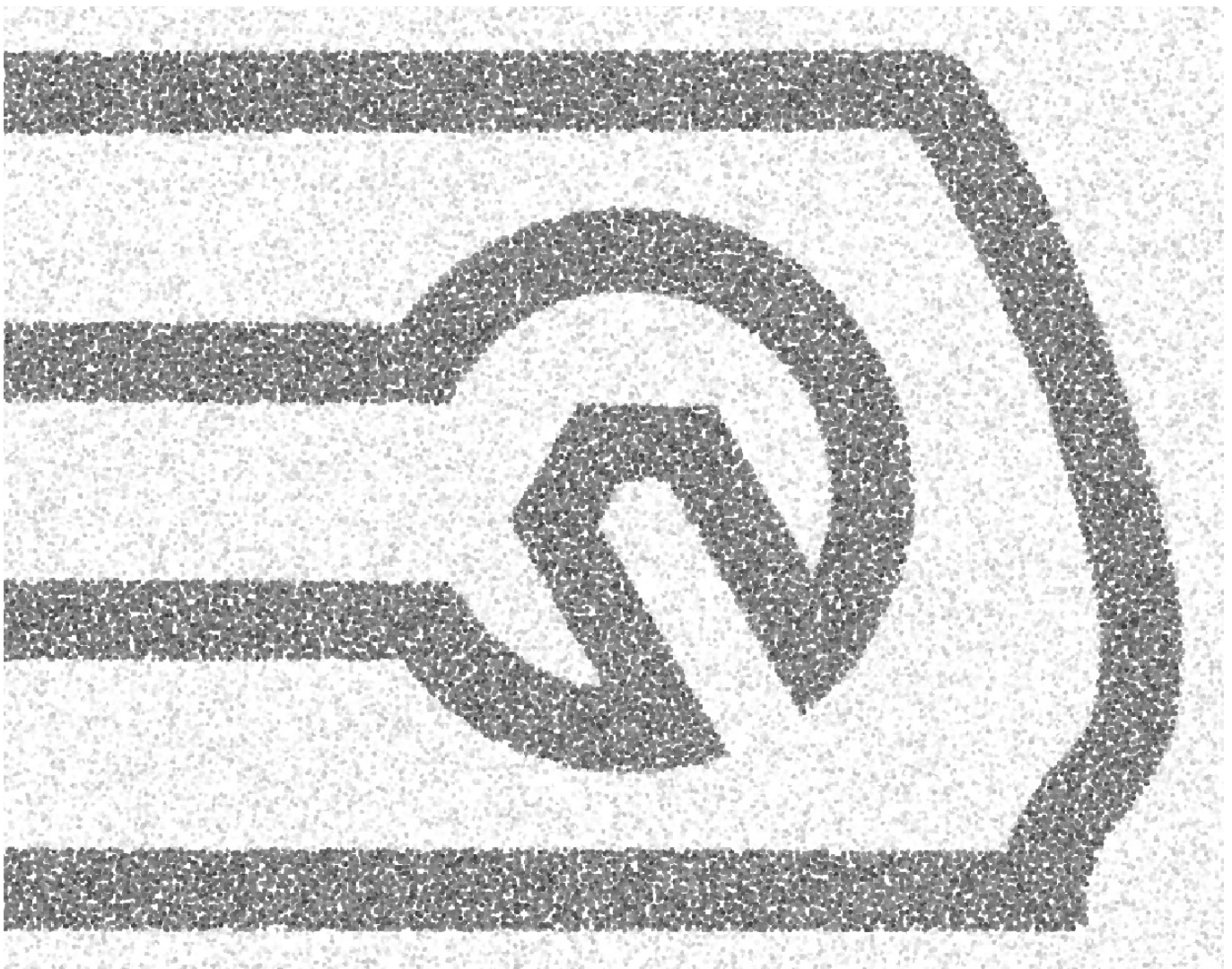


Chapter 3

Gearboxes



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- 3.1 Retarder - Intarder
- 3.2. Clutch
- 3.3 Gear selection system

3.1 Retarder - Intarder

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1 Introduction

Any Futura can be fitted with a retarder or intarder, this depending on the gearbox chosen. The Futura 15-metre has a preselector gearbox (AVS). This is fitted with a ZF intarder. Futuras with a 6-speed gearbox can be fitted with a Telma retarder or a ZF retarder. Futuras with an 8-shift gearbox can be fitted with a Telma retarder or a ZF retarder. Futuras with an AVS-gearbox always have a ZF intarder.

The Telma retarder works electromagnetically. A magnetic field originates because a current is sent by a coil pair. This results in a magnetic force that is opposite to the turning direction of the drive shaft, so this is slowed.

The ZF retarder works hydro-dynamically like the ZF intarder. A rotor driven by the drive shaft turns at an increased speed. This is fitted in an oil bath. The accelerated oil cannot move so quickly, so the rotor is slowed. This brakes the drive shaft, so also the vehicle. With a ZF intarder most of the oil and coolant channels are internal, while this is not the case for the ZF retarder.



The electrical diagrams as they appear in this section can vary somewhat from that built into the Futura. They are only to serve in explaining the working of the retarder/intarder. For the correct diagram one is referred to the diagrams in the black folder supplied with each Futura.

2 Safety

The correct operation and setting of the retarders and intarder is important for the safety of driver and passengers. Correct working can only be guaranteed when all instructions for installation, setting and maintenance are followed. Non-compliance with these instructions can lead to dangerous situations (e.g. overloading of the service brake when going down a hill).

Installation, maintenance and repairs may only be carried out by personnel who have been trained and authorised to do so by the Bova service organisation. Repairs or maintenance activities carried out by non-authorised persons can lead to dangerous situations and are not covered by the guarantee.

2.1 Safety at the workplace

To be able to work safely on the intarder (retarder) it is necessary to comply with the following:

1. Ensure the good extraction of exhaust fumes and vapours of cleaning substances and solvents.
2. Make sure the vehicle cannot roll away.
3. Never have the engine running while working on the retarder.
4. Use suitable tools.
5. Only use tools that fit perfectly.
6. Only use original parts.

2.2 Precautions

Before starting work on the intarder (retarder) the following must be complied with:

- Thoroughly clean the area around the gearbox before the intarder (retarder) is fitted.
- After the fitting of parts cover the opening so that no other foreign objects can fall in.
- Be very critical when considering re-using parts.
- New O-rings and gaskets must always be used.
- With the assembly of parts, these must always be perfectly clean and undamaged. This is the only way to prevent leaks and damage to the gearbox.
- When fitting bearings these must be evenly heated.
- Only use oil mentioned on the ZF lubricants list TE-ML 02.



Do not work on the system while it is still warm.

3 Electromagnetic Telma retarder

3.1 Advantages of electromagnetic brakes

1. Because there is no mechanical contact (with the exception of the bearings) neither is there any mechanical wear.
2. Reduces wear on the service brakes.
3. Works independently. Braking can also take place with the retarder when changing down.
4. Only uses a current when the retarder is activated.
5. Braking moment adjustable in four steps (max. 2200 Nm).
6. Available with foot operation giving fully automatic working.

3.2 Working

The working of the electromagnetic Telma retarder is based on current induction.

Two discs are fitted on the drive shaft. These discs are called rotors {1} and turn with the drive shaft.

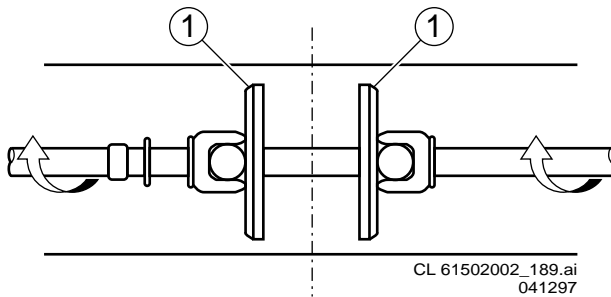


Figure 1 Rotors on the drive shaft

A stator {2} (Figure 2) is fitted between the two rotors {1}. This stator is connected to the chassis and consists of magnetic coils with alternating polarity (north/south).

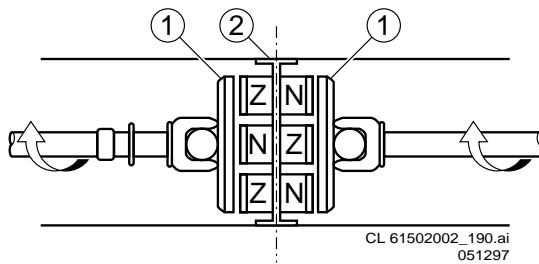


Figure 2 Rotors with a fixed stator

As soon as an electrical current runs through the coils a magnetic field is induced. This magnetic field passes through the turning rotors (see Figure 3). The magnetic field in turn induces a magnetic force that is perpendicular to the magnetic field. The magnetic force (called braking moment) is opposite to the direction of the turning drive shaft so it is slowed. The intensity of the current through the coils (and the number of activated coils) determines the extent of the braking moment).

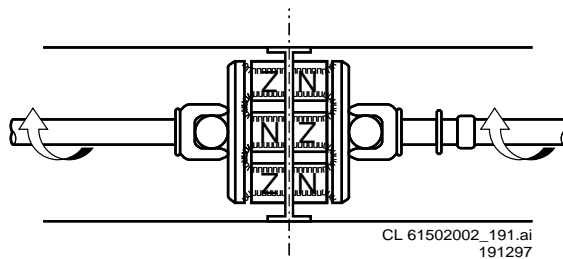


Figure 3 Current through the coils

3.3 Coil operation

The electromagnetic coils can be operated in a variety of ways.

3.3.1 Manual

The switch {1} is on the dashboard or fitted on the steering column.

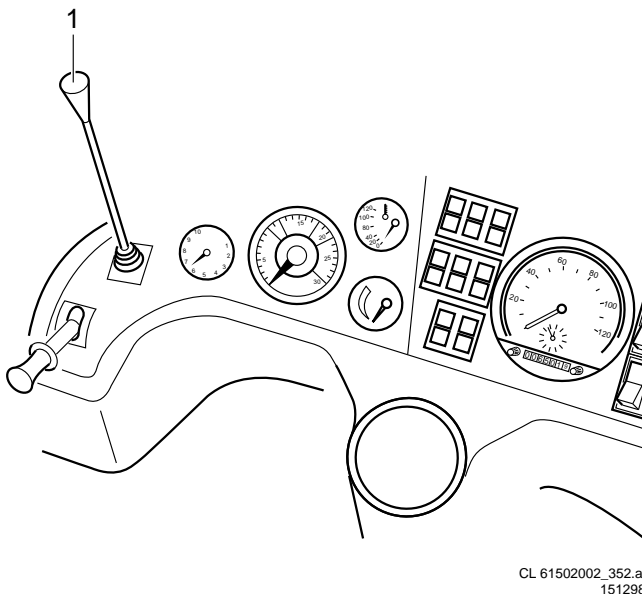
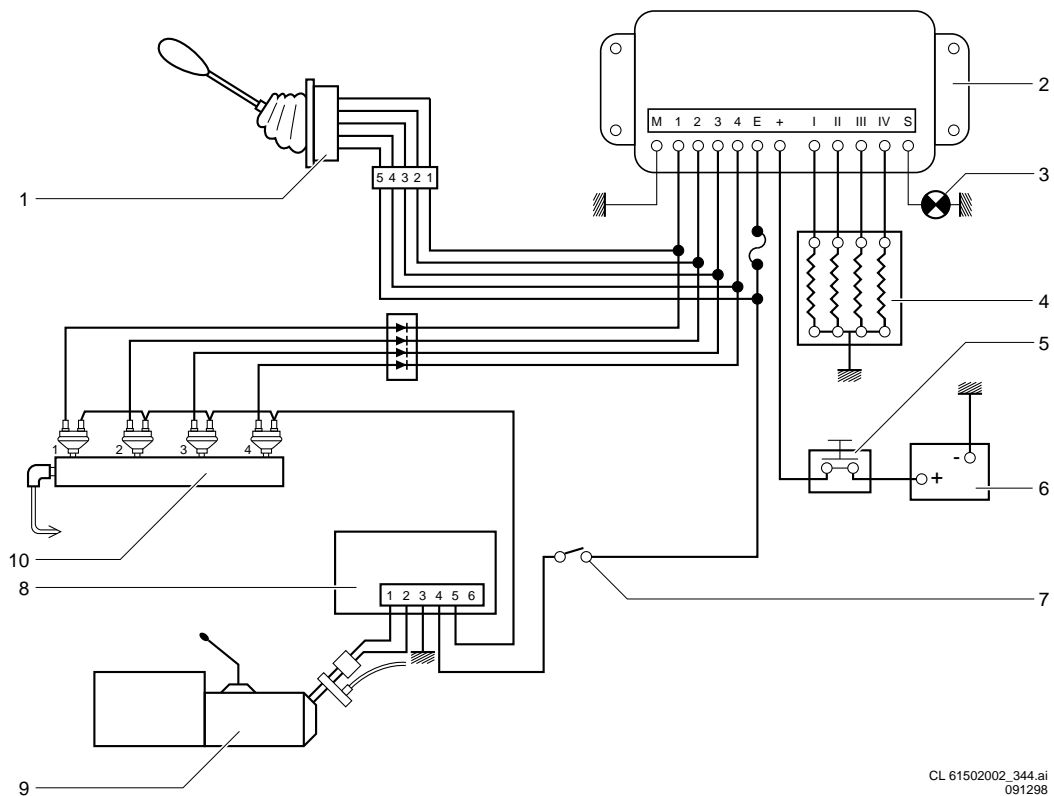


Figure 4 Control lever for retarder



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Figure 5 Diagram of Telma retarder

- | | |
|-------------------|--------------------------|
| 1. Hand switch | 6. Power |
| 2. Control box | 7. Switch foot operation |
| 3. Control light | 8. Switchbox |
| 4. Retarder | 9. Engine/gearbox |
| 5. Contact switch | 10. Pressure switch unit |

The handbrake switch {1} has five positions and makes it possible, using the control box {2}, to set the four circuits of the retarder {4} so the desired braking effect is obtained.

3.3.2 Foot operation (optional)

With vehicles fitted with foot operation the retarder is integrated in the service brake. The air behind the foot brake valve is sent to the pressure switch unit {10}, that can operate a maximum of four pressure switches depending on the extent to which the driver depresses the foot pedal.

The first two pressure switches are operated as soon as the driver depresses the pedal a little. The first two coil pairs of the retarder {4} are then excited.

The third coil pair is excited when the brake shoes are positioned just against the brake drum.

The fourth coil pair is excited when the service brakes start operating.

The retarder {4} is therefore fully operating before the service brakes start working. At low speeds (under 7 kph) it is not necessary for the retarder to work. Switch box {8} ensures the retarder is switched off at speeds under 7 kph.

With switch {7} the foot operation of the retarder is switched off. This is necessary in cases such as where the service brake has to be tested. This switch is not present if there is no foot operation.

3.3.3 Combined operation

With combined operation the control lever {1} and the brake pressure switches {10} are present. The driver decides if the retarder also automatically brakes or if this is determined by himself. This is particularly useful travelling downhill. The retarder can be fully activated while the service brake is not powered.

3.3.4 Operation by ABS

By using a relay (see electrical diagram Figure 14) the ABS system switches off the retarder when the ABS system starts operating. This blocking can only be released by the ABS system.

3.4

Removal and installation procedures

3.4.1 Coils

If after measuring (see §3.5.) a coil appears to be defective, the coil pair must be replaced. It is not necessary to disassemble the complete retarder for this. See Figure 6 for an exploded view.



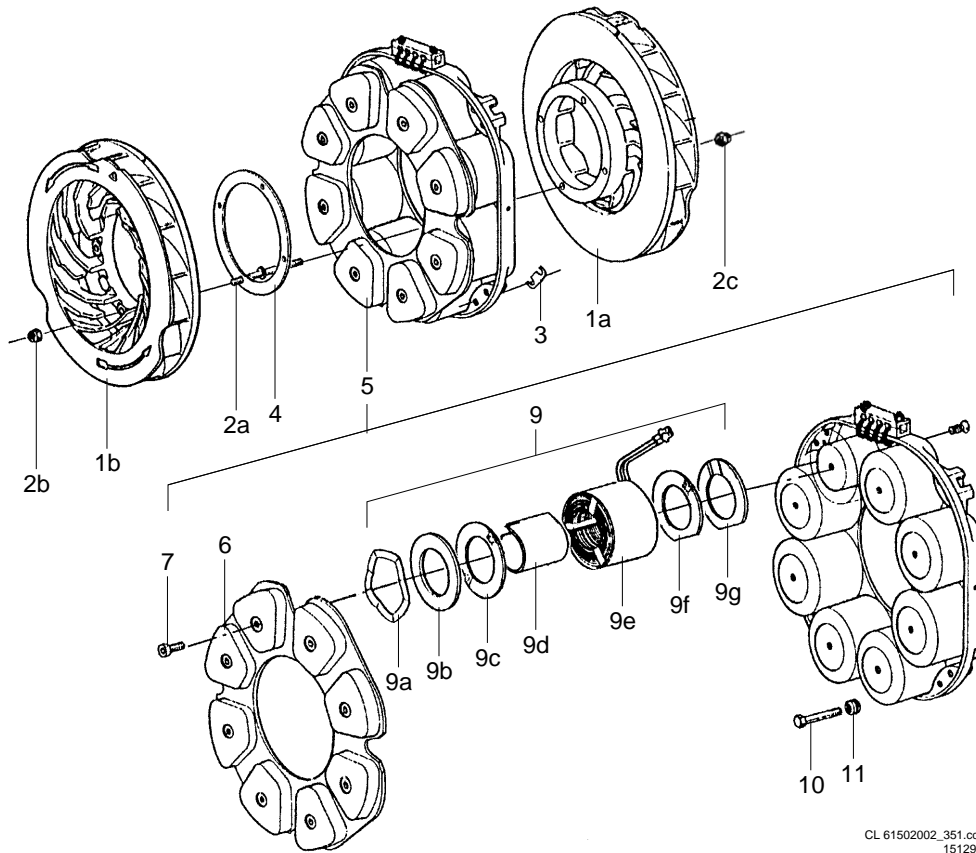
When a coil pair is replaced it is not necessary to disassemble the drive shaft.

1. Loosen the 4 nuts {**2b**}. Rotor {**1b**} can be slid over the drive shaft. Hence, the drive shaft does not have to be disassembled.
2. Remove the 8 Allen screws {**7**}. By removing these screws the pole shoe plates {**6**} can be taken off.
3. Break the connecting wires of the broken coils. One end is connected to the earth connection and the other end to the connecting block.
4. Remove the coils complete with the accessories {**9**} and replace them with a new set.
5. Replace the pole shoe plates {**6**} and tighten the Allen screws {**7**} 50 Nm.
6. Check whether shim {**4**} is damaged. It is best to always replace this after the disassembly of the rotor.
7. Replace rotor {**1b**} on the shaft and tighten the nuts {**2b**} crossways 93 Nm.
8. Check the air gap between both rotors and the stator. The distance between a rotor and the stator must amount to 1.4 mm all round. This distance can be obtained with shims {**3**}. The bolts {**10**} must be loosened for this.



The air gap can only be measured when the bolts have been tightened.

9. Tighten the bolts {**10**} 82 Nm when the air gap of 1.4 mm has been obtained all round.



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Figure 6 Construction of Telma retarder

3.4.2

Removal of complete retarder



Make sure the vehicle cannot roll away and that the vehicle ignition is off.

1. Clean the area around the retarder so that when a new retarder is fitted no dirt can end up between the various parts.
2. Remove the drive shaft. This is fixed with a total of 8 bolts (and nuts) { **1** } (see Figure 7).

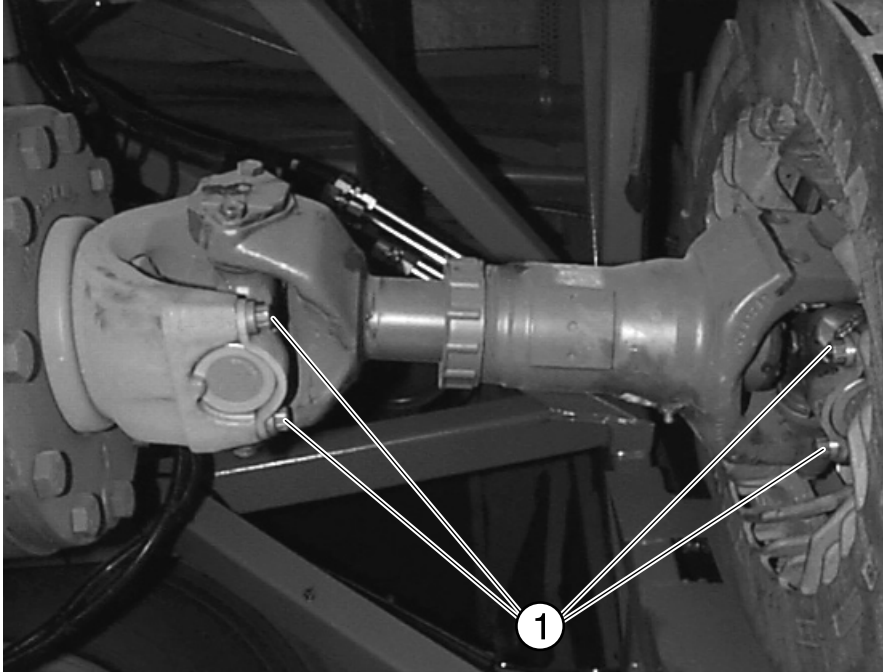


Figure 7 Drive shaft



3. *The complete retarder weighs 174 kg. Support the retarder with a jack.*
4. Remove the earth strip and the connections to the connecting block.



- Note the connection numbers on each wire so that they are connected correctly with the fitting of the new stator.*
5. The stator is supported by a diagonal { **2** } (Figure 8) that is connected to the chassis by two springs { **1** } (see Figure 8). This makes sure that the housing of the gearbox is not excessively loaded. Loosen the nuts { **3** } so that the diagonal can be removed with the retarder.

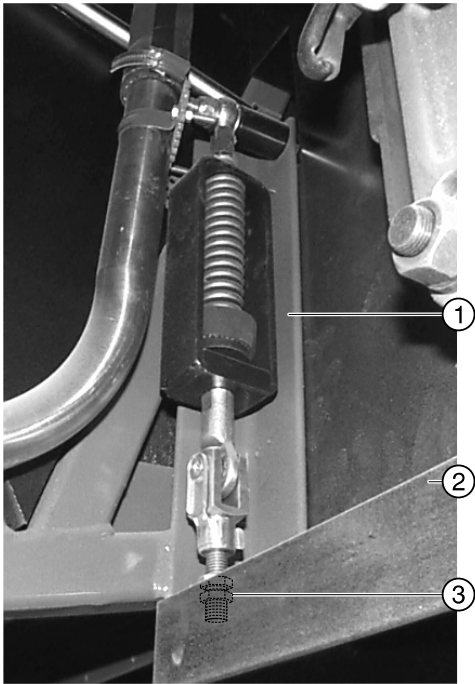


Figure 8 Supporting frame for retarder

6. If the retarder is well supported the 8 bolts {10} (see Figure 6) can be loosened. Keep the shims {3} so that they can be replaced in the correct position with installation, or make sure of the right size with new ones.
7. Loosen the 4 nuts {1} (see Figure 9) of the gearbox main shaft. The retarder is now completely freed from the gearbox and can be removed.

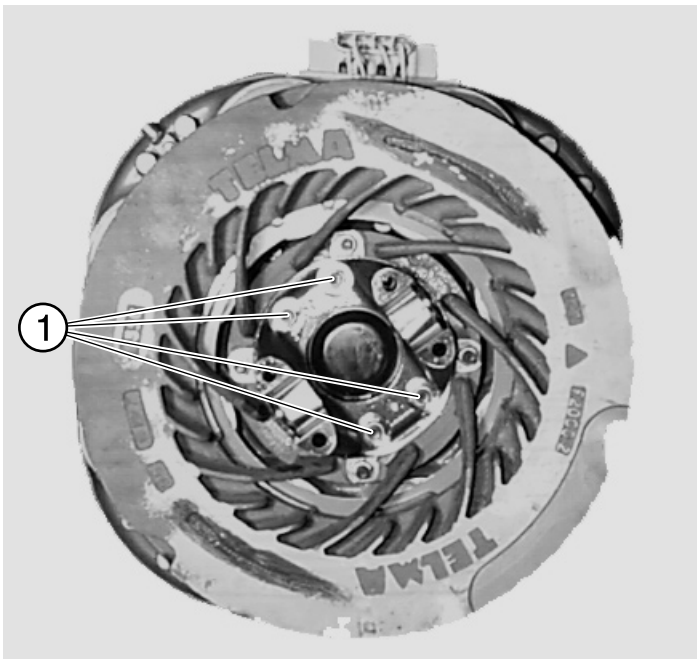


Figure 9 Front view Telma retarder

8. After the retarder has been placed on a solid workbench the 4 nuts {2b} (Figure 6) can be removed. The stator is now freed of both rotors.

3.4.3 Installation Telma retarder

1. Degrease and thoroughly clean all parts before starting to assemble the retarder. Use Figure 6 to assemble the retarder.
2. Place rotor {1a} on a workbench with the connecting flange facing upwards.
3. Fit stator {5} and then rotor {1b} on rotor {1a}. Do not forget to place a new shim {4} between the stator and rotor {1b}.
4. Tighten the 4 nuts {2c} crosswise 30 Nm. The 4 nuts {2b} are tightened crosswise 93 Nm.
5. Because the retarder weighs 174 kg it can only be placed on the gearbox main shaft with a hoist and jack.
6. Place the retarder on the drive flange of the gearbox. Tighten the tapered nuts {1} crosswise 138 Nm.
7. Grease the 8 bolts {10} (see Figure 6) with anti-seize compound. Then fit the stator with these bolts to the stator support. Make sure the hollow side of the lock washers is on the stator side. Do not yet tighten the bolts. The shims {3} must be fitted between the stator support and the stator. The thin shims must be on the rotor side because of heat development.
8. *When new rotors are fitted there is a thin coat of wax on them. Remove this with a knife before measuring the thickness of the air gap.*
9. The air gap between the rotor and stator must amount to 1.4 mm on both sides. This is obtained using the shims {3}. When the air gap is correct the bolts {10} can be tightened 82 Nm.
10. Fit the diagonal on the stator. Tighten the 2 nuts {2} (see Figure 8) hand-tight. The nuts must then make 6 turns so that the springs are preloaded.
11. Fit the drive shaft on the retarder (see Figure 7). The bolts (and nuts) {1} must be tightened 170 Nm.
12. Connect the connection wires, making sure of the correct connection number.
13. Thoroughly clean the earth connection to the body.
14. Check the air gap again before switching on the retarder.



3.5 Faults

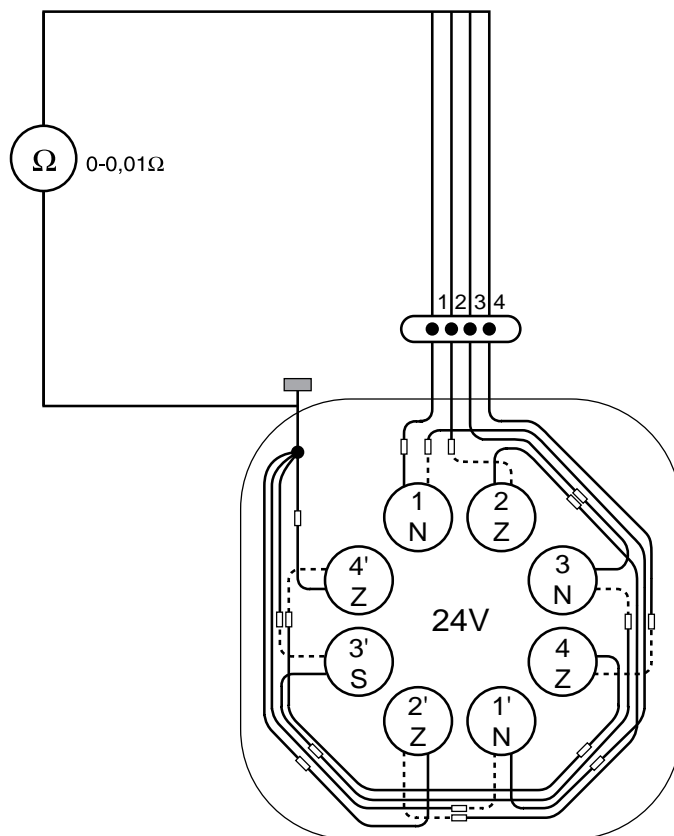
Any reduction of the working of the retarder, that is in a good mechanical state, is a result of an interruption in the earth connection or one of the circuits. A circuit consists of two coils.

An interruption can be measured by the following procedures. The measured current consumption and resistance values must correspond with the technical specifications. If there are deviations, each coil must be separately isolated and measured.

3.5.1 Technical specifications

		type F2200
Air gap	mm	1.4
Resistance per circuit ($\pm 5\%$ at 20°C)	Ω	0.73
Resistance per coil ($\pm 5\%$ at 20°C)	Ω	0.36
Current intensity per circuit ($\pm 5\%$ at 20°C)	A	33

3.5.2 Measuring resistance

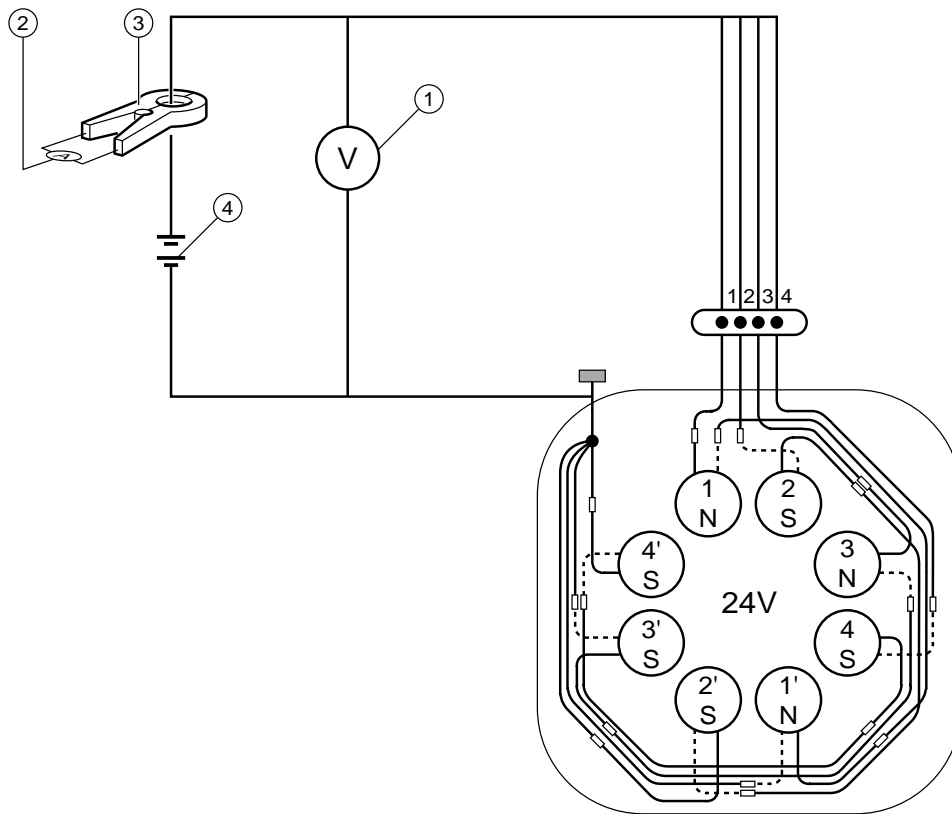


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Figure 10 Retarder connections

1. Switch off the vehicle ignition.
2. Remove the power and earth cable from the retarder. This prevents the influencing of the electrical circuit with the measurement.
3. Set the sensitivity of the digital ohmmeter to $1.0\ \Omega$.
4. Measure the resistance of each circuit directly on the connections block of the retarder and note the values measured.

3.5.3 Measuring current consumption and voltage



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Figure 11 Connections for voltage and current measurement

- | | |
|----------------|------------------|
| 1. Voltmeter | 3. Ampere pliers |
| 2. Amperemeter | 4. Power source |

1. Connect the voltmeter {1} and amperemeter {2} to the retarder as shown in Figure 11. Use ampere pliers {3} to measure the current.
2. At the same time measure the current through and the voltage over each circuit. Compare the values measured with the specifications.
3. If there is a circuit that varies from the specifications, both coils of this circuit must be isolated.
4. Measure again the resistance, voltage and current of the separate coils.
5. Compare the values with the specifications. It is then possible to establish which coil is defective.
6. Always replace a complete coil pair. Do this according to the procedure in paragraph 3.4.1.

3.6 Maintenance



When using compressed air and high-pressure cleaner never blow in the direction of persons.

The electromagnetic retarder is practically maintenance-free. However, there are a number of points that must be checked regularly. It is important to at least twice a year clean the retarder to remove lubricant and dirt. The vanes of the rotor are to be thoroughly cleaned to guarantee the good ventilation of the retarder. The best way of cleaning the retarder is using steam under pressure, without cleaning substance. Then dry with compressed air.

3.6.1 Control of electrical and mechanical parts

The following checks must be done **every six months**. If indicated, these must also be checked with the first service.

Check to be carried out	First service	Method
Correct play of the rotor/stator and measurement of the air gap	X	play max. between rotor and stator (1.4 mm)
Tightening of the fastening screws of the drive shaft	X	170 Nm
Check seal rings for leaks		visual
Condition of the fastening	X	visual
Condition of the insulation sleeves of the cables		visual
Condition of the coil connections		visual
Fastening of the cable shoes	X	visual
Condition of the earth connections		check for corrosion
Fastening of the earth connections	X	check for corrosion
Working of the relay box	X	listen or switch the relays
Condition of the contacts		visual
Bearing play drive shaft	X	visual
Fastening of the connecting clamps	X	visual
Working of the switching lever, foot switch, automatic cut-out, control box and light indication	X	

4 ZF intarder and ZF retarder

The ZF intarder and ZF retarder are hydro-dynamic auxiliary brakes integrated in the gearbox. The intarder is fitted as standard in the AVS (preselector) gearboxes and is optionally available for the 8-gear box. The ZF retarder is available optionally for the 6-gear box.

The difference between the ZF retarder and the ZF intarder is in the mechanical design. The intarder has one stator and one rotor while the retarder has two stators and a double-sided rotor. See appendix "Repair Manual ZF Intarder" and "Repair Manual ZF Retarder" for an illustration of the intarder and retarder. The intarder therefore has the cooling lines inside, while for the retarder these lines are external.

4.1 Advantages

1. Short activation times.
2. High efficiency (maximum 3000 Nm).
3. Shared oil use with the gearbox and therefore simultaneous replacement of the oil.
4. Low weight.
5. Shared cooling with the gearbox.
6. No extra space needed.

4.2 Working

Associated drawings: Appendix "Repair Manual ZF Intarder" and "Repair Manual ZF Retarder".

The oil in the intarder (retarder) ensures the brake action. The intarder (retarder) is operated by a 6-position lever (see Figure 4). The lever is fitted on the dashboard. Depending on the required braking moment the lever is put into a certain position. This position determines the quantity of oil in the intarder (retarder).

The gear wheel drive on the gearbox main shaft causes the rotor to be driven at an increased speed. The rotor turns in an oil bath. The oil accelerated by the rotor moves against the stationary stator(s) so the rotor is slowed. The braking power is transferred by the gear wheel drive to the gearbox main shaft. The braking energy is converted into heat. This heat is added by the heat-exchanger to the engine coolant.

4.3 Operation

The intarder (retarder) is operated by an electronic control device {1}. This receives and processes the following signals (see Figure 13 and Figure 14):

1. Required braking moment (from control lever or brake pressure switches).
2. Driving speed {11} Figure 14.
3. Coolant temperature.
4. ABS signal {10} Figure 14.

Depending on these signals the control device determines the quantity of oil in the intarder (retarder) and therefore the braking moment.

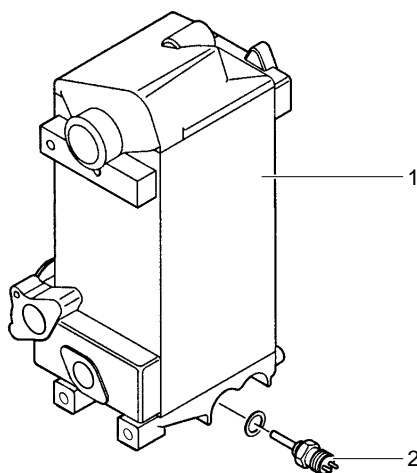
4.3.1 Safety functions

The electronic control device has a number of built-in safety functions that ensure the braking power is reduced if:

1. There is an electrical fault (short-circuit, wire breakage),
2. The oil in the intarder (retarder) becomes too hot,
3. The coolant becomes too hot.

The coolant is measured by a sensor {2} Figure 12 on the outgoing side of the heat-exchanger {1}. This temperature is compared with the highest permitted values. If these values are exceeded the control device will gradually reduce the braking power. If necessary the intarder (retarder) can be completely switched off by the control device.

The intarder (retarder) can also be switched off by the ABS system. The braking power is gradually increased to the set value after the intarder (retarder) has been switched back on by the ABS system.



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Figure 12

4.5 Removal and installation procedures ZF Retarder



Work may only be carried out on the ZF retarder by persons authorised to do so.

The removal and installation of the various parts is described in the ZF workshop manual. The book is called "Repair Manual ZF Retarder" and is supplied as an annex. In this repair manual the removal and installation procedures are described for the following parts:



The gearboxes in the Futuras are the Ecomid type. Remember this when establishing the correct removal/installation procedure.

- Heat-exchanger
- Oil reservoir
- Oil pump
- Oil filter
- Oil and air piping
- Drive shaft speed transmitter
- Gearing speed transmission
- Complete retarder
- Filter housing
- Stator and rotor
- Apply O-ring in the stator
- Proportional magnetic valve
- Switch valve
- Control valve
- Bearing bushes
- Drive gear
- Roller bearing

On pages 1-5 of the repair manual the special tools are mentioned that must be used with the removal and installation of the various parts.

The manual also describes the test procedure to be carried out after repairs.

4.6 Faults



Faults can lead to the (partial) failure of the intarder (retarder). This can cause the overloading of the service brakes if the vehicle is driven downhill.

Defective control lever (or cable breakage)

If a certain position of the control lever no longer works, neither will the corresponding braking moment. At the same time all higher positions of the control lever will be switched off. With the failure of the first position the intarder (retarder) is switched off.

Failure of speed and/or temperature sensor

With this failure the braking power is automatically limited to the second position by the control device, even if a higher braking moment has been chosen. In this way the intarder (retarder) continues to partly function.

Defect proportional valve

This failure results in the intarder (retarder) being fully switched off.

4.6.1 Fault identification and diagnosis

There is a control light fitted on the dashboard of the Futura. After switching on the ignition this light comes on for 3 seconds. During this time the control device carries out a function test. The control light continues to flash if there is a failure or if one occurs while driving. In this way the driver is clearly informed that the entire braking power is not available or that the intarder (retarder) has even switched off.

When the electronic control device identifies the fault, it is stored in the memory. The memory can be read in two ways:

1. Test box

An electronic test box can be connected to the diagnosis connection of the control device. This test box can be used to read off the faults in the memory of the control device. The operation of this test box is mentioned in the manual "Test Instruction for MOBIDIG 200". This manual is supplied with the test equipment.

2. Blink code

The memory can also be read by connecting an extra switch and lamp to the control device. The light blinks a number of times depending on the fault. The description of the blink code table can be found in "ZF Intarder, Faultfinding in electrical part". This is supplied as an appendix to the workshop manual.

4.7 Maintenance

4.7.1 Gearbox oil

Gearboxes fitted with a ZF intarder or ZF retarder may only be filled with SAE-30 engine oil. This oil must be able to be used to -30°C and must be on the TE-ML 02 list of lubricants of ZF. This lubricants list is supplied as an appendix to the workshop manual.

4.7.2 Oil replenishment

The oil is to be replenished for the first time after 5,000 km. The frequency thereafter depends on use.

light use (short journeys, flat terrain)	90,000 km.
heavy use	45,000 km.

In any case the oil must be replenished once a year.

Draining the oil

1. First take the coach on a longish test run to make sure the oil is up to temperature.



Switch off foot operation.

2. Do not use the intarder (retarder) immediately before or when driving the vehicle into the garage, this to make sure no oil remains in the intarder (retarder).
3. Make sure the vehicle is level and switch off the engine.
4. Drain the oil through the drainage plug in the bottom of the gearbox. The intarder also has a drainage plug next to the filter cover under the retarder (also see driver's manual ZF intarder).



Caution! The oil is hot.

5. After the draining of the oil the drain plugs must be cleaned and new seals fitted.
6. Replace the drainage plugs. The intarder drainage plug must be tightened 60 Nm, the gearbox plugs 14 Nm.

Replacing the oil filter

The oil filter must be replaced each time the oil is replenished.

For the replacement of the oil filter consult "Repair Manual ZF Intarder" and "Repair Manual ZF Retarder".

Filling oil with replenishment

1. Remove the overflow plug. This is in the left-hand side of the gearbox (also see the driver's manuals "ZF intarder" and "ZF retarder").
2. Fill the gearbox through this opening with oil. Fill until the gearbox overflows.
3. Replace the overflow valve in the gearbox 60 Nm.
4. Take a short test run of at least one minute with a minimum speed of 10 kph.



Do not operate the intarder (retarder)!

Switch off foot operation.

5. Stop the vehicle after the test run.
6. Switch off the engine.
7. Remove the overflow plug and check the oil level again. If necessary, top up until the gearbox overflows.
8. Replace the overflow plug with a new seal.



Between replenishment times regularly check the oil level in the gearbox. To measure the level correctly the intarder may not be operated before measuring.

Filling oil after repairs

If the gearbox and/or intarder (retarder) has to be removed for repairs, all the oil has to be removed. For this it is necessary at the start of a test run to operate the intarder (retarder) once briefly in position 6. This guarantees the good distribution of the oil.



The intarder (retarder) may not be operated immediately before the end of the test run.

Switch off foot operation.

The rest of the procedure is the same as in "Filling and replenishing oil".

5 Order numbers

Order numbers of parts that have to be replaced can be found in the parts book.

Use the chassis number to check whether you are using the correct parts book. The order numbers for parts of the Telma retarder are in group 580. For parts for the ZF intarder and ZF retarder you must contact Autobusfabriek BOVA b.v.

6 Appendices

- ZF intarder
Repair manual 6085 751 102

- ZF retarder
Repair manual 1313 751 106

- ZF lubricants list TE-ML 02.

3.2 Clutch

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1 Introduction

The clutches as built into the Futuras are exclusively with the purpose of:

- Propelling the vehicle. Or – to be able to smoothly engage the action of a running engine with stationary wheels.
- During the changing of gears to momentarily disengage the engine from the turning wheels.

The clutch may only momentarily slip when the vehicle is initially propelled. At this time just enough acceleration must be provided to prevent the engine cutting out. Only when the clutch pedal is completely released may the accelerator pedal be fully depressed to transfer the full engine torque to the wheels.



Driving with a foot on the clutch pedal or driving with a slipping clutch inevitably leads to a burned clutch plate. The result is a breakdown and costly repairs.

The clutch plate is provided with springing plates between the linings and vibration dampers to ensure the smooth engaging of the clutch. A constantly applied thrust bearing is used (see paragraph 3.1) so that the clutch pedal always adjusts itself.

2 Safety

The correct working and setting of the clutch is important for the safety of the driver and passengers. Correct working can only be guaranteed when all instructions for installation, setting and maintenance are followed. Non-compliance with these instructions can lead to dangerous situations (e.g. a clutch that does not release).

Installation, maintenance and repairs may only be carried out by personnel who have been trained and authorised to do so by the Bova service organisation. Repairs or maintenance activities carried out by non-authorised persons can lead to dangerous situations and are not covered by the guarantee.

2.1 Safety at the workplace



To be able to work safely on the clutch and clutch operation it is necessary to comply with the following:

1. Ensure the good extraction of exhaust fumes and vapours of cleaning substances and solvents.
2. Make sure the vehicle cannot roll away.
3. Never use the clutch when the engine is running (unless specifically mentioned).
4. Only use tools that fit perfectly.
5. Only use original parts.
6. The only clutch fluid to be used is SAE J-1703 (DOT 4).

2.2 Precautions



Before starting work on the clutch and clutch operation the following must be complied with:

1. Thoroughly clean the area around the gearbox before the clutch is fitted.
2. Be very critical when considering re-using parts.
3. O-rings and gaskets removed must always be replaced by new ones.
4. With the assembly of parts, these must always be perfectly clean and undamaged. This is the only way to prevent leaks and damage to the clutch system.

2.3 The environment

Clutch fluid is harmful to the environment. Keep drained off clutch fluid separate from other fluids and take them to an establishment appointed for the disposal of such fluids.

3 Working

3.1 Overview

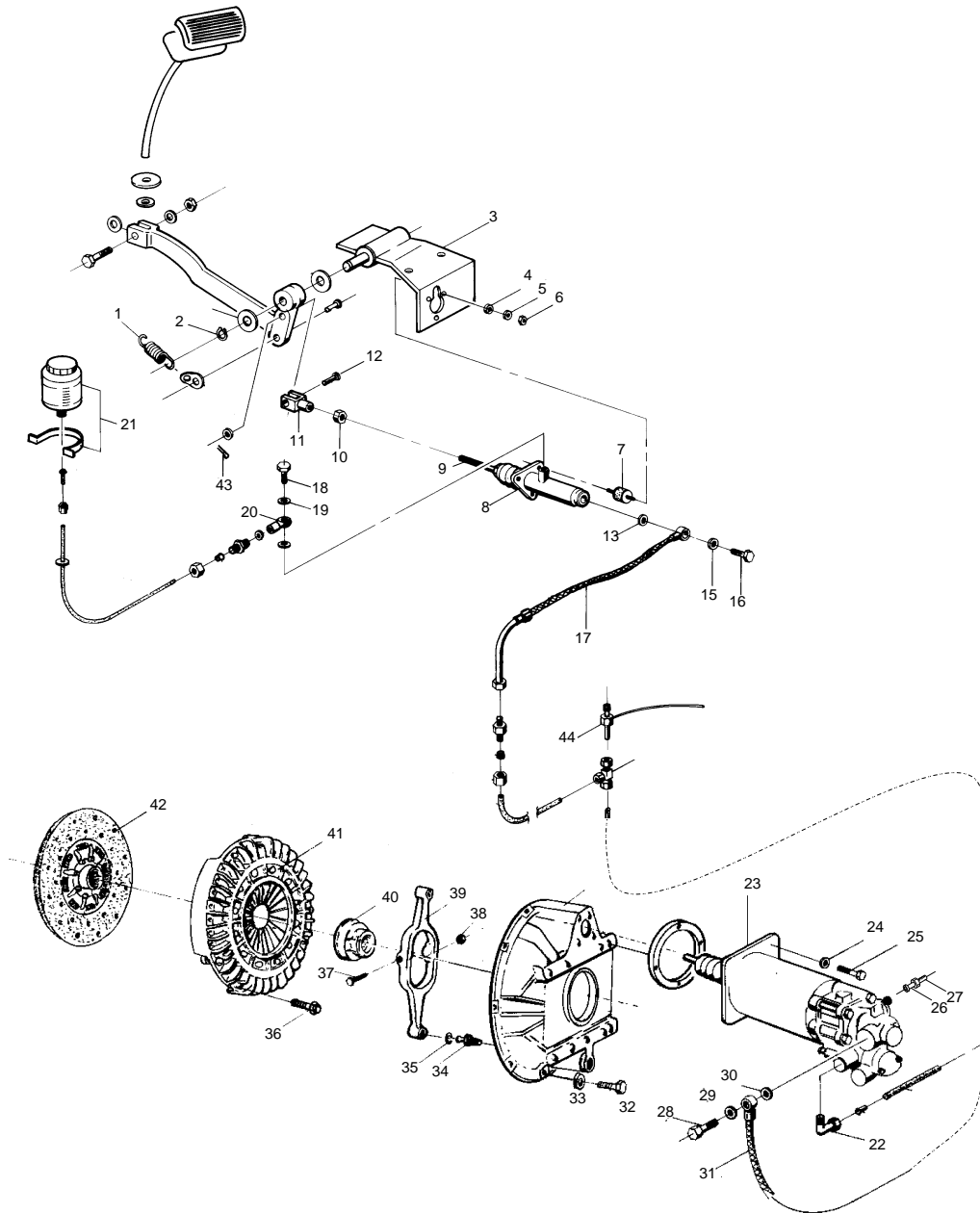


Figure 1 Overview of clutch operation

- | | | | | | |
|-----|------------------|-----|---------------------|-----|-------------------------|
| 1. | Tensioner spring | 17. | Hose | 32. | Bolt |
| 2. | Locking ring | 18. | Banjo bolt | 33. | Ring |
| 3. | Bearing base | 19. | Sealing ring | 34. | Ball pin |
| 4. | Ring | 20. | Banjo housing | 35. | Spring washer |
| 5. | Spring washer | 21. | Reservoir | 36. | Bolt |
| 6. | Nut | 22. | Air coupling | 37. | Adjuster bolt |
| 7. | Vibration damper | 23. | Clutch booster | 38. | Nut |
| 8. | Master cylinder | 24. | Ring | 39. | Lever |
| 9. | Push rod | 25. | Bolt | 40. | Thrust bearing |
| 10. | Nut | 26. | Air-bleeding nipple | 41. | Clutch release assembly |
| 11. | Yoke | 27. | Cap | 42. | Clutch plate |
| 12. | Pin | 28. | Banjo bolt | 43. | Split pin |
| 13. | Sealing ring | 29. | Sealing ring | 44. | Air-bleeding nipple |
| 15. | Sealing ring | 30. | Sealing ring | | |
| 16. | Banjo bolt | 31. | Hose | | |

3.2 Working

(See Figure 1)

If the clutch is not actuated, the clutch plate is pressed against the flywheel by the clutch release assembly {41}. The engine torque is transferred to the gearbox through the clutch plate {42}. The clutch plate {42} is released from the flywheel when the driver depresses the clutch pedal.

When the driver depresses the clutch pedal, the push rod {9} pushes in the clutch cylinder {8} against a piston. As a result, the clutch fluid is compressed and flows to the clutch booster {23}.

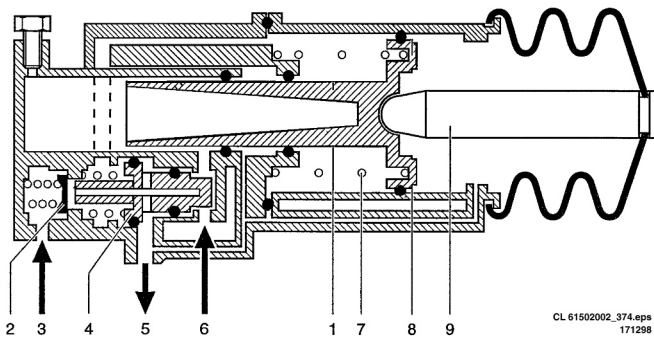


Figure 2 Clutch booster

- | | | | |
|----|-------------------|----|---------------------|
| 1. | Fluid piston | 6. | Fluid connection |
| 2. | Valve | 7. | Spring |
| 3. | Air inlet | 8. | Air pressure piston |
| 4. | Regulating piston | 9. | Pressure spindle |
| 5. | Air outlet | | |

(See Figure 2)

The clutch booster consists of a hydraulic part and an air pressure part.

The air pressure piston {8} is pushed against the pressure spindle by a spring {7}. The thrust bearing {40}, Figure 1 is therefore constantly loaded to some extent. As a result, the wear of the clutch plates is not noticeable due to the increasing play. As the clutch plates wear, the air pressure piston {8} is further pushed back.

Through connection {6} pressure is exerted on the fluid piston {1}. The clutch therefore also works when there is no air pressure present, but with considerably more pedal force.

Because of the fluid pressure on connection {6}, regulating piston {4} is pushed against the valve {2}. This closes the air outlet {5}. Air inlet {3} is now opened and pressure is built up on the left-hand side of the air pressure piston {8} so this moves to the right. Pressure spindle {9} comes out and pushes the thrust bearing {40}, Figure 1 against the release fingers of the clutch release assembly {41}, Figure 1. The gearbox is accordingly released.

3.3 AVS (preselector gearbox)

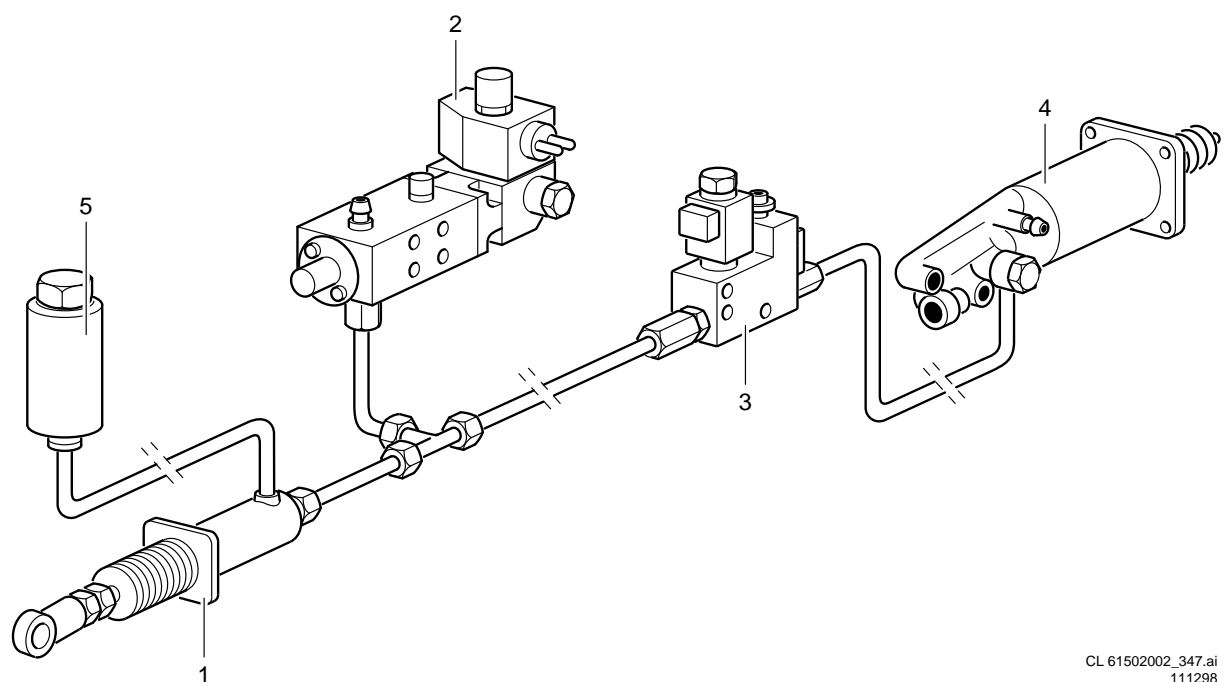
The operation of the clutch associated with an AVS gearbox differs in a number of ways from standard clutch operation. In the clutch line a pressure device {2} and valve {3} (see Figure 3) are included that together with a clutch switch (see Figure 6) ensure that with the premature release of the clutch no damage to the gearbox is caused.

The valve in the clutch line works as a shut-off valve. When the driver presses the clutch, this is registered by the clutch switch. This sends a signal to the electronics, that then actuates the "hold clutch" {3} valve (see figure below). The valve then shuts off of the line from the clutch cylinder to the clutch booster. This makes sure the clutch remains open even if the driver releases the pedal.

When the electronics receive a signal from the gearbox that the acceleration is actuated, a signal is first sent to the "acceleration switched" {2} pressure device. This pressure device is also a magnetic valve. The force on the valve causes a pressure wave in the clutch fluid. The pressure wave is then felt by the driver in the clutch pedal as a "tap" so the driver knows that the shifting procedure has taken place. The actuating of the "hold clutch" valve {3} then stops. The clutch pedal can now be released so the clutch engages again.



The clutch pedal may never be released before the driver feels the "tap" under his foot. The acceleration has not yet been actuated then, so damage could be caused to the gearbox.



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Figure 3 Overview AVS clutch line

- | | | | |
|----|---|----|----------------|
| 1. | Clutch cylinder | 4. | Clutch booster |
| 2. | "Acceleration switched" pressure device | 5. | Reservoir |
| 3. | "Hold clutch" valve | | |

4 Removal and installation procedures

4.1 Clutch plate and thrust bearing

4.1.1 Removal

For a parts overview see Figure 1.



If the clutch plate is replaced, it is advisable to also replace the clutch release assembly and the thrust bearing. If the clutch plate is worn, the clutch release assembly and the thrust bearing will usually also be due for replacement.

1. Remove the protective plate on the bottom of the gearbox.
2. Remove the drive shaft. See section 3.5. for the exact removal procedure for the drive shaft.
3. Remove the clutch booster. This procedure is described in paragraph 4.3.3.



Place the clutch booster with connected lines to the side.

4. Remove the gearbox. See section 3.6. to 3.8. for the procedure for removing the gearbox.



Allow a hot engine to first cool down before removing the gearbox. Oil and coolant can have a temperature of 80°C!

5. Remove the clutch release assembly **{41}**.
 - Remove the 4 bolts around the edge.
 - Insert the threaded ends with nuts in the threaded holes.
 - Remove the other bolts.
 - Loosen the nuts gradually.
6. Remove the clutch release assembly **{41}** with the clutch plate **{42}**.
7. Remove the adjuster bolts **{37}** of the thrust bearing **{40}**.
8. Remove the thrust bearing **{40}** from the fork **{39}**.

4.1.2 Installation

1. Check the guide bearing for play.
2. Fit the new clutch release assembly and clutch plate in the reverse order to removal, *taking account of the following:*



- Turn adjuster bolt **{37}** Figure 1 until the thrust bearing **{40}** is not quite tight.
- Centre the clutch plate using a dummy shaft against the flywheel. With S6-85 gearboxes the diameter of the dummy shaft is 57 mm, with an 8S-180 this diameter is 60 mm.
- Completely degrease the new clutch release assembly. Fix the clutch release assembly with the bolts **{36}** (50 Nm) to the flywheel.
- Remove the dummy shaft.
- Fit the gearbox. Fasten the fixing bolts 50 Nm.
- If there is a Telma present the 4 hexagonal bolts attaching the Telma to the drive shaft must be tightened 128 Nm (also see section 3.1 for adjustment).
- Tighten the bolts of the drive shaft 170 Nm.
- Connect all pipes and connectors at the correct place.
- Fill the cooling system with coolant water according to the procedure of paragraph 9.6.1. of section 6.1 "Futurair".
- Air-bleed the clutch line according to paragraph 5.

3. Check the working of the clutch by taking a test run.

4.2 Clutch cylinder

4.2.1 Removal

For a parts overview see Figure 1.

If the clutch cylinder is replaced the lines to the reservoir and clutch booster must be disconnected. It is best to also replace the clutch fluid then.

The clutch cylinder {8} is fitted immediately below the driver's position above the air storage tanks.



Clutch fluid is an aggressive fluid that attacks paint and clothes. It is also harmful to the environment if not disposed of properly.

1. Put a collector under the clutch cylinder so that the clutch fluid does not fall on the ground.
2. Remove lock nut {10} from yoke {11}.
3. Remove split pin {43}.
4. Remove the pin {23}, turn the yoke {11} from the push rod {9}.
5. Loosen the banjo bolts {18} and {16}. Allow the clutch fluid to flow into the collector.
6. Remove the clutch cylinder {8} from the bearing base {3} by loosening the 3 nuts {6}.

4.2.2 Installation

1. Fit the new clutch cylinder in the reverse order to removal paying attention to the following points (see Figure 4):
 - Check the spindle length {2} of the clutch cylinder {1}. Adapt the spindle length {2} if necessary.
 - Always fit new seals.
 - Adjust the play on the clutch cylinder according to paragraph 7.1.
 - Replace and air-bleed the clutch fluid according to paragraph 5.
2. Check the working of the clutch cylinder by taking a test run.

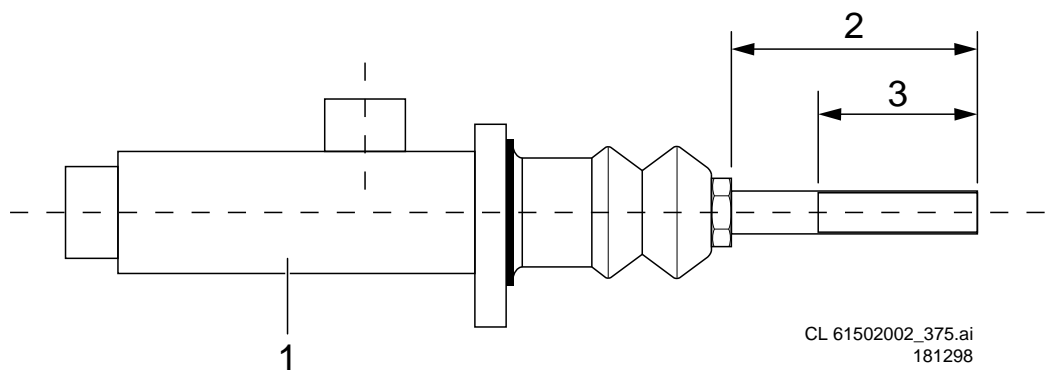


Figure 4 Check length clutch cylinder push rod

- | | |
|--------------------|------------------|
| 1. Clutch cylinder | 3. Thread length |
| 2. Spindle length | RHD42.5 mm |
| RHD47.5 mm | LHD47.5 mm |
| LHD72.5 mm | |

4.3 Clutch booster

4.3.1 Removal

For a parts overview see Figure 1.



If the clutch cylinder is replaced, the lines to the clutch booster must be disconnected. It is best to also replace the clutch fluid then.

The clutch booster {23} is fitted on the clutch housing above the gearbox. It can be reached through the service flap in the rear of the vehicle.



Clutch fluid is an aggressive fluid that attacks paint and clothes.

1. Put a collector under the clutch booster so that the clutch fluid does not fall on the ground.



Never use the clutch pedal when the clutch booster is not fitted and the clutch lines are still connected to the clutch booster. The pressure pin then shoots out of the clutch booster!

2. Remove banjo bolt {28} and coupling {22}. Allow the clutch fluid to flow into the collector.
3. Evenly remove the 4 bolts {25}. Remove the clutch booster.

4.3.2 Installation

1. Fit the new clutch booster in the reverse order to removal paying attention to the following points:
 - Always fit new seals.
 - Replace the clutch fluid and air-bleed the system according to paragraph 5.
2. Check the working of the clutch booster by taking a test run.

5 Replacement and air-bleeding of clutch fluid



Clutch fluid is an aggressive fluid that attacks paint and clothes. Keep drained off clutch fluid separate from other fluids and take them to an establishment appointed for the disposal of such fluids.

The clutch fluid must be replaced every two years. This fluid is the same as the brake fluid used in most passenger cars. The quality must be SAE J-1703 (DOT 4).



The clutch fluid can be replaced with or without air-bleeder. Always use an air-bleeder when possible.

5.1 With air-bleeder

5.1.1 Replacement

See Figure 5.

1. Make sure the vehicle's air system is fully up to pressure.
Connect the air-bleeder {6} to the fluid reservoir {5} and put the line under pressure.
2. Connect the air-bleeding hose {7} to the air-bleeding nipple {9} and put the other end of the hose in a transparent collector {8}.
3. Make sure the fluid reservoir remains full. At the clutch cylinder open the air-bleeding nipple {9} with a box spanner and close it again when the old clutch fluid has been replaced by new clutch fluid. This has happened when clear, new clutch fluid flows from the air-bleeding nipple {9} without bubbles.
With an AVS gearbox the air-bleeding nipples on the pressure device {2} and the valve {3} must also be opened for a short while afterwards to replace the old clutch fluid in this line with new clutch fluid and to air-bleed the clutch line.

When the clutch fluid has been replaced and the system has been fully air-bled, the pressure is built up in the system when the clutch pedal is depressed 20-30 mm. This can be felt by the increasing resistance under the pedal.

5.1.2 Air-bleeding

If one only wants to air-bleed the system one can stop at point 3 §5.1.1. when fluid without bubbles flows from the air-bleeding nipple {9}. The same applies for the pressure device {2} and the "hold clutch" valve {3} of the AVS system.

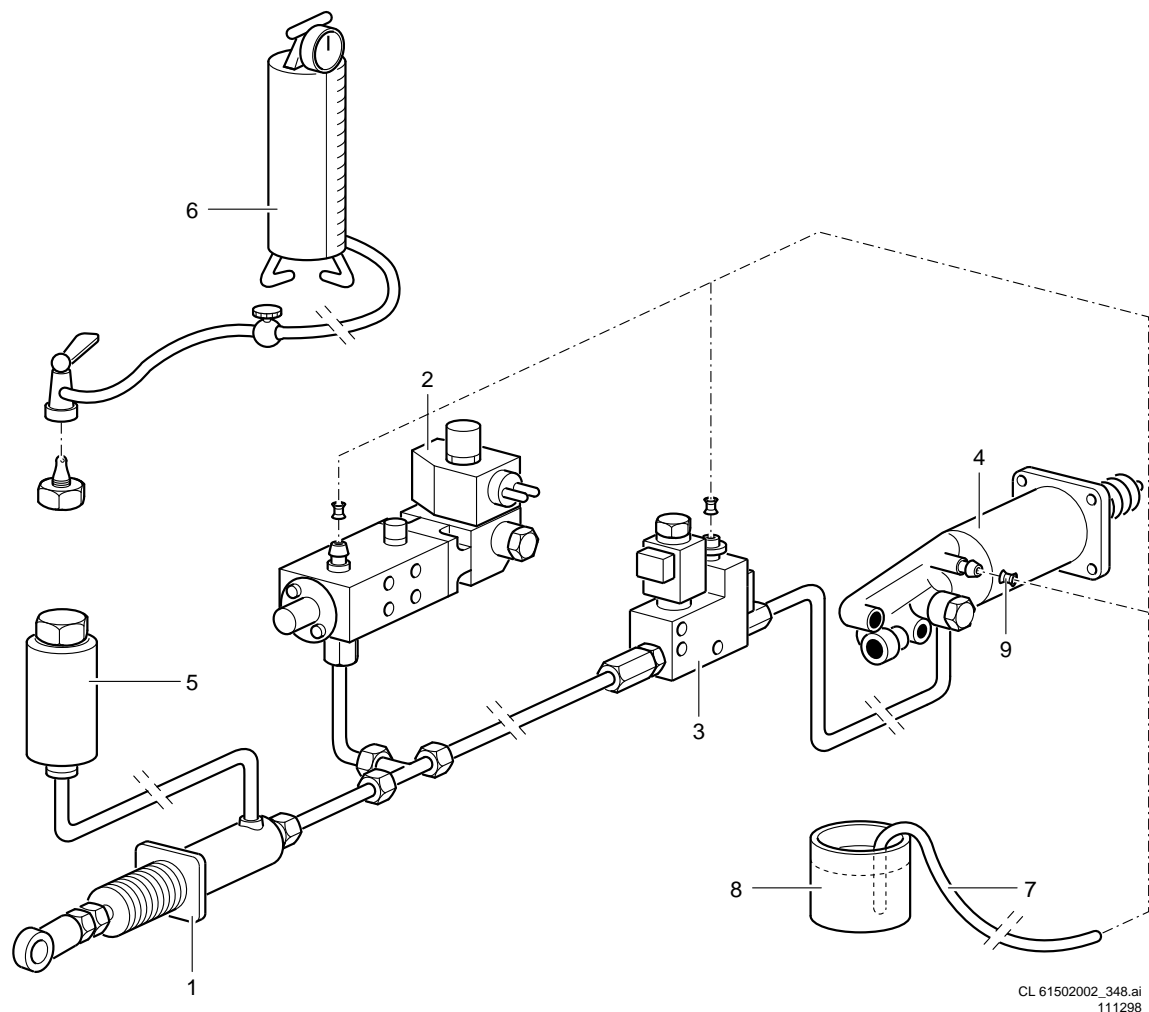


Figure 5 Air-bleeder

- | | | | |
|----|---|----|---------------------|
| 1. | Clutch cylinder | 6. | Air-bleeder |
| 2. | "Acceleration switched" pressure device (AVS) | 7. | Air-bleeder hose |
| 3. | "Hold clutch" valve (AVS) | 8. | Collector |
| 4. | Clutch booster | 9. | Air-bleeding nipple |
| 5. | Reservoir | | |

5.2 Without air-bleeder

5.2.1 Replacement

See Figure 1.

1. Switch off the vehicle ignition. With an AVS system the "hold clutch" valve cannot enter.
2. Fill the reservoir {5} to the maximum and keep it maximally filled during the replacement of the clutch fluid.
3. Take a transparent reservoir, e.g. a glass jar {8}, and fill it partly with clutch fluid.
4. Then connect a transparent hose (plastic) {7} to the air-bleeding nipple {9} of the clutch booster {4} and immerse the other end of the hose in the clutch fluid in the transparent reservoir.
5. Depress the clutch pedal a number of times and keep it in the depressed position.
6. At this moment turn open the air-bleeding nipple {9}. A second person is needed to do this.
7. Close the nipple and release the clutch pedal.



Do not release the clutch pedal before the nipple has been turned shut, otherwise air will enter the system.

8. Repeat steps 4, 5 and 6 until clear; new clutch fluid flows into the glass jar without air bubbles. The old clutch fluid has now been replaced with new clutch fluid.

With an AVS gearbox the air-bleeding nipples on the pressure device {2} and the valve {3} must also be opened for a short while (depress the clutch pedal a number of times and keep depressed) to replace the old clutch fluid in this line with new clutch fluid and to air-bleed the clutch line.

When the clutch fluid has been replaced and the system has been fully air-bled, the pressure is built up in the system when the clutch pedal is depressed 20-30 mm. This can be felt by the increasing resistance under the pedal.

5.2.2 Air-bleeding

If one only wants to air-bleed the system one can stop at point 3 §5.2.1 when fluid without bubbles flows from the air-bleeding nipples {9}.

Faults

For a parts overview see Figure 1.

Clutch slips	
Cause	Solution
Too little play between the push rod {9} and the piston of the clutch cylinder {8}	Adjust play between clutch cylinder and pedal
Compensating opening in the clutch cylinder {8} blocked or not free	Clean clutch cylinder or adjust play
Piston in clutch cylinder {8} seized due to insufficient lubrication	Replace clutch cylinder
Piston in clutch booster {23} seized due to insufficient lubrication	Replace clutch booster
Lining of clutch plate {42} greasy	Clean clutch plate
Lining of clutch plate {42} worn	Replace clutch plate
Release fingers of the clutch release assembly {41} loose or bent	Replace clutch release assembly (with clutch plate)
Loose or broken tensioner spring in clutch booster {23}	Replace clutch booster

Clutch does not release	
Cause	Solution
Too much play between the push rod {9} and the piston of the clutch cylinder {8}	Adjust play between clutch cylinder and pedal
Release fingers of the clutch release assembly {41} loose or bent	Replace clutch release assembly (with clutch plate)
Clutch plate {42} buckled or rough or rivets loose	Replace clutch plate with clutch release assembly
Air in clutch line	Air-bleed clutch line
Leak between clutch cylinder {8} and clutch booster {23}	Trace and seal leak

Clutch engages abruptly	
Cause	Solution
Rough, worn or burned clutch plate {42}	Replace clutch plate (and clutch release assembly)
Release fingers of the clutch release assembly {41} loose or bent	Replace clutch release assembly (with clutch plate)
Clutch plate {42} buckled	Replace clutch plate (and clutch release assembly)
Lever {39} pushes unevenly on the thrust bearing {40}	Check fastening of lever
Poor or insufficiently tightened engine mounting	Adjust engine mounting

Abnormal noise with use of the clutch	
Cause	Solution
Broken pressure springs	Replace clutch plate and clutch release assembly
Thrust bearing dry	Replace thrust bearing
Ball bearing in flywheel worn	Replace ball bearing
Lever {39} loose on the release shaft	Fasten lever correctly
Problem with the drive shaft	Check drive shaft

Stiff clutch pedal	
Cause	Solution
Release fingers of the clutch release assembly {41} loose or bent	Replace clutch release assembly (with clutch plate)
Clutch booster does not work	Check working of clutch booster



In paragraph 4 "Removal and installation procedures" it is described how to replace the parts mentioned above.

7 Maintenance

7.1 Adjustment of play for clutch cylinder, standard gearbox

The correct adjustment of the clutch cylinder prevents:

- a slipping clutch;
- wear to the clutch plate;
- the abrupt engaging of the clutch or no engagement at all.

The compensating opening in the clutch cylinder {44} must always be free when the pedal is in the rest position (see figure below). If this is not the case, the clutch fluid can remain somewhat under pressure so the clutch slips. This opening also ensures the return of the clutch fluid.

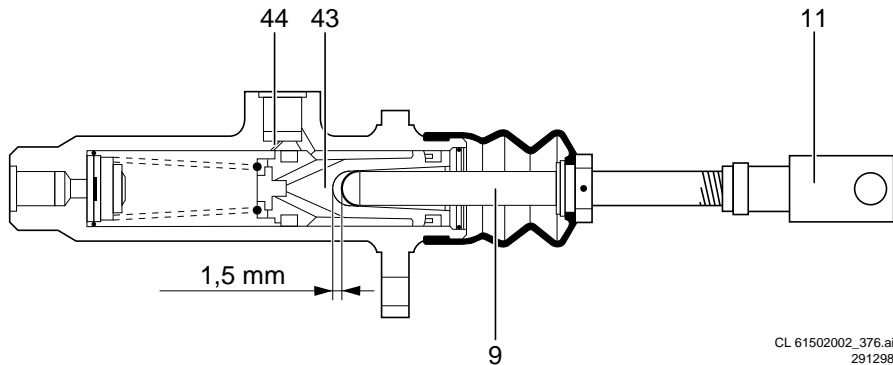


Figure 6 Clutch cylinder

9.	Push rod	43.	Piston
11.	Yoke	44.	Opening

1. Make sure the pedal is brought back into the rest position by the tensioner spring {1} (see Figure 1).
2. When the pedal is in the rest position there must be at least **1.5 mm** space between the push rod {9} and the piston {43} in the clutch cylinder. This play can be felt by moving the clutch pedal up and down by hand.
3. The play can be adjusted by screwing yoke {11} further or less far on the pressure rod {9}.



Check working on a test run.

7.2 Adjustment of clutch switch shifting point with AVS

See paragraph 5.3 of section 3.4 AVS.

7.3

Adjustment of shifting point for "emergency shift" valve with AVS

The "emergency shift" valve {1} must be fully depressed by the clutch pedal {3} to release air to the gearbox. The air pressure from the tank is then allowed through to the emergency switch. Through this switch air passes to one of the 4 lines to the gearbox. To give the gearbox the time to change gear the clutch must be depressed for at least 5 seconds.

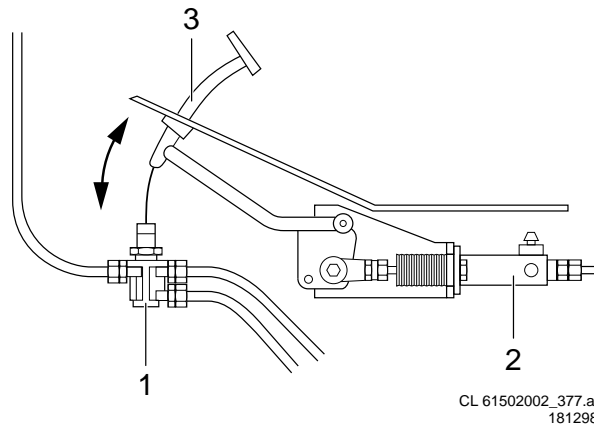


Figure 7 "Emergency shift" valve

1. "Emergency shift" valve
2. Clutch cylinder
3. Clutch pedal

1. Fully depress the clutch pedal.
2. Slide the valve {1} over the two elongated holes so that it is fully pressed in.
3. Tighten the hexagonal bolts of the valve.
4. Check the working of the valve by actuating the pneumatic emergency programme (see AVS manual). If the emergency button is put into the "N" position (clutch depressed) air must escape through the emergency switch (audible). This is the air that escapes from the gearbox.

7.4 Checking of clutch plate lining thickness

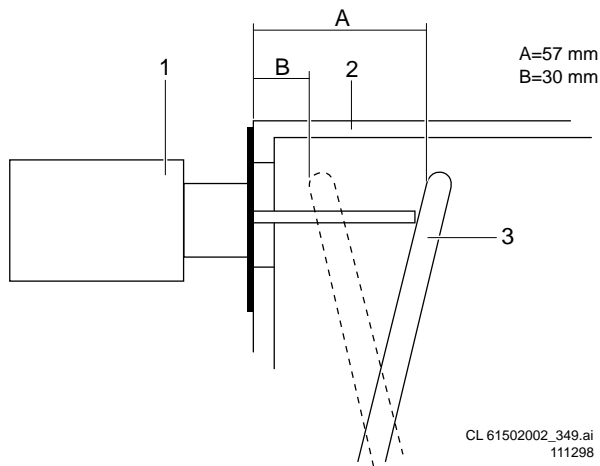


Figure 8 Checking lining thickness

- | | | | |
|----|----------------|----|--------------------------------|
| 1. | Clutch booster | A. | Measurement, new clutch plate |
| 2. | Clutch housing | B. | Measurement, worn clutch plate |
| 3. | Lever | | |

1. Remove the clutch booster {1} from the clutch housing.
2. Determine the distance from the clutch housing {2} to the lever {3}.
With a new clutch plate this distance (measurement A) is approx. 57 mm.

If this distance is only approx. 30 mm (measurement B) the clutch plate must be replaced.



3. Check the clutch plate visually after approx. 300,000 by removing the plate. This must be done because the thickness of the plate can be in order while the plate can still be damaged or burned and/or have deep grooves.

7.5 Lubrication

The clutch and clutch operation require no maintenance besides the adjustments and checks mentioned above. It is necessary that all hinge points are lubricated twice a year with e.g. Shell Retinax.

8 Order numbers

Order numbers of parts that have to be replaced can be found in the parts book.

Use the chassis number to check whether you are using the correct parts book. The order numbers for parts of the clutch and clutch operation are in group 340 (clutch) and group 349 (clutch operation).

3.3 Gear selection system

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1 Introduction

The gear selection system is subdivided into three main groups, one of which is split into two types, namely:

1. Bova shifting rod.
ZF shifting rod.
2. AVS (Automatic gear preselection).
3. Automatic unit.

General

The Futura can be equipped with various types of gearboxes.

The way the gearbox is operated depends on the following three points:

Length of the Futura

For the FL15 and FH15 Futuras, an AVS system has been selected as standard. The length of these vehicles is so long that this can no longer be spanned by means of a control rod. The length of the control rods for the other types of busses depends on the length of the bus.

Custom options

If the Futura is equipped with a manual gearbox (except FL/FH15), two types of control rods are possible, one control rod with a welded universal joint (BOVA) and one control rod with a threaded universal joint (ZF). Both control rods are discussed in this chapter.

BOVA shifting rod

This shifting-rod system is equipped with suspension points with sleeve bearings.

With this system, the control rod is supported at two places in the bus. A nylon sleeve provides guidance for the control rod.

The universal joints are welded to the linking rod.

ZF shifting system

The ZF gear selection system is equipped with various mechanical parts which enable the control rod to move freely in a number of directions. It is also possible to adjust the height of the universal joints which makes it possible for the link to be made optimally.

The universal joints are screwed onto the linking rod.

2 Safety



Safe operation of the gear selection system can only be guaranteed if all instructions relative to adjustments and maintenance are observed. The non-observance of these instructions can lead to dangerous situations (being stuck in a gear) and damage to the motor and the gearbox.

Installation, maintenance and repair may only be carried out by personnel that are trained and authorised by the Bova service organisation. Repairs or maintenance activities carried out by unauthorised persons can lead to dangerous situations and fall outside the provisions of the guarantee.

3 Precautionary measures

3.1 Safety at the work place



To be able to work on the gear selection system safely it is necessary to be careful about the following points:

1. Provide for a good evacuation of exhaust gases and fumes from cleaning products and solvents.
2. Prevent the bus from rolling.
3. Never operate the gear selector lever while the engine is running (unless specifically indicated).
4. Only use tools that are approved by the Bova service organisation.
5. Also only use tools that fit perfectly.
6. Only use original Bova parts.
7. Use the correct procedure for the various gearboxes.

3.2 Precautionary measures



Before working on the gear selection system it is necessary to be careful about the following points:

- Thoroughly clean the area around the gearbox and the shifting rod before working on them.
- Be very critical about reusing parts.
- When mounting parts they must be absolutely clean and undamaged. Only in this way will fast wear of the shifting rod be avoided.

4 Bova shifting rod

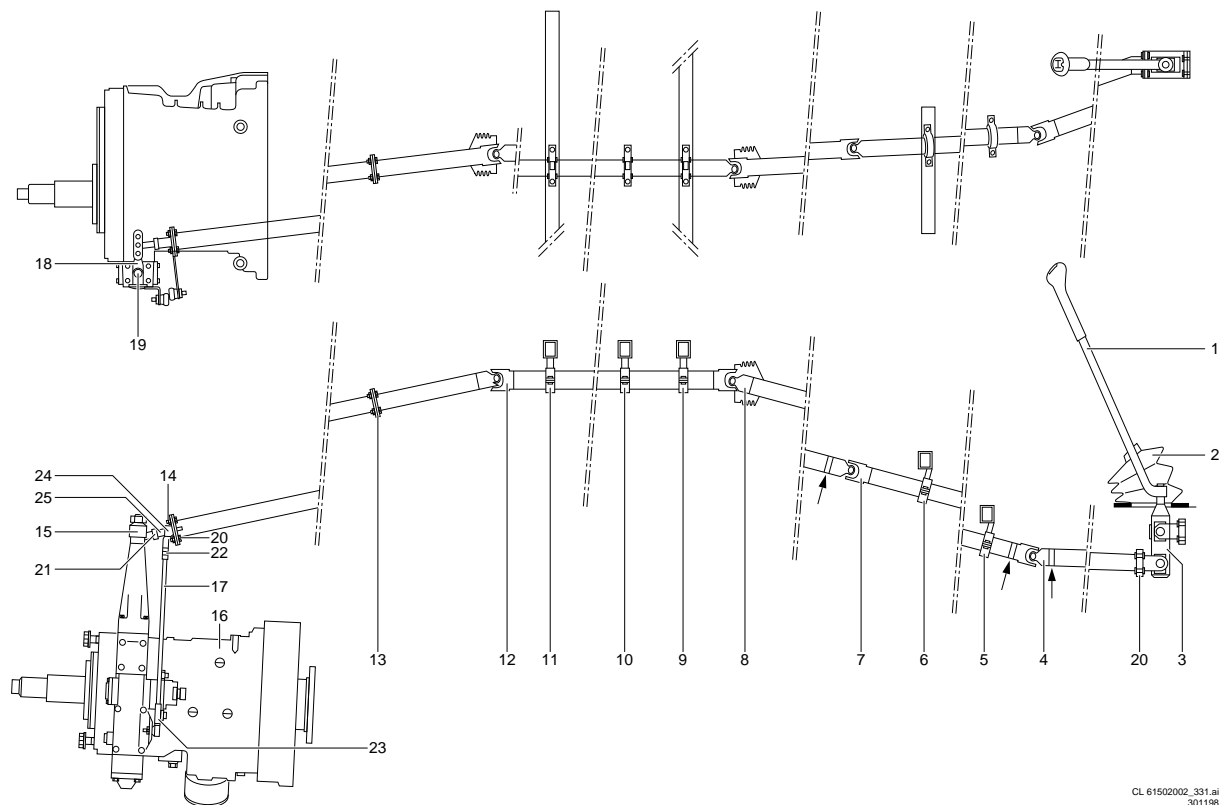
4.1 General

The shifting system supplied as standard equipment on the Futuras (except for the FL/FH 15) consists of a gear selector lever with a linking rod system attached to the shift tower on the gearbox. A number of universal joints are mounted in this linking rod system. These universal joints are welded to the rods and are the most vulnerable part of the shifting rods. The universal joints must be provided with sufficient grease at every major servicing (Shell Retinax, for example) so they will not rust.



At the suspension points of the shifting rod, nylon sleeves serve as bearings for the shifting rod. Because the shifting rod rotates in them, they are subject to wear.

Malfunctions of the shifting-rod system are usually characterised by excessive play of the gear selector lever or a gear that is difficult to engage. In both cases the shifting-rod system must be checked from front to back. The adjustment of the shift tower on the gearbox must also be checked.



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Figure 1 BOVA Gear selection system

- | | |
|--|-------------------------|
| 1. Gear selector lever | 15. Shift tower |
| 2. Cover | 16. Gearbox |
| 3. Shift block | 17. Command rod |
| 4. Universal joint | 18. Shift arm |
| 5. Suspension point with sleeve bearing | 19. Shift axle |
| 6. Suspension point with sleeve bearing | 20. Bolt |
| 7. Universal joint | 21. Locknut |
| 8. Universal joint | 22. Nut (left threaded) |
| 9 - 11. Suspension point with sleeve bearing | 23. Nut |
| 12. Universal joint | 24. Ball bearing |
| 13. Flange | 25. Threaded end |
| 14. Flange | |

4.2 Operation (see Figure 1)

The shifting rod forms the link between the gearbox and the gear selector lever. This gear selector lever can be moved in four directions from the neutral position. This is the so-called H-pattern or the double H pattern.

When the gear selector lever is moved forward or backward, the shifting rod also moves forward or backward. This pushes the shift arm {18} forward or backward. This shift arm is mounted on the shift axle {19} which causes it to be rotated to the left (gear selector lever forward) or to the right (gear selector lever backward). By means of an internal shifting mechanism, the appropriate gear is engaged.

In the neutral position, the gear selector lever can also of course be moved to the right or to the left. This causes the shifting rod between the shift block {3} and the universal joint {4} to move to the left or to the right. Because the shifting rod is suspended in the suspension points {5, 6, 9, 10, 11}, this motion is converted to a rotation movement. At the gearbox the shifting rod is connected to a command rod {17}. This command rod allows the rotational motion of the shifting rod to be converted to an upward or downward motion. This pushes the shift axle {19} up or down. With an 8S-180 gearbox, an auxiliary shift group is engaged or disengaged pneumatically.

4.3 Disassembly and assembly procedures

4.3.1 Removing play in nylon bearing

At each suspension point a nylon sleeve is used as a bearing for the shifting rod. Depending on the use of the vehicle, these nylon bearings will be worn after several years. This is evidenced by an increased play in the gear selection system. It is then best to replace all the nylon bearings.

As a temporary emergency solution, however, the following procedure can be carried out (this applies for all the nylon bearings).

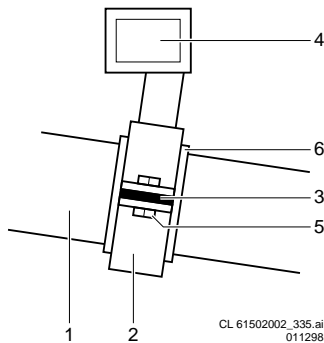


Figure 2 Emergency solution to remove play

- | | | | |
|----|------------------|----|---------------|
| 1. | Shifting rod | 4. | Chassis |
| 2. | Mounting bracket | 5. | Nut |
| 3. | Washer | 6. | Nylon bearing |

1. Loosen the nuts {5} on both sides.
2. Remove the washers {3}.
3. Tighten both nuts {5} again. The nylon bearing {6} is now more confined which reduces the play. Since this causes the bearing to be somewhat deformed, this is only a temporary measure and the bearing will have to be replaced after a while.
4. Check to be sure that all gears can now be engaged without too much play. If this is still not possible, the nylon bearings must be replaced and probably also the front universal joint.

4.3.2 Nylon bearing

Because the universal joints are welded to the shifting rod, it is not possible to replace them without sawing them apart or grinding off the nearest universal joint. This also applies for the installation of new nylon bearings. When a universal joint is replaced it is also advisable to replace the nylon bearings on both sides as well because they can then be replaced without sawing them apart.

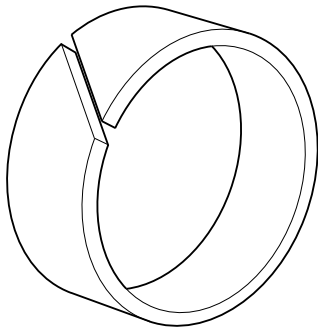
See Figure 2 for the associated drawing.

1. Loosen the nuts {5} on both sides.
2. Remove the lower mounting bracket {2}.



Be careful not to damage the shifting rod.

3. Saw the nylon bearing apart and remove it.
4. Cut the new nylon bearing open diagonally (see Figure 3). In this way the nylon bearing can be easily slide over the shifting rod.



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Figure 3 Cutting open the nylon bearing

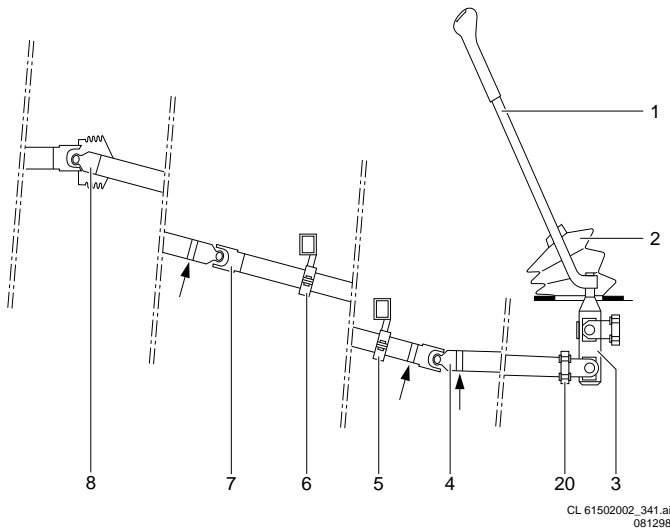
5. Bend the bearing open and slide it over the shifting rod.
6. Mount the lower attachment bracket {2} and retighten both nuts {5}. Do not forget the washers {3}!
7. Check to be sure that the shifting rod is well enclosed by the nylon bearing.
8. Adjust the shifting rod according to the procedure "Adjusting the gear selection system".
9. Check to be sure that all gears can be engaged correctly. If this is still not possible, all the nylon bearings must be replaced and probably also the front universal joint.

4.3.3 Universal joint (front)

The universal joints used with the Bova shifting rod are welded to the rod. To replace them they must therefore be ground off the rod.

Because the front universal joint (above the spare wheel) is exposed to street dirt, this joint will give the most problems after a number of years. Two more universal joints are in the baggage compartment and one universal joint is above the rear axle. It is accessible when a front wheel is removed. All universal joints must be greased (with Shell Retinax, for example) during each major servicing.

See Figure 4 for the appropriate drawing.



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Figure 4 Bova construction

- | | |
|------------------------|---|
| 1. Gear selector lever | 5,6. Suspension points with sleeve bearings |
| 2. Cover | 7. Universal joint |
| 3. Shift block | 8. Universal joint |
| 4. Universal joint | 20. Bolt |

1. Open the lid of the spare tyre compartment and remove the spare wheel.
2. Grind through the universal joint at the welding joint (see arrows at {4} on Figure 4). The universal joint is welded onto the rod and care must be taken that the rod does not become too short.
3. Check the rod for excessive wear. If the rod is seriously corroded, it must first be replaced (see the procedure "Shifting rod," § 4.3.4).
4. Replace the nylon bearings to the next universal joint. They can now be replaced without being sawed open. Be careful that the new universal joints are lined up with each other (as shown in Figure 4). If this is not done it is impossible to operate the gearbox!
5. Weld the new universal joint to the rod.
6. Lubricate the new universal joint generously with grease (Shell Retinax, for example) so no moisture can enter the universal joint.
7. Adjust the shifting rod according to the procedure "Adjusting the gear selection system," § 4.4.
8. Check the operation of the shifting rod by engaging all gears once.

4.3.4 Shifting rod

If the shifting rod has been seriously damaged by corrosion it must be replaced. This will always be the first part under the drivers compartment. It is also best to replace the universal joints {4} and {7}, and the nylon bearings {5} and {6} at the same time.

See Figure 4 for the appropriate drawing.

1. Open the lid of the spare wheel compartment and remove the wheel.
2. Loosen the 4 bolts {20} at the shift block {3}.
3. Grind through the universal joint {7} at the welding joint (see arrow at {7} on Figure 4). This universal joint is above the front axle and is accessible when one of the front wheels is removed.
4. Loosen the bolts of the mounting brackets {5} and {6}. The shifting rod can then be removed via the spare wheel compartment.
5. Construct a new shifting rod on a work bench. Use two new nylon bearings and two new universal joints. Shove the nylon bearings on the rod before the universal joints are welded to the rod. Be careful that the universal joints are lined up with each other (as shown on Figure 4).
6. Hang the shifting rod in the mounting brackets {5} and {6} but do not completely tighten the bolts of these mounting brackets as yet. Be careful that the universal joints {7} and {8} are lined up with each other.
7. Weld on universal joint {7}.
8. Lubricate the new universal joint generously with grease (Shell Retinax, for example) so no moisture can enter the universal joint.
9. Tighten the bolts {20} of the shift block {3}.
10. Tighten the bolts of the mounting brackets {5} and {6}.
11. Adjust the shifting rod according to the procedure "Adjusting the gear selection system," § 4.4.
12. Check the operation of the shifting rod by engaging all gears once.

4.4 Adjusting the gear selection system



A gearbox can only be operated correctly if, among other things, the shifting rod is well adjusted. Check this with the following procedure.



Adjustment of the gear selection system is only possible at the back at the shift tower. It is assessable via the service lid at the back of the bus.

See Figure 1 for the appropriate drawing.

In the neutral position the shift block {3} must be completely vertical (see Figure 4).

1. Place the gearbox in neutral.
2. Loosen the 4 bolts of flange {14}.
3. Loosen locknut {21}.
4. Loosen the nuts {22} and {23}.
5. First of all, care must be taken that the flanges {14} are right against each other. This can be accomplished by screwing the ball bearing {24} as a unit off of the command rod {17}.
6. Screw the ball bearing {24} onto the thread end {25} in such a way that both flanges are right against each other without there being tension on the axle of the shift tower.
7. Tighten locknut {21}.
8. Now rotate command rod {17} on ball bearing {24} in such a way that the gear selector lever is vertical (to the right because this is left threaded on the top).
9. Lock the command rod with nuts {22} and {23}.
10. Check the operation of the gear selection system by engaging all gears once. If this can be done without problems, the shifting rod is correctly adjusted.

4.5 Malfunctions

For an overview of the components see Figure 1.

Excessive play of the gear selector lever

Cause	Solution
nylon bearing(s) worn	reduce play by removing washers
	replace nylon bearing(s)
universal joint(s) worn	replace universal joints
shifting rod damaged by corrosion	replace section of shifting rod

Gear difficult to engage

Cause	Solution
incorrect adjustment of gear selection system	adjust gear selection system
damage in gearbox	consult Bova service department
universal joint(s) extremely dirty	clean and grease/replace universal joints

The chapter "Disassembly and assembly procedures" explains how to replace the above-mentioned parts.

4.6 Maintenance

For correct operation it is of great importance that the gear selection system be correctly adjusted and free of play. It is therefore recommended that during servicing all universal joints be well greased with Shell Retinax. This prevents moisture from entering the joints which protects against corrosion.



During servicing, check to be sure that all gears can be easily engaged, without excessive play and without strange background noise.

For inspection and maintenance of the gearbox you are referred to chapters 3.5 to 3.8 on gearboxes.

5 ZF shifting rod

5.1 General

As with the standard shifting system, the ZF gear selection system consists of a gear selector lever with a linking rod system attached to the shift tower on the gearbox. A number of universal joints are mounted in this linking rod system. These universal joints are not welded to the rods, but are attached to the rods by means of 8 recessed-head bolts. These joints are also the most vulnerable part of the shifting rods, but they can be easily replaced. The universal joints must be provided with sufficient grease at every major servicing (Shell Retinax, for example) so they will not rust.

Here the shifting rod is not suspended with nylon bearings, but by means of swing-arm bearings. Since the swing-arm bearings are almost completely free of play, it is possible to shift immediately and precisely. These swing-arm bearings are maintenance free.

For the rest, the gear selection system is the same as the BOVA gear selection system (see Figure 1).

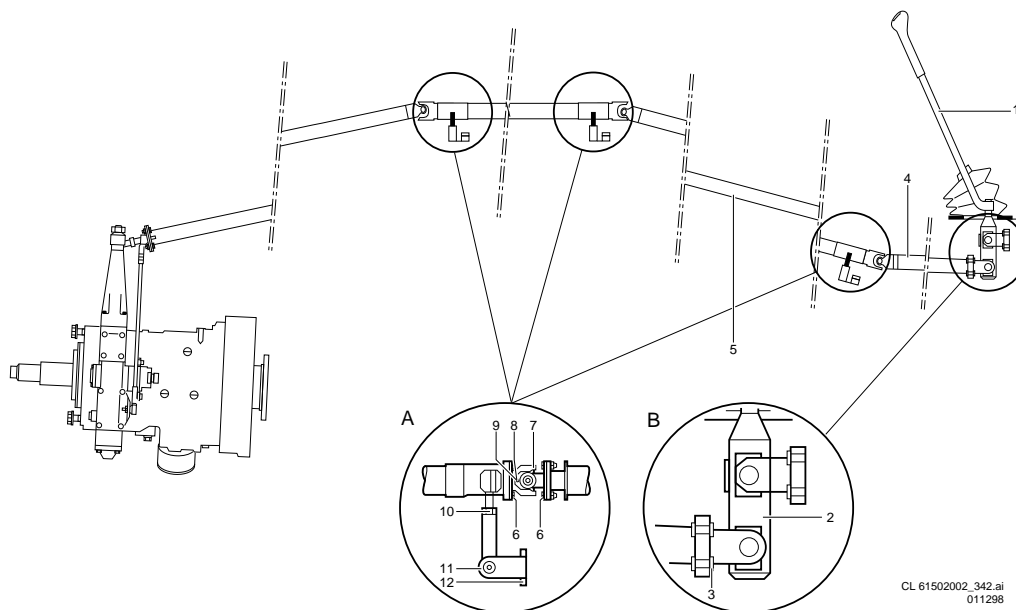


Figure 5 ZF Gear Selection System

- | | | | |
|----|---------------------|-----|-----------------|
| 1. | Gear selector lever | 7. | Universal joint |
| 2. | Shift block | 8. | Cotter pin |
| 3. | Bolt | 9. | Nut |
| 4. | Shifting rod | 10. | Nut |
| 5. | Universal joint | 11. | Swing arm |
| 6. | Bolt | 12. | Bolt |

Malfunctions of this shifting-rod system are usually characterised by excessive play of the gear selector lever which makes it more difficult to engage a gear. The shifting-rod system must then be checked from front to back. In most cases the cause will be found at the first universal joint since it is exposed to street dirt and therefore corrodes if it is not greased sufficiently. The adjustment of the shift tower on the gearbox must also be checked.

5.2 Operation

See Figure 5.

The operation of the ZF shifting rod is the same as the standard Bova shifting rod (see paragraph 4.2), but with swing-arm bearings being used rather than nylon bearings.

5.3 Disassembly and assembly procedures

5.3.1 Swing-arm bearing

Because the front swing-arm bearing (above the spare wheel) is exposed to street dirt, this bearing will give the most problems after a number of years.

See for the appropriate drawing.

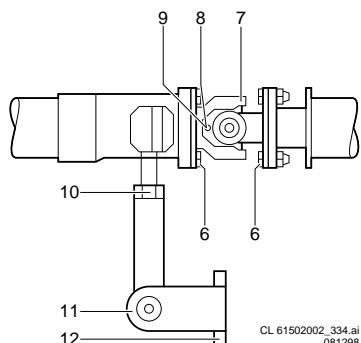


Figure 6 Swing-arm bearing

6.	Bolt	10.	Nut
7.	Universal joint	11.	Swing arm
8.	Cotter pin	12.	Bolt
9.	Nut		

1. Open the lid of the spare wheel compartment and remove the spare wheel.
2. Support the shifting rod so it does not sag when the swing-arm bearing is removed.
3. Remove cotter pin {8}.
4. Remove nut {9}.
5. Remove the four bolts {12}. The swing-arm bearing can now be replaced with a new one.
6. Fasten the new swing-arm bearing with two bolts {12}.
7. Check whether the swing-arm bearing is adjusted at the correct height. It is correctly adjusted if the shifting rod hangs without tension. The swing-arm bearing can be adjusted to the right length by turning the ball bearing in or out. The two bolts {12} must be loosened for this.
8. Lock the adjusted length with nut {10}.
9. Tighten the four bolts {12} and nut {9}.
10. Lock nut {9} with cotter pin {8}.
11. Adjust the shifting rod according to the procedure "Adjusting the gear selection system," § 4.4.



Check the operation of the shifting rod by engaging all gears once.

5.3.2 Universal joint (front)

The universal joints used with the ZF shifting-rod system are mounted on the rod with 8 recessed-head bolts, rather than being welded to the shifting rod as with the standard Bova shifting-rod system.

Because the front universal joint (above the spare wheel) is exposed to street dirt, this joint will give the most problems after a number of years. Another universal joint is in front of the back axle and is accessible when a back wheel is removed. A third universal joint is above the front axle and is accessible when a front wheel is removed. All universal joints must be greased generously during each major servicing (with Shell Retinax, for example).

See Figure 6 for the appropriate drawing.

1. Open the lid of the spare wheel compartment and remove the spare wheel.
2. Loosen the 8 recessed-head bolts {6}.
3. Check the rod for excessive wear. If the rod is seriously corroded, it must first be replaced (see the procedure "Shifting rod," § 5.3.3).



Be careful that the new universal joints are lined up with each other (as shown in Figure 5). If this is not done it is impossible to operate the gearbox!

4. Attach the new universal joint {7} to the rod with the 8 recessed-head bolts.
5. Lubricate the new universal joint generously with grease (Shell Retinax, for example) so no moisture can enter the universal joint.
6. Adjust the shifting rod according to the procedure "Adjusting the gear selection system," § 4.4.
7. Check the operation of the shifting rod by engaging all gears once.

5.3.3 Shifting rod

If the shifting rod has been seriously damaged by corrosion it must be replaced. This will always be the first part under the drivers compartment. It is also best to replace the universal joints {7}, and the swing-arm bearings {11} at the same time.

See Figure 7 for the appropriate drawing.

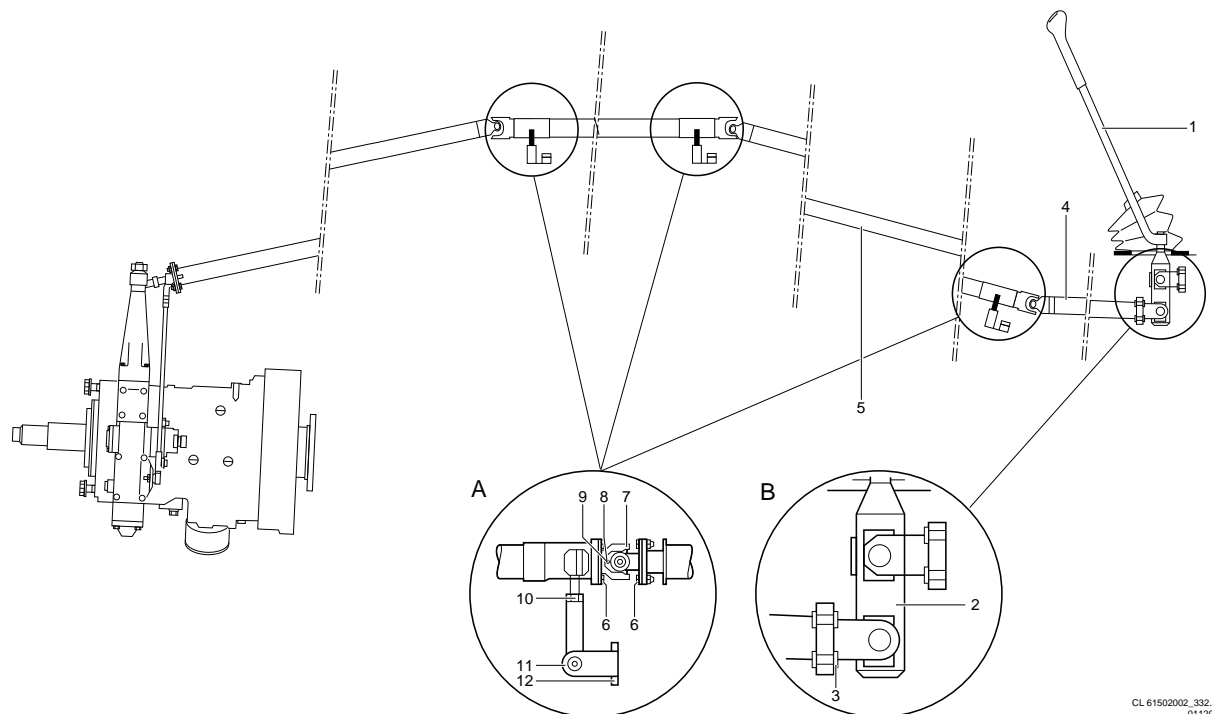


Figure 7 Shifting system with swing-arm bearings

1. Open the lid of the spare wheel compartment and remove the wheel.
2. Loosen the 4 bolts {3} at the shift block {2}.
3. Remove both universal joints {7}. One universal joint is above the front axle and is accessible when one of the front wheels is removed. Shifting rod {4} can now be replaced.
4. Remove cotter pin {8} and loosen the bolts {6} of the ball bearing. Shifting rod {5} can now be removed via the spare wheel compartment.
5. Loosen the bolts {12} so the swing-arm bearings can be replaced.
6. Construct a new shifting rod on a work bench.



Be careful that the new universal joints are lined up with each other (as shown in Figure 7). If this is not done it is impossible to operate the gearbox!

7. Mount new swing-arm bearings. Turn the ball bearing to the same height as the old ball bearings. Lock this length with nut {10}.
8. Mount the shifting rod to the ball bearings and the shifting block. Lock the nuts {9} with cotter pin {8}.
9. Lubricate the new universal joints generously with grease (Shell Retinax, for example) so no moisture can enter the universal joint.
10. Adjust the shifting rod according to the procedure "Adjusting the gear selection system", § 4.4.
11. Check the operation of the shifting rod by engaging all gears once.

5.4 Adjusting the gear selection system

See Figure 7 for the appropriate drawing.

The adjustment of the ZF gear selection system is the same as the standard Bova gear selection system (see § 4.2) except that swing-arm bearings are used rather than nylon bearings.

5.5 Malfunctions

For an overview of the components see Figure 5.

Excessive play of the gear selector lever

Cause	Solution
swing-arm bearing(s) worn	reduce play by replacing swing-arm bearing(s)
universal joint(s) worn	replace universal joints
shifting rod damaged by corrosion	replace section of shifting rod

Gear difficult to engage

Cause	Solution
incorrect adjustment of gear selection system	adjust gear selection system
damage in gearbox	consult Bova service department
universal joint(s) extremely dirty	clean and grease/replace universal joints

The chapter "Disassembly and assembly procedures" explains how to replace the above-mentioned parts.

5.6 Maintenance

For correct operation it is of great importance that the gear selection system be correctly adjusted and free of play. It is therefore recommended that during servicing all universal joints be well greased with Shell Retinax. This prevents moisture from entering the joints which protects against corrosion.



During servicing, check to be sure that all gears can be easily engaged, without excessive play and without strange background noise.

For inspection and maintenance of the gearbox you are referred to chapters 3.5 to 3.8 on gearboxes.

Order numbers

Order numbers of parts that must be replaced can be found in the parts book. Check on the basis of the chassis number whether the correct parts book is present.

The order numbers for parts of the manually shifted gearbox are in group 309. With regard to parts for the AVS gearbox the Bova service department must be consulted.