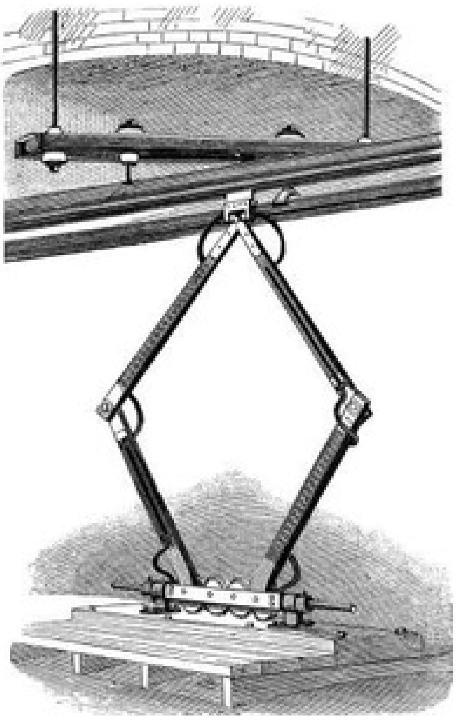
Pantograph

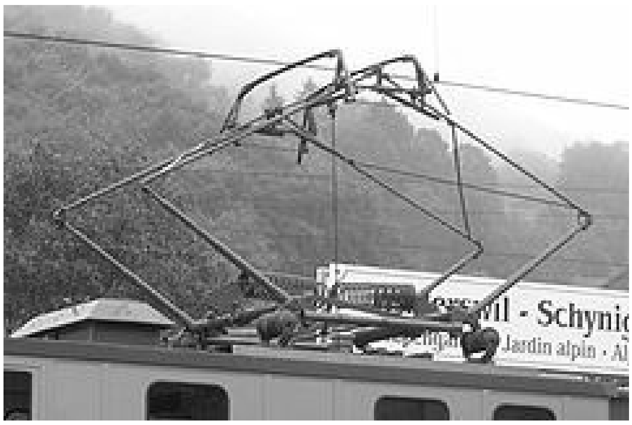


A pantograph for rail lines is a hinged electric-rod device that collects electric current from overhead lines for electric trains or trams. The pantograph typically connects to a one-wire line, with the track acting as the ground wire. The term stems from the resemblance to pantograph lever-rod devices for copying handwriting and drawings.

1895 flat pantograph on a Baltimore & Ohio Railroad electric locomotive. The contact ran inside the ∏ section bar, so both lateral and vertical flexibility was necessary.

A flat slide-pantograph was invented in 1895 at the Baltimore & Ohio Railroad and in Germany in 1900 by Siemens & Halske.

The familiar diamond-shaped roller pantograph was invented by John Q. Brown of the Key System shops for their commuter trains which ran between San Francisco and the East Bay section of the San Francisco Bay Area in California. They appear in photographs of the first day of service, 26 October 1903.



For many decades thereafter, the same diamond shape was used by electric-rail systems around the world and remains in use by some today.
The pantograph was an improvement on the simple trolley pole, which prevailed up to that time, primarily because it allowed an electric-rail vehicle to travel at higher speeds without losing contact with the catenary.

The most common type of pantograph today is the so called half-pantograph (sometimes 'Z'-shaped), which has evolved to provide a more compact and responsive single-arm design at high speeds as trains get faster. The half-pantograph can be seen in use on everything from very fast trains (such as the TGV) to low-speed urban tram systems. The design operates with equal efficiency in either direction of motion, as demonstrated by the Swiss and Austrian railways whose newest high performance locomotives, the Re 460 and Taurus respectively, operate with them set in opposite directions.

The electric transmission system for modern electric rail systems consists of an upper weight carrying wire (known as a catenary) from which is suspended a contact wire. The pantograph is spring-loaded and pushes a contact shoe up against the contact wire to draw the electricity needed to run the train.

The steel rails on the tracks act as the electrical return. As the train moves, the contact shoe slides along the wire and can set up acoustical standing waves in the wires which break the contact and degrade current collection. This means that on some systems adjacent pantographs are not permitted.

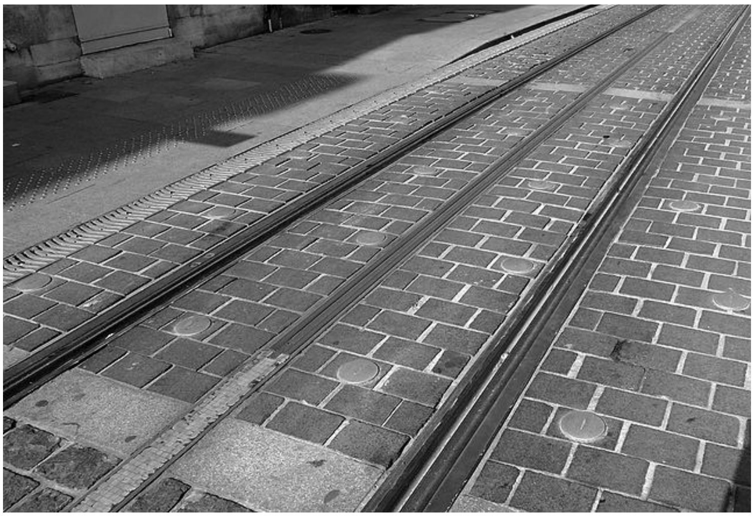
Pantographs are the successor technology to trolley poles, which were widely used on early tram/streetcar systems. Trolley poles are still used by trolleybuses, whose freedom of movement and need for a two-wire circuit makes pantographs impractical, and some streetcar networks, such as the Toronto Streetcar System, which have frequent turns sharp enough to require additional freedom of movement in their current collection to ensure unbroken contact.

Pantographs with overhead wires are now the dominant form of current collection for modern electric trains because, although more expensive and fragile than a third-rail system, they allow the use of higher voltages.

Pantographs are typically operated by compressed air from the vehicle's braking system, either to raise the unit and hold it against the conductor or, when springs are used to effect the extension, to lower it. As a precaution against loss of pressure in the second case, the arm is held in the down position by a catch. For high-voltage systems, the same air supply is used to "blow out" the electric arc when roof-mounted circuit breakers are used.

Pantographs may have either a single or a double arm. Double-arm pantographs are usually heavier, requiring more power to raise and lower, but may also be more fault-tolerant.

Most rapid transit systems are powered by a third rail, but some use pantographs, particularly ones that involve extensive above-ground running. Hybrid metro-tram or 'pre-metro' lines whose routes include tracks on city streets or in other publicly-accessible areas, such as the Manchester Metrolink, must of course use overhead wire, since a third rail would normally present too great a risk of electrocution.



One exception to this is the new Bordeaux tram system that uses an underground system called alimentation par sol (APS), which only applies power to segments of track that are completely covered by the tram. This system is used in the historic centre of Bordeaux where an overhead wire system would cause a visual intrusion. APS uses a third rail placed between the running rails, divided electrically into eight-metre segments with three-metre neutral sections between. Each tram has two power collection skates, next to which are antennae that send radio signals to energise the power rail segments as the tram passes over them. At any one time, no more than two consecutive segments under the tram should actually be live.

A bow collector is another device used on tramcars to transfer electric current from the wires above to the tram below. Once common in Europe, it has now been largely replaced by the pantograph.

When the bow collector was first conceived by German inventor Ernst Werner von Siemens in the late 1880s, American inventor Frank J. Sprague of Virginia had just patented his trolley pole system of current collection from an overhead wire. To avoid contravening this patent, the Siemens Company was forced to design its own, unique form of current collection, namely the bow collector. The bow collector was first used by the Siemens electric company in its early electric tramcars in either the late 1880s or early 1890s. The Hobart electric

tramway system - the first of its kind in the Southern Hemisphere opened in 1893 - used Siemens cars with very early bow collectors.
The bow collector is one of the simplest and most reliable methods of current collection. The earliest versions were simply heavy-gauge wire or steel bars bent into a rectangular shape and mounted long-side-down on the tramcar roof. The height of the collector was such that its top edge would scrape along the wire above. The top section is made of a 1” steel rod, machined to have a bow-shaped cross section, hence the name. This rod is known as the 'collector plate', and in later models may be up to several inches wide. Unlike many trolley poles, the bow collector does not normally have a revolving base (one exception was in Rome, where the entire assembly could be revolved), but is fixed centrally to the tramcar roof.

In the late 1900s the simple framing methods were gradually replaced by more complex and sophisticated methods, but the general mode of operation remained the same.
To maintain good electrical contact, the bow collector must exert considerable pressure on the wire above. Complicated systems of springs or weights were used to ensure good electrical contact, and hence maintain efficient operation.
The steel track acts as the electrical return.
The bow collector is mounted in such a way that the top edge of the collector plate would rise several inches above the wire when the collector frame is standing straight up. The collector leans opposite to the direction of travel; when the time comes to travel in the opposite direction, the collector must be swung over. To allow this to happen, the overhead wire must be raised by several inches at places where the bows are swung over, such as terminals and turn-outs. This operation is usually achieved by ropes and pulleys. The collector is folded down to a horizontal position when the car is not in use.
Some early cars had no means to swing the bows over. It was thought that this would happen automatically when the tramcar started travelling the other way. Collectors such as these were a failure.
Most Soviet trams (of which some are still in use in ex-USSR) had no means to swing the bows over. They had two bow collectors for both directions of travel.

The bow collector has fewer moving parts than the trolley pole, but is heavier and more complicated to construct. The construction of overhead wires for bow collectors is simpler than trolley pole wiring. As bow collectors do not have revolving mountings, the collector cannot jump off the wire or follow the wrong one at intersections, as trolley poles sometimes do. Thus overhead 'frogs' and guides for trolley poles are not necessary with bow collectors. Bow collectors are, however, much noisier than trolley poles.

The overhead wires for bow collectors are stretched tighter than for trolley poles, and straight sections are 'staggered', that is, the wire does not run completely straight down the centreline of the track, but rather zig-zags slightly across a small distance. This distributes wear across the bow collector's collector plate, and extends the collector's life.

In addition to some vintage tramways, bow collectors are still used in some tram systems in the former Soviet Union, (Kazan, Minsk, and Dzerzhinsk). They are also used by the Snaefell Mountain Railway on the Isle of Man.

Committee Minutes

24th November 2011

- On the RT trucks it was found that the change of hydraulic fluid had caused the rubbers in the master cylinders to swell causing binding. The fluid has now been changed back to the original, improving operation
- MMRS Exhibition, Interest was shown by visitors to the stand. Thanks were expressed to JM for organising the event and to those members who had loaned models and manned the exhibit.
- Society Birthday Lunch, Thanks were given to FS for his input and also AP for the organisation. It was felt that the table plans were helpful. The President has written to The Manor to thank them for their service.
- Royden New Eaton Unit; New unit collected from Leamington Spa together with a new Honda engine, these are in store until required.
- Junior Proficiency Scheme, A file has been set up. For Silver Standard membership of the 7¼” Gauge Society is required but not for the bronze level. It is expected that the system will be set up in March.
- It was pointed out that Membership subscriptions are now due on the 1st February, renewal forms will be sent out with the Newsletter which is due out in December.
- Speakers have been arranged up to April but there are still gaps in the programme.
- The 7.1/4 Juniors Day is arranged for the 30th June.
- Santa 2011. Copies of the discussions of the Santa sub-committee meetings have been circulated. The Mayor is due to visit on the first Sunday at 11.30 am.
- The electric skirting heater has now been installed. The new airpots for the transport of hot water have been found to be satisfactory.