TSUBAKI NAKASHIMA

Global reach, Local depth

Precision Rollers And Stampings

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1 Tsubaki Nakashima Group

Always innovating and evolving to meet changing market needs, Tsubaki Nakashima group has grown from a Japanese-based ball maker into a truly diversified, global company with a wide range of precision component solutions and assemblies. Customers value us for our consistent quality and service on both a local and a global level. Our customers are always moving toward the next level of technology, better performance, and higher durability. They rely on us for precision component solutions that make their products last longer, with less noise, and greater durability.

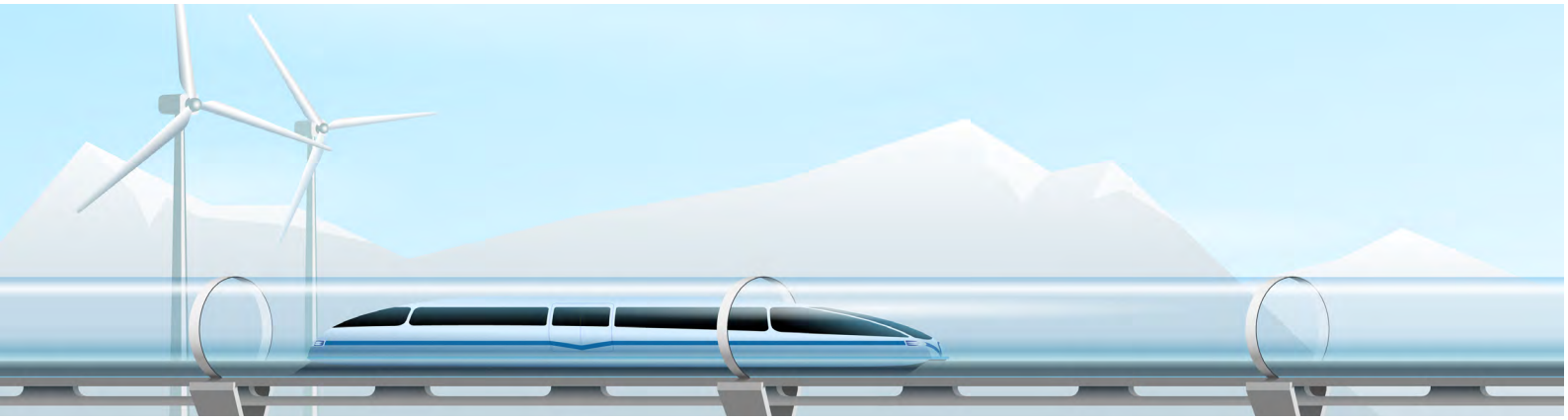
We like to summarise our approach to our customers as delivering improving QCDS

- Quality
- Delivery
- Cost
- Service

Our goal is to continually improve on the level of QCDS we provide. Our customers agree, the growing number who choose the products and service of Tsubaki Nakashima year after year demonstrates the strength of QCDS.

The end use applications are found in products directly connected to your daily lives; automotive, trucks, home appliances, machine tools, robots, drone, automation equipment, ballpoint pens, cosmetic sprays, and more.

- Founded in 1934
- Diversified industrial manufacturer
- Serving a global customer base
- Traded on the Tokyo Stock Exchange
- Operations on four continents
- 3000+ employees
- Headquarters in Nara, Japan



2 Production Facilities

North America	4	Asia (ex Japan)	6
Europe	5	Japan	4

Global Rollers Locations

HYDRAULIC POWER *Custom, Low Friction Products With Quick Delivery*
When low friction is essential for smooth operation, our components stand up to the challenge. We manufacture wear-resistant components that hold up to pressure and have dynamic load carrying capabilities. Using flexible manufacturing lines to produce a broad range of sizes in both diameters and lengths, we deliver a finished product within days of order.

3 The Global Quality Organisation

The Global Quality organisation is focused not only on supporting the manufacture of precision, zero defect product, but more importantly on ensuring our customer's needs are exceeded. Product application and materials development are just two areas where the TN quality and customer teams work together. As a truly global manufacturer of a wide range of precision bearing components our resources and expertise are extensive. You will see direct benefits from these resources and our focus on increasing customer satisfaction and improving QCDS.

Our Quality Mission

"To support the organization to establish and improve effective quality frameworks and technical knowledge with the goal of facilitating the overall success of our internal and external Clients"

Customer Driven Product Development

Standardization
Creating TN worldwide product and raw material specifications
Customer driven

High Performance Steel Project
Developing higher fatigue performance components

Low Alloy Steel Project
Reduce the usage of 100Cr6 for low load applications

Failure Analysis
Supporting customers and TN plants to detect root cause failures

Steel Benchmark
Rig testing for best product/application

Ceramic Balls & Rollers
Develop new sources and materials for next generation products

Low Noise Project
Developing products for lower noise applications

Manufacturing Process Improvement
Improvements that lead to increased customer savings, higher product quality and better QCDS

Customer

Resources
More than 20 engineers and technicians
Technology Center in the Netherlands
Metallurgical and test lab in Italy

Laboratory
Scanning Electron Microscope (SEM) + EDS
XRDs for retained austenite and residual stress
Optical Ermission Spectroscopy (OES)
Micro hardness tester
High resolution optical microscopes
Laser interferometer
Cleanliness test equipment

Testing
RCF test rigs for bearing life
RBF test rig for raw materials
Bearing vibration analyzer
Furnaces / Ultra-refrigerator for HT testing
Salt spray chamber test (SSC)

Analysis
Spectrophotometer infrared (FTIR)
Thermobalance
Spectrophotometer UV-Vis
Laboratory incubator for bacterial/mold
Karl Fischer for oil/water contamination

All Tsubaki Nakashima global rollers plants are certified to IATF 16949, ISO 14001, ISO 9001

4 Innovative Market Solutions

The Global Roller division which includes the sheet metal stamping plant is an integral part of the Tsubaki Nakashima world wide organisation. The division comprises four roller plants, in the Netherlands, Bosnia, Poland and the USA and a precision stamping facility also in the Netherlands.

Our industry position as the largest independent manufacturer of precision rollers allows TN the flexibility to offer products matching a wide range of customer specifications. Our roller technologies have been proven to create lower friction, bear heavier loads, and withstand the most severe conditions, ensuring that bearings containing TN rollers have the longest possible service life.

Our products are used in a growing number of applications, including transmissions, engines, pumps, wheel bearings, mining, heavy industry and railway.

Rollers for Hybrid and Electric Vehicles (EV's)

The transformation from internal combustion engine vehicles to hybrids and electrics (EV's) is growing rapidly. This evolution presents a challenge for bearing manufacturers, a big challenge to adapt and improve current product offerings to the specific requirements of these radical and exciting new vehicles.

Full electric vehicles, as opposed to hybrids, will have a significantly reduced number of bearings. For EV's, which are noiseless vehicles, the technological functionalities of these bearings are expected to improve. Energy efficient solutions for hybrid and electric vehicles are key, resulting in reduced friction and lightweight designs. The technical challenges to optimize the performance of the bearing must be combined with increased life.
The expectation is that full Electric Vehicles will provide 3 to 5 times more mileage compared to current internal combustion engine vehicles.

To support our customers with the extended requirements in bearing design, Tsubaki Nakashima has developed the Class 1 roller. These rollers (tapered and cylindrical) are the best fit for bearings specially designed for hybrid- and electrical vehicle applications.

Class 1 rollers have optimized geometry, extremely smooth superfinished end faces and the spread on all quality parameters between the rollers in one bearing set is less than one micron. This is achieved by packing the rollers in a tube in the sequence they are produced. This packing also guarantees that the raceway surfaces of the rollers have not been in contact with each other after the last superfinishing operation. This avoids any microdamages resulting in less noise and longer life. Please refer to the table on page 11 for comparison of the TN Roller Classes.

COMMERCIAL VEHICLES *High Performance Solutions For A Growing Market*
The safe and economical performance of commercial vehicles relies on high quality, precision components that go the extra mile. From steering to stopping, commercial vehicles are subject to serious challenges. We understand the demands of this growing market and produce components that will function safely, efficiently, and consistently for the long term.

5 Global Roller Division

TN - Veenendaal, the Netherlands

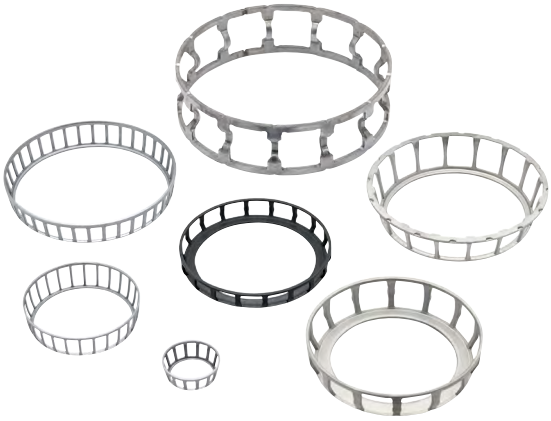
The TN Netherlands Precision Roller and Sheet Metal Stampings facility was established in 1954 and is the largest of the four roller plants. Manufacturing Tapered, Cylindrical, Spherical rollers and Precision Stampings for the automotive and industrial markets.

The Veenendaal site is the location for the division technology center. The technology team is focused on Zero Defect equipment and new product process development. Continuous innovation and ongoing training are key elements of our drive for ever-improving QCDS – Quality Cost Delivery Service.

Production & Markets

High volume tapered, spherical and cylindrical rollers
Sheet Metal Parts

Industrial and Automotive



INDUSTRIAL *Specialized Components For Crucial Uses*
Heavy equipment plays a vital role in shaping the future. Our high-performance components are engineered to withstand even the most unforgiving conditions. Longevity, reliability, and maintenance-free solutions are crucial components for industrial equipment and heavy machinery market segments.

TN - Konjic, Bosnia

The TN plant in Konjic, Bosnia founded in 1984, is focused on high volume, tapered rollers, typically for the Heavy Truck and Railway market.

Production & Markets

High Volume Large Tapered Truck Hub Rollers
Railway Rollers

Automotive and Railway

Rollers for Railway bearings

The plant has all the installed capabilities, equipment and competencies to fulfill the requirements as defined by the Railway Industry. In 2017 the AAR certification (Association of American Railroads) was awarded to the plant and it now supplies tapered rollers to the main railway bearing manufacturers.

Specifications & Capabilities
The Quality Management System is compliant with specification M-1003, section J (Specification for Quality Assurance), issued by AAR. Rollers for Railway applications fulfill M-934 requirements, also defined by AAR. In addition to these fundamental requirements, the plant is able to meet several specific customer requirements, such as quality inspections, special material and packaging. Both through hardening (in house heat treatment) and case carburizing (outsourced HT) can be offered.

Quality inspections
An extensive control plan is available for all process steps. Control Plans are used which incorporate the APQP (Advanced Product Quality Planning) techniques. The planned inspections are based on core tools, like P-FMEA and SPC (Statistical Process Control). SPC has been installed for all key process parameters.

RAILWAY *Long Life Under Heavy Loads*
Whether it's cargo or passengers on board, our components are designed to go the distance. We understand the rigorous industry requirements and produce components that withstand heavy loads at high speeds. With no time for maintenance, our solutions support longer wheel life and facilitate safe, fast and reliable arrival to the destination.

Non Destructive Testing
At a minimum, we guarantee that all rollers pass extensive (NDT) Non Destructive Testing inspections. If requested, TN can deliver EN 10204:3.1 certificates for each lot (pallet or other packing unit). Traceability of process data and quality records is guaranteed for a minimum of 20 years. NDT inspections are structured and managed according to the requirements of ISO 9712:2012. Strict authorisation levels are applied before release of batches.

The Heat Treatment process is compliant with CQI-9 requirements, defined by AIAG (Automotive Industry Action Group). 100% eddy-current surface inspection of raw material (wire and bars) by suppliers is also an option. Peeled wire is available for optimal surface quality.

Certificates
Continuous recording of process data, calibration of thermocouples with fixed intervals and daily supervision of process data are some of the basics of this standard.

TN - Erwin, USA

The Erwin, Tennessee plant began operations in 1980 and manufactures Tapered Rollers, Cylindrical Rollers and Precision Balls.

Production & Markets

High Volume Tapered and Cylindrical Rollers
Precision balls

Automotive, Industrial, Oil, Gas and Wind Energy

WIND ENERGY *Extreme Diameters That Perform Under Extreme Conditions*
A wind turbine has an average life cycle of 25+ years and demands reliable, anti-corrosive components to support longevity. TN produces a range of components designed to withstand the test of time. When the occasion calls for large scale steel balls and rollers designed for durability, dependability, and harsh weather conditions, TN boasts a set of core competencies to satisfy these challenges.

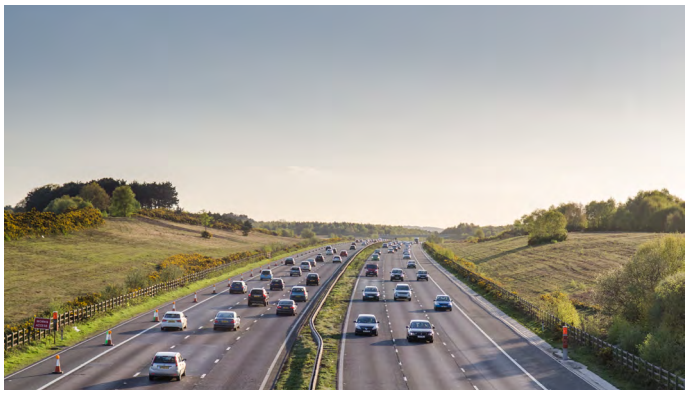
TN - Krasnik, Poland

The Krasnik Poland plant is a precision Ball and Needle roller production facility supplying products to the automotive and industrial markets. Established in 1948, the end product applications are typically Constant Velocity Joints and Needle Roller Bearings.
The majority of the plant output is Chrome Steel, Tungsten Carbide and Plastic balls in the range from 3,175mm to 50,800mm (G5-G300)

Production & Markets

Needle Rollers, Balls, various materials

Automotive and Industrial

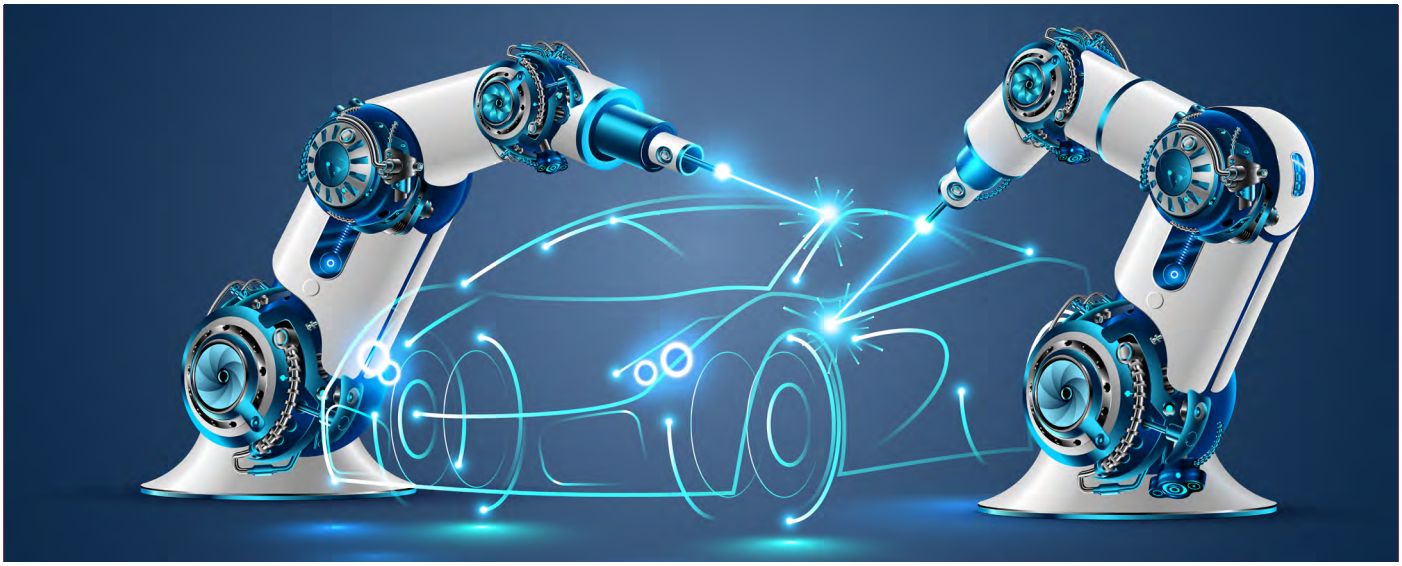


Needle Rollers

The Krasnik factory has a long history of Needle roller production and supplies a diverse global customer base. Main applications are in the automotive and industrial markets, such as rocker arm pivots, pumps, compressors, and transmissions.

Capabilities

- Diameter range 2.0 - 6.0 mm
- Length range 5 - 49 mm
- Material: AISI E52100 (European steel suppliers)



Tapered Rollers

As the world's largest independent producer of tapered rollers, TN manufactures rollers in a range of sizes, materials and profiles according to customer specification. Tapered rollers, typically found in automotive, wind, rail and industrial applications, carry both radial and axial loads and are able to carry higher loads than ball bearings due to the line contact between the roller and raceway.

Benefits

- Less friction, lower noise
- Increased bearing loads
- Higher speed capabilities
- Combined radial and thrust loads
- Decreased lubricant consumption
- Lower heat generation

High precision roller end face geometry with super finished raceway.

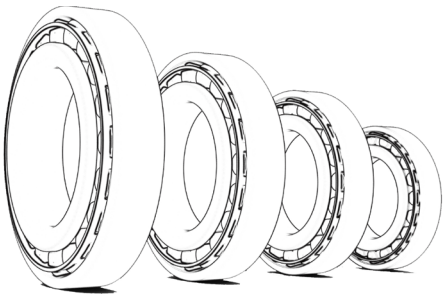
- Reduced energy consumption
- Low heat generation

The Class I Tapered Roller expands the roller range to three classes. The Class I roller is ideal in noise critical, low friction applications, such as automotive and industrial gearboxes and drive axles.

Capabilities

- Over 2 billion pieces per year
- Quality capabilities: Class I*, Class II, Class III
- Diameters from 3mm - 35mm
- Angles up to 25°
- Materials: Thru-hardened AISI E52100, other materials upon request

*Class I is a new development for the lowest friction requirements



Roller Raceway	Class T3	Class T2	Class T1	Class T1 Benefits
Diameter variation in microns (tube packed roller range)	+/-4	+/-4	+/-2	No Damage, Cleaner, Low Cost, Efficient Assembly, Consistent Batches
Diameter variation in microns (sequenced sample of 20)	1.5	1.5	1.0	
Roughness Ra	0.1	0.07	0.04	Low Wear, Friction, Cost
Roller End Face	**Class T3**	**Class T2**	**Class T1**	**Class T1 Benefits**
Radius on -%	16	10	6	Lower Noise
Roughness Ra	0.25	0.16	0.06	Low Noise, Heat, Friction

OIL & GAS *Premium Steel For The Harshest Applications*
For components specifically designed to handle extreme conditions, heavy thrust loads, high speeds and harsh environments, customers turn to TN. We use premium quality tool steel to create stronger, more durable components that will last throughout the lifecycle of a drilling application. With reduced lead times, we make it possible to get your product to market faster.

Cylindrical Rollers

TN manufactures cylindrical rollers on a global scale and offers a variety of materials, diameters and profiles according to specification. Typically found in automotive, wind, rail and industrial applications, cylindrical rollers facilitate a rigid rotation around a defined centerline. As a result of the line contact between the roller and raceway, bearings with this type of rolling element can carry higher loads in smaller packages. Now In combination with the TN Welded cylindrical cage – new development.

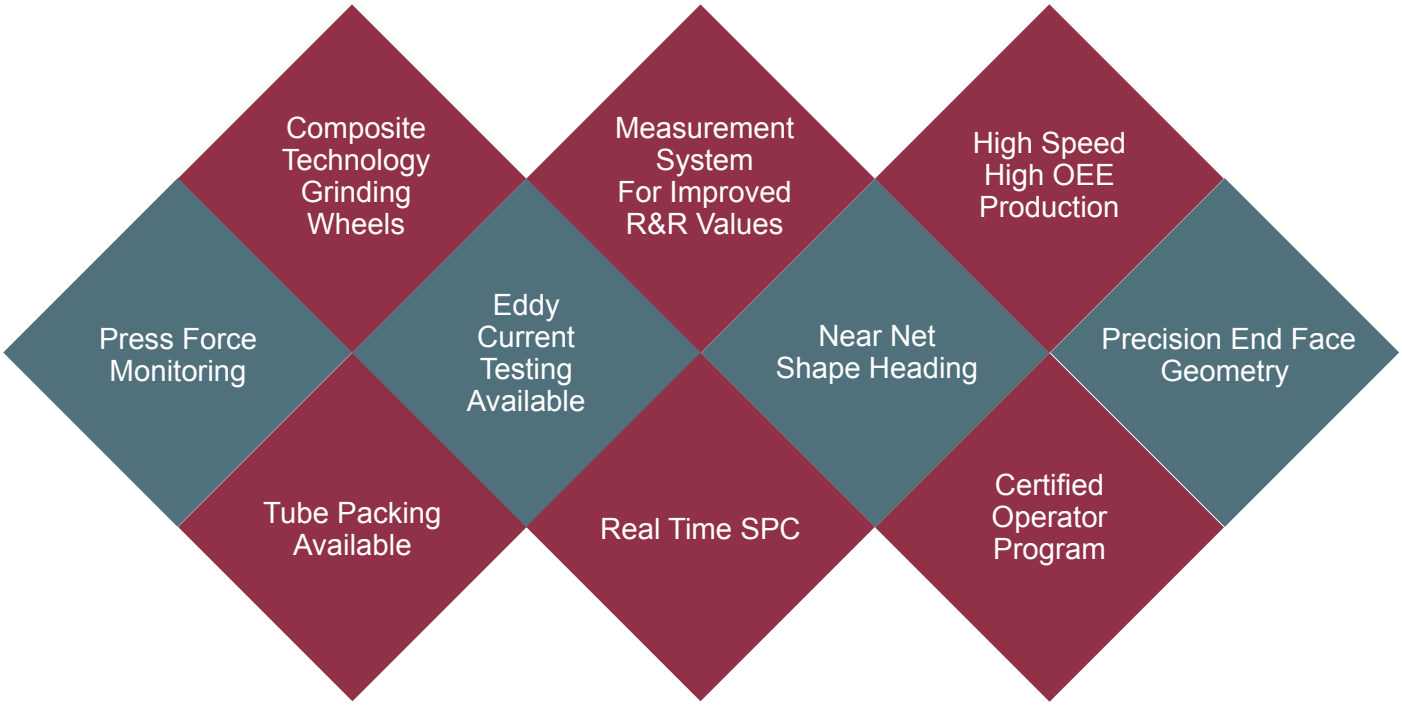
Benefits

- Less friction, lower noise
- Increased carrying capacity for high loads
- Tolerance to misalignment
- Decreased lubricant consumption
- Lower heat generation
- Lower bearing weight
- Reduced energy consumption

Capabilities

- Diameters from 3mm - 120mm
- Lengths up to 120mm
- Materials: Thru-hardened AISI E52100, AISI S-2 Tool Steel, AISI 440-C Stainless Steel

Advanced Production and Zero Defect Technology



Ceramic Roller capability starting in 2020

Spherical Rollers

TN recently added spherical rollers to its product line. The current manufacturing program consists of near net shape headed and heat treated blanks. Typically found in industrial applications, spherical roller bearings are designed to accommodate heavy radial loads, as well as heavy axial loads in both directions. Our rollers are manufactured to extremely tight tolerances, improving the overall quality and performance of a spherical bearing.

Benefits

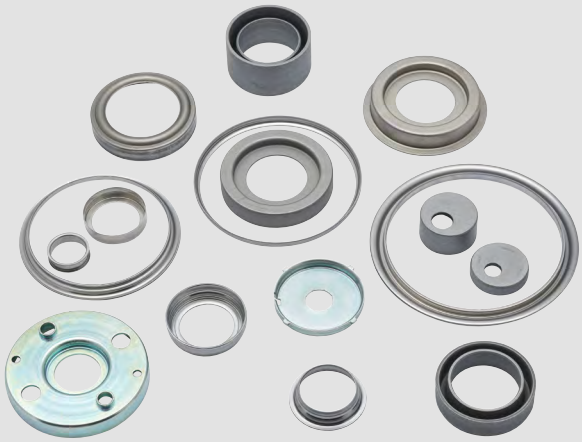
- Less friction, lower noise
- Increased bearing loads
- Higher misalignment handling
- Decreased lubricant consumption
- Lower heat generation

Capabilities

- Headed and heat treated blanks
- First pass raceway grinding available
- Face profiles made to customer specifications (flat, center holes, dimples)
- Diameters from 4 - 16mm
- Materials: various materials available

Cages and Sheet Metal Stampings

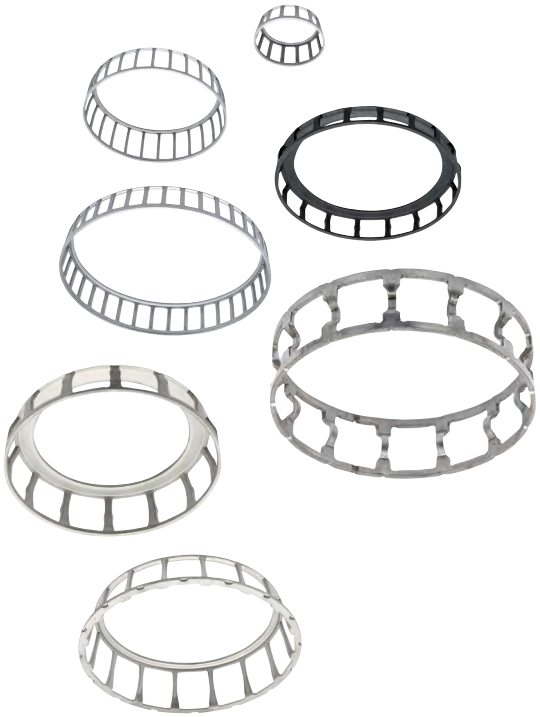
Our fully automated, deep-drawn transfer and die pressing technology allows us to manufacture a wide variety of precision sheet metal parts, including tapered and spherical roller cages as well as other products for automotive and industrial markets. This process delivers high precision and improves overall product performance.



Benefits

- Increased bearing loads
- Enhanced roller running accuracy
- Higher RPM's
- Lower friction and heat generation
- Reduced energy consumption
- Improved automated bearing assembly
- High temperatures tolerated, tensile strength unaffected

Not only do we manufacture precision bearing cages for the automotive industry, we also offer custom-designed products for industrial specialty applications. From belt tensioners to suspension rings, we supply stamped metal products to the world's top automotive brands.



Tapered Roller Cages

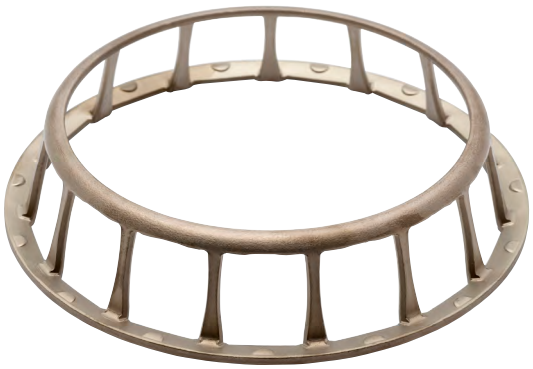
- Diameters from 30mm - 150mm
- 155 types of TRB cages

Spherical Roller Cages

- Diameters from 43mm - 130mm
- 35 types of SRB cages

Capabilities

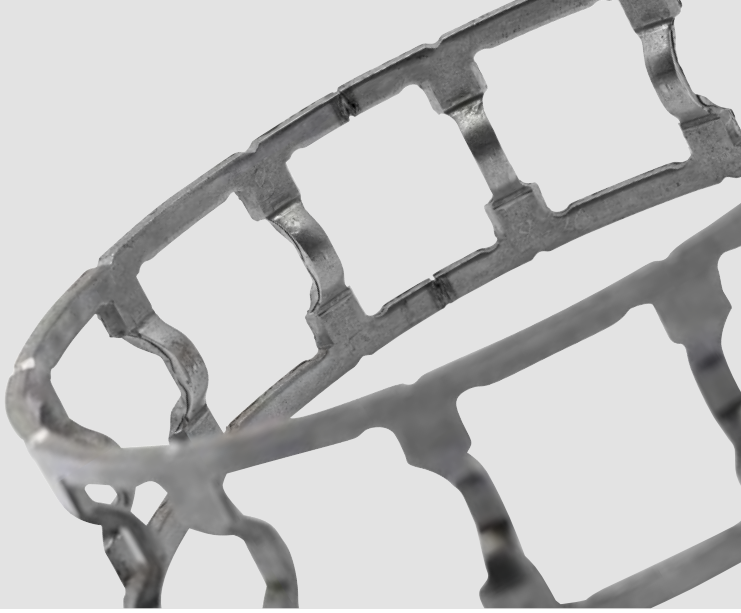
- Precision up to 50 µ tolerances
- Material width up to 400mm and 4mm thickness
- Low to high volumes
- Various materials available
- Flexible laser welding production cell
- Treatments: vibro-polishing, shot blasting, corrosion protection, magnesium and zinc phosphating, nitro carburizing, electroplating, ultrasonic cleaning
- Samples available within 3 weeks



PASSENGER VEHICLES *Trusted Reliability In High-Volume Components*
When dependability and reliability matter most, the largest producers of automotive bearings turn to TN. Our components are produced in efficient high-volume production channels and can be found in major automotive brands worldwide. We work closely with customers to establish and maintain efficient inventory systems, a necessary ingredient for success in the automotive marketplace.

Welded Products

TN's latest breakthrough development - the laser welding process. This recent development allows us to create customer-specific welded products, such as tapered and cylindrical roller cages and more. The opportunities are endless with this innovative development. The laser welding process offers tremendous savings versus traditional stamping methods, which allows us to create high-quality precision products while generating less waste and supporting small lot production batches. With laser accuracy, a small carbon footprint, and low tooling costs, TN's welding process offers impressive benefits.



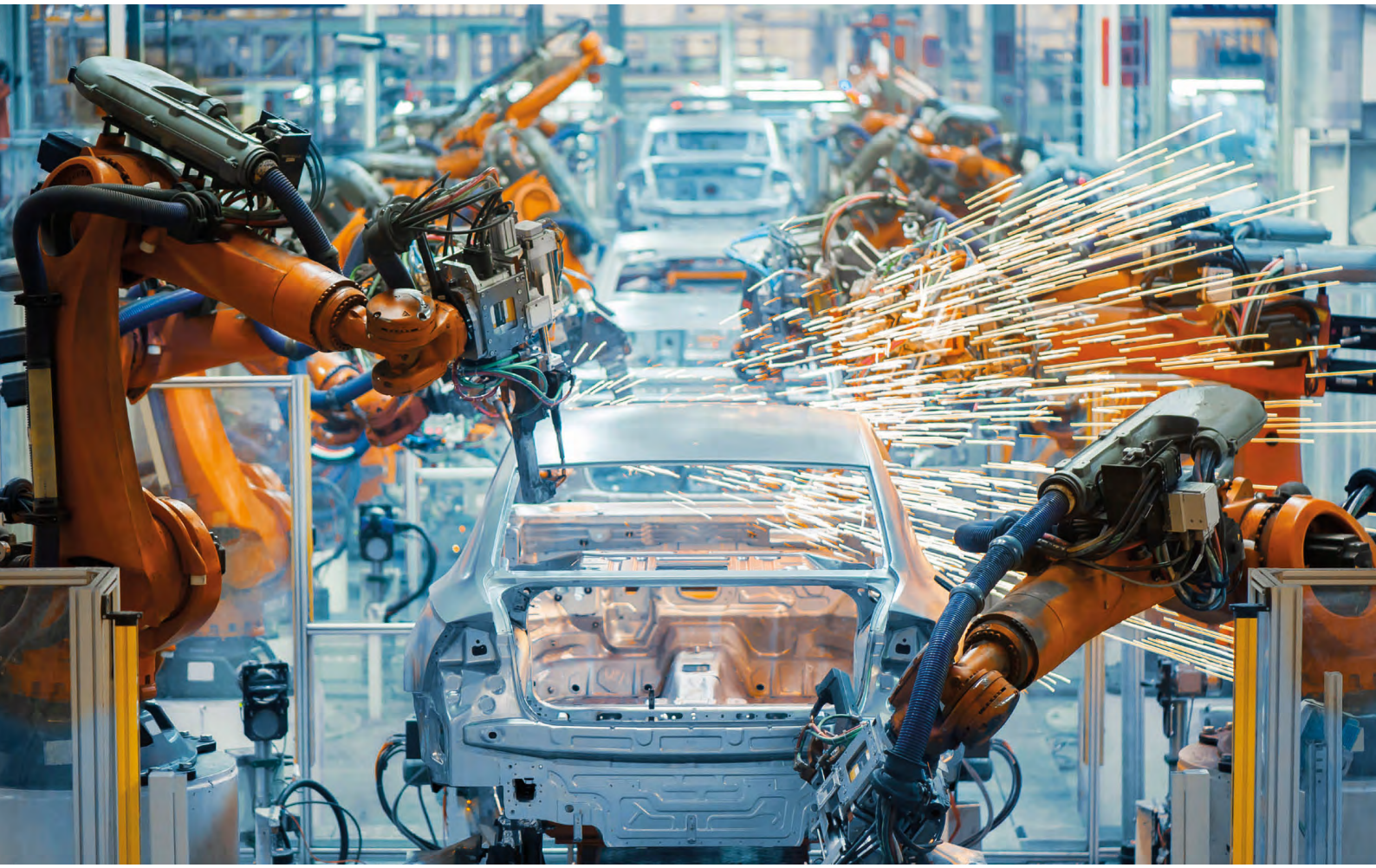
Benefits

- Lower cost
- Customer specified designs
- Low tooling cost
- Short lead time
- Samples within 14 days

In response to customer requests, the new welded cell was developed to produce high-quality precision welded products. Quantifiable customer benefits include low waste, small batch lots and lower tooling costs. Our engineers are happy to discuss your requirements and explain how our welded process and products could be the solution you are looking for.

Capabilities

- Material thickness up to 6mm
- Diameters up to 400mm
- Flexible laser welding production cell
- Gold, silver and bronze finishes available
- Flexible packaging available
- Treatments: vibro-polishing, shot blasting, corrosion protection, magnesium and zinc phosphating, nitro carburizing, electroplating, ultrasonic cleaning
- Various materials available



TSUBAKI NAKASHIMA

Global reach, Local depth

For more information on our precision rollers and sheet metal parts, please contact us at:
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