

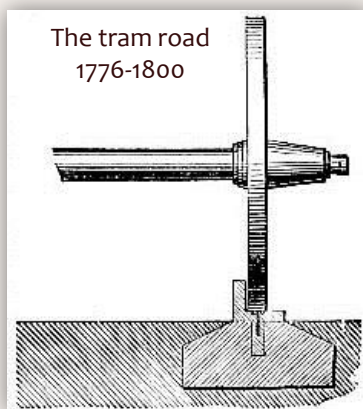
## THE FORERUNNERS OF RAILWAYS

The idea of using "tracked" roads is at least 2000 years old. Quarries in Ancient Greece, Malta and the Roman Empire used cut stone tracks to haul loads pulled by animals.

Around 1568, German miners working near Keswick had knowledge of tub railways. Archaeologists working in the Lake District have confirmed the use of "hunds". The wooden tubs, known as "hunds" ("dog" in German), ran on two wide boards, or rails, and were used to move ore within the mines. Planks at the bottom of the ruts and then laying rails of timber on the level surface was better than filling in the ruts with stones.

Railways had their origin in these tramways which were laid in the 16th Century, in the mineral districts of England for the conveyance of materials to other parts of the country and the sea. In those days, roads especially those bearing heavy traffic were with difficult to keep in good repair.

For more than 250 years, tramways consisted of rails of timber laid *"from the colliery to the river exactly straight and parallel, and bulky carts were made with four rollers fitting the rails, whereby the carriage was so easy that one horse would draw down four or five chaldrons of coals."* A Chaldron is a dry measure equal to about 1100 litres. The rails were formed of scantlings of good sound oak, and were connected by sills or cross timbers of the same material pinned together with oak trenails. The rails were made of wood, were a few inches wide and were fastened down, end to end, on logs of wood or "sleepers", placed crosswise at intervals of two or three feet. After the Industrial Revolution, it became more common to cover them with a thin, flat iron strip, in order to add to their life and reduce friction. This 'wearing' rail, could be easily renewed when worn. It was then possible to cover the cross pieces or sleepers with earth to protect them from the horses' feet. The wearing rail caused more wear on the wooden wagon wheels, so iron wheels were introduced in the 18th Century. The routes of these wagonways, laid by permission ("way-leaves.") of local landowners, led to a canal or boat dock for onward shipment.



While the normal load of coals for one horse on the common road was but 17 cwt., on the tramway a horse could regularly take 42 cwt. However, the iron sheathing was not strong enough to resist buckling with the loaded wagon weight, so rails made wholly of iron were invented.

The first true railways, using a flange to keep the wheel on a rail, were developed. However, they were still called Wagonways or tramways.

The tramway was developed into the railway in the early 17th Century. Its evolution is linked to the use of cast-iron flange rails (fig. 1) to replace the wooden rails; the continuous flange or ledge on their inner edge kept the wheels on the track. The roads were then called tram-roads, provably as an abbreviation of trammel-roads, the flanges of the rails being in reality trammels (beams) to gauge the width and confine the wheels to the track.

In 1604, Huntingdon Beaumont completed the Wollaton Wagonway, built to transport coal from the mines at Strelley to Wollaton Lane End, just west of Nottingham. It has been suggested that such "Wagonways" were used by James Clifford to transport coal from his mines in Broseley to

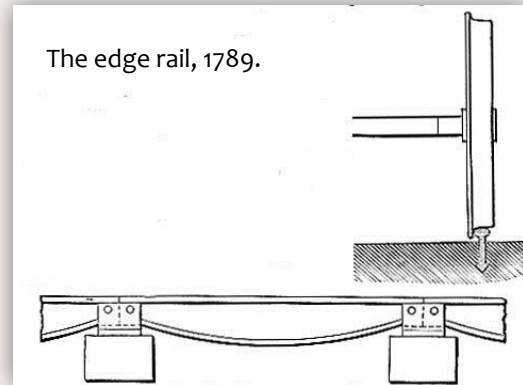
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the river Severn. These are older than that at Wollaton.

In 1767, the Coalbrookdale Iron Works began to cast iron rails. These were probably 6ft long, 3¾in wide and 1¼in thick. Other descriptions also refer to rails 3ft long and 2in wide.

A later system involved "L" shaped iron rails or plates, each 3ft long and 4 in wide, having on the inner side an upright ledge or flange, 3in high, for the purpose of keeping the flat wheels on the track. The wheels of a flangeway were plain, and could be used on ordinary roads. This was probably not commonly done, as the narrow wheels would gouge the road surface.

The leading objection to this system was that the rail was liable to be covered with dirt. Jessop therefore in 1789 laid down at Loughborough cast-iron "edge rails," raised above the ground so as to allow a flanged cast-iron wheel to run on them (fig. 2). This appears to have been the first system of rails laid on cast-iron chairs and on sleepers. The rails were pinned or bolted into the chairs.



A wrought-iron rail was patented by Birkenshaw in 1820, as the "fish-belly" rail, similar in form and mode of support to Jessop's rail, but rolled in continuous lengths, embracing a number of spans, with stiffening ledges or flanges on the under side. This form of rail grew into favour. It was laid in cast-iron chairs, spiked down to square or stone blocks at 3-foot intervals. The edge rail and the flanged wheel constitute the basis of the whole system of a railway. The rails forming a line or 'way' were placed 'to a gauge' or distance apart of 4 feet 8½ inches, and two parallel lines of way were spaced with 6 feet between the inner rails of the ways. This interspace is popularly known as the "six-foot." The evolution of this rail has become most common in railways around the world today.

Wooden sleepers continued to be used. The rails were secured by spikes passing through the extremities— but, circa 1793, stone blocks also began to be used, an innovation associated with Benjamin Outram, although he was not the first to make it. This type of rail was known as the plate-rail, tramway-plate or way-plate, names which are preserved in the modern term "platelayer" applied to the men who lay and maintain the permanent way of a railway.

### Edgeway, edge rails



Another form of rail, the edge rail, was first used by William Jessop on a line which was opened as part of the Charnwood Forest Canal between Loughborough and Nanpantan in Leicestershire in 1789. This line was originally designed as a plateway on the Outram system, but objections were raised to rails with upstanding ledges or flanges being laid on the turnpike road, this difficulty was overcome by paving, or "causewaying", the

road up to the level of the top of the flanges.

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In 1790, Jessop and his partner Outram began to manufacture edge-rails. The wheels running on an edgeway have flanges, like modern railways and tramways. 'Causewaying' is also done on modern level crossings and tramways.

These two systems of constructing iron railways, the "L" plate-rail and the edge-rail, continued to co-exist until well into the 19th century. In most parts of England the plate-rail was preferred. Most lines had been private and reserved exclusively for the use of their owners. Since it was used by individual operators, vehicles would vary greatly in wheel spacing (gauge) and the plate rail coped better. With Parliamentary sanction for certain new railways, these became available for the toll-paying public.



In the North of England and in Scotland the edge-rail was held in greater favour, and by the 1830's its superiority was generally accepted. Wheels tended to bind against the flange of the plate rail and mud and stones would build up.

The manufacture of the rails themselves was gradually improved. By making them in longer lengths, the number of joints (the weakest part of the line) was reduced. Wrought iron was replaced by cast iron, though that material was not widely adopted until after the patent for an improved method of rolling rails was granted in 1820 to John Birkinshaw, of the Bedlington Ironworks, Northumberland. His rails were 18 ft (5.49 m) long, and he recommended that several could be welded together to form longer lengths. They were supported on sleepers by chairs at intervals of 3ft, and were fish-bellied between the points of support. These were used by George Stephenson on the Stockton & Darlington and Canterbury & Whitstable lines. The fishbellied rails, however, were found to break near the chairs and from 1834, they began to be replaced with much stronger parallel-sided rails.

The wagonway had become widely used in connection with collieries and quarries. Gradually, it was realised that it might be a serious competitor to canals, even though a large number of canals had been constructed in England. At this time, the railways were nearly all drawn by horse - the use of steam was in its infancy.

In 1804, Richard Trevithick, in the first recorded use of self-propelled steam power on a railway, ran a high-pressure steam locomotive with smooth wheels, on an 'L' section plateway near Merthyr Tydfil, but it was found more expensive than horses. He made three trips from the iron mines at Penydarren to the Merthyr-Cardiff Canal and each time broke the rails that were designed for horse wagon loads. In 1812, the Middleton Railway (edgeway, rack rail) successfully used twin cylinder steam locomotives made by Matthew Murray of Holbeck, Leeds. In 1821, a wagonway was proposed that would connect the mines at West Durham, Darlington and the River Tees at Stockton, George Stephenson successfully argued that horse drawn wagonways were obsolete and a steam powered railway could carry 50 times as much coal. He was right because soon after the completion of the Stockton and Darlington railway in 1825, cost of coal transport began falling rapidly.



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Stationary steam engines for mining were generally available around the mid 18th century. Wagonways and steam-powered railways, that had steep sections, would utilise a stationary steam engine to haul up the wagons by cable. This is because the early locomotives and indeed horses were not powerful enough. The Stockton and Darlington had two inclined sections using cable, just as the later Coleorton Railway did.

The transition from a wagonway to a fully steam powered railway was a gradual evolution. Railways up to 1835 that were steam powered continued to make runs with horses, when the steam locomotives were unavailable. Some railroads, powered by stationary engines and cables, (San Francisco cable cars) and horse-drawn trams (Isle of Man, Douglas Bay Horse Tramway) are still in use today. Even when steam was common, it was convenient to use horses in station yards to shunt wagons from one place to another. Horses do not need lengthy times to raise steam in the boiler, and can also take short cuts from one siding to another.



Early example of a Mine Tub on wooden rails at Siebenbürgen, 1890's. Note the use of rollers rather than wheels.