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EXCELLENCE IN PC PARTS

WHEEL BEARING FAILURE DIAGNOSIS

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CONTENTS

DAMAGE TO ROLLER BEARINGS

Reasons for part failure

Wheel bearings are calculated to achieve a mileage of up to 1,000,000 km without any further ado. Certain generally abnormal causes can result in premature damage to a roller bearing with an impact on its service life.

- In 70% of these cases, the cause is incorrect lubrication: too much or too little, unsuitable lubricant, etc.
- Soiling accounts for a further 18%: this refers to liquids or solid particles in the bearing. This is why seals are so important, as their failure can cause lubricant to leak from the bearing, allowing dirt to penetrate.
- Incorrect installation accounts for a further 10%: installation by force, excessive overheating, incorrect adjustment and incorrect clearance, excessive tightening of the tapered sleeve, etc.

General forms of roller bearing damage

- Overheating
- Broken outer ring
- Tilting
- Excessively tight fit
- Fatigue
- Impressions on the roller body
- Soiling
- Lubrication faults
- Corrosion
- Flange fractures
- Wear due to scoring
- Wrong load direction

Diagnosing bearing damage

Roller bearings are machine elements with a wide range of applications. They prove to be reliable components even under harsh conditions. Premature failures are very rare occurrences. Roller bearing damage is revealed primarily by unusual operating behaviour of the bearing. A wide range of different characteristics are revealed when damaged bearings are examined. To find the cause of the damage, simple inspection of the bearing is usually not sufficient; on the contrary, consideration also has to be given to the surrounding parts, lubrication and seals, together with the operating and environmental conditions. A planned approach makes it easier to find the causes.

Unusual operating behaviour as a sign of damage

Damage to bearings is usually expressed by a gradual deterioration in operating behaviour. In rare cases, spontaneous damage, brought about for example by incorrect installation or missing lubrication, can cause immediate failure. Under certain circumstances, it can take several months from when the damage begins until actual failure of the bearing, depending on the operating conditions.

DAMAGE

Operating behaviour	Possible causes	Effects
Irregular running	Damage to rings and roller bodies	Increasingly wobbly wheels Increased tilting tendency Vibration in the steering
	Soiling	Increased vibrations
	Too much bearing clearance	Increased jolts
Unusual running noises	Not enough bearing clearance	Whining or whistling noise
	Too much bearing clearance Damage to the rolling surfaces Soiling Unsuitable lubricant	Rumbling or uneven noise
	Changed bearing clearance Temperature influences Damaged raceway	Gradual change in the running noise

Causes of bearing damage and measures

Wheel bearings are essential parts in motor vehicles. They make an important contribution to comfortable, safe driving. Wheel bearings are exposed to many different loads, such as high wheel speed, hard jolts from uneven road surfaces, dirt that has been swirled up and extreme temperatures.

This can have a negative impact on how wheel bearings work; under unfavourable conditions, the results may include failure or blocking of the wheel bearing. If the wheel bearing blocks while the vehicle is moving, this can result in dangerous traffic situations or accidents!

DIAGNOSING OVAL DEFORMATION DAMAGE

1. Remove the wheel bearing from the location bore.

2. Check whether there is a dark spot on each of the two opposite sides of the wheel bearing‘s outer ring surface. Make sure that there is no damage on the two surfaces at a 90° angle to the dark spots. If this is the case, the location bore is deformed and the steering knuckle needs to be replaced.

3. Dismantle the wheel bearing to make sure that there has not been any smoothing effect in the ball raceways of the outer ring. To do so, first remove the seal (e.g. with special pliers), then dismantle the unit consisting of outer and inner ring, cage and balls.

4. Clean the raceways of the outer ring and check for any scratches corresponding to the dark spots on the outside of the outer ring. These scratches confirm oval deformation of the steering knuckle.

OVAL DEFORMATION DAMAGE

Problem	Cause	Remedy
The wheel bearing starts to make loud noises (grating sounds) after it has been fitted during the subsequent trial run.	One of the two inner rings is damaged:	Replace wheel bearing and hub.
	1. The wheel hub does not fit because the setting is too narrow.	
	2. The wrong tool has been used to fit the inner ring so that it is canted on the wheel hub; the wedge or bushing is not parallel between the plunger and the side of the bearing ring.	Replace complete wheel bearing.
	3. Excessive oval deformation in the location bore with corresponding extreme restriction in the bearing clearance of the wheel bearing in the confined areas of the oval deformation.	Replace steering knuckle and wheel bearing.
	4. Damaged location bore in the steering knuckle.	Rectify minor flaws on the wheel hub (e.g. by polishing) or replace wheel hub and bearing.
	5. Deep scratches or dents, both on the bearing seat of the wheel hub and on the wheel bearing, caused by incorrect removal.	Rectify minor flaws on the wheel hub (e.g. by polishing) or replace wheel hub and bearing.

Problem	Cause	Remedy
Wheel bearing starts to make noises after a certain mileage has been completed (500-3,000 km); extreme heat development at the start of operation	Medium oval deformation in the location bore of the steering knuckle, that is still enough to restrict the radial clearance of the wheel bearing and thus cause the damage described in the previous point.	Replace steering knuckle and wheel bearing.
Extreme heat development at the start of operation	**1.** Axial clearance of wheel bearing between wheel hub and steering knuckle is extremely restricted. Parts incorrectly adjusted or incorrectly fitted.	Check settings of the steering knuckle and wheel hub and readjust if necessary.
	2. Incorrect installation of the wheel bearing in the location bore (no circlips in the location bores) causes gradual axial offset of the wheel bearing and hub. The turning hub rubs against the stationary wheel bearing seat. This high level of friction increases the temperature at the wheel bearing. The grease burns and the component fails.	Remove wheel bearing and check whether circlips are present, replace wheel bearing if necessary.

DIAGNOSING BEARING DAMAGE

Overheating

Cause

- Extreme external heat
- Inadequate heat dissipation
- Inadequate cooling or lubrication

Effect

- Discolouring of the rings, roller bodies and cages from yellow to blue
- Temperatures over 200°C reduce the hardness and load bearing capacity and can thus cause premature failure
- Deformation of the bearing components in extreme cases
- An increase in temperature can also cause deterioration or destruction of the lubricant

Remedy

- Temperature or overload checks
- Adequate heat dissipation

Broken outer ring

Cause

- Inadequate support of the rings in the bearing housing
- Initial axial load due to incorrect bearing clearance under high operating temperatures

Effect

- Normally there will be a uniform fracture in the peripheral direction, often accompanied by parts breaking out
- Under axial load, these fractures usually occur just behind the middle of the raceway
- Unusual wear pattern on the outside of the outer ring

Remedy

- Improve installation of the bearing
- Correct bearing clearance
- Follow the manufacturers‘ installation instructions.

Tilting

Cause

- Sagging shafts
- Burrs or dirt on the shaft or housing shoulders
- Shaft threads that are not axially parallel to the bearing seat
- Shaft nuts whose mating surfaces do not match the thread axis

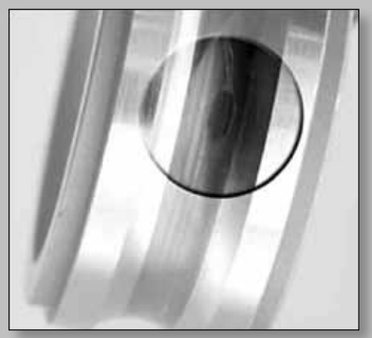
Effect

- Traces of wear running diagonally to the raceway edge of the standing ring

Remedy

- Inspect the shafts and housing for signs of running errors at the shoulders and bearing seats
- Machine the thread and bearing seat
- Use precise shaft nuts

Excessively tight fit



Cause

- Peripheral track made by wear on the raceways

Effect

- Continuous operation under high load, poor lubrication and inadequate bearing clearance quickly causes wear and fatigue

Remedy

- Adjust the bearing clearance and/or the wheel bearing correctly

DIAGNOSING BEARING DAMAGE

Fatigue

Cause

- Use of the wrong bearing (not visible from the outside, possibly the inner design is not suitable for the specific use)

Effect

- Often referred to as peeling; caused by cracks in the bearing surface and constant abrasion from individual small material particles from the inner/outer rings or roller bodies
- Peeling is a progressive process which, once begun, spreads quickly with constant use
- It is always accompanied by a noticeable increase in noise levels

Remedy

- Replace the bearing
- Adequate heat dissipation

Impressions on the roller body

Cause

- Static bearing overload
- Heavy impacts on the bearing
- Use of a hammer during installation
- Dropping the bearings or mounted components
- Fitting a bearing to a shaft by applying force to the outer ring.

Effect

- Impressions on the roller body appear as dents in the raceways and increased bearing vibrations (noise level)
- Severe impressions on the roller body can cause premature failure

Remedy

- Use suitable tools to fit/remove the bearings
- Only apply force to the ring with a stationary fit
- Follow the manufacturers‘ installation instructions

Soiling

Cause

- Suspended particles of dust, dirt or abrasive substances from dirty workplaces
- Dirty hands or tools
- Foreign additives in lubricants or cleaning solutions

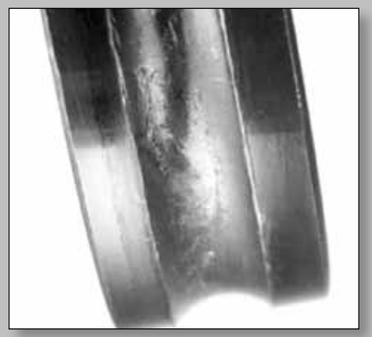
Effect

- Impressions in roller bodies and raceways cause vibrations

Remedy

- Keep workplaces, tools, equipment and hands clean to reduce the risks
- Do not perform any grinding work near to the bearing installation workplace
- Leave the bearings in their original wrappings until they are fitted in the vehicle
- The area should be adequately sealed off from dirty surroundings
- Cover any open, fitted bearings during work breaks

Lubrication faults



Cause

- Limited lubrication
- Excessive temperatures

Effect

- Discoloured roller bodies (blue/brown) and traces of wear on the roller bodies
- Abrasion of the roller bodies, rings and cages
- Total failure

Remedy

- Use the right lubricant in the right quantity
- Check the initial tension to reduce the bearing temperatures

DIAGNOSING BEARING DAMAGE

Corrosion

Cause

- Bearings were exposed to corrosive fluids or surroundings
- Defective seals or unsuitable lubricants

Effect

- Red/brown discolouring or deposits on the roller bodies, raceways or cages
- Increased vibrations, followed by wear
- Increased radial clearance or loss of initial tension

Remedy

- Avoid corrosive fluids in the vicinity of the bearings
- Use a suitable lubricant with corresponding specification

Flange fractures

Cause

- Unacceptably high axial load, inadequate support for the flange
- Axial impact load
- Incorrect installation/dismantling

Effect

- Supporting flanges are partly or completely fragmented or broken

Remedy

- Keep the load within the intended limits
- Comply with the installation instructions and procedures

Wear due to scoring

Cause

- Inadequate lubrication under high loads
- Inadequate quantity or consistency of the lubricant
- No hydrodynamic lubricating film between the contact surface of the rollers and the flange
- Too much initial tension due to thermal expansion
- Rollers canted by raceway wear or tilted rings

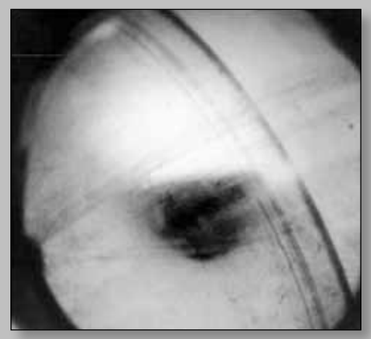
Effect

- Partial or large welds and deep scratches in the flanges and roller contact surfaces
- Coking of the lubricant in this zone

Remedy

- Use a suitable lubricant with corresponding specification
- Make sure the correct bearing initial tension is used

Wrong load direction



Cause

- Angled ball bearings are designed for one load direction. When load is applied in the opposite direction, low shoulders cause an elliptic contact surface to be cut away
- This results in a very high load and an increase in temperature, followed by increasing vibration and premature failure

Effect

- Balls show linear groove wear caused by the balls turning over the edge of the raceway

Remedy

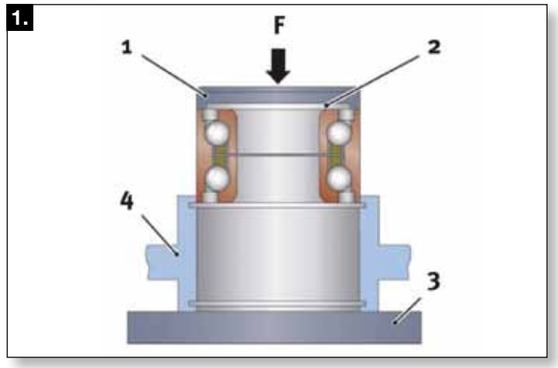
- Make sure that the angled ball bearings are fitted correctly

FITTING THE WHEEL BEARING IN THE STEERING KNUCKLE

First install the complete wheel bearing in the location bore of the steering knuckle as follows.

1. Press the wheel bearing into the location bore of the steering knuckle (4) by applying pressure to the bearing outer ring. To do so, use a dummy block (1) with groove (2) to ensure that the pressing force (F) is applied to the outer ring. The steering knuckle lies on the base plate (3) of the press.

1.



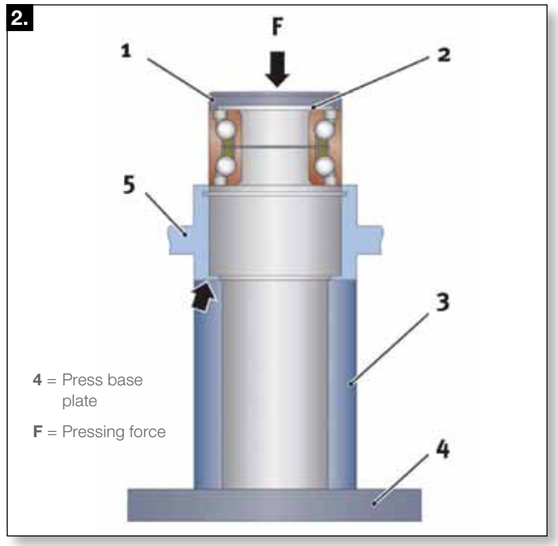
2. Press the wheel bearing into the location bore of the steering knuckle (5) by applying pressure to the bearing outer ring. The steering knuckle lies with its flange side centred on the carrying sleeve (3) (arrow). A press drives the bearing into position, precisely in-line, using a dummy block (1) with groove (2).

2.1. Finally fit a circlip in the groove in the steering knuckle using special pliers to secure the wheel bearing in the axial plane.

2.2. Pay attention to the bevel on one side of the bearing when fitting the wheel bearing in the location bore. This bevel must lie in the pressing-in direction to prevent the bearing from tilting while it is being pressed in.

Important: it is essential to ensure that the pressing force (F) is always transferred to the balls in the bearing! Otherwise this could cause notches to the running surfaces that will damage the bearing!

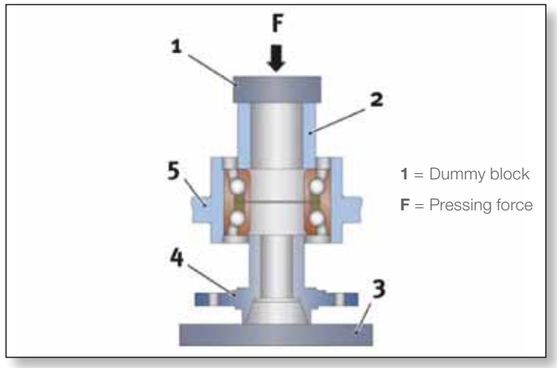
2.



MOUNTING THE WHEEL HUB

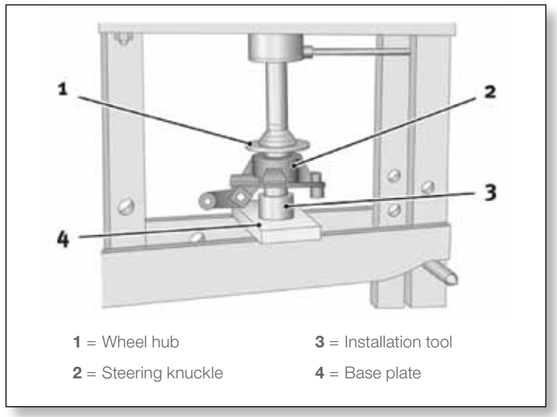
1. Place the wheel hub (4) on the base plate (3) of a press. Use an installation tool (2) to press on the wheel bearing that is already fitted in the steering knuckle (5).

Important: the tool must only be applied to the contact surface of the inner ring!



Note: in some vehicles, the components are installed in the reverse order. The steering knuckle lies on the base plate and the wheel hub is pressed in from above.

Important: do not forget the carrying sleeve! It supports the inner ring during the installation procedure to ensure that no notches are made in the ball raceways of the wheel bearing outer ring!

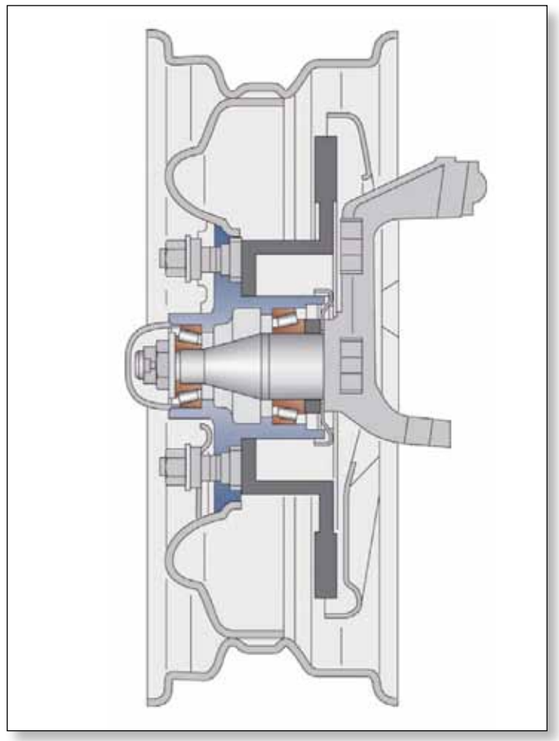


2. Tighten the fastening nut of the wheel bearing using the torque recommended by the vehicle manufacturer. The nut torque is not only important for fastening the wheel but also ensures that the wheel bearing runs with the optimum clearance. We urgently recommend using a torque wrench to achieve the right torque.

Note: the wheel bearing must not be twisted during installation, neither in the location bore nor on the wheel hub. Otherwise this could cause considerable damage. Complete wheel bearing units are available already lubricated ex works. They need no additional lubrication and must not be cleaned with solvents. Solvents could cause premature failure of the bearings.

INSTALLING AND ADJUSTING TAPERED ROLLER BEARINGS IN MOTOR VEHICLE WHEEL HUBS

General
The procedure for dismantling and fitting a tapered ball bearing can differ, depending on the vehicle manufacturer. Generally comply with the instructions issued by the vehicle manufacturer!

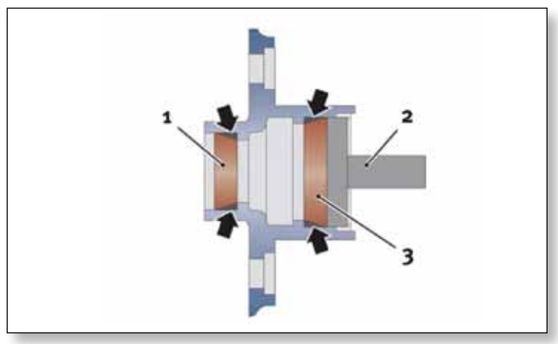


Car bearing with fitted tapered roller bearings (non-driving axle).

1. Clean wheel hub body.

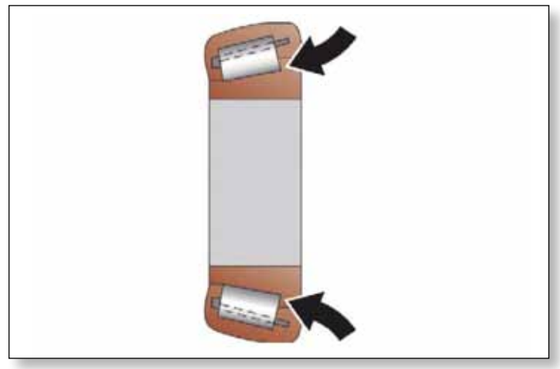
2. Lightly oil the seats of the outer rings (arrows). Press in the two outer rings (1 and 3) with a punch (2).

Important: the punch must only act on the contact surface of the outer ring! The outer rings must lie flush on the housing shoulders!



3. Grease the inner ring of the inner bearing well.

Important: also apply grease between the cage, inner ring and rollers **(arrows)**!

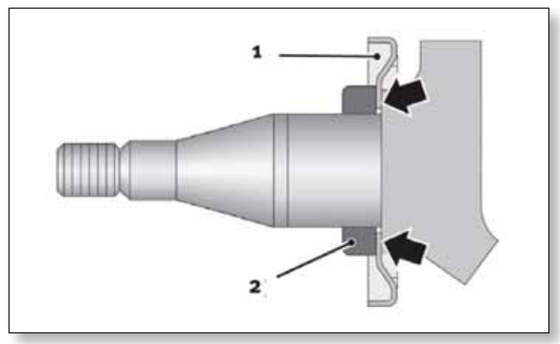


4. Insert the inner ring in the wheel hub.
5. Press the rotary shaft seal into the wheel hub.

Important: the sealing lip must point towards the bearing!

6. Place the safety cap (1) and the spacer ring (2) on the steering knuckle.

Important: the safety cap must lie on the full periphery of the steering knuckle collar **(arrows)**!



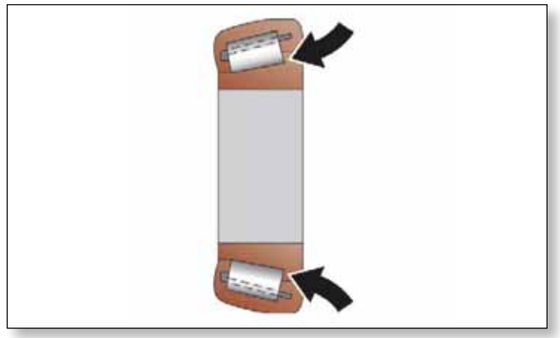
INSTALLING AND ADJUSTING TAPERED ROLLER BEARINGS IN MOTOR VEHICLE WHEEL HUBS

7. Push the wheel hub onto the steering knuckle.

Important: make sure that the rotary shaft seal is not damaged!

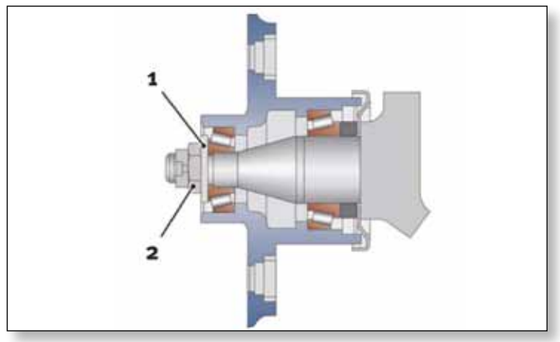
8. Grease the inner ring of the outer bearing well.

Important: also apply grease between the cage, inner ring and rollers **(arrows)**!



9. Push the inner ring of the outer bearing onto the steering knuckle.

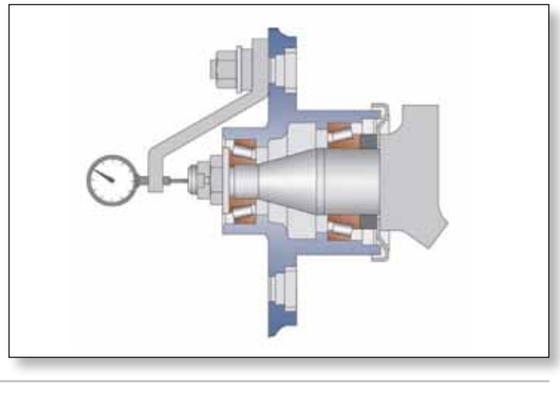
10. Fit the impact plate (1).
11. Screw on the castellated nut (2).
12. Tighten the castellated nut while turning the wheel hub at the same time until you feel a resistance.



13. Check that the bearing runs correctly with the right tilting clearance.

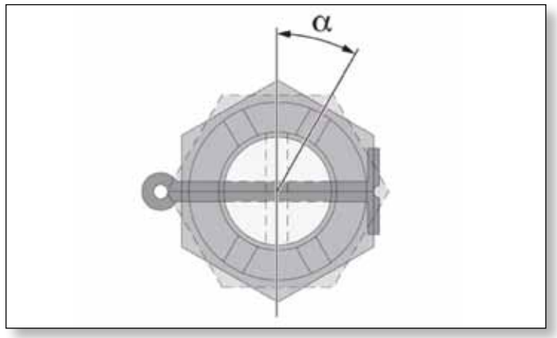
Note: the wheel must turn easily without any restraint.

Check and adjust the axial clearance of the bearing (use measuring instrument if necessary).



14. Turn the castellated nut back through max. 1/12 turn until it coincides with the next split pin hole and secure with a split pin.

Important: comply with the repair instructions issued by the vehicle manufacturers!



15. Fit the cover in position.
16. After the trial run, check to see whether the bearing clearance has changed. Correct the setting if necessary.