Railway technology of Europe in the 19th century

History of railways

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The development of railways in Poland

At the turn of the 18th century, when the industrial revolution began its inexorable march forwards, Poland lost its independence. After successive partitions, 82% of the territory of the Republic of Poland was under Russian rule, 11% was occupied by Austria, and 7% by Prussia. Over the following 100 years, when the world's railway industry was emerging, the division had a significant impact on how it developed in Poland.

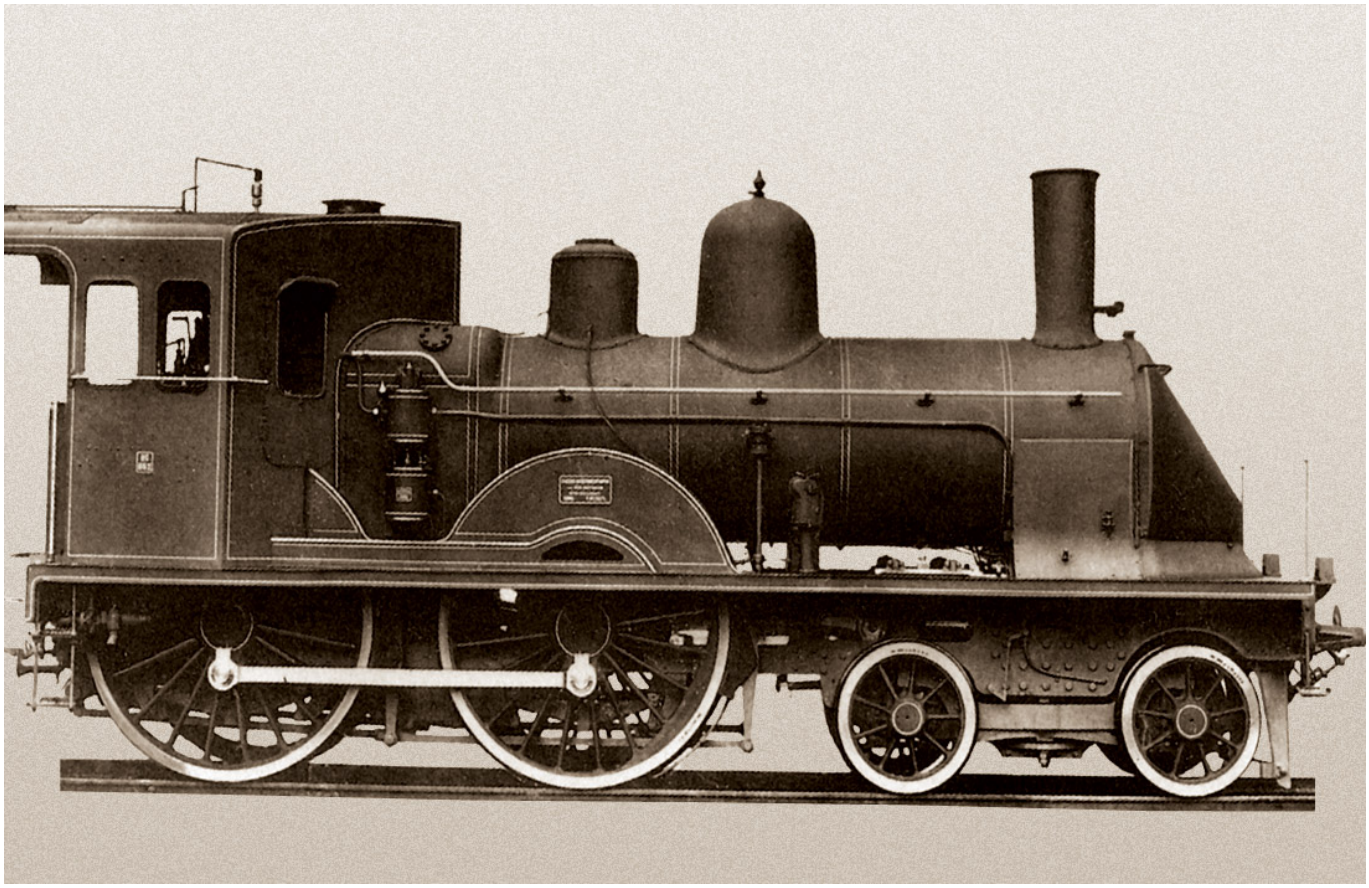
Under German rule

The Prussian Mining Department, based on English steam engine designs by Matthew Murray and John Blenkinsop (with the drive transmitted onto the rack on the outside of the rails), commissioned the construction of the locomotive to Johann Friedrich Krigar in 1816. This is how the first steam locomotive outside of England was built on the European continent. The locomotive was exhibited in Berlin. Afterwards, it was transferred to Chorzów where it was supposed to work in the Royal Ironworks (Königshütte in German). Unfortunately, due to the unreliable gear drive, an attempt to put the steam locomotive into operation failed. The experiments contributed to inhibiting work on implementing railway technology. In addition, the indebted Prussian state was not interested in introducing a new means of transport and it financed the development of inland navigation and maintenance of hardened roads. Only in 1838 was a railway act passed assigning the tasks of construction and operation of new lines to capital companies holding relevant licences. The growing railway industry was becoming a huge employment provider, offering regular salaries at decent level.

Railways and navigation

The routing of railway lines was significantly impacted by a strongly developed inland navigation. An example was the Wrocław-Opole-Kędzierzyn-Gliwice-Katowice-Mysłowice railway route purposefully led along the Odra, to offer a goods transport alternative to river transport, and to facilitate quick delivery of cargo from the ports to the nearest stations. Tracks were built from wide-bottom rails supplied by Belgian and English factories.

In 1842, one of the ships carrying rails from England sank, so a part of the rails was ordered in an emergency mode from Laura Ironworks in Siemianowice Śląskie which had only operated for a few years. The excellent quality of the produced elements encouraged other societies from the territory of Prussia to place subsequent orders. Side tracks were built from the so-called Brunel's rails and flat rails. Then again, unsaturated oak sleepers were shortly replaced by less expensive, pinewood sleepers soaked in zinc chloride (Russia) or creosote oil (Prussia) for preservation.



A two-cylinder German steam locomotive - 1895

First railway line

The first railway line in the present-day territory of Poland, and more precisely its section between Wrocław and Oława, was opened on 22 May 1842 at 6.00 AM. The train of 8 carriages was pulled by the “Silesia” locomotive, produced in the factory of Sharp, Roberts & Co. in Manchester. The first ride lasted 42 minutes and the return journey 43 minutes carrying 102 passengers. On that day the train made 4 runs.

Accommodation for crossing keepers

The tracks needed continuous supervision so gatehouses for crossing keepers were built every kilometre along the line, in particular at intersections with roads, bridges, cuttings or on low-visibility bends. The main tasks of the crossing keepers were: watching the route and checking the condition of tracks within the plot they had been assigned, and removing small faults, driving in track hooks (initially before every passage of a train), and also operating grade-crossing gates and conveying traffic information to engine drivers using optical telegraphs. The gatehouses were usually combined with small living quarters for the crossing keepers and their families. Originally, information about an approaching train was conveyed to crossing keepers by electric bells installed outside the gatehouses. Later, semaphore signals were used to permit entry to the station and exit on the route. At the beginning, signals were set manually, on site, and later signal box wire transmissions were used. In 1894 a green light was introduced to increase the visibility of the “clear” signal and the “stop” signal became the basic position of the railway semaphore. Other railway communication devices were the telegraph, and after 1876 the telephone, a key lock for setting the points and semaphores, and illuminated signalling and switchpoint lamps. Respective German railway companies had separate traffic control regulations.

Puffing steam…

Steam locomotives were imported from England until German factories mastered their manufacturing technology. Generally, from the beginning locomotives were produced with modern fire tube boilers. The oldest designs had external locomotive frames made from timber, while the drive from cylinders was transferred to the axle with centrally located cranks. As early as the 1840s locomotives with internal frames, external cylinders, coupling rod drives and side steam distribution systems were produced. The latter determined the quality of the vehicle's performance and the utilisation of a steam engine capacity. Different solutions for the valve gear were successively developed by: Stephenson, Meyer, Gooch, Allan-Trick and finally, the gear commonly used from 1850 was designed by Walschaerts-Heusinger.

First problems and first innovations

Track curves posed a problem. As the number of axles with bearings on the frame increased, which was connected with the size and weight of steam locomotives, the whole arrangement became more and more rigid. There were many attempts at solving the problem. Wheels without flanges were used, flanges were undercut, transverse travel of axles and finally the sliding Adams axles were introduced and the trailing axles were mounted in two-axle bogies (Bissel system). As technology developed and new technologies were introduced, the number and type of engines changed: from two so-called twin engines, through compound engines where one compression-ignition engine received steam from another engine supplied directly from the boiler, ending with 4 engines in various arrangements, both twin and compound. The small axle base and imperfect chain couplings caused disturbances in the movement of the train and devastation of the track. Thus, coupling bars and rubber or leather buffers filled with animal hair were invented and were later replaced by socket-type buffers with a conical spring. The spacing and height of buffers above the rail head was gradually adopted by all railways according to the guidelines of the Union of German Railway Administrations. It was another step, following the uniform track gauge, towards the introduction of identical technical standards.

Wheeled locomotives

Wheels in axle sets were also subject to transformations: from forged spoke wheels (composed of 8 segments that are properly bent and dressed into a full wheel), through cast steel spoke wheels, to cast iron disk wheels and steel rolled wheels. Axle-boxes with a grease tank were mounted on wheel set pivots.

In the 1890s eight- and twelve-wheeled carriages on Pullman bogies came into use. They had a corridor along the carriage and front wall passages. "American" type bogies were made of teak wood lined with steel sheet. They had dual suspension which cushioned the impact of the wheels. This solution made the carriage run smoothly, in contrast to the old bogies of the Prussian, Bavarian, Baden and Saxon type. The frames were then made from riveted steel sections, followed by a welded section in the 20th century.

Brakemen

Stopping a speeding train was troublesome. Originally, brakes were installed only in the tenders of steam locomotives. Later, they were mounted on trailing (driving) wheels, and hand brakes were used in carriages. Brakemen or porters would stand on the platforms and in braking booths of some carriages, which were arranged in the correct sequence on a train. In response to particular whistle signals of the locomotive, they activated the brakes. This task required the utmost attention and was very onerous, particularly in winter, because of the difficult work environment. Thus, the idea of

fitting the whole train with automatic brakes emerged. Brake designs have come a long way: from mechanical cable Haberlein brakes, through non-automatic brakes (the breaking of the braking cable did not automatically stop the train), Hardy's and Clayton's vacuum brakes, to automatic pressure brakes supplied by compressed air in systems designed by Westinghouse, Knorr, Kunze-Knorr, Hildebrand-Knorr, Dako and Oerlikon.

With regard to the small loading capacity the length of carriages was increased by adding a third axle in the middle. The third axle had a sliding design to ensure that the wooden frames withstood the load of the cargo. This solution was used in both passenger carriages and freight wagons. Ultimately, Diamond bogies were used for freight wagons and bogies with variable suspension stages (2, 3 or 4) were used for passenger carriages.

Travelling by the 3rd class was much less comfortable

First, second, third, and fourth – travelling comfort classes

Depending on the equipment standard, and thus on the travelling comfort, passenger carriages were divided into 4 classes. Each compartment had a separate door on the side walls. 1st class carriages had eight-people compartments equipped with seats with soft fabric- and leather-lined armrests, upholstered walls and window panes. 2nd class carriages had compartments for 10 people each. Until the 1870s both classes were heated by means of boxes with hot sand, water cylinders, and later briquette stoves, placed under the seats, and after the 1880s – heaters supplied with steam generated by the locomotive. Some carriages had coal and coke stoves. 3rd class was equipped with

hard benches for 10 people and initially had no window panes. 4th class carriages were first built as open platforms with rows of wooden benches across the carriage. Later, roofs were mounted and in 1887 the class was liquidated. It was restored in covered carriages at the beginning of the 20th century in response to the interest of travellers in inexpensive transport.

In addition, compartment lighting technology also developed: from candles, through to oil lamps, kerosene and illuminating gas lamps supplied from tanks mounted under the carriages. Before central systems supplying gas to lamps were built, candles were replaced, oil or kerosene was refilled and lamps were lit from the roof of the carriage. This was a task of “lighters” who walked on the roofs along the train set.

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