



# Automotive Engineering Expertise



Engine



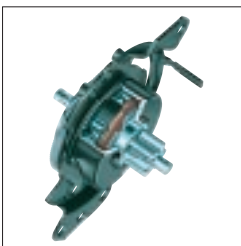
Transmission



Chassis



Interior



## Automotive Engineering Expertise

In automobile production centers around the world – whether in Europe, North or South America, Asia or anywhere else – not a single vehicle would roll off the production line without a strong supplier industry.

For over 50 years, INA components and systems have ensured that automobiles achieve higher technical precision, are safer and provide longer service life. We attain this by constantly analyzing existing solutions, forging new ideas, and developing products that are better than those of the past.

And so it's not just a coincidence that the world's leading automotive manufacturers combine forces with us from the very beginning of a new vehicle design.

Automotive engineering expertise. Our mission is to be your "go to" engineering partner.



*Creative Technology*

# The Engines of the future...

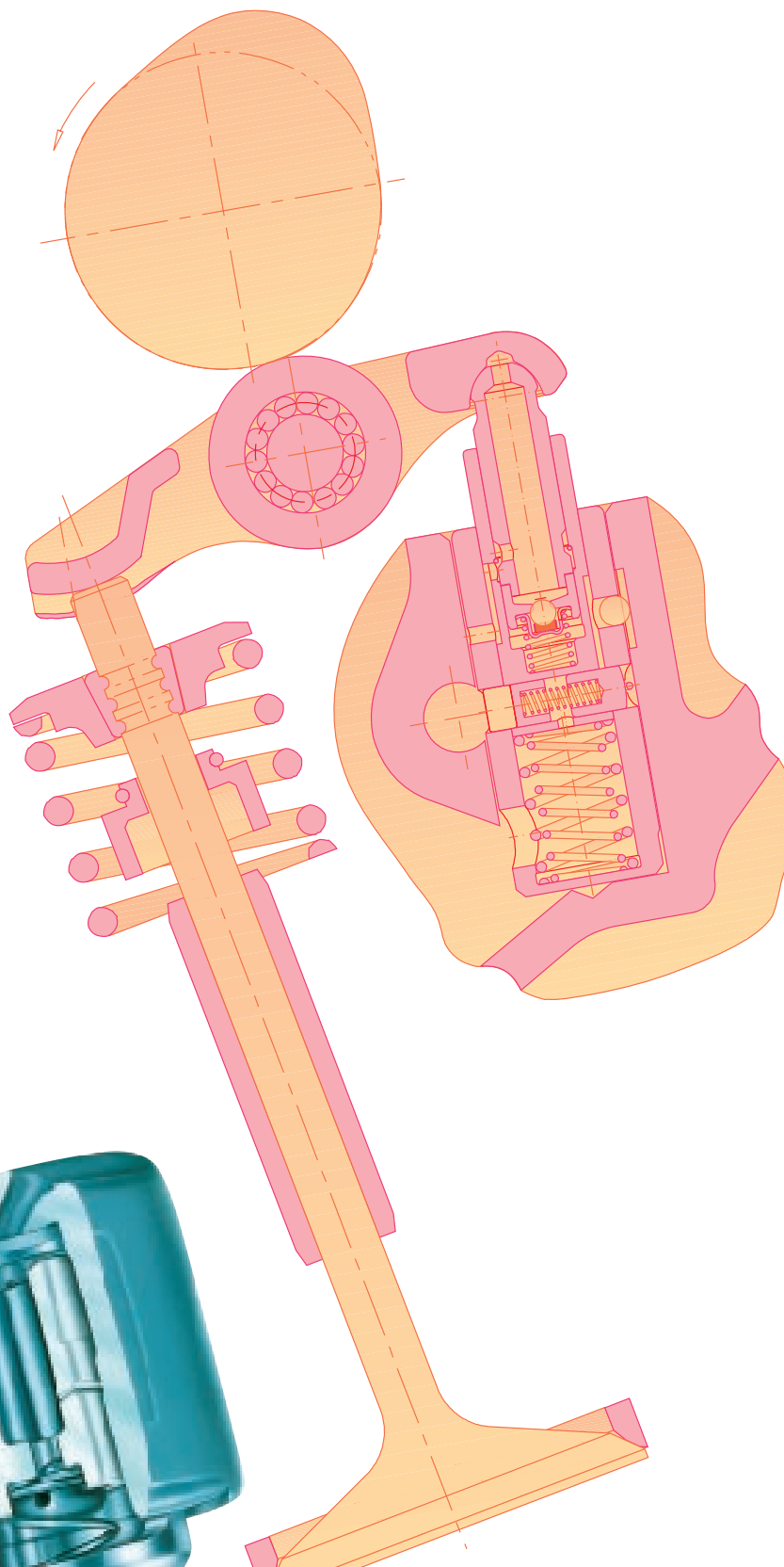
Today's modern engines must meet much higher demands than those of just 10 years ago. This is mainly due to the fact that the interests of individual mobility, the environment and economy are often in conflict. INA components help reconcile these factors.

In many cases, INA recognized and implemented new trends ahead of the rest of the industry. Take the 1960s, for example, when INA systematically pursued the in-depth development of hydraulic engine components. Viewed skeptically at first by many, these components are manufactured today with the cold forming process, which allows them to be produced economically in large quantities.

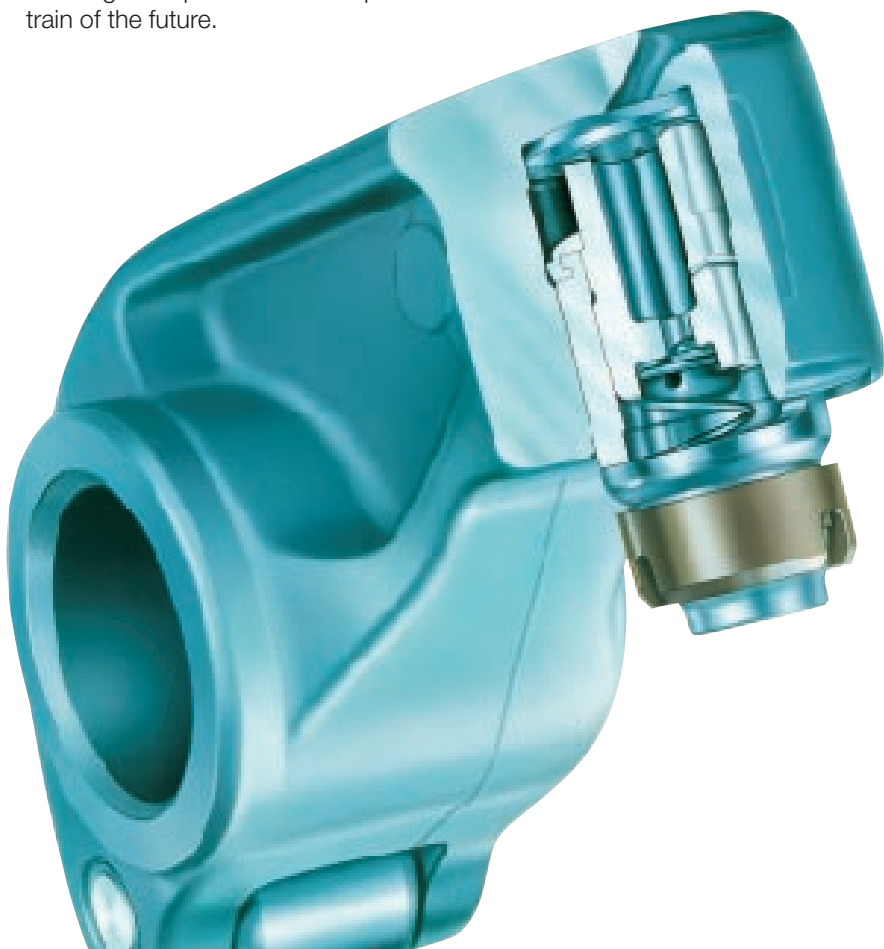
Additionally, we continue to focus our attention on environmental issues. This applies not only for applications in the vehicle, but also for manufacturing processes.

And because recycling our products is a priority today, our responsibility has come full circle.

INA engine expertise. For the power-train of the future.



*Mechanical and hydraulic bucket tappets. The right solution for contemporary engine design*



# ...and their drive components from INA...

INA provides many imaginative and creative solutions for the timing drive. Chain drive and belt drive tensioners optimize the tension of the timing drive system. Vibrations are effectively dampened, and variations in length are automatically compensated. The result is smooth and efficient running.

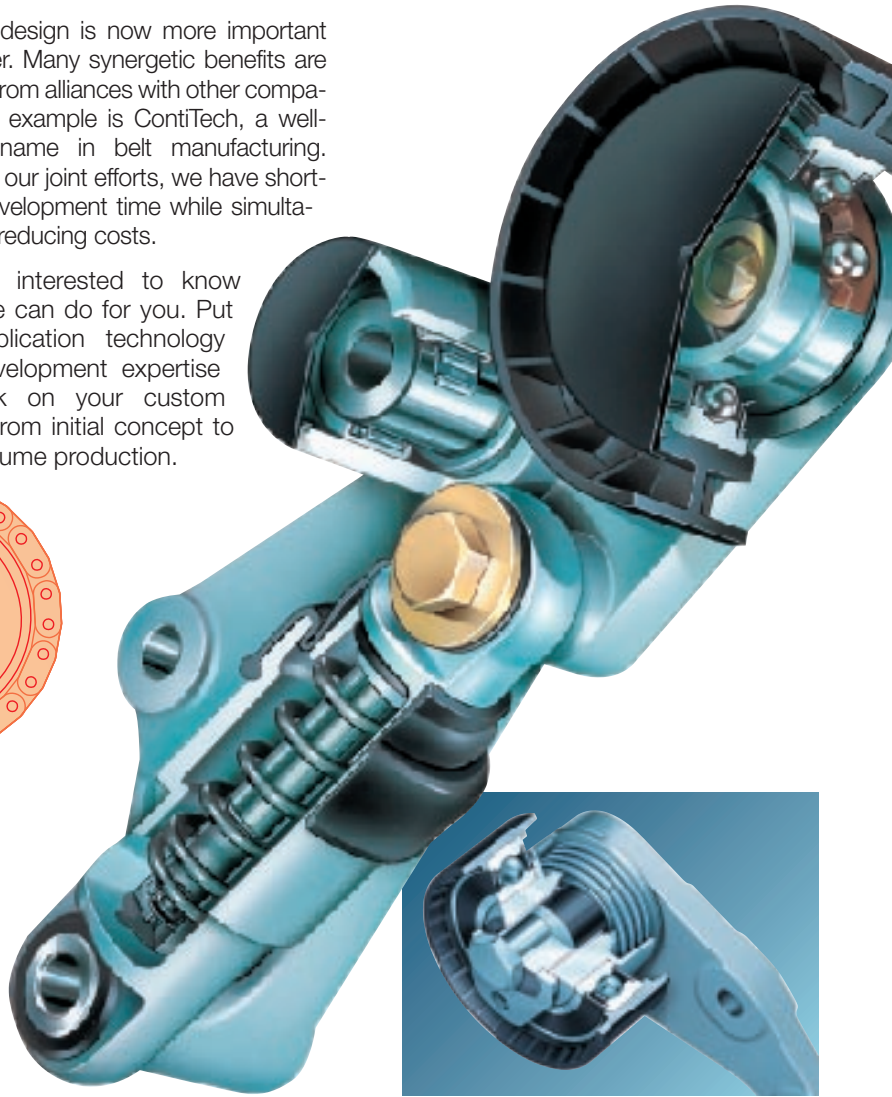
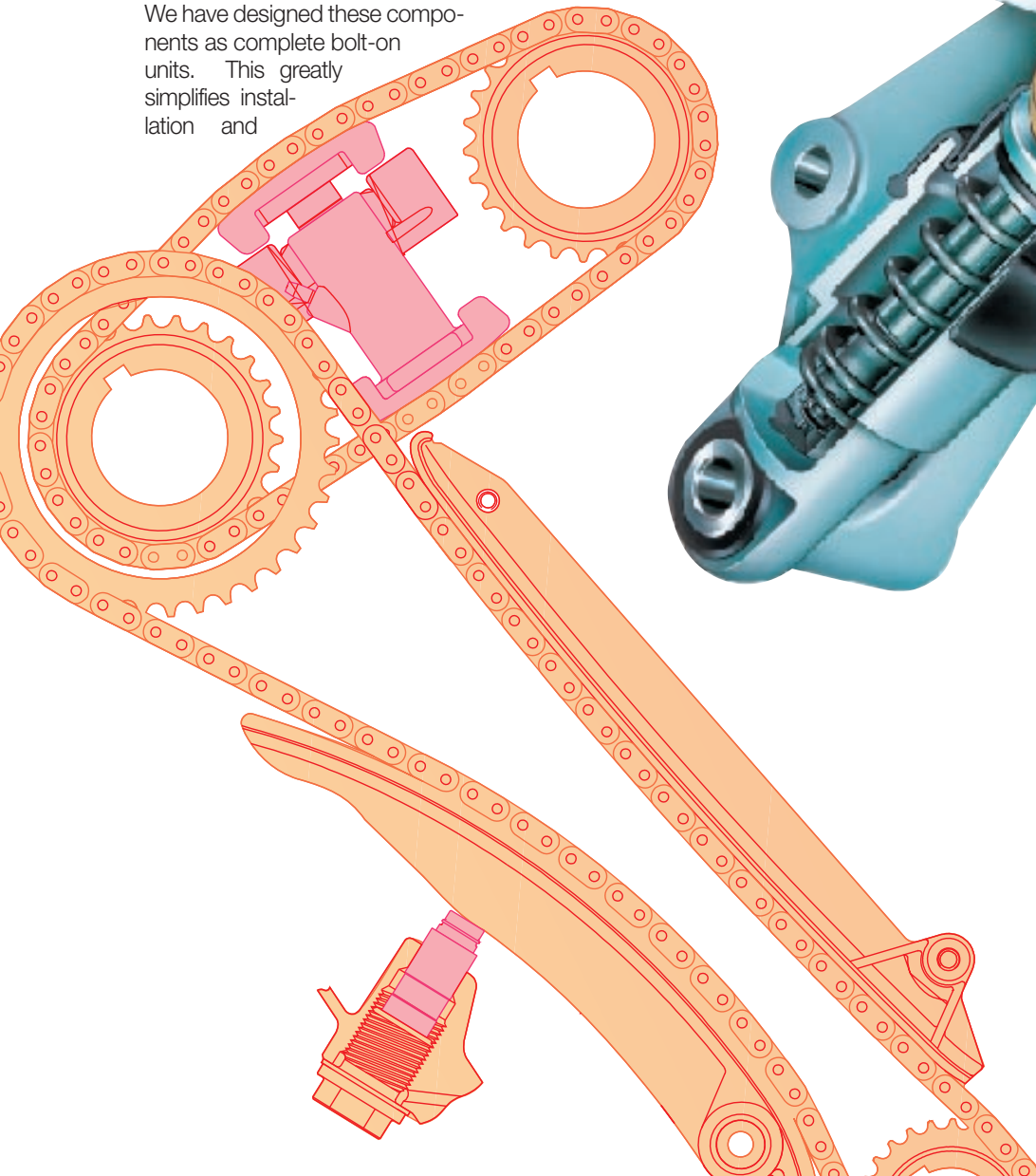
For accessory drives we can offer similar advantages. Hydraulic and mechanical tensioning systems maintain the belt at a specified tension level to prevent vibration. This is particularly important if high demands are placed on running characteristics or for engines that are especially rough running (such as diesel engines). The INA overrunning alternator pulley is an additional factor for smooth running in the belt system.

We have designed these components as complete bolt-on units. This greatly simplifies installation and

initial setting of tension. Since the resulting system is maintenance-free, value is added for both the OEM and the end user.

System design is now more important than ever. Many synergetic benefits are derived from alliances with other companies. An example is ContiTech, a well-known name in belt manufacturing. Through our joint efforts, we have shortened development time while simultaneously reducing costs.

We are interested to know what we can do for you. Put our application technology and development expertise to work on your custom design from initial concept to volume production.



Greater reliability and reduced noise levels. Mechanical belt tensioning unit for synchronous belts



The INA overrunning alternator device reduces torsional vibrations in the belt drive, especially useful for diesel and DI engines

# ...the other components we have to offer...

When INA introduces innovative solutions for engine components, it is often the result of intensive joint efforts with our customers. Even in the planning phase of a new project, we often make significant contributions ensuring success.

We are equally proud of our manufacturing expertise – whether it's in laser welding, precision grinding or cold forming. Using state-of-the-art manufacturing methods, we produce high-precision components to meet the constantly increasing demands of our customers.

This applies for the starter, the alternator, ABS or ASR systems, and equally for the injection pump, the throttle body or the many other engine components. Put us to the test. There are likely more INA products for modern engines than you might have thought.

We will also be on the lookout for new challenges in the future, and we will develop innovations to respond to those challenges. INA components and systems can be relied upon to make everything run smoothly – throughout the entire vehicle.



*Special ball bearing for orbital movement in a scroll air-conditioning compressor*



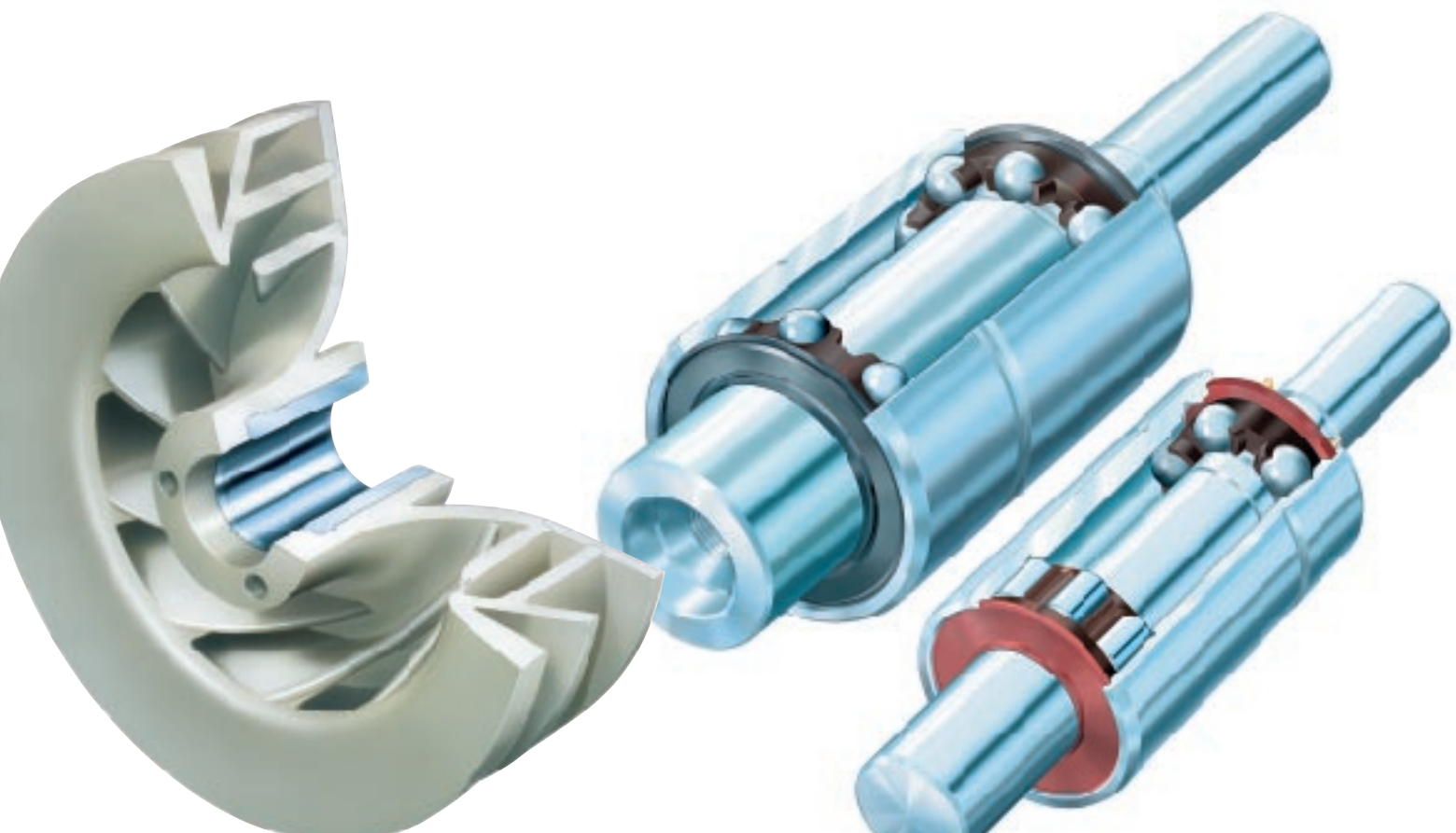
*Support roller with thick-walled, drawn outer ring for high piston loads in an ABS pump*



*Axial needle bearing cage with races*



*High precision deep drawn components and shafts for diesel injection systems*



# ...and how to optimize performance



INA's hydraulic and mechanical engine components help reduce fuel consumption in our vehicles significantly.

Take for example the INA roller-type finger follower with hydraulic pivot element. Precisely controlled valve clearances in the valve train ensure smooth running and low exhaust emissions. Reduced friction provides for increased efficiency and higher durability.

Our hydraulic camshaft phaser allows infinitely variable valve timing. This provides not only a positive influence on torque characteristics, but also reduces fuel consumption and exhaust emissions while improving idle speed smoothness.

It will not be long before our switchable hydraulic components allow the optimum adjustment of engine operation to any given traffic conditions.

That's why it makes sense that leading car manufacturers work with us in joint efforts. After all, INA has an outstanding worldwide reputation as a reliable development partner for hydraulic engine components.



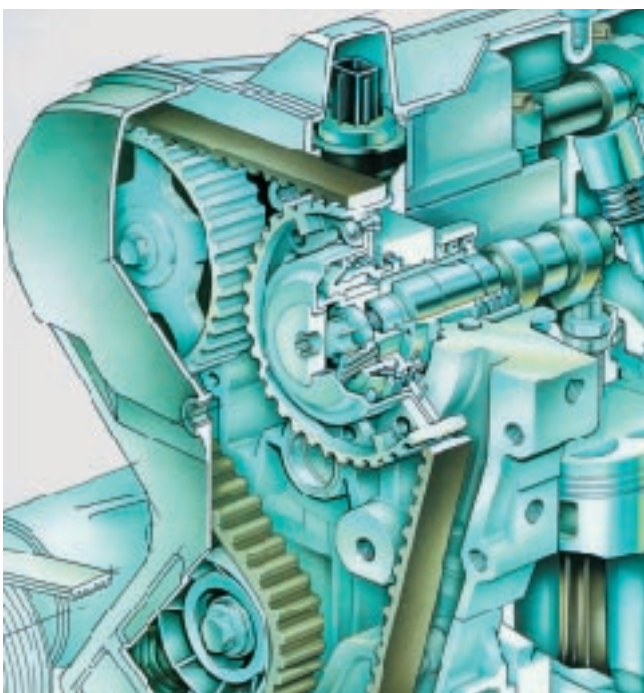
*With our state-of-the-art manufacturing methods – such as laser welding – we can cost-effectively manufacture the INA bucket tappet in mass production*



*Hydraulic camshaft phaser with timing chain sprocket. Its job: to ensure precise and continual adjustment for valve timing with a large torsional angle*



*INA center-pivot rocker arm with anti-friction bearings for reduced friction in OHV engines*



*Super efficient engines are on the horizon. And innovative INA components are making their contribution*



# Creative solutions from INA for the automatic gearbox...

Individual mobility on the one hand and increased environmental awareness on the other influence the design of today's automatic transmissions. Criteria such as efficiency, acoustics, service life and serviceability play a major role here. INA antifriction bearings and components help meet these requirements.

Take for example the highly stressed bearing for planetary gears. Centrifugal forces can occur which are the equivalent of 3,000 times the acceleration of gravity. INA has developed needle roller assemblies in various cage profiles and high strength steels which can withstand such extreme loading.

Especially for this application, we have developed several heat treating and surface coating processes. The most cost effective and appropriate is chosen depending on the specific situation.

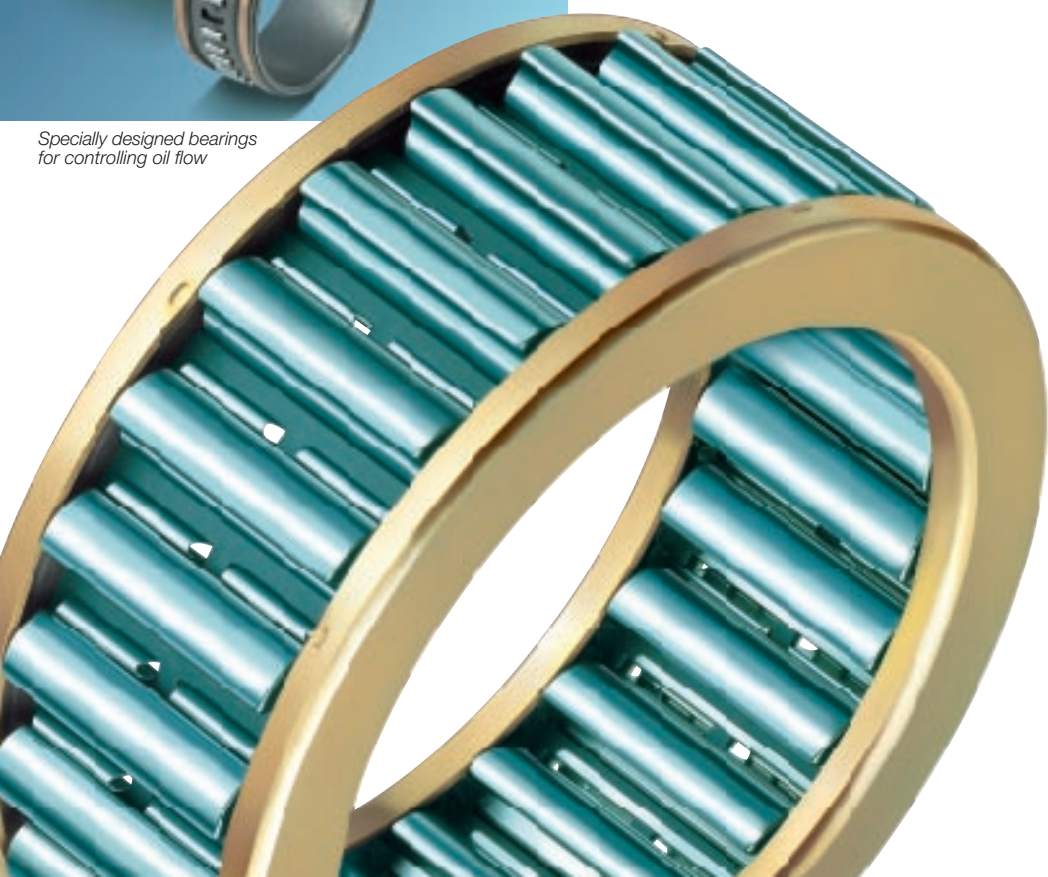
And what would today's automatic transmissions be without INA overrunning clutches? Shifting and lockout are completely independent – without additional shift elements.

Another example is INA axial needle roller bearings. Despite limited envelope, these bearings have very high load carrying capacity and can be combined with INA radial needle roller bearings. Also provided are assembly features to facilitate installation for our customers.

Yet our engineers are never satisfied with their achievements. They are already thinking today about components for the automatic transmission of tomorrow. It's a fact: Any solution can be improved upon.



*Specially designed bearings for controlling oil flow*



*INA planetary gear bearings – an advanced engineering development from two-stroke engine technology. They can withstand more than 3,000 times the acceleration of gravity*



*Sprag and roller overrunning clutches in various designs for high torque capacity*



## ...for smooth clutch actuation...

We have worked for over 25 years on optimizing the power transmission interface between the engine and transmission. INA has produced many pioneering solutions in this area.

The self-centering clutch release bearing and the lever stabilizer are only two examples. The design not only increases smoothness and service life, but also reduces vibrations transmitted to the pedal, thereby lowering passenger compartment noise. Because we engineer entire systems, we have also developed a special grease to meet the extreme lubrication demands of clutch release bearings. As a result, it was possible to increase service life by almost 100%.

And if our hydraulic clutch actuation system as a retro fit unit makes installation much easier today, the question must be asked: Who has really done the most in the last 25 years for clutch release systems?



*Roller bearing with integrated shaft seal and guide sleeve for release bearing*



*The INA hydraulic damper effectively reduces the level of transmitted vibration*



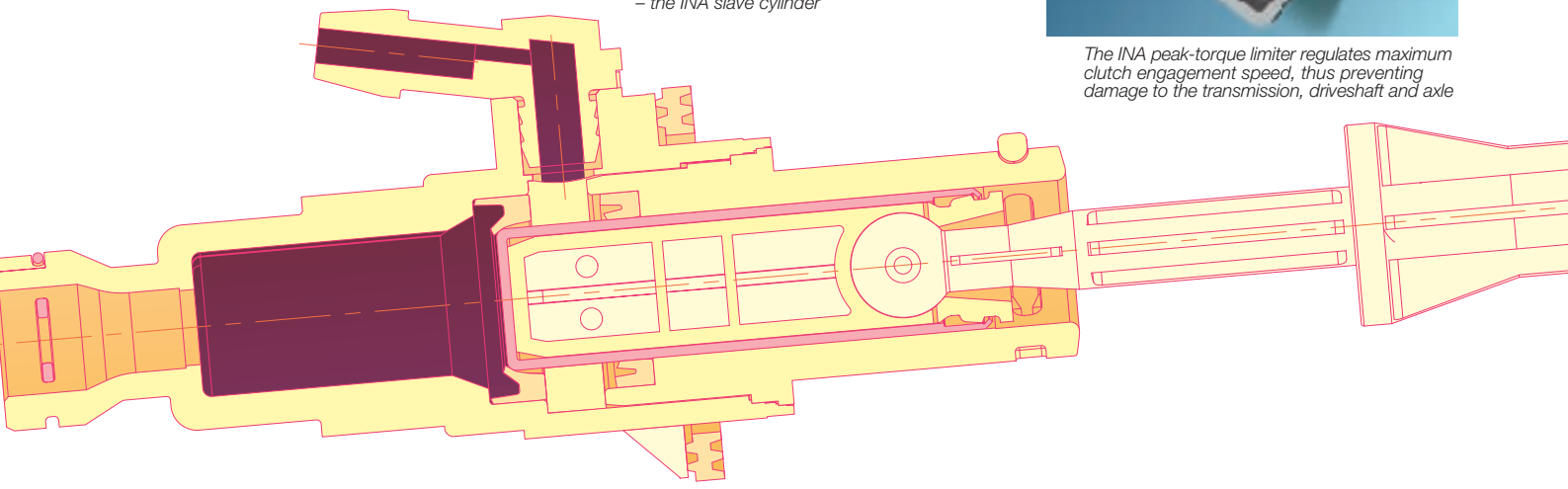
*For smoother clutch control and longer service life: INA release systems*



*For smoother shifting in manual transmissions – the INA slave cylinder*



*The INA peak-torque limiter regulates maximum clutch engagement speed, thus preventing damage to the transmission, driveshaft and axle*





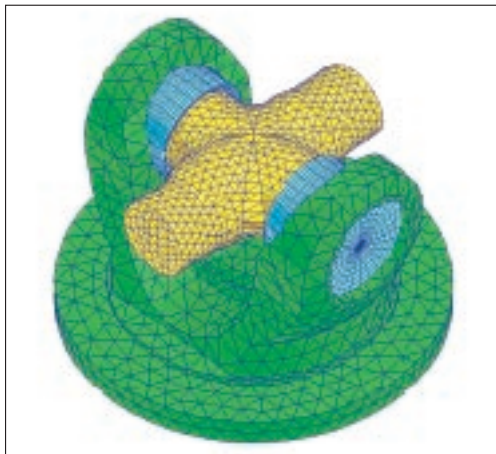
# ...and efficient transfer of power...

From our needle bearing to the latest developments for automotive transmissions, there is a wide range of INA solutions. For example, there is the special axle support ball bearing or the ready-to-install shift system – the INA gearshift module. Today's drive trains already contain a number of INA components – there will be even more tomorrow.

INA also offers many custom-made solutions for other areas of the drive train. For example, tripod rollers for fixed or sliding joints in the half shaft are designed to ensure efficient power transmission even at severe operating angles.

From the beginning, we have always taken our customers' requirements into consideration. INA's quality commitment includes carefully designed monitoring systems in our manufacturing processes to ensure that defects do not occur in the first place. The proof is our certification in compliance with standards QS 9000 and VDA 6.1.

We believe that this commitment to quality provides the best background for successful joint efforts.



*We support automotive manufacturers right from the beginning in developing new products. Here for example is an FE analysis of a universal joint with INA universal joint bearings*



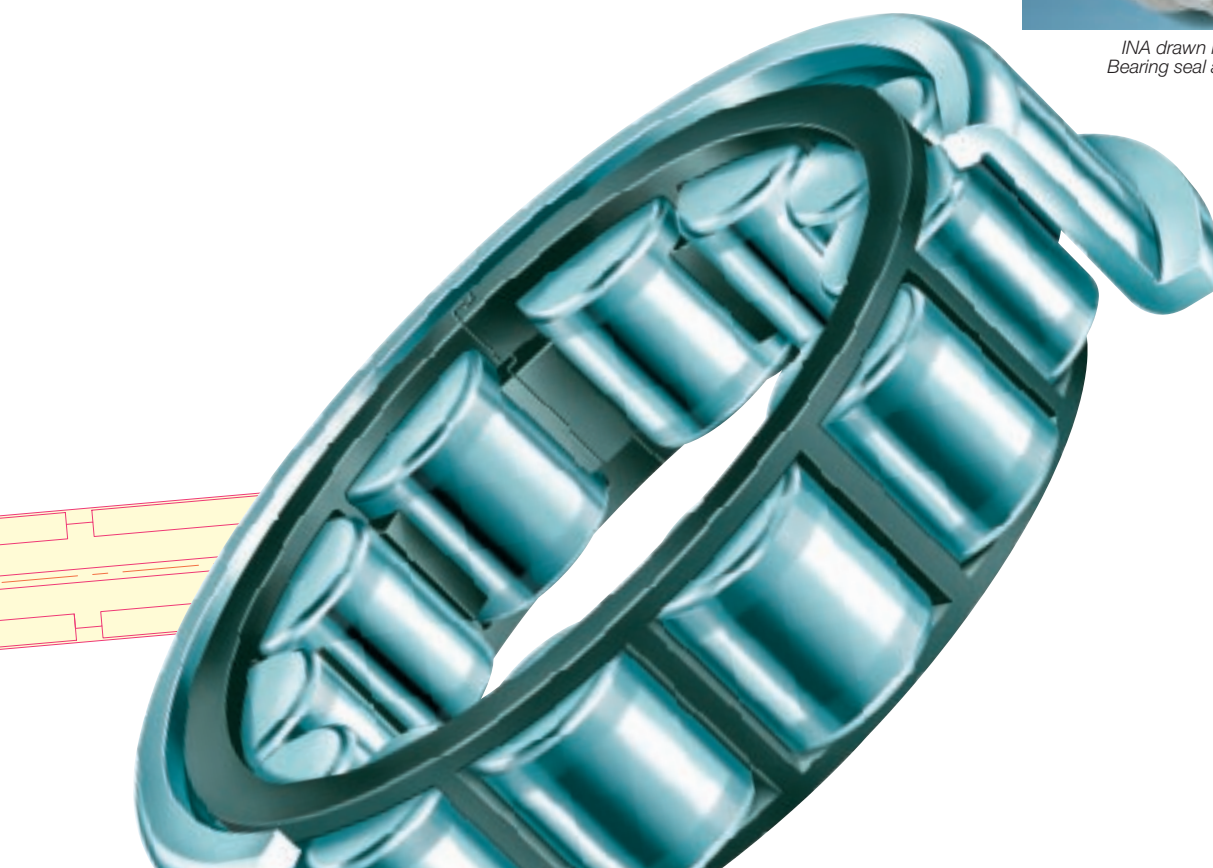
*INA half shaft support bearing – a ready-to-install, corrosion-protected solution for half shaft bearings*



*INA tripod rollers. The perfect solution for assembly*



*INA drawn race bearings for half shafts. Bearing seal and mounting are integrated*



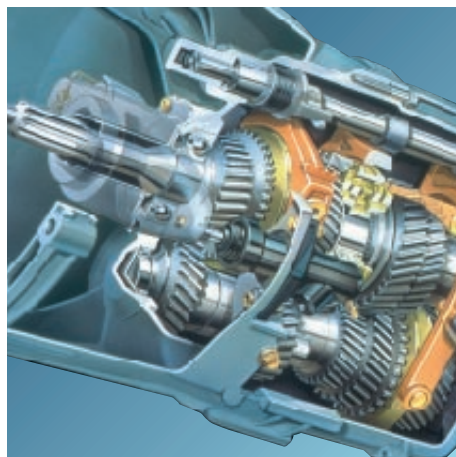
## ...and in the manual gearbox.

An important consideration in transmission design has always been the reduction of weight and space claim. This was true almost 50 years ago when the INA cage and needle roller assembly made it possible to build much smaller transmissions. This still applies today, and is true for all bearings, whether caged needle roller assemblies are used, or drawn cup roller or ball bearings.

INA is also the right development partner for the automotive industry when gear shifting must be as smooth as possible.

For example, when you downshift from second to first, the shift should be smooth and precise. INA synchronizer intermediate rings make this possible thanks to high dimensional accuracy and precisely defined surface roughness. Since we are also deeply involved in state-of-the-art manufacturing technology (high-precision grinding and honing processes, for instance), this poses no problem for us. The result: you can shift from second to first quickly and quietly.

But we are already thinking a step ahead – complete external and internal shift elements, for example. And when future electronically controlled clutch management systems ensure that fuel consumption continues to fall, we at INA will have contributed our share.



*When automotive manufacturers develop new transmissions, INA is involved – from the beginning*



*Bearings for gear-selector shafts and rails for axial or rotational and axial movement*



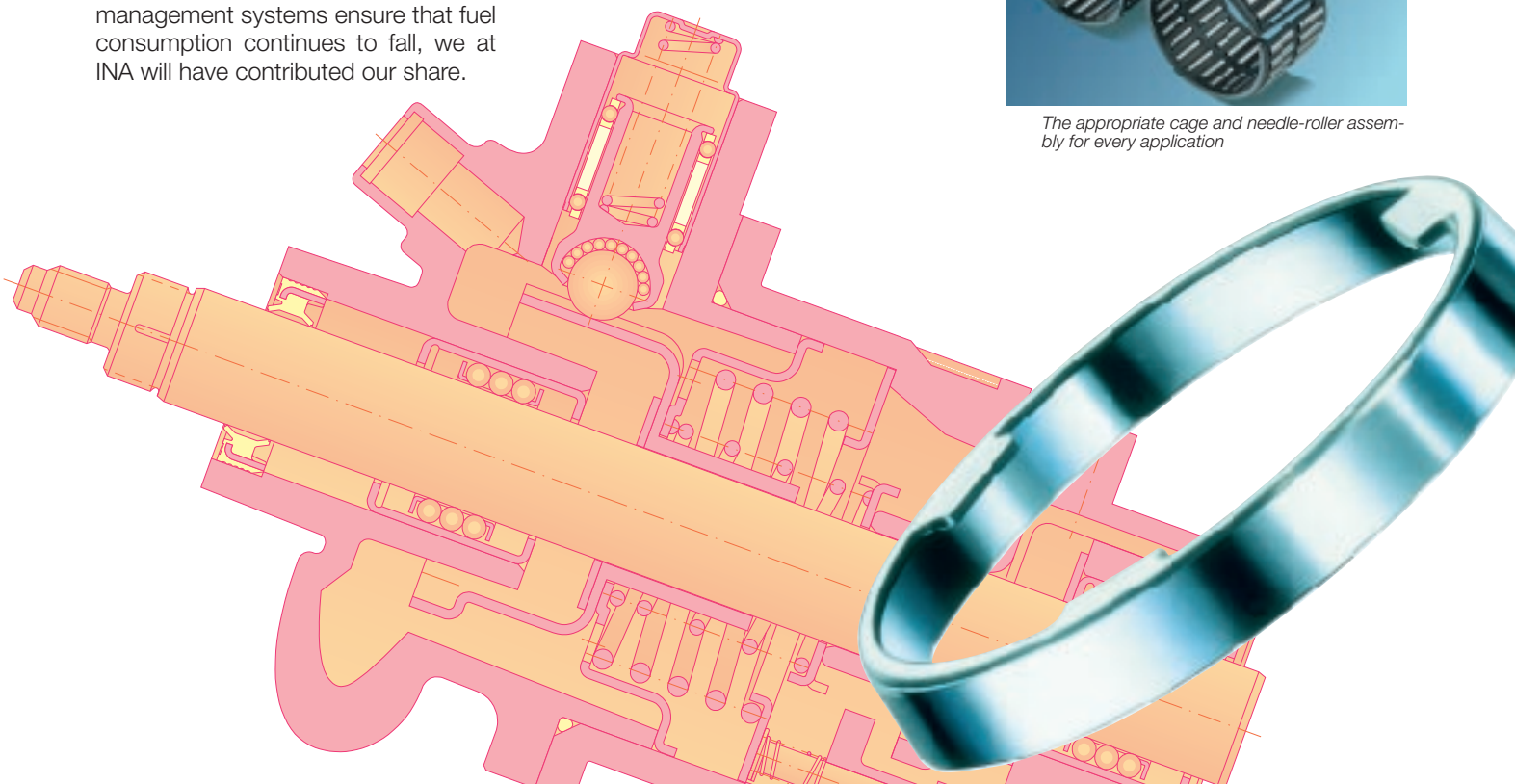
*INA link with integrated locking element. Perfect precision-blanking and bending technology*



*Various versions of shift detents*



*The appropriate cage and needle-roller assembly for every application*



# Always on the right track with INA components...

Our engineers have made sure that driving comfort is not neglected. Beyond that, an optimally tuned chassis and precise steering system ensure that the vehicle responds exactly to driver input in hazardous situations.

The future certainly belongs to the "smart" chassis which can adjust to varying conditions. With the increasing functionality of the overall unit, the significance of the anti-friction bearings also becomes greater.

Technology and safety are not the only important factors. We also consider economic factors. Limited construction space, simple installation, maintenance-free components and system design are just a few of the criteria met by INA components.

Consider for example our INA MacPherson strut bearing. This bearing can absorb radial and axial forces and is a ready-to-install, sealed unit which is specifically designed for your application and ideal for robot assembly lines.

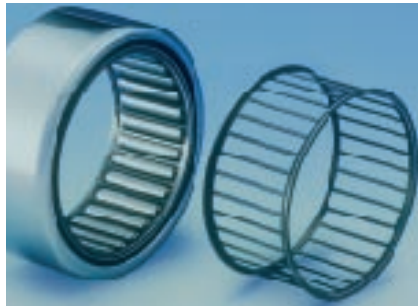
As you can see, you're on the right track with INA when you're looking for chassis systems.



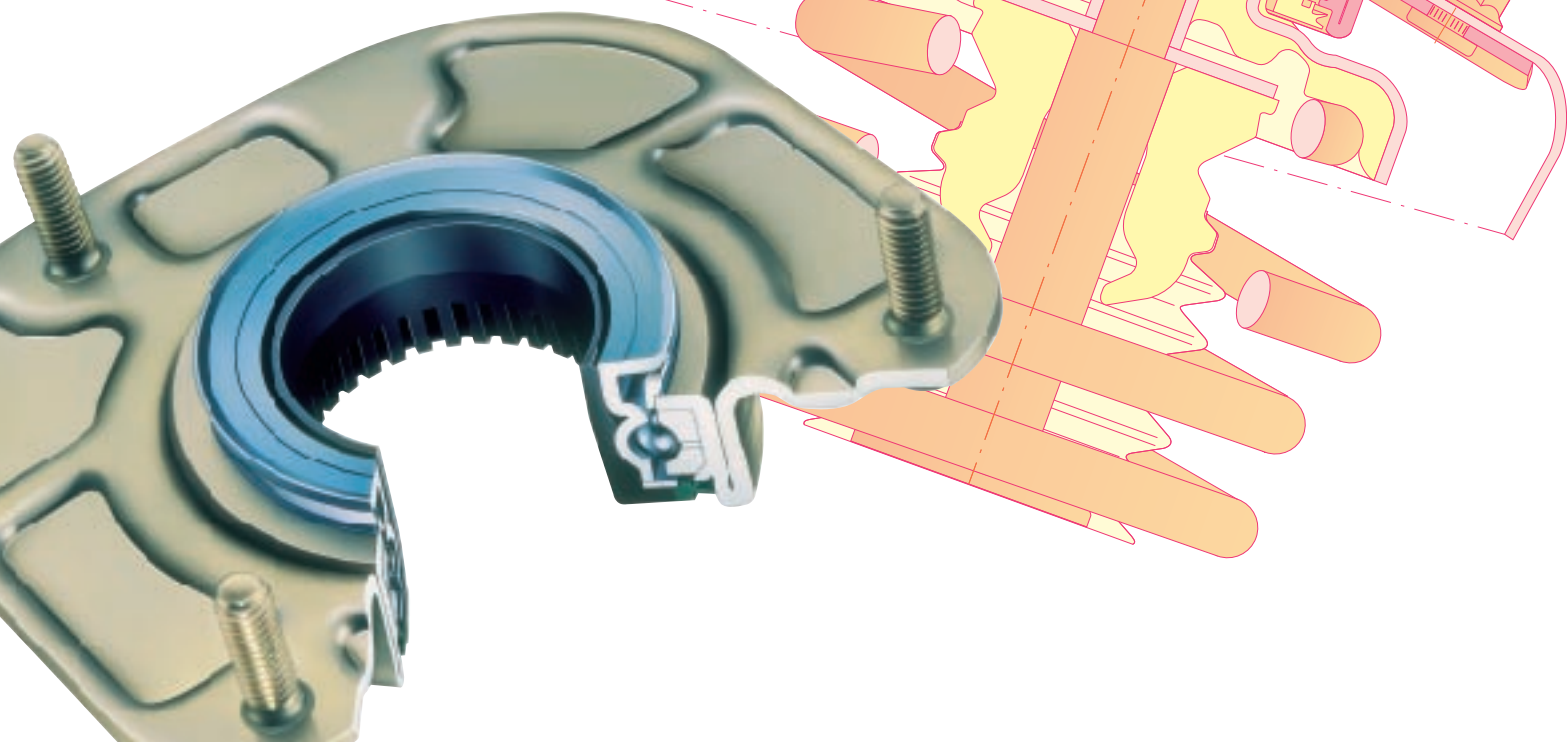
*Encapsulated axial bearing for use in MacPherson strut support*



*INA and plastics? No problem. We process many polymer materials – the INA MacPherson strut bearing housing, for example, is made of synthetic material. And there are more good ideas where that came from*



*Full-needle sleeve with filigree cage for maximum stress in the steering gear and heavy-duty steering knuckles*



## ...safety first at all times...

What does INA have to do with vehicle safety? As it turns out, our engineers frequently prove to be an important driving force for cutting edge solutions here as well.

One example is the INA sensor rings. Hidden away neatly, they do their job in the anti-lock brake or traction control systems. They guarantee that a sensor detects whether a wheel is locking, spinning or gripping the road surface.

As a result of an innovative tool design, we have been able to achieve an extraordinary level of dimensional accuracy. Using sensors intended for the vehicle, each sensor ring is checked individually. After all, the precise operation of the entire system depends on it. To ensure that safety does not fall victim to corrosion, we provide these sensor rings with our proven Corrotect® anticorrosion protection.

Together with our customers, INA engineers have developed a brake adjusting unit for heavy duty vehicles with disk brakes. This unit ensures that the gap between the disk and pads remains constant, thus maintaining optimal braking efficiency.

Our design engineers have taken advantage of cutting edge technologies for the manufacture of our products.

In the future, play it safe with your design and see what we can do for you.



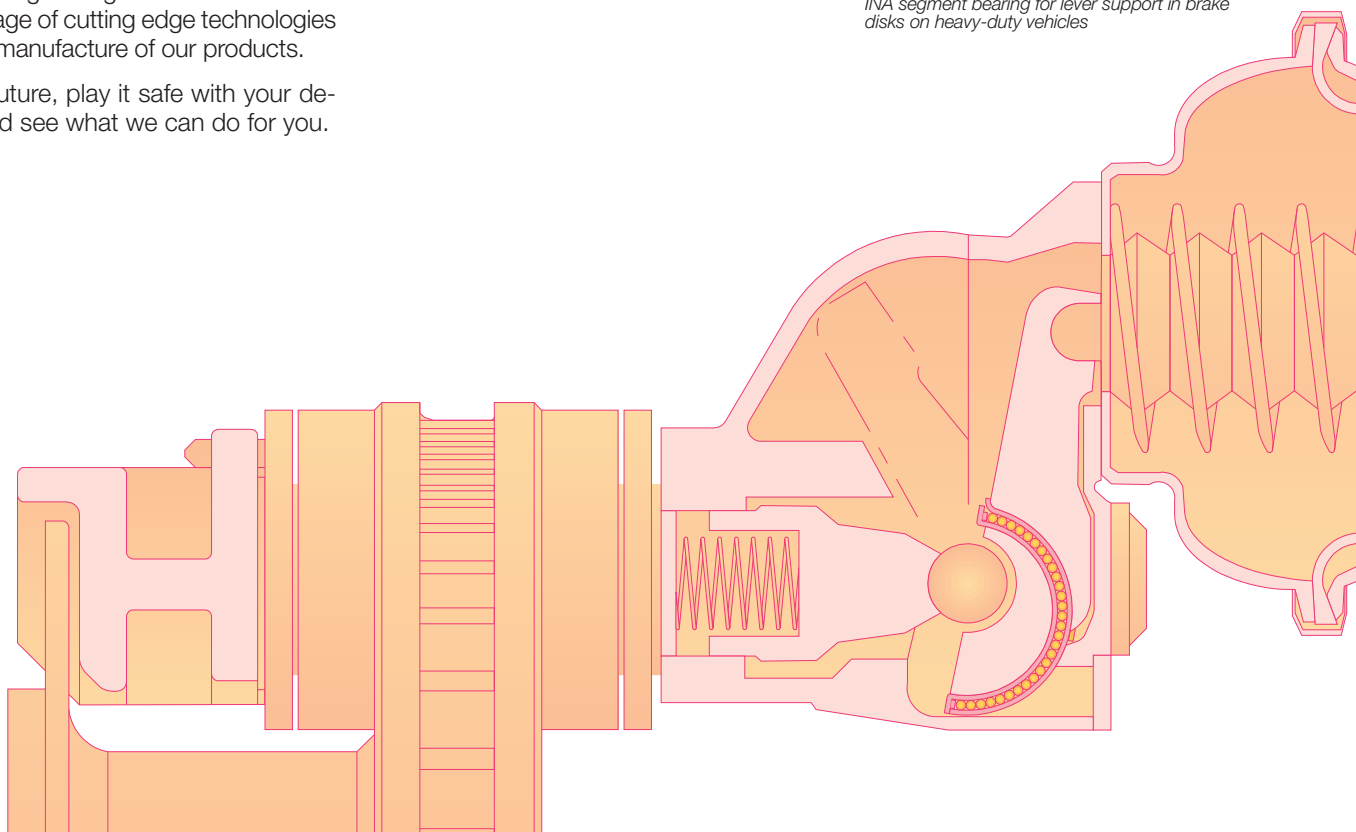
*With today's cars and trucks, safety is a prime concern. And INA is making a significant contribution*



*In conjunction with ABS, the heavy-duty brake-adjusting unit ensures constant braking efficiency*



*INA segment bearing for lever support in brake disks on heavy-duty vehicles*



## ...and performance you can count on every time.

Today, people are spending more and more time in their cars. As a result, interior comfort must also meet standards. For this reason, many car manufacturers place their trust in INA interior components as well.

Take our patented seat height adjuster, for instance. Positioning that is infinitely adjustable, precise and smooth is the key here. INA has developed a roller clutch assembly which can be fixed and released in both directions. The operating principle is very similar to that of a transmission overrunning clutch. An economical and elegant solution.

The contours of a roadster convertible are also very elegant. To prevent them from being disturbed by a rigid roll bar, the bar only appears when it is actually needed. We have equipped the two pivot points with maintenance-free ELGES pivot bearings, which move the roll bar rapidly and safely into position.

With narrow, full complement needle bearings, our engineers have also found a creative solution for backrest adjustment – and not merely because they allow simple and easy positioning. These bearings can even withstand a crash without being damaged, thus ensuring backrest stability. This is a crucial factor for safety.

INA bearings for the vehicle's interior performance can be counted on every time.



*The steering column can be easily and conveniently adjusted using INA components*



*With the ELGES ball pins, roadster's convertible top closes rapidly and simply*



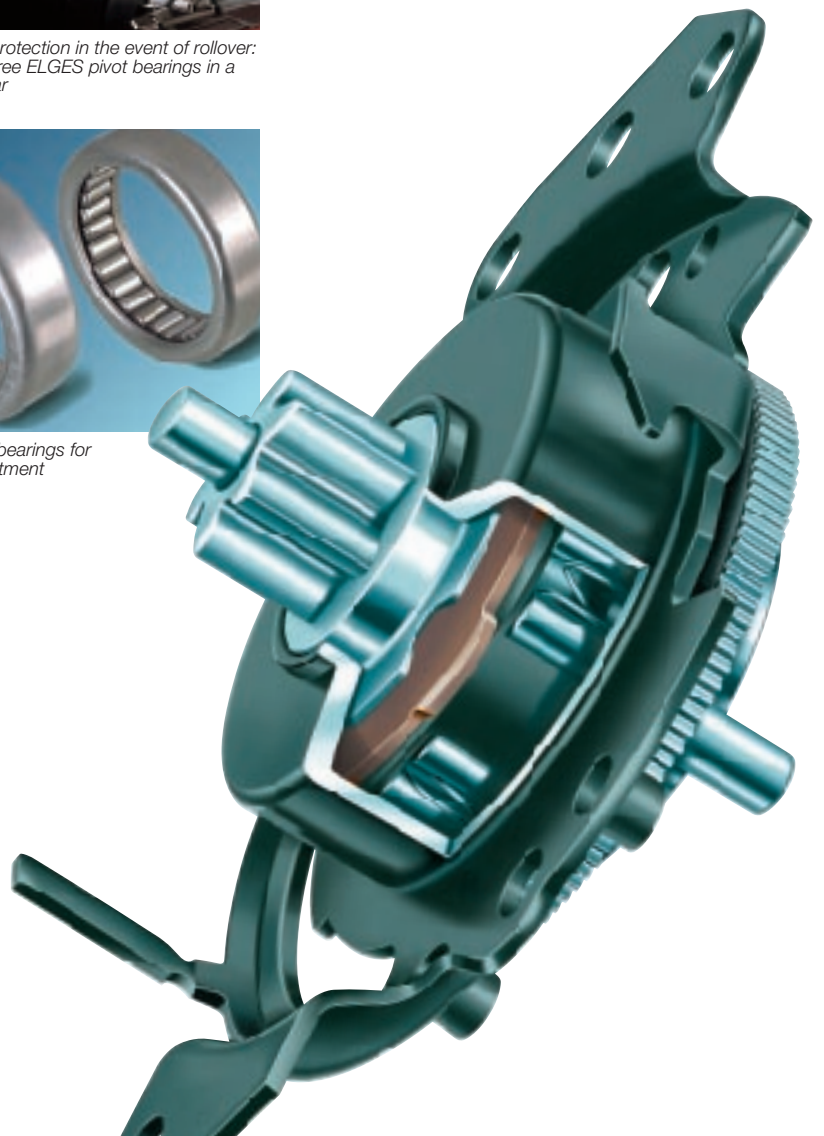
*For optimum protection in the event of rollover: maintenance-free ELGES pivot bearings in a roadster roll bar*



*Space-saving bearings for backrest adjustment*



*The INA roller clutch assembly ensures precise and infinitely-variable seat positioning*



## ...the steering system is well in hand...

Whether the steering column is rigid or has angular or longitudinal adjustment, comfort must be provided. The system must be easy, precise, quiet and extremely low in torque.

INA offers full complement or cage-guided angular contact ball bearings. This proven arrangement with two bearings has many advantages, such as great rigidity and low frictional torque on the one hand and easy, economical installation on the other. Since these ball bearings are manufactured through metal forming, they are also particularly cost-effective.

Clearance-free needle bearings are frequently used with rigid or angle-adjustable steering columns. Rubber tolerance rings help compensate tolerances occurring with steering housing tubes. This is cost saving because the steering shaft and housing tube no longer require special manufacturing.

Or you can select clearance-free INA four-point angular contact ball bearings, which are especially advantageous for steering columns with longitudinal adjustment. These fixed bearings absorb the axial forces generated in a crash, thus providing additional safety. Depending on requirements, these highly rigid components can also be combined with needle bearings to complete a fixed floating configuration. Working together, we can achieve the optimum solution.

You may have heard about INA universal joint bearings. After all, hardly a car manufacturer in the world does not use these drawn cup needle roller bearings. Incidentally, the assembly process is also from INA. This unequaled cost effective process is the only one which allows universal joint guidance without axial clearance or additional fastening elements. And if you'd like, we can also build the assembly machine for you. With INA components, the steering system is well in hand.



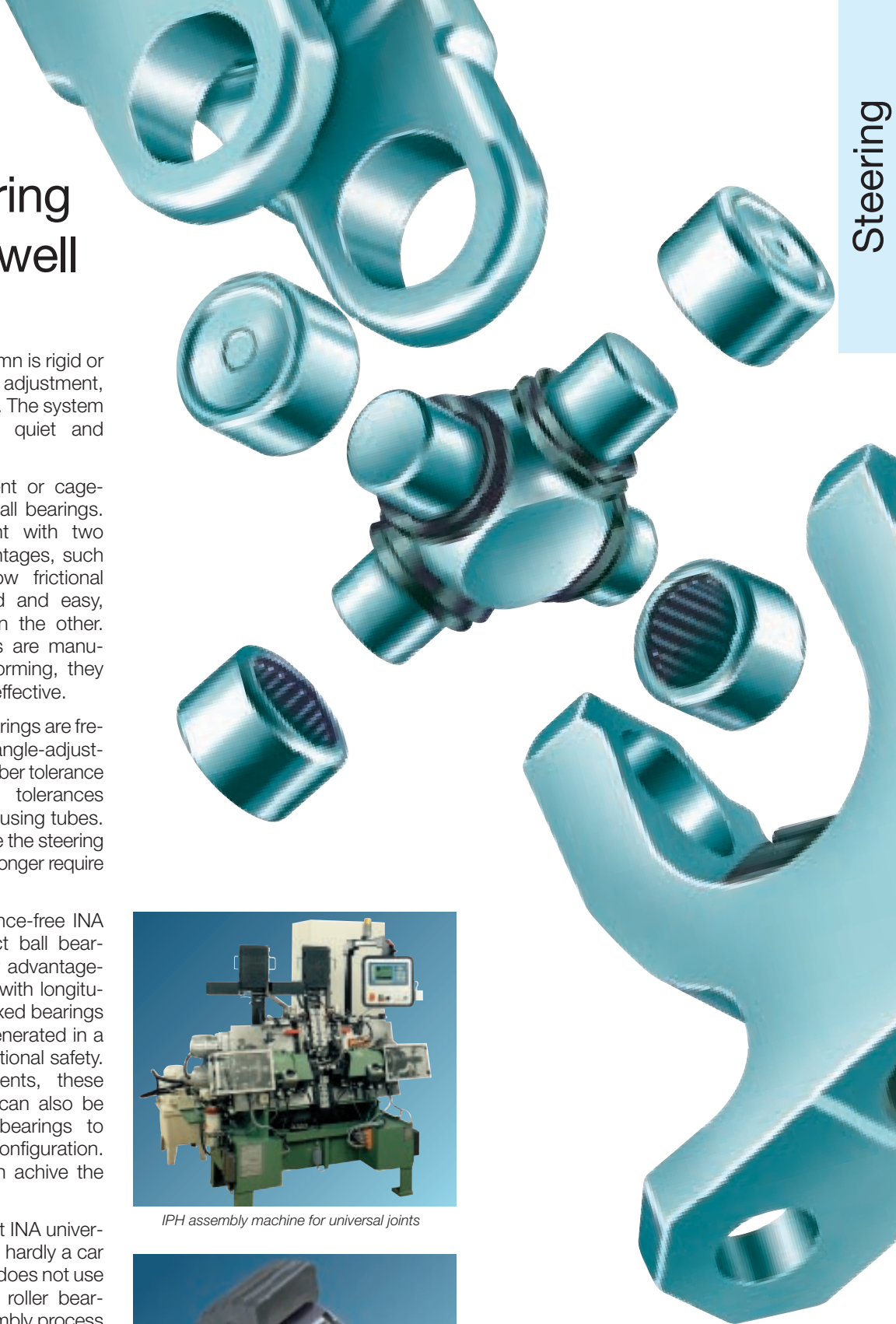
*IPH assembly machine for universal joints*



*Needle bearing with tolerance ring used with drawn housing for tubes. Tolerances are effectively compensated for*



*INA four-point ball bearing and angular contact ball bearing with integrated mounting features*



# Coming full circle.

For over 50 years we at INA have demonstrated our commitment to the automotive industry. Our customers and the entire automotive industry have benefited from our innovative technical solutions.

If your current planning includes a new vehicle design, we can provide help even before the kickoff. Over 400 specialists at INA engineering centers in Germany, France, Great Britain, the USA and Brazil are available to implement new product ideas – together with you. Of course, state-of-the-art methods such as dynamic simulation and FE analysis are employed in the design and modeling phase.

Once a prototype is available, the most important period for the new product undoubtedly begins with the validation phase. Even before the green light is given for volume production. Initial bench testing takes place in our modern, high-tech testing facilities, which include an environment simulation chamber and test stands for internal combustion engines.

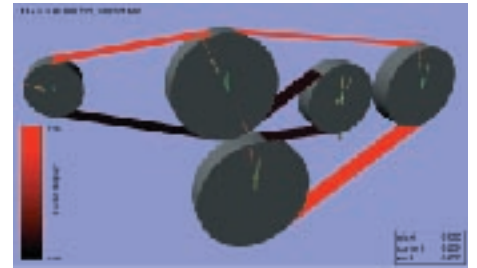
We manufacture our products in compliance with the quality criteria of the automobile industry as defined by standards QS 9000 and VDA 6.1. Our commitment to quality is successfully proven by the many awards which we, as suppliers, have received from our customers.

However, today's producers are also responsible for the disposal of their products in an environmentally responsible manner. Environmental protection is a long tradition at INA. Long before the subject was an everyday topic, it was one of our company objectives. The European Union environmental certification and our membership in the PartsLife System for workshop disposal demonstrate our commitment.

So we have come full circle, from the initial ideas to the disposal of used components. Our mission is to help you – allow us to become your "go to" engineering partner.



*There will be individual mobility in the future only if the automobile can exist in harmony with nature. INA is making a significant contribution. The European Union environmental certification is proof*



*Dynamic simulation of a belt drive – sophisticated computer programs calculate the dynamic behavior of INA components in operation*



*Acoustic analysis of an engine in an anechoic chamber. INA testing facilities are equipped with state-of-the-art technology*



*Before the individual components are actually manufactured, we can optimize shape, weight and rigidity using finite element analyses*

