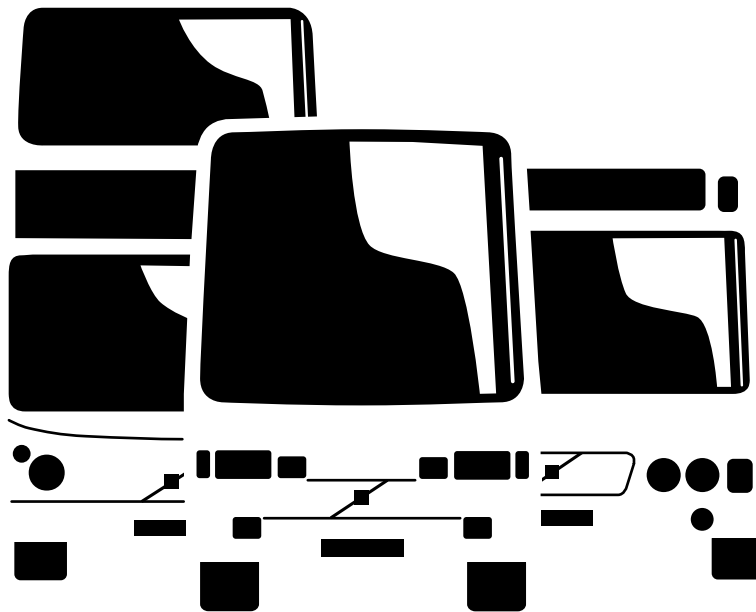


Service Manual Buses

Group **6**

Front Suspension
and Steering B10M



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Order number: TP 15420

Specifications

Wheel angles

Caster	2.0° ± 0.2°
Angle alteration with shims, 0.5 mm	0.125°
1.0 mm	0.25°
2 mm	0.5°
4 mm	1°
Camber	0.75° ± 0.25°
King-pin inclination (KPI)	5.75° ± 0.25°
Toe-in	0-3 mm
Curve angles (max, wheel lock) ¹	52°
inner wheel	max. 51°
outer wheel	41.5°-42.5°
Clearance, tyres	min. 5 mm

Trailer bus wheel angles

Front axle, inner wheel	37°-39°
outer wheel	30° ± 1°
Trailer axle, inner wheel	11°
outer wheel	12°
Switch settings at 12m radius for:	
Jack-knifing warning lamp switch, steered trailer	41°
non-steered trailer	49°
Jack-knifing brake limit switch, steered trailer	43°
non-steered trailer	51°

Front wheel suspension

Type	Rigid front axle
Max, angle deviation front axle spring pads	
Turning	1°
Deflection	1°
King pin diameter in bushing	50 mm
Shims for king pin bearing, thickness	0.10 and 0.35 mm
Axial clearance for king pin bearing	0.05-0.15 mm
Radial clearance for king pin bearing, max.	2 mm

Angle gear

Oil quality and change quantity	ATF oil, approx. 0.2 litres
---------------------------------------	-----------------------------

Power steering gear

Make and designation	ZF 8043
Type	Ball-and-nut
Number of steering wheel turns from lock to lock	approx. 4.5
Reduction ration	20.2:1
Max. output torque at 13 MPa (130kgf/cm ²)	4320 Nm (432 kgf m)
Torque increase across pressure point ²	0.4-0.6 Nm (0.04-0.06 kgf m)
Max. internal leakage	2.0 litres/min.
Oil quality and change quantity	ATF oil, approx. 4 litres

¹ Applies to buses with 12 R 22.5 and 295/80 R 22.5 tyres.

² The marking is made on the steering gear steering spindle without oil in the steering box and with the drag link disconnected from the pitman arm.

Servo pump

Make	ZF
Type	Vane pump
Drive	Gear
Direction of rotation (viewed from drive side)	Anti-clockwise
Reduction engine - pump	1:1.58
Min. capacity at engine speed 500 r/min (8.3 r/s)	
5 MPa (50 kgf/cm ²) 50°C	10.5 litres/min
Max. pump pressure	13 MPa (130 kgf/cm ²)
Max. capacity	16 litres/min

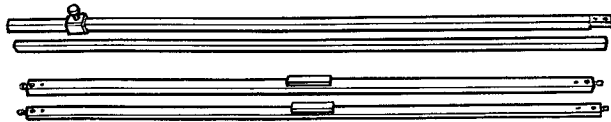
Tightening torques

Nm

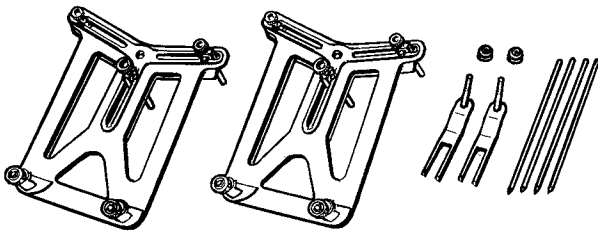
Steering wheel nut	75
Pitman arm nut	550
Nut for stud, drag link	350
Retaining bolt for steering box	330
Crown nut on king pin ¹	550
Crown nut ¹ track rod	350
Crown nut ¹ drag link	350
Clamp bolt, track rod	80
Clamp bolt, drag link	80
Crown nut for servo pump gear	100
Clamp bolt for steering shaft universal joint (M8)	30
Retaining bolt for angle gear	85
Bolt, gear housing - flange, angle gear	42
Bolt for reaction rod	85
Bolt for track rod steering arms	750
Bolt for king pin cover	40
Bolt for V-brace, bracket on front axle	430
Bolt on steering arm, drag link	475
Safety washer, V-brace attachment	85
Bellows plate for front axle	185

¹ Tightened to stipulated torque and thereafter to next split pin hole.

Special Tools



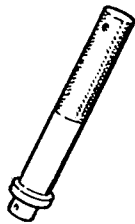
999-
6170 Measuring Instrument for checking toe-in



6170



1801



2000



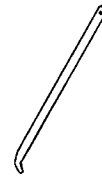
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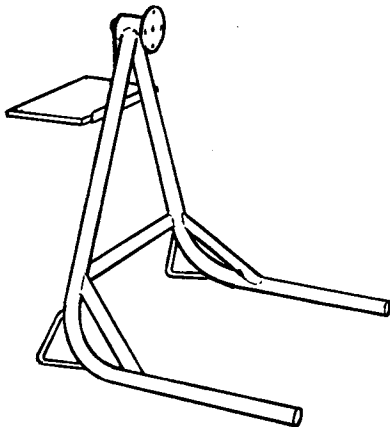
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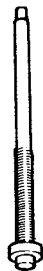
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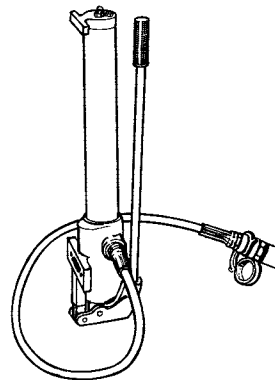
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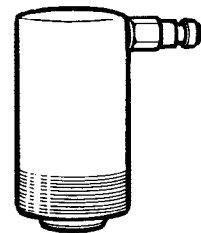
2520



2619



2670



2671



2672

999-

1801 Standard handle 18x200 mm.

2000 Standard handle 25x200 mm.

2021 Adaptor for removing upper sealing ring, steering knuckle.

2091 Adaptor for fitting bearing outer ring into steering knuckle.

2267 Hollow drift for pressing ball bearing on to angle gear output shaft.

2337 Lever for removing sealing ring from servo pump.

2497 Adaptor for removing pitman arm, used with

puller 2681. Also used with hydraulic tool for removing trailer steering link shaft.

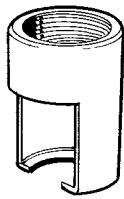
2520 Frame for servicing power steering gear. Used with jig 6516.

2619 Spindle for removing king pin and pitman arm. Used with pressure cylinder 2671.

2670 Hydraulic hand pump for pressure cylinder 2671. Alternative to 6222.

2671 Hydraulic pressure cylinder. Used with hydraulic hand pump 2670 or with air-driven hydraulic pump 6222.

2672 Crank for spindle 2619.



2681



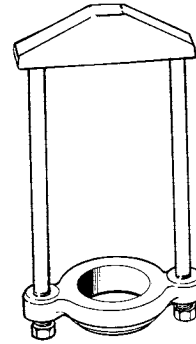
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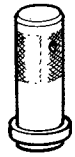
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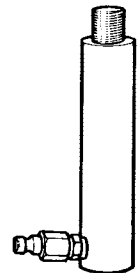
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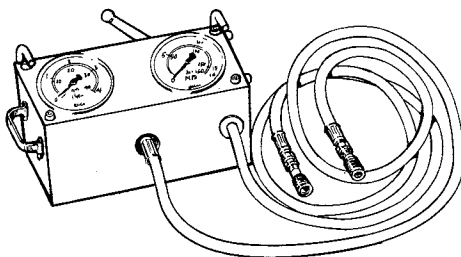
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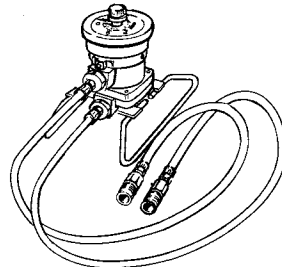
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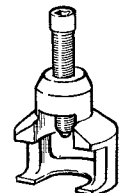
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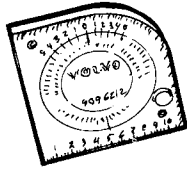
6201

- 2681 Puller** for removing pitman arm. Used with hydraulic tool.
- 2693 Adaptor** for removing and installing angle gear input shaft needle bearing, and for inserting sealing ring into angle gear adjusting nut.
- 2694 Protection sleeve** for protecting angle gear input shaft splines when fitting cover and when screwing adjusting nut on to angle gear housing. Also for installing sealing ring on power gear steering spindle.
- 2697 Adaptor** for fitting plastic bushing and sealing ring, steering knuckle.
- 2855 Press tool** for pressing out king pin. Used with hydraulic tool.
- 2859 Hollow drift** for installing sealing ring into power steering gear steering spindle housing.
- 2876 Spacer sleeve 3 mm** for checking power steering.

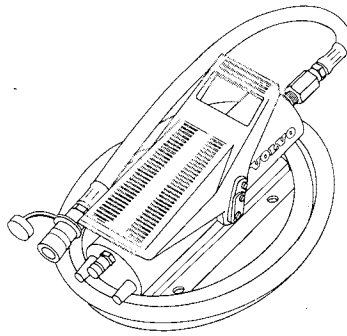
- 2996 Drift** for installing needle bearing on servo pump.
- 4090 Slide puller** for removing needle bearing from angle gear output shaft.
- 4113 Hollow drift** for removing and installing ball bearing, also for installing shaft with ball bearing, servo pump.
- 4150 Adaptor** for installing sealing ring on servo pump.
- 6159 Pin**, used with hydraulic tool to remove trailer steering link shaft.
- 6161 Hydraulic cylinder** used with hydraulic pump 6222.
- 6162 Test instrument** for power steering.
- 6163 Flow meter** for checking power steering.
- 6180 Adaptor** for removing plastic bushing, steering knuckle.
- 6201 Puller** for separating ball joints.



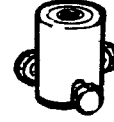
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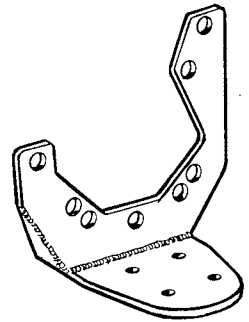
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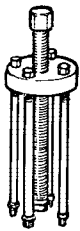
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6516



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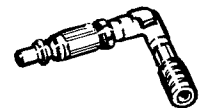
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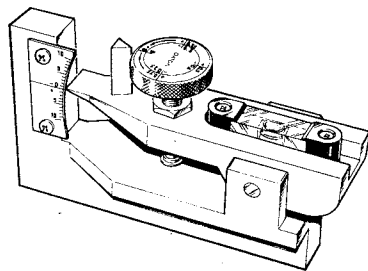
6714



6722



6743



6755



6786



6827



6828

6209 Hollow drift for pressing on ball bearing inner bearing race, angle gear.

6212 Protractor for checking front axle member.

6222 Air-driven hydraulic pump for pressure cylinder 2671. Alternative to 2670.

6459 Socket key for turning angle gear output shaft when adjusting and measuring angle gear pre-load. Also used for turning power steering gear steering spindle when checking and adjusting pressure point. Used with torque wrench 999 9708.

6516 Jig for servicing power steering gear. Used with frame 2520.

6519 Steering wheel puller

6545 Guide for pressing out king pin.

6546 Press washer for pressing out king pin.

6714 Extractor for removing sealing ring from power steering gear input shaft.

6722 Test nipple, used in power steering functional checks.

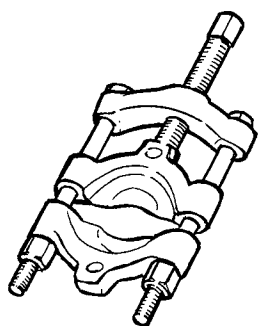
6743 Spacer sleeve 10 mm (two) for checking power steering.

6755 Angle meter kit, used when checking wheel geometry

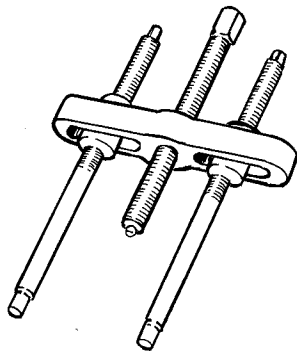
6786 Extractor for sealing ring.

6827 Nipple, used in power steering functional checks.

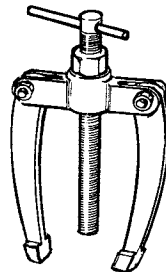
6828 Nipple, used in power steering functional checks.



998-5433



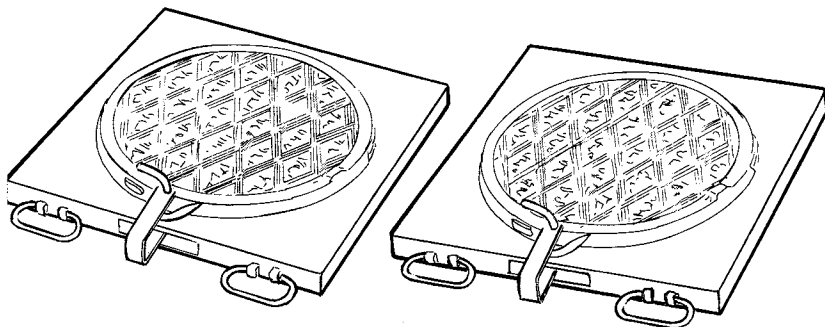
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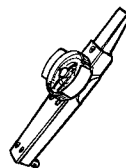
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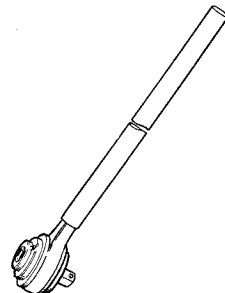
998-6182



999-9673



999-9708



999-9711

998-5433 Puller for steering shaft needle bearing inner race, for steering shaft ball bearing, for ball bearing inner bearing ring and ball bearing, for angle gear output shaft. Also used with puller 998 5434 for removing servo pump gear.

5434 Puller for removing servo pump gear.

6174 Puller for removing steering knuckle roller bearing outer ring. Used with expander 998 6182.

6182 Expander for removing steering knuckle roller bearing outer ring. Used with puller 998 6174.

999-9673 Turntable for measuring curve angles (wheel lock). For adjusting angle gear and for checking and adjusting power steering gear pressure point. Used with socket 6459.

9708 Torque wrench, alternative to 9177.

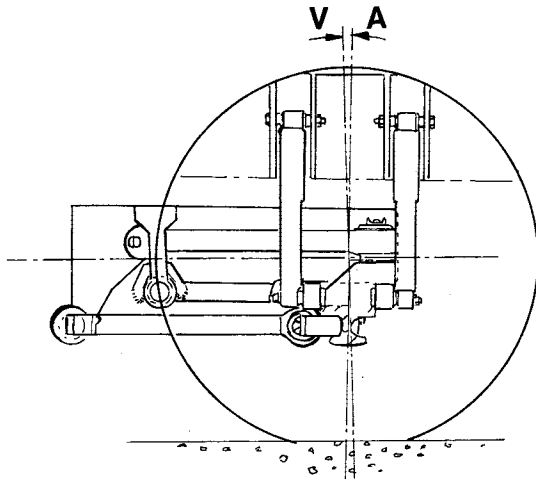
9711 Torque multiplier. Used for tightening pitman arm nut.

Group 60 General

Wheel alignment

Certain specific adjustments must be made to the front wheel steering and suspension members in order to provide the bus with the best possible steering and roadholding as well as minimising tyre wear.

During production the front axle member and steering knuckles are already designed to ensure the correct caster, camber and king pin inclination.

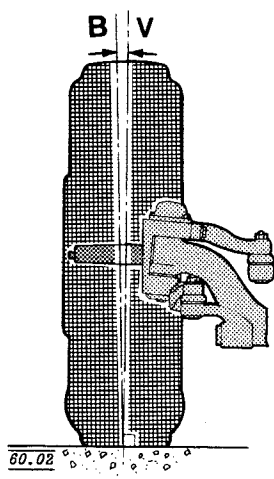


If the measured values deviate from those given in the specifications, check in the first place the wheel bearing clearance, king pin journal wear, the springs and their suspension. If these are corrected and the caster, camber and king pin inclination are still not as specified, then the steering knuckles and/or front axle member are probably deformed.

Caster

Caster refers to the inclination of the king pin forwards or rearwards. If the king pin inclines rearwards, as is shown by the angle between A and V (vertical) in the illustration, this is known as positive caster.

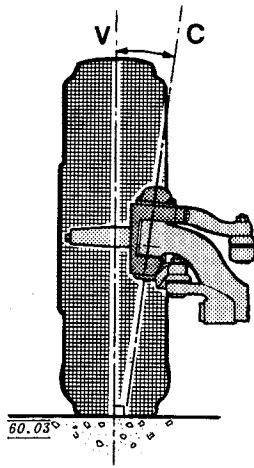
Caster makes the front wheels always tend to roll straight ahead. The greater the caster, the greater will be the tendency for the wheels to roll straight ahead and this increases stability. Insufficient caster increases the risk of steering wheel vibration.



Camber

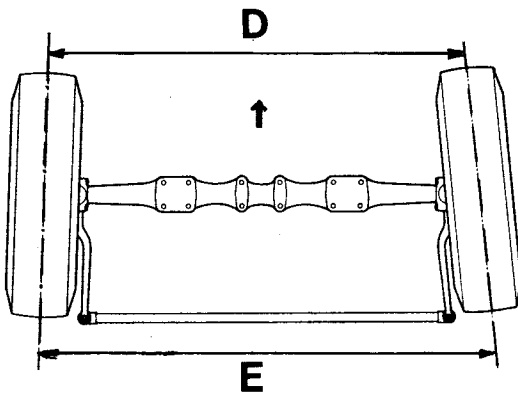
Camber means the inclination of the wheels inwards or outward. If the wheel inclines outward, as shown by the angle between B and V (vertical) in the illustration, this is known as positive camber.

Camber counteracts undesirable load on the outer wheel bearing, which would exert leverage on the steering knuckle journal. The load is diverted instead towards the stronger inner wheel bearing.



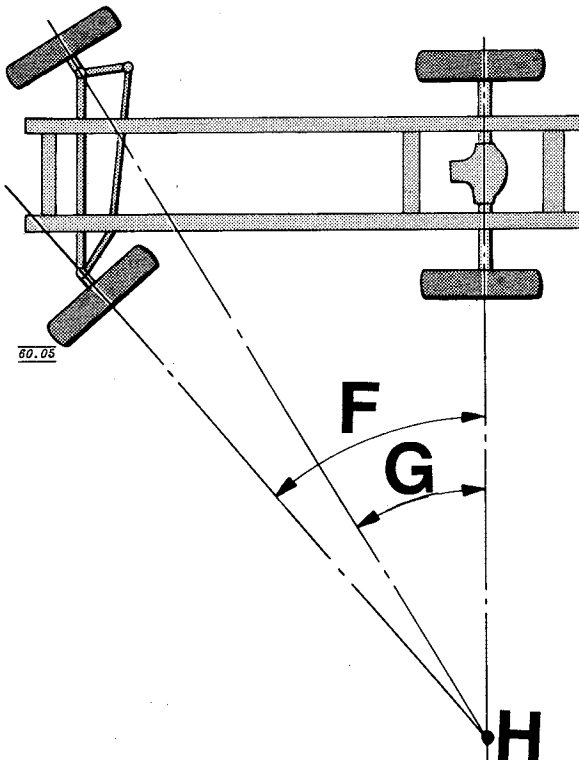
King pin inclination

King pin inclination refers to the inward inclination of the king pin. This makes it easier to turn the wheels, while tending to prevent shocks, etc., from the road from reaching the steering wheel.



Toe-in

Toe-in means the inward inclination of the wheels at their front edges. Toe-in (the difference between measurements D and E in the illustration) is necessary to counteract the tendency of the wheels to roll outward, away from each other, which is a result of the camber. Reduced camber therefore reduces the need for toe-in.



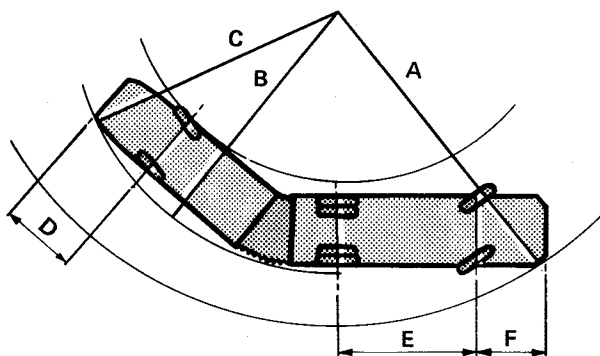
Curve angles (max. wheel lock)

Curve angles are the two different angles taken up by the inner and outer wheels at full steering wheel lock.

When the bus is driven through a curve, the inner wheel is steered further away from the straight ahead position than the outer one in order for the wheels to have the same rolling centre (H). Should the wheels have different rolling centres, there would be significant tyre wear each time the bus went round a corner since the wheels would strive to go away from or towards each other.

Because tyre width limits the angle of the steering arms for the steering knuckles, it is not possible to achieve the ideal theoretical curve angles. Even different wheel bases influence the front wheel geometry to such an extent that it deviates more or less from the ideal condition shown in the illustration.

Articulated buses with steered trailer axle



In an articulated bus with steered trailer axle, a set of steering linkages connect the trailer axle to the turntable, as shown, so that as the bus front wheels turn in one direction, the trailer wheels turn in the other direction. This reduces the turning radius. The steering ratio for the rear axle is determined by the steering arm, which is available in two versions, giving steering ratios of 0.25 and 0.29 respectively.

In a similar way to the front wheels, the trailer axle wheels take up different curve angles so that they both have a common rolling centre.

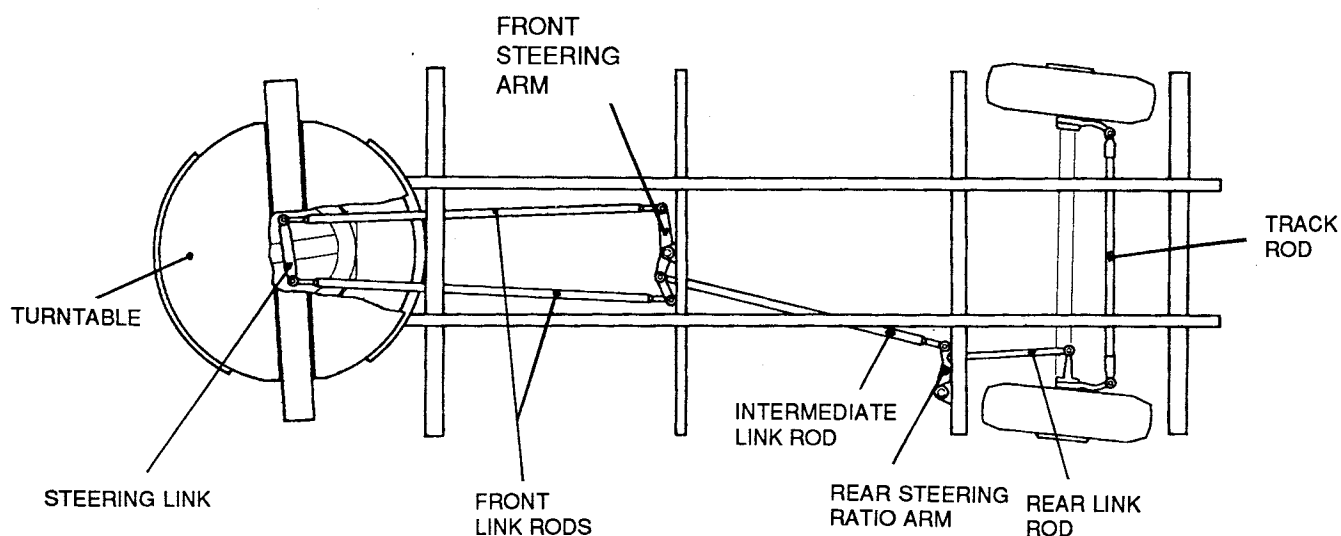
It is also very important for the trailer wheels to be exactly parallel to the driving unit front wheels when the bus is driving in a straight line, both to ensure stability and to eliminate tyre wear due to scrubbing. The wheels are adjusted parallel by adjusting the length of the rear link rod.

Steering geometry, articulated bus with steered trailer

- A Outer sweep radius
- B Inner sweep radius
- C OutswEEP, rear outer corner
- D Rear overhang, trailer
- E Wheelbase, driving unit
- F Front overhang, driving unit

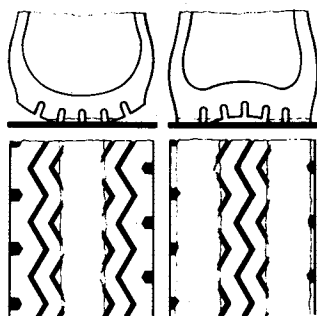
TRACTOR UNIT

TRAILER UNIT

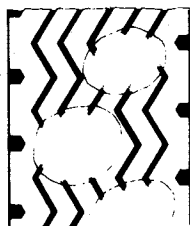


Trailer wheels when turning left

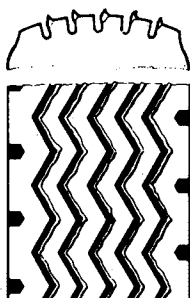
Specimens of tyre wear due to Incorrect wheel adjustment



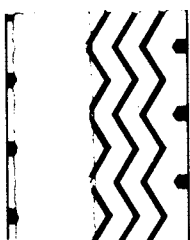
Incorrect air pressure will cause even wear all the way round, either at the centre (pressure too high) or at both edges (pressure too low) of the tyre.



Worn patches may be due to the wheel being out of balance, incorrect caster or loose bearings or bushings. Incorrect tracking may also cause this type of wear.



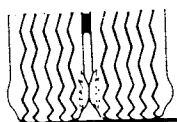
Incorrect toe-in will result in "feathering" of one edge or the other in the tyre tread pattern.



Incorrect camber or incorrect king pin inclination will cause one half of the tyre to wear quicker than the other.



If the tyre on one wheel in a pair of dual wheels is worn much more than the other, check that the two tyres have the same specified diameter.

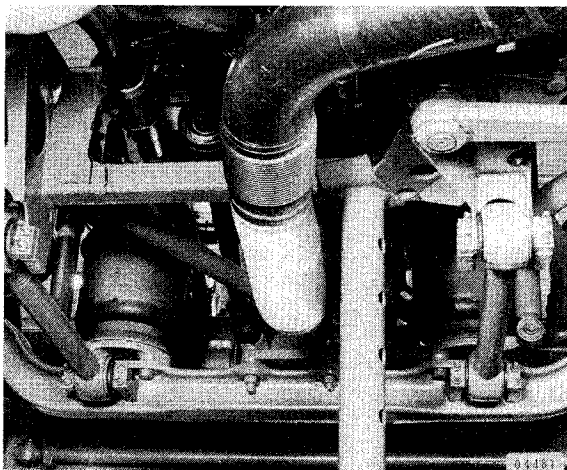


The tyres on dual wheels may rub together if they have low air pressure, or the wheel centres have been fitted incorrectly or are not the correct type for the tyres being used.

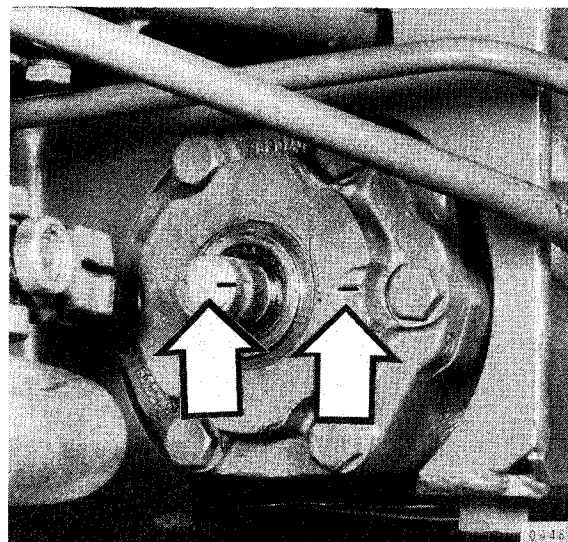
Service Procedures

Procedure before check-measuring wheel angles

1. Ensure that the bus has been rolled forward (on a flat, even surface) so that the front wheels are pointing straight ahead. Carry out checks and measurements according to steps 2-8 below:
2. Check the frame and suspension according to the Service Manual, Section 7. Check particularly that the bellows height is 249 ± 3 mm.
3. Jack up the front of the bus and place stands under the frame, just ahead of the front wheels and clear of the suspension components, as shown.



the steering wheel back half this number of turns. Turn the power steering gear input shaft to align its marking with the marking on the housing, as shown. Reconnect the universal joint, taking care not to move the steering wheel linkage or the power steering gear input shaft.



4. Check that the radial and lateral throw of both front wheels is in accordance with the figures stated in the Service Manual, Section 7.
5. Check the front tyre pressures and inspect the tyres for wear. Refer to the previous page for tyre wear indications and likely causes.
6. Check the king pin bush radial clearance using the procedure described in Section 6.
7. Check the drag link and track rod for deformation and looseness. The ball joints must not be loose.
8. Check once again that the wheels are pointing straight ahead. Remove the universal joint connection at the power steering gear input shaft. Check that the marking on the end of the shaft (see illustration) is pointing towards the mark on the power steering gear box. If it is not, with the universal joint still disconnected, turn the steering wheel from full lock to full lock and count the number of turns. Turn

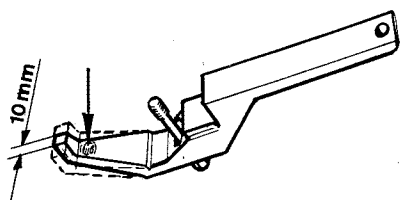
9. Take the weight of the bus on the jacks, remove the stands, lower the bus to the ground and remove the jacks.

Check-measuring and adjusting caster, and check-measuring camber and king pin inclination

Special tool:

999-6755 Angle meter kit

The measuring arm 999-6868 in the angle meter kit 999-6755 used for these procedures must be modified slightly, in accordance with the following sketch, to adapt it for use with the B10M bus.



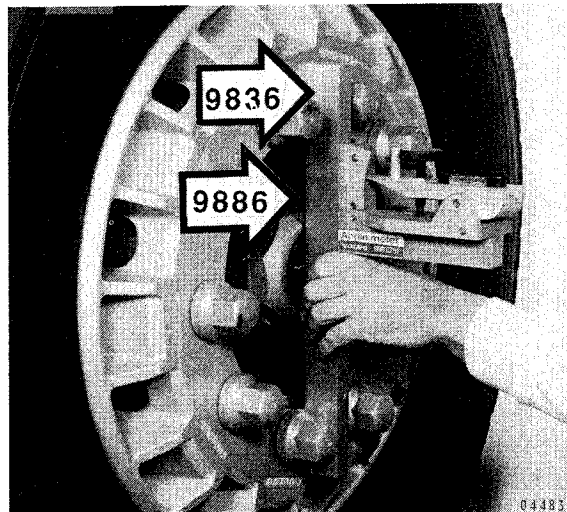
NOTE: Each measurement must be made 3 times. Add the 3 measurements and divide the sum by 3 to obtain an average result.

The front axle member and stub axles are manufactured and assembled so as to provide the correct caster, camber and king pin inclination. If the measured values differ from the Specifications, check the front axle member by removing it and carrying out the Service Procedure entitled "Check-measuring removed front axle".

NOTE: Ensure that the measuring faces on the wheels and suspension components are free from rust and paint runs, i.e. that they are perfectly clean and flat.

Measuring camber

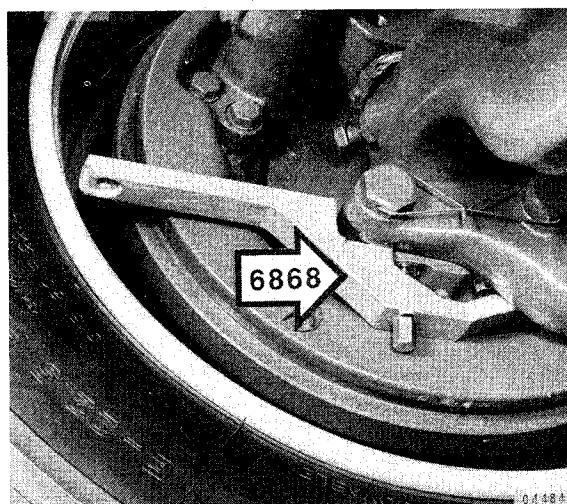
1. Measure the camber across the wheel rim with the aid of straight edge 9836, attached to the angle meter with screw 9880.



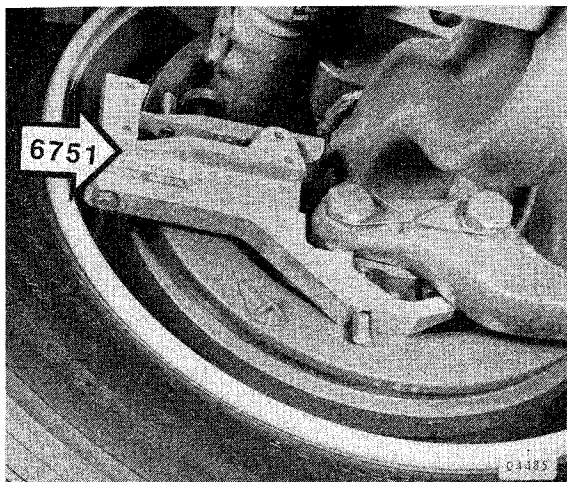
2. The average camber from 3 measurements must be $0.75^\circ \pm 0.25^\circ$. If the measurement is incorrect, the front axle must be removed and checked in accordance with the Service Procedures in Group 61, Front Wheel Suspension.

Measuring and adjusting caster

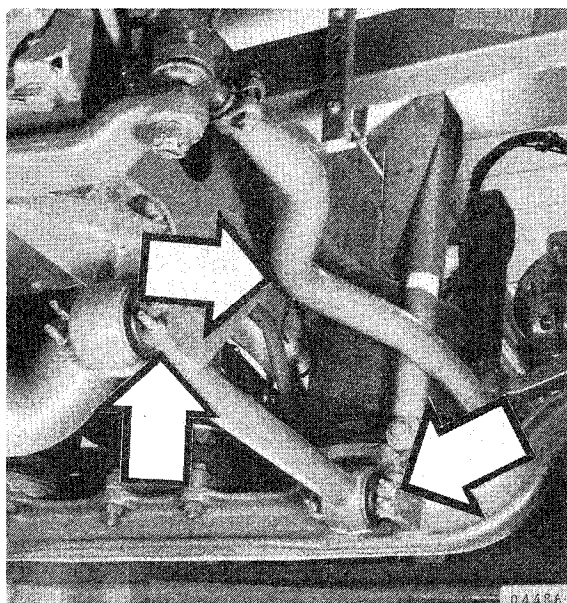
3. At the right hand front wheel, remove the front outer screw from the steering knuckle lower cover.
4. Secure the modified measuring arm 6868 to the flat surface beside the steering knuckle lower cover, with the screw which was removed from the cover in step 3. Ensure that no projection, such as the grease nipple, prevents the arm or angle meter from resting on the side of the wheel hub back plate.



5. Using an M10 x 25 screw, secure the angle meter 6751 in line with the measuring arm 6868.

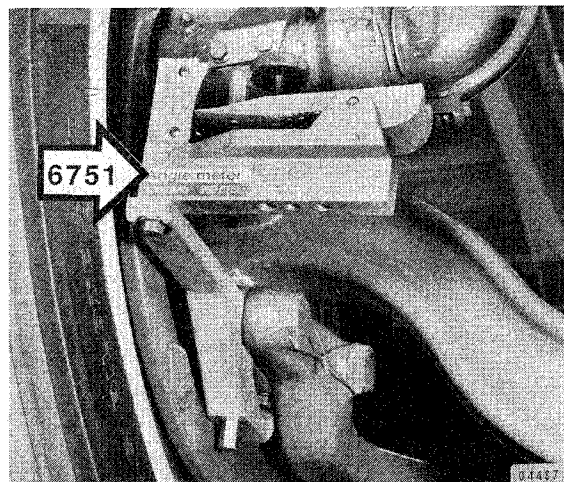


6. Adjust the angle meter so that the level bubble lies between the markings. Read off the caster angle on the scale. The average of three such measurements should be $2.0^{\circ} \pm 0.2^{\circ}$.
7. If the measured caster angle is incorrect, adjustment is made by reducing (to **Increase** the angle), or increasing (to **decrease** the angle) the thickness of the shims at the ends of the longitudinal reaction rods (**not** the V-brace), as follows.
8. Begin by altering the shim thickness at the front ends of the reaction rods, by the same amount on each side of the bus. If insufficient adjustment can be made there, continue by altering the shim thickness at the rear ends of the reaction rods, again by the same amount on each side.



Measuring king pin inclination

9. At the right hand front wheel, remove the front outer screw from the steering knuckle lower cover.
10. Secure the modified measuring arm 6868 to the flat surface beside the steering knuckle lower cover, with the screw which was removed from the cover in step 3. Ensure that no projection, such as the grease nipple, prevents the arm from resting on the side of the wheel hub back plate.
11. Using an M10 x 25 screw, secure the angle meter 6751 at right angles to the measuring arm 6868.



12. Adjust the angle meter so that the level bubble lies between the markings. Read off the king pin inclination angle on the scale. The average of three such measurements should be $5.75^{\circ} \pm 0.25^{\circ}$.
13. Repeat steps 9 to 12 inclusive on the left hand front wheel.

Toe-in

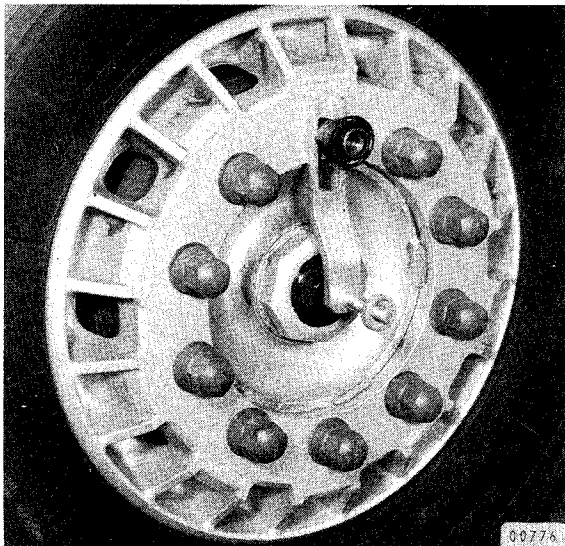
Special tool:

999-6170 Measuring Instrument

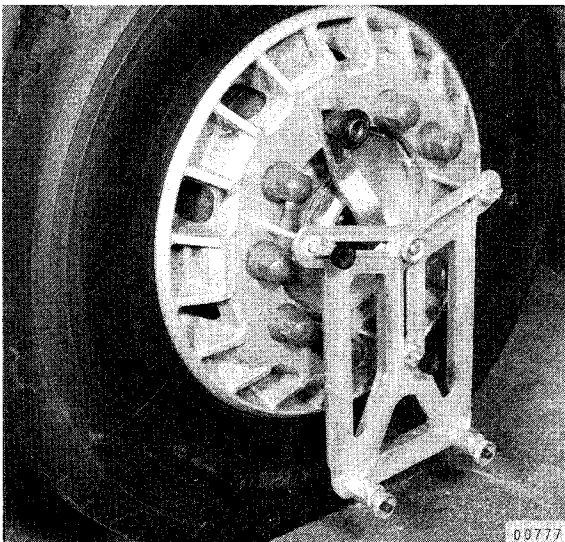
Check-measuring toe-in

1. Perform the "Procedure before check-measuring wheel angles" as detailed previously in this section.
2. Ensure that the bus is positioned with the front wheels pointing straight ahead. The steering wheel must not be turned or the bus lifted after it has been positioned since this will put a strain on the steering rod and tyres.
3. Remove a wheel nut and fit the attachment under the wheel nut. On alloy wheels, the protection cap on a nut must be removed and the nut inverted.

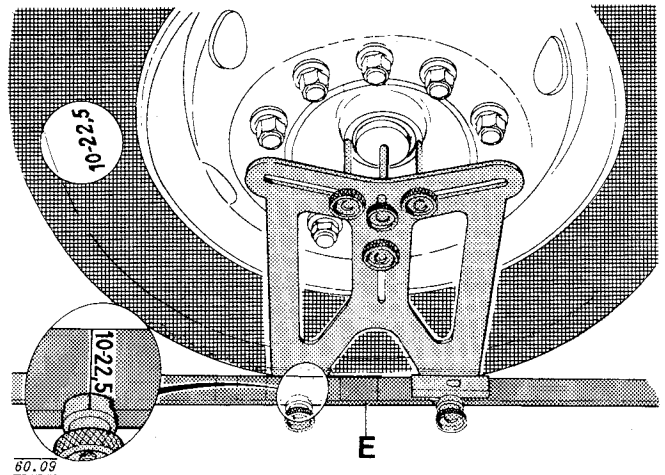
NOTE: If a gauge with magnetic feet is used on alloy wheels, drilled steel plates must be placed under the appropriate wheel nuts to provide a magnetic surface for the gauge.



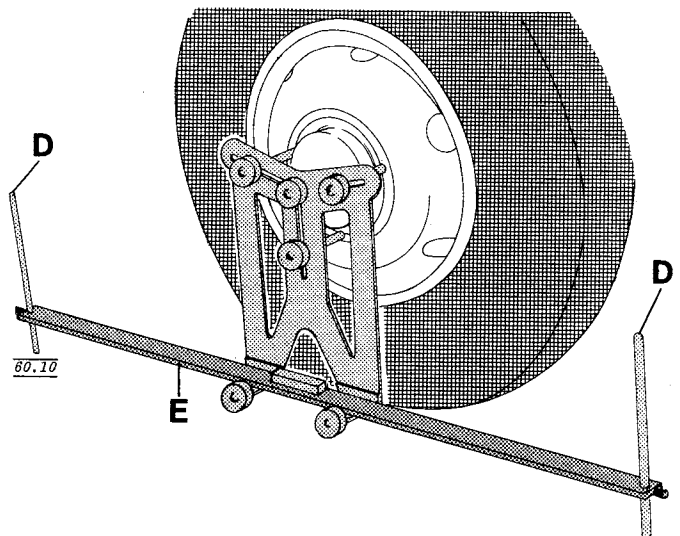
4. Place the holder on the attachment and adjust the spacer pins so that they lie against the rim. Tighten up the centre nut.



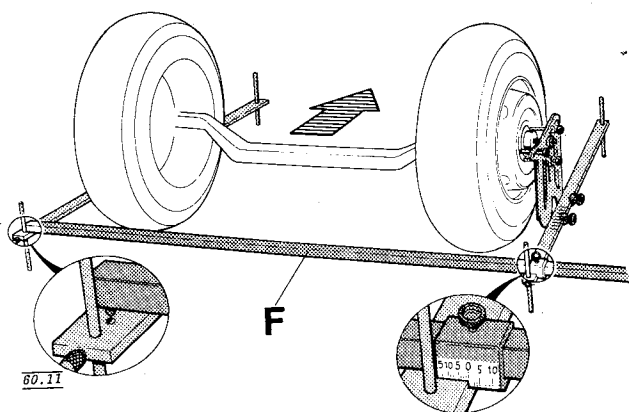
5. Place the alignment gauges (E) on the holders with the "Front" marking facing forwards. Check the tyre size. Adjust the alignment gauges so that the corresponding mark on the gauges is opposite the mark on the rear gauge attachments.



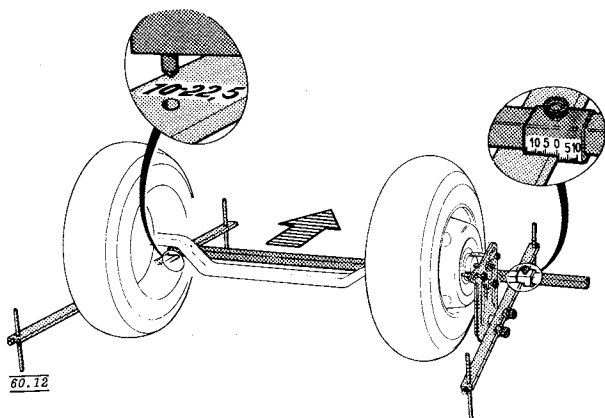
6. Slacken the centre nuts and align the gauges (E) horizontally using a spirit level on the gauges. Fit the support pins (D) in the holes at the ends of the gauges and tighten up the centre nuts.



7. Ensure that the centre nuts, spacer pins, gauge attachments and support pin lock screws are firmly tightened.
8. Position the alignment rod (F) on the alignment gauges, behind the front wheels. Place the alignment rod pin in one of the alignment gauge holes. Position the other end of the alignment rod over the corresponding hole in the other alignment gauge. Zero-set the measuring gauge on the alignment rod against the outside of the alignment gauge.



9. Transfer the alignment rod to the front side of the wheels. Place the alignment rod pin in the hole where the actual tyre size is given. Place the other end of the alignment rod opposite the corresponding hole in the other alignment gauge. Read-off the toe-in on the measuring gauge. The measured toe-in should be 0-3 mm; if it is not within these limits adjust in accordance with steps 10-14.



Adjusting toe-in:

10. Lift off the alignment rod and unscrew the centre nuts securing the holders. Lift off both holders, together with the alignment gauges. Leave the centre attachments in place.
11. Slacken the clamp bolts at both ends of the track rod. Adjust the toe-in by turning the track rod (1/2 turn = 1 mm). Tighten up the clamp bolts.



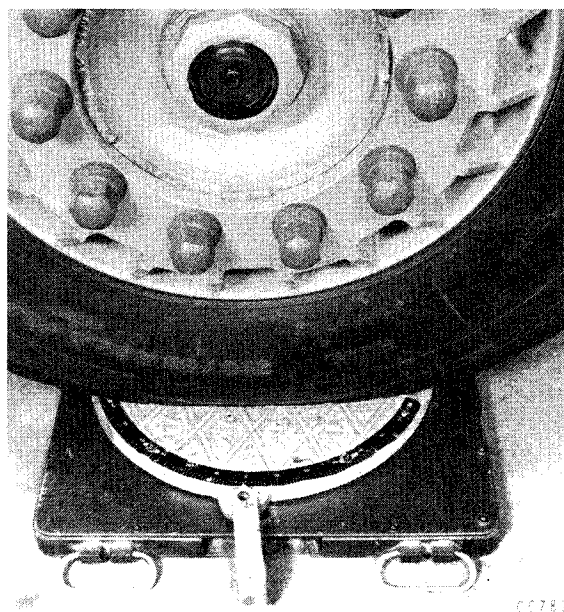
12. Drive the bus a short distance, enough for the wheels to roll a couple of turns, in order to take the strain off the steering rod and tyres.
13. Place the holders, alignment gauges and other items on the wheels again. Re-check the toe-in measurement by repeating steps 6 to 9 inclusive.
14. If the toe-in measurement is still incorrect, repeat steps 10 to 13 inclusive.

Curve angles (max. wheel lock)

Other equipment:

999-9673 Turntable (2 required)

1. Perform the "Procedure before check-measuring wheel angles" detailed on page 11 and if necessary adjust the toe-in as described above.
2. Place a turntable 9673 under each front wheel. Point the wheels straight ahead. Zero-set the turntables.



3. Apply the footbrake fully and keep its pedal pressed down with a pedal support or with the help of an assistant.
4. Turn the steering wheel counterclockwise to the left full lock position and read off the curve angles on the turntables. Turn the steering wheel clockwise to the right full lock position and read off the curve angles again.

The measured curve angles (max. wheel lock) should be:

inner wheel	52°
outer wheel	41.5° - 42.5°

Note: At full wheel lock (right turn for LHD bus; left turn for RHD bus) the distance between the tyre and the drag link should be not less than 5 mm. If extra wide tyres are used, the curve angles will be reduced proportionally.

5. The curve angles are adjusted as follows:

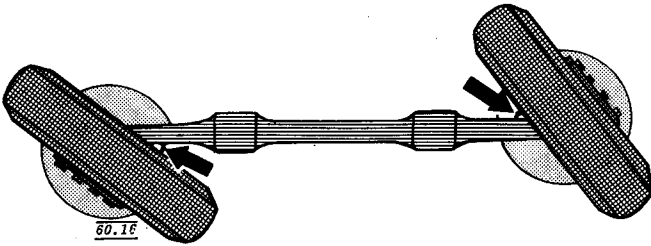
Left turn: Slacken the lock nut for the left hand side rear stop bolt. Turn the steering wheel to left full lock. Adjust the left hand side rear stop bolt to obtain the correct curve angle for the left-hand front wheel (inner wheel). If necessary slacken the lock nut and screw in the right hand side front stop bolt if this is limiting the wheel lock during adjustment.

Both the left hand rear stop bolt and the right hand front stop bolt should touch the steering knuckles in order to adjust to the correct curve angle. Lock the stop bolts with their lock nuts.

Warning: After adjusting the max. wheel lock curve angles, check and adjust the unloading mechanism, as describe In Group 64 Service Procedures. If this check is not done the servo pump and steering gear may be damaged due to excessive pressure (with resulting overheating) at max. wheel lock.

For trailer tracking and adjustments, refer to the "Trailer Steering System" section.

BUS FRONT

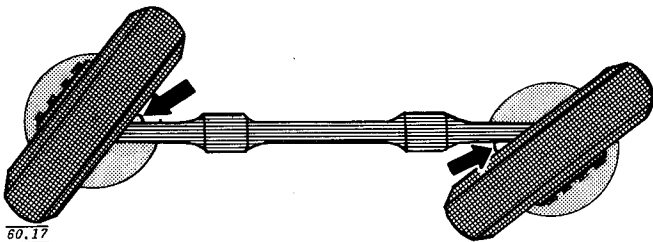


Point the wheels straight ahead and zero-set the turntables. Turn the steering wheel to full left lock and check that the curve angles are correct.

Right turn: Slacken the lock nut for the right hand rear stop bolt. Turn the steering wheel clockwise to right full lock. Adjust the right hand rear stop bolt to obtain the correct curve angle for the right front wheel (inner wheel). If necessary slacken the lock nut and screw in the left hand side front stop bolt if this is limiting the wheel lock during adjustment.

Both the right hand rear stop bolt and the left hand front stop bolt must touch the steering knuckles in order to adjust to the correct curve angle. Lock the stop bolts with their lock nuts.

BUS FRONT

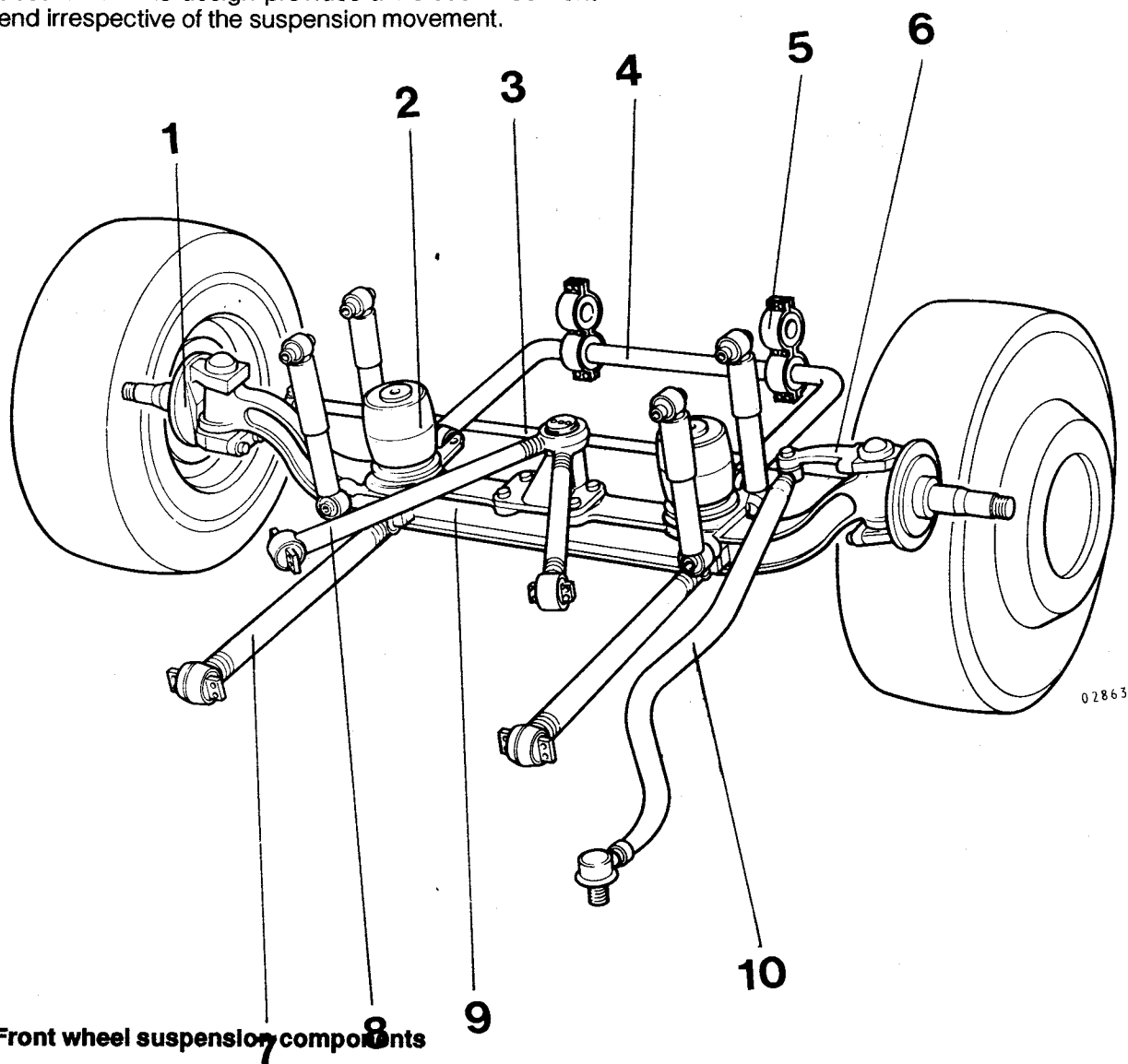


Point the wheels straight ahead and zero-set the turntables. Turn the steering wheel to full right lock and check that the curve angles are correct.

Note: If the curve angle for the outer wheel does not agree with the correctly adjusted curve angle for the inner wheel, then the track rod or steering arms are probably deformed.

Group 61 Front Wheel Suspension

The front end has a very stable suspension from a strong V-shaped support in the middle of the front axle. At each air bellows there is a longitudinal reaction rod as well as attachments for the anti-roll bar and shock absorbers. This design provides a vibration-free front end irrespective of the suspension movement.



Front wheel suspension components

- | | | | |
|---|------------------------|----|--------------------|
| 1 | Steering knuckle | 6 | Steering arm |
| 2 | Air suspension bellows | 7 | Reaction rod |
| 3 | Track rod | 8 | V-support |
| 4 | Anti-roll bar | 9 | Front axle member |
| 5 | Anti-roll bar clamp | 10 | Steering drag link |

Front axle

The front axle is of the rigid type, that is, the front axle member is drop-forged in a single piece from an alloy steel bar.

Refer to Section 7 of the Service Manual for details of the wheels, hubs and chassis-to-front axle suspension.

Steering knuckle assembly

The wheel and its bearings are located on the steering knuckle, which pivots on the front axle member (2) by means of the king pin (9).

The steering knuckle crown is journalled on the king pin by means of a tapered roller bearing (13), and at the bottom by means of a bushing (4). The acetal plastic bushing takes up radial loads, while the roller bearing takes up both axial and radial loads. The roller bearing outer ring and the bushing have a press-fit.

Steering knuckle axial clearance is adjusted by means of shims (12) between the roller bearing and spacer sleeve (11).

The taper of the king pin keeps it properly located in the front axle member and it is located vertically by a castellated nut (15) and washer (14) in the upper journal.

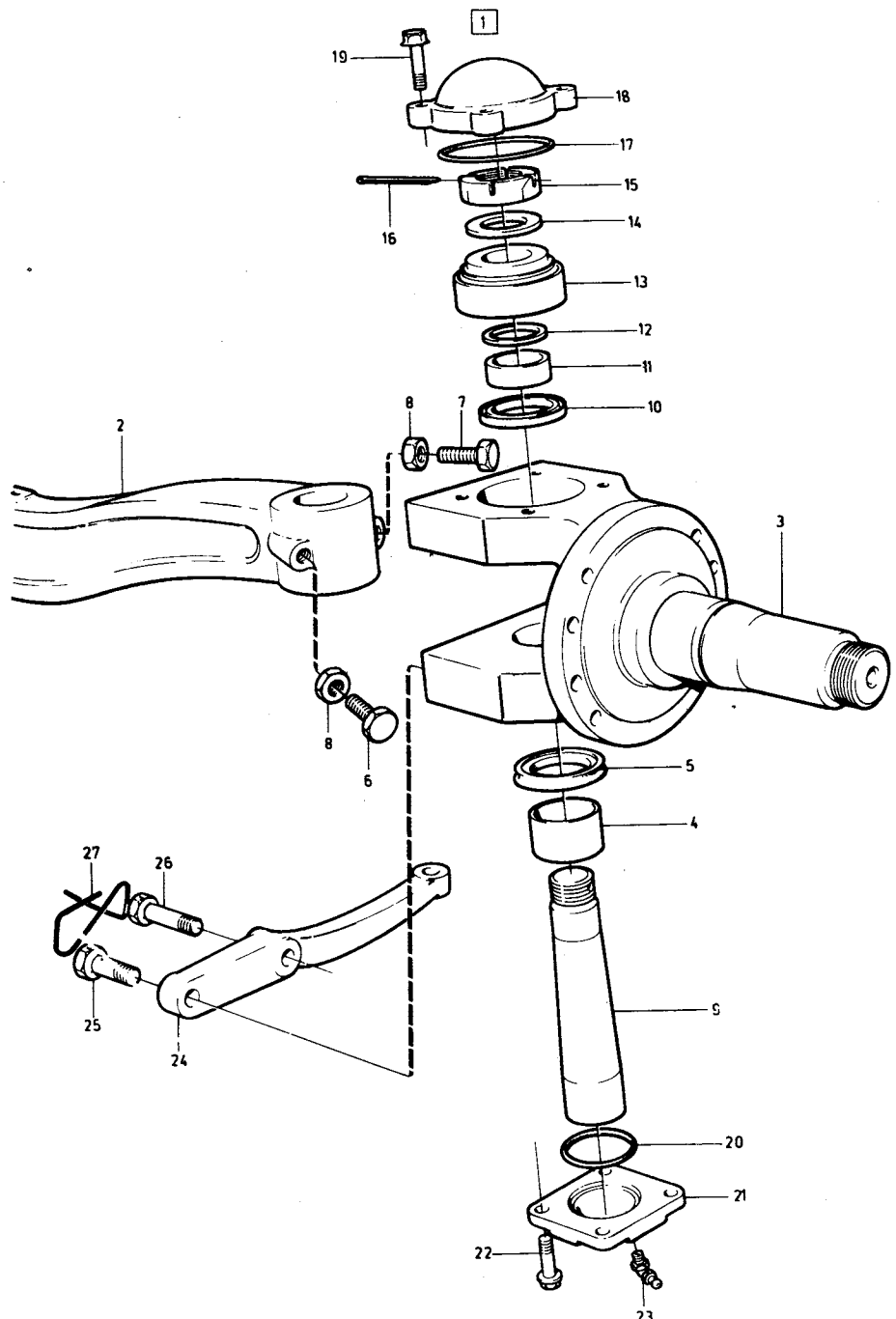
The roller bearing is protected against dirt by a cover (18) which is sealed by an O-ring (17) and an upper sealing ring (10). The bushing is protected by a lower cover (21) and a lower sealing ring (5).

The steering knuckles have replaceable steering arms (24) for attachment to the track rod, with an extra arm on the steering side for the steering gear drag link. The turning movement of the steering knuckles is limited by stop bolts (6 and 7), one at the front and the other at the rear.

Lubricating nipples are located in the steering knuckle upper (18) and lower (21) covers. Two nipples on the upper cover, one pointing forwards and the other rearwards, improve accessibility. It is sufficient to grease the upper bearing through either one of these nipples.

Steering knuckle components

- 1 Steering knuckle, complete
- 2 Front axle member
- 3 Steering knuckle
- 4 Bushing
- 5 Lower sealing ring
- 6 Stop bolt
- 7 Stop bolt
- 8 Stop bolt lock nut
- 9 King pin
- 10 Upper sealing ring
- 11 Spacer sleeve
- 12 Shim
- 13 Roller bearing
- 14 Washer
- 15 Castellated nut
- 16 Split pin
- 17 O-ring
- 18 Upper cover
- 19 Bolt
- 20 O-ring
- 21 Lower cover
- 22 Bolt
- 23 Lubrication nipple
- 24 Steering arm
- 25 Bolt
- 26 Bolt
- 27 Lock wire



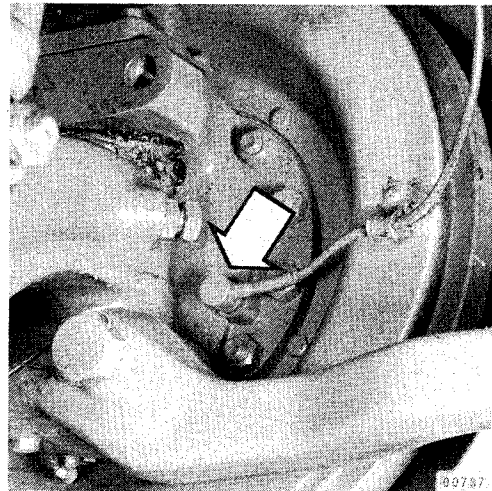
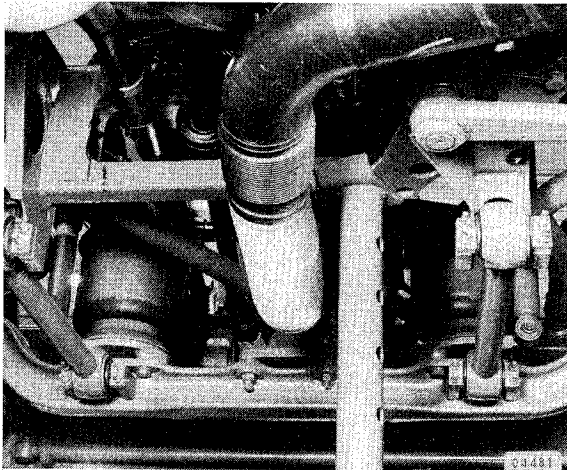
Service Procedures

Front axle, removal

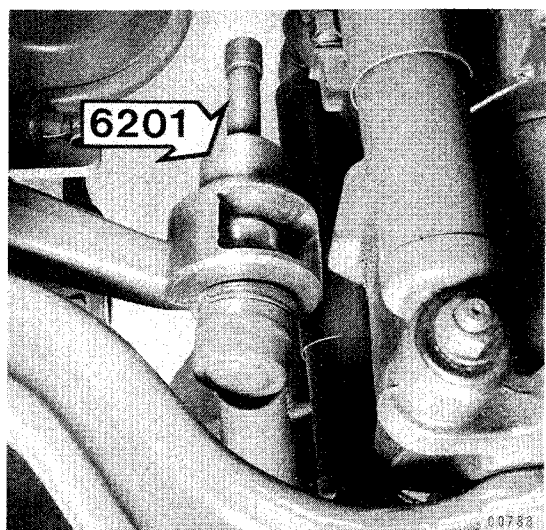
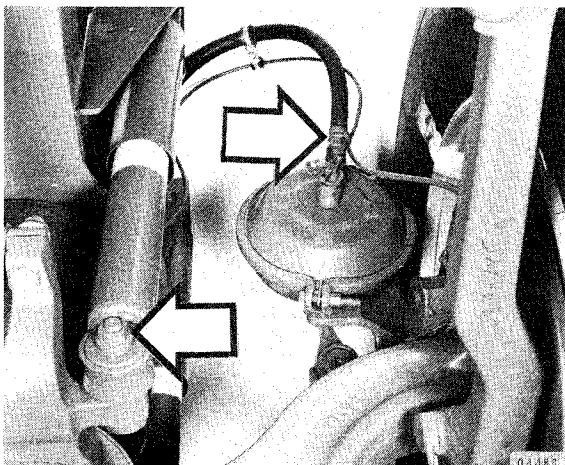
Special tool:

999 6201 Puller

1. Raise the bus and place stands under the frame on both sides, just ahead of the front wheels and clear of the suspension components, as shown.
3. If the bus is equipped with ABS, pull out the senders for the anti-lock brakes from the hub and remove the cable clamp.

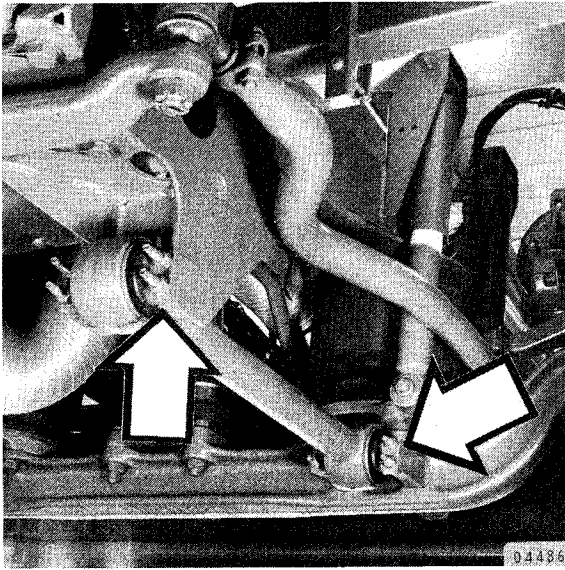


2. Disconnect the brake hoses from the frame and the shock absorbers from their lower attachments.
4. Remove the drag link split pin and nut at the steering arm and detach the drag link from the steering arm using puller 6201.

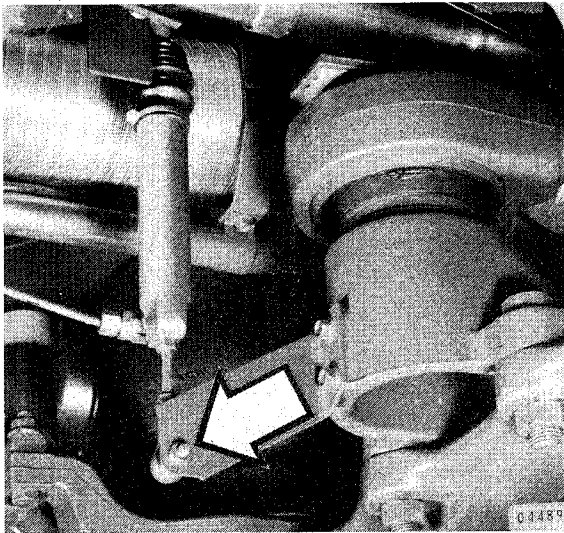


5. Remove the reaction rod, angle support and anti-roll bar.

Note: Make a note of the shim locations as they are removed, to ensure that they are replaced in their original positions afterwards.



6. Disconnect the level control piston rod from the bracket on the front axle.



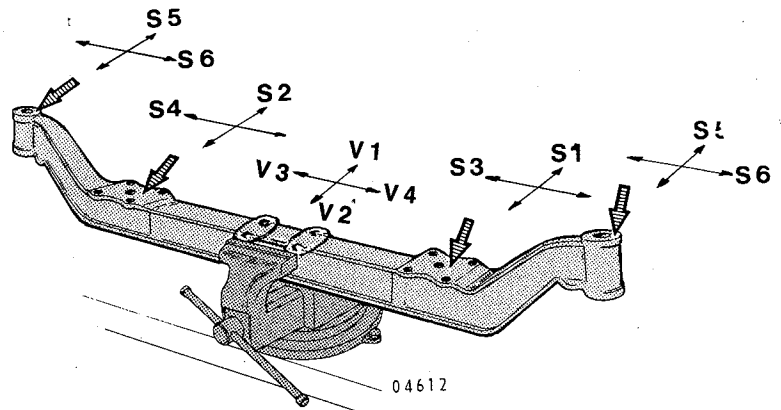
7. Lower the front axle with the wheel lift and roll it out from under the bus.

Check-measuring removed front axle member

Special tool:

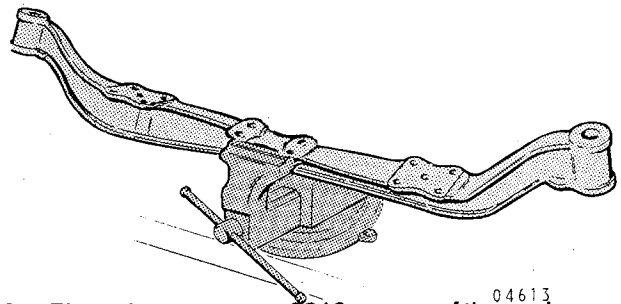
999 6212 Protractor or 6755 Angle meter

1. Secure the front axle member to a bench with a strong clamp or place it where it is in a stable position and cannot be accidentally moved. Clean and examine the flat surfaces to make sure they are free from burrs, etc.

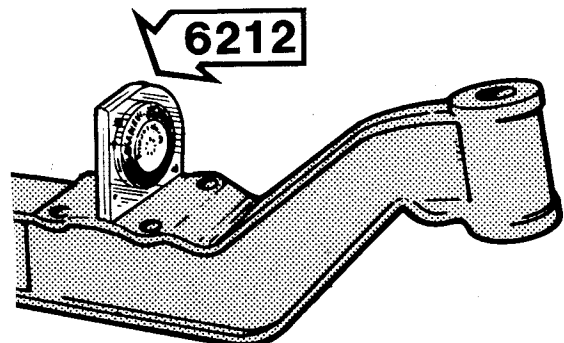


NOTE: The annotations S1-S6 refer to the angles measured in the text below.

Check-measuring possible torsional damage (twist) between spring pads and V-support attachments

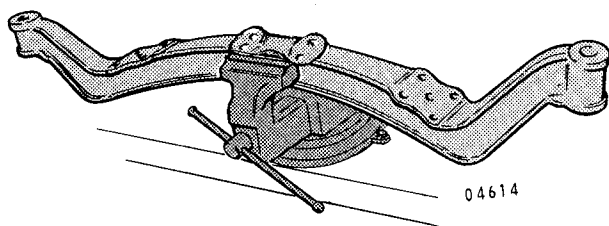


2. Place the protractor 6212 on one of the spring pads in the longitudinal direction as shown and read off the angle to the horizontal. Note this angle as S1.

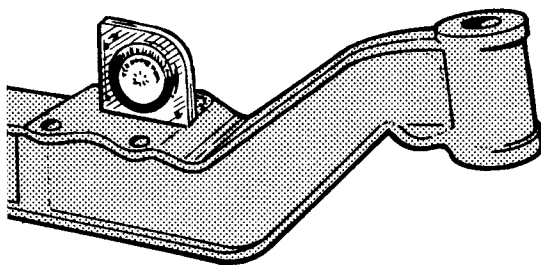


3. Transfer the protractor to the spring pad at the other end of the axle, position it in a longitudinal direction and read off the angle to the horizontal. Note this angle as S2.
4. The maximum permitted difference between the two angles measured at the spring pads (S1 and S2) is 1° . The maximum permitted difference in longitudinal level between the V-support attachment faces (V1 and V2) is 0.5 mm, as measured with a straight-edge and depth gauge.

Check-measuring front axle member lateral straightness (bow)



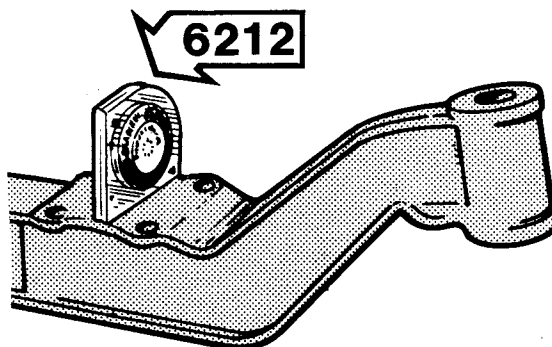
5. Place the protractor 6212 on one of the spring pads in a transverse direction as shown and read off the angle to the horizontal. Note this angle as S3.



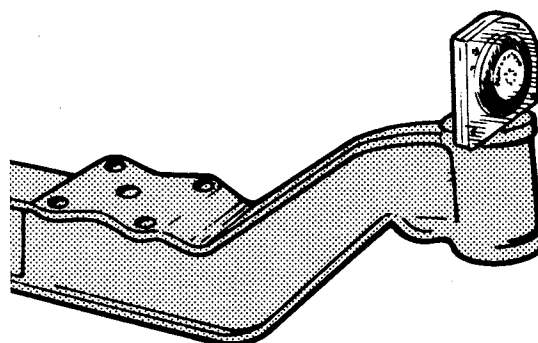
6. Transfer the protractor to the spring pad at the other end of the axle, position it in a transverse direction and read off the angle to the horizontal. Note this angle as S4.
7. The maximum permitted difference between the two angles measured at the spring pads (S3 and S4) is 1° . The maximum permitted difference in transverse level between the V-support attachment faces (V3 and V4) is 0.5 mm, as measured with a straight-edge and depth gauge.

Check-measuring angle between spring pad and king pin top face:

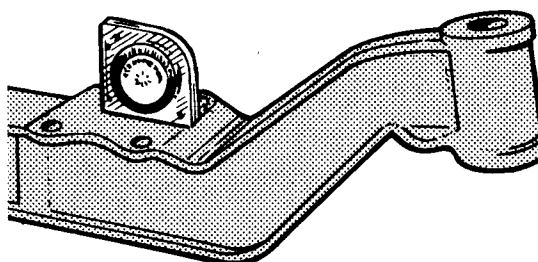
8. Place the protractor 6212 on one of the spring pads in a longitudinal direction as shown and read off the angle to the horizontal. Note this angle as S5.



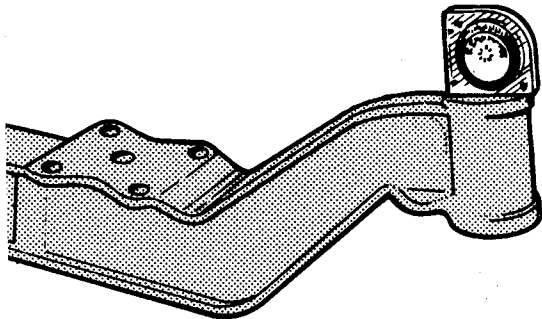
9. Transfer the protractor to the machined face above the king pin hole, position it in a longitudinal direction and read off the angle to the horizontal. The difference between the angles at the spring pad (S5) and the machined face above the hole must be $0 \pm 0.25^{\circ}$.



10. Repeat the same measuring procedure for the spring pad and king pin hole machined face at the other end of the front axle member.
11. Place the protractor 6212 on one of the spring pads in a transverse direction as shown and read off the angle to the horizontal. Note this angle as S6.



12. Transfer the protractor to the machined face above the nearest king pin hole, position it in a transverse direction and read off the angle to the horizontal. The difference between the angles at the spring pad (S6) and the machined face above the hole must be $5.75^\circ \pm 0.25^\circ$.

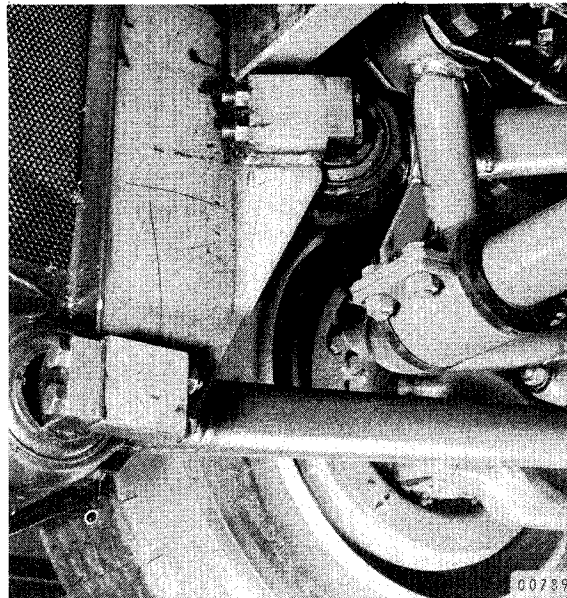


13. Repeat the same measuring procedure for the spring pad and king pin hole machined face at the other end of the front axle member.
14. If a deviation is measured which is less than the maximum values given above, the front axle member can be cold-aligned.

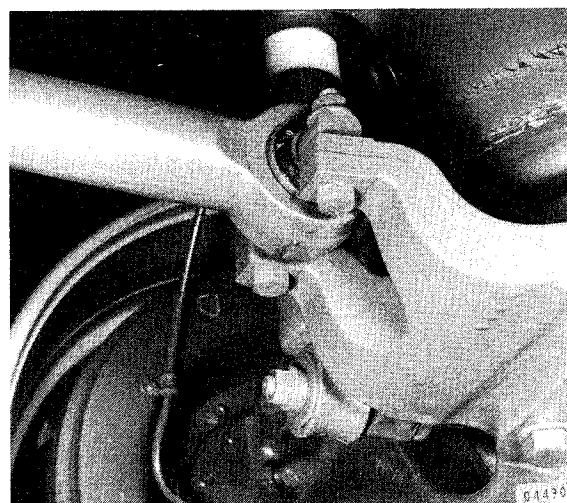
Note: If the front axle has had to be cold-aligned, it must be checked with magnetic powder for cracks.

Front axle, installation

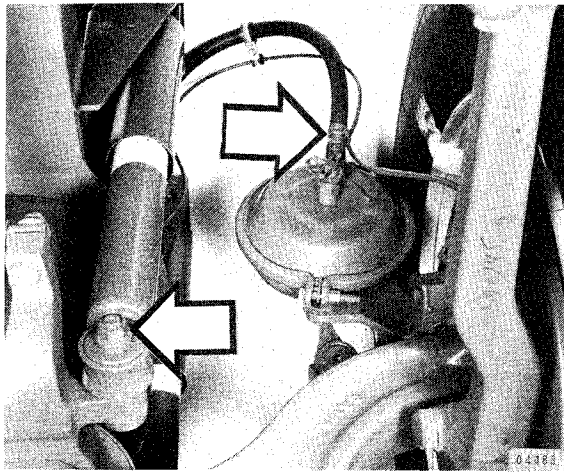
1. Place the front axle on wheel lifts and lift it up into position.
2. Fit the reaction rods and V-support together, inserting any shims which were removed during dismantling, and tighten to a torque of 85 Nm.



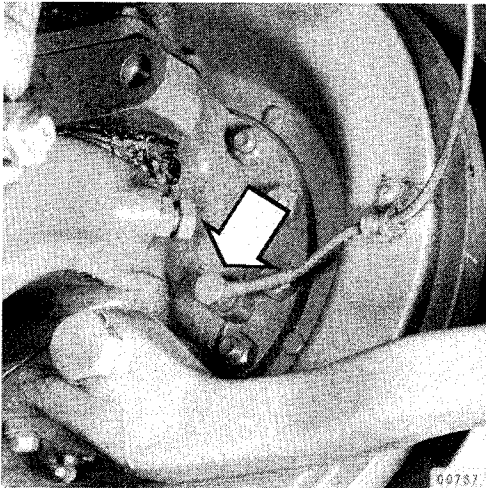
3. Tighten the anti-roll bar to a torque of 85 Nm.



4. Fit and tighten the shock absorbers to a torque of 220 Nm.
5. Fit and secure the brake hose to the frame.



6. If the bus is equipped with ABS, press in the sender for the anti-lock brakes and clamp the cable.

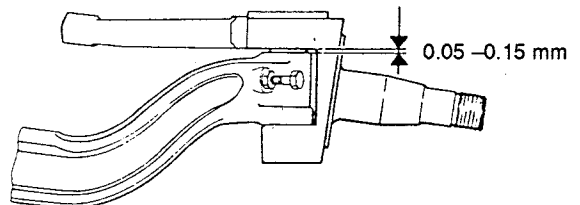


7. Fit the drag link to the steering arm, tighten its securing nut to a torque of 350 Nm and then further to the next split-pin hole. Lock the nut with a new split pin.
8. Fit the level control cylinder to the front axle.
9. Remove the stands and lower the bus.
10. Check and if necessary adjust toe-in and curve angles, depending on the work which has been carried out.

Steering knuckle

Check-measuring and adjusting axial clearance

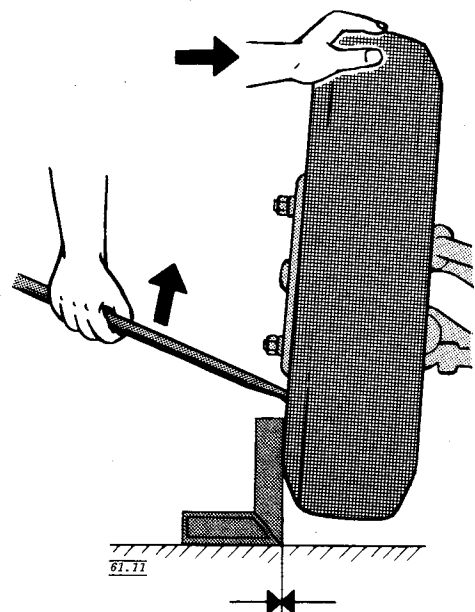
1. The bus should be standing on a flat floor for the measurements so as to load the king pin journals.
2. Measure the clearance (intermediate space) between the steering knuckle and front axle member, using a feeler gauge. The permitted clearance is between 0.05 and 0.15 mm.



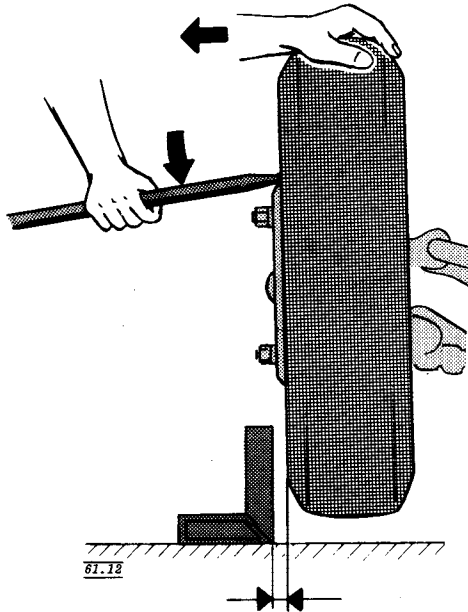
3. If the clearance is too much or too little, adjust by removing or adding shims between the steering knuckle journal's roller bearing and spacer sleeve. The procedure for replacement of king pin and journals is detailed later in the Manual.

Check-measuring radial clearance

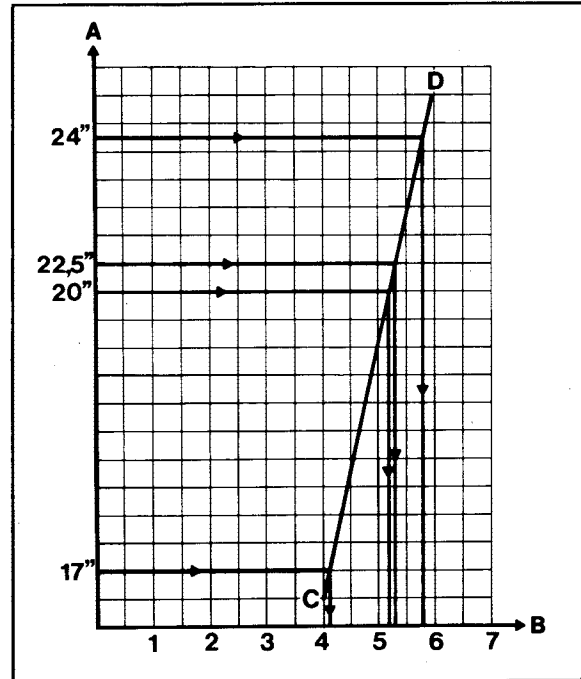
1. Jack up the bus under the front axle.
2. Apply the footbrake, and keep its pedal pressed down with a pedal support or with the help of an assistant depress the brake pedal, enough so that the wheel bearing clearances will not influence the measuring. With a tommy bar in the wheel's lower hole lever the wheel upwards and place a suitable gauge, such as the set square shown in the figure, against the side of the tyre.



3. Lever downward with the tommy bar in the wheel's upper hole while measuring at the same time the distance between the angle gauge and the tyre.



4. The maximum permitted bushing radial clearance is 2 mm at the bushing. The clearance between the angle gauge and the tyre may be greater than this, due to the fact that the measuring point is situated further away from the actual bushing. The clearance measurement increases with tyre size since the distance between the bushing and the measuring point becomes further with a bigger tyre. For a tyre size of 22.5", the maximum permitted clearance at the angle gauge is 5.3 mm. Refer to the following graph to see which clearance is permissible at the angle gauge for the tyres being used.



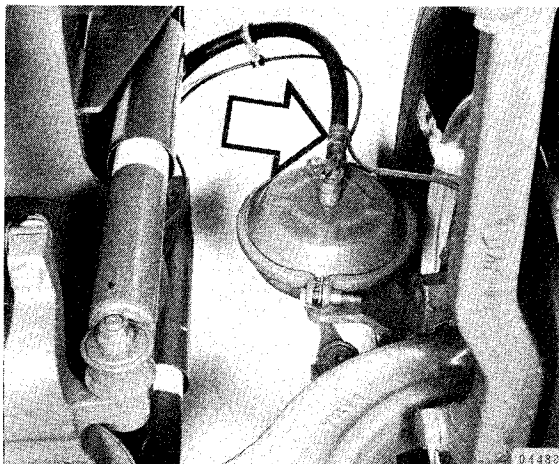
61.13

Replacing king pin and journal (hub and wheel bearing removed)

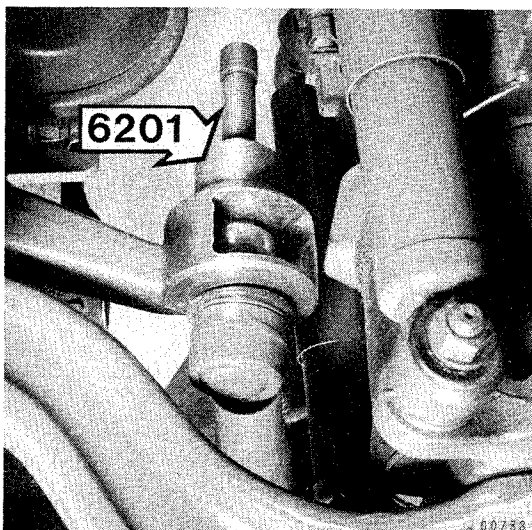
Special tools:

999-1801 Standard handle
2000 Standard handle
2021 Adaptor
2091 Drift
2619 Spindle
2670 Hydraulic pump or
6222 Hydraulic pump
2671 Hydraulic cylinder
2672 Crank
2697 Adaptor
2855 Press tool
6174 Puller
6180 Drift
6182 Expander
6545 Guide
6546 Press washer

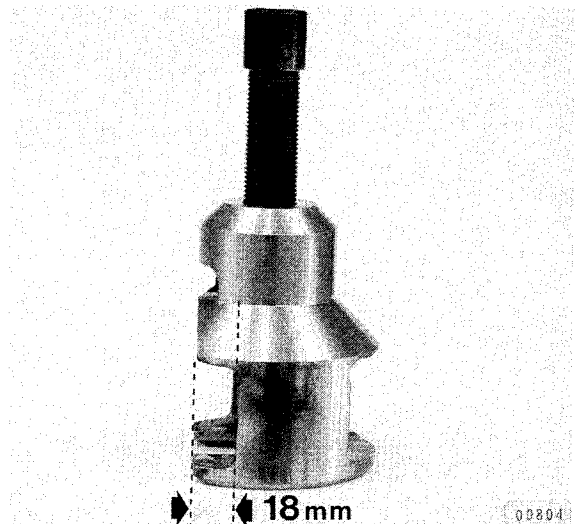
1. Use an old sealing ring to protect the wear ring from damage when working on the king pin.
2. Disconnect the brake hose from the nipple at the frame.



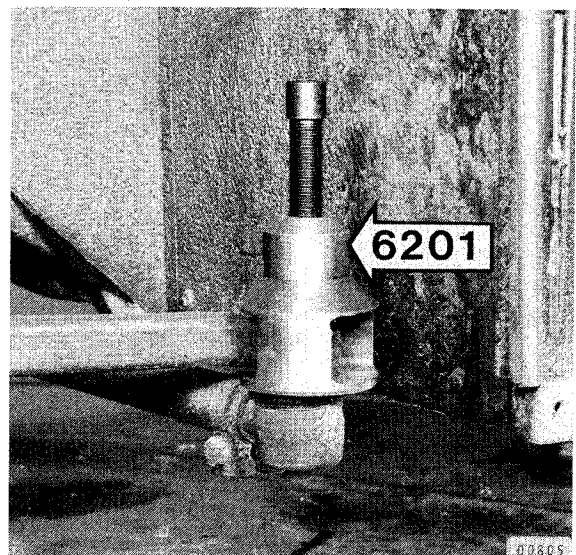
3. Remove the split pin and unscrew the drag link nut at the steering arm. Remove the drag link from the steering arm using puller 6201.



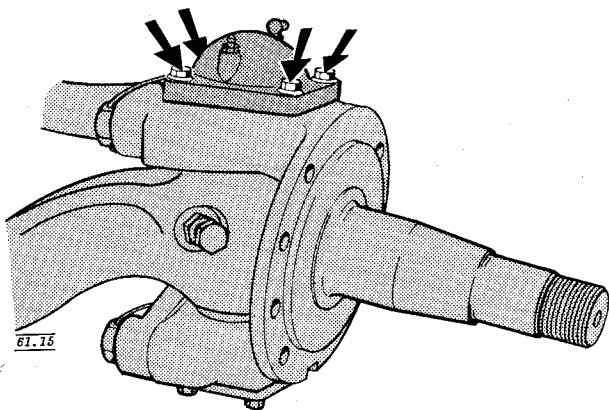
4. Some material must be removed from the puller 6201, as shown in the fig. below, in order for it to fit on the steering arm.



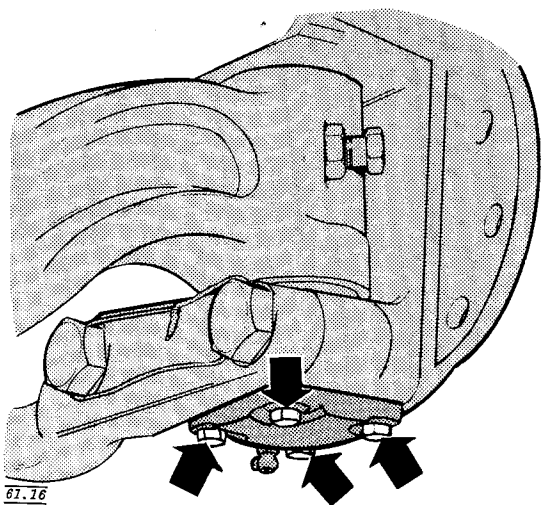
5. Remove the split pin and unscrew the track rod nut at the steering arm. Remove the track rod from the steering arm using puller 6201.



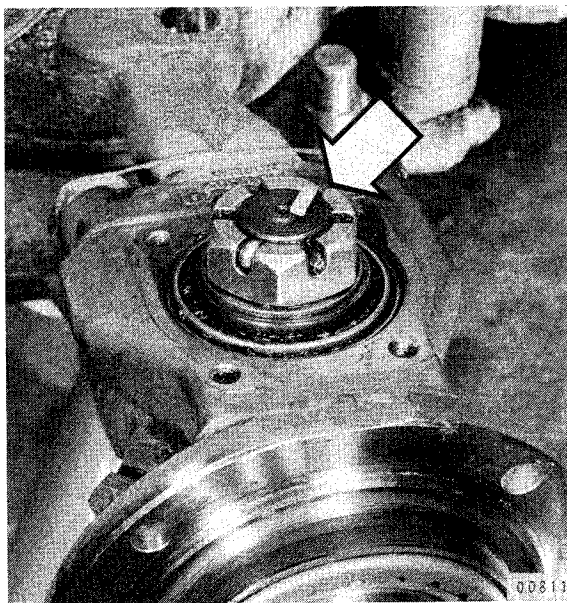
6. Take off the upper cover and wipe clean of grease.



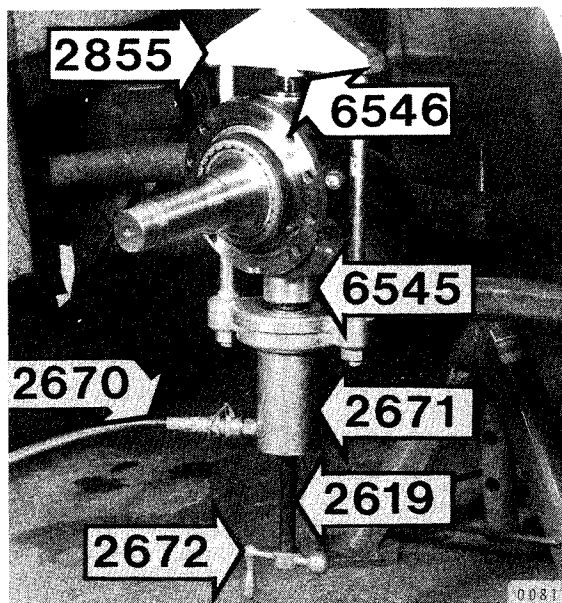
7. Take off the lower cover and wipe clean of grease.



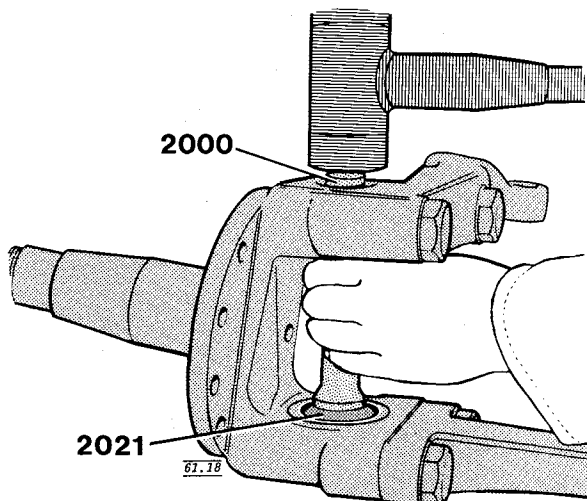
8. Remove the split pin from the king pin upper end, unscrew the nut and remove the axial washer.



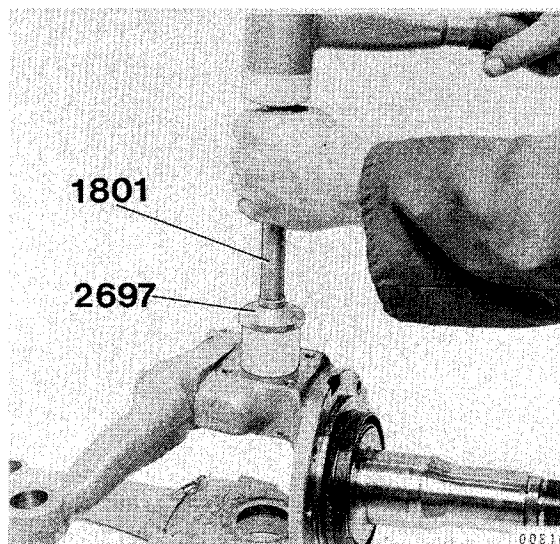
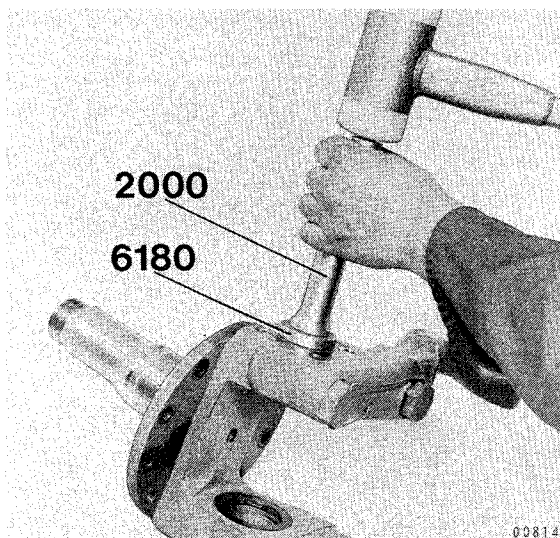
9. Press out the king pin from the front axle using press tool 2855, spindle 2619, hydraulic pump 2670 or 6222, hydraulic cylinder 2671, crank 2672, guide 6545 and press washer 6546.



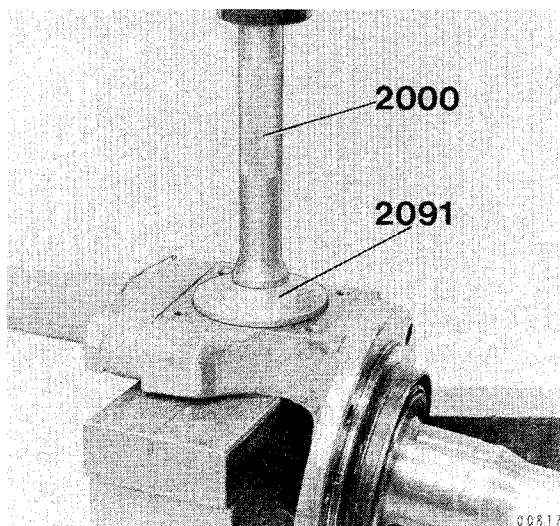
10. Remove the steering knuckle from the front axle member.
11. Remove the roller bearing with its spacer sleeve and shim.
12. Remove the lower sealing ring from the steering knuckle.
13. Tap out the upper sealing ring from the steering knuckle using standard handle 2000 and adaptor 2021.



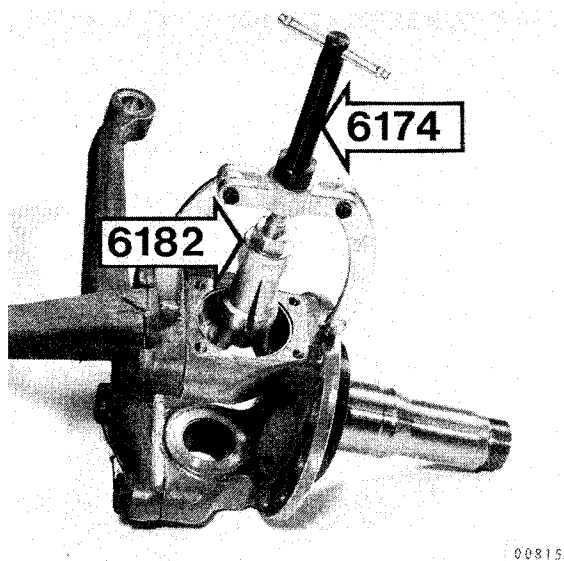
14. Tap out the plastic bushing (4) from the steering knuckle using standard handle 2000 and drift 6180.



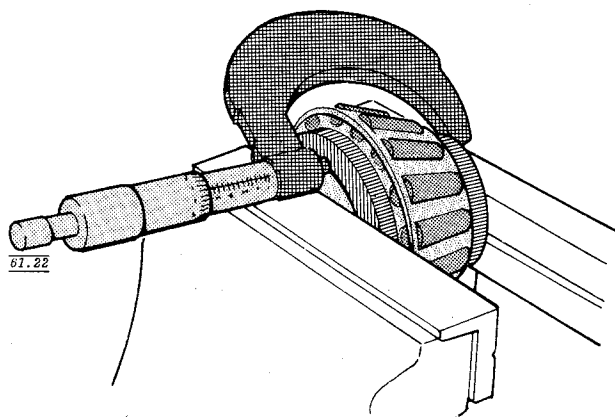
18. Press the bearing outer ring into the steering knuckle using standard handle 2000 and adaptor 2091.



15. Remove the bearing outer ring from the steering knuckle using puller 6174 and expander 6182.



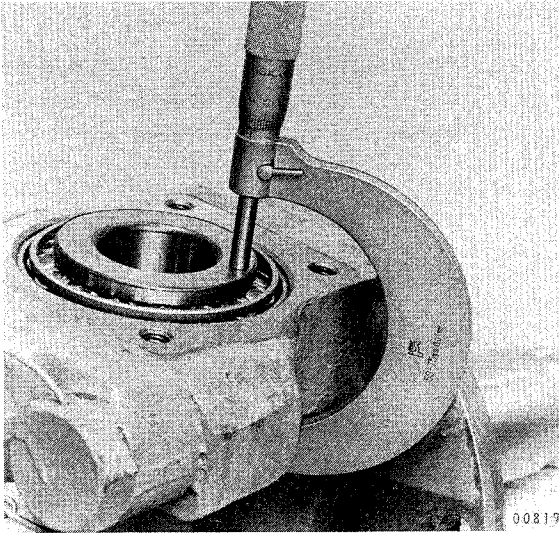
19. Compress together the old roller bearing (13) with the spacer sleeve (11) and shims (12) in a vice with soft jaws. Measure the overall thickness with a micrometer and note the measurement.



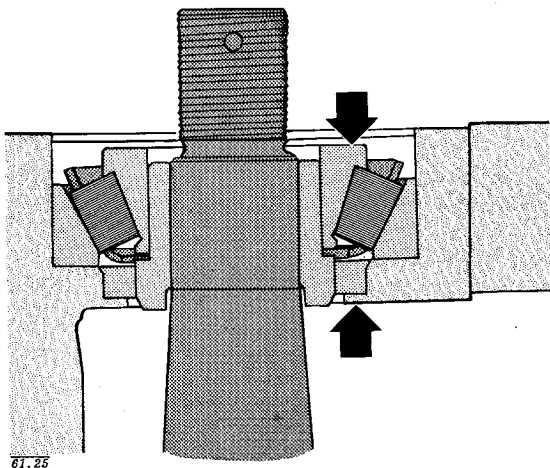
16. Remove the lubrication nipples. Replace all parts included in the king pin kit according to the parts catalogue. Clean and check other items for damage and wear.

17. Tap a new plastic bushing (4) into the steering knuckle using standard handle 1801 and adaptor 2697.

20. Compress together the new roller bearing (13) and the new spacer sleeve (11), without shims, in the same way. Measure the overall thickness with a micrometer and note the measurement. The difference between this measurement and the one in step 19 determines the thickness of the shim(s) (12) required to be placed between the new roller bearing (13) and the new spacer sleeve (11).
21. Fit appropriate thickness shim(s) according to step 20 between the roller bearing (13) and the spacer sleeve (11), compress them together in a vice with soft jaws, and measure the overall thickness with a micrometer. The measurement should now be the same as that obtained in step 19.
22. Temporarily fit the roller bearing into the steering knuckle.
23. Rotate the bearing several turns and measure the distance between the upper edge of the bearing and the lower edge of the steering knuckle. Note this measurement.

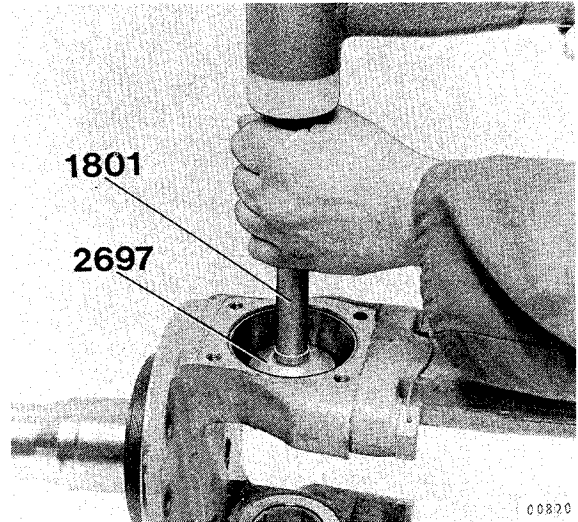


24. Deduct the measurement obtained in Step 23 from the measurement obtained in Step 21. The difference should be 0.05-0.15 mm. If not, remove or add shims between bearing and spacer sleeve until the measurement is correct.

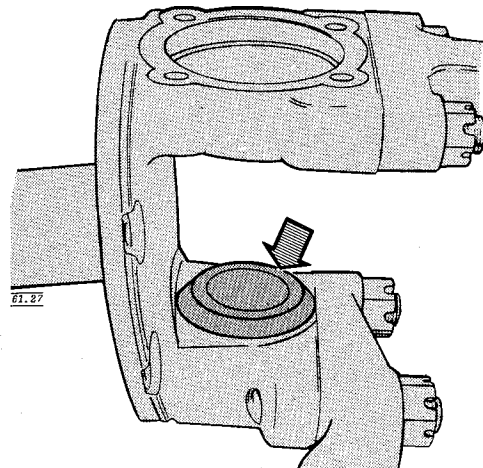


25. Remove the roller bearing (13) from the steering knuckle.
26. Tap in a new upper sealing ring (10) using standard handle 1801 and adaptor 2697.

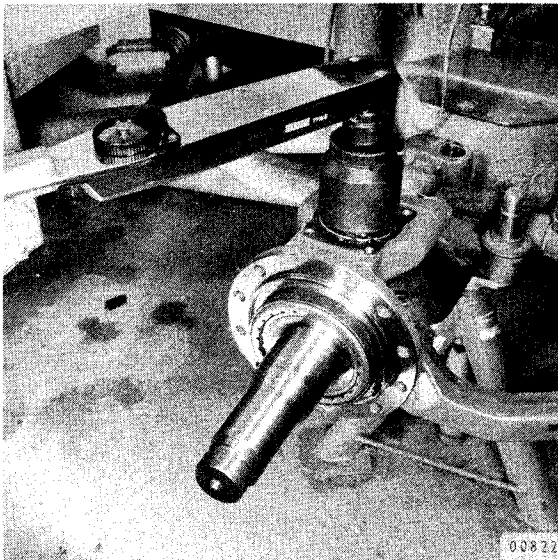
Note: The sealing ring is inverted, with the flat face facing upwards.



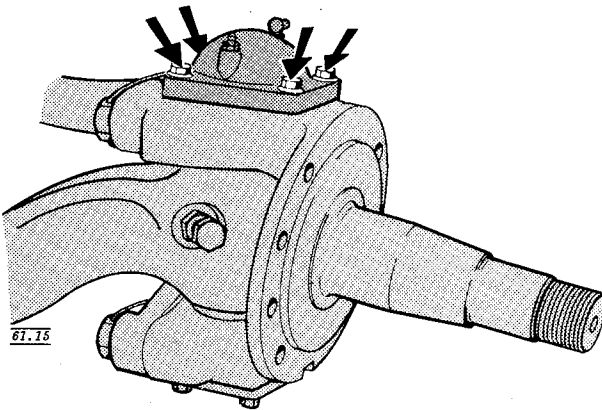
27. Grease the lower surface of the sealing ring (10) where it contacts the steering knuckle and place it in position in the steering knuckle.



28. Slide the steering knuckle on to the front axle member.
29. Grease and fit the king pin (9) and roller bearing (13) complete with spacer sleeve (11) and shim(s) (12). Place the washer (14) on the king pin and screw on the crown nut (15).
30. Tighten the nut (15) to a torque of 500 Nm (50 kgf m) and then further to the nearest split pin hole. Lock the crown nut with a new split pin (16).

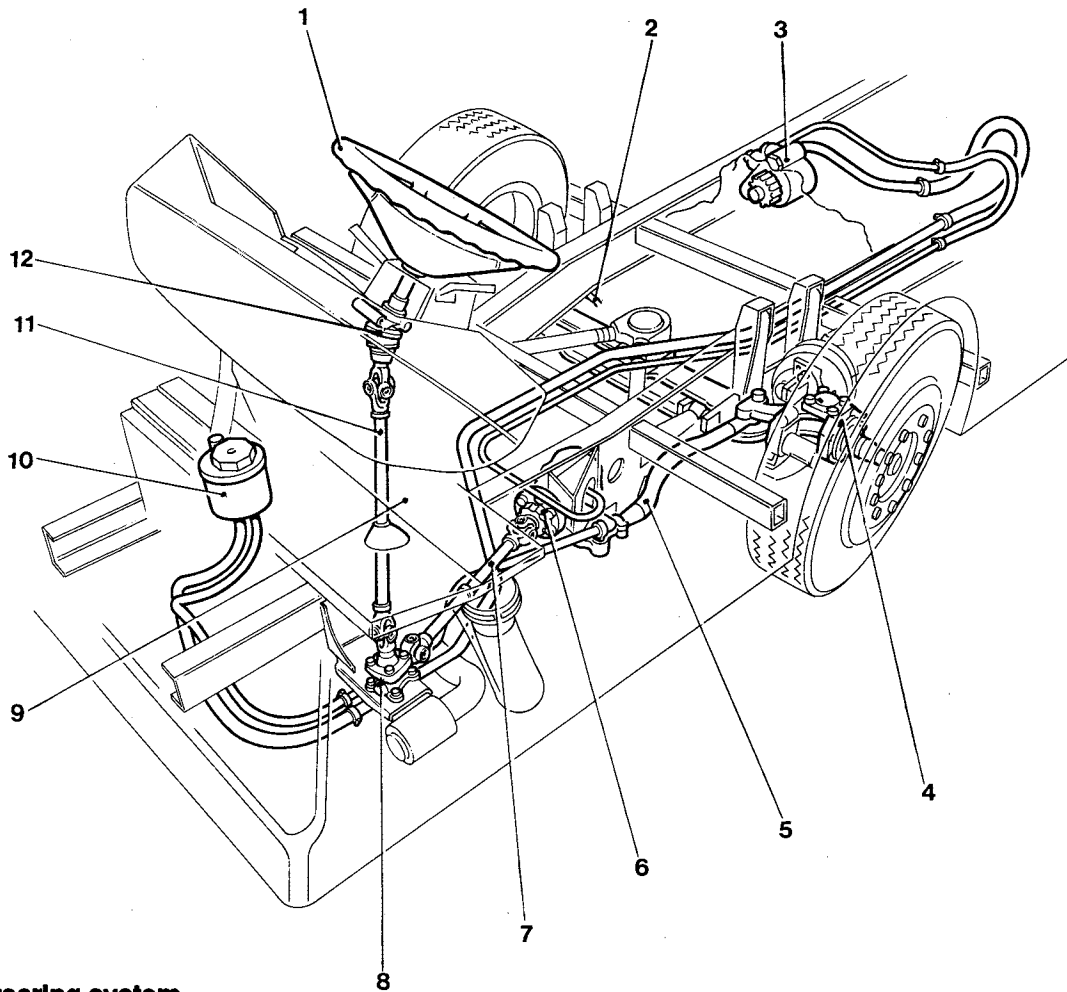


31. Fit the upper (18) and lower (21) covers together with new greased O-rings.



32. Screw in three new lubrication nipples (23).
33. Lubricate the king pin journals with grease having a lithium base with EP-additive (molybdenum disulphide), with NLGI No. 2 consistency.
34. Bolt the track rod to the steering arm (24) and tighten the nut to a torque of 200 Nm (20 kgf m) then tighten further to the nearest split pin hole. Lock the nut with a new split pin.
35. Attach the drag link to the steering arm (24) and tighten the securing nut to a torque of 350 Nm (25 kgf m) then tighten further to the nearest split pin hole. Lock the nut with a new split pin.
36. Connect the brake hose to the nipple at the frame. Press in the sender for the anti-lock brakes and clamp the cable tight.
37. Remove the protection from the wear ring.

Group 64 Steering



Front axle, steering system

- | | | | |
|---|---------------------|----|---------------------------------|
| 1 | Steering wheel | 7 | Steering shaft |
| 2 | Track rod | 8 | Angle gear |
| 3 | Servo pump | 9 | Steering column height adjuster |
| 4 | Steering knuckle | 10 | Oil reservoir |
| 5 | Drag link | 11 | Steering column |
| 6 | Power steering gear | 12 | Steering wheel tilt adjuster |

Steering system

Steering wheel movement and torque are transmitted to the steering knuckles via the power steering gear where hydraulic pressure is used to reinforce the mechanical torque from the steering column. Hydraulic pressure is obtained from the servo pump (3), which is driven by a gear from the engine and supplied with oil from an oil reservoir (10). The pump (3) delivers oil at high pressure to the power steering gear (6), where its pressure provides hydraulic power assistance before returning to the oil reservoir (10).

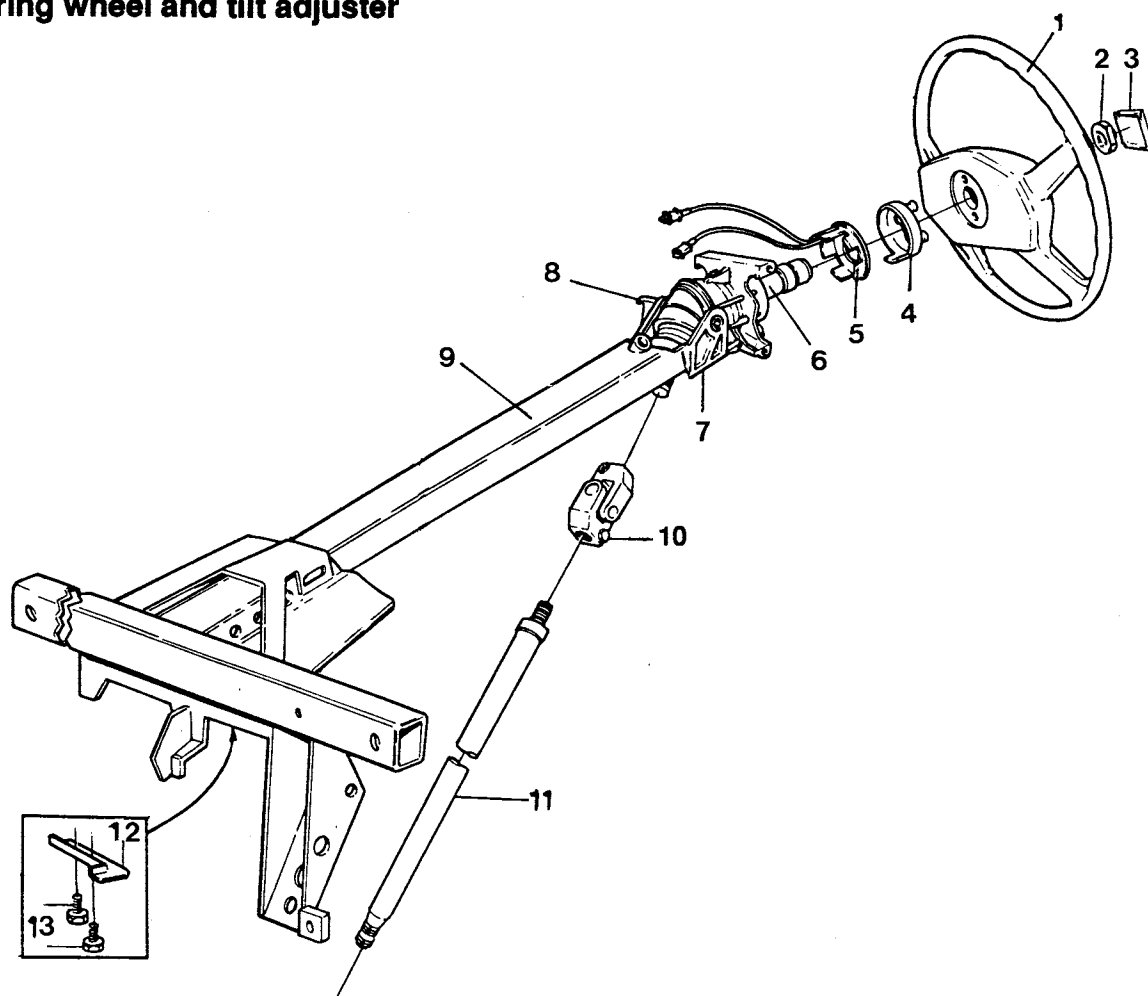
Mechanical steering power is transmitted from the steering wheel (1), through its tilt adjuster (12) and a universal joint to the power steering gear (6) via the steering column (11), its angle gear (8), the steering shaft (7) and universal joints.

Mechanical hydraulically-assisted steering power goes from the power steering gear (6) via the drag link (5) out to the left hand wheel steering knuckle's (4) steering arm. The movement is transmitted via a track rod (2) to the steering arm on the right hand wheel steering knuckle.

The height of the steering column can be altered by means of the height adjuster (9), operated by a foot pedal. Steering wheel tilt is adjusted by a hand lever operated tilt adjuster (12).

Steering wheel and steering column

Steering wheel and tilt adjuster



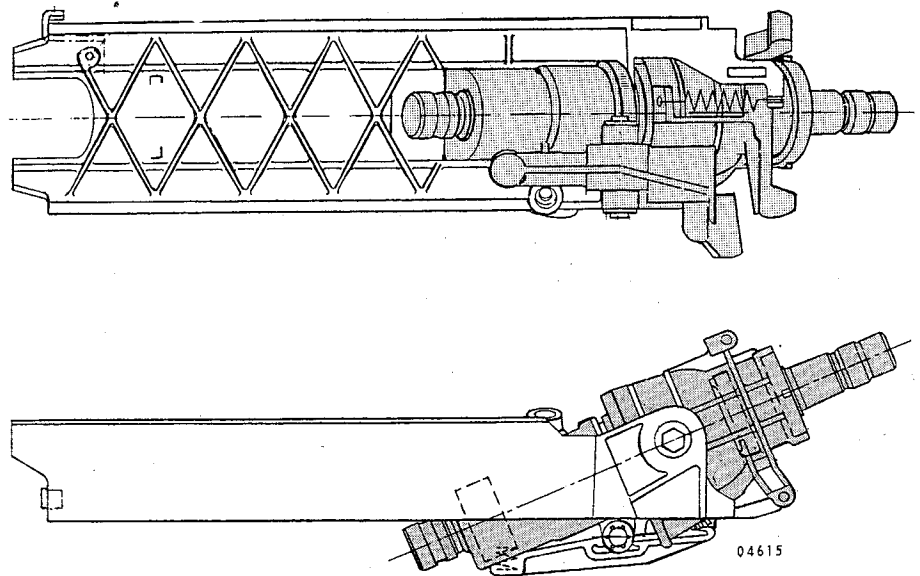
Steering wheel and column components

1	Steering wheel	6	Tilt adjuster input shaft	10	Universal joint
2	Nut	7	Tilt adjuster pivot pin	11	Steering column
3	Cover	8	Tilt adjuster lever	12	Bracket
4	Dir. indicators reset ring	9	Bracket	13	Bolts
5	Horn ring				

The steering wheel (1) is secured by a nut (2) under a cover (3) to splines at the end of a short shaft (6) which is the input to the tilt adjuster. The lower end of the tilt adjuster is connected to the steering column (11) via a universal joint (10).

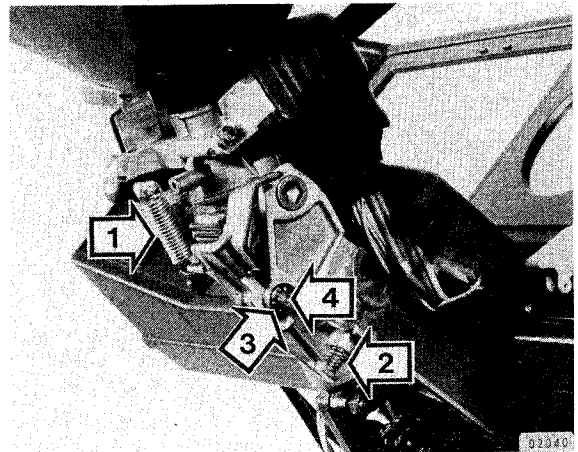
The tilt adjuster adjusts the steering wheel towards/away from the driver, and the complete assembly is pivoted on a pin (7) in a bracket (9) which is secured at its lower end by another bracket (12) and bolts (13) to the bus frame. The tilt mechanism is in the form of a clamp, operated by a hand lever (8).

The direction indicator stalk is returned to its neutral position by a projection on a ring (4). Below this ring is another (5), which carries the horn button electrical connections.



Tilt adjuster components

- 1 Spring
- 2 Lower cover
- 3 Lock ring
- 4 Pivot pin

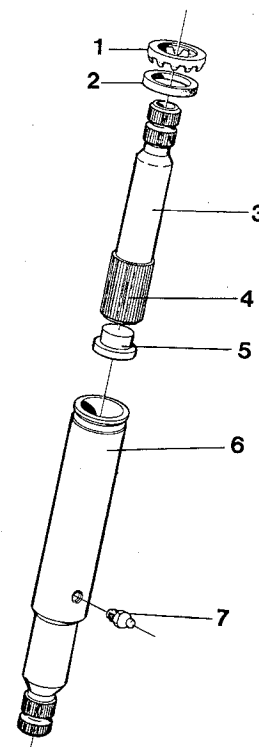


Steering column

The steering column, below the tilt adjuster universal joint, consists of a shaft assembly with two sections, upper (3) and lower (6). The two sections are held together by a retainer (1) and seal (2) which fit into the top of the hollow lower steering shaft (6). Torque is transmitted from the upper shaft to the lower shaft by splines (4) which allow vertical relative movement, and can be lubricated by means of a nipple (7) in the side of the lower shaft. A pedal-operated height adjuster acts on the lower steering column, allowing it to move vertically when the height is to be adjusted.

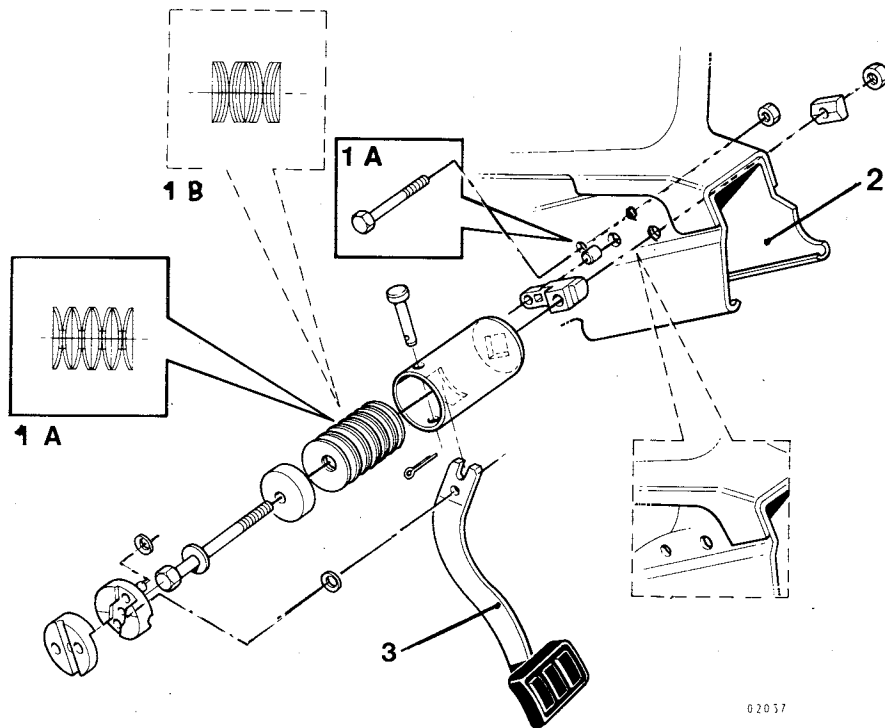
Steering column components

- 1 Retainer
- 2 Seal
- 3 Upper steering shaft
- 4 Splines
- 5 Plug
- 6 Lower steering shaft
- 7 Lubricating nipple



Steering column height adjuster

The lower steering column is normally clamped in its vertical location by a foot-pedal operated height adjuster. If the column needs to be moved up or down, pressure on the foot pedal releases the clamping spring (1) or (2) (there are two different spring versions), allowing vertical movement. When the pedal is released the springs clamp the column firmly in its current position.



Steering column height adjuster components

- 1A Clamping spring and screw (late version)
- 1B Clamping spring and screw (early version)
- 2 Pedal and steering wheel bracket
- 3 Operating pedal

Angle gear

The angle gear is of the straight toothed bevel type. Turning the steering wheel transfers power to the output shaft (19) through both the bevel gears.

The input shaft (2) is journalled at its upper end in a needle bearing (11) and in a ball bearing (5) at the lower end, which can be adjusted by using a different thickness support washer (4).

The output shaft journals comprise two ball bearings (18 and 20) and a needle bearing (15).

For adjusting to correct backlash there are shims (8) between the cover (9) and the gear housing (1), and also an adjusting washer (17) (available in different thicknesses) on the output shaft between the ball bearing (18) and the gear housing. The other output shaft ball bearing (20) is adjusted by means of the adjusting nut (24).

The angle gear is lubricated by ATF type oil. The oil filler and level plug (10) is screwed into the filter hole in the cover.

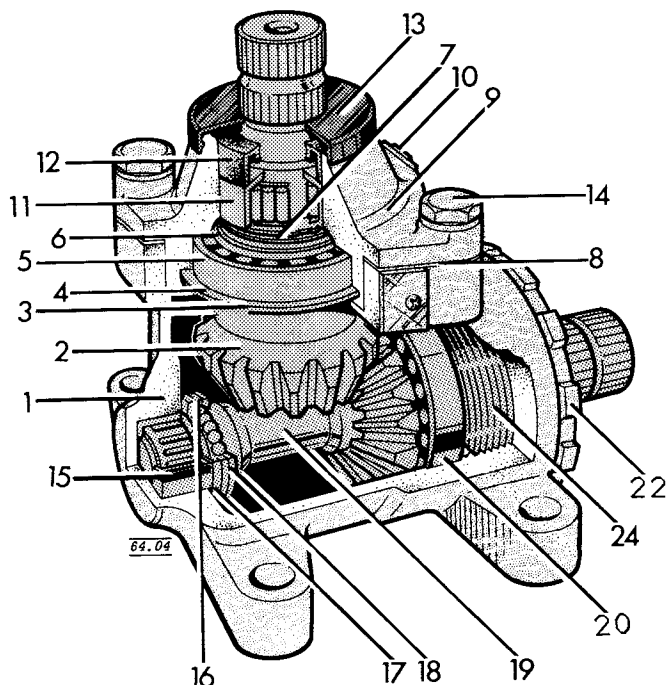
Steering shaft

The steering shaft is a torque rod which transmits steering torque from the angle gear output shaft to the input shaft of the power steering gear. It is tubular and splined at both ends to allow a small amount of axial movement. Universal joints at each end of the shaft provide the connections to the angle gear and power steering gear. The splines and universal joints are grease-lubricated.

Normal control B10M RHD and LHD buses have individual steering shafts, right- and left-handed. Forward control B10M buses have a longer but similar shaft.

Angle gear components

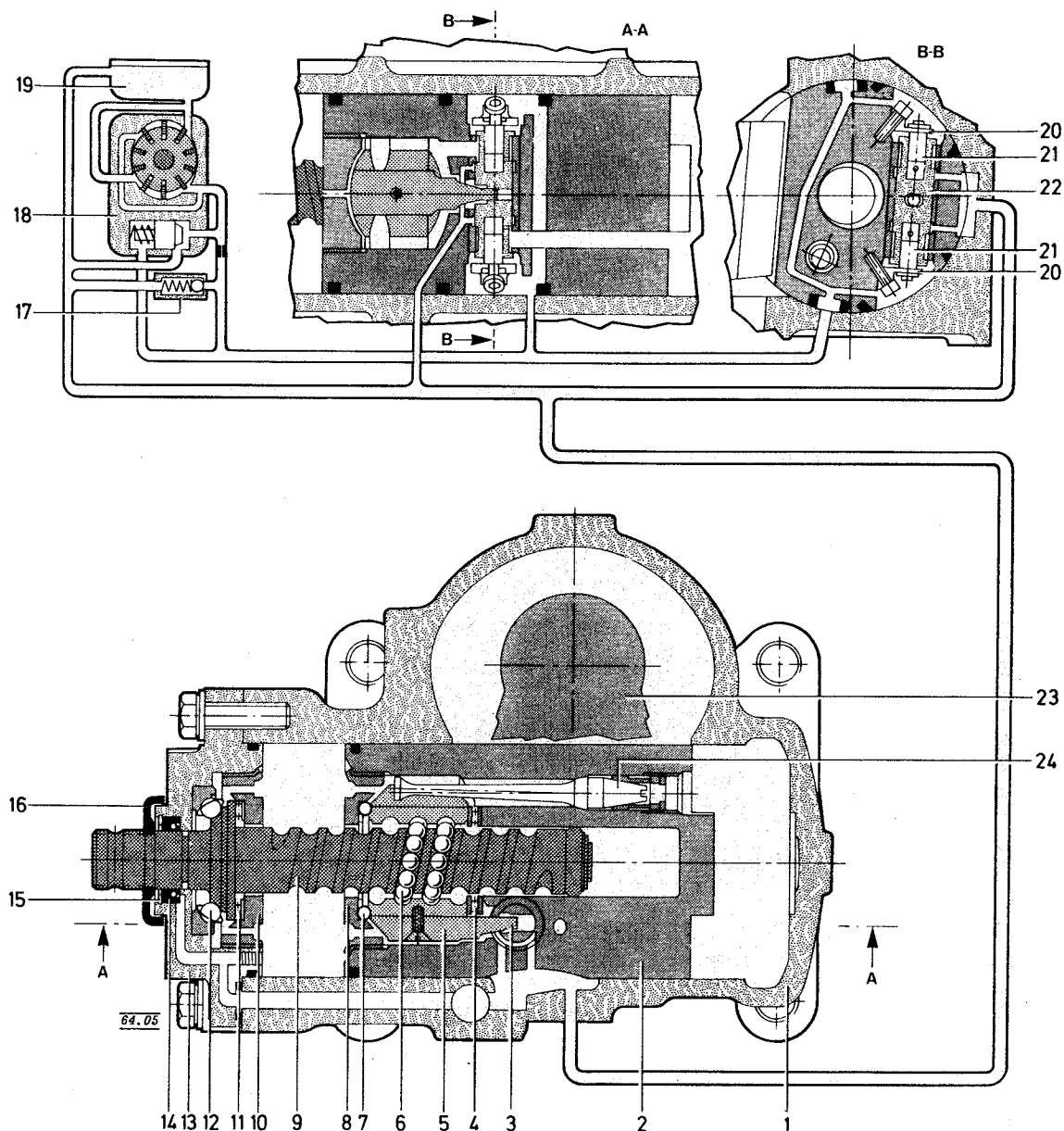
- 1 Angle gear housing
- 2 Input shaft
- 3 Circlip
- 4 Support washer
- 5 Input shaft ball bearing
- 6 Support washer
- 7 Circlip
- 8 Shims
- 9 Cover
- 10 Oil filler and level plug
- 11 Needle bearing
- 12 Sealing ring
- 13 Dust cover
- 14 Bolt (M10 x 40)
- 15 Needle bearing
- 16 Circlip
- 17 Adjusting washer
- 18 Output shaft ball bearing
- 19 Output shaft
- 20 Output shaft ball bearing
- 21 Adjusting nut
- 22 Lock nut



Power steering gear

The power steering gear transmits both mechanical and hydraulically-assisted steering wheel torque to the drag link and steering knuckles.

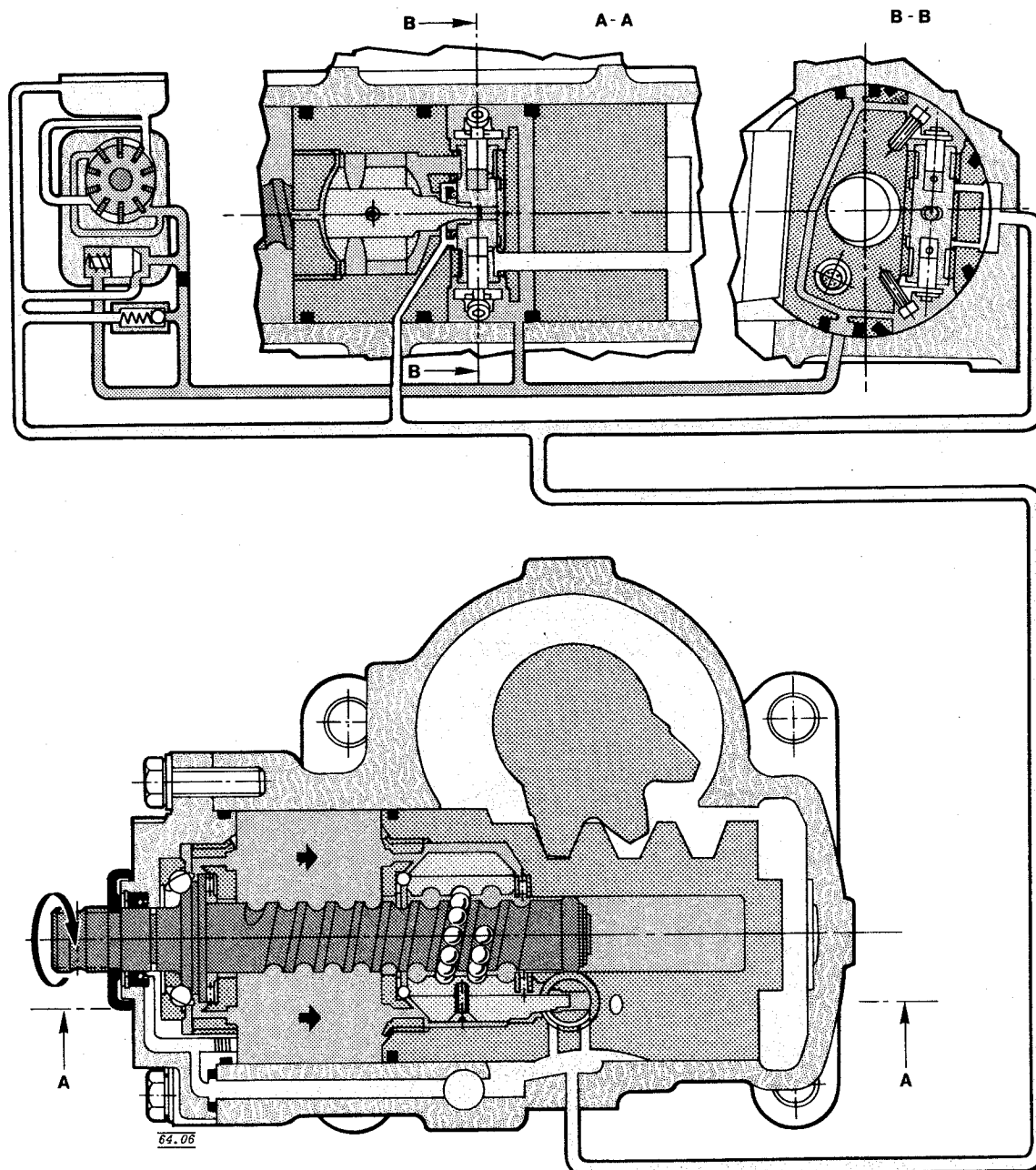
In the event of failure in the hydraulic system or if the oil supply should cease, the steering gear functions mechanically. However, under such circumstances the bus steering will feel very heavy.



Power steering gear ZF 8043

Steering valve in neutral position

- | | | |
|-------------------------|-------------------|--------------------------|
| 1 Steering gear housing | 9 Worm | 17 Safety valve |
| 2 Operating piston | 10 Eye nut | 18 Servo pump |
| 3 Steering pin | 11 Needle bearing | 19 Oil reservoir |
| 4 Needle bearing | 12 Ball bearing | 20 Retainer |
| 5 Ball nut | 13 Cover | 21 Reaction piston |
| 6 Balls | 14 Sealing ring | 22 Steering valve piston |
| 7 Ball bearing | 15 Circlip | 23 Sector shaft |
| 8 Eye nut | 16 Dust cover | 24 Torsion rod |



Steering wheel turned to the right

Item numbers in the text refer to the figure on the previous page

The steering gear housing (1) has an internal cylinder in which the operating piston (2) slides. The top side of the piston is in the form of a rack, which meshes with the sector shaft (23) teeth. When the steering wheel is turned, the worm (9) and ball nut (5) mechanism moves the operating piston to left or right. This movement is transferred to the sector shaft (23) which turns the external pitman arm.

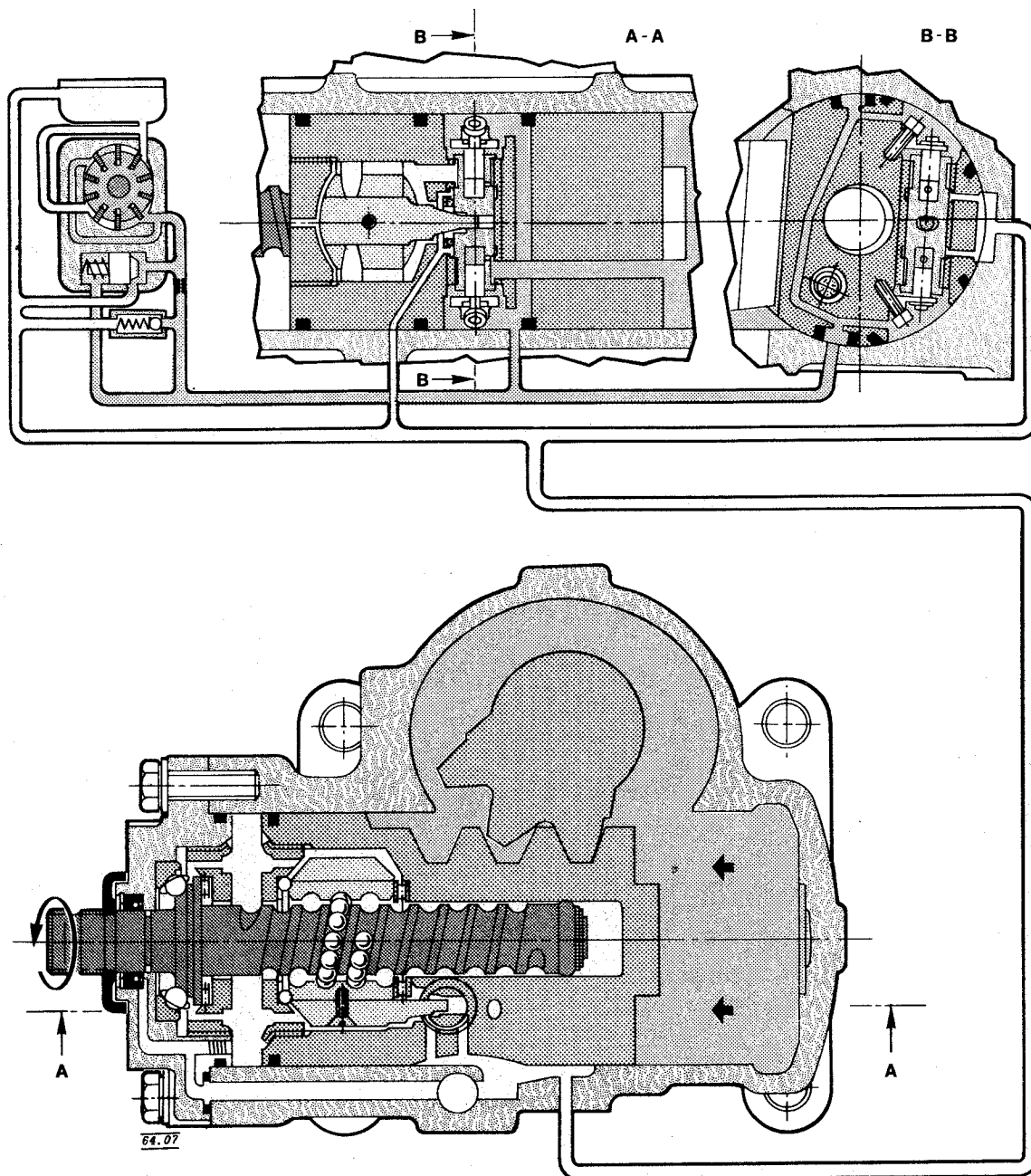
The ball nut (5) and steering valve mechanism, consisting of a steering valve piston (22), two reaction pistons (21) and a torsion rod (24), are all contained inside the operating piston (2).

The steering valve piston (22) slides in a bore drilled in the operating piston (2). Both the reaction pistons (21) are secured to the operating piston by means of retainers (20). Each reaction piston is made up of an outer and inner piston. The torsion rod (24) has a tension fit

in the operating piston (22) and its lower section runs free in a groove in the ball nut (5).

Hydraulic power aids mechanical steering movement only when the steering valve piston (22) is displaced from its neutral position.

Turning the steering wheel generates torque which is transmitted via the worm (9) and the balls (6) to the ball nut (5). The ball nut turns once the resistance of the torsion rod (24) has been overcome. The turning movement of the ball nut (5) is transmitted to the steering valve piston via the steering pin (3). When the steering valve piston (22) is moved in one direction, pressurized oil flows to one end of the operating piston (2) to aid the movement. If the steering wheel is turned right, the operating piston is pushed to the right; and if the steering wheel is turned left, the operating piston is pushed to the left.



Steering wheel turned to the left

In spite of the fact that the power steering provides considerable assistance to the driver, road "feel" is still available due to the reaction pistons (21), which operate as follows.

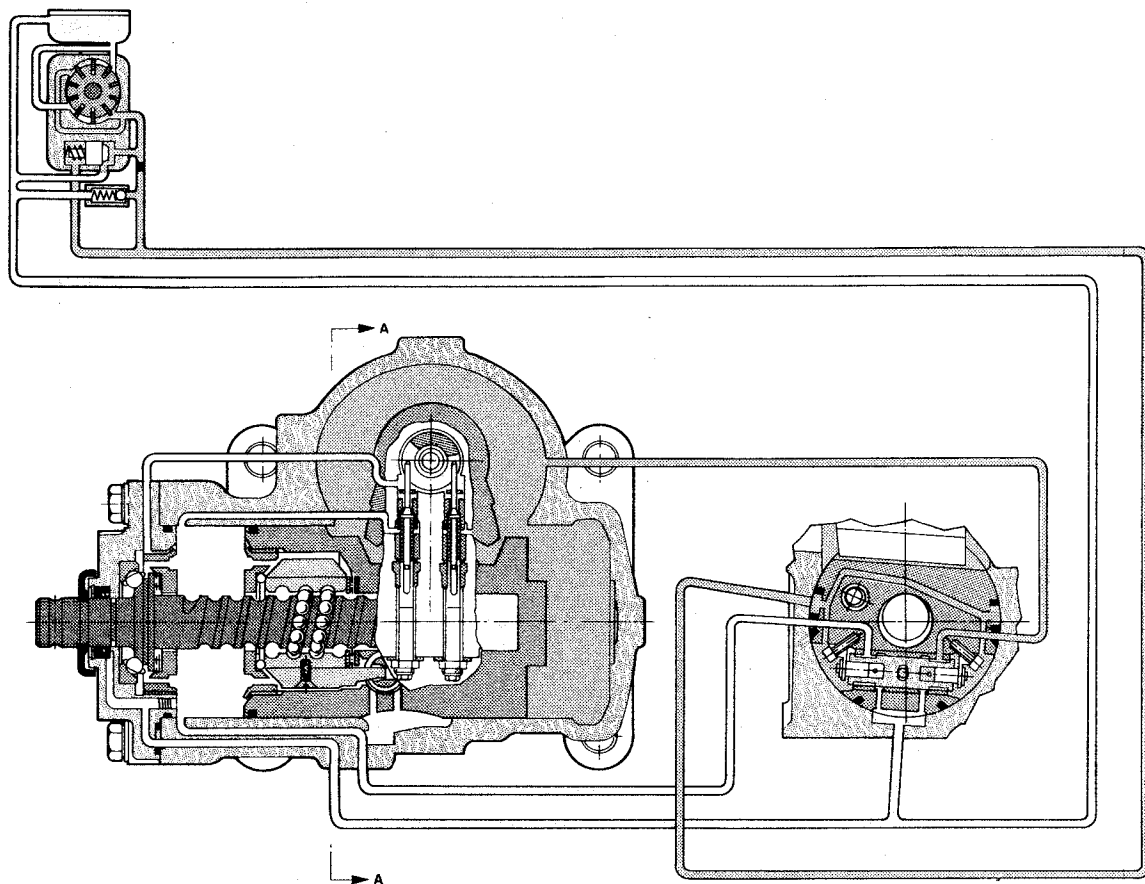
With the steering valve piston (22) in the operating position, oil under pressure reaches the inner piston area of one of the reaction pistons (21), and also the corresponding surface on the steering valve piston (22). Because the reaction pistons (21) cannot move, being held in a fixed position, the steering valve piston (22) tries to return to the neutral position.

The result is that the greater the frictional resistance to turning between the wheels and the ground during the steering operation, the higher the oil pressure in the power steering system and the greater the force re-

quired in order to push the steering valve piston away from the neutral position. This is known as "hydraulic retraction".

The presence of an inner reaction piston further reinforces hydraulic retraction. Pressurized oil flows through a hole in the outer reaction piston and in behind the inner piston to push it out and in doing so exerts further pressure on the steering valve piston.

When the left or right turn of the steering wheel is completed, the ball nut (5) returns to its initial position, thereby activating the torsion rod (24), which moves the steering valve piston (22) back to the neutral position. Because the torsion rod is not completely straight, the steering valve piston centre position (hydraulic steering balance) adjusts when the torsion rod turns.

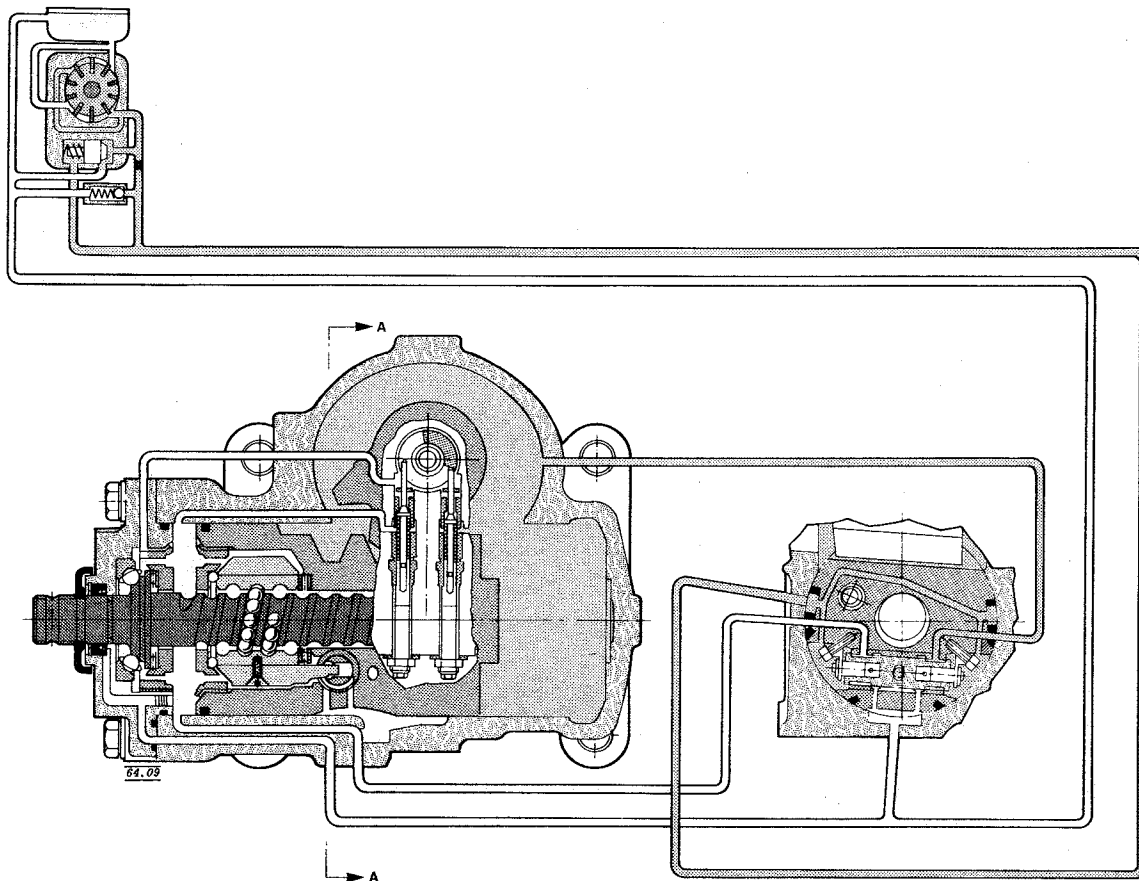


Both unloading valves closed

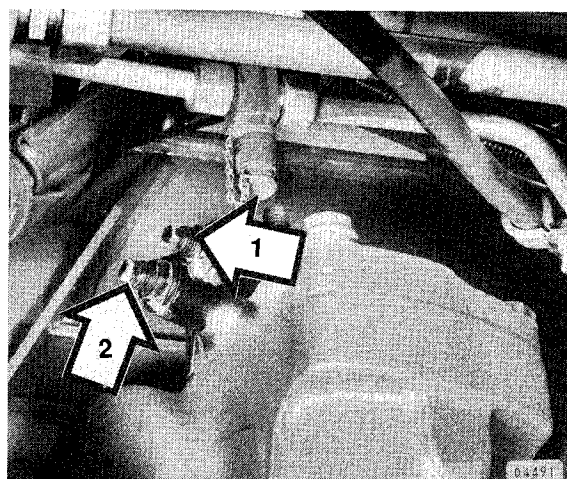
The steering gear is provided with an unloading mechanism which reduces pressure in the servo cylinder immediately before the operating piston (2) reaches one or other of its end positions. This prevents the servo pump (18) from being overloaded at full wheel lock.

The unloading valves are placed in the side cover. Each valve has a cone which normally closes the connection between the pressure side and the return oil drilling.

As the sector shaft turns and approaches one of the end positions, the appropriate (front or rear) valve cone is lifted from its seat by an abutment on the sector shaft, and opens the bypass connection between the pressure side and the return oil drilling. This reduces the oil pressure in the power steering system.



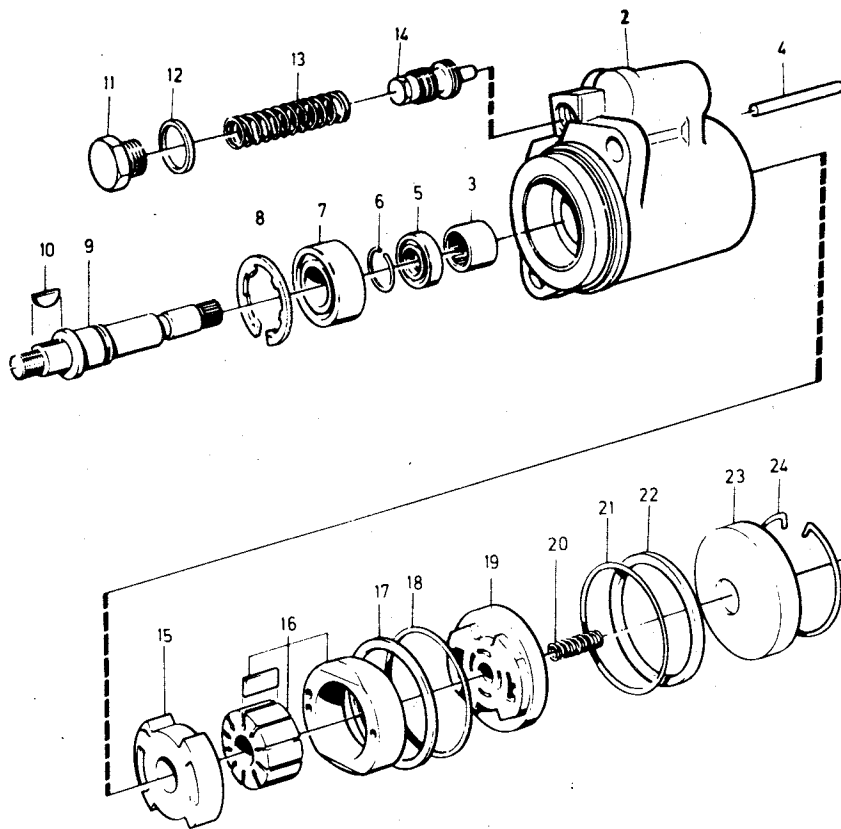
Rear unloading valve open, oil pressure considerably reduced



Unloading valves

- 1 For steering wheel lock left
- 2 For steering wheel lock right

Servo pump



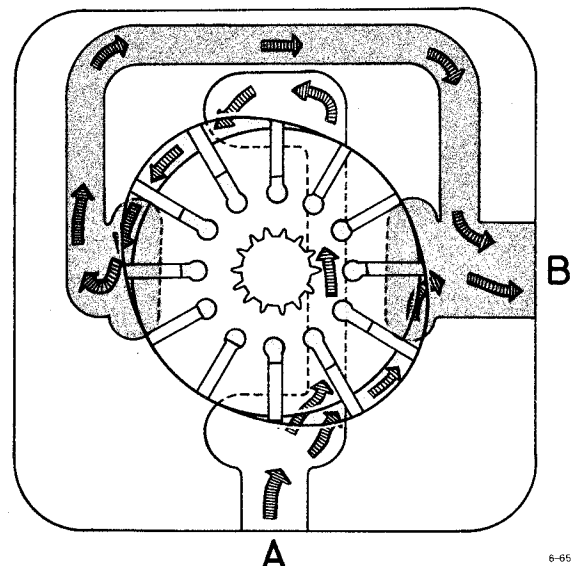
Servo pump components

- 1 Oil pump complete
- 2 Body
- 3 Needle bearing
- 4 Pin
- 5 Sealing ring
- 6 Lock ring
- 7 Ball bearing
- 8 Circlip
- 9 Shaft
- 10 Key
- 11 Plug
- 12 Sealing ring
- 13 Spring
- 14 Control valve piston
- 15 Plate
- 16 Rotor assembly
- 17 Support ring
- 18 Rubber ring
- 19 Plate
- 20 Spring
- 21 O-ring
- 22 Support ring
- 23 Cover
- 24 Circlip

The vane type servo pump is driven by a gear from the engine.

The rotor assembly (16) has ten movable vanes slotted into and rotated by a cylindrical rotor block, with the complete vane assembly enclosed by a housing. As the block rotates a combination of centrifugal force and oil pressure presses the vanes against the housing walls.

The interior contour of the rotor housing is oval, hence the cross-sectional area between the rotor, the rotor housing wall and any two of the vanes changes as the rotor turns. When a pair of vanes move from the suction side to the pressure side, the area between them first increases, causing oil to be drawn into the space. Once the connection with the suction side has been passed, the space between the vanes meets a connection to the pressure side instead. As the area between the vanes then decreases, the pressure rises and oil is forced out into the discharge drilling. The pump has two intake and two discharge drillings, to provide double capacity.



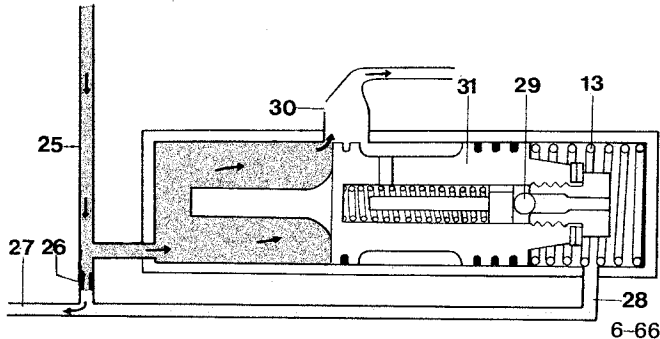
Oil circulation in the pump

- A Inlet
B Outlet

The pump housing contains a control valve which regulates the oil flow and maximum pressure.

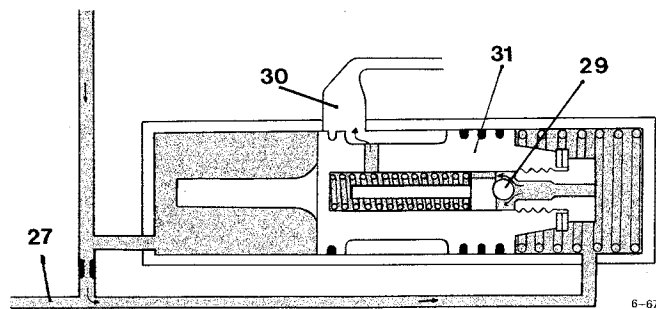
At the beginning of pump operation, the spring (13) presses the control valve piston (31) to the left. Oil at pump pressure passes through the pressure drilling (25) via the orifice valve (26), out into the delivery line (27), and then to the steering gear. The connection drilling (28) ensures that the space to the right of the control valve has pump delivery pressure, since it is connected to the delivery line (27).

There is a difference in pressure at either side of the orifice valve (26), which causes the pressure on the left-hand side of the control valve piston to be higher than that in the delivery line (27) and to the right of the piston. When the spring (13) pressure has been overcome, the piston moves to the right. This happens when the pump is delivering sufficient pressure, and the piston movement allows surplus oil to flow back to the inlet side of the pump. The spring is designed to allow a small bypass flow to occur during normal operation, with the pump supplying just less than its maximum capacity.



Control valve in normal position

- 13 Spring
- 25 Pressure drilling
- 26 Orifice valve
- 27 Delivery line
- 28 Connection drilling
- 29 Safety valve
- 30 Return drilling
- 31 Control valve piston



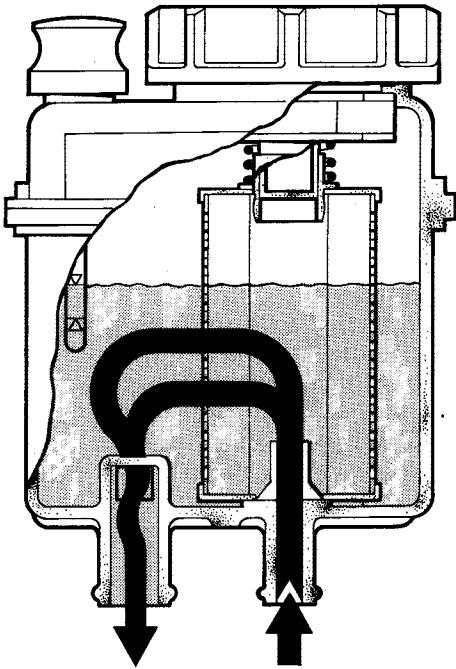
Control valve, maximum pressure condition

If the flow of pump delivery oil stops completely, for example because the wheel is blocked, the pressure in the line (27) will rise, cancelling out the difference in pressure across the control valve piston (31). The spring will then push the valve to the left, closing the return drilling connection so that the pressure increases even more.

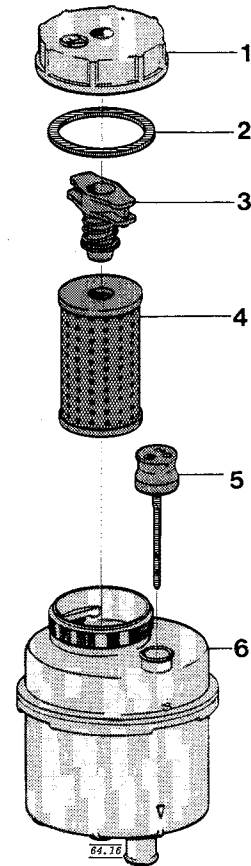
If the pressure continues to rise until it reaches maximum pump pressure, it exceeds the safety valve (29) spring pressure. This valve is located inside the control valve piston, and when it opens oil is allowed to flow to the return drilling (30) by this alternative path, limiting the maximum possible pressure. The reduction in pressure on the right-hand side of the piston means that the piston (including the safety valve) moves to the right to open the normal return drilling connection.

When the pressure has dropped to normal, the safety valve (29) closes and the control valve piston (31) returns to its normal position.

Oil reservoir and filter

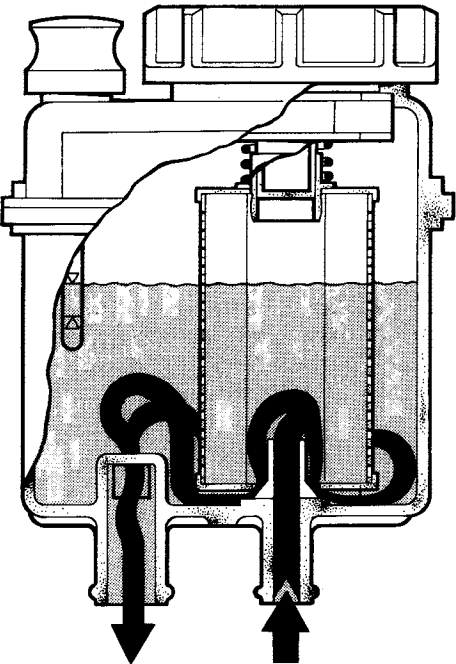


Normal oil flow



Oil reservoir and filter

- 1 Cap
- 2 Sealing ring
- 3 Filter retainer
- 4 Oil filter
- 5 Dipstick
- 6 Oil reservoir



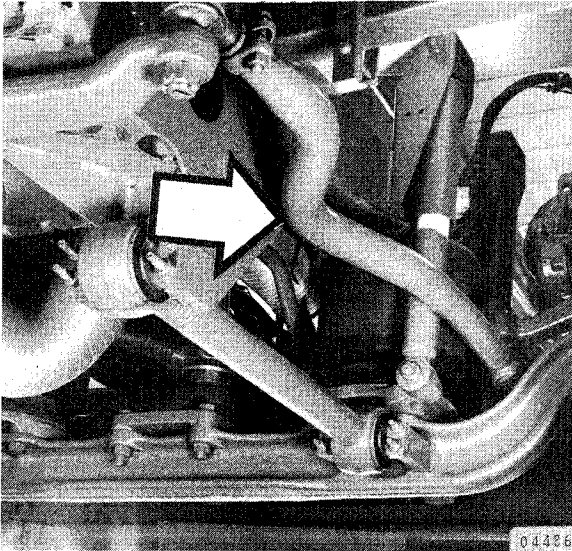
Overflow valve operation

The oil reservoir houses a filter (4), through which oil returning from the power steering system passes, from the inside of the filter to the outside, where it enters the reservoir. Due to the fact that the oil first passes through the power steering system and then through the filter, there is less risk of the pump sucking in air.

The filter reservoir includes an overflow valve. If the filter becomes clogged, the increase in oil pressure overcomes the spring washer pressure and forces the filter off its seat. This permits oil to flow directly from the inlet port into the reservoir without going through the filter.

A dipstick allows the oil level in the reservoir to be checked.

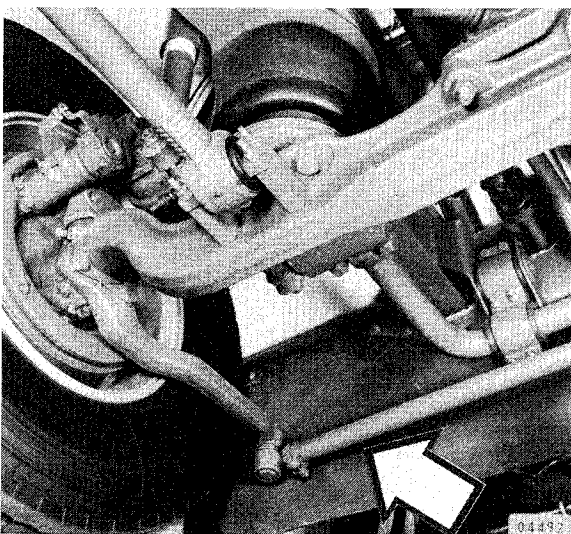
Drag link, track rod with ball joints



Drag link

The drag link transmits steering wheel movement and steering power from the power steering pitman arm to the steering arm connected to the steering knuckle.

The drag link consists of a tubular-shaped rod with a fixed ball joint at one end and a replaceable one at the other. The replaceable ball joint is screwed into the end of the drag link and locked with a clamp. The length of the drag link can thereby be adjusted when adjusting the steering.



Track rod

The track rod transmits steering wheel movement and the steering power from the steering knuckle on the steering side to the steering knuckle on the other side of the vehicle.

It is tubular in shape and has a replaceable ball joint at either end. The joints are screwed into the track rod with right- and left-handed threads and locked with a clamp. The length of the track rod can thus be adjusted by slackening the clamps and rotating the rod in order to get correct toe-in.

Service Procedures

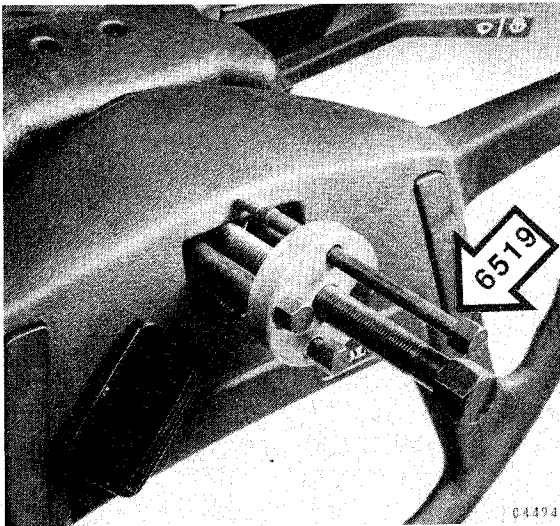
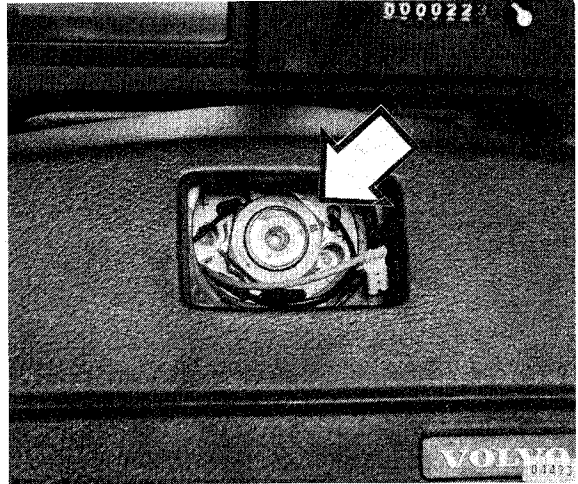
Steering wheel

Removal

Special tool:

999 6519 Steering wheel puller

1. Position the bus so that the front wheels point straight ahead.
2. Switch off the electrical system with the battery master switch.
3. Use a screwdriver to lever off the cover from the centre of the steering wheel.
4. Ensure that the steering is positioned so that the steering wheel spokes are parallel to the lower edge of the instrument panel. If the steering wheel is being removed for some other reason than to change its alignment with the tilt adjuster input shaft, make marks on both the steering wheel hub and the tilt adjuster input shaft before separating them, so that the wheel can be replaced in exactly the same position. Note that the end of the tilt adjuster shaft may already be punch-marked, as shown in the illustration. Unscrew the steering wheel nut and pull off the steering wheel using puller 6519.



Installation

1. Line up the marks made on the steering wheel hub and the tilt adjuster input shaft, made in step 4 of the steering wheel removal procedure above, unless a new steering wheel is to be fitted, in which case mount the steering wheel on the steering shaft splines with the steering wheel spokes parallel to the instrument panel.

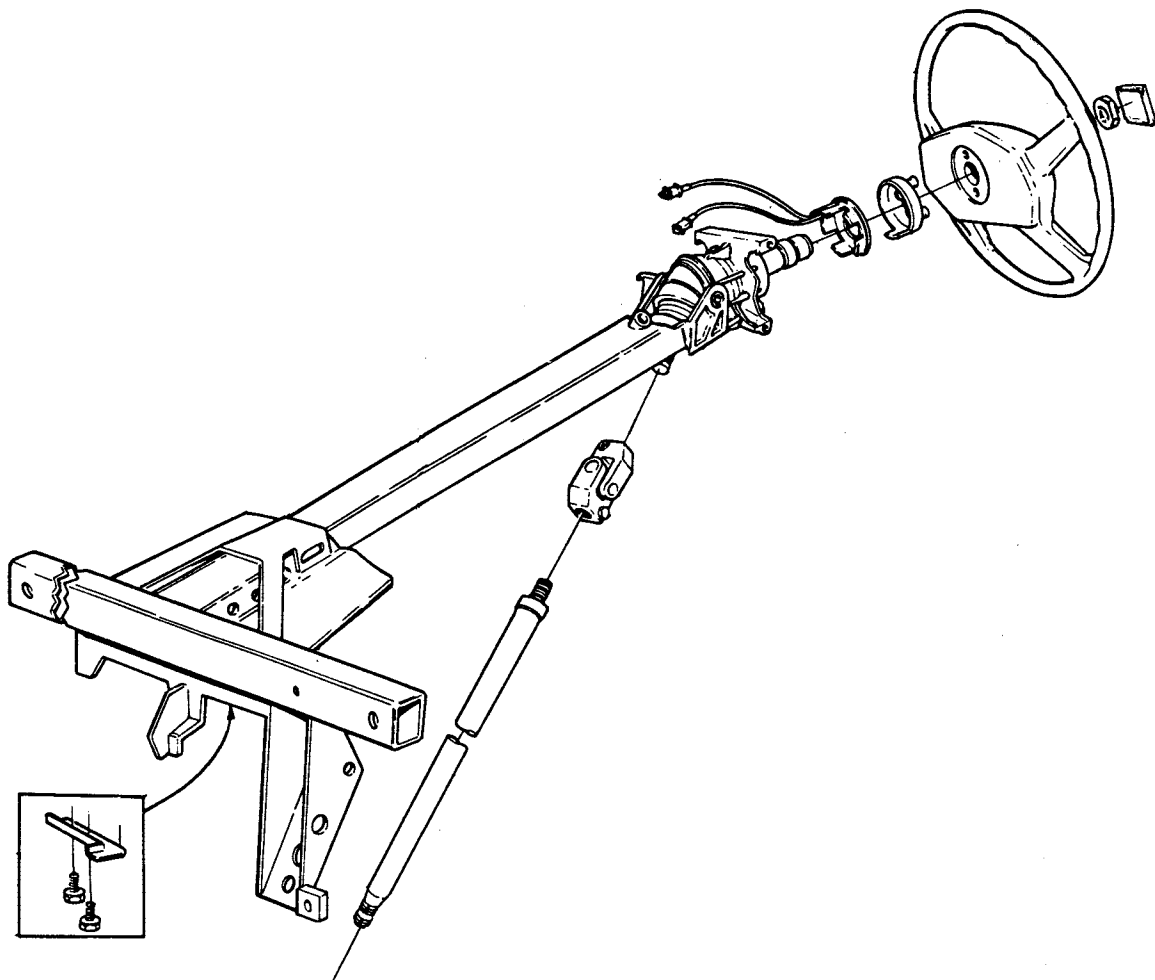
2. Fit and tighten up the steering wheel nut to a torque of 75 Nm.
3. Snap the steering wheel centre cover into position.

Tilt adjuster

NOTE: If the tilt adjuster is damaged it cannot be repaired but must be replaced as a complete unit.

Removal (Steering wheel removed)

1. Use the height adjuster to set the steering column to its most upright position.
2. Remove the four sections of plastic casing surrounding the tilt adjuster and steering column, by removing their securing screws.
3. Remove the stalk levers from the top of the steering column.
4. At the top of the steering column, slacken the clamp bolt clamping the upper end of the universal joint to the output shaft stub at the bottom of the tilt adjuster.
5. Remove the bolts securing the steering column bracket to the bus frame. Lift off the complete bracket and tilt adjuster assembly.
6. Clean all the parts and inspect for distortion or damage.



Installation

1. Position the tilt adjuster assembly so that the lower end of the steering column bracket is aligned with the bus frame, insert the securing bolts and tighten.
2. At the top of the steering column, slide the universal joint on to the splines of the output shaft stub at the bottom of the tilt adjuster. Tighten the clamp bolt to 30 ± 5 Nm
3. Fit and secure the stalk levers at the top of the steering column.
4. Install and secure the four sections of plastic casing surrounding the tilt adjuster and steering column.
5. Make the electrical connections for the stalk levers and the horn ring.

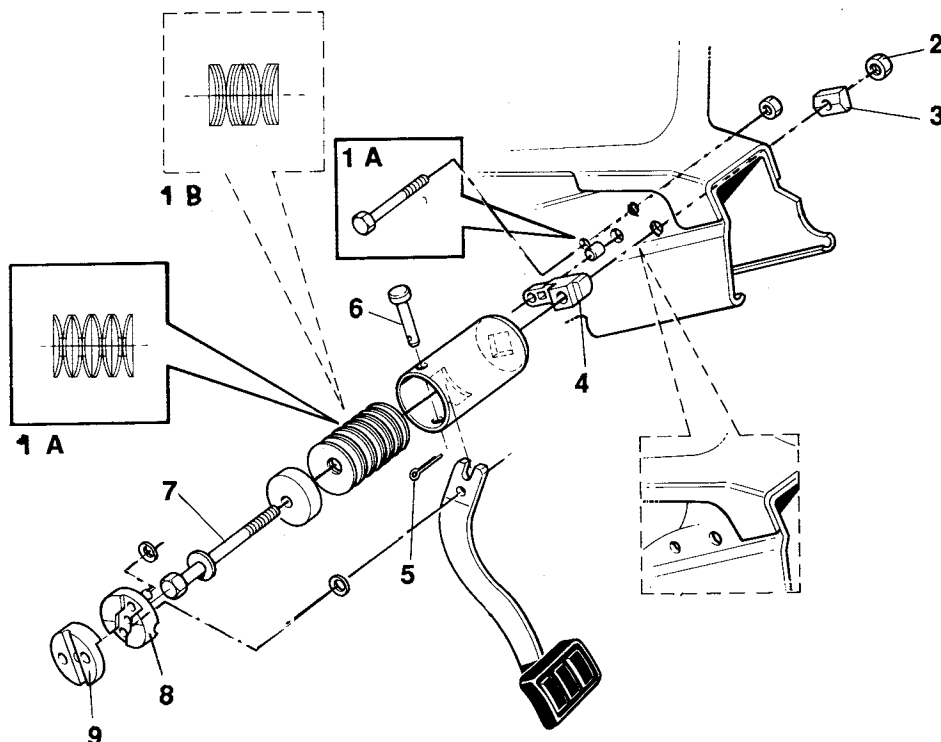
Universal joints

There are four universal joints in the steering system. The procedure for replacing the universal joint nearest the steering wheel is similar to steps 1 to 4 inclusive in the tilt adjuster removal instructions. Note that the lower clamp bolt for this universal joint should be tightened to 46 ± 5 Nm, whereas the upper clamp bolt tightening torque is 30 ± 5 Nm.

Replacement of the other universal joints is straightforward, and the clamp bolts for all must be tightened to 46 ± 5 Nm.

Steering column height adjuster

There are two versions of height adjuster. The 12 compression spring discs in the later version (1A) differ from the earlier version (1B) in that they are stacked differently relative to each other, and are pre-compressed by an M8 screw (7) passing through the steering console, as shown in the illustration.

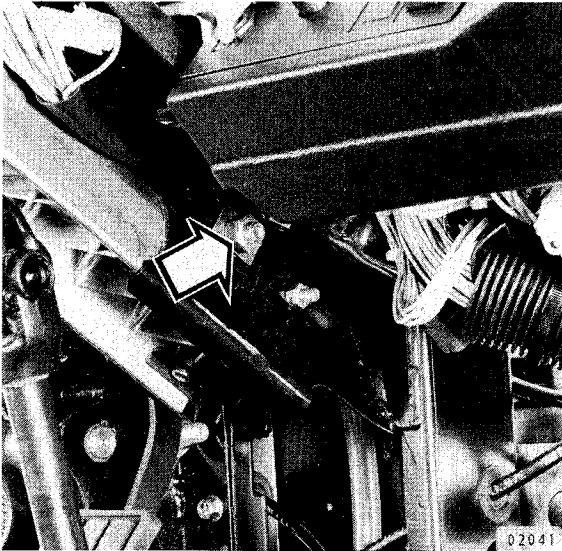


Steering column height adjuster components

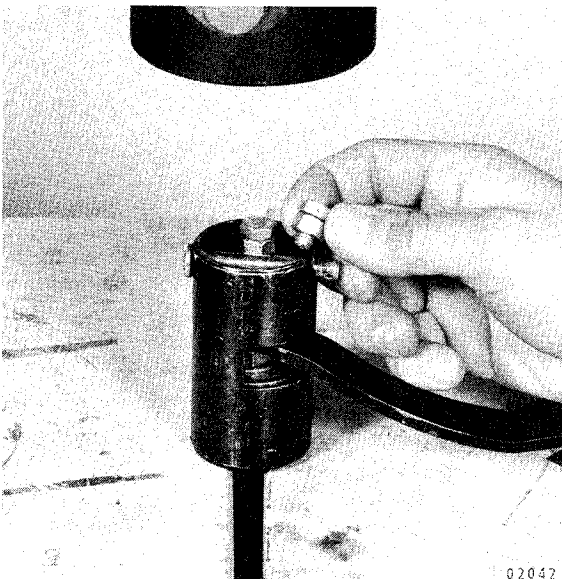
1A	Spring discs (later version)	4	Inner clamp plate	8	Clamping block half
1B	Spring discs (early version)	5	Split pin	9	Clamping block half
2	Height adjuster nut	6	Cotter pin		
3	Outer clamp plate	7	Compression screw		

Dismantling

1. Switch off the electrical system at the electrical master switch.
2. Use the height adjuster to lift the steering column up to its highest position. Use the tilt adjuster to tilt the steering wheel as far forward as possible.
3. Unscrew and remove the height adjuster nut (2) and outer clamp plate (3).



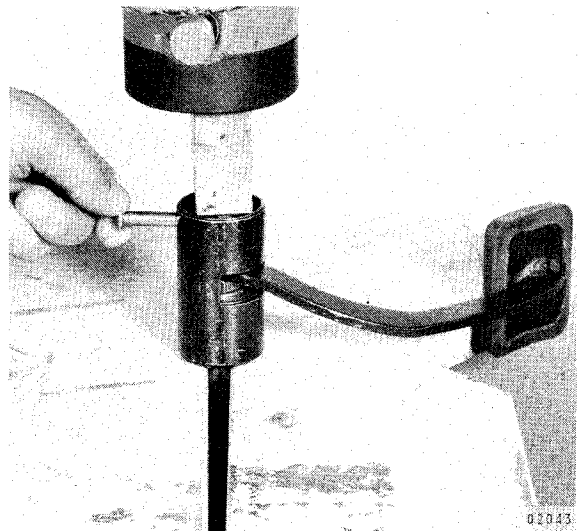
4. Withdraw the complete pedal assembly. Remove the inner clamp plate (4).
5. Remove the split pin (5) from the cotter pin (6).
6. Place the pedal unit in a press, and using two 12 mm long M8 screws and two M8 nuts, compress the spring set (1) enough to relieve the pressure on the cotter pin (6). Remove the pin (6) and slowly release the pressure. When removing the pedal unit from the press ensure that the pedal does not fall out.



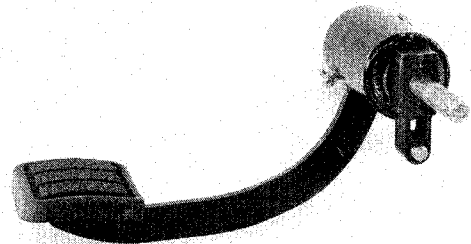
7. Remove the clamping blocks (in two halves, (8) and (9)) and screw (7), along with the spacer and the 12 spring discs (1). Note the relative positions of the spring discs before discarding them.
8. Inspect the pedal and spring disc housing for damage and wear.
9. Clean all the parts which are to be reassembled.

Reassembly

10. Smear the new spring discs (1) and spacer with oil.
11. Slide the spacer and the new spring discs (1) on to the screw (7) in the same relative positions as the old discs had.
12. Insert the screw assembly into the housing. Fit the pedal, clamping blocks (8) and (9) and the two small washers. Ensure that the pin on the inner clamping block (8) fits into the notch on the pedal.
13. Place the pedal assembly in a press. Insert the two M8 screws into the clamp and press down until the cotter pin (6) can be inserted.



14. Remove the pedal assembly from the press and insert a new split pin.
15. Tap into place the inner clamp plate, ensuring that it is located correctly in relation to the pedal.

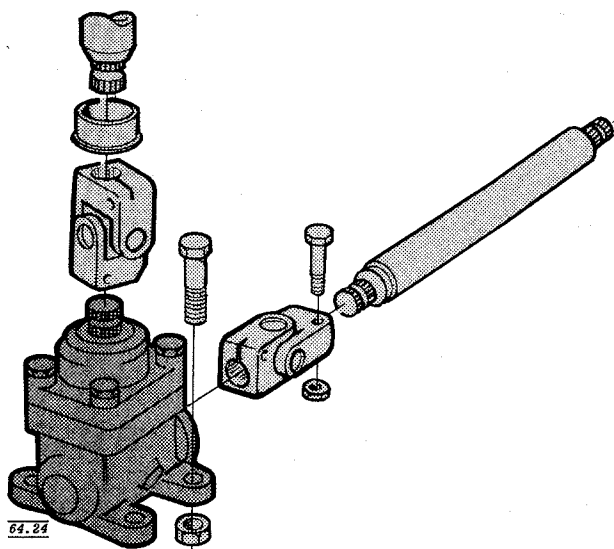


16. Position the pedal assembly into the steering console. Fit the outer clamp plate (3) and nut (2).
17. The correct clamping pressure is applied to the height adjuster in two alternative ways, depending on the version in use.
18. **Earlier version.** Tighten the nut (2) so much that the height can only be adjusted when the pedal is pressed.

Later version. Pre-tighten the M8 through screw (7) so much that height adjustment can be made without pressing the pedal, and then tighten the nut (2) enough to only permit height adjustment when the pedal is pressed.

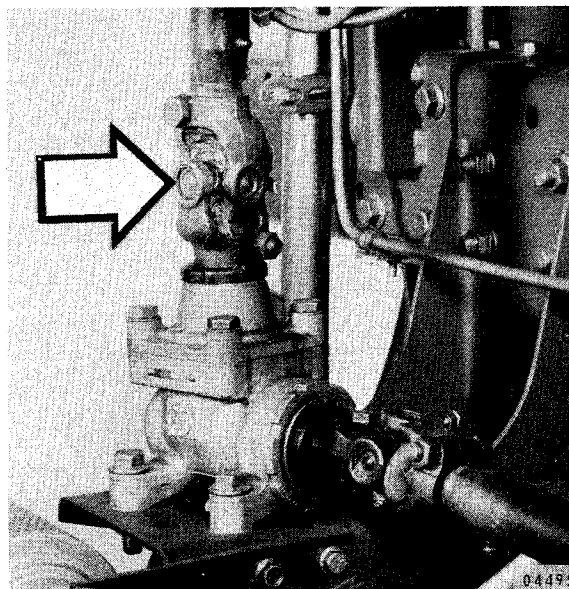
With correct assembly and adjustment the play at the pedal should be between 5 and 10 mm.

Angle gear



Removal

1. Point the front wheels straight ahead.
2. Jack up the front of the bus and place it on stands.
3. Remove the steering column lower universal joint from the angle gear.



4. Remove the steering shaft front universal joint from the angle gear.
5. Remove the retaining bolts and lift out the angle gear.

Dismantling

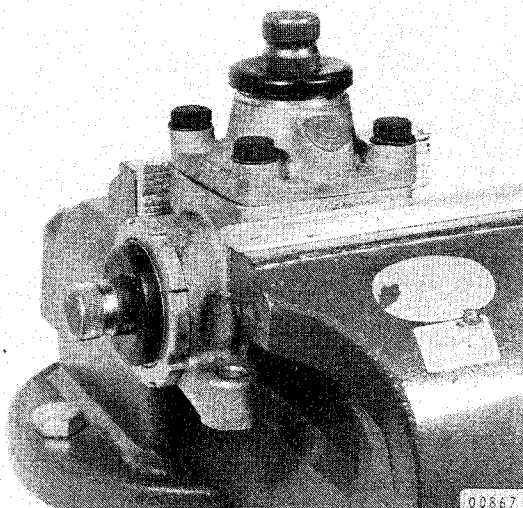
Special tools:

999-1801	Standard handle
2267	Hollow drift
2693	Adaptor
2694	Protection sleeve
4090	Slide puller
6209	Hollow drift
6459	Socket key

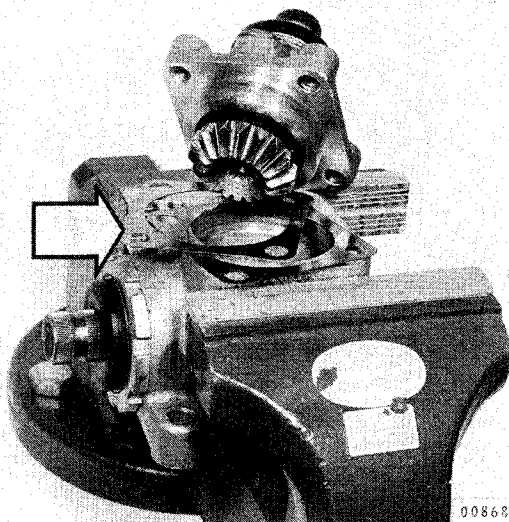
Other equipment:

998-5433	Puller
999-9177	Torque wrench or
9708	Torque wrench

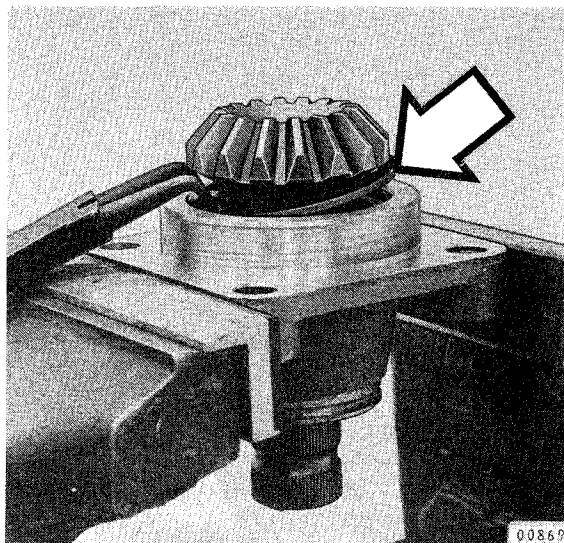
1. Secure the angle gear in a vice with soft jaws and scribe alignment marks on the cover housing.



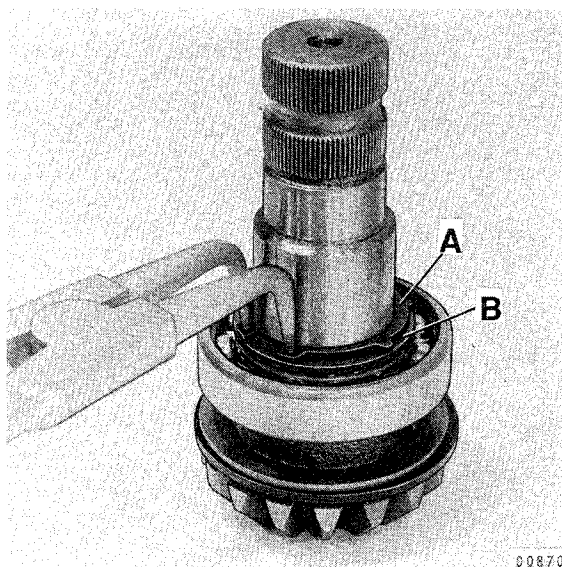
2. Remove the cover bolts and washers, and remove the cover from the housing, taking care with the shims, between the cover and housing. Measure and note the total thickness of the shims.



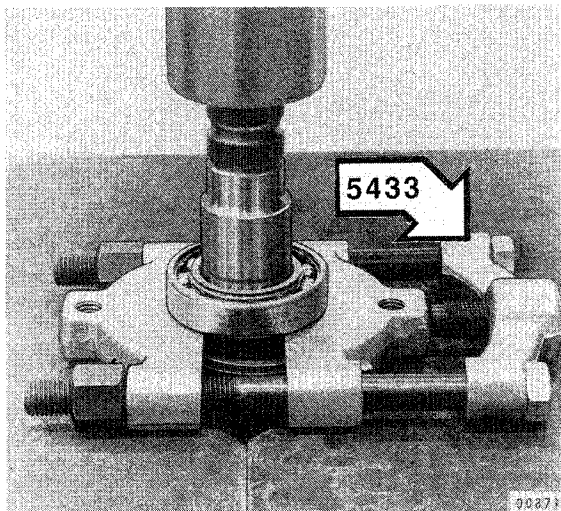
3. Remove the dust cover from the input shaft.
4. Remove the circlip and the input shaft from the cover.



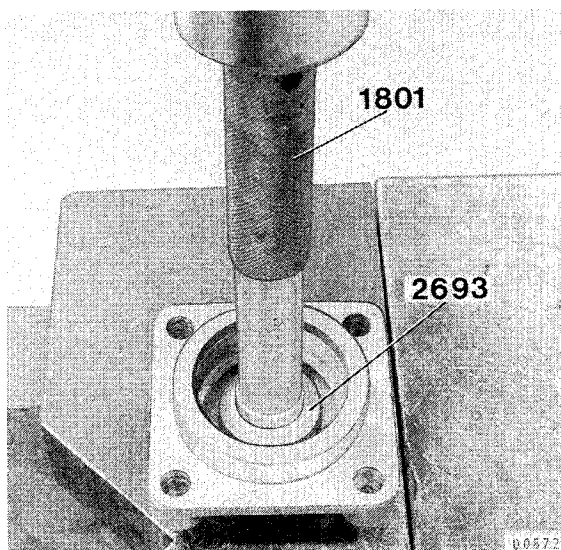
5. Remove the circlip (A) from the input shaft, and the support washer (B) beneath it. Measure and note the thickness of the washer (this washer is available in different thicknesses).



6. Press the ball bearing off the input shaft, using puller 5433 as a support, and remove the support washer.

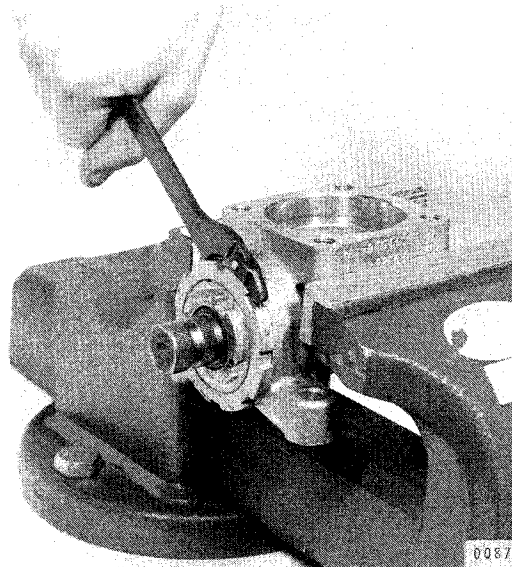


7. Remove the circlip between the input shaft and bearing.
8. Using standard handle 1801 and adaptor 2693, press the needle bearing and sealing ring out of the cover.

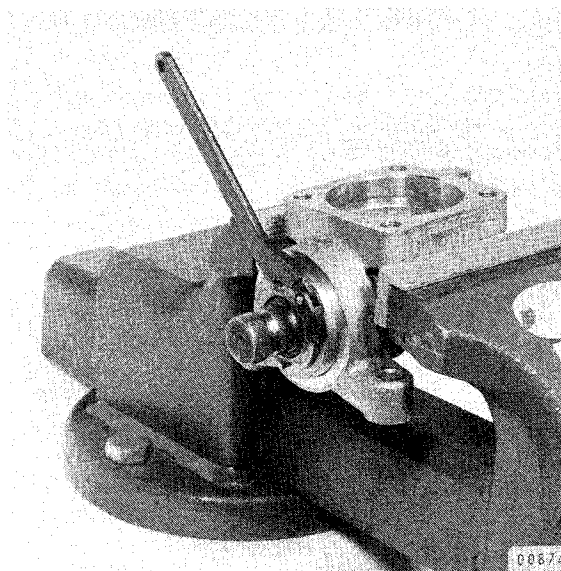


Output shaft, dismantling

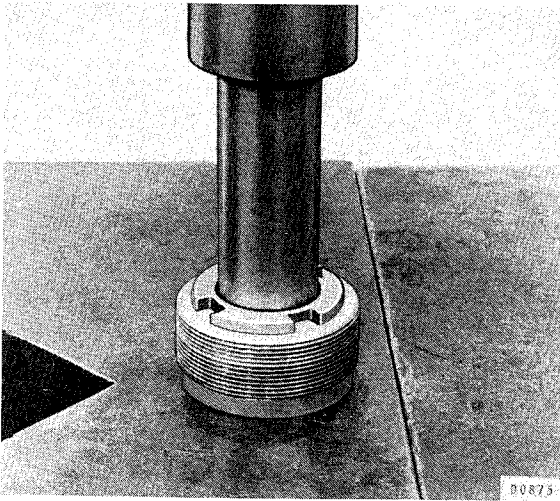
9. Remove the dust cover from the output shaft.
10. Remove the lock nut from the output shaft.



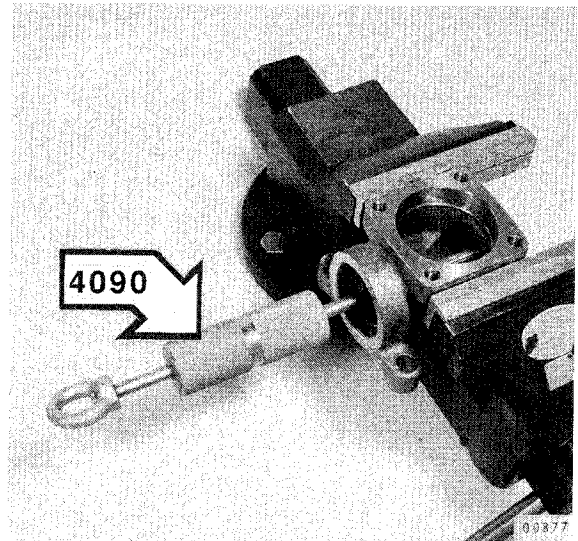
11. Remove the adjusting nut and sealing ring from the output shaft.



12. Press the sealing ring out of the adjusting nut using a suitable drift.

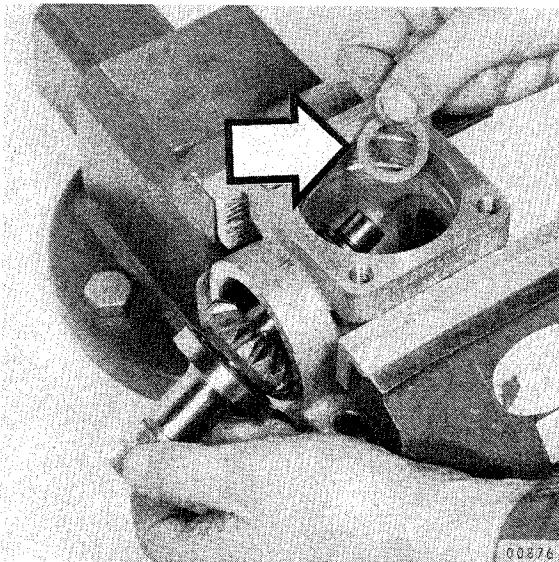


15. Withdraw the needle bearing from the angle gear housing, using slide puller 4090.

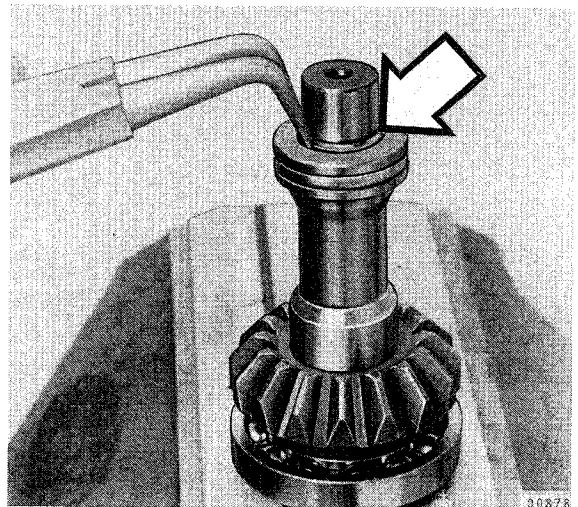


13. Remove the O-ring from the lock nut or the angle gear housing.

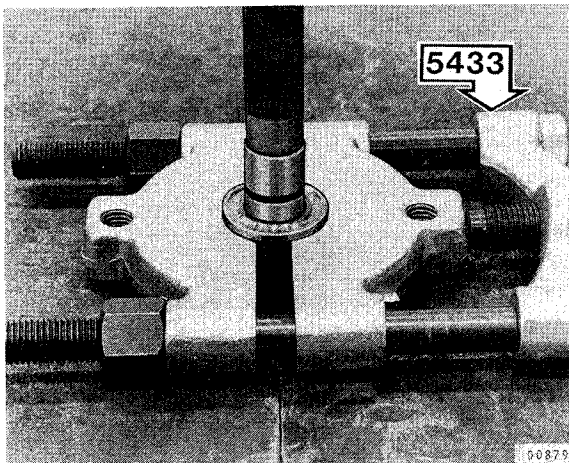
14. Remove the output shaft with ball bearing and ball bearing from the angle gear housing. Measure and note the total thickness of the adjusting washer(s), which are available in different thicknesses.



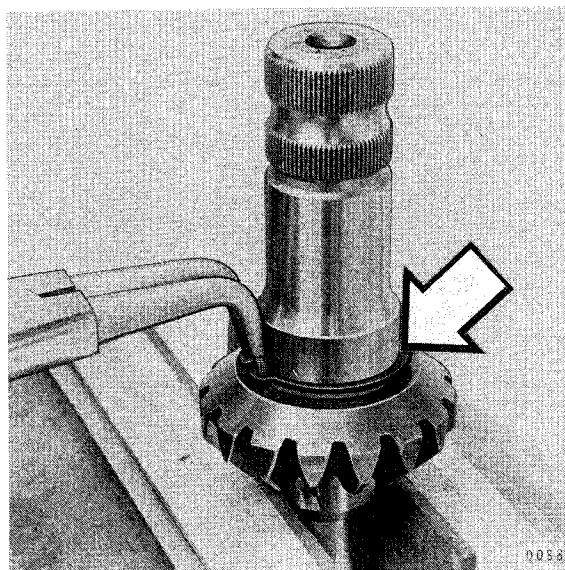
16. Remove the circlip from the output shaft, then remove the ball bearing and its outer bearing race.



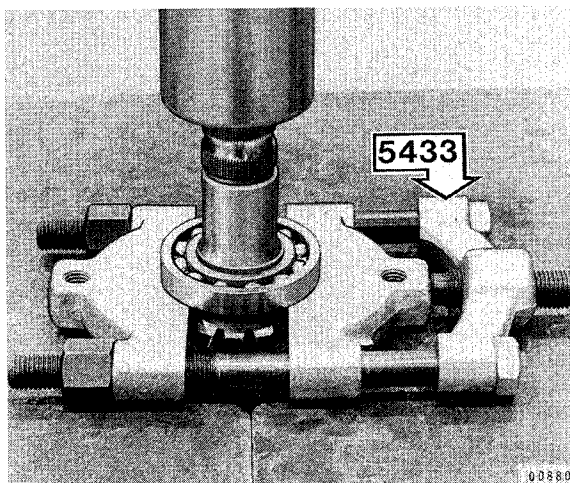
17. Using the puller 5433 as a support, press the output shaft out from the ball bearing inner bearing race.



19. Remove the circlip from the output shaft.



18. Using the puller 5433 as a support, press the output shaft out from the ball bearing.

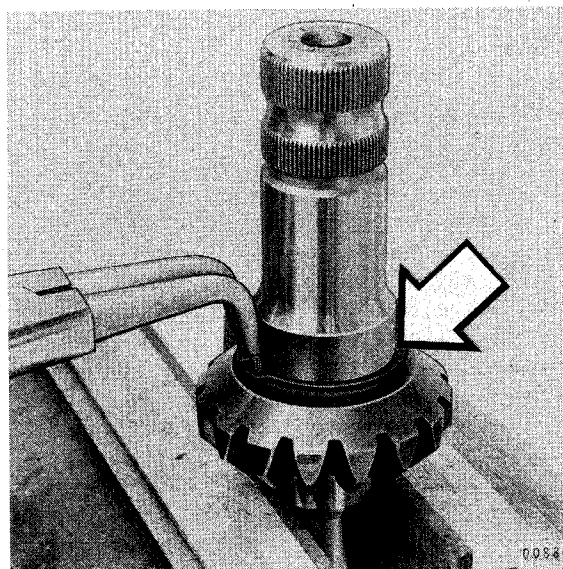


Cleaning and checking

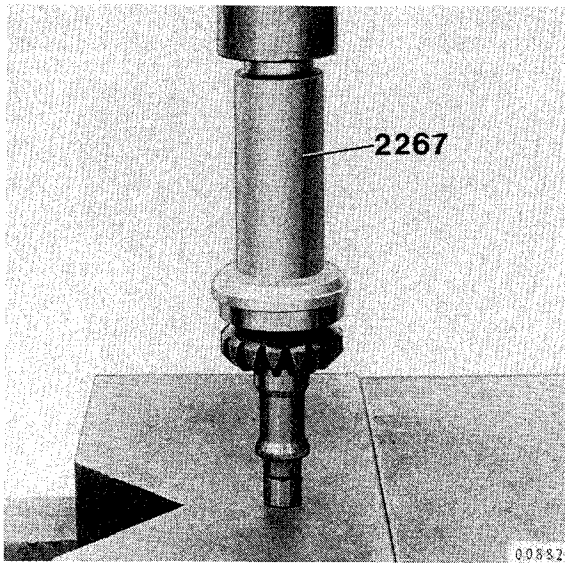
Clean and check all parts thoroughly. Replace defective or damaged parts. The dust cover, the sealing rings and the O-ring must always be renewed.

Output shaft, reassembly

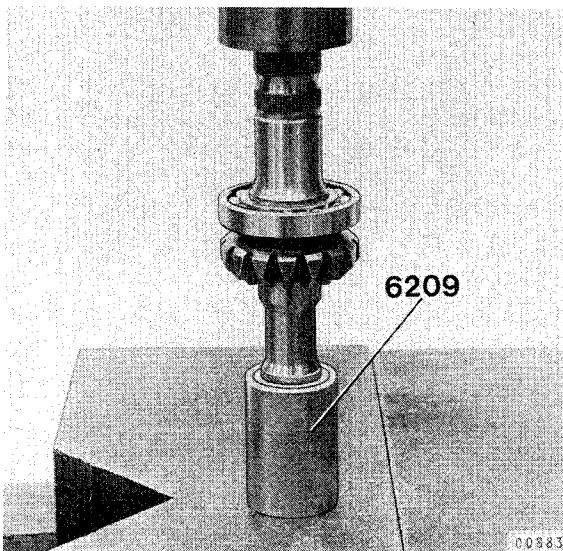
1. Fit the circlip on the output shaft.



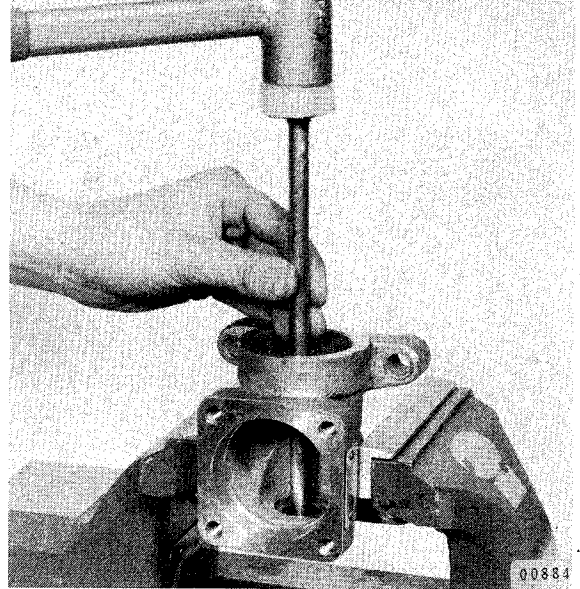
2. Using hollow drift 2267, press a well-oiled ball bearing on the output shaft.



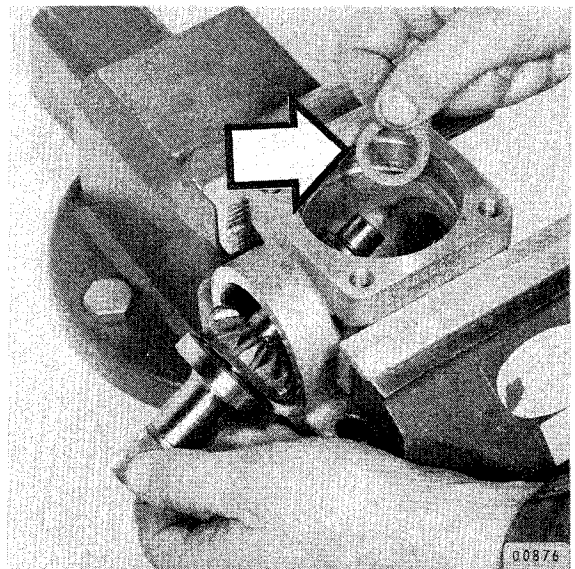
3. Press the ball bearing inner bearing race on to the output shaft, using hollow drift 6209 as a support.



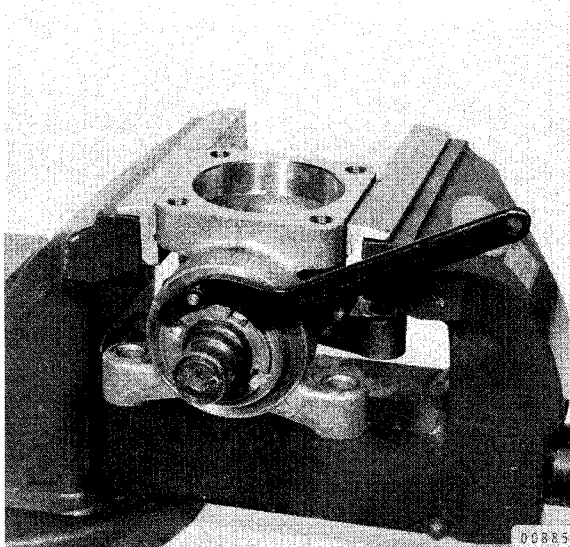
4. Place the ball bearing and its well-oiled outer bearing race on the output shaft. Lock the ball bearing to the output shaft with the circlip.
5. Fit a well-oiled needle bearing in the angle gear housing. Carefully tap the needle bearing into the bottom of the housing using a brass drift.



6. Place the output shaft and adjusting washers into the angle gear housing. The total washer thickness should be the same as that measured in Disassembling, step 14.

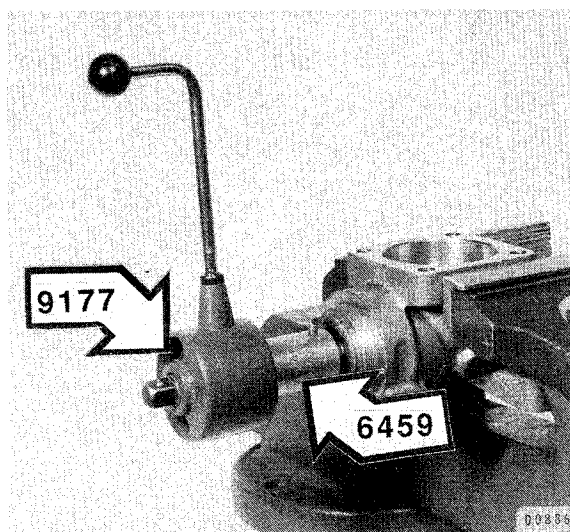


7. Fit the adjusting nut on the angle gear housing and output shaft. Lightly tighten the nut.



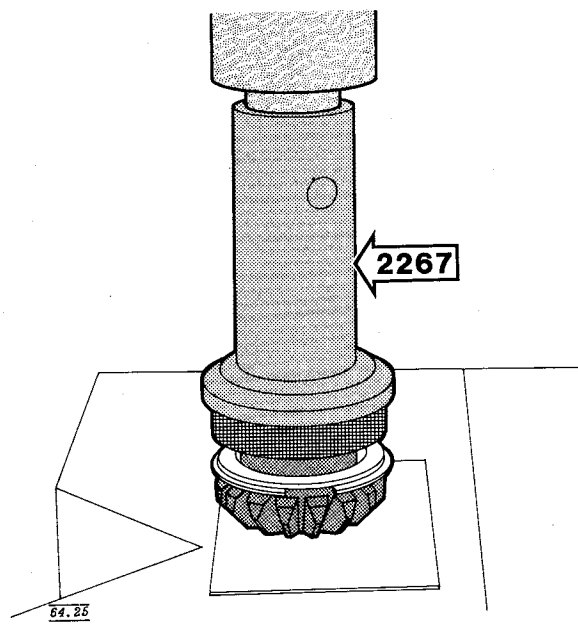
8. Place socket 6459 on the output shaft and tighten up the bolts. Make sure the bolts fit in the groove so as not to damage the shaft splines. Fit torque wrench 9177 or 9708 to socket key 6459.

Pre-load the ball bearing by tightening up the adjusting nut so that a torque of 0.1 Nm (0.01 kgf m) is required to rotate the output shaft.

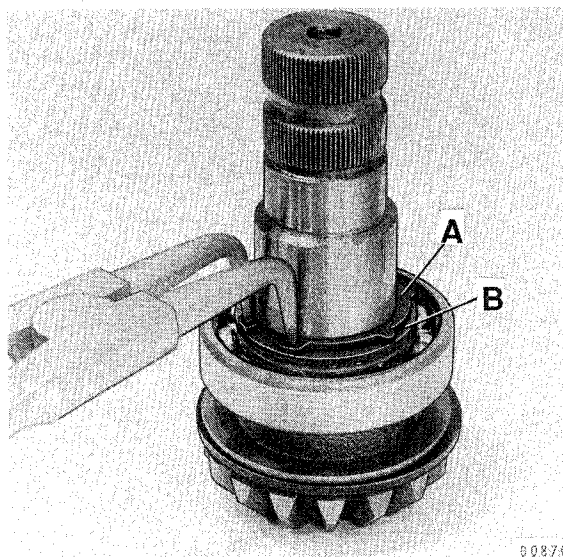


Reassembly

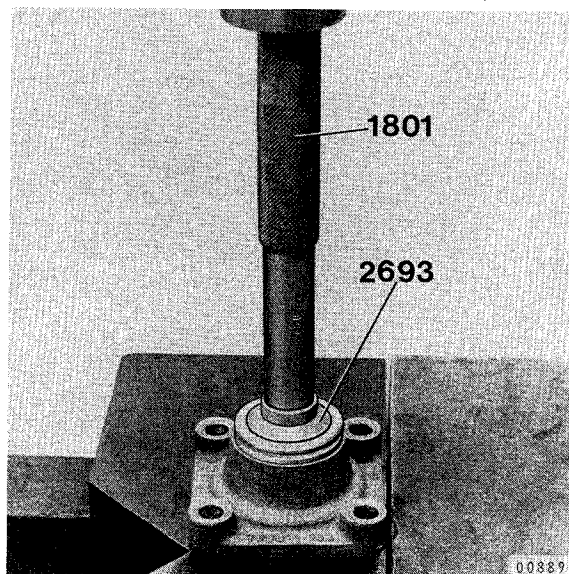
9. Place the circlip and support washer on the input shaft.
10. Press a well-oiled ball bearing on the input shaft. Place a soft metal sheet on the press table underneath the gear to protect it.



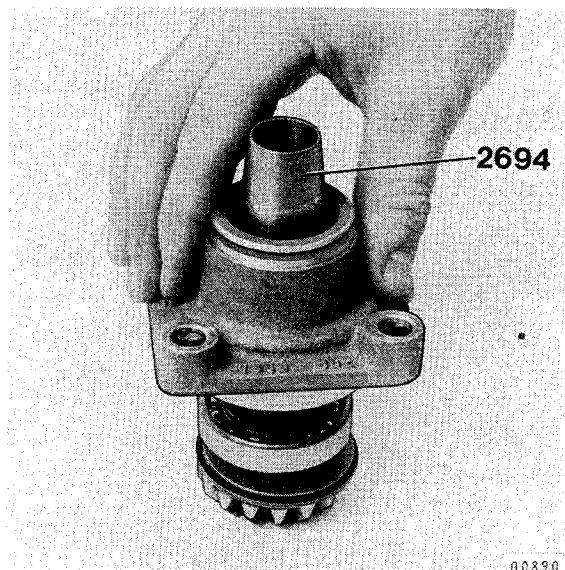
11. Place the support washer (B) against the ball bearing and fit the circlip (A) on the input shaft. The support washer is available in different thicknesses – choose the correct thickness so that the circlip fits exactly in the circlip groove.



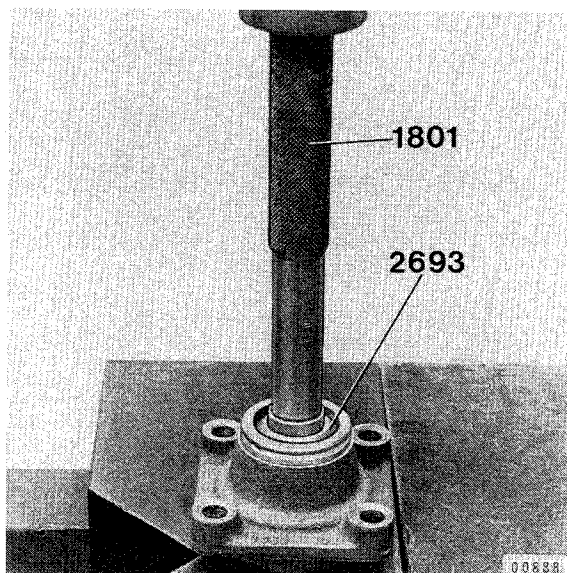
12. Using standard handle 1801 and adaptor 2693, press a well-oiled needle bearing into the cover flush with the inside.



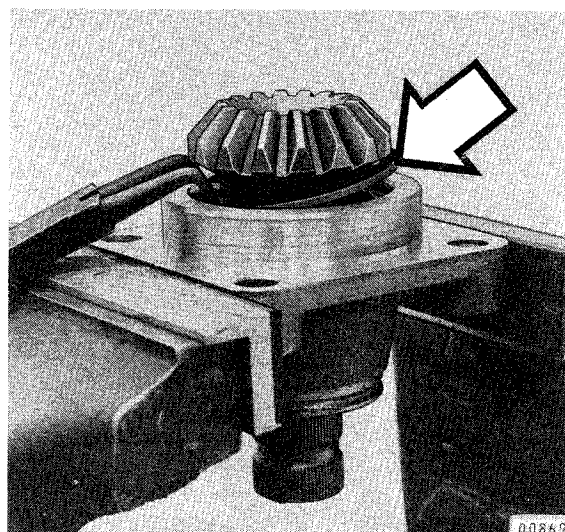
14. Place protection sleeve 2694 over the input shaft splines and press the cover down over the input shaft.



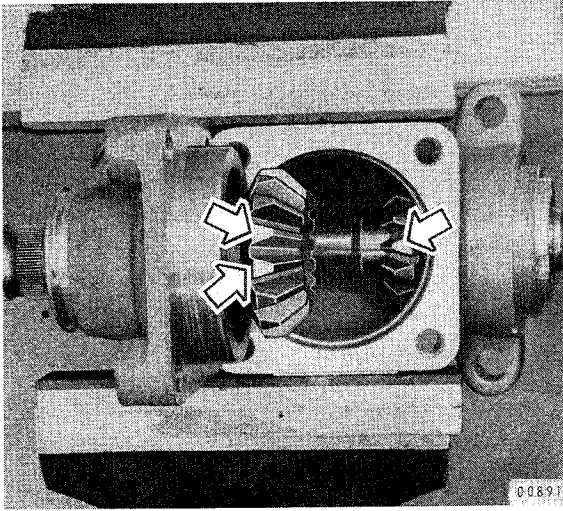
13. Smear plenty of grease on the sealing ring lips, and press the sealing ring into the cover.



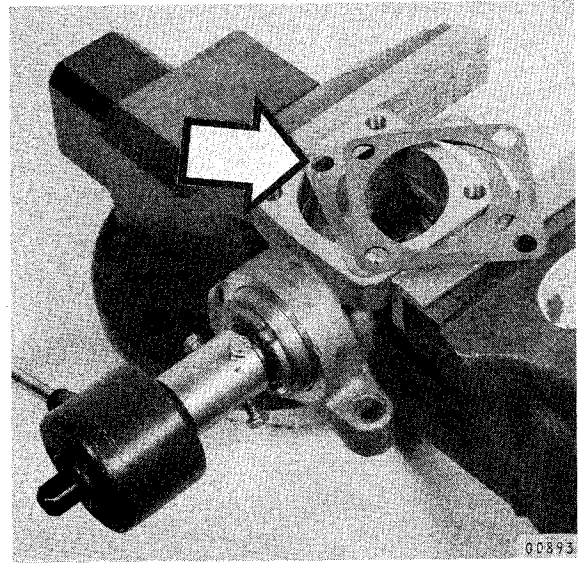
15. Remove protection sleeve 2694 and fit the circlip into the cover.



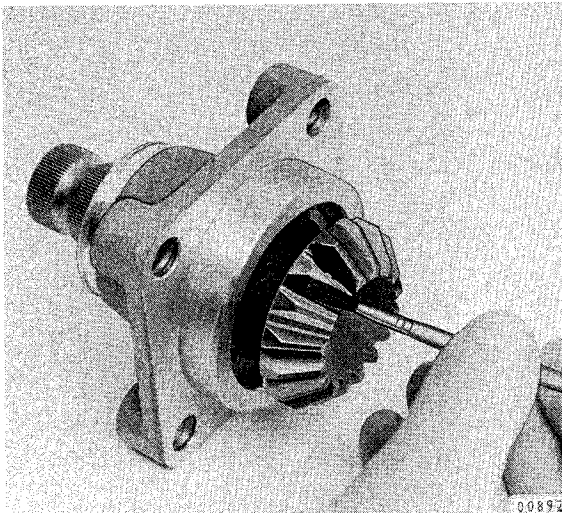
16. Mark two adjacent teeth on the input shaft and a tooth on the output shaft with paint spots. These teeth must align so that the gears have the same mesh during adjustment and final assembly.



18. Place shims, with the same total thickness as measured in Dismantling, step 2, on the angle gear housing.



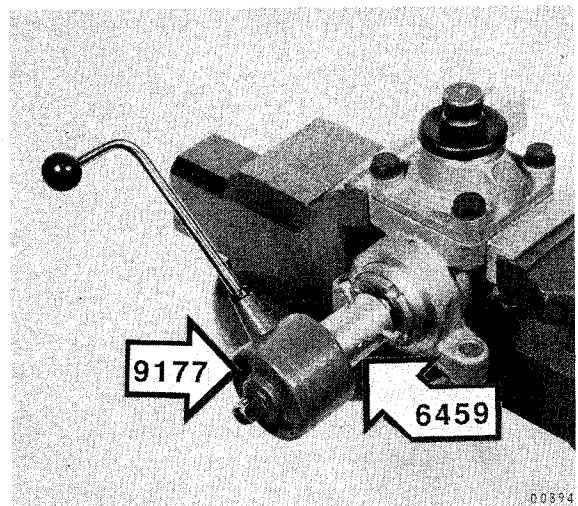
17. Mark 3 or 4 teeth on the input shaft with paint in order to provide a contact surface pattern.



19. Place the cover on the angle gear housing together with the shims.
20. Fit and tighten the bolts to a torque of 42 Nm. Fit the dust cover

Checking torque across output shaft

21. Rotate the output shaft in both directions, while manually braking the input shaft at the same time.
22. With socket key 6459 and torque wrench 9177 measure the preload between the gears. The maximum torque required on the output shaft is 0.25 Nm (0.025 kgf m). Check that the gear has no clearance.



If the torque is greater than 0.25 Nm:

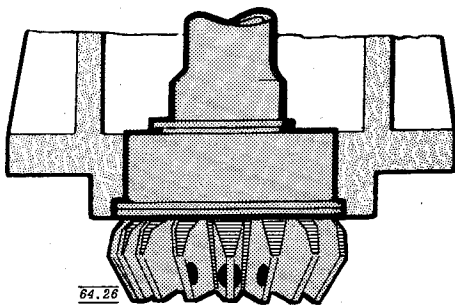
Place shims between the cover and the angle gear housing, or insert a thicker washer between the output shaft and the angle gear housing, or both, bearing in mind the contact pattern.

If the gear has excessive clearance:

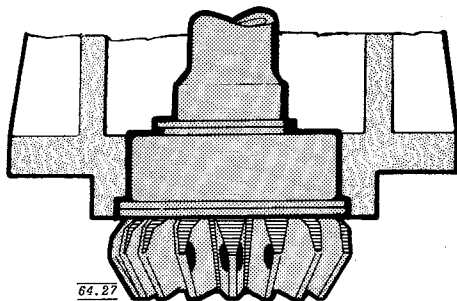
Remove the input shaft cover. Remove the necessary shims from between the cover and angle gear housing, or change to thinner adjusting washers between the output shaft and the angle gear housing, or do both, bearing in mind the contact pattern.

The contact pattern should indicate whether the total shim thickness needs to be increased or decreased.

Correct contact pattern

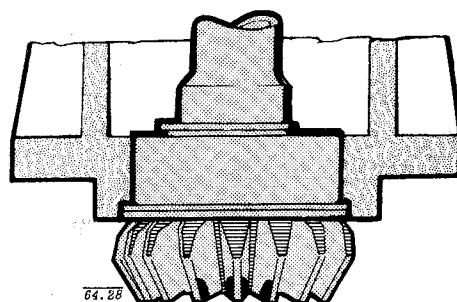


Contact pattern too high



If the contact pattern is too high, increase the thickness of the shims between the angle gear housing and the cover, or reduce the thickness of the adjusting washers between the output shaft and the angle gear housing.

Contact pattern too low



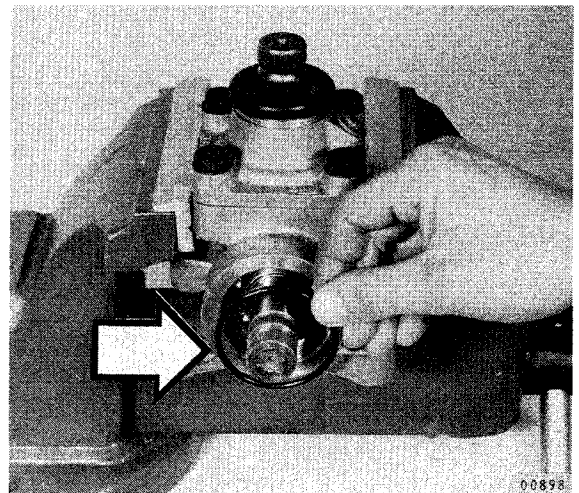
If the contact pattern is too low, reduce the thickness of the shims between the angle gear housing and cover or increase the thickness of the adjusting washers between the output shaft and the angle gear housing.

23. Rotate the angle gear in both directions and check that the gears do not grab or bind at any point.

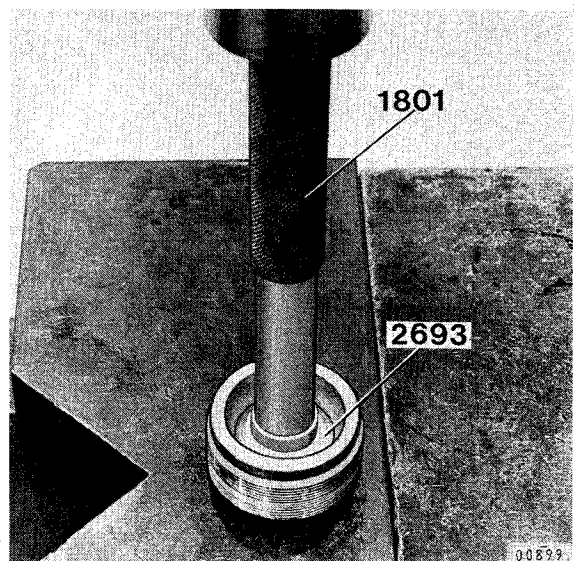
If in spite of being properly adjusted the gears grab or bind at any point, proceed as follows:

Try moving the gears by one or more teeth with respect to each other. If this does not help, replace one or both shafts.

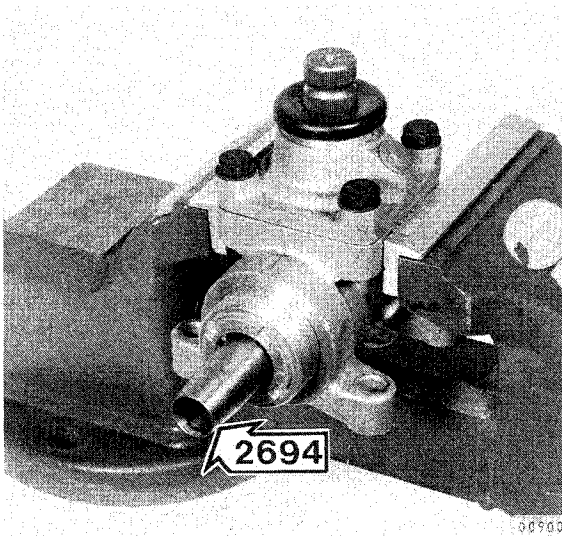
24. Remove the adjusting nut. Oil and fit the O-ring into the angle gear housing. The O-ring is placed on the inside of the adjusting nut threads in the angle gear housing.



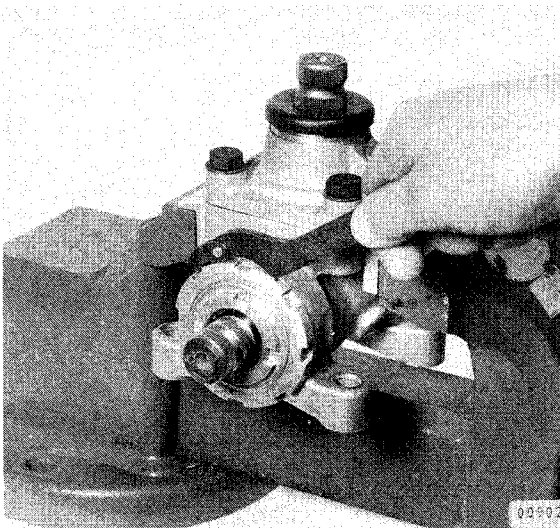
25. Using standard handle 1801 and adaptor 2693, press the sealing ring, with its lips well greased, into the adjusting nut.



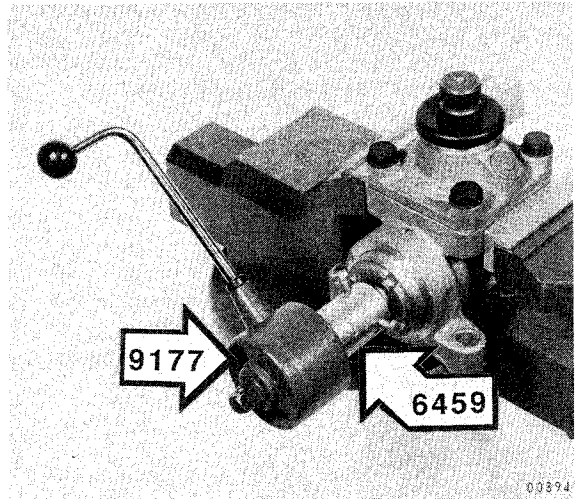
26. Place protection sleeve 2694 over the output shaft splines and screw the adjusting nut on to the angle gear housing. Remove protection sleeve 2694.



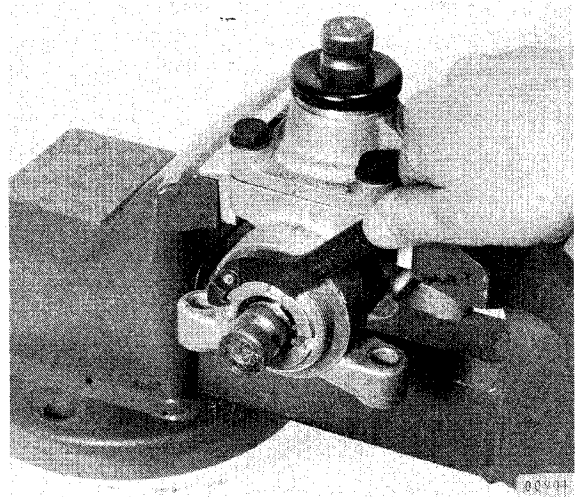
27. Tighten the adjusting nut lightly.



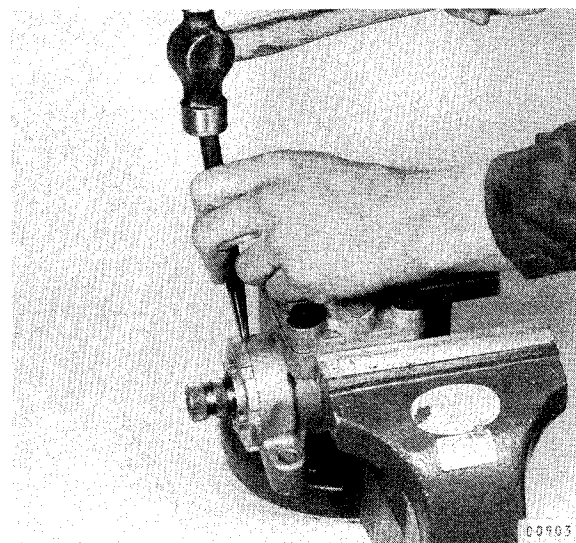
28. Place socket key 6459 on the output shaft and tighten up the bolts, making sure that the bolts grip in the groove and do not damage the shaft splines. Fit torque wrench 9177 or 9708 on to socket key 6459. Pre-load the ball bearing by tightening the adjusting nut so that the torque required to rotate the output shaft is 0.15-0.25 Nm.



29. Tighten the lock nut on to the adjusting nut.



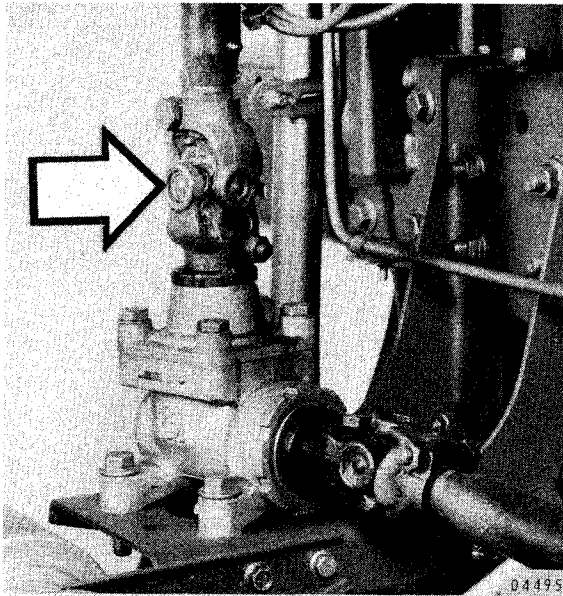
30. Lock the lock nut against the angle gear housing by punching in two of the hook wrench recesses as shown.



31. Fit the output shaft dust cover.

Installation

1. Fit the angle gear in position and tighten the retaining bolts to a torque of 80 Nm (8 kgf m).
2. Fit the steering shaft rear universal joint and tighten the lock bolt to a torque of 30 Nm (3 kgf m).
3. Make sure the front wheels point straight ahead with the steering wheel in the centre position. Fit the steering shaft lower universal joint and tighten the lock bolt to a torque of 30 Nm.



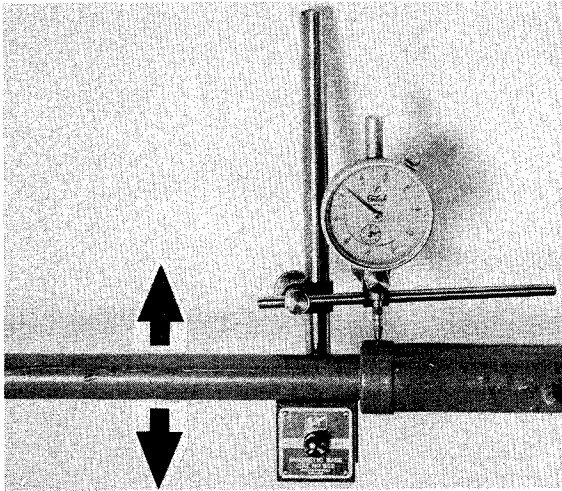
4. Check the angle gear oil level and if necessary top up with ATF oil.
5. Lower the bus.

Steering shaft

Checking splined joint

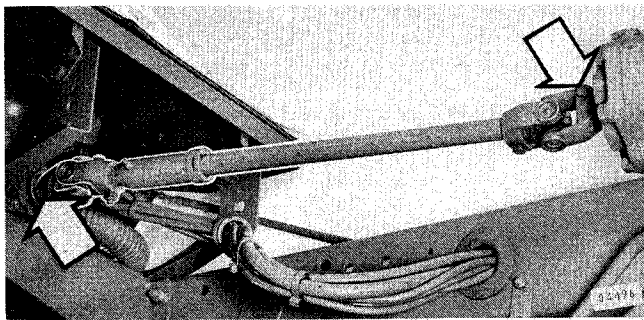
Place a dial indicator and magnetic foot on the steering shaft. Pull the steering shaft by hand and read-off from the dial indicator the radial clearance in the slide joint.

If the radial clearance exceeds 1.5 mm, fit a new steering shaft.

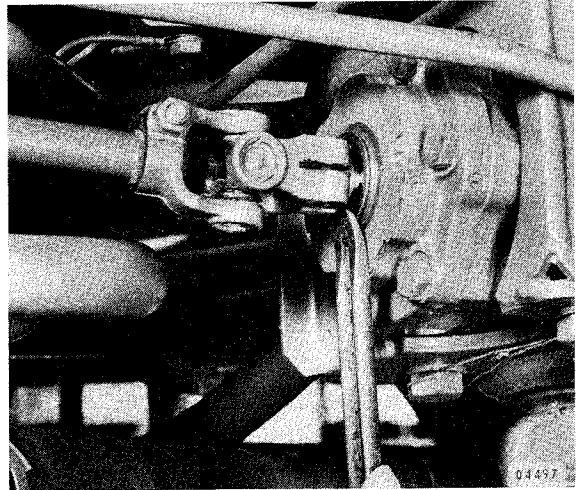


Removal

1. Slacken the clamp bolts for the steering shaft universal joints nearest the angle gear and steering gear.



2. Push the steering shaft up into the slide joint and remove the shaft. If necessary use a lever between the gear housing and the steering shaft universal joint.

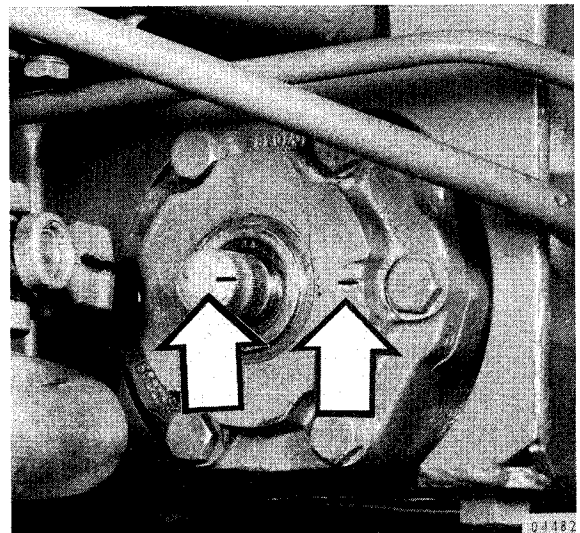


Replacing steering shaft universal joint

3. Slacken the clamp bolt at the other end of the universal joint on the steering shaft and pull off the joint. If necessary, use a plastic mallet.
4. Fit a new universal joint and tighten the clamp bolt to a torque of 30 Nm (3 kgf m).

Installation

1. Position the steering wheel with the spokes parallel to the instrument panel. Check that the marking on the end of the power steering gear input shaft (see illustration) is pointing towards the mark on the power steering gear housing. If it is not, with the universal joint still disconnected, turn the steering wheel from full lock to full lock and count the number of turns. Turn the steering wheel back half this number of turns. Turn the power steering gear input shaft to align its marking with the marking on the housing, as shown.



2. Fit the steering shaft complete with universal joints to the steering gear steering spindle and the angle gear output shaft, taking care not to move the steering gear linkage or the power steering gear input shaft. Fit and tighten the universal joint clamp bolts to a torque of 30 Nm (3 kgf m).

Power steering gear

Checking oil level

NOTE: The greatest cleanliness must be observed when working on the power steering. Always clean around connections before disconnecting and clean the oil reservoir before taking off the cap. Drained oil must **not** be put back into the system.

1. The oil level should be checked at every routine safety check. Check the level with the engine switched off to find out if there are oil losses. The level should be at the MAX mark on the oil dipstick.

If the level is lower, top-up with ATF type oil, with the engine switched off to ensure that no air is sucked in.

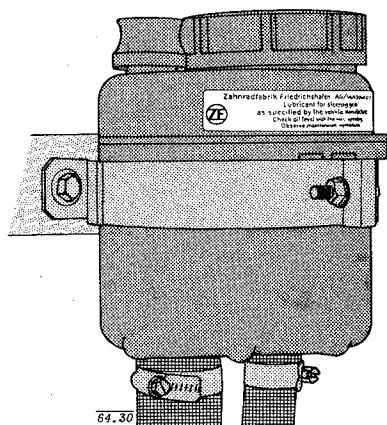
2. Start the engine and recheck the oil level, which should now be at the MAX. mark.

Changing oil filter

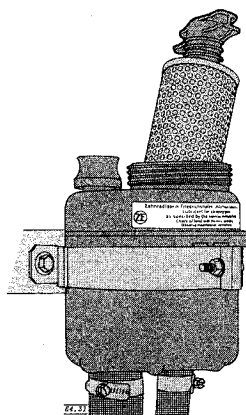
The filter should be changed for the first time at the 10 000 km warranty service, and thereafter every 80 000 km, or at least once a year. The filter should also be changed if the power steering has been repaired.

Replacing filter element

1. Clean the outside of the oil reservoir and unscrew the large cap.



2. Press down and turn to release the filter locking device. Lift up the filter and place a finger over the hole at the centre to prevent dirt falling from the inside of the filter into the oil reservoir.



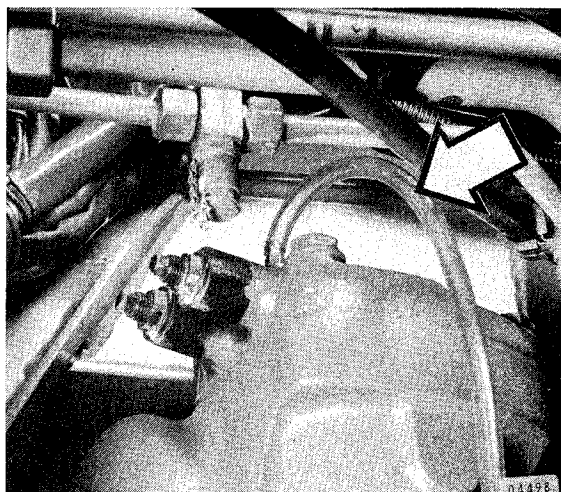
3. Transfer the filter locking device from the old filter to the new one.
4. Fit the filter and make sure that the filter locking device is locked securely in the reservoir recess.
5. Fill with oil and check the level. If the oil has been drained from the reservoir, the power steering must be bled by turning the wheels to full left and right lock several times.

Topping-up

6. Fill with ATF-type oil up to the edge of the reservoir. With the stop button pushed in, turn over the engine in short bursts with the starter. Oil must be added as the level drops to prevent air from being sucked into the system.

Bleeding

7. When the oil level is constant, start the engine and turn the steering wheel repeatedly with even movements between the full lock positions without pressing against them.
8. Remove the protection cap from the bleed nipple. Fit a transparent plastic hose on the nipple and insert the free end of the hose into a transparent container.



9. Turn the steering wheel to full lock in one direction.
10. Open the bleed nipple, with the engine at low idle. Turn the steering wheel to full lock in the other direction. This causes the operating piston in the steering gear to press out any air through the bleed nipple. Close the bleed nipple.
11. Check the oil level as described earlier, and top up as necessary. If required, repeat Steps 9 and 10 until absolutely no air is expelled. Switch off the engine.

12. When the power steering has been bled, the oil level will rise 10-30 mm above the MAX mark on the oil dipstick. This is due to there being a small amount of air left in the oil. It is, however, of no importance since the oil is in the form of small air bubbles which disappear when the oil comes under pressure.
13. Remove the plastic hose from the bleeder nipple and fit the protection cap.

Introduction to functional check

Special tools:

999-2876 Spacer sleeve 3 mm
6162 Test Instrument
6163 Flow meter
6722 Nipple
6827 Nipple
6828 Nipple
6743 Spacer sleeve 10 mm (2 off)

NOTE: The greatest cleanliness must be observed when working on the power steering. Always clean around connections before disconnecting them and clean the oil reservoir before taking off the cap. Drained oil must **not** be put back into the system.

The table below shows those values required when checking the power steering system on the B10M.

Steering gear	Servo pump	Engine speed r/s (r/min)	Oil temp. °C	Checking the flow		Max. internal steering gear leakage l/min	Max. pressure MPa (kgf/cm ²)
				Pressure MPa (kgf/cm ²)	Flow l/min		
ZF8043	ZF vane pump 1585013	8.3 (500)	50	5 (50)	10.5	2.0	13 (130)

Procedures before functional check

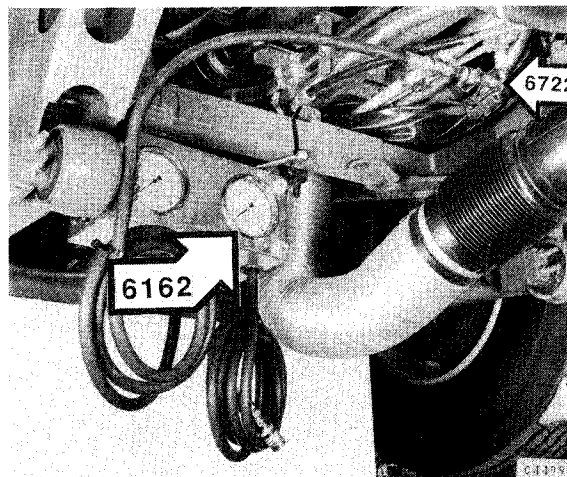
Mechanical adjustments

1. Check and if necessary adjust the steering centre position as described in Group 60 Service Procedures, Procedure before check-measuring wheel angles, step 8.
2. Check and if necessary adjust the toe-in as described in Group 60, Service Procedures, Toe-in.
3. Check and if necessary adjust the curve angles as described in Group 60, Service Procedures, Curve angles (max. wheel lock).

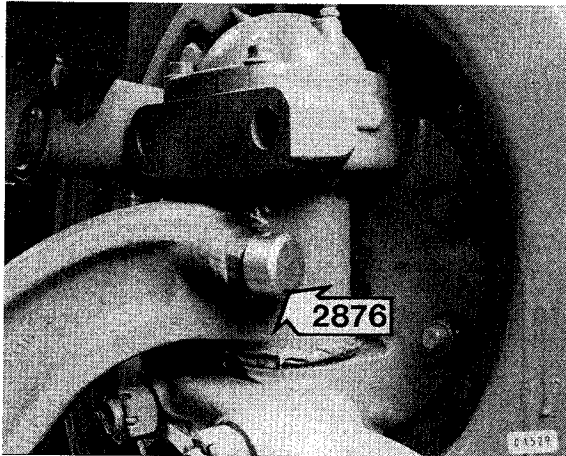
Checking and adjusting unloading valves

During the following checks, it makes no difference whether the test instrument 6162 lever is set to either OPEN or CLOSED, since its flow facility is not used.

1. Jack up the front of the bus and place it on secure stands, placed clear of the steering and suspension components, so that its front wheels are just clear of the ground. The checks and measurements are performed with the engine running so that all necessary precautions must be taken to ensure that it is not accidentally put into gear and that vibration when the engine is running will not cause the bus to fall off the stands.
2. Connect the hose marked INLET on the test instrument 6162 via a nipple 6722 to the connector on the servo pump delivery line.



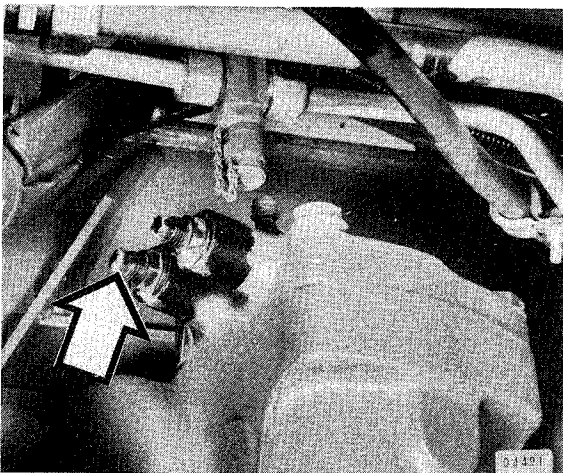
3. Place a 3 mm spacer sleeve 2876 on the rear stop bolt of the steering knuckle which is **not** on the steering side of the bus.



4. Start the engine and run it at low idle.
5. If necessary fill up the oil reservoir with ATF-type oil.
6. Check the servo pump pressure by holding the steering wheel at full right (LHD bus) or full left (RHD bus) lock for **no more than 5 seconds**. When full lock has been reached, the instrument will normally show a pressure surge. The indicated pressure on the gauges while at full lock should be between 3 and 5 MPa (30-50 kgf/cm²).

If the pressure is incorrect:

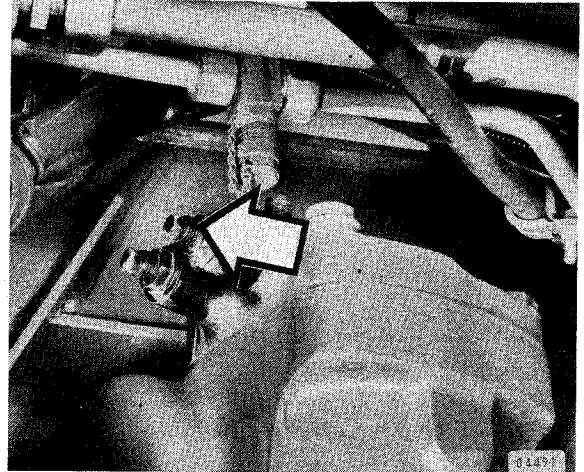
Screw out the rear adjusting screw until the pressure is 7-8 MPa (70-80 kgf/cm²) and then screw it in until the pressure falls to 3-5 MPa (30-50 kgf/cm²). Lock the adjusting screw and repeat step 6.



7. Turn the steering wheel to the other full lock position and read off the indicated pressure, which should be 3-5 MPa (30-50 kgf/cm²).

If the pressure is incorrect:

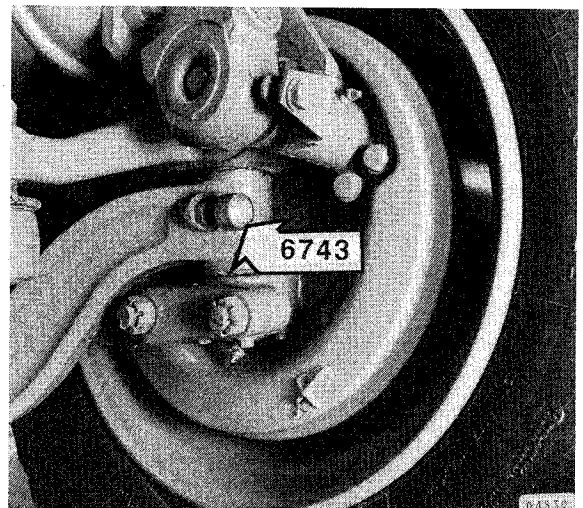
Screw out the front adjusting screw until the pressure is 7-8 MPa (70-80 kgf/cm²) and then screw it in until the pressure falls to 3-5 MPa (30-50 kgf/cm²). Lock the adjusting screw and repeat step 7.



8. Remove the spacer sleeve 2876 and switch off the engine.

Checking power steering system pressure

9. Place 10 mm spacer sleeves 6743 on **both** steering knuckle stop bolts.

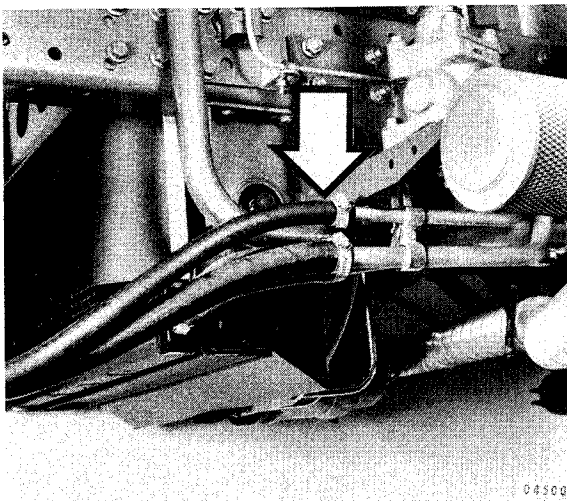


10. Start the engine and run it at low idle.
11. Turn the steering wheel to full right lock for **no more than 5 seconds** and read off the pressure on either gauge.

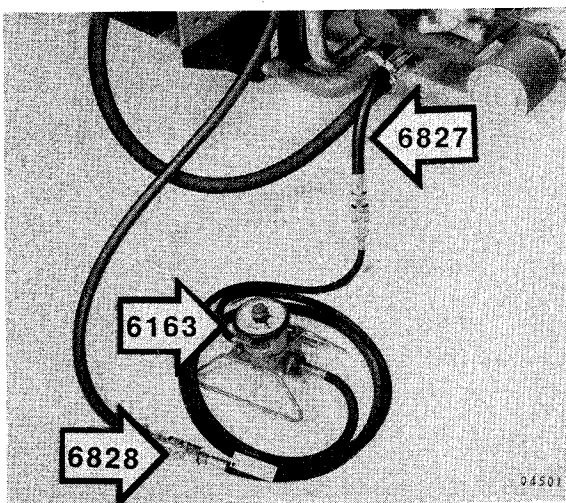
12. Repeat step 11, but this time with the steering wheel at full left lock.
13. Both pressure readings should be within 5% of the servo pump pressure measured in the previous section. If the specified pressure is not reached, check if there is a fault on the servo pump or steering gear, and then proceed to the functional checks.
14. Remove the spacer sleeves 6743 and switch off the engine.

Functional checks

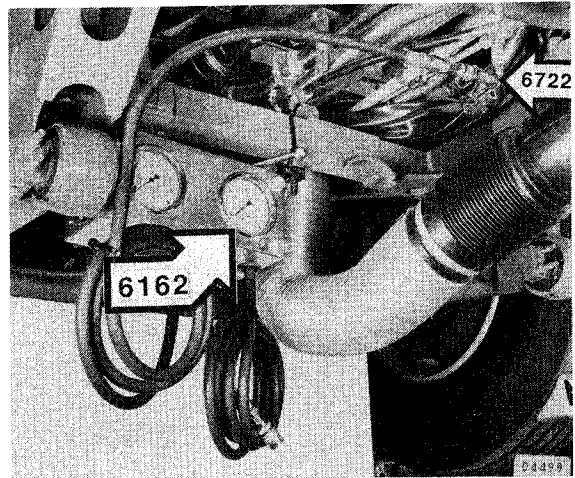
15. Disconnect the return line at the connector just under the steering angle gear, catching any spilled oil in a container.



16. Connect the flow meter 6163 via nipple 6827 to the return pipe and nipple 6828 to the return hose (series connection). The direction of flow is marked by an arrow on the flow meter, which must be positioned so that it can be seen from the driving seat.



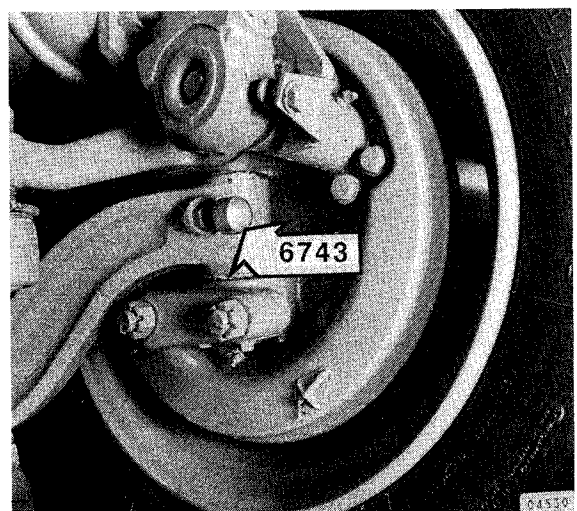
17. Connect the test instrument 6162 INLET via nipple 6722 to the test nipple on the bus, if not already connected for the previous "Checking and adjusting unloading valves" test.



18. If necessary refill the oil reservoir with ATF-type oil.
19. Start the engine and run it at low idle speed while turning the steering wheel from end to end a couple of times.
20. Stop the engine and check the oil level in the reservoir. If necessary add more oil.

Servo pump flow check

21. Start the engine and let it run at low idle speed.
22. If not already in place from the previous test, fit a spacer sleeve 6743 on the steering side steering knuckle stop bolt.



23. With the engine idling, turn the steering wheel just hard enough to maintain a reading of 5 MPa (50 kgf/cm²) on the test instrument gauges.

24. Zero-set the flow meter and firmly hold the pointers by pressing the flow meter knob. Release the knob and allow the pointers to rotate for exactly 6 seconds. Press the knob again to stop the pointers and read off the indicated flow.

25. Multiply the indicated flow reading by 10 to obtain the flow in litres/minute. This should not be less than 10.5 litres/minute. If the flow is less, the servo pump is faulty and must be repaired.

Checking for internal leakage in the steering gear

26. Run the engine at low idle speed.

27. Place 10 mm spacer sleeves 6743 on **both** the steering knuckle stop bolts on the steering side, if not already in place after the previous tests.

28. Zero-set the flow meter and firmly hold the pointers by pressing the flow meter knob. Turn the steering wheel as far as possible in one direction and hold it against the spacer sleeve to obtain maximum pressure, while measuring the flow. Release the flow meter knob and allow the pointers to rotate for exactly 6 seconds. Press the knob again to stop the flow meter pointers and release the steering wheel. Read off the flow.

NOTE: The maximum pressure must not be maintained for more than 10 seconds.

29. Multiply the flow reading by 10 to obtain the flow in litres/minute. The value obtained indicates how much internal leakage is present in the steering gear. If it exceeds 2 litres/minute, the steering gear is affected seriously enough to need repair.

30. Repeat steps 28 and 29 with the steering wheel turned in the other direction.

31. Stop the engine, remove the spacer sleeves from the stop bolts, disconnect the flow meter and test instrument and reconnect the delivery and return lines.

32. Top up the oil reservoir, run the engine for a short time while turning the steering wheel, stop the engine and top up the reservoir again if necessary.

33. Check all connections for leakage.

34. Lower the bus to the ground.

Checking and adjusting pressure point

Special tool:

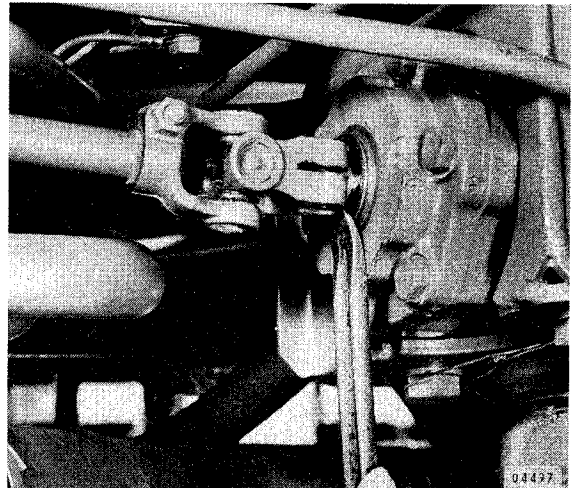
999-6459 Socket

Other equipment:

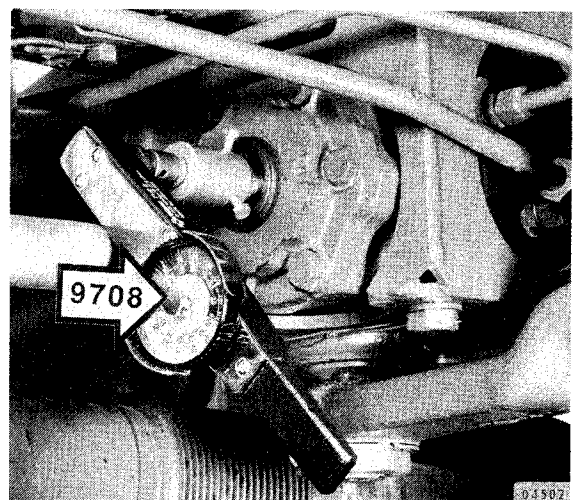
999-9708 Torque wrench

The steering gear pressure point is adjusted before the bus is delivered from the factory. It should be re-checked at approx. 10 000 km. The steering gear has by this time been run-in so that the torque across the centre position (pressure point) has reduced. This can give rise to vibration and shaking at the steering wheel.

1. Drain the oil from the power steering system as described earlier.
2. Remove the clamp bolt and disconnect the steering shaft from the power steering gear input shaft. If necessary use a lever to prise off the universal joint.



3. Fit socket 6459 mounted in torque wrench 9708 on the steering shaft.



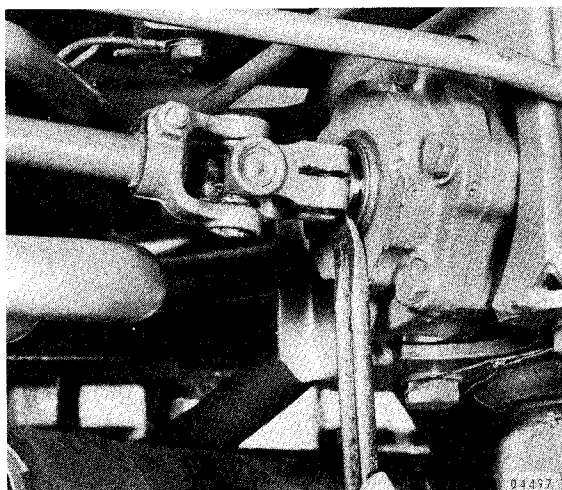
4. Turn the steering spindle from one full lock position to the other and count the number of turns. Turn back half that number and set the steering gear to the centre position according to the marking. The steering gear torque is greatest when the steering gear is in this position (pressure point).
5. Move the torque wrench backwards and forwards so that the steering gear centre position is passed in both directions. Across the centre position (pressure point) the torque reading should increase by 0.4-0.6 Nm (0.04-0.06 kgf m). If necessary adjust the pressure point on the sector shaft adjusting screw. Tighten the lock nut and re-measure.
6. Place the steering gear in the centre position according to the marking, with the steering wheel straight and the spokes parallel to the instrument panel.
7. Fit the steering shaft to the power steering gear. Fit and tighten the clamp bolt to a torque of 30 Nm (3 kgf m).
8. Fill the power steering system with oil and bleed as described earlier.

Replacing Input shaft sealing ring

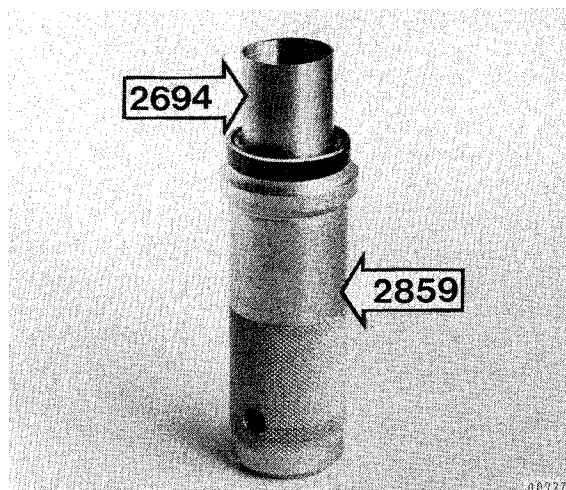
Special tools:

999-2694 Protection sleeve
2859 Hollow drift
6714 Puller

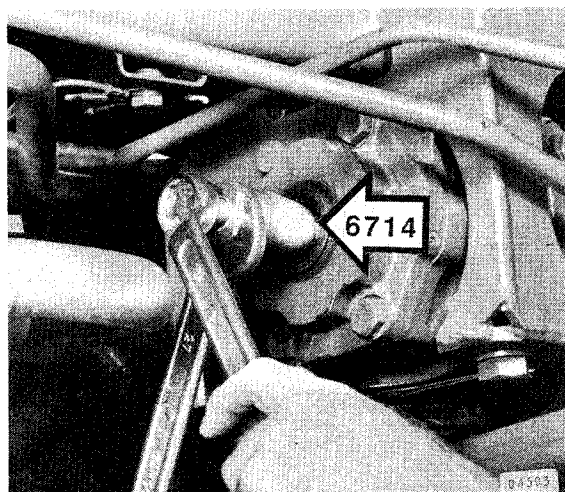
1. Ensure the bus wheels are pointing straight ahead. Remove the clamp bolt and remove the steering shaft universal joint from the steering gear input shaft. If necessary use a lever to prise off the universal joint.



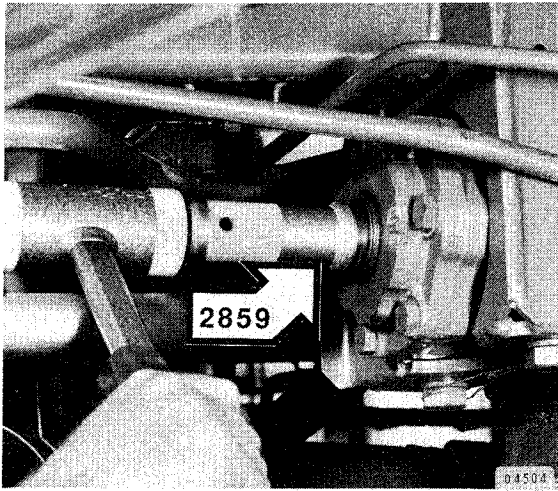
2. Place a container to collect oil underneath the steering gear and clean the area around the steering gear input shaft. Remove the dust cover and circlip in front of the sealing ring.
3. Prepare the new sealing ring by smearing it with oil and place it on protection sleeve 2694, with the flat side against the tapered end of the sleeve. Put the protection sleeve 2694 with the new sealing ring into hollow drift 2859, with the protection sleeve's tapered end facing downwards.



4. Remove the old sealing ring with extractor 6714.



5. Fit protection sleeve 2694 with sealing ring and hollow drift 2859 on the steering spindle. Tap on the sealing ring. The sleeve protects the sealing ring lip from being damaged by the steering input shaft splines.



6. Fit the circlip into its groove. Fit the dust cover.
7. Position the steering wheel straight with the spokes parallel to the instrument panel and the steering gear in the centre position according to the marking.
8. Fit the steering shaft universal joint on to the steering gear input shaft. Fit and tighten the clamp bolt to a torque of 30 Nm (3 kgf m).
9. Top up with oil and bleed as previously described.

Power steering gear, removal

Before removing the power steering gear from the bus, inspect the gear and its hydraulic oil connections for leaks and perform a functional check as described at the beginning of this section.

1. Drain the oil from the power steering gear as described earlier.
2. Remove the steering shaft universal joint from the power steering gear input shaft as described in Steering shaft - removal, step 1.
3. Disconnect the hydraulic oil connectors from the power steering gear unit.
4. Place a trolley jack under the power steering gear to take the weight.
5. Unbolt the power steering gear from the bus frame, lower the trolley jack and wheel it out from under the bus.

Dismantling

(Numbers in the text refer to the illustration on the next page)

Special tools:

999-2520 Frame

2694 Protection sleeve

2859 Drift

6459 Socket key

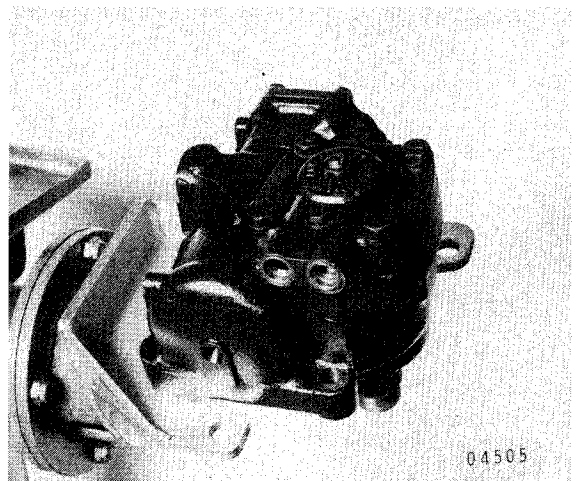
6516 Jlg

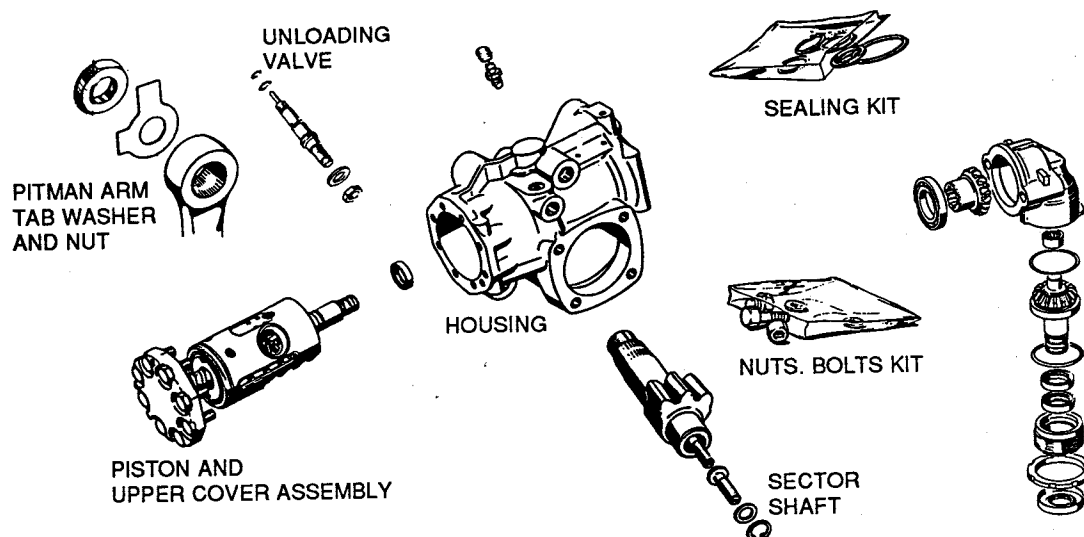
6714 Extractor

9177 Torque wrench or

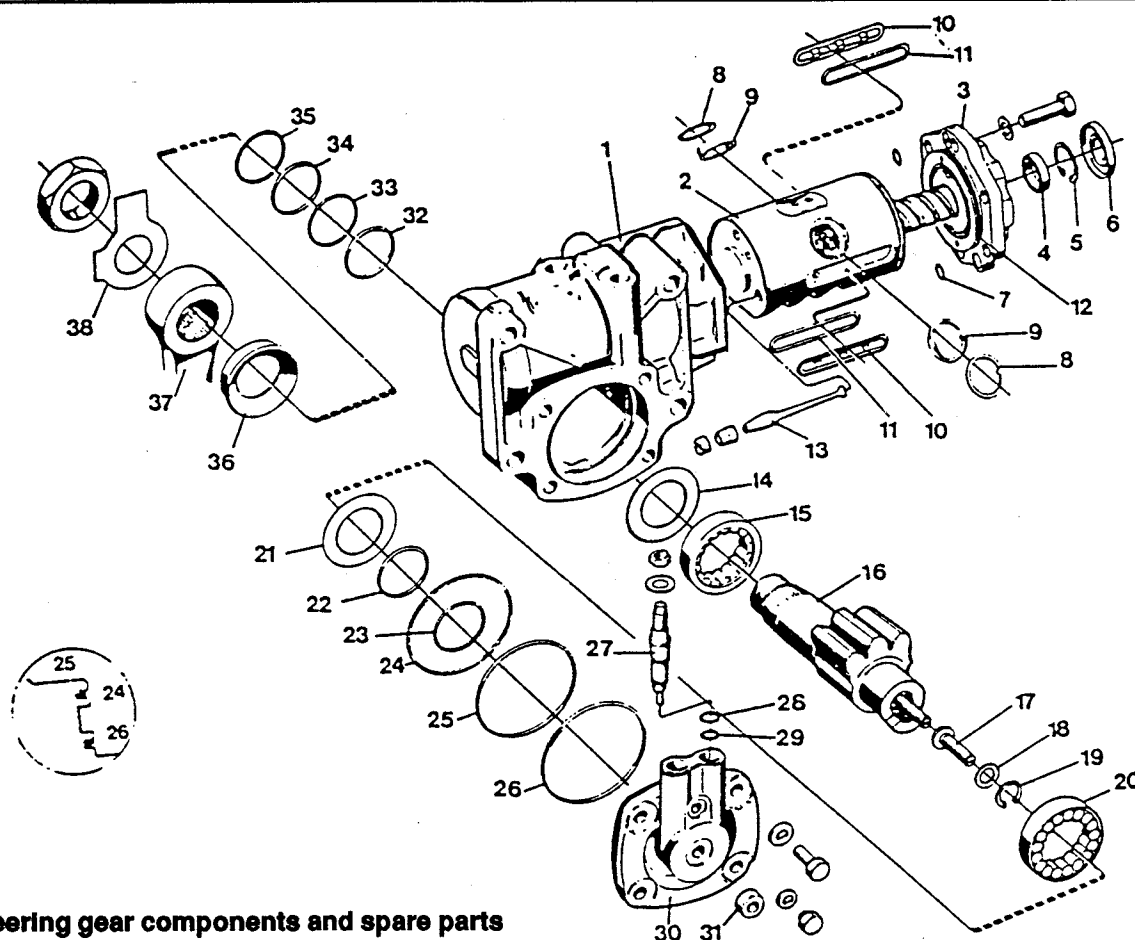
9708 Torque wrench

1. Carefully and thoroughly clean the outside of the power steering gear unit. Place the unit in the frame 2520 with jig 6516.





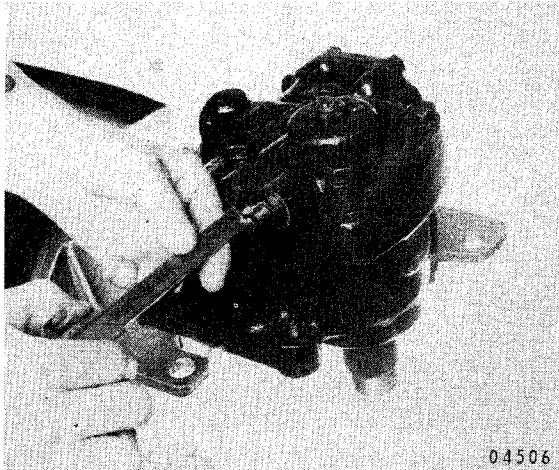
Spare parts



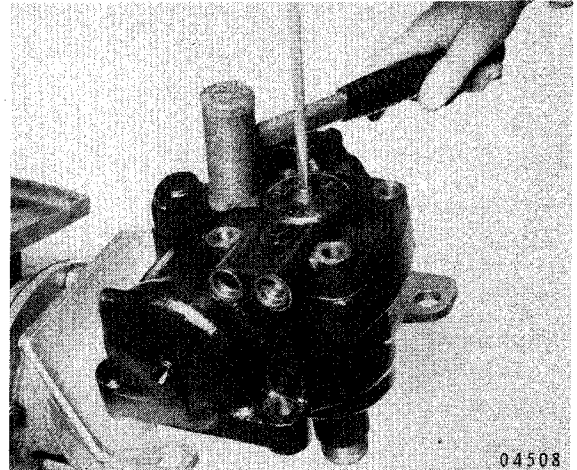
Power steering gear components and spare parts

1	Housing	14	Axial washer	27	Unloading valve
2	Piston	15	Roller bearing	28	O-ring
3	Upper cover	16	Sector shaft	29	O-ring
4	Input shaft seal	17	Adjusting screw	30	Side cover
5	Circlip	18	Shim washer	31	Lock nut
6	Dust cover	19	Circlip	32	Oval sealing ring (rubber)
7	O-rings (3 in kit, 2 used)	20	Roller bearing	33	Support ring (plastic)
8	Packing (plastic)	21	Axial washer	34	Oval sealing ring (rubber)
9	Packing (rubber)	22	Oval sealing ring (rubber)	35	Support ring (plastic)
10	Packing (plastic)	23	Support ring (plastic)	36	Dust cover
11	Packing (rubber)	24	Packing (plastic)	37	Pitman arm
12	O-ring	25	O-ring	38	Tab washer
13	Torsion rod	26	O-ring		

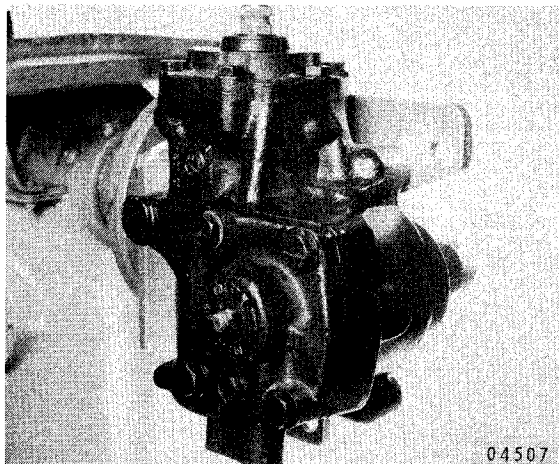
2. Place a container under the unit, remove the drain plug and drain out any remaining oil.
3. Measure and note the distance the two unloading valves (27) project from the side cover (30). Slacken the lock nuts and unscrew the unloading valves, noting where they fit so that they can be placed in their correct positions on reassembly.



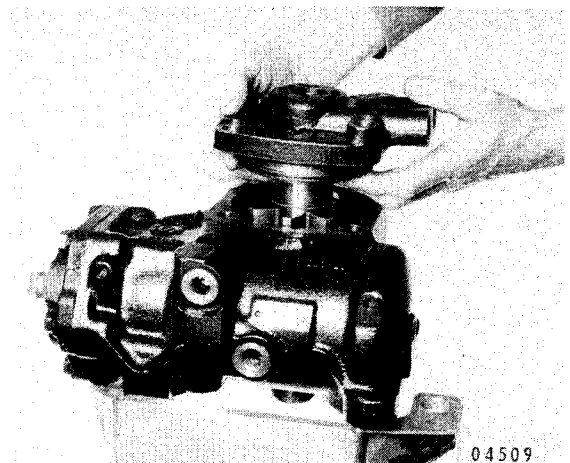
5. Screw the adjusting screw (17) in towards the cover; this will force the cover (30) out from the housing (1). Using a plastic-faced mallet tap the cover to help release it from the housing.



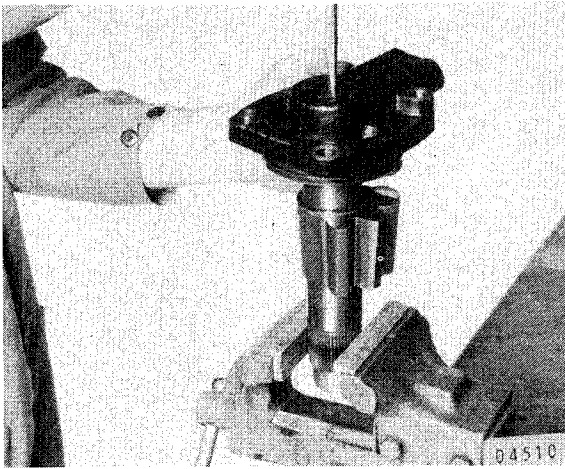
4. Make punch marks on the side cover (30) and housing (1) to ensure correct reassembly. Turn the input shaft to its centre position. Remove the side cover screws and the lock nut (31) for the adjusting screw (17).



6. Carefully lift the cover, complete with sector shaft (16), away from the housing.

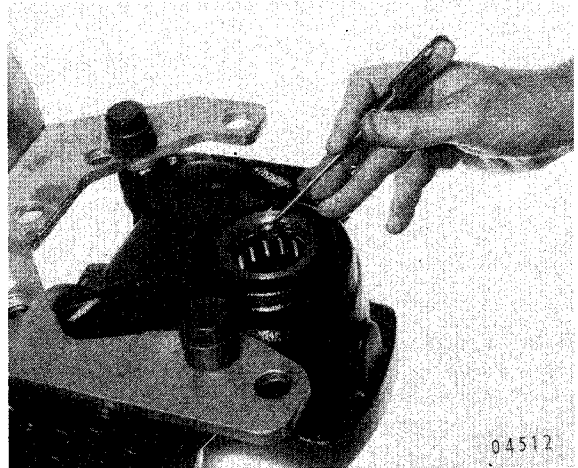


7. Remove the sector shaft by screwing the cover screw inwards. Remove the lock ring (19) and adjusting screw (17), with its associated shim washer (18) from the sector shaft.

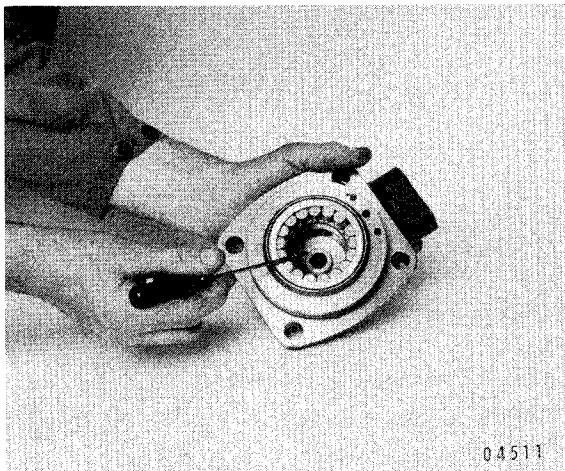


9. Remove the oval sealing rings (32, 34) and support rings (33, 35) from the housing.

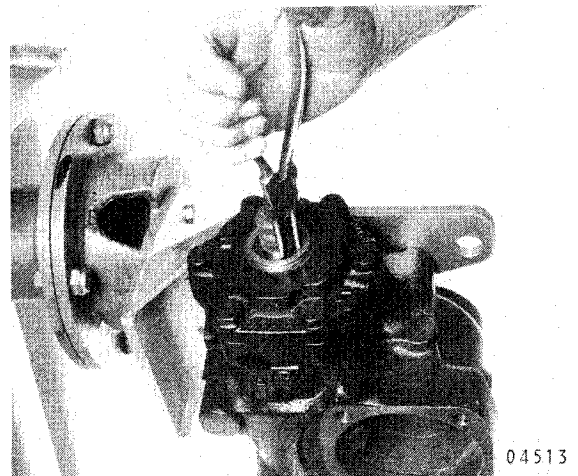
NOTE: If the roller bearing (15) is damaged it must be changed. If undamaged, it must not be removed, because the housing is peened over to hold it in place and an attempt to remove the bearing will damage it.



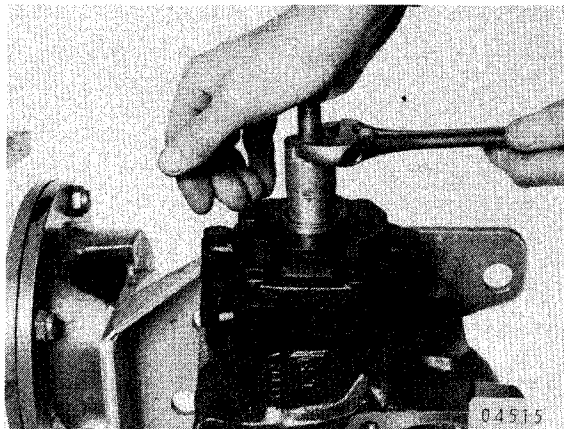
8. Remove the oval sealing ring (22), support ring (23) and O-ring (26) from the cover.



10. Begin removing the piston by removing the dust cover (6) and circlip (5).

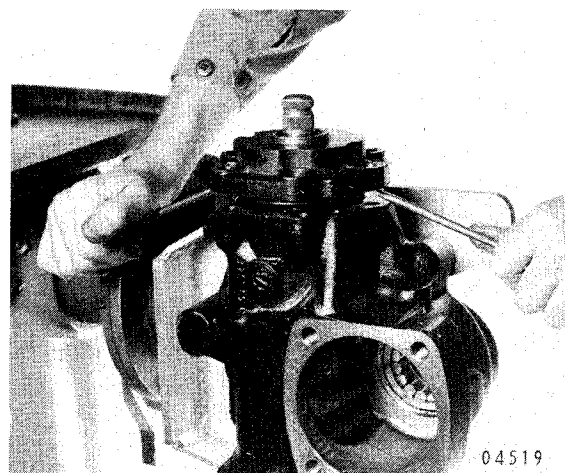
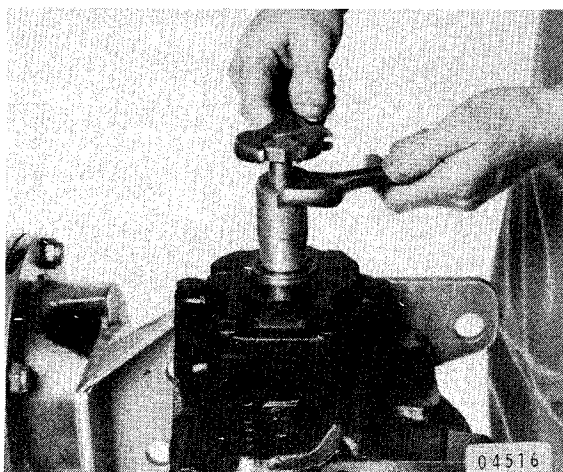
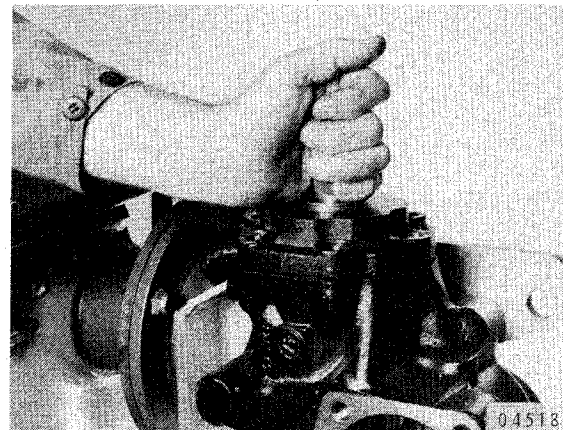


11. Using extractor 6714 remove the input shaft seal (4). As the extractor is turned, press it down so that it grips the metal shroud on the seal. Remove the seal by screwing the extractor in.



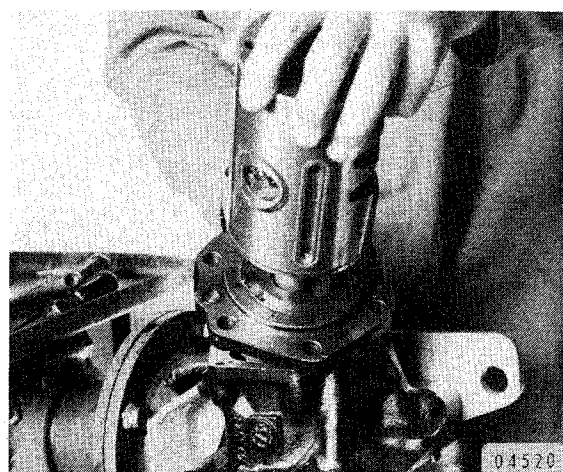
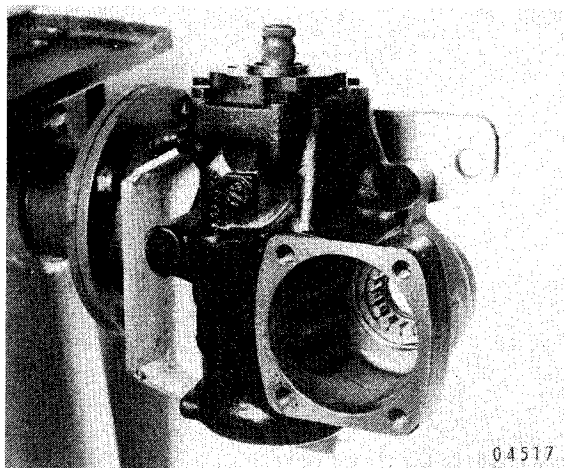
13. Turn the input shaft **clockwise** to release the upper cover (3) from the housing (1). Carefully lever the cover upwards with two screwdrivers and withdraw the piston (2).

NOTE: There are two small O-rings (7) between the cover (3) and housing (1).



12. Punch marks on the upper cover (3) and housing (1) to ensure correct reassembly. Remove the upper cover (3) securing screws.

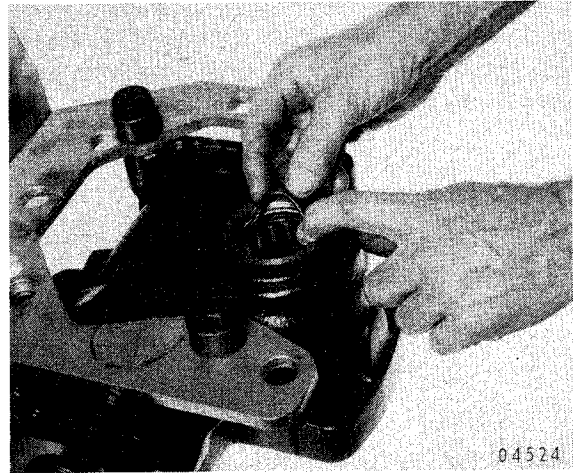
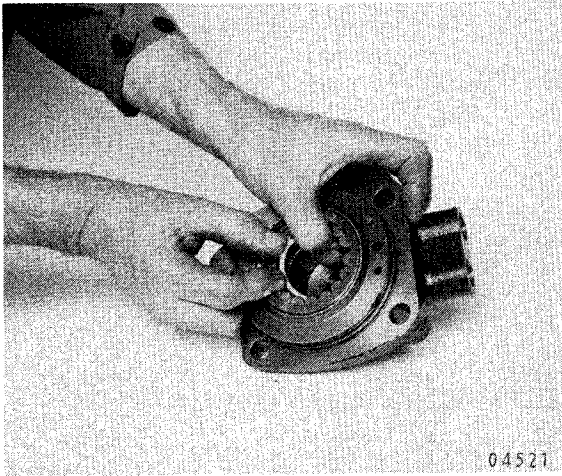
14. Remove the O-ring (12) from the cover.



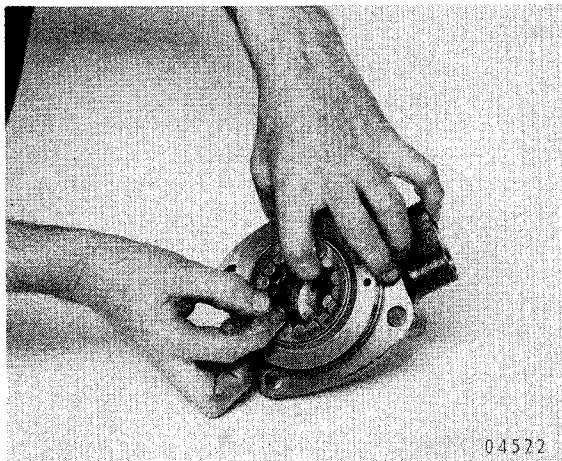
15. Clean and inspect all parts for damage or wear. Renew any damaged or worn components.

Reassembly

1. Fit the support ring (23), oval sealing ring (22) and O-ring (26) into the side cover (30).

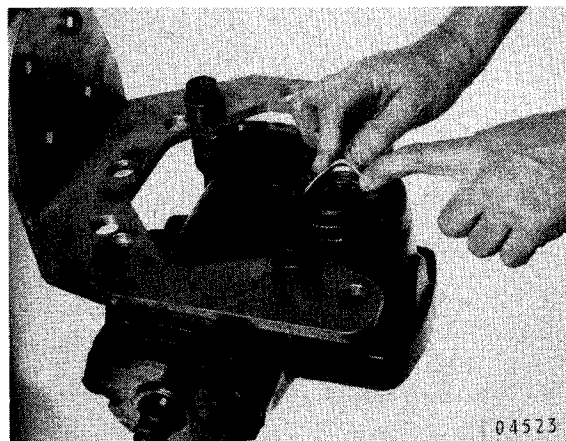


3. Fit the two small O-rings (7) into the cover (3).
4. Insert the piston (2) and upper cover (3) in the housing and carefully press them into place according to the markings made in Dismantling, step 12. Take care not to damage the sealing rings.

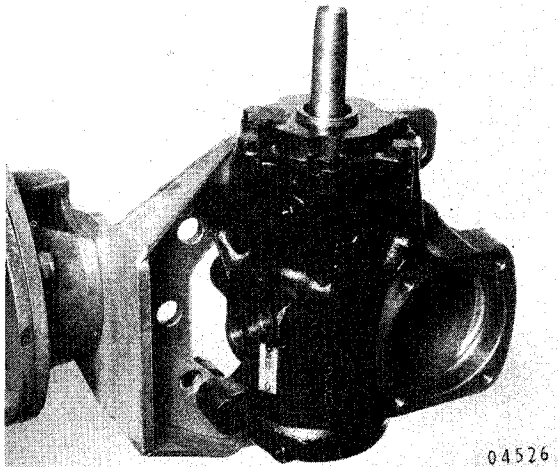


2. Insert the two support rings (33, 35) and the oval sealing rings (32, 34) into the housing (1). Fit a new O-ring (12) into the upper cover (3).

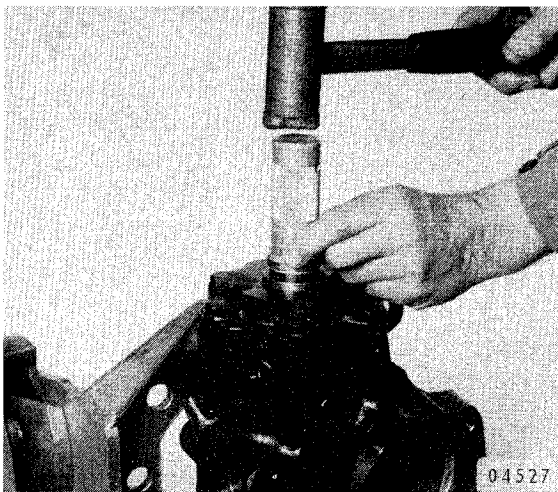
5. Insert the screws and tighten them diagonally to 115 Nm.



6. Position protection sleeve 2694 on the input shaft to prevent the seal lips from being damaged by the input shaft splines.

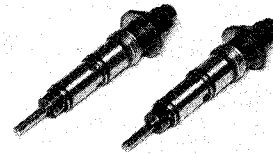


7. Tap in a new seal, with the flat side uppermost, using drift 2859. Fit the circlip (5) and dust cover (6).



8. Turn the input shaft so that the piston slides to its centre position. Ensure that the piston does not turn.
9. Fit the adjusting screw (17), adjusting screw shim washer (18) and circlip (19) in the sector shaft. If possible the adjusting screw should be fitted so that there is no play. It must however not bind, or have more than 0.05 mm play. Adjusting screw shim washers (18) are available in thicknesses of 2.95, 3.00, 3.05, 3.10, 3.15, 3.20, 3.25, 3.30 and 3.35 mm.
10. Fit the side cover (30) on to the sector shaft (16) by turning the screw (17) counterclockwise through the cover.

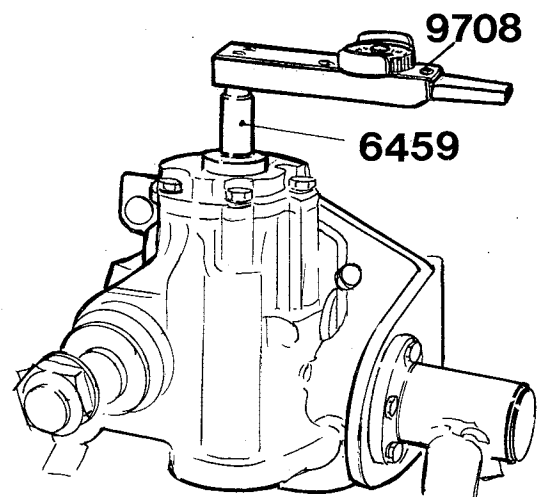
11. Place the assembled side cover (30) and sector shaft (16) on the housing.
12. While turning the adjusting screw (17) counterclockwise, carefully tap the side cover (30) with a plastic-faced mallet until it is located in the correct position, according to the punch marks made during dismantling.
13. Fit the side cover (30) securing screws and tighten to 190 Nm.
14. Fit O-rings (28, 29) on to the unloading valves (27) and screw the valves into the side cover (30) in the positions noted during dismantling. When they have been screwed in to their correct depths, tighten the locking nuts.



15. Screw the adjusting screw (17) inwards until the sector shaft reaches its lowest position. Fit but do not tighten the adjusting screw lock nut (31). The lock nut seal must face the cover.

Pre-adjusting sector piston pressure point

1. Screw socket key 6459 on to the input shaft. Ensure that the lock screws on the key fit in the groove so that the splines are not damaged. Put torque wrench 9177 or 9708 set to the 0-6 Nm range on the key. Turn the input shaft from one end to the other and count the number of turns. Turn back half the number of turns and position the steering gear in its centre position according to the markings on the input shaft and cover. This is the pressure point position.



2. Turn the input shaft one turn to the left away from the centre position. Begin turning the shaft back to the right again with the torque wrench and note the torque reading before the centre position.
3. Continue turning the shaft to the right past the centre position. Read the torque as it passes the centre position (pressure point). The torque at this point should be 40-60 Nm higher than that noted in step 2. This increased torque is due only to the preloading between the sector and ball nut, since all other factors which can increase the torque when the power steering gear is installed in the bus can be ignored.
4. If necessary adjust the pressure point with the sector shaft adjusting screw; screwing inwards increases the torque and screwing outwards decreases it. Re-check the pressure point torque if the adjusting screw position had to be altered.
5. When the correct preloading has been achieved tighten the lock nut to 90 Nm. Keep the adjusting screw in its preset position with a screwdriver.
6. Re-check the pressure point torque (steps 2 and 3) after tightening the lock nut. Unscrew the key 6459 from the input shaft. Remove the power steering gear from the frame 2520 and jig 6516.

Installation

1. Place the power steering gear unit in a trolley jack and wheel it under the bus.
2. Raise the jack to locate the unit in its correct position and bolt it to the bus frame. Note that the lower front bolt is a guide bolt to ensure precise fitting.
3. Make the hydraulic connections.
4. Fit the drag link and tighten to a torque of 350 Nm and then further to the next split pin hole. Lock the nut with a new split pin.
5. Slide the steering shaft universal joint on to the power steering gear input shaft, fit and tighten the clamp bolt to 30 Nm.
6. Fill the power steering gear with oil and bleed it as described earlier.
7. Check and adjust the pressure point with the power steering gear installed in the bus as described earlier.

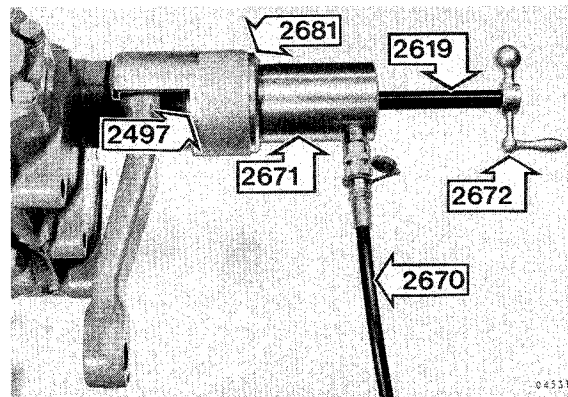
Pitman arm

Removal

Special tools:

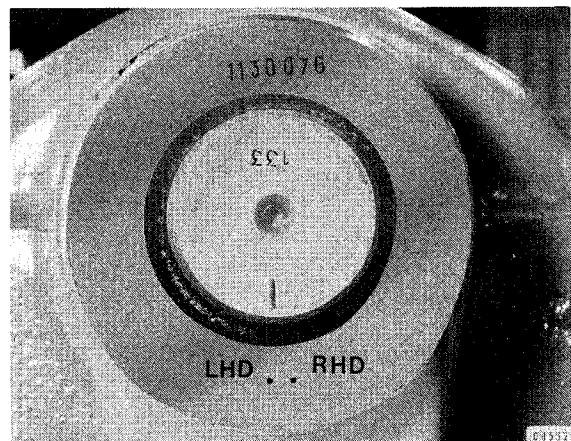
- 999-2497 Adaptor**
2619 Spindle
2670 Hydraulic hand pump
or 6222 Air-driven hydraulic pump
2671 Hydraulic pressure cylinder
2672 Crank
2681 Puller
9711 Torque multiplier

1. Jack up the bus and support the front axle on stands.
2. Remove the pitman arm using pump 2670 or 6222, cylinder 2671, crank 2672, spindle 2619, puller 2681 and adaptor 2497.



Installation

1. Grease the recess round the sector shaft with roller bearing grease.
2. Fit the pitman arm according to the marking; there are two punch marks for alignment, one for RHD and the other for LHD.

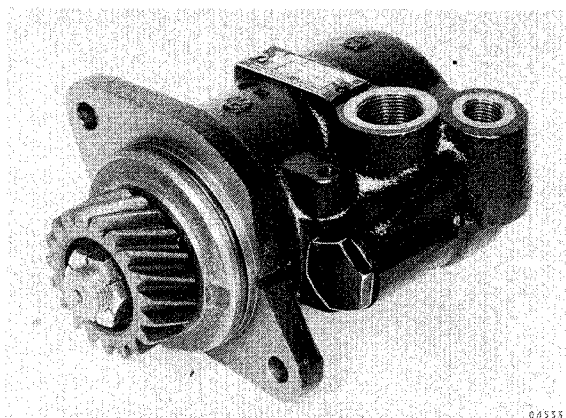
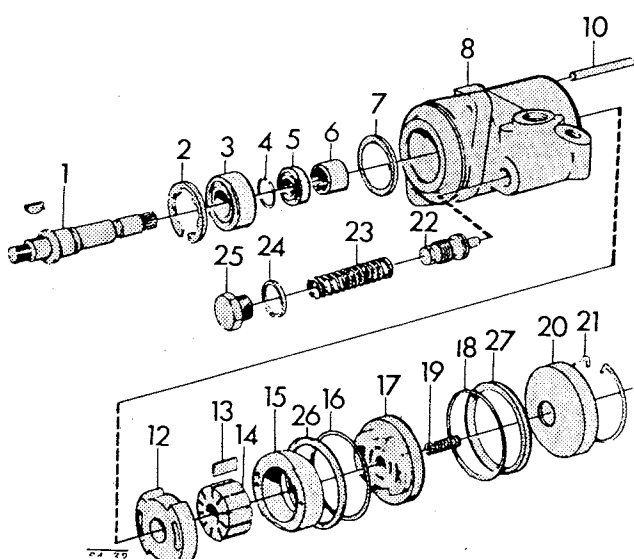


3. Fit the lock washer and screw on the pitman arm nut.
4. Fit the drag link and tighten to a torque of 350 Nm and then further to the next split pin hole. Lock the nut with a split pin.
5. Tighten the pitman arm nut, using torque multiplier 9711, to 550 Nm. Lock the nut with the lock washer.

Servo pump

Removal

NOTE: The greatest cleanliness must be observed when working on the power steering. Always clean around connections before disconnecting and clean the oil reservoir before taking off the cap. Drained oil must **not** be put back into the system.



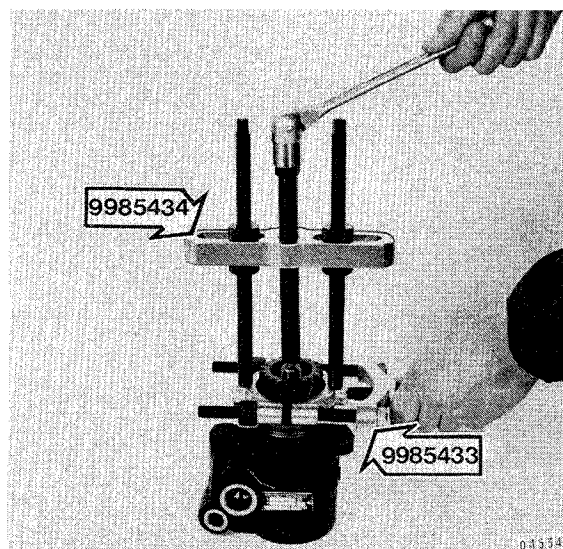
1. Drain the oil from the power steering as described earlier.
2. Unscrew the delivery oil line and suction oil line from the servo pump. Fit plastic plugs in the connection holes.
3. Unscrew the pump retaining bolts and remove the pump.

Dismantling

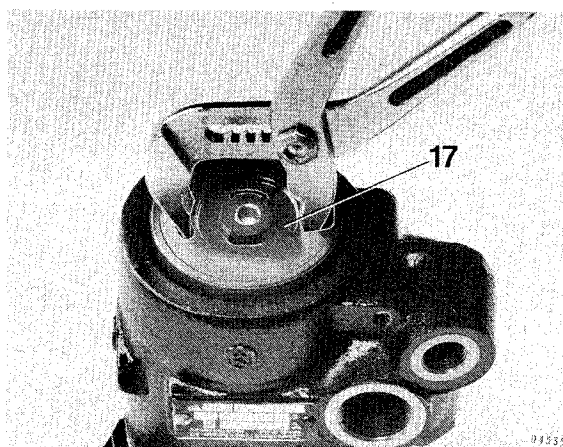
Special tool:

999-2337 Lever
998-5433 Puller
5434 Puller

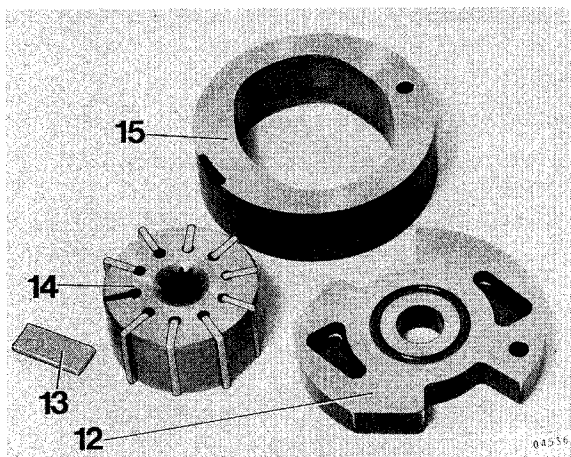
1. Clean the outside of the servo pump.
2. Clamp the gear wheel in a vice with soft jaws and unscrew the gear wheel nut. Pull off the gear wheel using pullers 5433 and 5434.



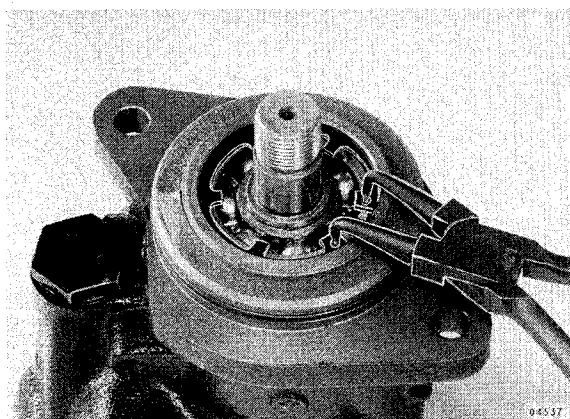
3. Remove the wire clip (21). Lift up the cover (20) with the help of tape or a sucker. Remove the spring (19).
4. Lift out the outer plate (17).



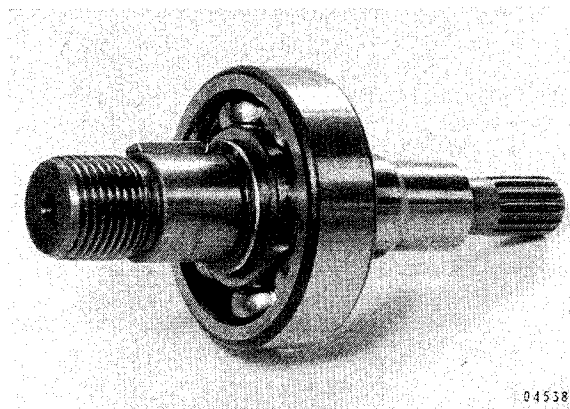
5. Invert the pump and shake out the rotor (14) with the vanes (13), and, if possible, the rotor housing (15) and inner plate (12). Otherwise the rotor housing (15) and the inner plate (12) can remain until tapped out during step 9 below.



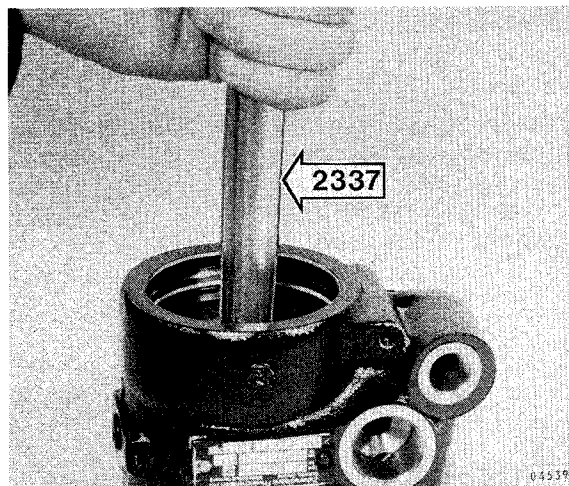
6. Remove the guide pin (10).
7. Remove the circlip (2).



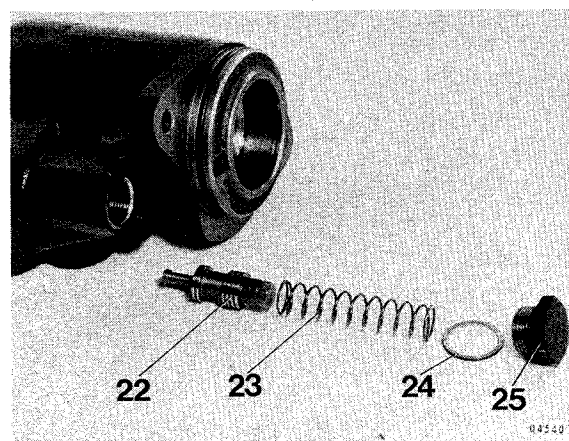
8. Tap out the shaft (1) and bearing (3) using a brass drift.



9. If not already removed in step 5, tap out the inner plate (12) and the rotor housing (15) from the drive side, using a 16 mm brass drift.
10. Press out the needle bearing (6) using a suitable drift.
11. Knock out the sealing ring (5) with lever 2337.



12. Unscrew the plug (25) for the control valve and remove the washer (24). Remove the spring (23) and the control valve plunger (22).



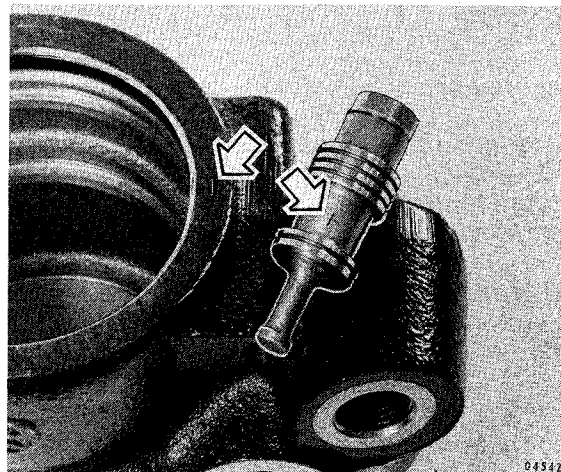
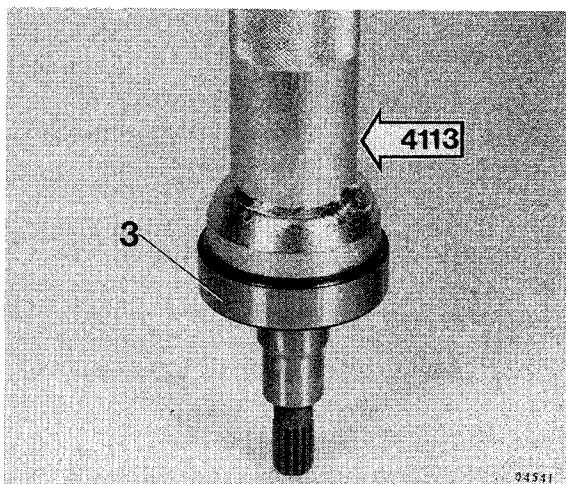
13. Remove the O-rings (7,16 and 18) and also the support rings (26 and 27) from the body (8).

Inspection

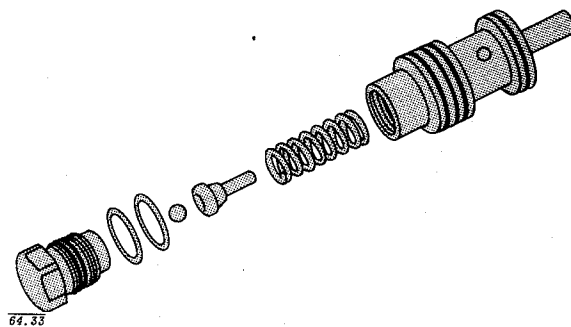
Special tool:

999-4113 Hollow drift

1. Clean all parts. Replace the sealing ring, O-rings and support rings.
2. Check the shaft (1), especially the sealing ring (5) sealing surface and the needle bearing (6) wear surface, also the threads and splines.
3. Check the bearing (3) on the shaft. If necessary replace the bearing by removing the circlip (4) and pressing the bearing off using hollow drift 4113. Fit a new bearing using the same drift.



8. If the control valve plunger is not to be replaced, screw it apart. Do not grip on the guide surfaces but use polygrip pliers to grip across the holes.
9. Clean and check the piston parts. If any part is damaged, discard the complete plunger assembly and fit a new one. If the plunger assembly is undamaged, screw the parts together. Fit the same number of adjusting washers under the bolt as were present during dismantling. The number of washers determines the pump's opening pressure (max. pressure).



4. Check the needle bearing (6) and replace it if necessary.
5. Check the outer and inner plates (17 and 12) for wear and scoring, particularly the surfaces which contact the rotor (14).
6. Check the rotor (14), the rotor housing (15) and the vanes (13) for wear. The vanes should move easily in the rotor slots. The rotor, vanes and rotor housing are replaced as a set.
7. Check that the control valve plunger does not bind in the body. If the plunger is to be replaced, make sure the new one is of the same tolerance group as the body, that is, their numbers agree (1 or 2 on the body and I or II on the control valve plunger).

10. Clean all parts thoroughly.

Reassembly

Special tools:

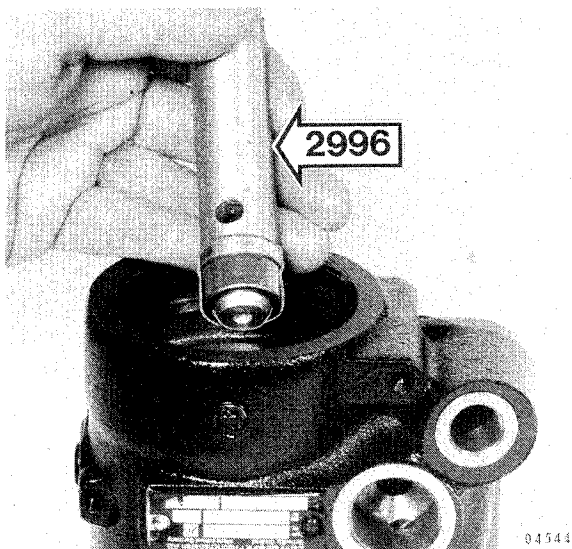
999-1801 Standard handle

2996 Drift

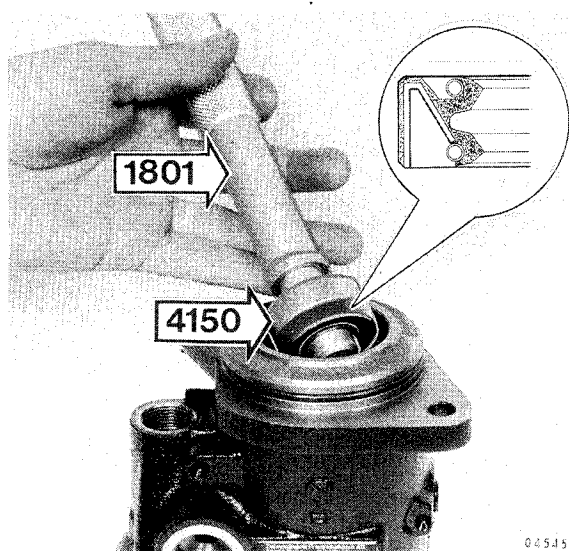
4113 Hollow drift

4150 Adaptor

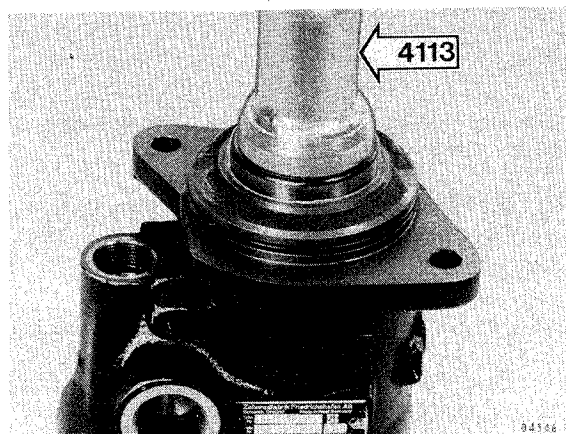
1. Using the narrow end of drift 2996, press the needle bearing (6) into the body until the drift bottoms in the body.



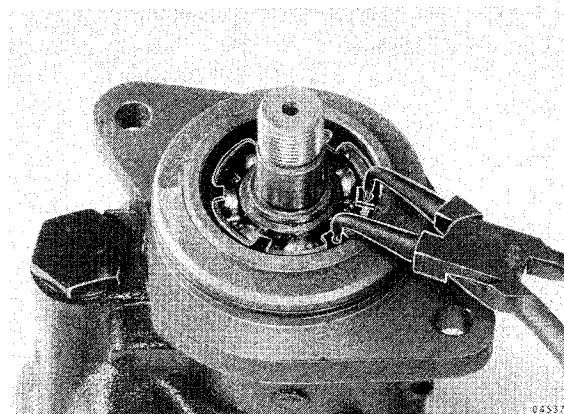
2. Fill the space between the sealing ring (5) lips with universal grease and press in the sealing ring using adaptor 4150 and standard handle 1801. The flat side of the sealing ring should face outward.



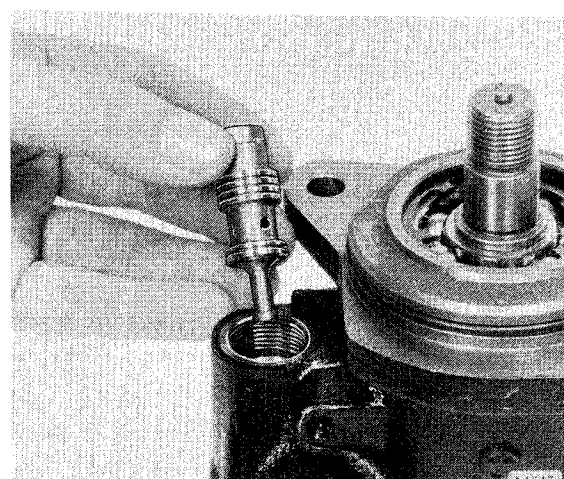
3. Place the shaft and bearing in the body. Press in the bearing using hollow drift 4113.



4. Fit the circlip (2).



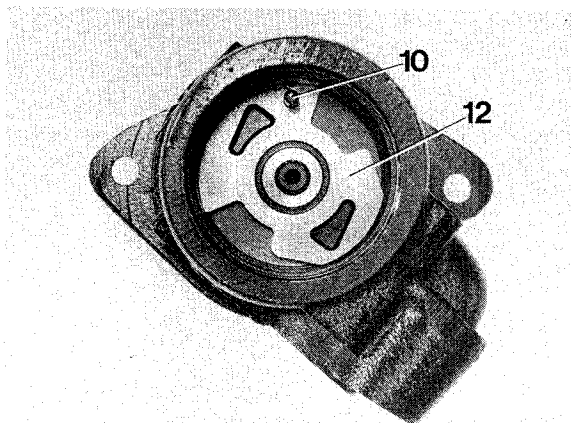
5. Fit into position the control valve plunger (22), the spring (23) and the washer (24). Screw in the plug (25).



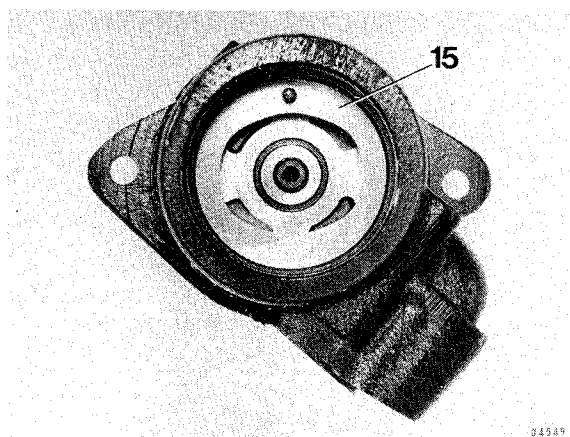
6. Fit the O-rings (16 and 18) together with the support rings (26 and 27) into the body (8).

NOTE: Make sure that the inner O-ring (16) and support ring (26) are smaller in diameter than O-ring (18) and support ring (27).

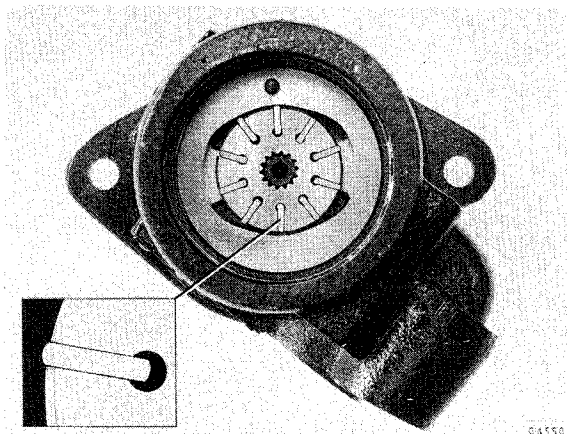
7. Fit the guide pin (10) and inner plate (12) in the body.



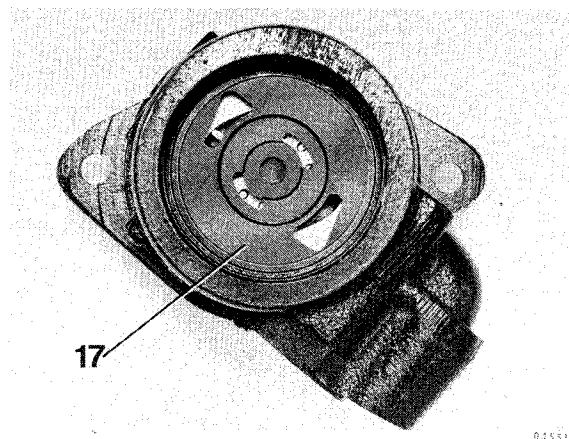
8. Place the rotor housing (15) in the body with the recess (shortened arrow) facing so that the arrow points in the direction of rotation (counterclockwise viewed from the drive side).



9. Place the rotor (14) in the rotor housing, already inside the pump body. The depression in the internal splines must face the drive side. Fit the vanes (13) into the rotor slots with the machined sides facing outward towards the rotor housing.



10. Place the outer plate (17) on the rotor housing (15) with the guide pin (10) in its hole. Carefully tap down the plate using a brass drift.



11. Place the spring (19) in the outer plate and fit the cover (20). Press down the cover and fit the lock ring (21).



12. Place the groove key in the shaft if it was removed. Heat the gear wheel to approx. 100°C, fit it on the shaft and screw on the nut. Tighten the nut to a torque of 90-110 Nm (9-11 kgf m).

Installation

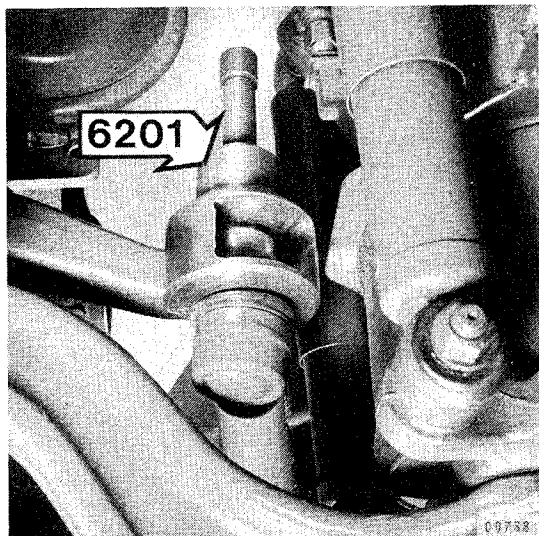
1. Fit a new O-ring on the pump.
2. Fit and tighten up the pump to a torque of 37 Nm (3.7 kgf m).
3. Clean the delivery and suction oil line connections and screw the lines into the pump.
4. Replace the filter, fill with oil and bleed the power steering as described previously.

Drag link Removal

Special tool:

999-6201 Puller

1. Remove the split pins and unscrew the drag link nuts at the steering arm and pitman arm.
2. Remove the drag link from the steering arm and pitman arm using puller 6201.

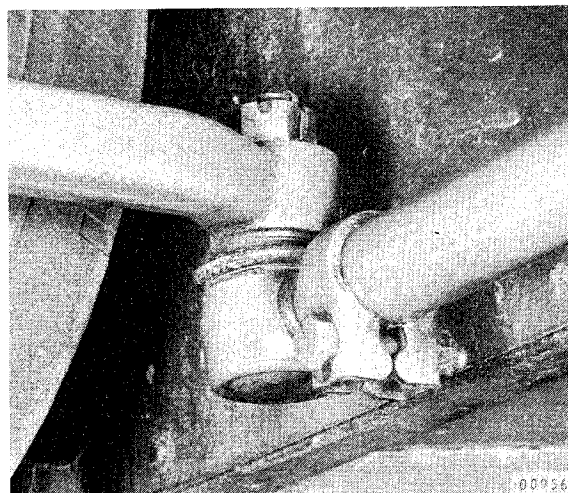


Track rod

Removal

Special tool:

999-6201 Puller



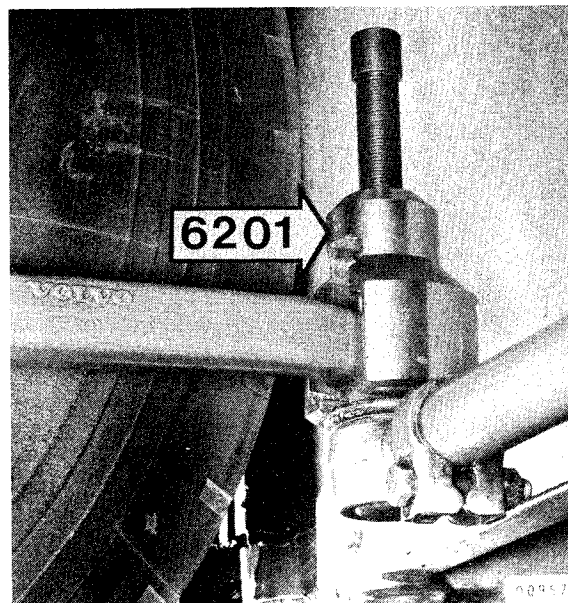
1. Remove the split pins and unscrew the nuts at the steering arms. Remove the track rod using puller 6201.

3. Replacing ball joint:

Slacken the clamp bolt and unscrew the ball joint, taking care to ensure that the drag link length remains unchanged. Do not tighten up the clamp bolt until the steering has been adjusted on drag link installation, see step 3 in the following section.

Installation

1. Fit the drag link and ball joint assembly to the steering arm. Fit and tighten the nut to a torque of 160-210 Nm (16-21 kgf m) and then further to the next split pin hole. Lock the nut with a new split pin.
2. Point the front wheels straight ahead. Turn the steering wheel from full lock to full lock and count the number of turns. Turn back the steering wheel half this number of turns and set the steering gear to the centre position according to the marking.
3. Adjust the drag link to the pitman arm by slackening the clamp bolt and adjusting the length. Fit the nut and tighten up the clamp bolt. Tighten the nut to a torque of 70-90 Nm (7-9 kgf m) and then further to the next split pin hole. Lock the nut with a new split pin.



2. Replacing ball joint:

Slacken the clamp bolts and unscrew the ball joint. Screw on the new ball joint so that the track rod length is the same as before. Do not tighten up the clamp bolts until toe-in has been checked and if necessary adjusted.

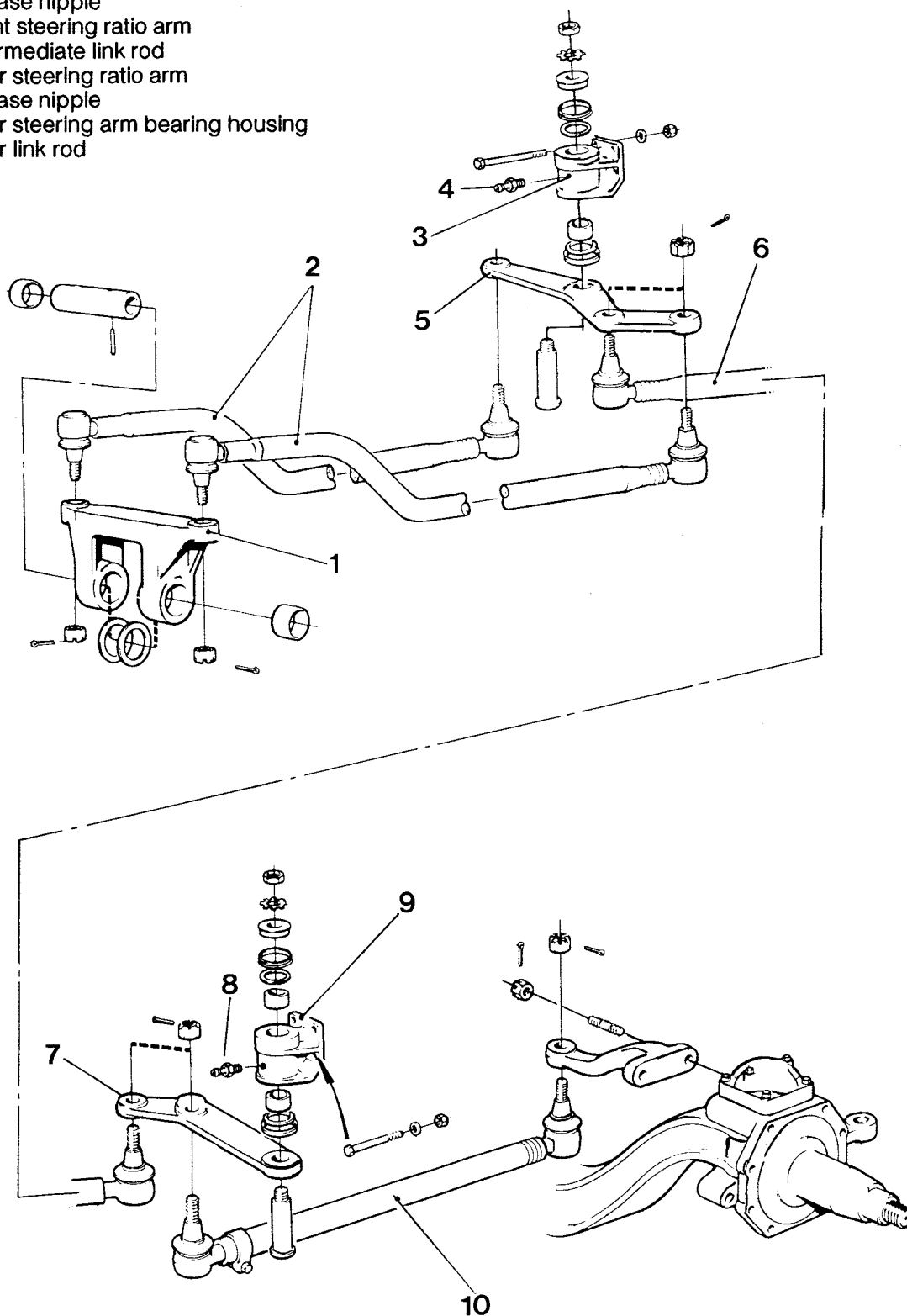
Installation

1. Fit the track rod to the steering arms and screw on the nuts. Tighten the nuts to a torque of 200 Nm (20 kgf m) and then to the next split pin hole. Lock the nuts with new split pins.
2. Check and if necessary adjust the toe-in as described in Group 60, Service Procedures.

Trailer steering system

Trailer steering components

- 1 Steering link
- 2 Front link rods
- 3 Front steering arm bearing housing
- 4 Grease nipple
- 5 Front steering ratio arm
- 6 Intermediate link rod
- 7 Rear steering ratio arm
- 8 Grease nipple
- 9 Rear steering arm bearing housing
- 10 Rear link rod



Articulated buses with steered trailers use a steered linkage connected to the turntable. The linkage is arranged so that the trailer unit wheels steer in the opposite direction to the tractor unit's front steered axle wheels, thus reducing the sweep.

The steering link (1) attached to the turntable moves when the tractor unit begins a turn. This causes the front link rods (2) to impart a turning motion to the front steering ratio arm (5), which is pivoted on the trailer frame and turns within the front steering arm bearing housing (3), lubricated via a grease nipple (4). The intermediate link rod (6) is connected to the front steering ratio arm at a point which provides the required steering ratio.

The forwards or backwards movement of the intermediate link rod (6) acts on the rear steering ratio arm (7) which is again pivoted on the trailer frame in the rear steering arm bearing housing (9), lubricated by a grease nipple (8). The rear link rod (10) thus receives a further reduction in steering ratio according to its connection position on the rear steering ratio arm (7). The desired turning movement is then applied by the rear link rod (10) to the steering arm on the knuckle on the steering side. The movement is transmitted by a track rod (not shown) to the steering arm on the non-steering side steering knuckle.

Service Procedures

Checking and adjusting tracking

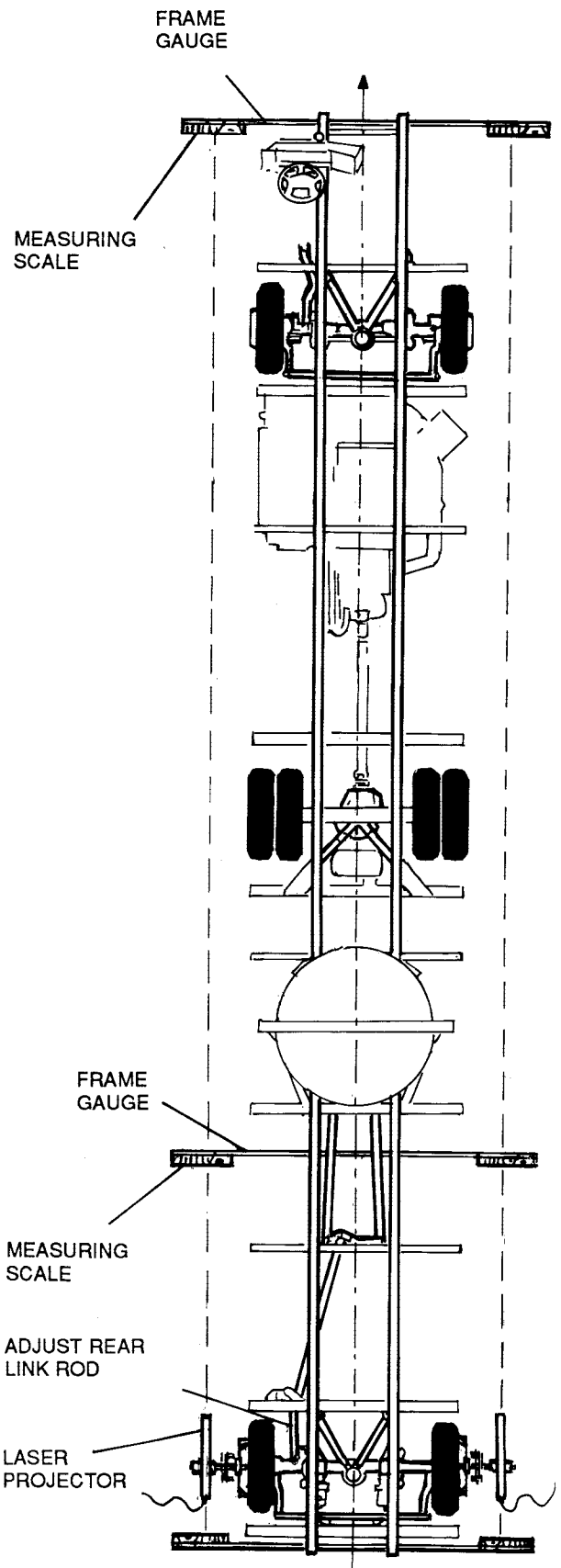
Faulty tracking in the trailer unit will cause the trailer to wander out of line with the tractor unit when the bus is travelling straight. There will also be an increase in sweep radius on one side and a reduction in sweep radius on the other side when cornering. Incorrect tracking will also result in excessive tyre wear.

1. Drive the bus forwards so as to position the bus and trailer, aligned as straight as possible, on a flat floor over a pit. Lines painted on the floor will help to show misalignment.

NOTE: Perfect alignment between the tractor and trailer unit will only be possible if the drive axle is exactly at right angles to the longitudinal centre line of the bus frame.

WARNING: When using laser projectors, do not look directly into the laser beam from the projector; the beam may cause eyesight injury.

2. Disconnect one end of the rear link rod (see illustration on next page) and support it out of the way of the suspension members.
3. Attach scaled measuring rods as shown to the frame members; one at a suitable position on the frame of the tractor unit (such as at the front end), one on the trailer unit just behind the turntable and the third at the rear of the trailer unit.



Location of measuring scales when checking trailer unit tracking

4. Check by using the laser projector or projectors (the procedure is easier if two laser projectors can be used), that the tractor and trailer units are absolutely straight. Compare the positions of the laser spots on all three measuring scales, at both sides of the bus, to check this alignment. If necessary use a jack to move the trailer unit sideways. The bus and trailer are aligned straight when all three scales on each side have the same reading. Lower the jack when the units are aligned.
5. Fit toe-in measuring scales to both the trailer unit measuring rods and note the position of the light spot on each side, if necessary moving the laser projector. Measure both forwards and backwards on each side of the bus.
6. The amount of toe-in on the trailer wheels is represented by the difference (if any) between the left and right side readings on the toe-in scales. The toe-in should preferably be between 1 and 3 mm, although the specification permits toe-in to be zero. If necessary jack up the trailer unit, adjust the track rod, lower it to the ground and repeat the measurements until the toe-in is within these limits and is equal on both sides.
7. Remove the toe-in scales from the trailer measuring rods, and remove the measuring rods and laser projector(s).
8. Adjust the length of the rear link rod so that it will fit into the joint from which it was disconnected in step 2.
9. Test drive the bus, with an observer checking that the trailer wheels follow in the tracks of the tractor drive wheels when driving straight, and that the trailer sweep radius is the same when turning both left and right.

Trailer link rods, replacement

Special tool:

999-6201 Puller

Removal

1. Remove the split pins and the nuts at the ball joints.
2. Remove the link rods using puller 6201.

Installation

3. Fit the link rod to the ball joints and tighten the nuts to a torque of 200 Nm, then further to the next split pin holes. Insert new split pins to secure the nuts.

Trailer steering link bushing, replacement

Special tools:

999-2497 Adapter

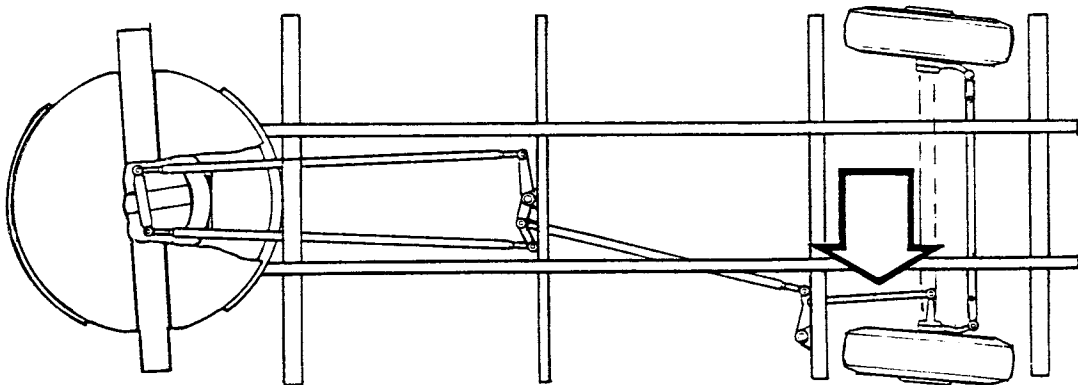
6159 Pin

6161 Hydraulic cylinder

6201 Puller

6222 Hydraulic pump

1. Completely open the underside of the trailer unit bellows at the turntable.
2. Remove the split pins and castellated nuts from the front link rod (2) ball joints.
3. Using a narrow drift, tap out the lock pin for the shaft in the trailing unit steering link (1).
4. Place wooden blocks under the steering link (1). Press the shaft out of the steering link (1) with the help of hydraulic cylinder 6161, pin 6159, adapter 2497 and hydraulic pump 6222. Take care of the two spacer washers at the centre of the shaft.
5. Remove the wooden blocks from under the steering link (1) so that it rests on the frame member under the turntable.



Rear link rod, adjustable to obtain correct tracking

6. Using puller 6201 remove the link rod ball joints from the steering link (1). Lower the steering link away from the turntable.
7. Remove and discard the steering link bushings. Grease the new bushings, insert them into the steering link and lift it into position on the turntable.
8. Attach the link rods (2) to the steering link (1).
9. Position the shaft and align the hole for the lock pin. Support the steering link with wooden blocks. Place the spacer washers between the steering link and frame member and tap in the shaft. Remove the wooden blocks and tap in a new lock pin.
10. Tighten the castellated nuts on the ball joints to a torque of 200 Nm and fit the split pins.
11. Apply rustproofing to the steering link and the link rod ball joints.
12. Close the underside of the turntable bellows.

Trailer front steering ratio arm, removal

Special tool:

999-6201 Puller

1. Disconnect the intermediate link rod (6) front ball joint from the front steering ratio arm (5) using puller 6201. Support the rear end of the intermediate link rod (6) to prevent it from jamming in the rear steering ratio arm attachment.

2. Remove the four bolts securing the front steering arm bearing housing (3) on the cross-member. Lower the steering arm (5) to the edge of the recesses in the rear plate on the trailer unit bellows.
3. Using puller 6201 disconnect the rear ball joints on the front link rods (2) and take down the front steering ratio arm (5) together with the intermediate link rod (6).

Trailer rear steering ratio arm, removal

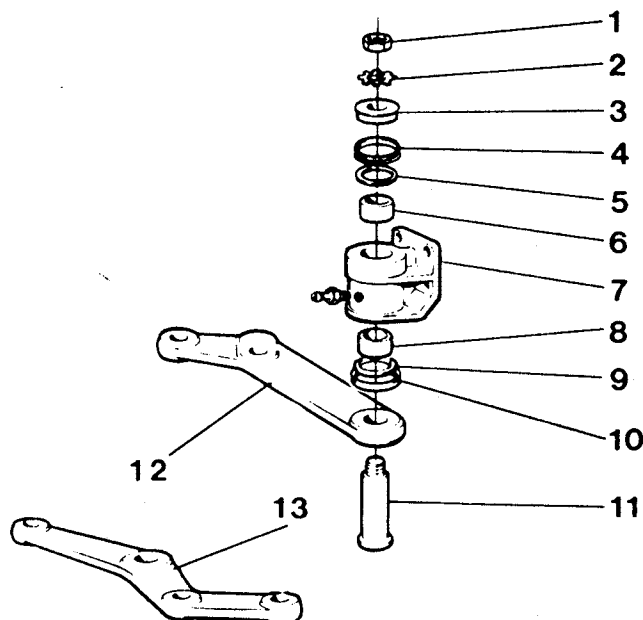
Special tool:

999-6201 Puller

1. Disconnect the rear link rod (10) and intermediate link rod (6) from the rear steering ratio arm (7), using puller 6201.
2. Remove the four bolts securing the rear steering ratio arm bearing housing to the frame and remove the complete steering arm and bushing assembly.

Replacing bushings in bearing housings

1. Unscrew the bearing housing nut (1) and remove the bearing housing from the steering arm shaft.
2. Using a hydraulic press, press the shaft (11) out of the steering arm.
3. Tap out the two bushings (6 and 8) from the bearing housings.



- | | |
|---|------------------------------------|
| 1 | Nut |
| 2 | Lock washer |
| 3 | Washer |
| 4 | Sealing ring |
| 5 | Thrust washer |
| 6 | Bearing bushing |
| 7 | Bearing housing with grease nipple |

- | | |
|----|--------------------------|
| 8 | Bearing bushing |
| 9 | Thrust washer |
| 10 | Sealing ring |
| 11 | Shaft |
| 12 | Rear steering ratio arm |
| 13 | Front steering ratio arm |

4. Install new bushings (6 and 8) and a new shaft (11).
5. Clean the bearing housing and lubricate with chassis grease. Place a sealing ring (10) on top of the steering arm. Place a thrust washer (9) on the underside of the bearing housing (with the teflon-lined surface, if there is one, facing down towards the steering arm). Fit the bearing housing to the steering arm. Place the upper thrust washer (5) in the bearing housing (with the teflon-lined surface, if there is one, facing upwards).
6. Tighten the nut (1) and bend down the lock washer tabs.
7. Connect the appropriate link rod or rods to the steering arm.
8. Lift the assembly into position and tighten the four bolts securing the bearing housing to the cross-member to a torque of 140 Nm. Tighten the castellated nuts on the link rod or rods to 200 Nm and then further to the next split pin hole, and insert new split pins.

Malfunction

FAULT	
REASON	REMEDY

Steering stiff in both directions

Oil level too low and/or air in power steering

Fill with oil
Check power steering for leakage
Bleed and top-up with oil.

Oil flow in power steering insufficient

Check function of power steering
Check that filter is not clogged or cracked
and that suction line is not blocked.
Dismantle and check servo pump.

Excessive internal leakage in steering box.

Dismantle and check power steering gear.

Steering wheel and steering shaft universal joints bind.

Replace universal joints.

Steering stiff in one direction

Unloading too early.

Check and adjust unloading mechanism.

Incorrectly adjusted and/or faulty valves or seals
in steering box.

Disassemble and check power steering gear.

Steering heavy with rapid steering wheel turns

Insufficient oil flow in power steering.

Check power steering function.

Air in power steering.

Check power steering for leakage.
Bleed and top-up with oil.

Stiff return to straight ahead steering

Abnormally large resistance in wheel suspension.

Check tyre pressures.
Check that steering knuckles do not bind.

Pressure point set too hard.

Adjust pressure point.

Too little caster.

Adjust caster.

FAULT	
REASON	REMEDY

Difficult to hold straight course

Oil level too low and/or air in power steering.

Fill with oil.
Check power steering for leakage.
Bleed and top-up with oil.

Steering incorrectly adjusted.

Adjust steering gear in centre position according to marking, when front wheels point straight ahead.

Pressure point incorrectly adjusted.

Adjust pressure point.

Looseness in steering shaft universal joints and/or ball joints.

Replace steering shaft universal joints and/or ball joints.

Retaining bolts for steering gear or its bracket have loosened.

Tighten to correct torque.

Impacts felt in steering wheel

Oil level too low and/or air in power steering.

Fill with oil.
Check power steering for leakage.
Bleed and top-up with oil.

Pressure point set too loose.

Adjust pressure point.

Looseness in steering wheel and steering shaft universal joints.

Replace universal joints.

Faulty power steering gear.

Dismantle and check power steering gear.

Steering wheel vibration

Front wheel throw or imbalance.

Check and balance brake drums and front wheels.

Steering wheel independently goes to full lock position

Steering gear's steering valve mechanism faulty.

Dismantle and check power steering gear.

Torsion rod incorrectly adjusted.

Dismantle and check steering gear

FAULT	
REASON	REMEDY

Noise in power steering

Oil level too low and/or air in power steering.

Fill with oil.
Check power steering for leakage.
Bleed and top-up with oil.

Faulty servo pump.

Dismantle and check servo pump.

Faulty steering gear.

Dismantle and check power steering gear.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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Reference to Service Bulletins

VOLVO

Volvo Bus Corporation
Göteborg, Sweden