Innovation and research

The service life of individual components in overhead wire systems / pantographs is being continually extended with the use of new materials, even at high speeds. BARTELS develops and adapts processing methods to ensure the efficient production of components made of carbon fibre/glas fibre reinforced polymers, titanium, aluminium and stainless steel.

In general, the operational use of measurement systems to monitor contact behaviour requires extensive reconstruction of the collector head. BARTELS develops solutions for use in international projects in collaboration with the producer and operator.

Global experience

Numerous patents, global test drives, many years membership in CENELEC committees and the introduction of titanium and CFRPs in the construction of pantographs all underpin the work of the Railway Engineering business division.

In 2011, the company DOZLER was integrated into the Railway Engineering business division. DOZLER’s products were taken over and have been developed further. We continue to serve DOZLER customers with established expertise and high-quality products and services.

Certification and quality

BARTELS GmbH is certified to carry out welding work on rail vehicle components according to DIN EN 15085-2 certification level CL1 for aluminium, steel, stainless steel and titanium. BARTELS manufactures heavy rail/test/tram pantographs as well as series parts and assemblies.

Customer satisfaction is our number one priority. This is why we work to the quality standards as set out in DIN ISO 9001:2008. Our use of this quality management system demonstrates our commitment to quality and continuous improvement of our products and services in all that we think and do.
Flexible manufacture

- Individual items and series manufacture
- Manufacture to sample
- Manufacture of out-of-production parts
- Supply of ready-to-install and tested parts/ assemblies

Refurbishment and modernisation services

- Repair of accident damage
- Paintwork repairs
- Repainting/ powder coating
- Service life extension
- Replacement of assemblies

Engineering and advice

- Re-design and modification of entire pantographs and assemblies
- Construction of prototypes
- Testing and test support
- Configuration and optimisation
- Integration of measurement systems
- Adoption/ creation of 3D CAD models
Repairs and retrofits
All makes

Flexibility

When in use, pantographs are constantly subject to a variety of external factors, such as oscillations, discontinuities or defects in the contact wire, wind load, bird strikes, ice and storm damage to trees. The need for robustness, however, must be balanced with requirements in terms of vehicle dynamics and wear.

Good contact behaviour requires that the mass travelling in point contact with the overhead wire be kept to a minimum. At high speed, wind load is considerably greater than contact pressure and so wind resistance and its impact on the contact force must also be kept low.

This explains why pantographs are relatively delicate in structure and susceptible to damage by external mechanical forces.

BARTELS is offering the repair and the refurbishment from the single part up to the whole pantograph for all types and brands of pantographs.

You can rely on our professional expertise, flexible manufacturing options and railway engineering certifications.

- Professional inspection and assessment of damage (damage report, assessment of the work involved)
- Repair and refurbishment of all makes
- Supply of ready-to-install pantographs/ assemblies
- Rapid order turnaround

In this case, however, there’s not much that we can do...
Repairs and retrofits
All makes

A variety of processing methods on 70 machines...

You can rely on our experience in assessing and repairing damage of any kind. Our manufacturing flexibility allows us to turn around orders quickly and smoothly, so ensuring the rapid return of your components for immediate installation.

- **General machining**: turning, milling, drilling, slot broaching, sawing
- **Sheet metal processing**: punching, shearing, trimming, deep-drawing, beading, riveting
- **Tube bending and forming**: NC and conventional, tube widths
- **Threading**: cutting, rolling, press-fit threaded inserts
- **Finishing work**: grinding, polishing, brushing, tumbling, glass blasting
- **Welding**: WIG, MAG, spot - steel/ stainless steel, aluminium, titanium, certified to DIN EN 15085-2 CL1
- **Soldering, manual**: hard and soft soldering
- **Wire processing**: swaging of terminals / forging of rod ends
From goods trains to InterCity Express trains ...

The BARTELS / DOZLER Railway Engineering business division has been manufacturing pantographs for trams and mainline trains for more than 50 years. In addition to the DO2106 manufactured and sold in volume, we develop and sell pantographs to customer specifications.

For many years, we have also supplied pantographs with integrated measurement systems to capture contact wire parameters. The FM 2k series features high-precision measurement and a robust design. We can adjust the measurement options available to customers specific requirements.

BARTELS has been manufacturing individual parts and assemblies for mainline trains for 25 years. You can rely on our professional expertise, flexible manufacturing options and railway engineering certification.

- Pantographs for trams
- Individual parts and assemblies for mainline trains
- Development of customer-specific solutions
- Repair and maintenance

Single arm pantograph DO2106

- Contact wire voltage: 800 - 1500 V/DC
- Working stroke: 2300 mm
- Contact strip length: 1050 mm
- Contact strip width: 60 mm
- Total width: 1700 mm
- Nominal contact pressure: 70 N +/- 5 N

For more detailed information, please contact us.
Monitoring the contact wire position

Deviations from the nominal vertical stiffness and from the normal contact wire position relative to the track result in increased wear and pose a risk to operational safety.

The FM 2k measurement system allows measurement and recording during journeys of the vertical contact wire position at rest and the uplift with variable contact pressure adjustments.

Standard and customized solutions with adapted interfaces and/ or individuell functions available. Contact us for individual advice.

- Measurement of the vertical contact wire position
- Uplift of contact wire with variable contact force
- Recording of measurements along the track
- Optional: Measurement of the horizontal contact wire position

Contact wire measurement system FM 2k

- Contact pressure: 8 N - 250 N (adjustable)
- Working range: 2500 mm
- Working contact pressure: Constant with lifting mechanism (electronically controlled)
- Internal friction: Max. 2 N
- Mass: 110 kg

For more detailed information, please contact us.
From individual parts to assemblies ...

BARTELS DOZLER Railway Engineering business division has been manufacturing pantographs for trams and mainline trains for more than 50 years. BARTELS has been manufacturing individual parts and assemblies for mainline trains for 25 years.

BARTELS is your flexible partner for development and manufacturing of customized parts and assemblies. No matter if new parts/ replacement parts/ prototype parts/ single parts/ serial parts. Regarding your demand we develop together with you the best technical solution and the adequate economic manufacturing technology.

Our manufacturing flexibility allows us to turn around orders quickly and smoothly, so ensuring the rapid delivery of your components for immediate installation.

The following pages give a more detailed description of the individual parts/ assemblies we manufacture.

Benefit from our considerable expertise and our certifications for the manufacture of your parts and assemblies. Contact us for individual advice!

- Bracings
- Control rods
- Collector heads
- Collector head assemblies
- Horns
- Wind deflector plates
- Operating systems
- Highly flexible wires for operating systems
Customer-specific pantographs for mainline operation

Heavy rail pantographs have been manufactured in the Dozler Railway Engineering business division for 50 years. Building on this experience, Bartels individually develops products to your specifications, for both AC and DC applications.

The following features are standard in our products:

- Easy assembly and dismantling with only a few standard tools
- Electricity-conducting components made of seawater-resistant aluminium for maximum current carrying capacity
- No paint/no maintenance (with the exception of wearing parts)
- All connecting elements made of stainless steel
- Standard parts only (screws, self-locking nuts, ball bearings, etc.)
- Bimetal contact plates to prevent corrosion between aluminium and copper leads
- Option of an ADD system with adjustable response threshold (no stopping of the train for a minor leakage)
- Low weight 95 - 115 kg (final weight dependent on base frame and collector head)
Individual solutions

BARTELS processes stainless steel wires measuring 2-10 mm in diameter. The swaging of a wide variety of end fittings allows the production of ready-to-install components for a wide range of requirements.

Two stationary and three mobile machines are used to swage stainless steel terminals of all types. As few as one unit and as many as several thousand can be manufactured cost-effectively with the use of different processes.

We are happy to collaborate with you in developing the appropriate combination of wire and end fitting for your use. You can rely on our considerable experience in wire engineering.

Contact us for individual advice!

<table>
<thead>
<tr>
<th>Design</th>
<th>Use/properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 19</td>
<td>Standard version for static bracing</td>
</tr>
<tr>
<td>Dyform</td>
<td>Pre-stretched with especially low residual stretch and virtually the same properties as a rod but can be rolled into considerably smaller rings for transport purposes</td>
</tr>
<tr>
<td>Rod</td>
<td>High-tensile cross-section (1450 N/mm²). Within approved loading limits no residual stretch with maximum stiffness. Cross-sections smaller than 1x19 possible</td>
</tr>
<tr>
<td>7 x 19</td>
<td>Flexible, standard version for pulleys with rolls</td>
</tr>
<tr>
<td>6 x 36 + SE</td>
<td>Highly flexible, for greater protection against fatigue cracks</td>
</tr>
</tbody>
</table>
Assemblies | Components

Wires

From individual parts to series production

BARTELS manufactures wires with end fittings to customer requirements. Whether you require just a small number of units, a prototype, a functional model or series production, you need look no further than BARTELS for a flexible partner when it comes to the manufacture of customised wire.

- Special wire with extra short thread ends for confined installation conditions
- Special terminals with connections as required
- Forged rod ends with connections as required
- Special lengths (processing table up to 20 m)
- Wire with thimbles (copper ferrules for stainless steel wire, aluminium ferrules for galvanised wire)
- Current connectors (customer-specific)
- Special Bowden cable (any length, diameter, connections)

Standard connections for wires and rods

Bracing wires (high-tensile rod)
Wires for lifting/lowering mechanisms (highly flexible wire)
Customised solutions

It is essential to maintain the contact pressure of carbon collector strips on high-speed pantographs within defined limits. As the contact pressure is subject to the varying effects of the flow field around the vehicle, individual adjustments need to be made in the collector head.

Wind deflector plates correct aerodynamic deviations, be the result of the geometry of the pantograph, the direct spring and damping behaviour of the collector strips or the aerodynamic tilting moment of the entire collector head.

BARTELS manufactures series wind deflector plates as bent or drawn parts, with reinforcing beads and/or rivet nuts for fastening. They are made of powder-painted aluminium or stainless steel, but can also be made of carbon fibre or glass fibre reinforced polymers.

We are happy to collaborate with you in developing the appropriate combination of geometry and material for your use. Contact us for individual advice!
A solution for every requirement

Contact wires can sometimes be temporarily or persistently out of position even with regular monitoring.

End horns prevent or reduce the risk of entanglement of the pantograph in the overhead wire. This might otherwise immediately destroy the pantograph and the overhead wire. In high-speed rail systems, the state of the end horns (glass- or carbon-fibre reinforced polymer end horns) is constantly monitored using compressed air.

BARTELS manufactures end horns for a wide variety of requirement profiles:

- Low weight and low air resistance
- Long service life, high shock resistance
- High corrosion resistance
- End horns with a monitoring system
- Insulation properties to ensure potential intervals
- Mounts for wind deflector plates or for links

The materials used are aluminium, stainless steel, titanium and glass fibre reinforced polymers. A flame-sprayed hard material coating is used for metal end horns to increase service life in contact with the overhead wire.

We are happy to collaborate with you in developing the appropriate combination of geometry and material for your use. Contact us for individual advice!

To illustrate 20 years of test support, the picture shows how the weight of end horns has gradually been reduced from 650 g to 160 g.
Assemblies | Components
Steering rods and guides

Robust & light

Bartels manufactures steering rods and guides made of steel, stainless steel and CFRPs. The CFRP version is used when high bending stiffness but minimum weight is required.

Depending on the version, the end fittings for standard rod ends or other components are welded on, rolled on or the tube reduced in diameter for an internal thread. For the CFRP version, terminals are fitted with adhesive.

The rod ends are available in galvanised or stainless steel versions, with bearings or with spherical bearings for especially low friction and robustness.

We are happy to collaborate with you in developing the appropriate combination of geometry, material and end connection for your use. Contact us for individual advice.

- Steering rods and guides
- Steel, painted
- Stainless steel, polished
- CFRP, painted
- Standard or special connections
- Individual manufacture (sample, smaller volumes or high volume)
- Ready-to-install supply
Assemblies | Components
Collector heads
and collector head assemblies

The central functional unit

The collector head is a pantograph’s central functional assembly. When in direct contact with the overhead wire, its function is to guide the contact strips along the overhead wire with minimum intrinsic weight and to absorb oscillations and quite considerable impacts due to discontinuities in the overhead wire. In high-speed rail systems, high wind loads also act on the collector head. During operation, it is essential not to cause the overhead wire to oscillate together with the pantograph. With 4-6 MW power transmission, the contact strips should maintain high operational performance under all operating conditions.

Depending on the requirements profile, BARTELS manufactures collector heads of all types for tram and for heavy rail pantographs for all speed ranges, and installs measurement systems in existing collector heads.

We are happy to collaborate with you in developing a collector head that matches your requirements. Contact us for individual advice!
Installation of measurement systems
Advice / Engineering / Manufacture

Tracking of forces, oscillations and deviations ...

Despite the great progress made in computer simulations of the interaction between pantographs and overhead wire systems, test drives are still essential. The quality of the contact can only be truly assessed by studying the electrical, mechanical and aerodynamic behaviour of the pantograph under actual operating conditions in conjunction with the state of the overhead wire system at the time.

Taking measurements is an elaborate operation as the signals from the high voltage range must be transmitted using fibre optics. Moreover, the aerodynamic forces directly acting on the contact strips during contact with the overhead wire cannot be measured as they impact on only the actual force at the contact point with the overhead wire and so are not externally measurable. Reference measurements are therefore always required, the contact strips being held above measuring wires just under the contact wire.

BARTELS GmbH draws up proposals as to how existing series pantographs can be fitted with measurement systems specific to customer requirements. As forces are being measured at interfaces, measurement transducers cannot simply be built on but the collector head must be dismantled and then rebuilt such that the collector head retains its function and the impact on its aerodynamic properties is kept to a minimum.

Benefit from our considerable expertise and our certifications for the manufacture of your parts/assemblies. Contact us for individual advice!
Certified. Flexible. BARTELS.

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