal underground to the canal made this uneconomic. Subsequently a new road was built from Chorzow to Gliwice for the transport of coal.

Coal mining had started at Chorzow before the mine at Zabrze had opened. The Königsgrube (so-called from 1800) was sunk in 1790, but suffered from explosions and flooding. To overcome these problems, two new shafts sunk in 1795, and steam pumps were installed in 1797. Steam winding followed in 1814. An ironworks at Chorzow was developed between 1797 and 1801 a short way from the coal mine, and was linked to the mine by a tramway, built in 1801-2 and around 600m in length[12]. Originally made of wood, the track was replaced by cast iron in 1812. It was for this tramway that the first steam locomotive on the mainland of Europe was built.

In 1814-5, two Prussian engineers, Eckhardt and Krigar, had visit England and seen Blenkinsop-type engines at work, both at Leeds and Newcastle. Krigar, the Inspector at the Royal Ironworks in Berlin, described the experience:
"Nothing is more surprising for a traveller at the first glance than to meet in a field a long train of wagons which move without the help of any animal."[13]

The experience certainly seems to have made a great impression on him, as Krigar was the man behind the two Blenkinsop-type locomotives to be built in Berlin[14]. The works drawings were lost in a fire in Berlin in 1848, but sketches, correspondence and other papers survive in archives in Germany.[15] Immediately after returning, together with his foreman Schmahel, Krigar set about constructing a steam locomotive at the ironworks in Berlin.[16] A loco was ordered for the mines in the Saarland, but the first loco was designed for the ironworks at Chorzow, at that time possibly the most important ironworks on the European mainland. There they hoped to make a full scale trial of conveying coal from the mine to the ironworks.

The benefits of railways were soon appreciated in Prussia as, in 1816, Dr. Bernard Karsten proposed a 27 Meilen (203.377km) long railway to link Upper Silesia with Wroclaw.[17]

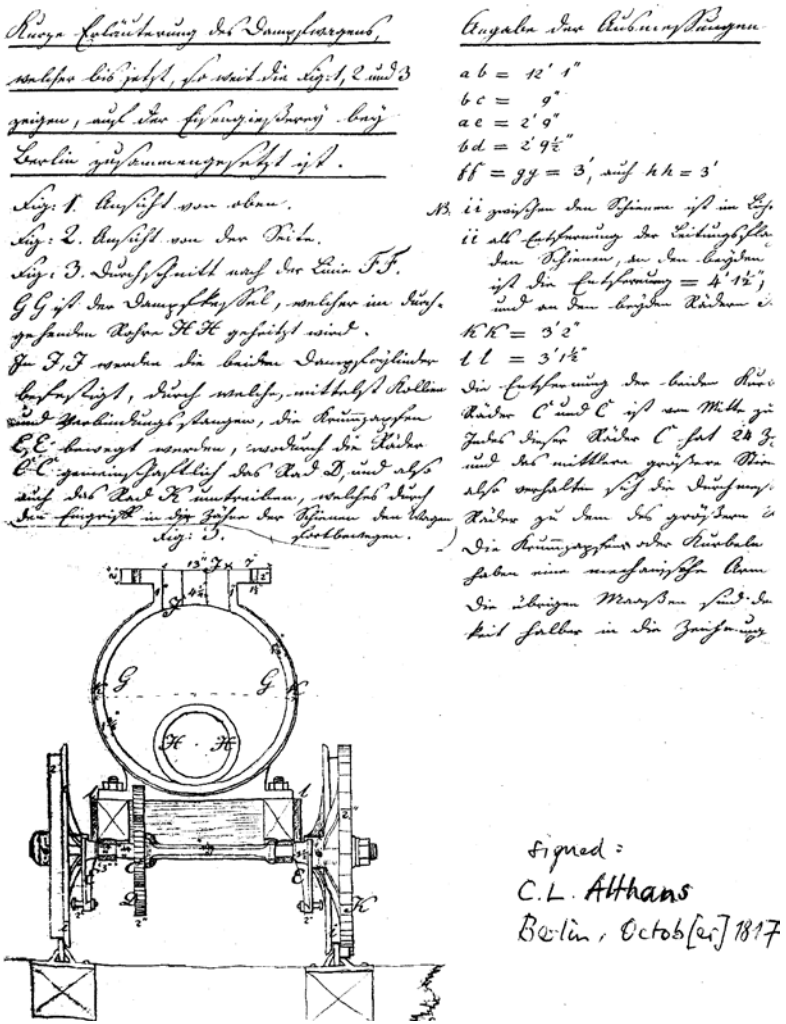
The first locomotive built in Berlin was significantly smaller than the English engines. A cast iron boiler, 2m long and 63cm dia. and made in two halves, was fitted on a four wheeled wooden chassis. The used steam did not exhaust through the 2m high sheet iron chimney, but through a special exhaust pipe. It was ready on 9th July, 1816, and the first locomotive on the European mainland was paraded in front of an astounded public throughout the week for an entry of 4 Grosschen. With the boiler filled with 16 buckets of water, the loco could reach a speed of 50 paces a minute and pulled by chain a four wheeled wagon loaded with 50 Centner (1 Centner = 1cwt). It used about 2.5 Centner of coal a day, costing 27 Grosschen. The track comprised short cast iron sections and had a width of around 94cm[18].

At the end of July the loco was transported to Gliwice where it arrived on the 23rd October 1816 packed in 13 cases. There it turned out that its gauge was 380mm smaller than the existing track. Drawings in the Mining Museum at Zabrze show that there was a similar difference in gauge between the tramways underground and those above ground, and presumably the locomotive was built to fit the narrower underground tramway. If the incorrect gauge had been sent to Berlin it does suggest some disorganisation, or even recalcitrance, within the Silesian mining authorities to the introduction of the loco. However, as they were using modern technology within the iron works and on the canal, perhaps it was dissatisfaction with dictatorial orders sent by the authorities in Berlin. Other defects with the loco included leakage from both the boiler and cylinders, both suggestive of poor workmanship, a later criticism of the second loco. After the first trial, which finally took place in 1817, the first loco was found to be underpowered with its two cylinders of 130mm dia and 314mm stroke. It was decided to replace them immediately in Gliwice with a new cylinders of 262mm diameter. However, it is uncertain if this was done, but the ironworks certainly had the ability to undertake such work. The loco was put to work, but instead of being used on the tramway it was converted into a stationary water pumping engine[19], horses being used on the tramway as previously.

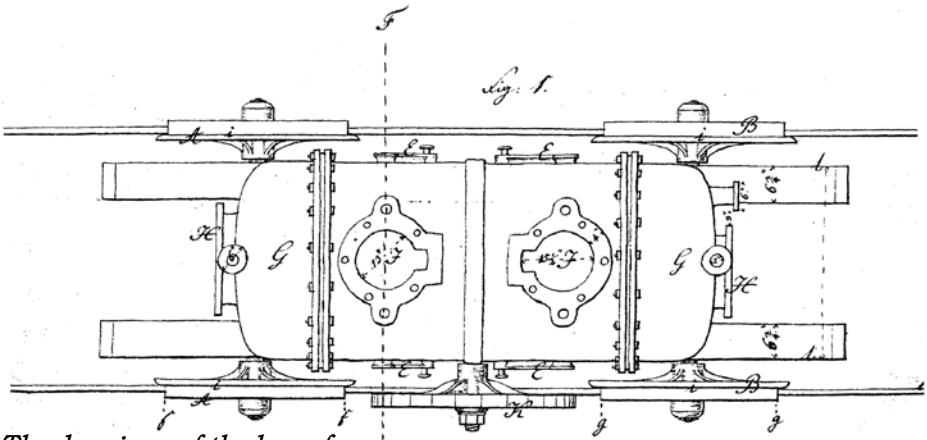
The second Berlin-built Blenkinsop-type locomotive was constructed to work in the Saarland. In 1815, following the Napoleonic wars, most of the Saarland became Prussian territory, with St. Ingbert and Blieskastel going to Bavaria, while France kept the coal seams in the Rosselle valley. Mining practice in the Saarland was not particularly advanced. It had been developed by Prince Wilhelm

Hendrich of Nassau-Saarbrücken (ruled 1740-68), though less so by his successor Prince Ludwig. In 1792 the area was occupied by French troops and the Prince was ejected the following year. The Saarland stayed under French control until 1815. Along with the coal industry, ironworks were also slow to develop, with the main markets for coal and iron being in the German territories to the east of the Saarland.[20]

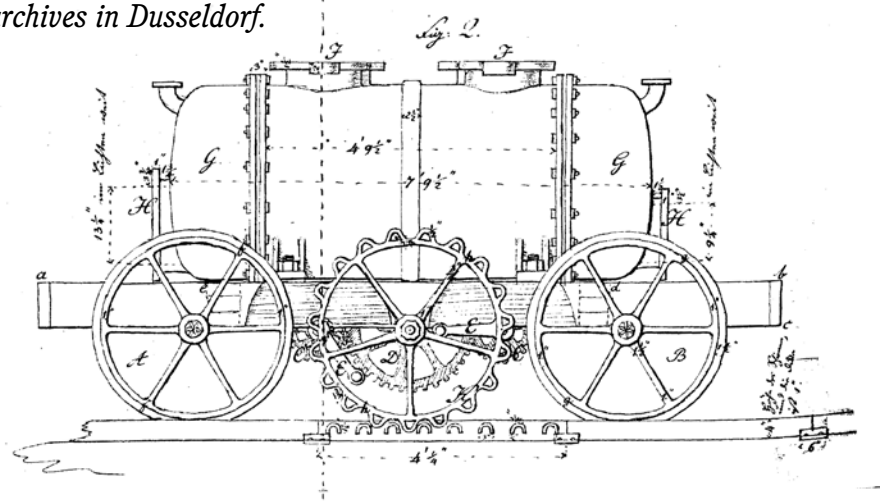
The Mining Office in Saarbrücken was established on 8th December, 1815, with Leopold Sello in charge from 1816 to 1857. He had been worked in Silesia after training at Freiberg mining academy and introduced many technical improvements,



such as the 'Friedrich' tramway at the Gerhard mine in 1821 which used horse traction. Steam pumping was used from circa 1822. On the 27th May 1814, even before the office in the Saarland had been established, experiments with a steam locomotive using cast iron rails in the Saarbrücken district had been ordered by the Prussian office for salt, mining and salt-works in Bonn in order to develop their knowledge of steam locomotives. Before the Chorzow locomotive trials were completed, it was decided to construct a larger loco in Berlin with a ten Zoll cylinder diameter for Saarbrücken. For the trial, the Bauerwald tramway was initially chosen. It is in a wooded valley on the right bank of the Saar climbing to the Gerhard coal mine from the village of Louisental up a gentle half degree steep slope.[21]



The drawings of the loco, from the archives in Dusseldorf.



The first trial was, however, in the Geislautern iron works, between Saarbrücken and Saarlouis. This ironworks was to cast and lay track to a sample sent from Berlin and carry out all necessary accompanying work for the construction of the trackway and the trial under the direction of the Royal Mining Office Inspector of Works, de Berghes, in Saarbrücken. At the same time Krigar proposed that a lockmaker or blacksmith from the area should be trained in Berlin to undertake the dismantling and erection of the steam locomotive, and to carry out any repairs or alterations which became necessary.

On 22nd September 1818 the locomotive was sent from Berlin via Hamburg and Amsterdam to Cologne. The Rhine Mining Office in Bonn informed the Mining Office in Saarbrücken that it had arrived there packed in 8 cases comprising 174 individual parts, and weighing 8780 kilograms, on the 12 December. From Cologne it would be sent to Geislautern at a cost of 6 Frcs. 68 Cent per 100 kg. Finally the ironworks office reported on 4th February 1819 its arrival at a freight cost of 586 Frcs. 50 Cent[22].

In Geislautern, the trial was delayed because of problems making a 100 foot long railway produced to the sample rail sent from Berlin. Eventually a trial was reported by Mining Inspector de Berghes on the 25th September as being very unsatisfactory. Both the construction and execution as well as the usability and appropriateness of the loco were questioned. However, the authorities insisted, in a message dated 26th December, that basic research must be carried out quickly, and a definitive judgement reached regarding the locomotive.[23]

In a further report dated 31st October 1821, de Berghes summarised the repeated experiment. He described the locomotive, revealed its defects and made suggestions for the elimination of them. The loco consisted of a wooden chassis, carried by four wheels with concave wheel rims. A cast iron boiler with a tubular fire box created the steam for two cylinders, one behind the other, of 10 Zoll diameter. The pistons drove two small gear wheels by means of crossheads and two connecting rods. They in turn drove a larger gear wheel situated on one side of its own axle. This was situated close to the rail in order to mesh with the teeth on the rail and thus to move the loco. The motion was described as 'unsteady, stumbling, precarious'. The fairly complicated 'regulator', constructed from a four-way cock, did not allow starting or stopping to be controlled accurately. 'The existing pump worked well, but it lacked a reservoir out of which it could draw water, so that the small bucket used for this purpose quickly became empty. With 30 Thaler,' maintained de Berghes, 'this major defect could be rectified.'[24]

Dr. Bothe[25] states that from this description, the loco was built to Trevithick's patent and furnished with Blenkinsop's toothed rail, and was similar to its prototype, which Thomas Waters in Gateshead had built to the order of Blackett. This suggests that the

Prussian locomotives were based on the Blenkinsop-type ones used in the north-east. Translation of the reports of visits to Britain now held in the Prussian Archive in Berlin would clarify which were the prototypes used.

The 30 Thaler were granted, and the repairs completed were, allowing a definitive trial to be arranged for the 22± March 1822. Attending in an official capacity were Sello and Ironworks Inspector van der Broek from Geislautern. At 7 o'clock, states the report, the boiler was filled with water and the fire lit, and around 11 o'clock the steam had a pressure of 40 lbs per sq. Zoll so that adequate power must have been available to move the empty wagons. After several trials 'it succeeded putting itself perceptibly in motion', and it ran a little down the slightly sloping track; however when one altered the steam regulator, the loco refused to perform and it only managed a few revolutions if four to six men helped it to move. The steam escaped from all the joints, feeds and stuffing boxes, and the pistons turned out to be tight. All attempts failed, though they were continued on the first day until 11 o'clock in the evening and on the next day from early in the morning until 4 o'clock in the afternoon. Thus the experts came to the opinion, 'that all the parts of the loco were not made with as much accuracy as was so necessary for a complicated machine'.[26]

Countering these remarks, Krigar, the constructor of the locomotive in Berlin, protested. He referred to a report of the Mining Office for the Prussian-Brandenburg province of the 9th November 1818, in which the said loco, with a steam pressure of from 50 to 60 lbs per sq Zoll, was expected to pull a load of from 800 to 1000 Centner. The results of the earlier experiment showed that 4.75 hours after the lighting of the fire, and after the expenditure of 1.5 Scheffel of coal, a steam pressure of 15 lb was reached. At this pressure, the loco travelled along the available track of around 100 feet in 1.66 minutes. At 18 lbs pressure a greater speed was achieved, and with 20 lbs pressure the loco went so quickly that it covered 92 feet of track in 1.25 minutes. (less than 0.2 mph!) At this pressure it pulled a load of 40 Centner in 1.33 minutes, a load of 72 Centner in 1.5 minutes. Krigar also suggested that a variation of 10 Centner to the load on the freight wagon made little difference.

After this protest, the trials in Geislautern were repeated on the orders of the Rhine Mining Office, but with no improvement. Sello stated on 31± May 1822, in agreement with van der Broek and de Berghes, that the results were only attained with the greatest effort and with help from men because the excessive friction and heaviness of the loco had to be overcome. The frequent stoppage of the loco was the result of poor fit of the pistons, which allowed a considerable amount of steam to pass between them and the cylinder wall, causing great wastage of steam.

Sello, considered that even if these defects were rectified, then the gear drive would always result in a faltering and wobbly motion. Finally it was stated that the costs for transport, repair, etc had risen 1956 Thaler 17 Sgr. 9 Pf.

The loco was left abandoned in Saarbrücken, till finally the Mining Office on the 23rd September 1834 suggested dismantling it and the useful parts be removed to the Sayner Ironworks near Koblenz. Instead, the Finance Ministry ordered that it be auctioned off to the highest bidder, either complete or dismantled.

The newspaper of the Kreis Saarbrücken and Saarlouis of the 10th April 1835 announced that the parts of a steam loco of old construction, consisting of cast iron, wrought iron and brass, would be auctioned. However, if the offer was too low it would not be accepted. A further announcement on 24th May 1835 gave a free hand for the loco's sale. On the 18th January 1837 it was finally sold for 324 Thaler 22 Sgr.[27]

So ended the first Prussian steam locomotives, a failure caused by poor technical expertise and by passive resistance and antipathy of the officials, both from the central administration and from those in outlying offices. It shows the difficulty in introducing new technology to a country, controlled by centralised bureaucracy, but with independent offices set at a considerable distance to the centre.

Thanks to Artur Zbiegieni, Jan Jurkiewicz, Stanislaw Januszewski, Leszek Budych and staff at the Gliwice Museum and the Mining Museum at Zabrze in Poland, Ralf Banken, Hans-Joachim Uhlemann and staff at the archives in Berlin and Dusseldorf in Germany, and Sheila Bye in England for help with this paper.

Endnotes

[1] For more complete details of Prussian industrialisation see: W.O.Henderson, The State and the Industrial Revolution in Prussia 1740-1870 (Liverpool 1958)

[2] A mining engineer from a noble family in Saxony, he joined the Prussian service in 1777

[3] Wolfhard Weber, 'Industriespionage als technologischer Transfer in der Frühindustrialisierung Deu tschlands', Technikgeschichte, Vol.42 (1975), p. 287-305

[4] Archive material at the Geheimes Staatsarchiv Preussischer Kulturbesitz, Berlin.
Ministerium für Handel & Gewerbe Abteilung für Bergwerks-, Hütten- und Salinenwesen.
121 D III 2 Research visits

1	vol.1	1778-1780	Oberbergrat Waltz, von Eschen & Bückling to England, Sweden and France.
2	vol.1	1783-1824	Eversmann to Holland and England.
3	vol.1	1814-1825	Eckhart and Krigar to ironworks, etc. in England
4	vol.1	1825-1828	Krigar to ironworks, etc. in England.
5	vol.1	1826-1828	von Oeynhausen & von Dechen to England.
	vol.2	1829	

8	vol.1	1832-1837	Oberbergrat von Dechten to Schlesien.
10	vol.1	1781-1782	von Reden & von Stein to King of Poland's Province.
102	vol.1	1850-1860	Ironworks in England.
	vol.2	1861-1865	

[5] A mining engineer from Hameln, he was a nephew of von Heinitz who he succeeded as head of the Prussian mining administration in 1802.

[6] See drawings in the collection of the Coal Mining Museum, Zabrze, Poland.

[7] For John Baildon see W.P.Baildon, Baildon & the Baildons, 1924-6, 3 vols., and the forthcoming Biographical Dictionary of Civil Engineers.

[8] Artur Zbiegieni, 'Hydrotechnical Solutions for Inclined Planes at the start of the 19th Century on the adit section of the Klonice Canal' (Institute for the History of Architecture, Art and Technics, Politechnic of Wroclaw, February 1997).

[9] Present location unknown, but a photograph taken by Dipl-Ing Martin Eckholt in 1940 is in the collection of Dipl-Ing H-J Uhlemann in Berlin

[10] David Tew, Canal Inclines and Lifts (1984, ISBN 0 86299 031 9).

[11] Probably dating from 1810-1815, they can be found in the Coal Mining Museum in Zabrze (drwg. nos. 2713 and 2714),

[12] Krzysztof Soida, Narrow gauge Railways in Upper Silesia (1995 Katowice) ISBN 83-85831-82-7 (in Polish)

[13] Quoted in Conrad Matschoss, The Development of the Steam Locomotive (Vol.1, 1908, reprint 1987) ISBN 3-18-400788-X (in German)

[14] Feldhaus, F.M., Ruhmesblätter der Technik (1910, Leipzig) (in German)
Ilja Mieck, Preussische Gewerbepolitik in Berlin 1806-44 (1965 Berlin) (in German)
C.F.Dendy Marshall, A History of Railway Locomotives Down to the End of the Year 1831

[15] Archive material at the Geheimes Staatsarchiv Preussischer Kulturbesitz, Berlin.
Ministerium für Handel & Gewerbe Abteilung für Bergwerks-, Hütten- und Salinenwesen.
121 D III 3 Nr.3
(Correspondance regarding both locos)
Nordrhein-Westfälisches Hauptstaatsarchiv, Dusseldorf
Oberbergamt Bonn - HSA 562 Nr.1191
(Saarland loco only, includes sketches, folio 13-14)
There is also a drawing of a Blenkinsop loco, similar to that published in France, but with a description in German, in the archives of the Cast Iron section of the Gliwice Museum.

[16] Dopp, 'The steam locomotive of the Royal Ironworks in Berlin in 1816', Mitteilungen des Vereins für die Geschichte Berlins (No.1, 1911, p1-4) (in German)

[17] Michal Jerczynski and Stanislaw Koziarski, 150 Years of Railways in Silesia (1992 Opole, Silesuian Institute in Opole) (in Polish)

[18] Dopp, 'The steam locomotive of the Royal Ironworks in Berlin in 1816'

[19] Matschoss, The Development of the Steam Locomotive

[20] Ralf Banken, 'Die Industrialisierung der Saarregion 1815-1914' (Dissertation Johann Wolfgang-Goethe-Universität Frankfurt am Main 1996) (in German)

[21] Dr. Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia' Zeitschrift des Verein Deutsche Ingenieure (1872 Vol.XVI, pp153-157) (in German)

[22] Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia'

[23] The English engineer John Cockerill, who had set up an engineering works in Belgium, sent letters to Berlin in January 1819 regarding the locomotive. Geheimes Staatsarchiv Preussischer Kulturbesitz, Berlin 121 D III 3 Nr.3, p188-189
[24] Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia'
[25] Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia'
[26] Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia'
[27] Bothe, 'Contribution to the history of the introduction of steam locomotives into Prussia'