SCHAEFFLER REPXPERT

FAG Function and Failure Diagnosis

CV Joints

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Our products are based on a comprehensive systems approach. Innovation, technical expertise, and the highest material and manufacturing quality make us not only one of the leading development partners for vehicle manufacturers, but also a pioneering provider of value-retaining spare parts and complete repair solutions for clutches and clutch release systems, engine, and transmission applications, and chassis applications in original-equipment quality – right up to the appropriate special tools.

With our FAG brand, we are the specialist for chassis repair and supply a wide range of products and repair solutions. Our portfolio for this includes wheel bearings, steering and suspension parts, drive shaft assemblies, and strut mountings. By using state-of-the-art sealing and surface coating technologies, we offer the same high level of quality throughout the entire portfolio. Every individual component, including the smallest accessory part, is developed and tested according to Schaeffler quality standards. Therefore, our products ensure safe and agile road handling in every driving situation.

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Contents

1 How CV joints work

Tripod joint

Wheel joint kit

Wheel joint

Nowadays, front-wheel and most rear-wheel drive vehicles have two side shafts that each consist of a fixed shaft with two CF joints at the ends. The side shafts permit vibration-free, constant drive of the individual wheels. The shorter the distance between the drive point (engine/gearbox) and the output point (wheel), the lower the energy loss.

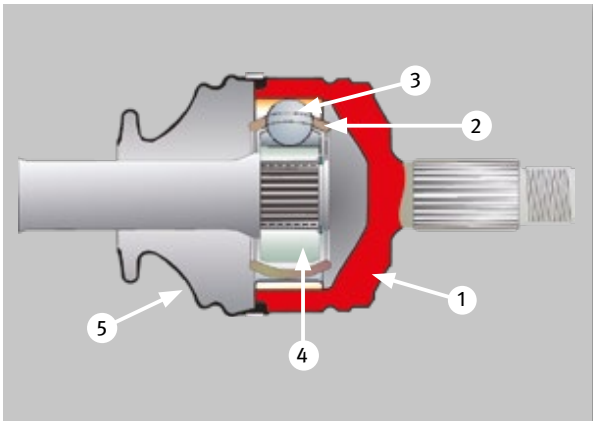
The core task of the CV joints consists in low-friction transfer of the torque from the gearbox to the wheel, compensating for deflection in the chassis, and also for steering movements in front-wheel drive vehicles. The degrees of freedom needed for steering and deflection are provided by the bending angle and axial displacement of the joints. To this end, each side shaft needs a plunging and a fixed joint.

2 Typification of CV joints and their structure

2.1 Fixed joints

The name is derived from the function: The pivot of the shaft is not changeable, thus facilitating rotation. Fixed joints do not permit any axial movement. As a rule, they are used in front-wheel drive vehicles at the wheel end of the side shafts, permitting bending angles of up to 53° depending on the vehicle type.

Component parts:



1. Housing
2. Cage
3. Balls
4. Core
5. Axle boot

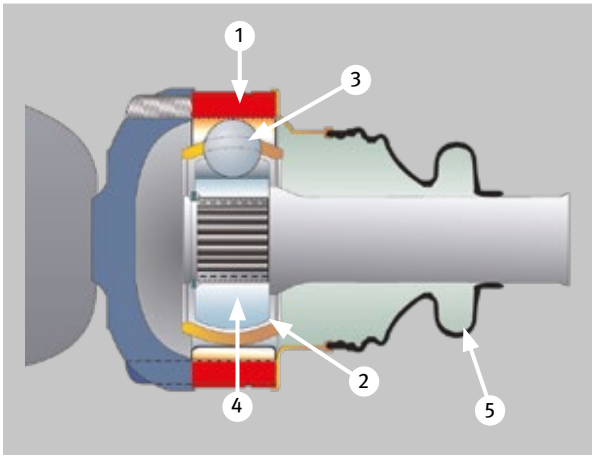
2.2 Plunging joints

They permit both angular movement and axial movement, and are available in the following different types:

2.2.1 Plunging joints

- Also referred to as “VL”-type joints because of the V-shaped design of the raceways on the inside of the joint.
- The ball raceways are straight.
- Bending angles of up to 22° are possible.
- The plunging distance is approx. 48 mm.
- Good torque transmission is ensured even at high speeds.
- In front-wheel drive vehicles, they are only fitted to the gearbox side. In rear-wheel drive vehicles, plunging ball joints can be used at both ends of the side shaf.

Component parts:

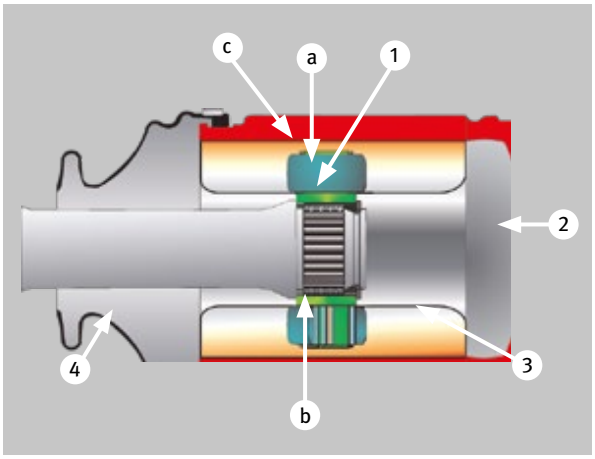


1. Outer raceway
2. Cage
3. Balls
4. Core
5. Axle boot

2.2.2 Plunging tripod joints

- Are fitted to the gearbox side, attenuating the transmission of engine vibrations by up to 65%. Therefore they are mainly fitted to vehicles with diesel engines and often together with automatic gearboxes. This also safeguards an uninterrupted flow of power to the wheels. Plunging tripod joints have less friction between the component parts and permit changes in length of the side shaft.
- Bending angles of up to 18° are possible.
- The plunging distance is approx. 55 mm.
- The tripod joint has three stubs, with needle bearings connecting them to the outer rollers. The raceways of the outer rollers move in linear fashion in each of the inner raceways of the housing or “bell”.
- The needle bearings of the outer rollers of the tripod joint perform various tasks. In addition to low-friction compensation for the length of the side shaft, they have to transmit the drive forces from the gearbox to the side shaft.

Component parts:

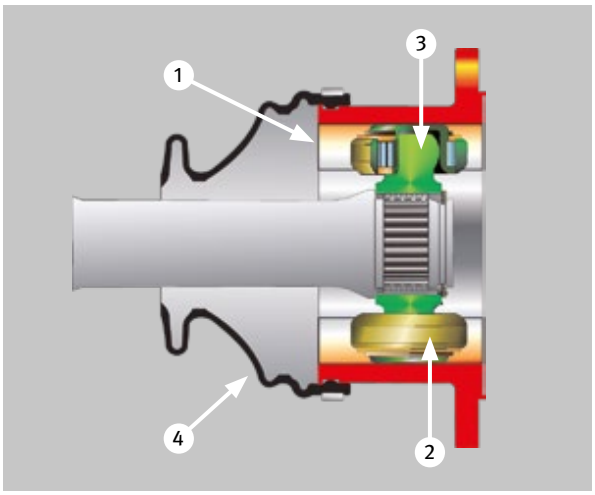


1. Tripod joint
   a) Bearing surface
   b) Needles
   c) Retainer
2. Bell
3. Straight raceway
4. Axle boot

2.2.3 Circular plunging tripod joints

- Ideal for use on the gearbox side in small vans and sports cars. Three independent rollers are placed on the stubs of the tripod joint, moving within groove-shaped raceways as in conventional plunging tripod joints. The stubs of the tripod joint are circular in shape so that the rollers can move on the tripod joint like a pendulum bearing. This achieves a smooth drive while attenuating jolts and vibrations in torque transmission by up to 70%.
- Circular plunging tripod joints are suitable for transmitting high torques.
- Bending angles of up to 18° are possible.
- The plunging distance is approx. 40 mm.

Component parts:

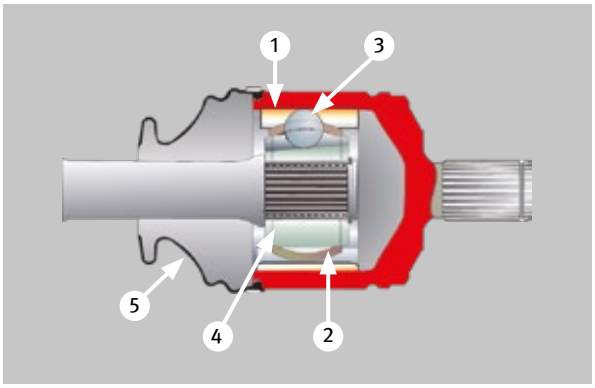


1. Straight raceway
2. Rollers
3. Tripod joint
4. Axle boot

2.2.4 DO plunging joints (double offset joint)

- Fitted to the gearbox side of those front-wheel drive vehicles with limited space. The design is pin-shaped and consists of a combination of the plunging ball joint and the plunging tripod joint.
- DO plunging joints have straight raceways.
- Bending angles of up to 22° are possible.
- The plunging distance is approx. 55 mm.

Component parts:



1. Straight raceway
2. Cage
3. Balls
4. Core
5. Axle boot

3 Service life of CV joints depending on ambient conditions

The service life of CV joints primarily depends on the conditions in which the vehicle is being operated. Damage to a joint can have severe consequences, with loss of traction force in the most favourable case. In the worst case, a wheel can block or the side shaft itself works loose. It is no rarity for such situations to result in damages to surrounding parts such as gearbox, oil sump etc.

Problems in CV joints are revealed by vibrations and noises while driving. It is advisable to have the vehicle checked by an expert at a garage at the smallest sign of any discrepancy.

80% of the problems in CV joints are caused by a change in the working distance of the side shaft, 8% by faults or negligence during installation. 8% come from cracked axle boots which lead to a loss of lubricant, resulting in soiling of the joint. Only the remaining 4% of all joint failures have been caused by jolts and normal wear and tear of the parts.

In many cases where side shafts are damaged, the cause is not eliminated during the first visit to the garage. The actual problem is still present and reoccurs repeatedly to the customer's dissatisfaction.

Correct alignment of the unit consisting of engine, gearbox and wheel suspension makes an important contribution to the durability and long service life of joints and side shafts. CV joints normally have a long service life. But this can only be safeguarded by regularly checking that the axle boots do not leak and that the clamps fit firmly.

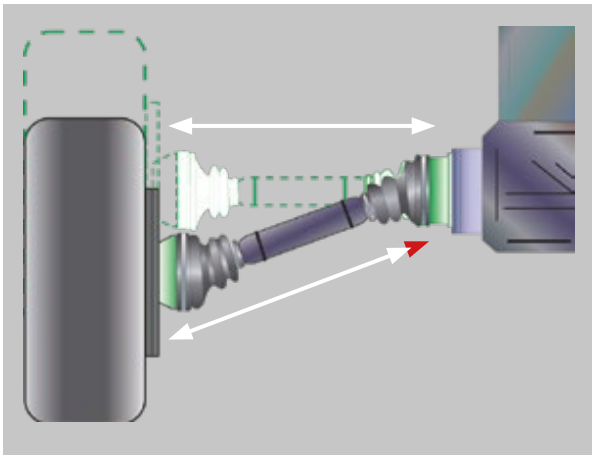
If the engine and/or gearbox have to be removed as a result of an accident or repairs to the units, it is important to ensure that the unit assembly is correctly centred when subsequently fitting it back into the vehicle. The fastening points of the beams have corresponding tolerances to achieve correct alignment.

When work is being carried out to the steering trapeze, it is extremely important to achieve a 100% setting of the toe difference angle and the maximum steering angle. If the maximum steering angle is outside the bending angle of the joint, there is a risk of destroying the joint. In axles designed to use the end stops of the steering angle, these also have to be checked for signs of wear and tear or damage.

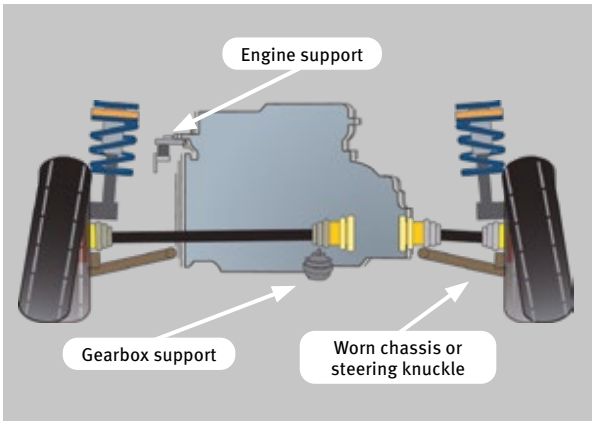
4 Possible causes of damage to side shafts and CV joints

The working distance of the side shaft is stipulated by the design. Any corresponding changes caused by outer influences can result in severe damage. The necessary working distance is mainly changed by the following influences:

1. Engine and/or gearbox support
2. Centre alignment of engine and gearbox
3. Discrepancies in the wheel suspension (damage to the hubs, steering knuckles, joints, shock absorbers, etc.)



Load in daily operation (change in angle and length)



Strain from changes in the working distance (caused by worn engine bearing and gearbox bearing, incorrect centre alignment of engine and gearbox)

4.1 Damage to fixed joints

As a rule, it is the joint on the gearbox side that will be damaged first by overload on the side shaft.

Excessive vibrations and jolts are also transmitted to the outer joint, thus causing cracks to the inner component parts of the joint.

Most joint failures are caused by defective or torn axle boots. The outer joint is frequently affected in this case, as the larger bending angle places more of a load on the axle boot.

4.2 Damage to plunging joints

Discrepancies in the overall assembly consisting of the power units and the axle body also cause malfunctions in the plunging joints.

4.2.1 Damage to plunging ball joints

In plunging ball joints, an enlarged distance makes the core protrude too far so that the drive work is only performed at one end of the joint. Excessive tension is caused at the ends of the raceways with the inner component parts of the joint (cage, core and balls) exposed to greater wear and tear or suffering damage.

A reduced distance presses the core of the joint against the gearbox flange. Here again, excessive strain is placed on the joint itself and on the inner component parts of the transmission, causing damage in the worst case.

Symptoms for such damage are of extreme noises and finally a destroyed joint, with a loss of power transmission.

Defective plunging ball joint

4.2.2 Damage to circular plunging tripod joints

In circular plunging tripod joints, which are usually fitted to the gearbox side, any change in length of the side shaft moves the tripod joint back and forth because of deflection and rebounding or steering in the inner raceways of the housing. Discrepancies in the whole assembly between power units and axle body can lengthen or shorten the working distance.

If the working distance is lengthened too far, this makes the tripod joint slide out of the holder, with a loss of drive force. In the worst case, surrounding component parts will be damaged. If the distance is shortened, the tripod joint impacts on the base of the housing, damaging the inner component parts of the gearbox.

Defective tripod ball joint

4.2.3 Damage to DO plunging joints

Frequently, ignorance and/or negligence when removing and fitting these components will cause avoidable damage with premature wear and failure.

Damage to the cage can be caused by:

- natural wear and tear caused by the functioning of the component part (extremely rare)
- impacts or jolts, transmitted by uneven road surfaces
- jolts when removing and fitting the joint
- inadequate or excessive lubrication
- excessive tension caused by lengthening or shortening of the working distance

Broken cage

4.3 Damage to the axle boot

Problems with the axle boots, particularly at steered axles, are the most frequent cause of damage. In many cases, the reason are incorrectly fitted clamps. If the clamps are not fastened with the right torque or if even plastic tapes are used, the necessary contact pressure is missing and the axle boot slides off the joint.

Due to inadequate venting inside the joint during installation or damage to the material because of unsuitable grease a premature failure is very probable.

To achieve an appropriate service life, the axle boots have to be firmly and tightly sealed but still fitted with the necessary flexibility. This is the only way for them to perform properly.

Causes of damage:

- natural wear and tear of material or aging (porosity, cracks)
- excessive lubrication
- inadequate ventilation during installation (reducing the bending angle)
- unsuitable or incorrectly fastened clamps

Incorrect fitted boot

5 Lubricant

Any cracks or leaky axle boots will result in a loss of lubricant while dirt penetrates the joint. Inadequate or excessive lubrication or even unsuitable lubricants cause premature wear and tear of the inner component parts.

Defective boots

5.1 Molybdenum sulphide as lubricant for CV joints

Grease is not suitable as a lubricant in certain cases. This applies particularly to CV joints. Contrary to common opinion, CV joints are lubricated with oil and not grease.

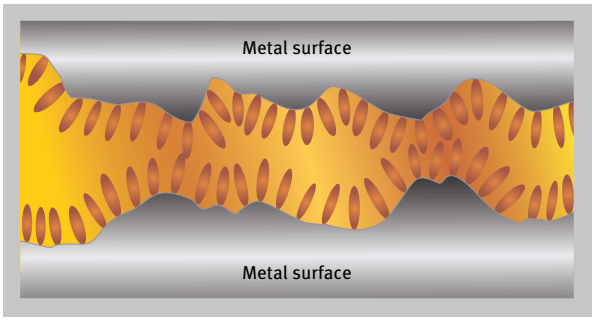
Oil is used in situations where high temperatures can be caused by the surroundings, high revs, high loads or constant friction of the inner component parts. All these factors come together in CV joints. For this reason, lubrication must be constant and take place in a suitable manner. The rotating components and raceways do not have a smooth surface, as it appears at first glance. A look through the microscope reveals a complete irregular surface.

To avoid direct contact between the two surfaces, those lubricants are used which form a thin lubricating film. Oil, with its special properties, is particularly suited in this case.

5.2 Why is molybdenum sulphide called grease?

The high loads occurring in CV joints demand resistant lubrication of the joint. A thin oil film cannot withstand these loads and would soon be displaced. Due to the structure of solid additives such as molybdenum sulphide they cannot be simply displaced and therefore represent, in combination with oil, the ideal lubricant. In this way, “lubricating rails” are formed between the surfaces, thus considerably improving the lubricating properties.

Molybdenum sulphide is a “polar” additive. In other words, its polarised molecules align themselves vertically to the metal surface, thus forming a more resistant lubricating film.



Lubricating film between friction partners

6 General repair recommendations

Collisions caused by accidents or unusual jolts resulting from the road surface are not included in normal agerelated wear and tear. It repairing side shafts damaged by these causes, all surrounding parts must be examined precisely to obtain a complete, reliable diagnosis in order to avoid subsequent repairs.

The following points must be checked:

1. Condition and fastening of all drive unit bearings
2. Steering knuckle with add-on parts (joints, tie rods, etc.)
3. Chassis, drive unit supports, axles (including all fastening bolts)
4. Wheel bearings and wheel hubs
5. Upper and lower shock absorber suspension
6. Axle alignment to check the axle geometry

Please comply with the manufacturer's repair instructions for the specific vehicle.

Comply with the following points during installation to avoid damage to the axle boots and CV joints and to ensure correct sealing:

1. Only fit new and suitable clamps.
2. Do not reuse any existing clamps.
3. Do not use either plastic tapes or twisted wires.
4. Always use the lubricant included with our products.
5. The following procedure is recommended for inner cleaning:
   a) Dismantle the CV joint from the side shaft.
   b) Remove as much lubricant as possible.
   c) Clean the assembled joint.
   d) Use solvents containing acetone for cleaning and to remove dirt.
   e) Dry with compressed air.
6. Before reassembly, at first fill the inside of the joint with molybdenum disulphide and squeeze the remaining lubricant into the premounted axle boot.
7. To remove surplus air from inside the axle boot, insert a screwdriver between the axle boot and the side shaft.
8. Mount the clamps and fasten them in place.


7


8

7 Troubleshooting

Diagnosis	Noises at higher speed	Jolting	Vibrations and lateral movements
Symptoms	Constant noises from the wheels at 80 km/h	Cyclic jolts at all times while driving	Vibrations when starting up and braking
		Jolts in the steering when steering in one or both directions	Lateral movements of the car body and/or steering
Possible causes	Unsuitable or soiled lubricant or inadequate lubrication	Interior damage to the outer joint	Interior damage to the inner joint
	Interior damage to the joint	Interior damage to the inner joint	Damage to or imbalance in the rod or shaft of the split axle
	Leaky axle boot	Leaky axle boot	Deformed/damaged tyres or imbalance in the wheel
	Damage to the wheel bearing	Incorrect torque for the axle nut	Alignment of the wheels outside the tolerance
	Tyres in poor condition	Damage to engine supports, wheel suspension and/or chassis	Engine support in poor condition or broken
		Loose or damaged compensation weights or rubbers on the side shaft	Damage to the car body and/or chassis
Checks before dismantling	Check that the clamps fit properly and are fastened correctly	Check that the clamps fit properly and are fastened correctly	Check that the clamps fit properly and are fastened correctly
	Check the axle boot for porosity and cracks	Check the axle boot for porosity and cracks	Check whether the side shaft is bent or damaged
	Reproduce the noise by turning the wheels with the vehicle jacked up	Check the engine support and chassis	Check the condition of the tyres for wear and tear
Checks and work after dismantling	Check for damage or dirt inside the joints	Check for irregular wear to the inner component parts of the joints	Check the condition of the inner component parts of the wheel-side joint
	Check for noises in the wheel bearings	Check the gearing on the side shaft for taking the joint	Check the alignment of all components, check the balancing of the wheels
	Clean and check the tapered roller bearings and replace at the first signs of wear and tear	Check the compensation weights of the side shaft, replace and/or fasten as the need arises	Check whether the side shaft is bent or damaged, replace the complete shaft if necessary
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