
Repair Manual

***911 Carrera*
(993)**

**Volume I:
General
Engine**

Preface

Structure

The "Technical Literature" for the "911 Carrera (993)" model is basically structured as before, i.e. the structure follows the familiar repair groups.

A new feature is that the structure includes the main groups **0 to 9** and the main group **D**.

Main groups:	0	Complete vehicle – General
	1	Engine
	2	Fuel, exhaust, engine electrical system
	3	Transmission
	4	Chassis
	5	Body
	6	Body equipment, outside
	7	Body equipment, interior
	8	Air conditioning
	9	Electrical system
	D	Diagnosis

Layout

The layout in the below items remains unchanged throughout the repair manual

1. Table of tightening torques
2. Special tools required
3. Exploded views
4. Legends for the exploded views
5. Assembly notes / use of special tools

As a new feature, however, the former item 6 (Repair group diagnosis) is no longer filed in the volume corresponding to the respective repair group. The **Diagnosis test plans / diagnosis procedures** have been combined in a **separate Diagnosis volume** broken down according to the main groups 0 to 9.

Another new feature is that the contents of the "Service Information Technik" are indicated in the Repair Manual. This brochure concentrates on a description of the design and function of components and of the new features introduced for a particular model year.

Service Number

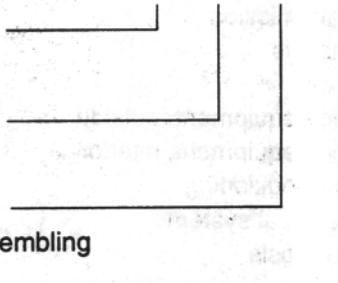
All major repair procedures and repair descriptions are identified by a two- or four-digit **Service Number** completed by two additional digits to identify the work that corresponds to the first six digits of the working position number in the Working Times and Damage Catalog.

Example: 30 37 37 Dismantling and assembling clutch control shaft

Explanation: 30 37 37 50 (full working position number)

Repair group

here: Clutch, control

**Component designation**

here: Clutch control shaft

Activity

here: Dismantling and assembling

Index

here: Removed

Presentation in the various documents

30 37 37 50 Working position no. from
Working Times and Damage Catalog,
consisting of repair group, component designation, activity and index

30 37 37 Six-digit number in **Repair Manual**,
consisting of repair group, component designation and activity

30 37 Service number in **Service Information**,
consisting of repair group and component designation

Goal

The introduction of a service number in the "technical literature" is intended to facilitate standardization and positive identification to allow direct cross-referencing among the various documents. This is of particular importance with regard to the use of electronic media.

Structure of the Repair Manual

This Repair Manual describes all the important operations that require special instructions to ensure proper completion. This manual is an essential source of information for the shop foreman and the shop mechanics as the information in this manual must be observed at all times to keep the vehicle in safe and roadworthy condition. The basic safety rules of course also apply without exception to all repairs on motor vehicles.

Breakdown of the Repair Manual

1. Overview of repair groups
2. Registration sheet for supplements
3. List of contents
4. Technical data
5. Repair groups

Breakdown of the repair groups

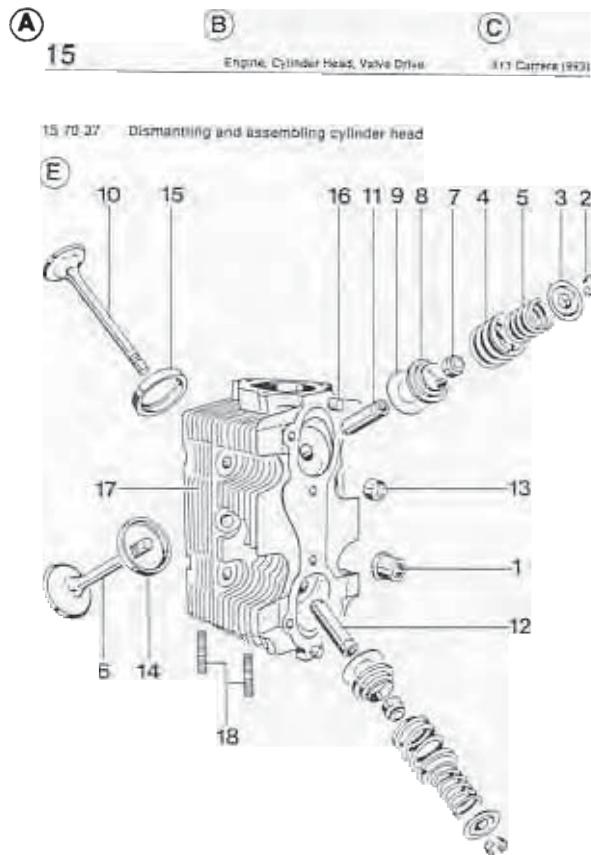
1. Table of tightening torques
2. Special tools required
3. Exploded views
4. Legends for the exploded views
5. Assembly notes / use of special tools
6. Diagnosis for repair groups

The Repair Manual will be updated regularly with supplements which must be filed immediately to maintain the usefulness of the manual. Appropriate entries must be made in the registration sheet to prove that the manual is complete.

The contents of the Repair Manual will be supplemented by Technical Information Bulletins which will be integrated into the manual from time to time.

Descriptions of design and function can be found in the service training course reference material.

Layout of the exploded view



C 15 **B** Engine, Cylinder Head, Valve Drive
911 Carrera (939)

G **H**

No.	Designation	Qty.	Removal	Note:	Installation
1	Cylinder head nut	4	Use screwdriver insert for 9295 polygon-head nut		Apply a thin coat of Optimoly HT to cylinder head nut bearing surface
2	Valve collet	4			
3	Valve spring retainer	2			
4	Valve spring, outer	2			
5	Valve spring, inner	2			
6	Inlet valve	1			
7	Valve stem seal	2	Pull off		Replace, use assembly sleeve
8	Valve spring ring	2			
9	Washer	1			
10	Exhaust valve	1			
11	Valve guide, inlet	1			
12	Valve guide, outlet	1			
13	Thread insert	2			
14	Valve seat insert, inlet	1			
15	Valve seat insert, exhaust	1			
16	Roll pin	2			Pressed in to stop
17	Cylinder head	1			Fitted with Locite 270, protruding length 23 - 0.5 mm. Screw studs with unmarked end into cylinder head (exhaust side)
18	Studs M 8 x 22	2			

15 - 4

15 70 37 Dismantling and assembling cylinder head
Printed in Germany - I, 1993

15 - 5

D**E****F****F****E****D**

- A - Repair group, numbers
- B - Repair group, text
- C - Type of repair vehicle
- D - Page number
- E - Operation, including "Service No." and "Title"
- F - Impressum, supplement number, year of printing
- G - Diagram item number in dismantling sequence
- H - Special notes for removal or installation

The assembly notes/Special Tool lists following the exploded view are always arranged in the order of text → diagram.

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I General / Engine

The Repair Manual of the 911 Carrera (993) also includes the 911 Carrera 4 manual (993 four-wheel drive). The 911 Carrera (993) is the basic model covered by the repair operations described in this Manual. "911 Carrera (993)" is also indicated in the header of each page.

Descriptions of repair operations that deviate for the 911 Carrera 4 will be included after the respective 911 Carrera section. The repair descriptions of both models are separated by a cover page. All pages included after the cover page (separation sheet) have the "911 Carrera 4" heading. To facilitate distinction, the page numbering will start with 100.

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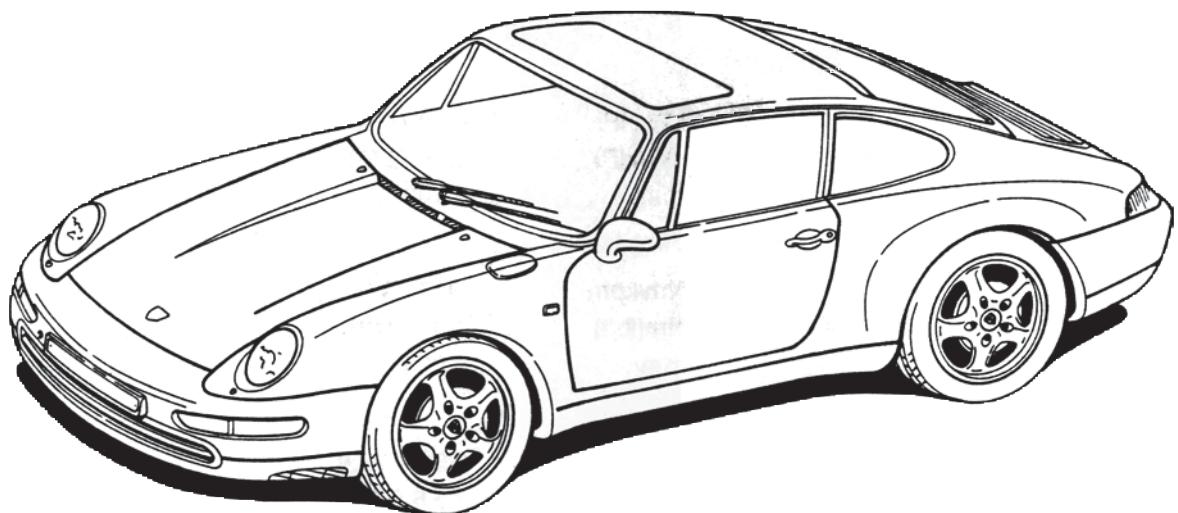
The Service Information gives a detailed description of the technical features of the new 911 Carrera.

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911 Carrera
(993)



Technical data

(Adjusting values and wear limits are included in the respective repair groups)

Note: U.S. values are given in brackets

Drive unit

Internal engine designation	Manual transm.	Row M 64 / 05	USA 07
	Tiptronic	Row M 64 / 06	USA 08
No. of cylinders		6	
Bore	mm/in.	100 (3.94)	
Stroke	mm/in.	76.4 (3.01)	
Displacement (actual)	c.c./cu.in.	3600 (219.7)	
Compression ratio		11.3 : 1	
Max. engine power			
to 80/1269 EEC	kW/HP	200 / 272	
Net Power, SAE J 1349	kW(HP)	200 (270)	
at engine speed	rpm	6100	
Max. torque			
to 80/1269 EEC	Nm/kpm	330/33.6	
Net Torque, SAE J 1349	Nm(lbft)	330 (243)	
at engine speed	rpm	5000	
Max. specific power output			
DIN 70020	kW/l/HP/l	55.6 / 75.6	
SAE J 1349	kW/l (HP/l)	55.6 (75,0)	
Rpm limiter,			
fuel cutoff at	rpm	6700	
Idle speed	rpm	800 ± 40	
Fuel octane rating	RON/MON	98/88	
Engine weight (dry, ready for fitting)			
Manual transmission	kg (lbs)	232 (511)	
Tiptronic	kg (lbs)	224 (494)	

Engine design

Type	6-cylinder four-stroke internal combustion engine with 2 horizontally opposed cylinder banks (flat engine)	
Crankcase	Light-alloy, two-piece	
Crankshaft	Forged, 8-bearing design	
Main bearings	Friction bearings	
Connecting rods	Forged	
Big end bearings	Friction bearings	
Pistons	Light alloy, pressed	
Cylinders	Light alloy, individual cylinders	
Cylinder head	Light alloy, individual cylinder heads with ceramic exhaust port liners	
Valve guides	Press-fitted	
Valve arrangement	1 inlet, 1 exhaust, suspended in V-design	
Valve timing	One overhead camshaft each on right and left	
Camshaft	Cast	
Camshaft drive	Double chain	
Valve clearance	Hydraulic lash adjustment	
Timing for 1 mm valve lift and zero clearance	Inlet opens Inlet closes Exhaust opens Exhaust closes	1 degree BTDC 60 degrees ABDC 45 degrees BBDC 6 degrees ATDC
Induction system	With controlled tuning flap	

Engine cooling

	Air-cooled system
Fan drive	Via V-belts from the crankshaft
Transmission ratio: Crankshaft to fan	approx. 1:1.60
Air delivery rate	1010 l / sec at 6,000 rpm of crankshaft

Engine lubrication

	Dry sump lubrication with separate oil tank
Oil cooling	Thermostatically controlled, front oil cooler in right-hand front fender, 2-stage electric fan
Oil filter	in return line
Oil pressure at n = 5,000 rpm	approx. 6.5 bar at 90° C oil temperature
Oil pressure indicator	0...5 bar, electric, and oil pressure warning lamp
Oil consumption	up to 1.5 l / 1000 km

Exhaust system

Twin-branch system, heat exchanger with joining of exhaust pipes outside of heat exchanger, twin-branch 3-way catalytic converter with Lambda control and central induction across mixing chamber, one muffler per exhaust line

Emission control

Lambda control with 3-way catalytic converter (metal carrier) or internal engine control

Heating

Engine-dependent hot air heating with additional electric fans and automatic temperature control

Fuel system

Type	DME (Digital Engine Electronics)
Fuel supply	1 electric roller cell pump

Clutch

Manual transmission	Single-plate dry clutch hydraulically operated double-mass flywheel
Thrust plate	G MFZ 240
Drive plate	rigid, dia. 240

Electrical system

Interference suppression	ECE-R 10 and 72/245/EEC	
Battery voltage	V	12
Battery capacity	Ah	75
Alternator output	A/W	115/1610 A/C
Ignition	DME, dual ignition, knock control	
Firing order	1 - 6 - 2 - 4 - 3 - 5	
Ignition timing control	Via DME	
Spark plugs	Bosch FR 6 LDC Bosch FR 5 DTC Beru 14 FR - 5 DTU	
Spark plug gap	mm (in)	0.7 + 0.1 (0.026 + 0.004)

Body construction

Integral steel body, electrically extending rear spoiler, Coupé, optionally with sunroof, Cabriolet

Dimensions (at DIN curb weight)

		Row	USA
Length	mm (in.)	4245 (167.1)	4260 (167.7)
Width	mm (in.)	1735 (68.3)	
Height	mm (in.)	1300 (51.2)	1315 (51.8)
	Sport chassis	1285 (50.6)	
Wheelbase (design)	mm (in.)	2272 (89.4)	
Front track	mm (in.)	1405 (55.3)	
Rear track	mm (in.)	1444 (56.9)	
Ground clearance (at gross vehicle weight)	mm (in.)	110 (4.3)	120 (4.7)
	Sport chassis	90 (3.5)	
Ramp angle (at gross vehicle weight)	degrees	13.0	
	Sport chassis	12.0	
Front overhang angle (at gross vehicle weight)	degrees	11.0	
	Sport chassis	10.5	
Rear overhang angle (at gross vehicle weight)	degrees	12.5	13.1
	Sport chassis	11.5	

Weights to DIN 70020 (manual transmission)

Total curb weight	kg	1370	
Curb weight to 70/156/EEC	kg	1445	
Gross vehicle weight	kg	1710	1690
Max. front axle load	kg	720	
Max. rear axle load	kg	1065	
Max. roof load including roof rack	kg/lbs	75 (165) with original Porsche roof transport system	

Capacities

Engine	Use only approved engine oils. Refer to Technical Information Handbook
Engine oil capacity	Approx. 11.5 l (approx. 9 l for oil change) Determined by measurements with oil dipstick as per Owner's Manual
Manual transmission with differential Tiptronic with torque converter	3.6 l approx. 9 l
Differential	0.9 l
Fuel tank	approx. 71 l (approx. 10 l reserve)
Brake fluid reservoir	approx. 0.34 l
Washer fluid for windshield and headlights	approx. 7.3
Power-assisted steering	approx. 1.0 l ATF (Dexron)

Performance (manual transmission)

Top speed	km/h / mph	270 (168)
Acceleration from 0 to 100 km/h	s	5.6
Kilometer from standing start	s	25.1

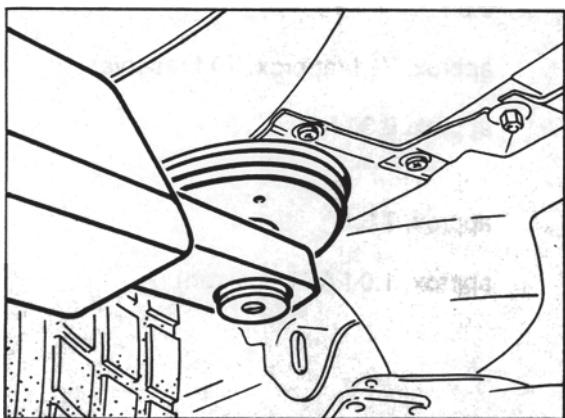
Hill climbing

Manual transmission		
In %	1st gear	75%
	2nd gear	51%
	3rd gear	33%
	4th gear	23%
	5th gear	16%
	6th gear	11%

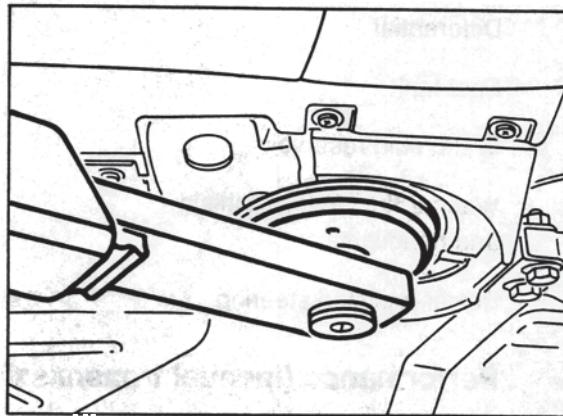
Raising the vehicle

The vehicle may only be raised at the jacking points illustrated. When driving the vehicle onto a lifting platform, make sure that there is sufficient clearance between the platform and the vehicle.

Front



Rear



1421-03

1422-03

Service every 20,000 km

Page

Diagnosis system: read out fault memory	1
Change engine oil	
Air cleaner: replace filter element	
Particle filter: replace filter element	
V-belt or Polyrib belt: check condition and tension	
Replace spark plugs (only on vehicles without catalytic converter)	
Visual check for leaks: oils and fluids	
Crankcase ventilation: check tightness of hose connections	
Fuel system: visual inspection for damage, routing and tight fit of line and hose connections	
Intake air system: check hoses, lines and connections for tight fit	
Parking brake: check free travel of parking brake lever	
Brake system: visual check of brake pads and brake discs for wear	
Brake hoses and pipes: visual check for damage, routing and corrosion	
Clutch: check free travel and pedal end position	
Throttle actuator: check for smooth operation and full-load position	
Check operation of resonance flap	
Steering gear: visual check of rubber bellows for damage.	
Tie rod joints: check play and condition of dust caps	
Power steering: check fluid level	14
Ball joints: visual inspection of dust caps for damage. Check bolt connections of front and rear suspension alignment for tight fit	
Transmission / final drives: check oil levels	15
Automatic transmission: check ATF fluid level	
Drive shafts: visual inspection of bellows for leaks and damage	
Exhaust system: visual inspection for leaks and damage, check fitting	
Tires: check condition and tire pressure	
Door hinges: lubricate with oil	
Check door and hinge locks and safety hook of front hood for tightness and operation	
Seat belts: check operation and condition	
Seals of doors, hoods and roof: remove rubber abrasions. Apply suitable lubricant.	
Check operation of vehicle lighting. All headlights: check adjustment.	
Signal horn: check operation	
Windshield washer system, headlight cleaning system: Check fluid level and nozzle adjustment, check antifreeze content in winter season	21
All other electrical systems, monitor lamps and warning lamps: check operation	21
Ignition circuits 1 and 2: check operation	
Test drive:	
Brake pedal and parking brake, clutch, automatic speed control, steering, heater, air conditioning and instruments: check operation	
Visual inspection for leaks: oils and fluids	22

Additional service every 40,000 km	Page
Automatic transmission: change ATF and ATF filter	23
Toothed belt for power steering: check condition	
Replace spark plugs (only for vehicles with catalytic converter)	
Replace both engine oil filters	
Additional service every 80,000 km	
Replace fuel filter	30
Manual transmission / final drives: change oil	
Automatic transmission: change oil in final drive	
Yearly service – starting after the first 2 years	
File Status Report for Long-life warranty	
Service every 3 years	
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Service every 4, 8, 10 years and then every 2 years	
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Recommended annual service	
Visual inspection for leaks: oils, fluids	
Diagnosis system: read out fault memory	
Parking brake: check free travel of parking brake lever	
Brake system: visual check of brake pads and brake discs for wear	
Check brake fluid level	
Steering gear: visual inspection of bellows for damage	
Tie rod joints: check play and condition of dust caps	
Ball joints: visual inspection of dust caps for damage	
Drive shafts: visual inspection of bellows for leaks and damage	
Exhaust system: visual inspection for leaks and damage, check fitting,	
Tires: check condition and tire pressure	
Seals of doors, hoods and roof: remove rubber abrasions. Apply suitable lubricant.	
Check operation of vehicle lighting.	
Windshield washer system, headlight cleaning system: Check fluid level and nozzle adjustment, check antifreeze content in winter season.	
Battery: Check electrolyte level and electrolyte density	30
All other electrical systems and monitor lamps and warning lamps: check operation	
File Status Report for Long-life warranty (first report after 2 years)	
Test drive:	
Brake pedal and parking brake, clutch, automatic speed control, steering, heater, air conditioning and instruments: check operation	
Visual inspection for leaks: oils and fluids	

03 20 00 Maintenance

Diagnosis system:

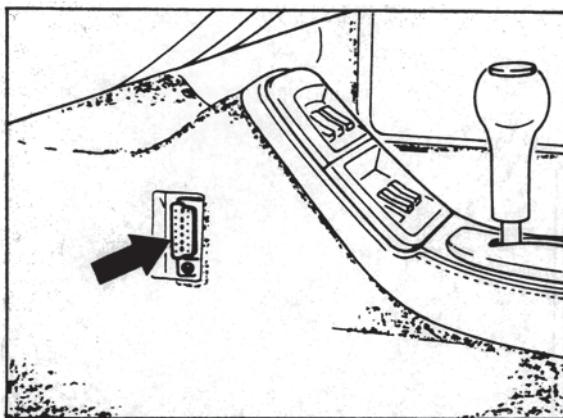
Reading out the fault memory

The procedure for reading out the fault memory is described in the operating instructions for System Tester 9288. A copy of the operating instructions is supplied with each tester.

The System Tester 9288 is connected to the vehicle via a 19-pin socket. The socket is located in the passenger footwell next to the glove box.

Also refer to Repair Group 03, Diagnosis, for operating instructions, repair group D, volume 8 diagnosis.

Starting with Model Year '95, the diagnostic socket is located on the left-hand side of the center console and is fitted with a plugged-on cover

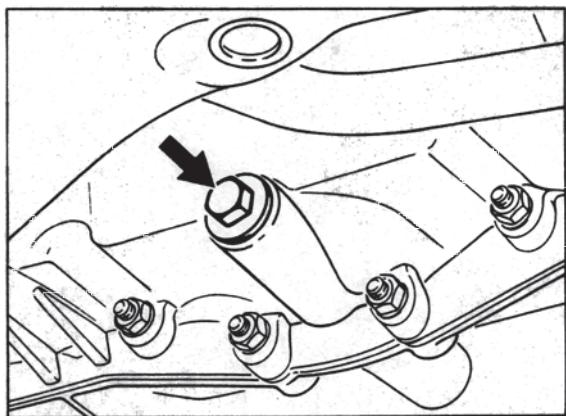


Changing engine oil (without filter)

Precondition: Engine at operating temperature (70...90° C oil temperature)

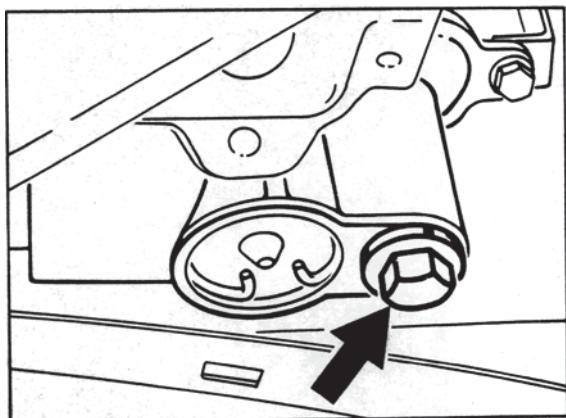
1. Remove engine guard and right-hand side member panel. Undo the drain plugs in the crankcase and thermostat housing and drain engine oil.

Crankcase drain plug



605-03

Thermostat housing drain plug



1454-03

2. Clean drain plugs. Always replace the seals. Tightening torque of drain plugs is

50 Nm (37 ftlb.):

at the thermostat housing

50 + 5 Nm (37 + 3.7)

at the crankcase 50 + 5 Nm (37 + 3.7)

3. Fill with approx. 6 liters of engine oil. Run engine at idle and top up with approx.

3 liters. The oil change capacity is approx.

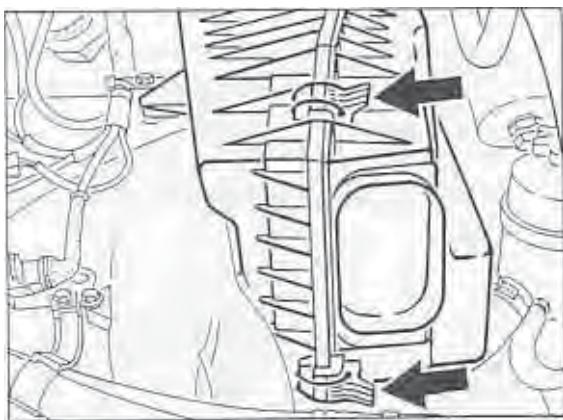
9 liters. Use only approved engine oils. Refer to Technical Information Handbook.

Check oil level at operating temperature and at idle speed (refer to Owner's Manual).

Check engine, oil reservoir, lines and front oil cooler for leaks (visual inspection)!

Air cleaner:**Replacing the air cleaner element**

1. Unhook clamps and lift off housing cover.



1417-03

2. Take out filter element and clean filter housing with a lint-free cloth.
3. Fit new filter element.

Check hose connections of entire intake system for tight fit!

Particle filter:

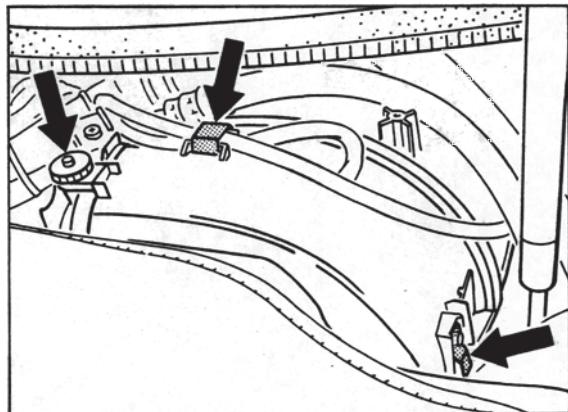
Replacing filter element

Note

The particle filters are fitted on the left and right-hand sides in front of the heater/air conditioning housing.

Removal

1. Remove cover for heating and air conditioning system. Screw out knurled nut and disengage retaining clamps from housing cover using a screwdriver. Lift off housing cover.



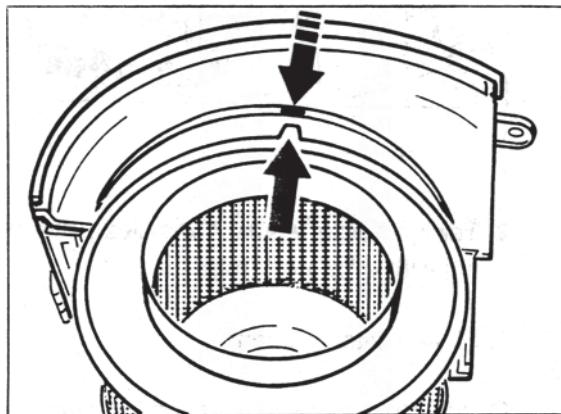
1469-03

2. Take particle filter out of housing duct from above.

Installation

1. Place particle filter into housing duct. Assembly mark faces up.
2. Fit housing cover into housing duct from above and align with assembly mark of particle filter (refer to Fig.).

Fig. shows rear of particle filter and housing cover



1470-03

3. The assembly mark of the particle filter is visible from outside in the housing cover.

Checking and/or adjusting alternator, fan wheel and air conditioning compressor drive belts

Caution: Make sure the ignition key is pulled off whenever measurements are made.

Checking used drive belts

(alternator and fan wheel)

Use belt tension measuring instrument (Special Tool 9574) to check tension.

A description of how to use the Special Tool is contained in Repair Group 13, page 13 - 30.

Retensioning the belt is only required if the belt tension displayed at the measuring instrument is less than 15 scale increments when the engine is cold and less than 20 scale increments when the engine is hot.

Retensioning the belts

Retension belts as described in the General Adjustment Notes section.

Before measuring the belt tension, start engine and let engine idle briefly.

Tension:

Cold engine: 15 to 23 scale increments

Engine at operating

temperature: 20 to 28 scale increments

Fitting a new belt

(alternator and fan wheel)

When fitting a new belt, be sure to observe the correct **assembly sequence** in order to avoid any loss of belt tension during vehicle operation.

1. Fit new belt. Adjust tension by inserting or removing shims as required.

Shims are available for belt tensioning in thicknesses of 0.5 mm and 0.7 mm. The 0.7 mm shim is identified by a 2 mm dia. drill hole.

2. Before measuring the belt tension, start engine once more and run engine at idle briefly.

Tension:

Cold engine: 23 to 35 scale increments

3. Run engine at idle for approx. 15 minutes or test drive vehicle for approx. 10 miles.

Check tension again.

Specification: 28 to 40 scale increments

Retension if required.

Test requirement: Engine at operating temperature

Adjustment specifications for A/C compressor drive belt

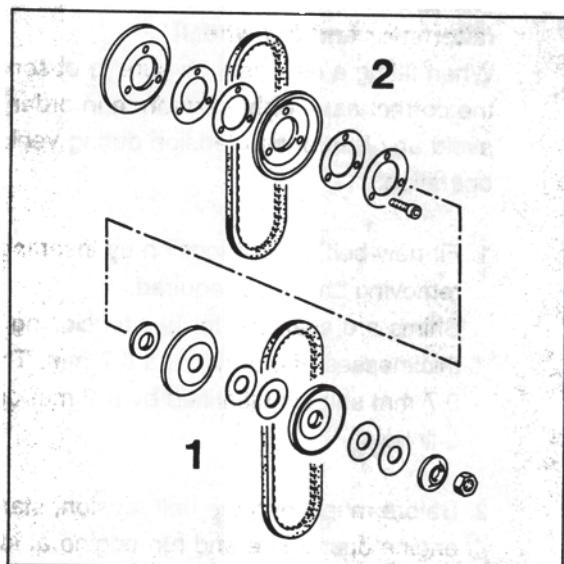
Specification: 30 to 35 scale increments

Retension if required.

General adjustment notes

Fan wheel and alternator have separate drives.

4. Use only V-belts that have been approved by the manufacturer.

**Note**

Rotate engine only at lower belt pulley or by operating the starter. After completing all operations, check to make sure that hexagon head nut has been tightened sufficiently on alternator shaft.

1863-27

1 = Alternator drive components

2 = Fan wheel drive components

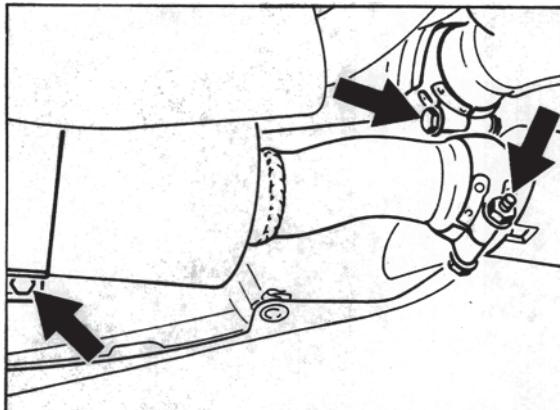
Adjusting the V-belts

1. Use polygon wrench (999 571 052 02) to lock shaft and undo hexagon head nut. Remove shims and pulley half.
2. If belt tension is below specification, remove one shim from between pulley halves and refit in front of front pulley half. Tighten hexagon head nut to 50 ± 5 Nm.
3. Three additional M 6 screws have to be undone for V-belt and fan wheel.

Replacing spark plugs

(Remove both rear mufflers)

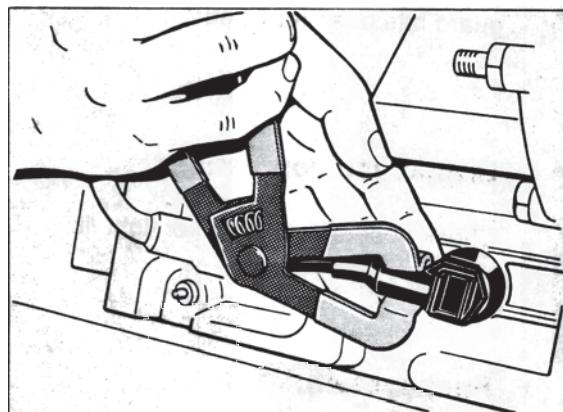
1. Remove engine guard. Remove ball clamps from tailpipe and rear muffler / catalytic converter and take out hexagon head bolts. Remove both tailpipes.



1441-03

1. Undo rear muffler at tightening strap and lift off rear muffler. Remove rear muffler bracket.
3. Undo hot-air hose from right-hand heat exchanger (cyls. no. 4 to 6) and from air distributor pipe and take off hose.
4. Undo both left and right-hand engine covers from camshaft housing, hydraulic pump support bracket as well as front and rear engine cover. Leave engine cover suspended at ignition cables.

5. If spark plugs are difficult to remove, use Special Tool (disassembly clamp) 9513, Part No. 000.721.951.30.



498-03

6. Unscrew spark plugs with commercially available Snap-on socket, Part No. S 9706, and Snap-on extension, Part No. FXW 4.

Note

Do not use any lubricant on the plug threads.

Visual inspection for leaks:

Oils, fluids

This check can be carried out after the engine guard has been removed.

Crankcase ventilation:

Check hose connections for tight fit.

Fuel system:

Visual inspection for damage, correct routing and tight fit of line connections.

Intake air system:

Check that hoses, pipes and connections are securely fitted.

Parking brake:

Check free travel of the parking brake lever

The parking brake is fitted with asbestos-free brake linings. The parking brake must **never be adjusted in such a way** that the lining has to "grind itself free" in operation.

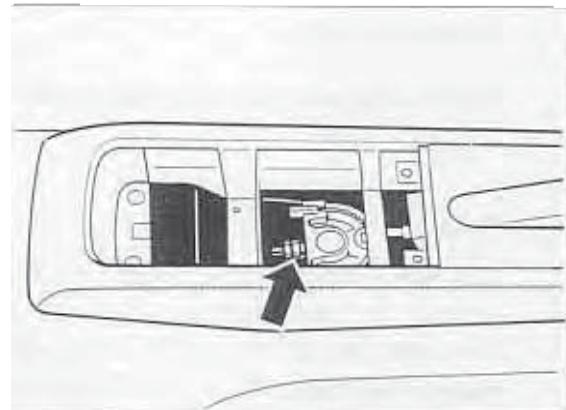
If the brakes do not show any effect when the parking brake lever is pulled up by more than 4 notches using medium force, the parking brake must be readjusted.

Adjusting the parking brake:

1. Remove rear wheels.
2. Release parking brake lever and push back disc brake pads until the brake disc rotates freely.
3. Undo the adjusting nuts on the turnbuckle (arrow) until the cables are slack.

Note

Remove the cassette box behind the parking brake lever to gain access to the turnbuckle. The fastening screw is located below the rubber insert.



576-46

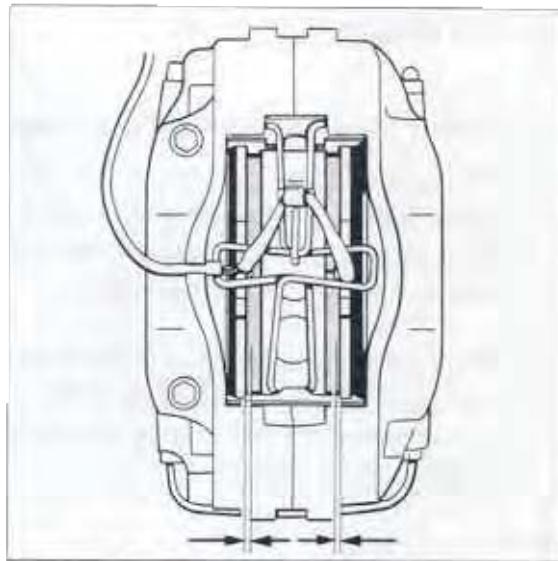
4. Insert a screwdriver across the hole in the brake disc to reset the adjuster until the wheel is locked. Then undo the adjuster again until the wheel can be rotated freely. *Now undo by a further two notches.*
5. Pull up parking brake lever by two notches and turn adjusting nut on the turnbuckle until both wheels can just barely be rotated by hand.
6. Release parking brake lever check if both wheels rotate freely.

Brake system:

Visual inspection of brake pads and brake discs for wear

Note

The brake pads must be replaced on both sides of one single axle as soon as the brake pad wear warning lamp lights up or, at the latest, when the pads have worn down to a thickness of 2 mm. If pad wear is indicated by the wear warning lamp, the warning contact (sensor complete with wire and connector) must be replaced. Replacement of the warning contact(s) can be avoided by replacing the brake pads at the latest when they are worn to a thickness of 2.5 mm. Warning contacts must be replaced if the wire core is exposed. Replacement is not necessary, however, if rubbing wear is limited to the plastic part of the warning contact only.



578-46

1. Remove rear wheels to check rear brake pads.

The front brake pads are visible with the wheels fitted.

2. Check brake pads visually for wear.

The wear limit is reached as soon as the remaining pad thickness is down to 2 mm.

Brake hoses and pipes:

Visual inspection for damage and routing (corrosion)

Checking the brake fluid level

Top up brake fluid if required (refer to marks on reservoir).

Never top up beyond the MAX mark as this may cause brake fluid to escape past the bleed hole.

Important information about the brake fluid

Use only new brake fluid DOT 4.

Observe brake fluid quality.

The brake fluid DOT 4 Type 200 (change interval 3 years) used until now is **no longer available** via the Porsche Parts Service.

"**Super DOT 4**" brake fluid will be delivered instead. A 2-year change interval applies to this brake fluid.

Vehicles with brake systems containing the old type of brake fluid must be filled **with Super DOT 4** the next time a brake fluid change is due.

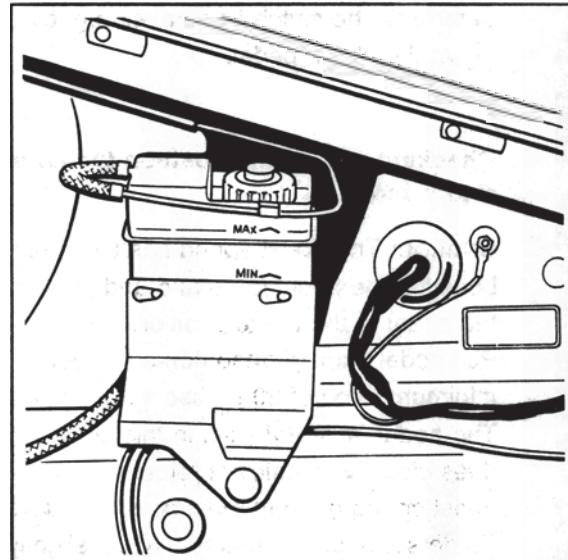
This brake fluid is available under the following part number:

Container size 1 litre = 000.043.203.66

Container size 30 litres = 000.043.203.67.

Miscibility of brake fluids:

The brake fluid DOT 4 Type 200 used until now is miscible with Super DOT 4. This means that **Super DOT 4** can be used to top up the brake fluid-level in vehicles with brake systems containing the old type of brake fluid until the next time a brake fluid change is due. Both brake fluids are coloured amber.



Clutch:

Checking free travel and final position of the pedal

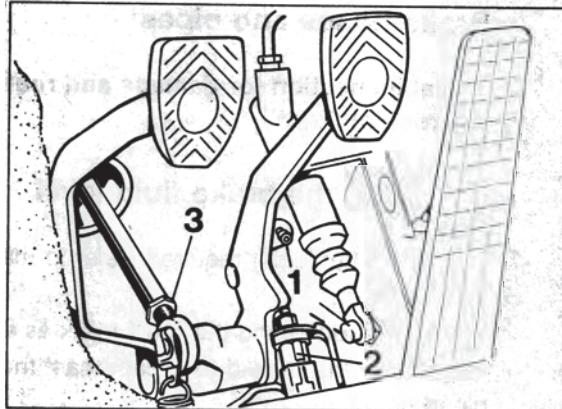
Clutch free travel

The clutch master cylinder has an internal stop. The boost spring forces the pushrod or the clutch pedal, respectively, constantly against this stop. Due to this automatic hydraulic adjustment, it is not possible to determine the clutch free travel, e.g. by checking at the clutch pedal.

Checking pedal final position (pedal return/return force)

Caution: The boost spring has two functions: boosting the pedal force and returning the pedal to the home position.

Pull pedal back into the home position with a minimum force of 30 N (use a spring scale). The pedal must not yield in this position. If it does yield (= insufficient return force), the boost spring preload must be reduced slightly. To do so, undo Allen screw **No. 1** slightly until a correct tradeoff between return effect and pedal force boost is obtained.



1452-46

Note

To ensure correct clutch operation, the following items must be observed, among others, when the pedals are adjusted:

Correct bleeding of hydraulic clutch circuit

Tightness of hydraulic system

Correct adjustment of boost spring

Pedal return into home position

Pedal travel stop provided by correctly adjusted floorboard stop
(pedal travel 150 + 5 mm)

Installation position of pedal assembly matches standard specifications.

Throttle operation:

Check for smooth operation and correct wide-open position.

Checking resonance flap for operation

When the ignition is switched on, the resonance flap is closed by vacuum action. When the ignition is switched off, the resonance flap is opened (rest position). The opening and closing noise is audible in the engine compartment.

Steering gear:

Checking the bellows for damage

Tie rod joints:

Checking for play and condition of dust seals

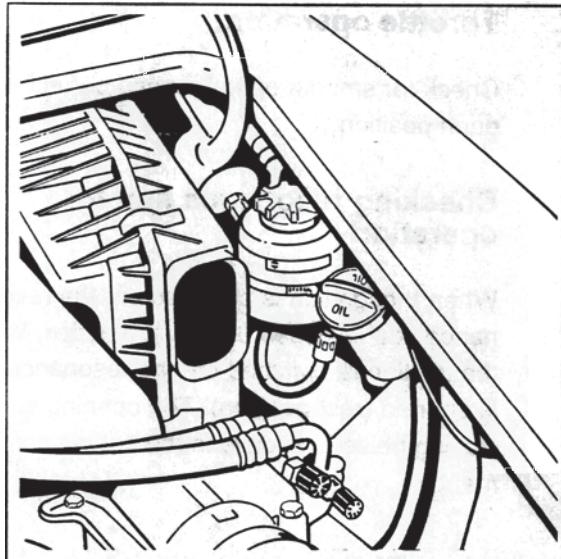
Check that joints, dust seals and bellows operate correctly and that the dust seals and bellows do not leak.

The rubber dust seals and bellows at the steering gear and tie rods can be damaged by outside impacts, e.g. stone chip damage or during assembly. If the dust seals leak, the joint or the respective tie rod must be replaced as ingress of dirt or moisture will lead to destruction of the joint.

Power steering:

Checking fluid level

The reservoir is located on the right-hand side in the engine compartment. Check the level* with the engine idling and without operating the steering.



1472-48

Correct fluid level:

In the case of reservoirs with a transparent upper section (first version used), the fluid level must be between the min. and max. marks on the reservoir.

If the reservoir does not have a transparent upper section, the level must be between the two marks on the dipstick attached to the lid. Unscrew the lid and wipe the dipstick clean. Screw the lid back on, remove it again and check the fluid level*.

Note on toothed belt for power steering pump

The tension of the toothed belt cannot be adjusted but its condition must be checked.

Porsche started to fill the brake systems with Pentosin CHF 11S (green) in March 1996. ATF was used before the Pentosin and ATF are miscible. This means that Pentosin can be used to top up the fluid level in 993 vehicles before the aforementioned introduction date. On vehicles with Pentosin filling, always fill or top up the brake system with Pentosin.

Axle joints:**Visual inspection of dust seals for leaks**

Check dust seals of axle joints (ball joints) of front and rear suspension as follows:

Place vehicle on lifting platform with steering lock unlocked.

After cleaning the components, check condition visually. Press rubber dust seals with the fingers to detect any hidden cracks.

Proceed as follows on front axle:

Turn front wheels to full lock. Visually inspect visible surfaces on left and right-hand surfaces.

After turning the front wheels to the opposite full lock, check the other half of the rubber dust seals.

Suspension alignment (wheel alignment specifications):

Check bolt connections of front and rear suspension geometry (wheel alignment) for tight fit.

Transmission / final drive:**Visual inspection for leaks, checking oil levels**

For further notes, refer to page 03 - 16.

Notes

Visual inspections are not possible in a small area around the brake cover panels. Check this area by feeling with your fingers.

If the rubber dust seals leak, the joint or the respective steering arm must be replaced as ingress of dirt or moisture will lead to destruction of the joint.

Checking ATF fluid level

The specified fluid level is of great importance for proper operation of the automatic transmission.

Test requirements:

Transmission guard is removed

Vehicle must be on a level surface

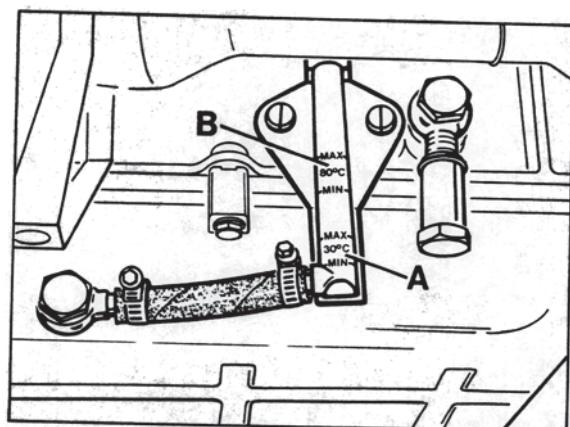
Engine is idling

Parking brake is pulled

Selector lever is set to "P"

ATF temperature 80°C

The ATF fluid level must be between the MIN and MAX marks at a temperature of 80°C.



389-38

A = Testing range at 30°C ATF temperature

B = Testing range at 80°C ATF temperature

The ATF temperature may be determined precisely with System Tester 9288.

If required, top up with ATF fluid across the quick-fill device.

Drive shafts:

Visual inspection of cup seals for leaks and damage

Exhaust system:

Visual inspection for leaks and damage, check bolt connections for tight fit and examine mountings

1. Check exhaust system for tight fit and complete exhaust system for leaks. Check mountings of exhaust system.
2. Check that connection at heat exchanger/cylinder head bolt union is tightened correctly.
3. Check all flange connections of exhaust system as well as oxygen sensor and emission test plugs for proper tightening.

Tightening torques:

- 1 - Heat exchanger to cylinder head 23 Nm (17 ftlb.)
- 2 - Heat exchanger to catalytic converter 23 Nm (17 ftlb.)
- 3 - Ball flange clamps 25 - 30 Nm (18 - 22 ftlb.)
- 4 - Strap for catalytic converter or front muffler 20 Nm (15 ftlb.)

Tires:**Checking tire condition and tire pressure****Tire condition**

Tires are safety-relevant items that are only capable of meeting the requirements imposed if they are run at the correct tire pressure and with sufficient tread depth.

The tire pressures indicated are minimum pressures. The tires must never be run at lower pressures since this affects roadholding and may lead to severe tire damage.

Valve caps protect the valve against dust and dirt and therefore help prevent leaks. Always screw on caps tightly and replace missing caps.

For safety reasons, do not limit tire checks to checking the tire pressure but also check for sufficient tread depth, ingress of foreign matter, pinholes, cuts, tears and bulges in the sidewall (cord breakage)!)

Tire pressure of cold tires (approx. 20°C)**911 Carrera / 911 Carrera S /
911 Carrera 4 / 911 Carrera 4S****16-inch and 18-inch wheel**

(16-inch and 18-inch wheels (summer tires
16-inch winter tires))

front	2.5 bar exc. pressure
rear	3.0 bar exc. pressure

17-inch wheels (summer and winter tires)

front	2.5 bar exc. pressure
rear	2.5 bar exc. pressure

Collapsible spare tire

front/rear	2.5 bar exc. pressure
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911 Carrera RS (M 002 / M.003)

M 002 = basic version /
M 003 = Clubsport version

Summer and winter tires

(Winter tires = 17-inch wheels
summer tires = 18-inch wheels)

front	2.5 bar
rear	3.0 bar

Folding spare wheel

front / rear	2.5 bar
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Oiling door hinges

Check door and hood locks and safety catches of front hood for secure fit and correct operation

Checking for secure fit:

The fastening screws of the door lock, front and rear hood locks as well as the fastening nuts for the upper lock sections of the front and rear hoods must be tightened to 10 Nm (7 ftlb.).

Functional check:

Door lock

When the door is closed, the door lock must engage into the lock striker in two stages and disengage again when the door opener (inside and outside) is operated.

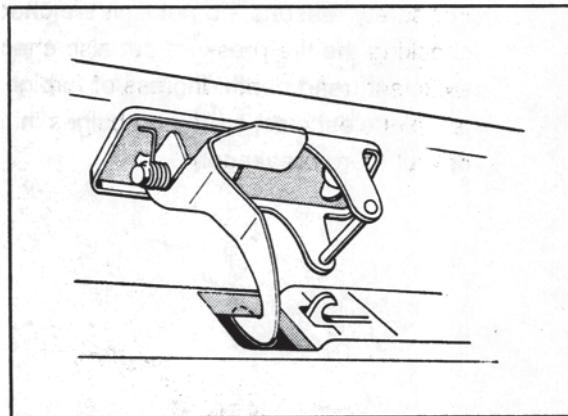
Front and rear hood locks.

When the hoods (front and rear) are closed, the hood locks must engage as soon as the upper lock sections move into their seats and must disengage again when the hood release is pulled.

Safety catch - front hood

After the hood lock has been released, the front hood must be held down by the safety catch. At the same time, this safety catch must engage into the retaining plate at its lowest point.

When the hood is open, the retractor spring must pull the safety catch back to the stop against the baseplate of the upper lock section.



Seat belts:**Checking operation and condition****Operational check:**

When the belt is pulled evenly, the belt strap must roll smoothly off the belt retractor across the guide fitting, and the plug-in latch of the seat belt must engage audibly into the lock. The seat belt retractor must lock if the belt strap is pulled with a jerk.

Check of belt condition:

The belt strap must be inspected visually for damage. If damage such as cuts, fraying, separating seams etc. is found, the seat belt must be replaced.

Seals for doors, hoods and roof:

Remove scuffed rubber, apply a suitable protective coating to seals

Cleaning:

Remove rubber scuffings and stains with benzine.

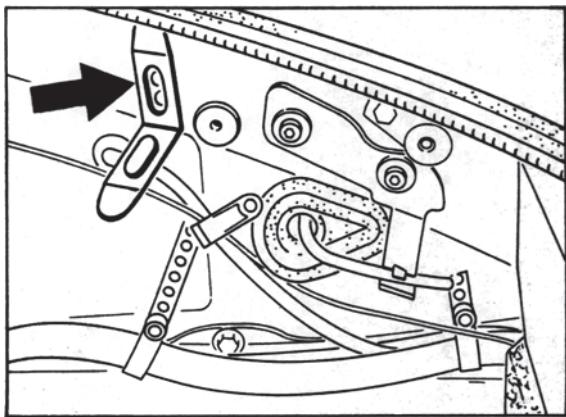
Care:

Coat seals with glycerine, talcum powder or a similar rubber care product.

Checking operation of lighting system:

Adjusting headlights

1. Open trunk lid.
2. Remove trunk mat from wheel housing wall.
3. Open cover for headlight adjusting screws.

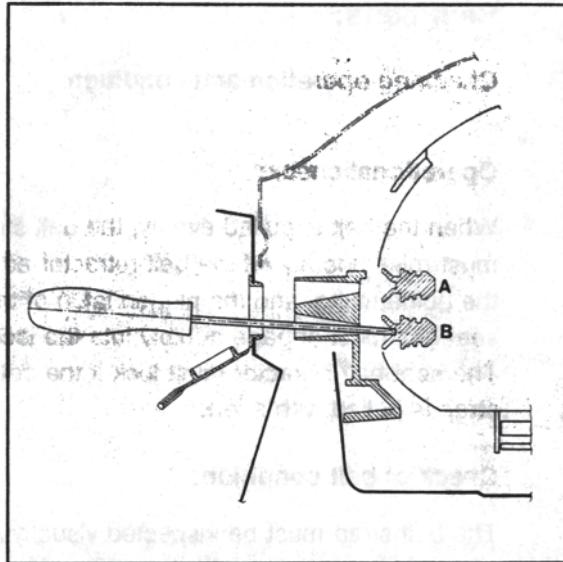


1586-03

4. Clean lens and switch on dipped beam.
5. The vehicle must be placed on a level surface. Using a headlight aiming device, adjust headlights with vehicle in roadworthy condition (full fuel tank, driver's seat occupied or loaded with 75 kgs, tires inflated to correct pressure).

Note

Adjust headlights with control switch set to the 0 position. (headlight beam adjuster).



1585-03

A - Lateral and vertical adjustment
B - Vertical adjustment

Use a standard 5 mm ball socket screwdriver for adjustment.

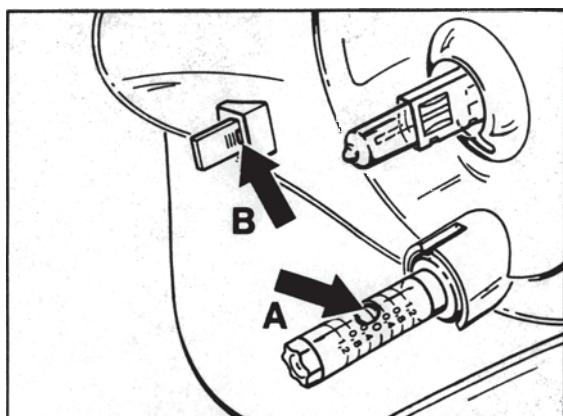
Adjusting headlights (U.S.A. version)

Note

To comply with legal requirements, a bubble level (A) well visible from outside is fitted to the reflector at the bottom of the headlight. This bubble level is used to adjust the headlights and check the height adjustment.

To allow the side adjustment to be checked, an adjustable slide (B) is fitted to the side of the reflector. This slide is factory-set to the "zero adjustment mark" after the headlight has been adjusted.

The Fig. shows the headlight with the glass removed

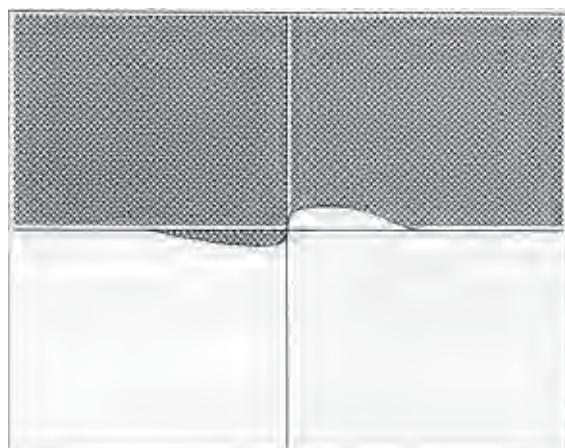


1780-03

Note

Set headlight adjuster to 10cm/10m.

2. Rotate upper adjustment thumbwheel (side and height adjustment, refer to p. 03 - 20, Fig. No. 1585-03 A) until the upper light/dark cutoff of the low beam light area is in the center of the diagram shown.



1781-03

3. Rotate lower adjustment thumbwheel (height adjustment, Fig. No. 1585-03 B) until the bubble inside the bubble level is in the "O" position. At the same time, the light/dark cutoff line must line up with the horizontal line on the left and right side.

4. Repeat items 2 and 3 if required.

Adjustment:

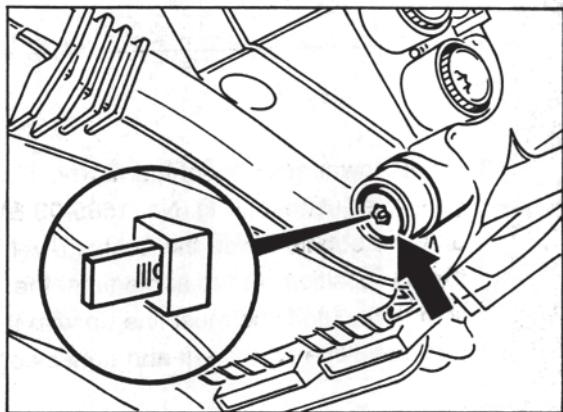
1. The vehicle must be placed on a level surface. Adjust with the vehicle in roadworthy condition (full fuel tank, driver's seat loaded with one person or 75 kgs, tire pressure meets specifications) using a headlight adjuster.

Note

The side adjustment of the headlights is marked by the adjustable slide. This zero adjustment mark is factory-preset and must not be altered. Readjustment should be limited to **accident repairs or replacement of headlight assemblies.**

Adjusting the zero adjustment mark:

1. After having completed the headlight adjustment, unlock headlight inside luggage compartment and lift out headlight.
2. Turn adjustment screw of slide (for checking the side adjustment) with "Torx Tamper Resistant T 40" special tool until the "zero adjustment mark" lines up with the reflector.

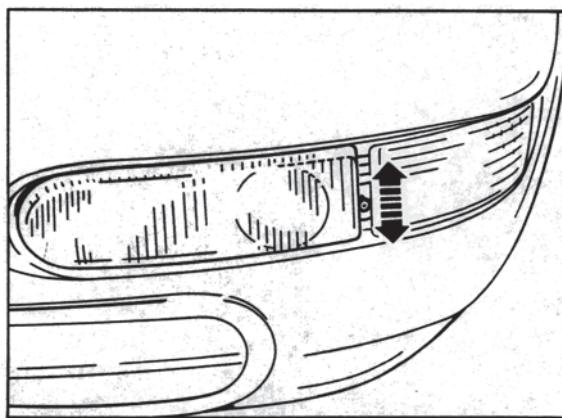


1782-03

3. Refit headlight.

Adjusting foglamps

1. Using a headlight aiming device, adjust headlights with vehicle in roadworthy condition (full fuel tank, driver's seat occupied or loaded with 75 kgs, tires inflated to correct pressure).



1587-03

Windshield washer, headlight washer system:**Checking operation, fluid levels and nozzle adjustment****Note**

The headlight washer nozzles are preadjusted.
No correction is required.

Check operation of all other electrical devices as well as warning and hazard lamps

Ignition circuit 1 and 2:**Checking operation**

1. Measure CO and HC values with engine at operating temperature and both ignition circuits in operation.
2. Use System Tester 9288 to switch off ignition circuit 1.
3. Measure CO and HC value.
4. Switch ignition circuit 1 back on and switch off ignition circuit 2.
5. Measure CO and HC value.

The CO and HC values must not change significantly when the engine is running with only one ignition circuit.

Test drive:

Check operation of service and parking brake, clutch, automatic speed control, steering, heater, air conditioning and instruments.

Visual check for leaks:**Oils and fluids**

It is recommended to run a test drive once with the engine guard removed to allow the engine and transmission to be checked for leaks and to avoid any additional assembly work if leaks are detected.

Do not exceed a vehicle speed of 95 mph.

03 80 00 Additional service

Replacing ATF fluid and ATF strainer

Filling capacity: approx. 9.0 l

Oil change capacity: approx. 3.0

Oil grade:

ATF-Dexron II D

Tightening torques:

ATF strainer to control unit = 8 Nm (6 ftlb.)

ATF pan to transmission = 6 Nm (4 ftlb.)

Drain plug to ATF pan = 40 Nm (29 ftlb.)

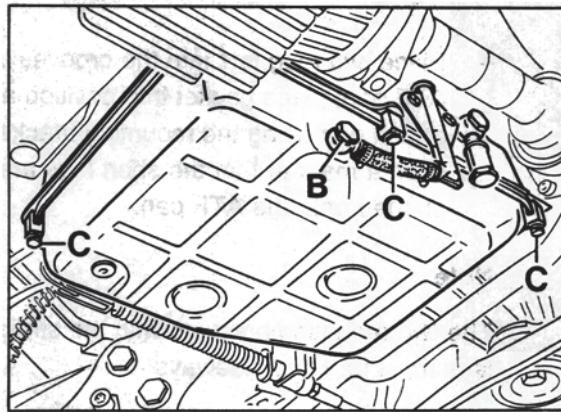
Banjo bolt to ATF pan = 40 Nm (29 ftlb.)

When changing the ATF fluid, the vehicle must be on a level surface, the engine must be stopped and the transmission guard must be removed.

Removing ATF pan and ATF strainer:

Drain ATF fluid.

Remove ATF pan by undoing banjo bolt for oil level pipe and six mounting bolts.

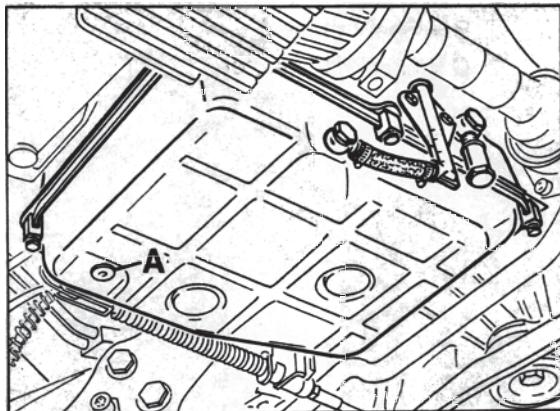


386-38b

B = Banjo bolt

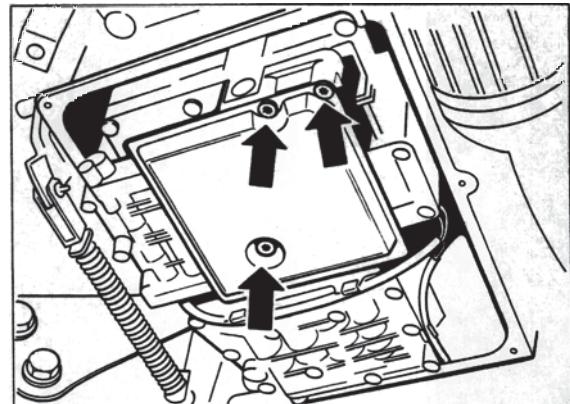
C = Mounting bolts

Remove ATF strainer with Torx insert T 27.



386-38a

A = Drain plug with seal



382-38

Installing ATF strainer and ATF pan:

Clean ATF pan thoroughly.

Fit ATF strainer with new O-ring.

Tightening torque: **8 Nm (6 ftlb.)**.

Place two magnets into the grooves in the ATF pan, place gasket into position and attach pan using the mounting brackets in such a manner that the short legs are pushed onto the ATF pan.

Note

The two mounting brackets with the straight legs must be fitted sideways.

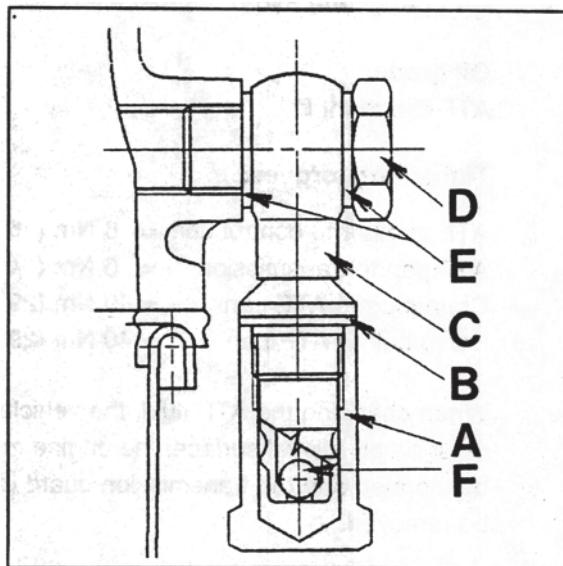
Screw in ATF drain plug with new seal.

Tightening torque: **40 Nm (29 ftlb.)**.

Screw in banjo bolt for oil level pipe complete with new seals. Tightening torque:
40 Nm (29 ftlb.).

Filling in ATF fluid:

With the engine stopped, start by filling in ATF fluid up to the 30°C Max mark across the quick-fill adapter.



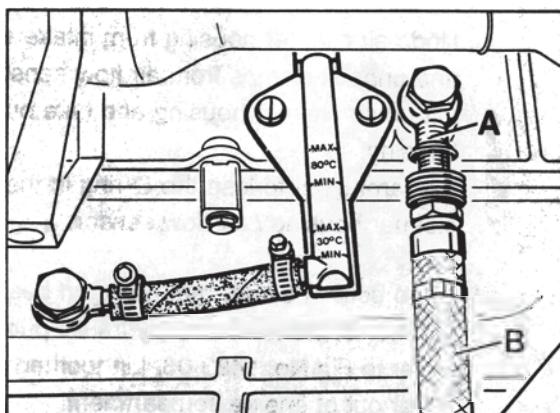
391-38

A = Plug nut

(Tightening torque 30 Nm, 22 ftlb.)

B = Seal (replace)

C = Quick-fill adapter



388-38

A = Quick-fill adapter

B = Hose of filler device

Start engine with selector lever set to "P" and allow engine to idle. Observe ATF level in oil level pipe and immediately top up to the 30°C Max mark if required.

Note

The ATF level in the transmission may vary according to the fluid temperature. The marks on the oil level pipe refer to ATF temperatures of 30°C and 80°C.

Run vehicle to warm up transmission and check ATF fluid at 80°C.

The fluid level must now be between the 80° C mark and the Min and Max marks.

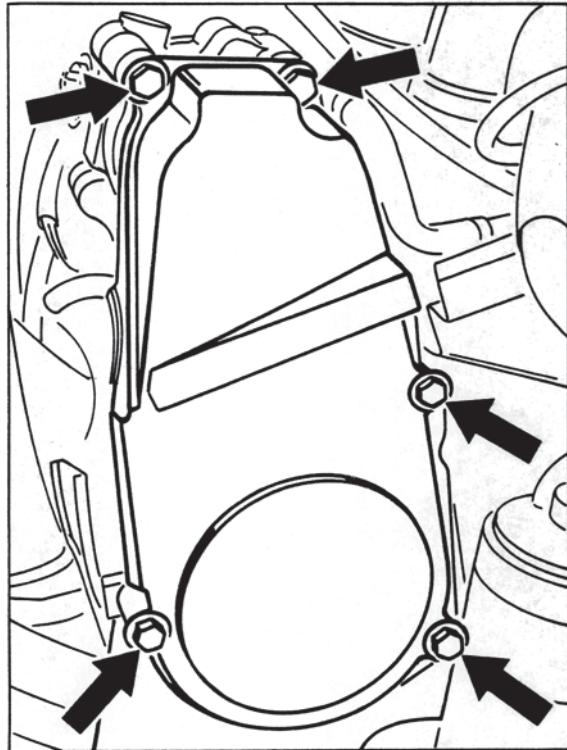
To determine the ATF temperature exactly, use System Tester 9288.

Toothed belt for power steering:

Checking condition

1. Remove transmission guard from transmission. Undo hot-air hose from heater flap box at air distributor pipe.
Undo three M 6 x 15 mm hexagon head bolts from toothed belt cover.

The figure shows the engine removed from the vehicle



1423-03

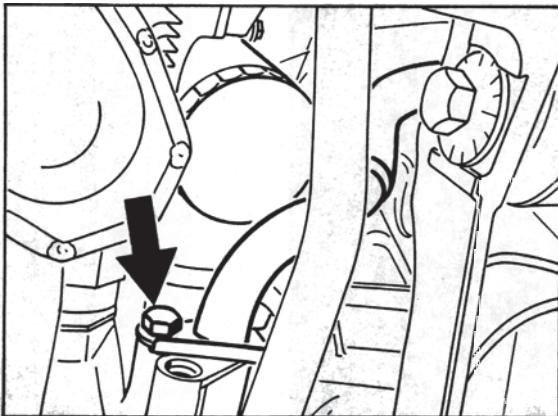
2. Unhook clamps of air cleaner cover.
Remove housing cover and filter element.

3. Undo air cleaner housing from intake air rail and unhook clamps from air flow sensor. Lift up air cleaner housing and take out housing.
Be careful not to lose the O-ring in the air cleaner housing / air flow sensor.
4. Undo both M 8 x 30 mm hexagon head screws on the top of the hydraulic pump. Refer to Fig No. 1423-03. Lift toothed belt cover out of engine compartment.
5. Rotate engine and check toothed belt for wear and damage. The belt tension cannot be adjusted.

Replacing both engine oil filters

Replacing oil filter on engine housing

1. Remove engine guard. Undo hot-air hose at heating flap box and at air rail and take off hose.
2. Undo hexagon head bolt at crankcase and pull oil pipe out of crankcase. Catch remaining oil in a pan.

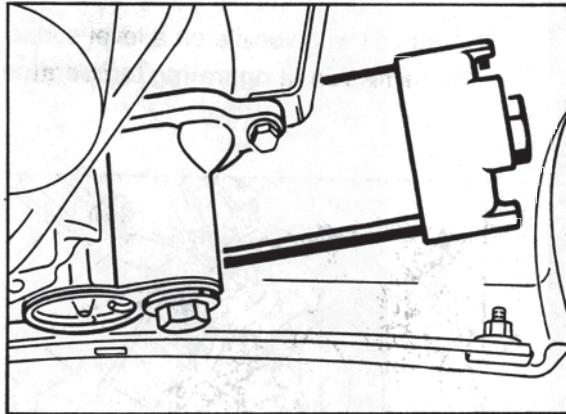


1439-03

3. Undo oil filter with Special Tool 9204.
4. Apply a thin coat of oil to new oil filter. Tighten oil filter manually until seal is seated firmly. To tighten fully, turn by approx. another 1/2 turn. Always replace O-rings for oil pipe.

Replacing oil filter on thermostat housing

1. Remove right-hand side member panel. Undo rear wheel housing liner in oil filter area.
2. Undo oil filter with Special Tool 9204.



1440-03

3. Apply a thin coat of oil to seal of new oil filter. Tighten oil filter manually until seal is seated firmly. To tighten fully, turn by approx. another 1/2 turn.

Check oil level at operating temperature and idle speed (refer to Owner's Manuals). Check engine, oil reservoir, pipes and front oil cooler for leaks (visual inspection)!

Changing transmission oil (manual transmission)

Filling capacity: 3.6

Oil grade:

Transmission SAE 75 W 90 to API GL 5 or
MIL-L 2105 B.

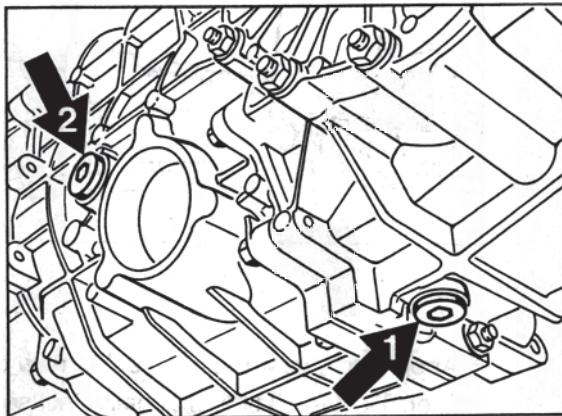
1. Remove transmission guard.
2. Drain oil with vehicle on a level surface and
transmission at **operating temperature**.

Note

Due to the length of the transmission, the oil requires some time to flow into the oil cavity in the front transmission cover.

If oil is filled in too quickly, the transmission may overflow even before the specified oil quantity has been reached.

It is therefore very important to top up very **slowly**, observing the specified **oil quantity**.



1437-03

1 - Drain plug with magnet

2 - Filler plug

3. Clean filler and drain plugs, replace seals and tighten bolts to 30 Nm (22 ftlb.).
4. **Slowly** fill in 3.6 liters of transmission oil with the vehicle on a level surface.

Changing transmission oil in real wheel drive (Tiptronic)

Filling quantity: approx. 0.9

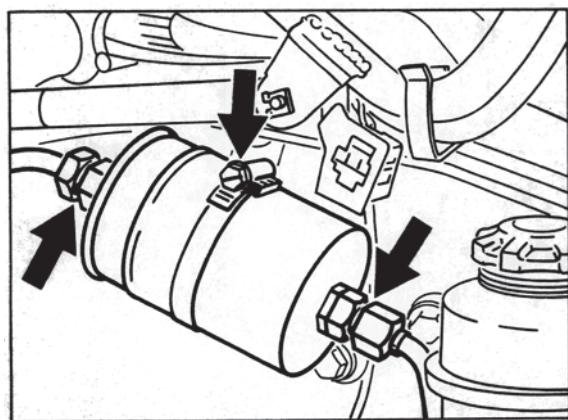
Oil grade:

Transmission oil SAE 75 W 90 to API GL5 or
MIL-L 2105 B, or optionally SAE 90.

1. Remove transmission guard.
2. Drain oil with vehicle on a level surface and transmission at operating temperature.
3. Clean filling and drain plugs, replace seals and tighten bolts to 50 Nm (37 ftlb.).
4. Fill in transmission oil with the vehicle on a level surface until the oil overflows at the neck.

Replacing fuel filter

1. Unhook clamps of air cleaner cover. Take out housing cover and filter element.
2. Separate air cleaner housing from intake air rail and unhook from air flow sensor. Lift up air cleaner housing and take out housing. Be careful no to lose the O-ring in the air cleaner housing / air flow sensor.
3. Undo fuel lines, using a second wrench to lock. Drain remaining fuel into a suitable container.
4. Undo clamp and remove fuel filter.



1420-03

5. Fit new filter. Observe direction of flow = direction of arrow.
6. Start engine and check fuel lines and fuel filter for leaks.

Check fuel and injection lines for leaks and tight fit!

Battery:

Checking electrolyte level

Note

To avoid short circuits, the battery must always be disconnected when working on the electrical system. However, the battery must never be disconnected when the engine is running.

1. Open luggage compartment lid.

2. Remove covers.

3. Undo and pull off ground connector.

Checking electrolyte level

1. Check electrolyte level of all cells.

2. If the electrolyte level has dropped below the minimum mark, top up with distilled water to the max. mark.

Note

Excessively low battery electrolyte level reduces the battery capacity and the life of the battery.

Changing brake fluid (vacuum brake booster)

Important notes

Use only new DOT 4 brake fluid. Observe **change interval and brake fluid quality.** Refer to page 03 - 11 for further information.

Total brake fluid quantity approx. 1 liter.

Procedure for changing brake fluid

Fill reservoir with new brake fluid up to upper edge. **Connect bleeder device to reservoir.**

Clamp shut overflow hose/venting hose with a hose clamp. The overflow hose/venting hose has been omitted as from October 1995; see Technical Information, Group 4, No. 16/95.

Switch on bleeder device. Bleeder pressure approx. 1.5 bar.

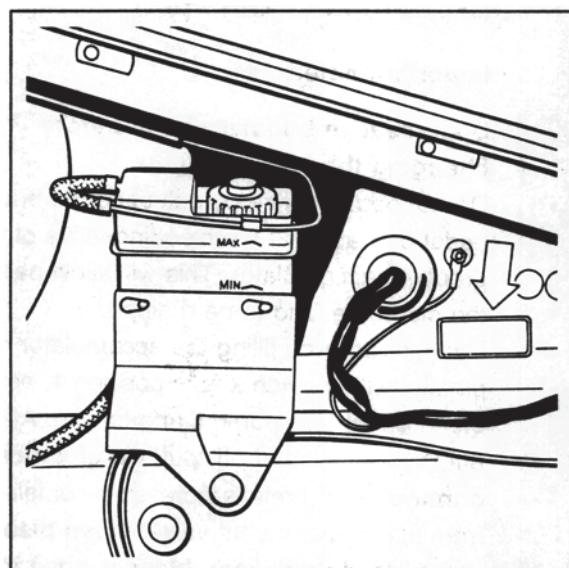
Proceed with brake fluid change on the individual calipers (no particular sequence required).

Open each bleeder valve until clear, bubble-free brake fluid escapes or until the respective change quantity per caliper is reached (approx. 250 c.c.). Make sure all brake calipers are bled on both bleeder valves.

To monitor the escaping brake fluid for cleanliness, freedom from air bubbles and to determine the brake fluid used, use a recipient bottle.

Also drain some brake fluid at the bleeder valve of the clutch slave cylinder (approx. 50 c.c.).

Switch off and disconnect bleeder device. Top up brake fluid if required.

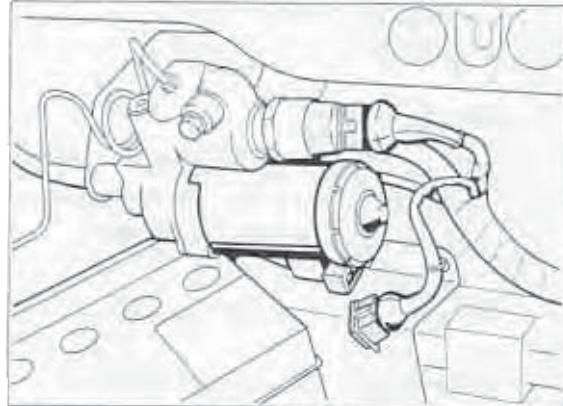


Changing the brake fluid (hydraulic brake booster)

Important notes

Use only new DOT 4 brake fluid. **Observe correct fluid change intervals and fluid grade. Refer to page 03 - 11 for further information**

Total brake fluid quantity for brake fluid change approx. 1.6 liters.



348-47

Brake fluid change procedure

Important notes

Depressurize booster circuit before changing the brake fluid.

Do not depressurize by actuating the brake pedal but rather at the bleeding valve of the pressure accumulator. This will allow part of the old brake fluid to be drained.

Caution: Start by filling the accumulator completely (with ignition key in position 1, actuate brake pedal until pump starts to run). After the pump has switched off, **pull off electrical connector** and release pressure completely from accumulator vent valve. **Open bleeder valve slowly and keep bleeder hose in place.**

Caution: A pressure of up to 180 bar is present in the system.

Wear goggles and protective gloves!

To allow the brake fluid to be changed in a rapid and practical manner, a filling and bleeding device should be used.

If the booster circuit has not been depressurized completely, do not actuate the brake pedal while the bleeder device is connected.

Changing the brake fluid: 1st step

With the booster circuit depressurized, top up with fresh brake fluid to upper edge of reservoir. **Connect bleeder device to reservoir.**

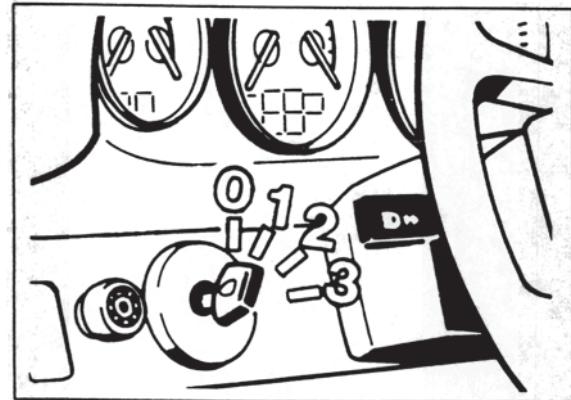
Clamp shut overflow hose/venting hose with a hose clamp. The overflow hose/venting hose has been omitted as from October 1995; see Technical Information, Group 4, No. 16/95. Switch on bleeder device. Bleeding pressure: approx. 1.5 bar.

Use a recipient bottle to allow the escaping brake fluid to be checked accurately for cleanliness and freedom from bubbles and to determine the quantity of brake fluid used.

Fluid change quantity per wheel:
approx. 250 cc.

Bleed at both bleeder valves on each wheel.

Caution: Pump the break pedal at least 10 times over its full travel after opening the **first** bleeder valve. This additional operation is only necessary for vehicles with hydraulic brake boosters and then only for the first bleeder valve.



2004-47

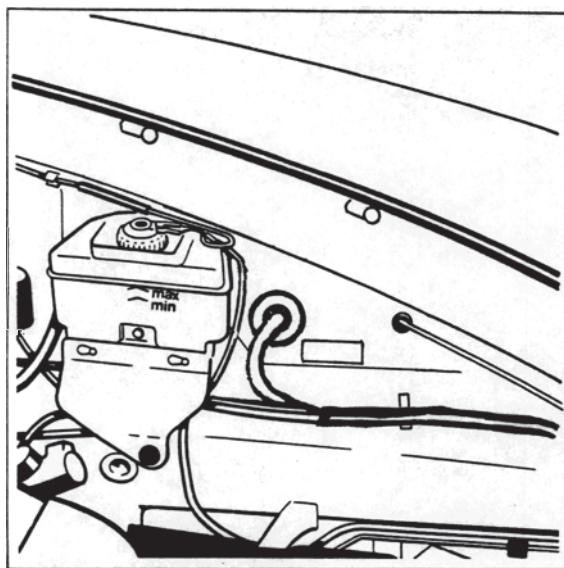
Switch off and disconnect bleeder device. Remove hose clamp from overflow hose (vent).

Fill pressure accumulator completely by connecting the electrical connector.

After the pump unit has switched off, correct brake fluid level. **Never top up beyond the "Max. mark".**

Changing the brake fluid: 2nd step

With the bleeder device switched on, drain approx. 200 cc brake fluid at pressure accumulator. For this purpose, connect electrical connector to pressurizing pump with ignition key in position 1. As soon as the specified quantity has been drained, pull off connector and close bleeder valve.



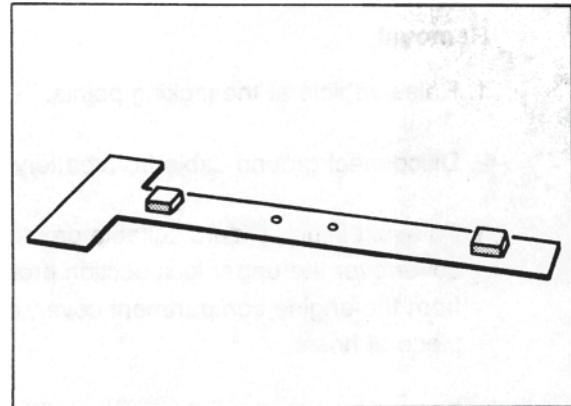
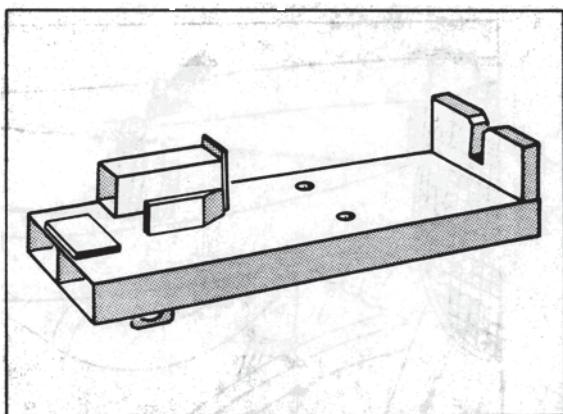
1 Tightening torques for the engine

Location	Thread	Tightening torque Nm (ftlb.)
Crankshaft/crankcase		
Connecting rod bolt (Identification: 14)	M 9 x 1.25	
First stage:		30 (22)
Final stage:		1 x 90° ± 2° rotating angle
Final check		60 (refer to page 13-10d)
Oil pump	M 8	23 (17)
Crankcase bolt connection (through bolts)	M 10 x 1.25	50 (37)
Hexagon head nuts or hexagon head bolts to crankcase	M 8	23 (17)
Double mass flywheel to crankshaft	M 10 x 1.25 x 70	85 (63)
Drive plate to crankshaft (Tiptronic)		90 (66)
V-belt pulley to crankshaft	M 14 x 1.5	170 (125)
Plug - pressure relief and safety valve	M 18 x 1.5	60 (44)
Oil drain plug for crankcase housing	M 20 x 1.5	50 (37) + 5 (4)
Oil drain plug for thermostat housing	M 20 x 1.5	50 (37) + 5 (4)
Screw-in neck in left-hand crankcase section (oil return to oil tank)	M 22 x 1.5	70 (52)
Screw-in flange in right-hand crankcase section (oil feed to oil pump)	M 24 x 1.5	90 (66)

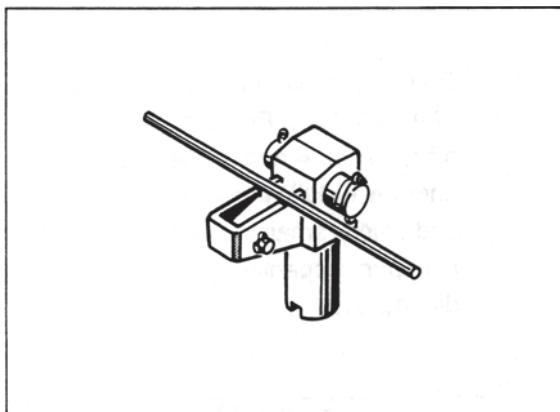
Location	Thread	Tightening torque Nm (ftlb.)
Cylinder and cylinder head		
Cylinder head bolts		
First stage:		20 (15)
Final stage:		1 x 90° ± 2° rotating angle
Camshaft housing/ cylinder heads	M 8	23 (17)
Knock sensor bridge to cylinder bank	M 6	9.7 (7)
Knock sensor to knock sensor bridge		20 ± 5 (15 ± 4)
Engine - NTC to cylinder head 3		10...12, max. 15 (7...9, max. 11)
Rocker arm shafts	M 6 x 35	13 (9)
Spark plugs	M 14 x 1.25	30 (22)
Timing gear		
Sprocket to camshaft	M 12 x 1.5	120 (88)
Chain sprocket to camshaft (4-hole chain sprocket)	1 st step 2 nd step	20 (15) 90° rotation
Gear / power steering pump to camshaft		120 (88)
Flange stud (slider and tensioning rail to crankcase)		30 (22)
Chain housing to crankcase		23 (17)
Chain housing cover		9.7 (7)
Valve cover to camshaft housing	M 6	9.7 (7)
Bearing saddle / chain housing		9.7 (7)

Location	Thread	Tightening torque Nm (ftlb.)
Fan		
Tensioning strap		8 (6)
Alternator pulley		50 ± 5 (37 ± 4)
Pulley section / idler	M 6	
Fan wheel for alternator cooling		14 ± (10 ± 0.7)
Exhaust system		
Heat exchanger/ cylinder head		28 (21)
Heat exchanger / catalytic converter or front muffler		23 (17)
Catalytic converter final muffler (ball clamp)		25...30(18...22)
Final muffler / tailpipe (ball clamp)		25...30(18...22)
Tensioning strap to catalytic converter or front muffler		20 (15)
Tensioning strap / final muffler		20 (15)
Oxygen sensor	M 18 x .5	50...60(37...44)
Plug to catalytic converter	M 8 x 1	15 (11)
Air injection lines		25 (18)
Belt monitor		
Bracket to crankcase	M 6	15...20(11...15)
Belt monitor to bracket	M 6	9.7 (7)

Location	Thread	Tightening torque Nm.(ftlb.)
Fuel system		
Tank sender unit		30 – 3 (22 – 2)
Clutch		
Double-mass flywheel (manufactured by Luk)		
Double-mass flywheel to crankshaft	M 10 x 1.25 x 70	85 (63)
Pressure plate	M 8 x 40	23 (17)

10 01 19 Removing and installing the engine**Special Tools**

442-10



441-10

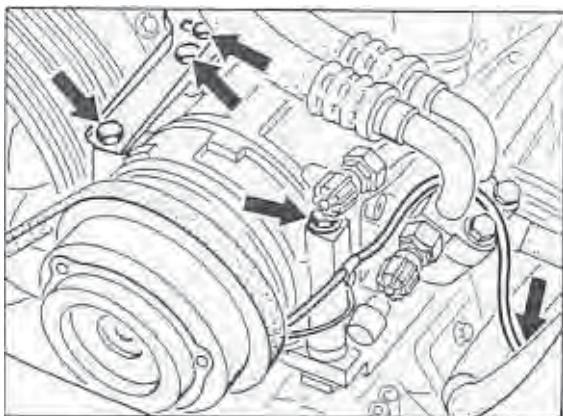
No.	Designation	Special tool	Order number	Explanation
1	Engine mounting plate	9111/3	000.721.911.13	
2	Adapter for engine mounting plate	9111/1	000.721.911.11	
3	Support plate	9111/2	000.721.911.12	

10 01 19 Removing and installing the engine

The engine/transmission assembly is removed as a unit from below.

Removal

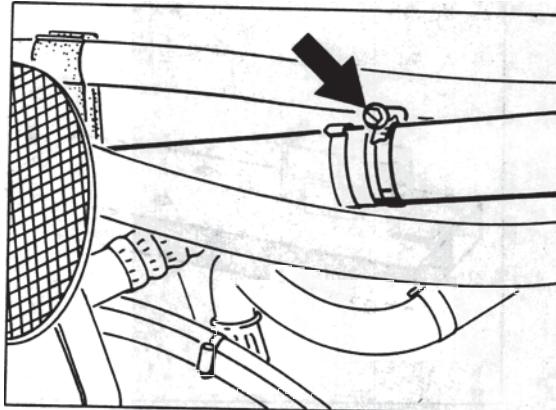
1. Raise vehicle at the jacking points.
2. Disconnect ground cable from battery.
3. To avoid injury, slide a suitable protective cover over the upper lock section protruding from the engine compartment cover, e.g. a piece of hose.
4. Disconnect plugs, remove air conditioning compressor from console and leave it attached to the hoses connected to it. The compressor may be placed on a suitable rigid support on the left-hand side panel.



1477-15

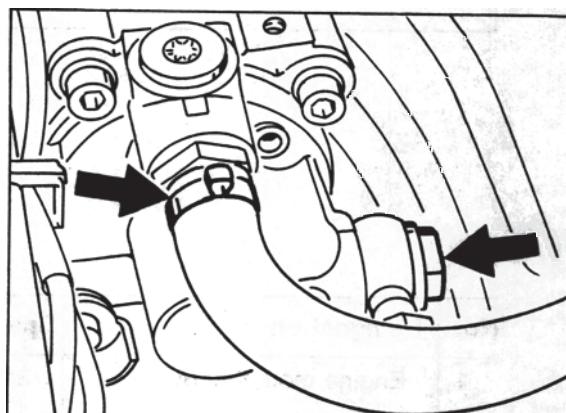
5. Remove hot air blower.
6. Remove air cleaner assembly.

7. Disconnect crankcase / oil tank vent hoses.



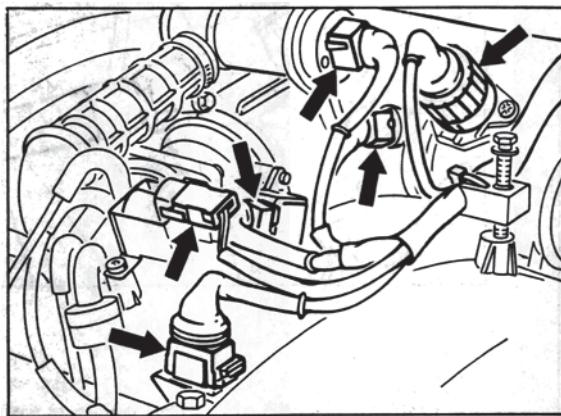
1594-10

8. Drain reservoir of power steering pump (draw off fluid). Pull spark plug connectors off cyls. No. 4 and 5. Place suitable pan under hydraulic pump. Disconnect hoses and catch remaining oil in a pan. Always plug pump openings and hoses (to prevent dirt ingress).



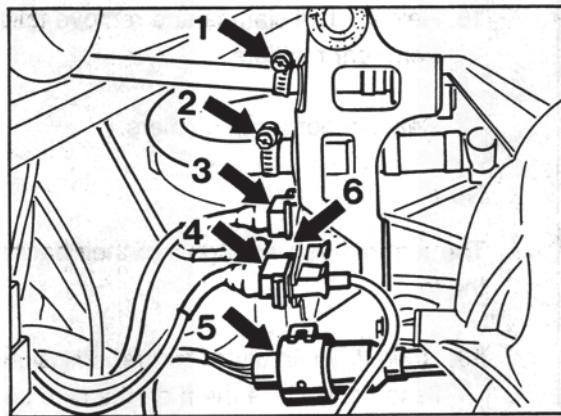
1593-10

9. Disconnect plug from intake rail. Take care not to lose the plug seal.



1475 - 15

10. Disconnect the following connectors or wires, respectively, in the left-hand front engine compartment area:



1458-10

1 - to carbon canister

2 - to brake booster

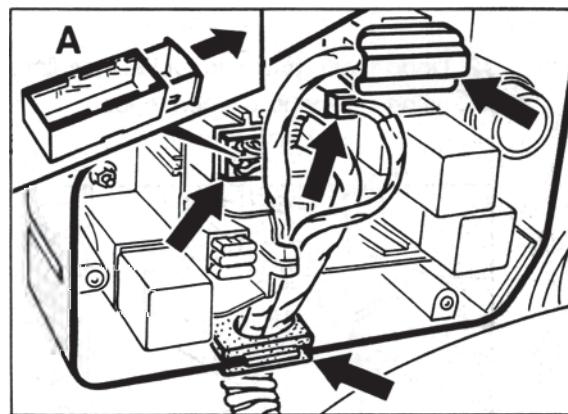
3 - to temperature sensor II (cyl. no. 3)

4 - to knock sensor

5 - cruise control connector

6 - to reference mark sender

11. Undo cover of electrical system of engine compartment. Disconnect connectors carefully (to avoid breakage).

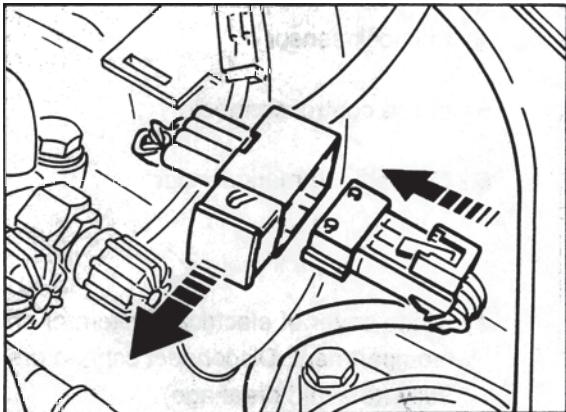


1476 - 15

Note

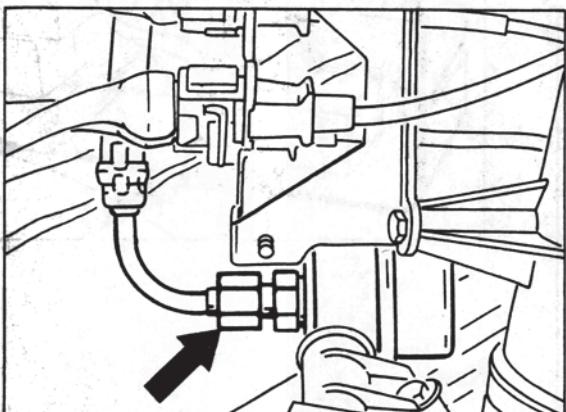
Release connector A before pulling it off.

- 11a. Remove right-hand cover next to air conditioning compressor, unlatch oxygen sensor plug and disconnect plug.

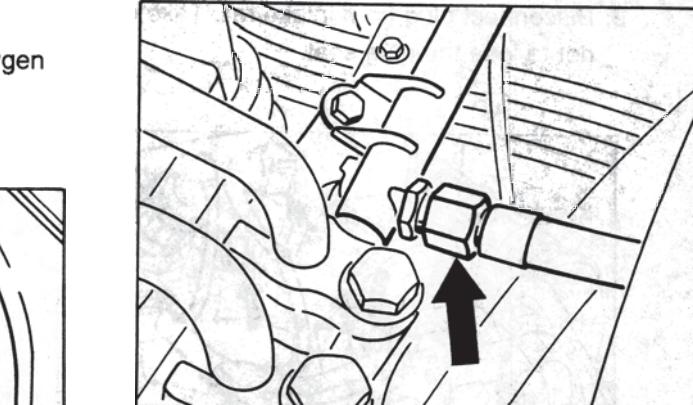


1630-15

12. Undo fuel return and fuel supply line, using a second wrench to lock.



1595-10



1596-10

13. Unlatch throttle operating cable from pedal return lever, back off lock nut and take off ball joint.

14. Raise vehicle

15. Remove engine / transmission guard and rear underbody paneling.

16. Release ball clamps and remove tailpipes from rear mufflers.

17. Remove both rear mufflers.

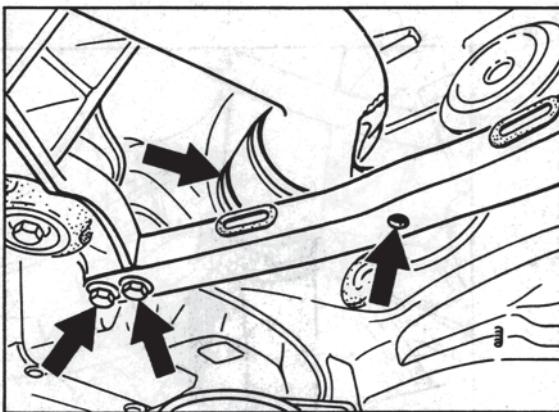
Note

The rear mufflers engage into their buckets at the top.

18. Undo drive shafts at the transmission flange and place them on the side sections of the subframe. **Protect** the drive shafts against damage, e.g. with hose sections.

19. Undo hexagon head screw and pull selector rod coupling off the internal shift rod.

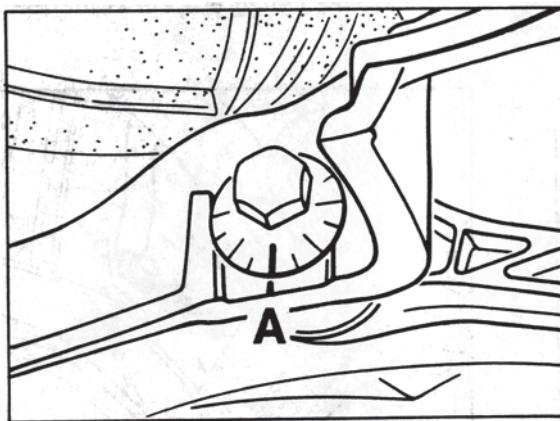
20. Remove hot air hoses, hot air pipes, hot air flaps and front transverse strut.



1616-10

21. Remove complete stabilizer assembly.

22. Mark position of toe eccentrics (A area).

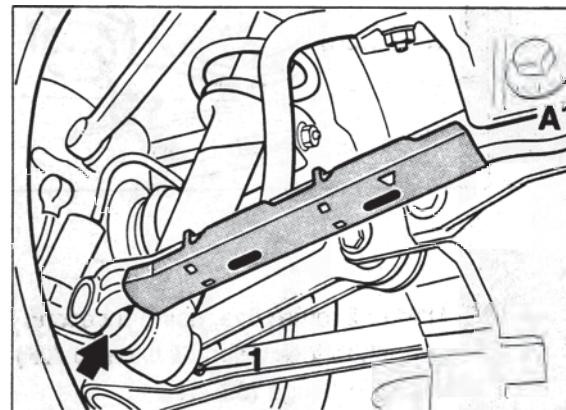


1481-10

- 22a. Loosen fastening nut no. 1 (without removing it). Remove toe eccentric (A area). Rotate toe control arm 2 towards the out-side (detaching it from the cross member).

Important:

While doing so, the rubber boot of the ball joint must be rotated as well (arrow); otherwise, the boot might get damaged.



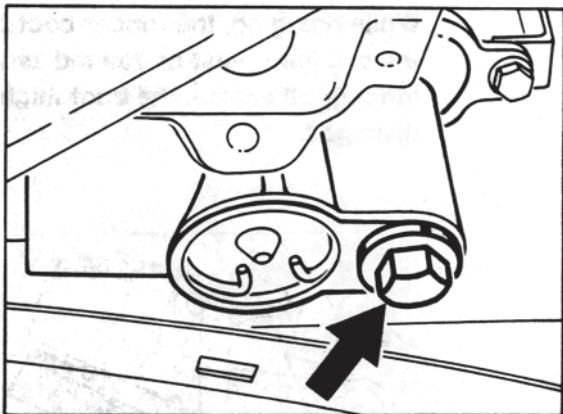
1635-10

- 22b. Detach toe control arm 2 on the other side as well and rotate it downwards.

- 22c. Remove rear cross member.

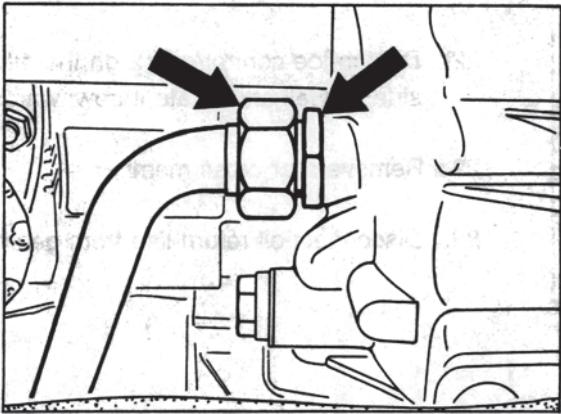
23. Disconnect oil return line from gearbox.

24. Release right-hand sill cover and engine oil from thermostat housing. When the engine is to be rebuilt, also drain oil from crankcase.



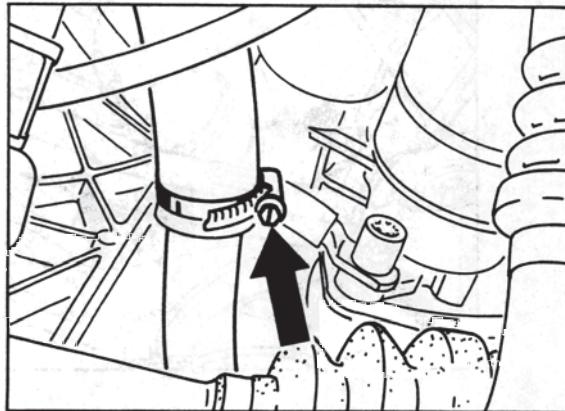
1454-03

25. Undo oil return line, using a second wrench to lock. Plug oil line (36 A/F) and screw-in flange (32 A/F).



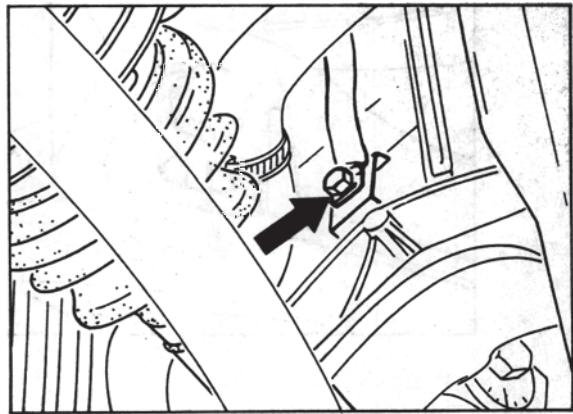
1598-10

26. Release hose clamp and pull hose off the oil pipe. Catch remaining oil in a pan.



27. Undo wire of term. 30 from starter.

28. Undo ground strap between body (RH inner side panel) and starter from body.

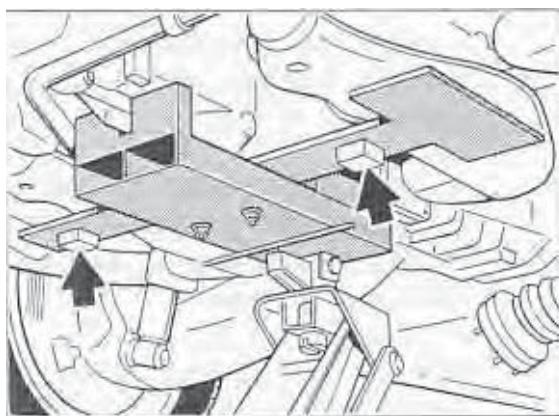


29. Pull throttle operating cable out of its guide.

30. Place engine jack complete with engine mounting plate, applying a slight preload

Note

- a. Observe position of mounting plate. Lock lever in horizontal position.
- b. The support blocks on the mounting plate **face down**.



1381-10

32. Carefully lower engine/transmission assembly somewhat. Working from the engine compartment, unbolt the clutch slave cylinder and suspend it to one side complete with the lines remaining connected.

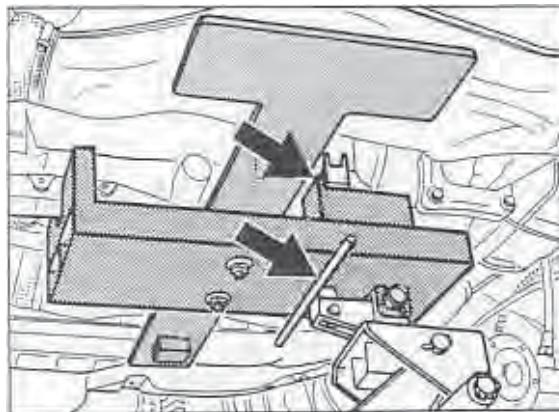
Note

Do not actuate the clutch pedal after the slave cylinder has been removed. **Attach a note to this effect inside the vehicle.**

33. Lower engine/transmission assembly further, move or place right-hand drive shaft over starter. When lowering the assembly, take care not to damage the lower spark plug connector (cyl. no. 3) and the clutch housing vent line.

Caution

When the vehicle is placed back on its wheels, the rear crossmember and both steering arms 2 should by all means be refitted to provide sufficient rigidity.



459-10

31. Unbolt transmission crossmember (6 bolts). Unbolt engine mount. (Use long-reach socket).

Installation

Observe the following aspects during installation:

1. Replace all fastening nuts.
2. Install engine/transmission unit.
3. Fit toe control arms 2 to cross member.

Note

Before fitting toe control arms 2 to the cross member, check weight and **quality category** of the toe eccentrics.

Required quality 10.9 (initial version 8.8 / see parts catalogue). The quality category is indicated on the screw head.

Replace eccentric, if required (e.g. if thread not o.k. or if quality category 8.8).

In this case, transfer the position marks to the new eccentrics.

Important:

To tighten the eccentric (A area), proceed as follows.

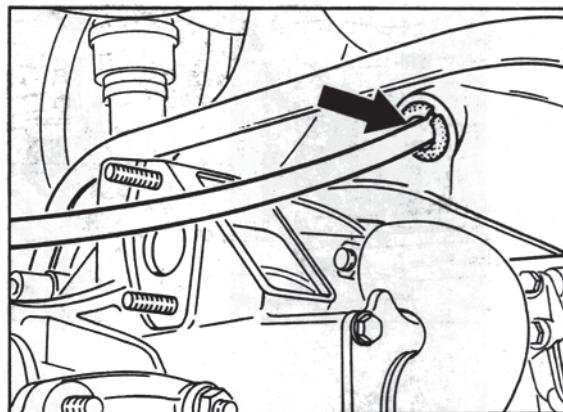
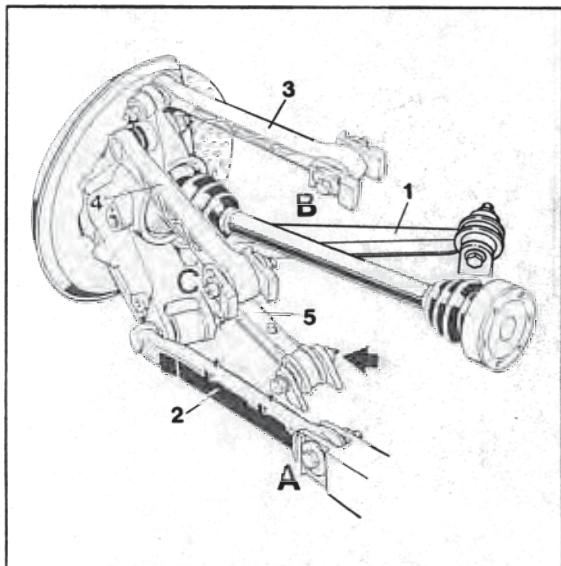
4. Tighten the toe eccentric (A area) **in zero position**. Tightening torque: 100 Nm (74 ftlb.).

Zero position: Toe control arm 2 and rear cross member form a horizontal line. To obtain this **zero position**, lift wheel carrier using all-purpose jack.

Note

The toe eccentrics can also be tightened after the vehicle has been put on its wheels and has been rocked back and forth approx. 25 mm.

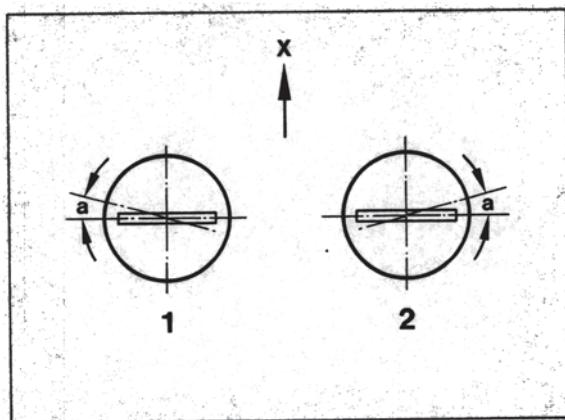
5. Check whether all plugs have been removed completely from the oil hoses and oil pipes and **especially from the bends of the hoses and pipes**.
6. Tighten the fastening screw of the gearshift rod coupling. Tightening torque 23 Nm (17 ftlb.).
7. Fit accelerator cable from below. Make sure the rubber sleeve fits properly.



2118-10

8. Put the engine compartment rubber seal between body and engine paneling in place correctly before installing the engine/transmission unit in its final position.
9. Make sure the inner rubber seals of the connectors fit correctly.
10. Fit lid of assembly bores of engine suspension:

Put the metal lid in place from below. The holding brackets on the lids must face upwards into the engine compartment. As shown in the figure, the holding brackets must be positioned at a right angle to the direction of travel in the "a" area. Only in this area is a tight fit ensured.



2149-10

1 = Lid left

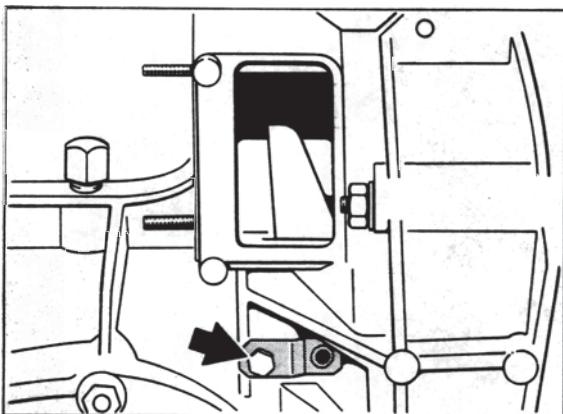
2 = Lid right

a = 5 mm dimension - installation area

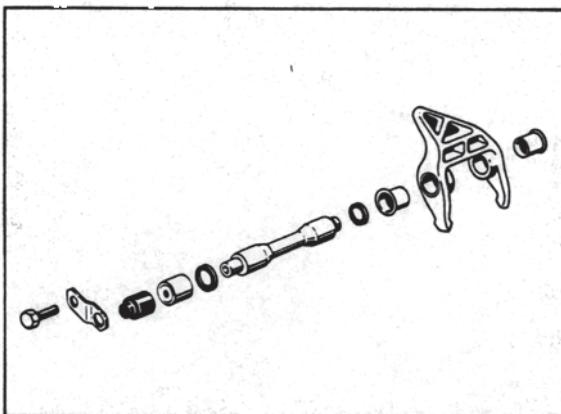
34 35 27 Removing and refitting the transmission

Removal:

1. Remove wire from starter and wire from reverse light switch.
2. Remove M 6 x 16 hexagon head bolt, bracket and mount cover. Pull out release shaft using a M 6 x 40 hexagon head bolt.
3. Undo 4 fastening nuts and separate transmission from engine. Use Special Tool P 119 to undo upper fastening nut on starter.



1391-10

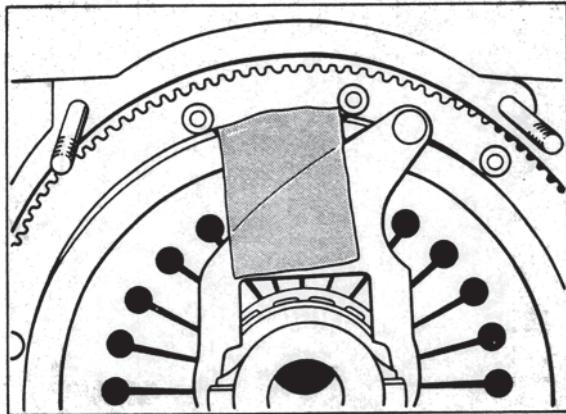


1388-10

34 35 27 Removing and refitting the transmission**Refitting:****Note:**

Apply a very thin coat of Olista Longtime 3 EP to input shaft splines (for corrosion protection only).

1. Engage release fork in release bearing and use a length of suitable adhesive tape to locate it provisionally in the installation position.



1390-10

2. Connect transmission to engine.
3. Engage release shaft with seals into release fork.
4. Remove locating tape from release fork across the assembly hole.
5. Fit needle-roller bearing, mount cover and bracket and tighten with M 6 x 16 hexagon head bolt (also refer to assembly notes, Group 30, page 30 - 1).

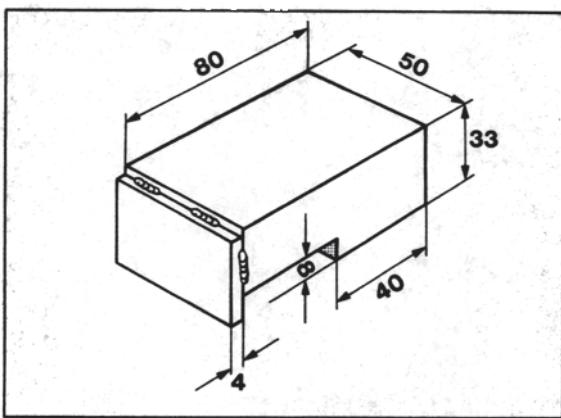
10 Tightening torques: Removing and installing the engine

Location	Thread	Tightening torque Nm (ftlb.)
Engine carrier to engine mount	M 12	85 (63)
Transmission carrier to body	M 12	46 (34)
Drive shaft to transmission flange	M 10	81 (60)
Oil drain plug to thermostat housing		50 + 5 (37 + 4)
Oil drain plug to crankcase		50 + 5 (37 + 4)
Selector rod (fit bolt)		18 (13) (lock additio- nally with Loctite 270)
Stabilizer bar to crossmember	M 8	23 (17)
Stabilizer mount to shock absorber	M 10	46 (34)
Link no. 2 to crossmember (ecc.)	M 12 x 1.5	85 (63)
Link no. 2 (track rod) to wheel carrier	M 12 x 1.5	85 (63)
Rear crossmember to side panels	M 12 x 1.5	120 (88)
Front crossmember to side panel	M 10	65 (48)

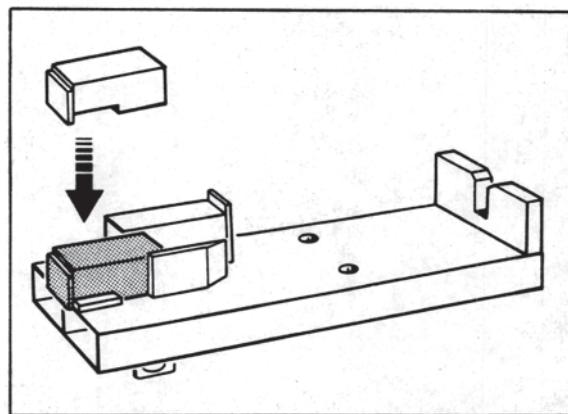
10 Special Tool 9111/3

Fit auxiliary support to Special Tool 9111/3 (engine mounting plate).

The auxiliary support should be fabricated in the workshop.



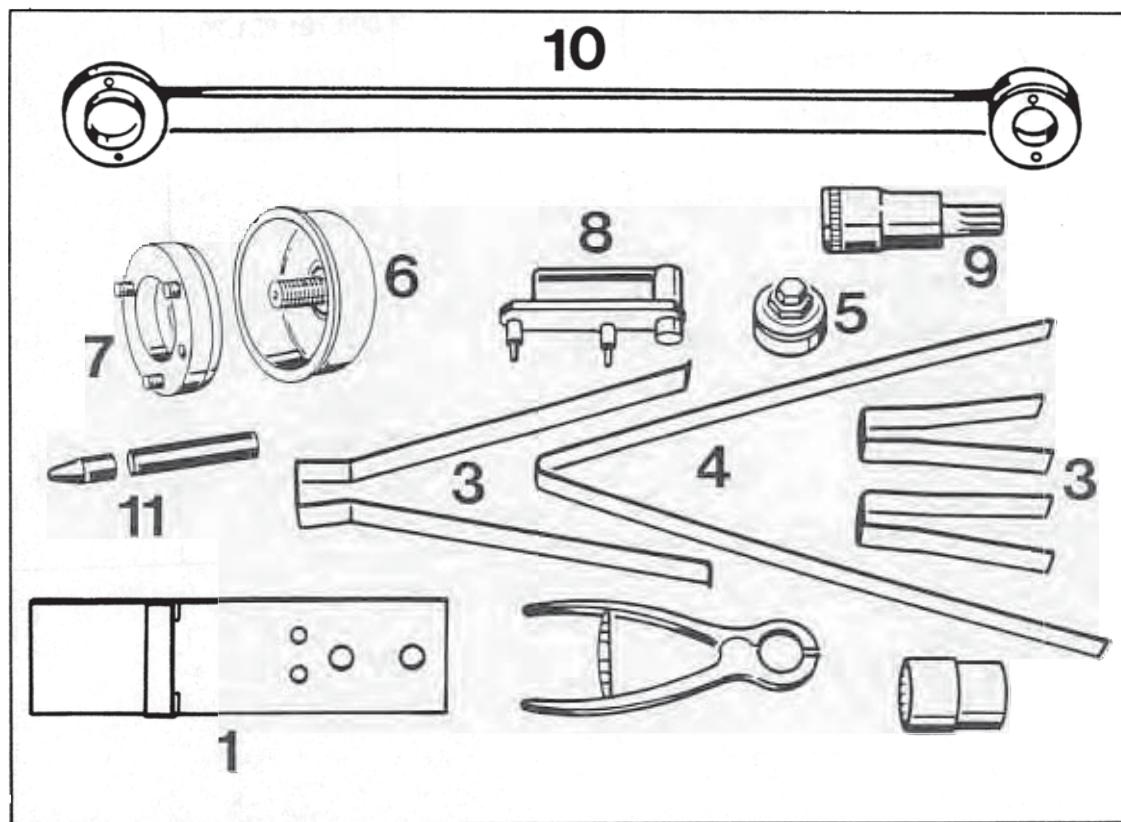
1775-10



1776-10

10 01 37 Disassembling and Assembling Engine

Tools



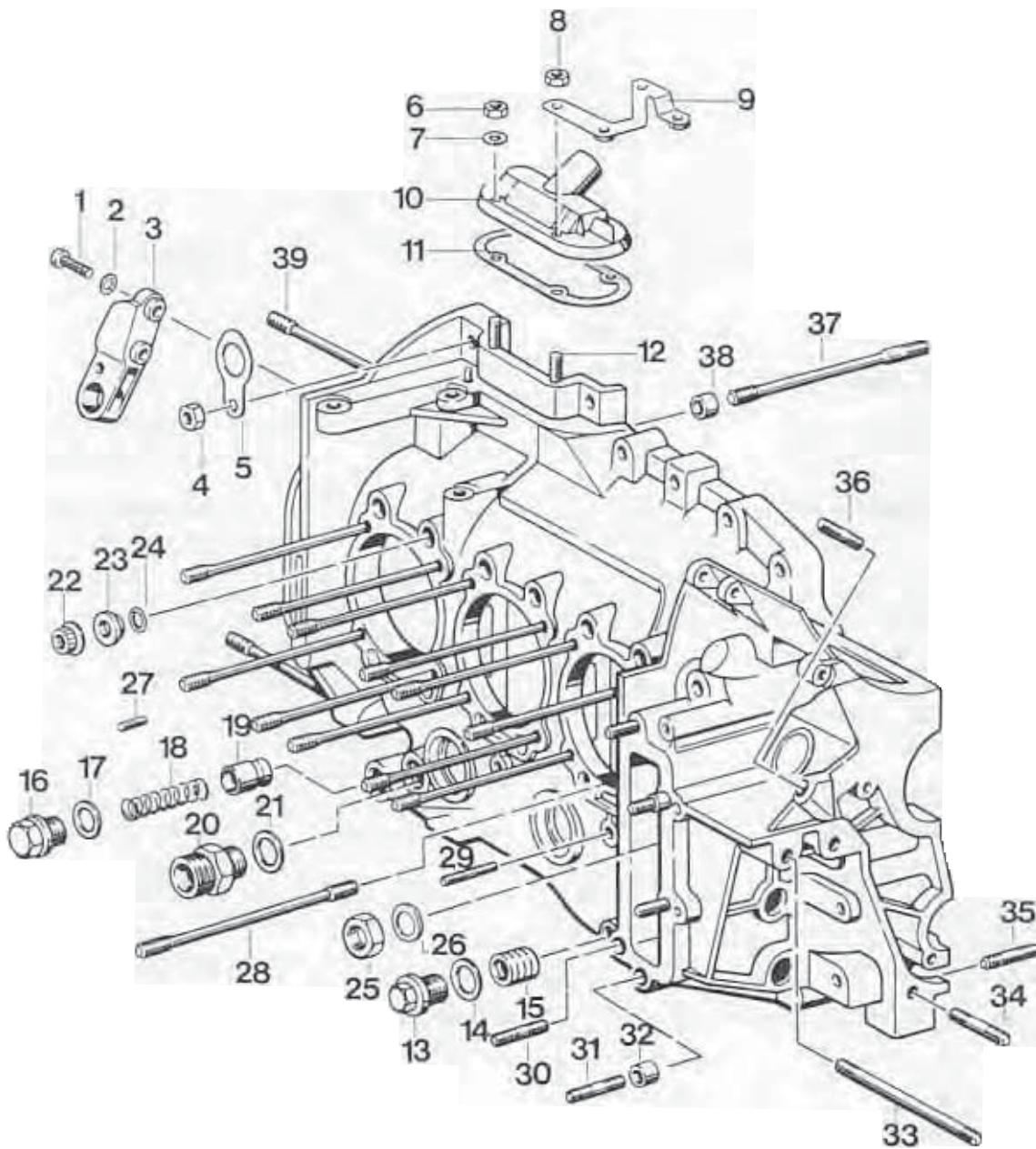
352/13

No.	Description	Special Tool	Order Number	Remarks
1	Holding plate	209 a	000.721.209.10	Bolt crankshaft on holding plate with multiple-tooth socket bolts, Part No. 928 102 152 01.
2	Circlip pliers			Standard
3	Straps (conrod)	P 221	000.721.221.00	Modify as required (con-rod dimensions modified)
4	Strap (timing chain)	P 222	000.721.220.00	

No.	Description	Special Tool	Order Number	Remarks
5	Oil seal fitting tool (pulley side)	P 216 d	000.721.216.40	
6	Thrust piece for oil seal	9517	000.721.951.70	
7	Installing tool	9517/1	000.721.951.71	
8	Installing tool for flywheel	P 238 b	000.721.238.20	
9	Multiple-tooth screwdriver socket	9290	standard	
10	Holder for pulley	9548	000.721.954.80	
11	Installing sleeves for studs	9511	000.721.951.10	
12	M 14 wrench socket for studs		Snap-on Order No. FM 14 (2 required)	

10 01 37 Dismantling and assembling crankcase sections**Left-hand crankcase section**

Note: Unless indicated otherwise, apply Loctite 270 to all stud threads when reassembling the engine!



No.	Designation	Qty.	Removal	Note:	
					Installation
1	Hexagon head bolt M 6 x 30	1			
2	Washer	1			
3	Sensor bracket	1			
4	Self-locking hexagon head nut	1			
5	Retainer	1			
6	Self-locking hexagon head nut	2		tightening torque 10 Nm (7 ftlb)	
7	Washer	2			
8	Self-locking hexagon head nut	2		tightening torque 10 Nm (7 ftlb)	
9	Retainer	1			
10	Ventilation cover	1			
11	Gasket	1		replace, coat both sides with Loctite 574	
12	Stud M 6 x 20			projection length 20 + 1 mm	
13	Drain plug M 20 x 1.5	1		tightening torque 70 Nm (52 ftlb)	
14	Seal A 22 x 27	1		replace	
15	Threaded insert M 20 x 1.5	1			
16	Plug for oil pressure re- lease valve	1		tightening torque 60 Nm (44 ftlb)	
17	Seal A 18 x 24	1		replace	
18	Thrust spring	1			
19	Piston	1		oil before fitting	
20	Screw-in flange (oil return)	1	heat screw-in flange area	bond in place with Loc- tite 270, tightening torque 70 Nm (52 ftlb)	
21	Seal A 22 x 27	1		replace	

No.	Designation	Qty.	Note:	
			Removal	Installation
22	Multiple-tooth nut	11		tightening torque 50 Nm (37 ftlb), tighten with double hexagon head socket insert
23	Stepped disc	11		
24	O-ring 8 x 2	1		replace, oil lightly
25	Hexagon head nut M 10 x 1.25 (at main bearing saddle VII)	1		tightening torque 50 Nm (37 ftlb)
26	Washer A 10.5	1		
27	Spray jet for piston cooling	6	heat spray jet area	bonded in place with Loctite 639, peened at circumference to lock
28	Stud M 10 x 164	12	heat area	projection length 130.2 - 0.5, use Loctite 649 to secure
29	Stud M 6 x 43	3		projection length 31 - 0.5 mm
30	Stud M 8 x 42	3		projection length 25 - 0.5 mm
31	Stud M 8 x 47	2		projection length 25 - 0.5 mm
32	Adapter sleeve	2		projection length 6 - 0.5 mm
33	Stud M 10 x 111	1		projection length 90 - 1 mm
34	Stud M 10 x 55	1		projection length 36 - 1 mm
35	discontinued			
36	Stud for distributor M 8 x 44	1		projection length 28 - 0.5 mm

No.	Designation	Qty	Removal	Note:	
					Installation
37	Stud M 10 x 1.25 / M 11 x 169	2		bond in place with Loctite 649, projection length 116 + 0.5 mm	
38	Adapter sleeve	2		projection length 9.5 ± 0.3 mm	
39	Stud	2		projection length 105 mm	

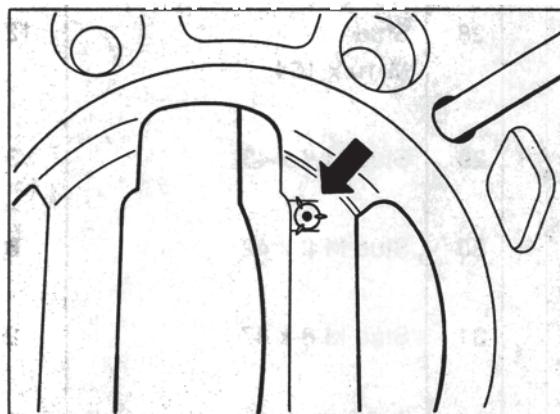
Replacing oil spray jets for piston cooling

1. Using a 5 mm dia. drill bit, drill a pilot hole to approx. 2 mm depth. Remove cover, spring and ball.
2. Insert a M 5 tap (finishing tap No. 3) and pull out jet remains. If required, use M 6 tap (taper tap No. 1).
5. Peen circumference of spray jet.

Note

Heat surrounding area of spray jet to facilitate removal.

4. Bond new spray jet in place using Loctite 640 or Loctite 270. Observe installation position, ball points towards bearing saddle. Bore must be free from Loctite.

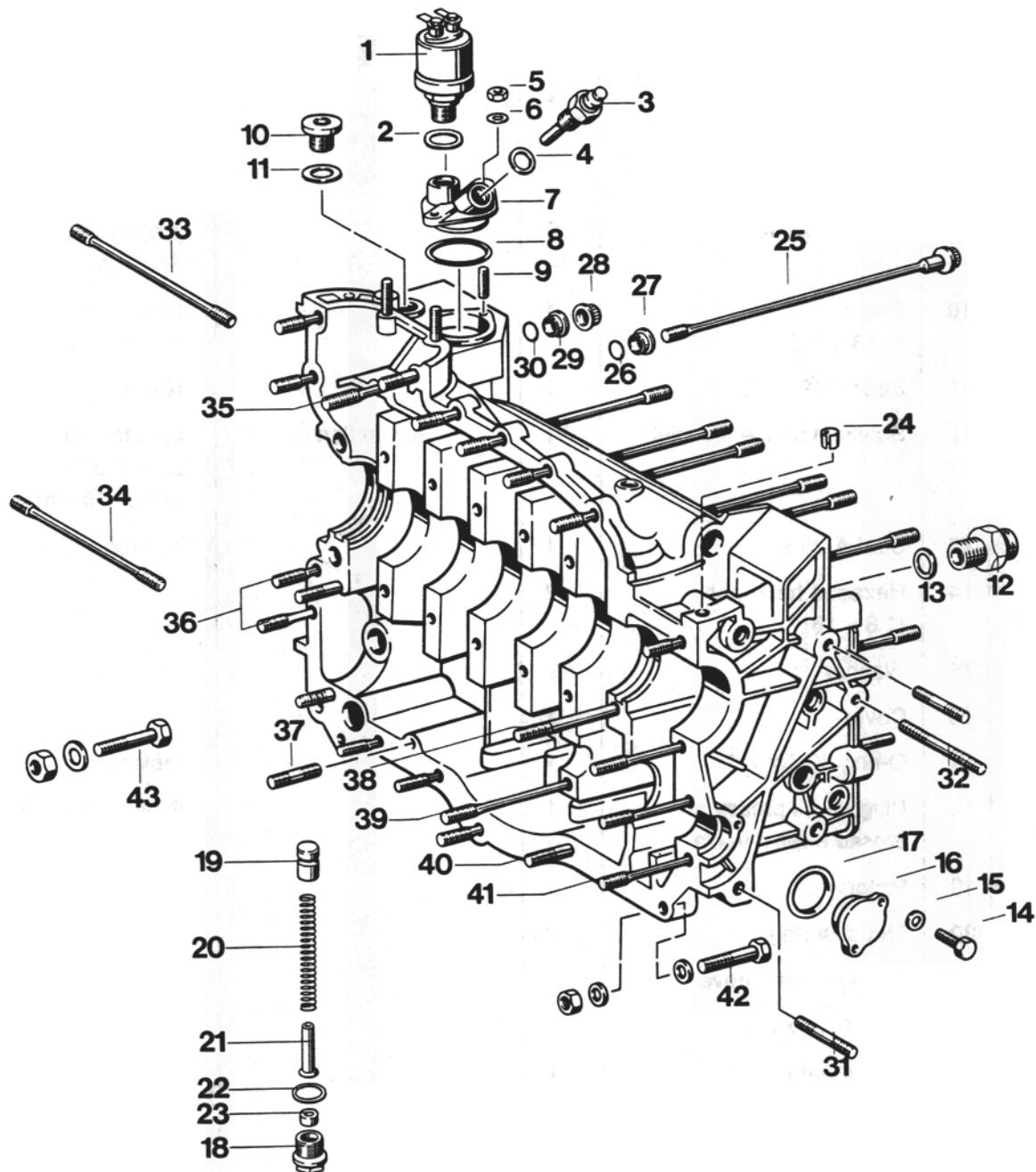


Note

Oversize spray jets are available from the Parts Department. Part No. 964.101.020.50

Right-hand crankcase section

Note: Unless indicated otherwise, apply Loctite 270 to all stud threads when assembling the engine!



No.	Designation	Qty.	Removal	Note:	
					Installation
1	Oil pressure sender	1			
2	Seal 18 x 24	1		replace	
3	Temperature gauge sender	1			
4	Seal 14 x 18	1		replace	
5	Self-locking hexagon nut	2			
6	Washer	2			
7	Cover	1			
8	O-ring	1		replace	
9	Stud M 6 x 16	2		projection length 15.5 mm	
10	Plug M 18 x 1.5	1		tightening torque 45 Nm (33 ftlb)	
11	Seal A 18 x 22	1		replace	
12	Screw-in flange (oil inlet)	1	heat screw-in flange	coat threads lightly with Loctite 270, tightening torque 90 Nm (66 ftlb)	
13	Seal A 25 x 30	1		replace	
14	Hexagon head bolt M 6 x 16	2			
15	Washer	2			
16	Cover	1			
17	O-ring 33.3 x 2.4	1		replace	
18	Plug for oil pressure pressure relief valve	1		tightening torque 60 Nm (44 ftlb)	
19	Piston			oil when fitting	
20	Thrust spring	1			
21	Spring guide sleeve	1			
22	Seal A 18 x 24			replace	
23	Spacer ring	1			
24	Tension sleeve 8 x 16 (blower mounting)	1		opening must point to- wards pulley	

No.	Designation	Qty.	Removal	Note:	
					Installation
25	Through bolt	11		oil lightly, always use a second wrench to lock. To install, use a double hex head socket insert (14 A/F)	
26	O-ring 8 x 2	11		replace, oil lightly	
27	Stepped disc	11			
28	Multiple-tooth mut	2		use a double hex head socket insert (14 A/F)	
29	Stepped disc	2			
30	O-ring 8 x 2	2		replace	
31	Stud M 10 x 35	2		projection length 36 - 1 mm	
32	Stud M 10 x 90	1		projection length 90 - 1 mm	
33	Stud M 10 x 140	1		projection length 140 mm	
34	Stud M 10 x 105	1		projection length 105 mm	
35	Stud M 8 x 52	1		projection length 52 mm	
36	Stud M 8 x 48	2		projection length	
37	Stud (for mounting of oil pump) M 8 x 22	3		projection length 22 mm	
38	Stud M 10 x	1		projection length 55 mm	
39	Stud	1		projection length 108 mm	
40	Stud M 8 x 32 (for circum- ferential mounting)	13		projection length 32 mm	
41	Stud M 8 x 78	3		projection length 78 mm	
42	Hexagon head bolt M 8 x 45	1			
43	Hexagon head bolt M 8 x 55	1			

Assembly notes

Sealing the crankcase mating sections

Use only Loctite 574 to seal.

Loctite 574 hardens only when contact with metal is made and air ingress is prevented. After having applied the sealant, bolt up the crankcase sections within approx. 10 minutes since the sealant bead applied directly to the metal surface will otherwise start to cure.

Removing old sealant

In case of repairs, the old sealant coat must not necessarily be removed. It is sufficient to de-grease the surface and apply the new coat of sealant after the solvent has evaporated.

New Loctite will soften the old sealant embedded in the machining marks and will cure after assembly.

Should it be required to remove the old sealant, it is recommended to use a fine-mesh wire brush or Loctite adhesive remover 80646.

Applying sealant

1. For manual application, it is recommended to use a short-pile paint roller and to pour the sealant into a dish with grooves at its circumference (for squeezing excess sealant off the roller).
2. Apply a uniform coat of Loctite 574 sealant to the left-hand crankcase section using the paint roller. Use a small paint brush to apply sealant to the areas around the bolt holes.

Crankcase Mounting Bolts/Studs and Nuts

Mounting Sequence of Bolts

1. Lubricate 11 bolts and 24 round seals lightly with oil.

Note

Lubricate seals with oil only immediately before installation; never keep lubricated seals in storage for a long time.

2. Place insulators on bolts.

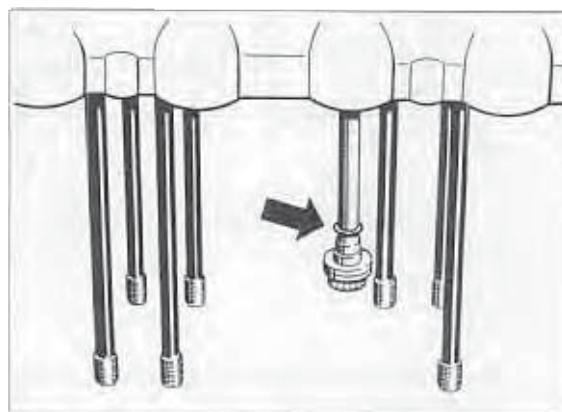
3. Guide round seals over the threaded zone with the tapered adapter of Special Tool P 9511, and slide on to the reduced shaft head end of the bolts.

Important

O-ring must not be pushed on to the bolt collar (10 mm dia.)!

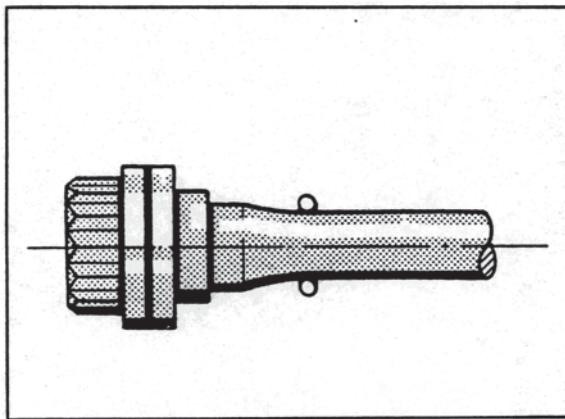
Assemble the sections and tighten the outer crankcase M 8 nuts until there is contact between both mating surfaces.

4. Insert the prepared bolts into the right crankcase section from underneath against the metal stop.

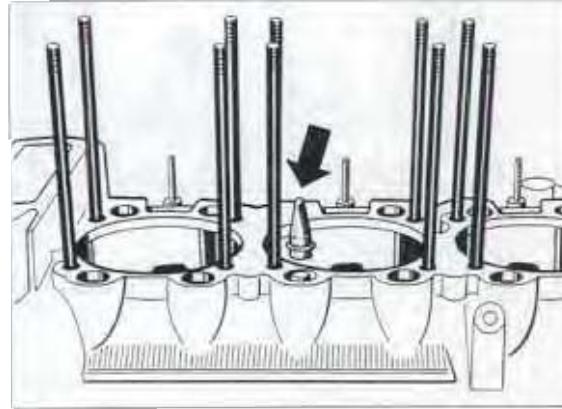


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5. Slide the tapered adapter with mounted and lubricated round seal on the threaded end.



336/13

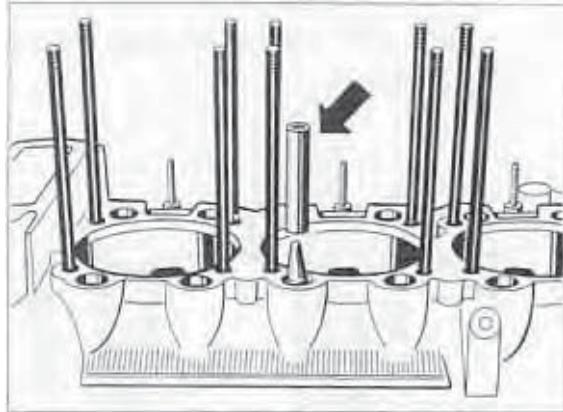


331/13

Prepare left and right crankcase sections for assembling. Coat mating surfaces and bearing seats of the left section lightly with Loctite No. 574.

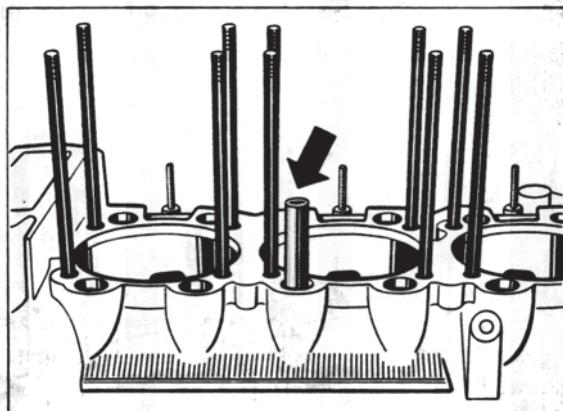
6. Slide round seal off of the tapered adapter carefully, with A-end (thin wall) of the cylindrical sleeve.

Special Tool 9511



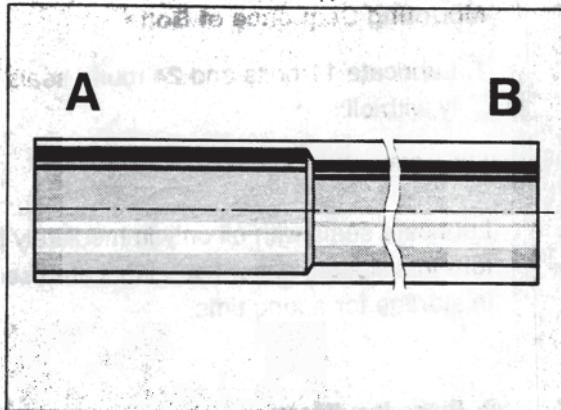
332/13

7. Remove tapered adapter and slide round sleeve into final position carefully with the B-end (thick wall) of the cylindrical sleeve, while counterholding on the bolt head.



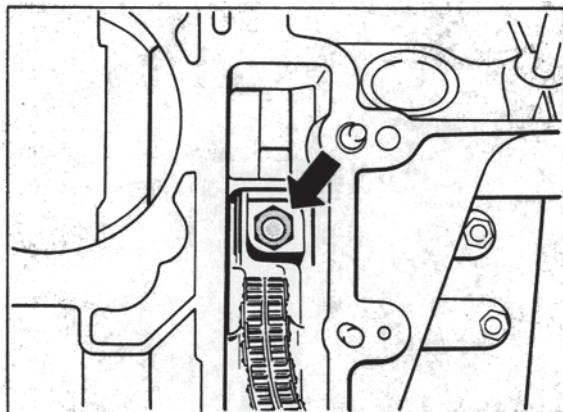
333/13

8. Install insulators dry and press on lightly with the cylindrical sleeve's B-end.
 9. Install multiple-tooth nuts (threads lubricated with oil) finger tight.
 10. Proceed with both studs for the right crankcase section (near bearing no. 1) accordingly.



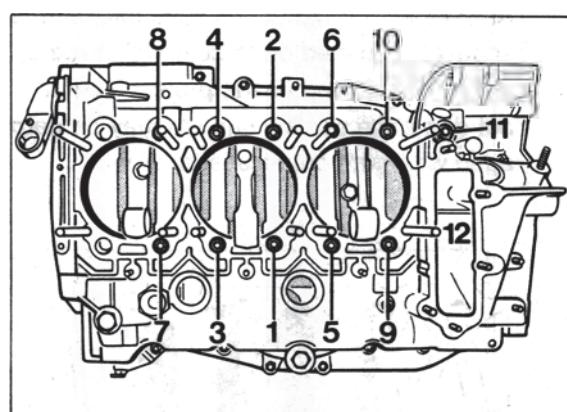
335/13

11. Mount M 10 x 1,25 hexagon nut and A 10,5 spring washer on the stud, with rounded side facing the hex.nut.

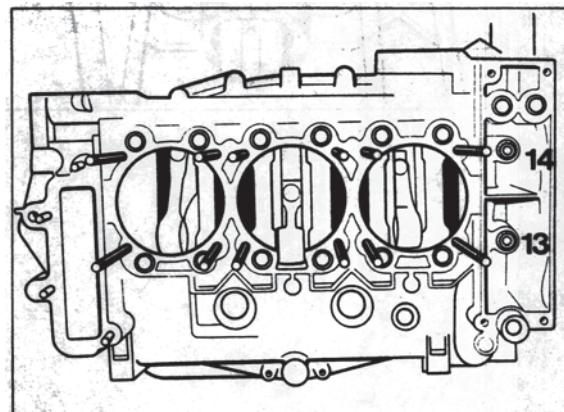


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12. Tighten bolts and studs with 50 Nm (36.9 ftlb) Note specified tightening sequence.



302-13



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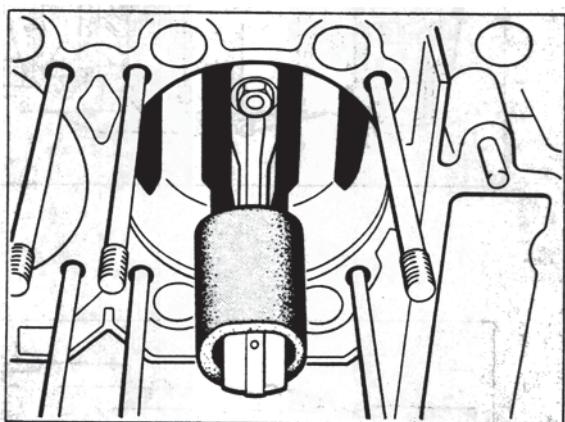
Note

A second person should always counterhold while tightening, to avoid damaging the O-rings while turning the bolts. Use a M 14 wrench socket from „Snap-on“.

13. Tighten outer crankcase bolts with a final torque of 25 Nm (18 ft. lbs.).

Note

After fitting the right crankcase half, a tube should be pushed on to connecting rod cylinders 1 and 4 as damage protection. If this is not done, the sealing surface may be damaged when the crankcase is turned.



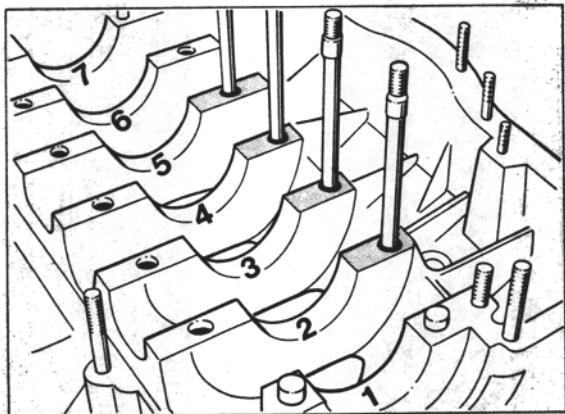
438-13

Assembly instructions**Right half of crankcase**

Installation of lower anchorage bolts on RS engine (M 64/20)

Note

Additional O-rings (6 x 2.5) are inserted on 4 anchorage bolts of the lower bearing block mounts (bearing blocks 2, 3, 4 and 5) (part no. 999 707 288 40).

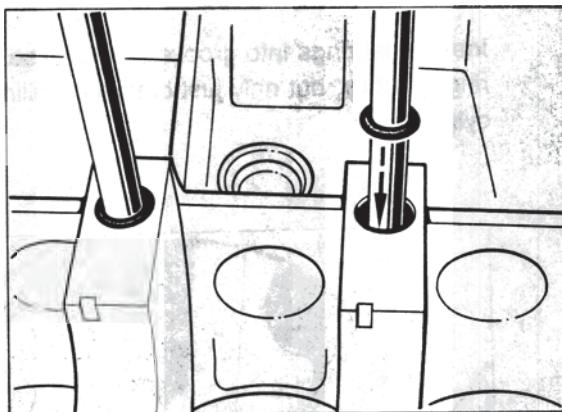


2202-10

Installation

Insert the pre-assembled anchorage bolts into the right half of the crankcase from below.

Place conical sleeve on thread end using special tool P 9511. Push O-ring (dry) into bearing block up to bevel. Remove conical sleeve.



2201-10

Assembly instructions

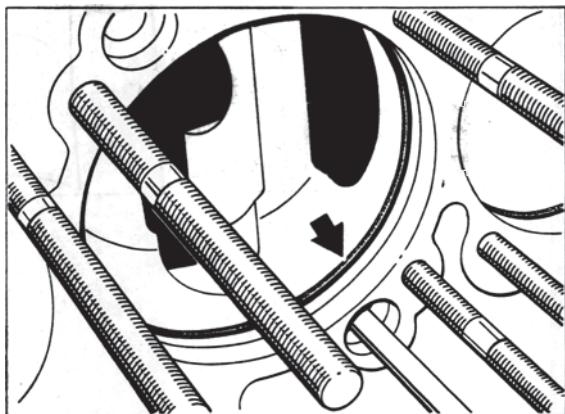
Installation of cylinder base seals on
RS engine (M 64 / 20)

Note

Sealing is no longer provided by O-rings on
the cylinder but by seal rings in the crankcase.

Installation

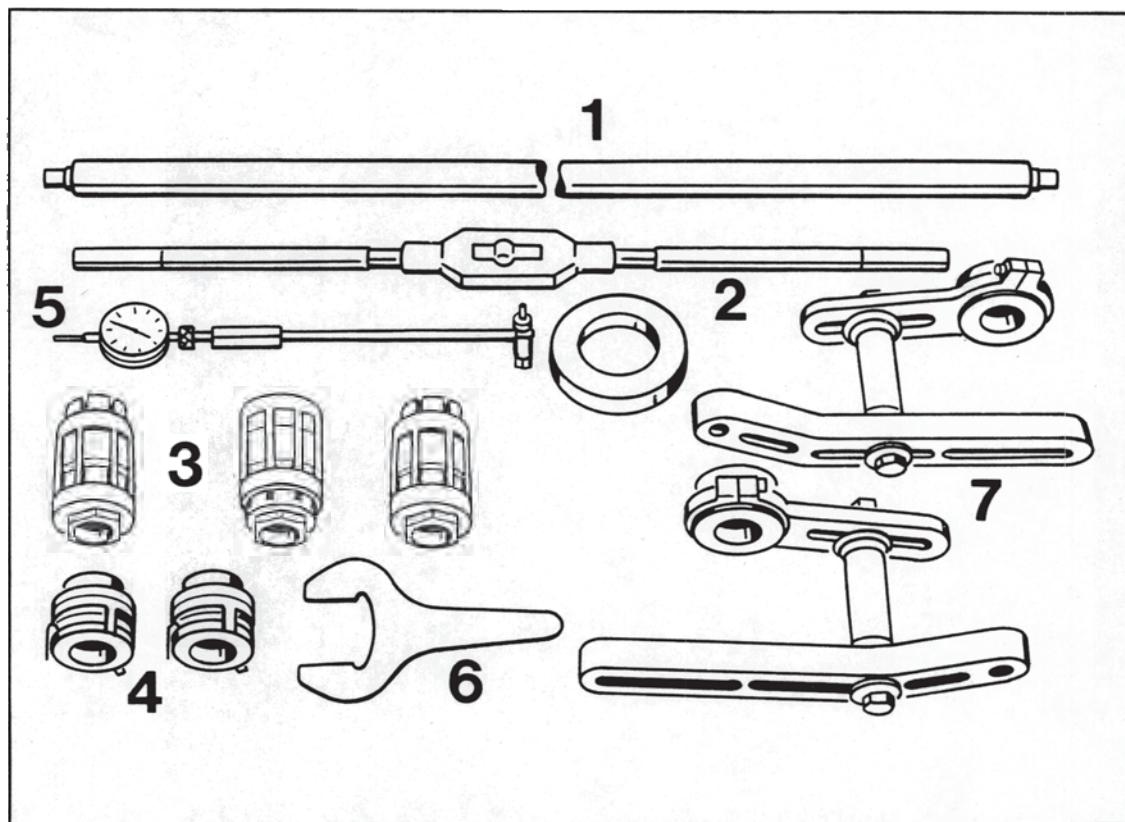
Insert seal rings into groove dry. Grease seal
rings slightly, but only just before installing
cylinders.



2200-10

10 10 Measuring and repairing the crankcase

Tools



930-13

No.	Description	Special Tools	Remarks
1	Guide rod for reamer 35 x 1500 mm		comm. avail. (supplied by Hunger)
2	Tap wrench size 4		comm. avail. (supplied by Hunger)
3	Main bearing reamers		comm. avail. (supplied by Hunger)
4	End bearing bushings EL 35		comm. avail. (supplied by Hunger)
5	Internal measuring device with measuring ring dia. 65.000 mm		commercially available
6	Wrench, 58 A/F		comm. avail. (supplied by Hunger)
7	Guide for support of guide rod		comm. avail. (supplied by Hunger)

10 10 03 Measuring the crankcase

General

Whenever the crankcase is dismantled in the course of rebuilding the engine, measure the main bearing bores.

Measuring

1. Attach crankcase to engine support P 201 using mounting hardware P 201 b and assemble both housing sections.

Lightly tighten all through bolts and four M 8 fastening nuts at bearing 1 (flywheel side) and at bearing 8 (pulley side).

2. Applying light blows with a plastic mallet, align both crankcase sections. The gap at bearing bore 8 must not show any offset whatsoever.

Use an internal measuring device to measure bearing bore 8 diagonally and align to max. 0.02 mm.

3. Tighten all through bolts and 4 additional hexagon nuts (M 8) at bearing 1 and bearing 8 to specified torque.

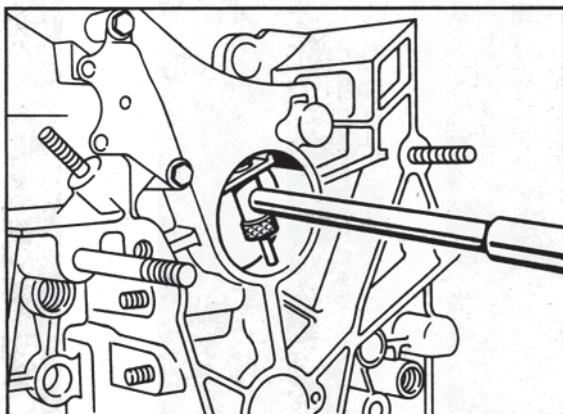
4. Measure all 8 main bearing bores using an internal measuring device.

If the bearing bores are too narrow, use a standard reamer to ream bores to standard dia. 65.00.

Specified size for bearing bores 1 to 8 is 65.000 mm to 65.019 mm.

5. If the bearing bores are too large, use a roughing or finishing reamer, respectively, to ream to 65.25 mm oversize dia. (B bearings).

The checking dimension for B bearings is 65.25 mm dia. to 65.269 mm dia.



931-13

10 10 49 Reworking and reaming

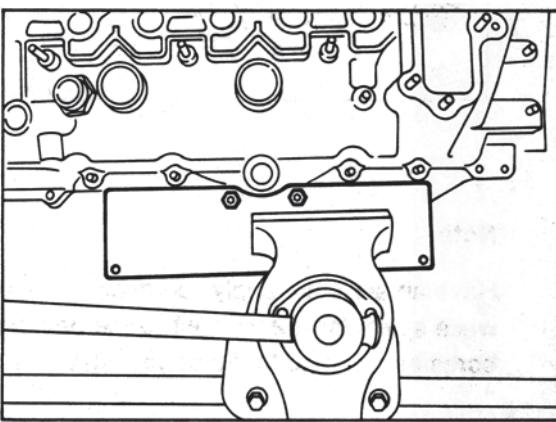
General

Reaming of the light-alloy Silumin crankcase for B bearings is done in two steps. When reaming the bearings, always grease the reamer using white spirits.

1st step = roughing reamer 65.20 mm dia.
2nd step = finishing reamer 65.25 mm dia.

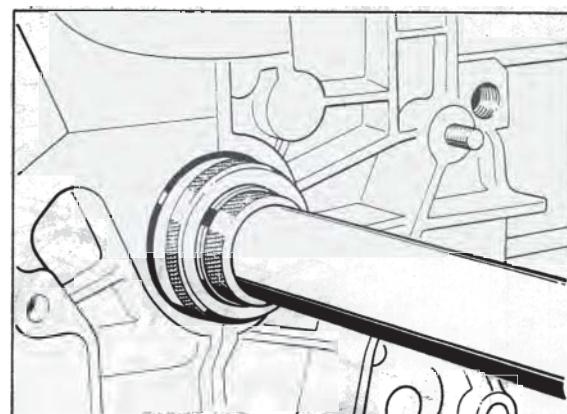
Reaming

1. Fit shop-made tool to crankcase and tighten in a vise.



932-13

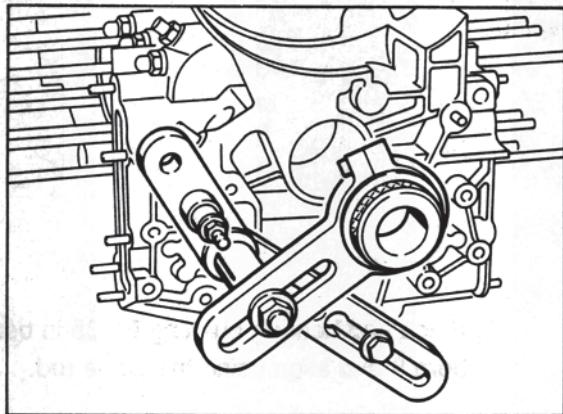
3. Place end bearing bushing EL 35 in bearing bore 8 and align using the guide rod.



933-13

2. Place end bearing bushing EL 35 in bearing bore 1.

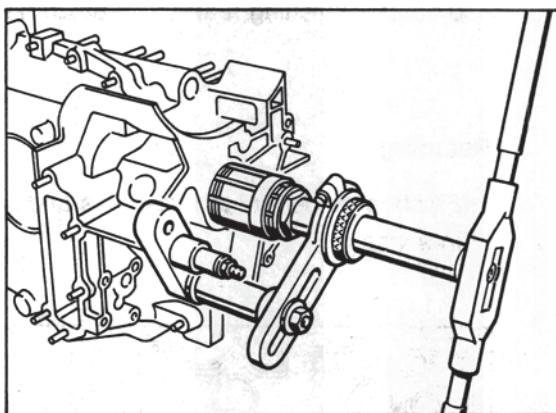
4. Now attach and align both guides for support of the guide rod.



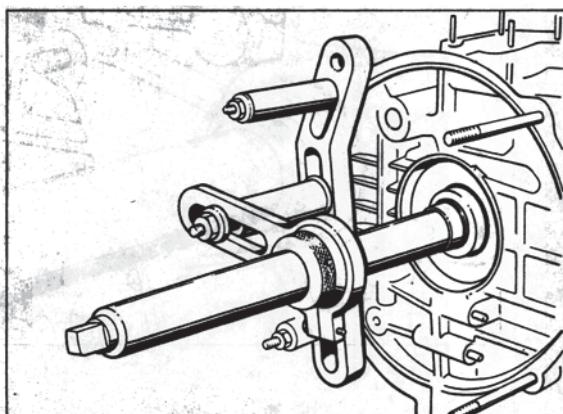
934-13

5. Remove end bearing bushings after tightening and aligning, respectively.

6. Insert guide rod complete with reamer into bearing 8 and ream all bearing bores slowly and steadily.



936-13



935-13

Note

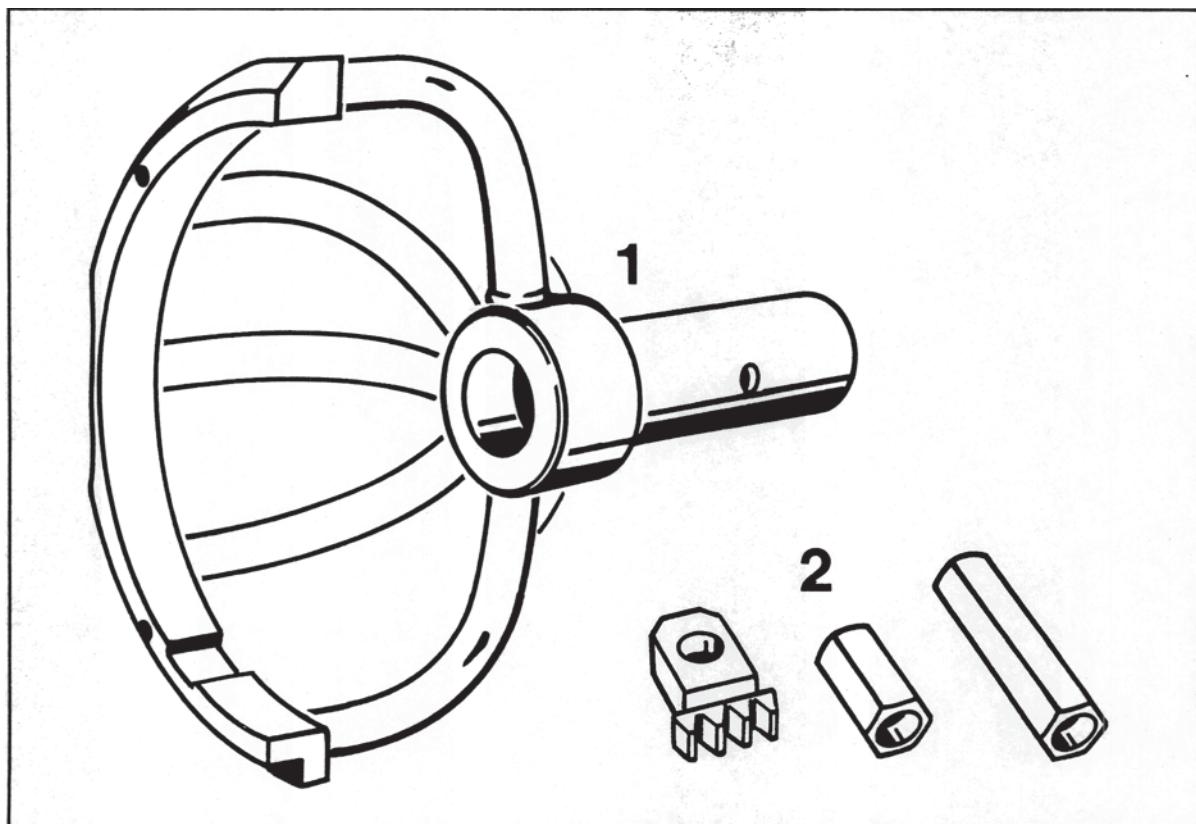
Have an assistant apply liberal amounts of white spirits for greasing while the bearing bores are reamed to the correct size.

Note

When tightening the guides, make sure the guide rod does not bind, i.e. the guide rod must be checked for free rotation during the whole tightening process.

13 01 Engine Holder

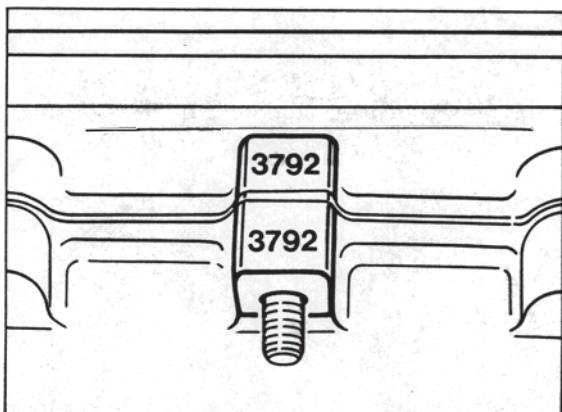
Tools



No.	Description	Special tool	Order No.	Explanation
1	Engine holder	P 201	000.721.201.00	Mount engine holder to right-hand crankcase section (cyl. no. 4...6). Use spacer sleeves (shop-made).
2	Toothed sector and mounting parts	P 201 b	000.721.201.20	

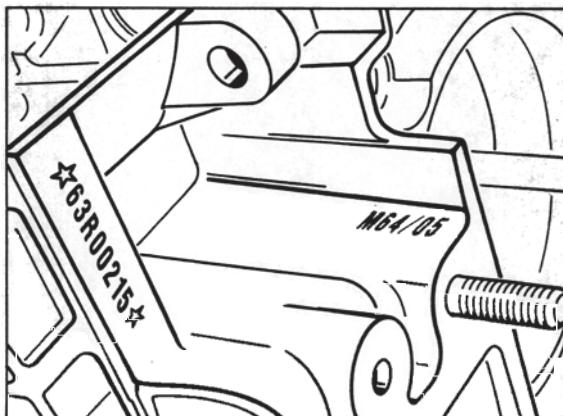
13 10 Identification of crankcase engine number and engine type

1. The crankcase sections are machined as a unit and must always be fitted in combination with each other. Observe identification mark.



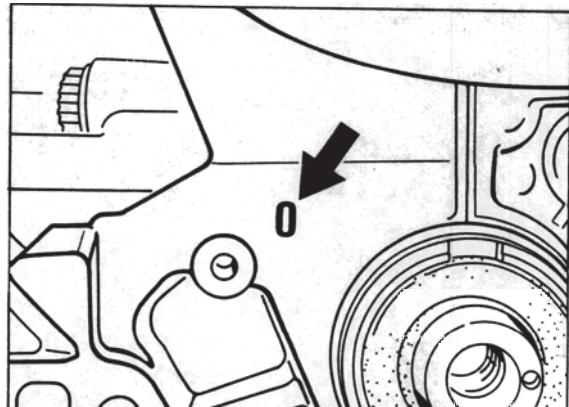
1413-13

2. Engine number and engine type identification



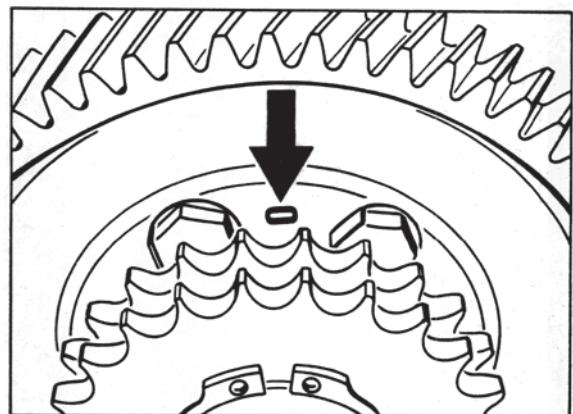
1414-13

3. Crankcase matching number



1415-13

4. Intermediate shaft matching number



1416-13

13 48 Crankshaft - Standard and Repair Dimensions

Sizes	Main bearing d 1	Big end bearing d 2	Main bearing dia. d 3 (bearing 8)	
Standard	59.971...59.990	54.971...54.990	30.980...30.993	
- 0.25	59.721...59.740	54.721...54.740	30.730...30.743	
- 0.50	59.471...59.490	54.471...54.490	30.480...30.493	
Sizes	Flange Ø d 4	Timing gear fit dia. d 5	Support dia. d 6	Guide bearing width A
Standard	89.780...90.000	42.002...42.013	29.960...29.993	28.000...28.060
Wear dia.	89.580		29.670	
	Crankcase dia. Bearing 1...8			
	Standard 65.000...65.019			
	Oversize 65.250...65.269			

Grind running surfaces for oil seals to 29.670 and 89.580 sizes only if score marks are too deep.

In other cases, repolish if required, $R_t = 3$.

Oil bores are rounded to $R 0.5$ after grinding.

Remove sharp edges with $R = 0.2 \dots 0.5$.

Max. permissible radial runout relative to support in-...max. 0.04.

Surface treatment requirements: Gas carbonitrided PN 2063.

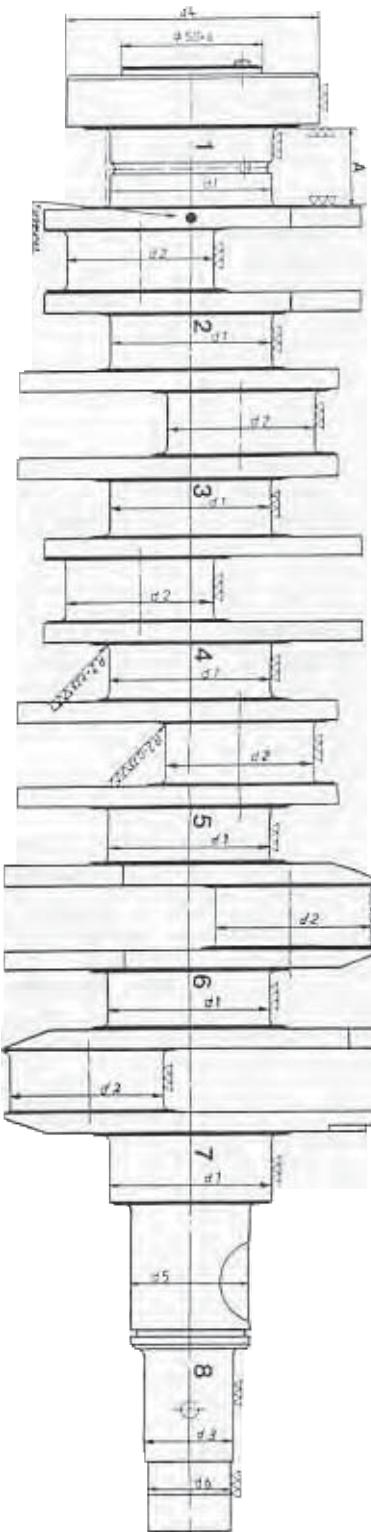
Do not straighten main bearings 3 and 5 after nitriding treatment.

Straightening the other main bearing by levering at the radii is permissible.

Running surfaces of main and big end bearing journals are polished after nitriding treatment.

Color coding or repair sizes:

1st repair size	blue dot
2nd repair size	green dot



13 40 02 Con-rod weight classes

The con-rods are allocated to weight classes. The last digit of the part number indicates the weight class. The last digit is marked on the shaft of con-rods supplied as spare parts.

Note

The weight difference between con-rods installed in the same engine must not exceed 6 g. To determine the weight class, weigh the entire con-rod without the bearing shells.

The con-rod markings for spare parts are stamped with paint.

Type 1 and 2 con-rods are no longer available as spare parts.

If con-rods need to be replaced, a complete set of type 3 con-rods must be installed.

Note

Type 3 con-rods are also available as individual parts.

Type 1 (from the start of 993 production)

Weight from (grams)	Weight to (grams)	Weight group for spare part	Part no. of replacement con-rod	Code on con-rod
508	514	1	993.103.020.50	50
	520	2	993.103.020.51	51
520	526	3	993.103.020.52	52
	532	4	993.103.020.53	53
538	544	5	993.103.020.54	54
	550	6	993.103.020.55	55
544	550	7	993.103.020.56	56

Type 2

From engine no.: M64/05 63 S 02522 - 05847 / M64/06 63 S 51344 - 52684 /
M64/07 64 S 02413 - 04238 / M64/08 64 S 50791 - 51180

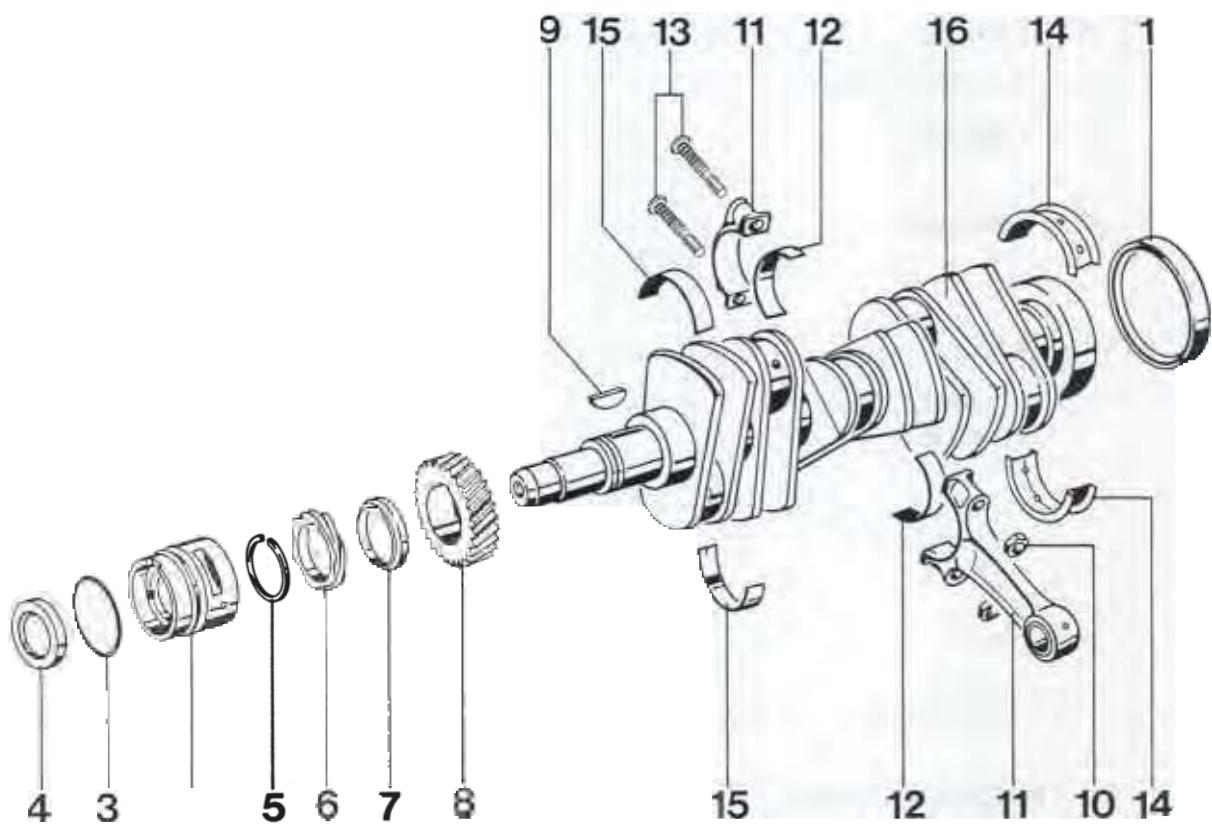
Weight from (grams)	Weight to (grams)	Weight group for spare part	Part no. of replacement con-rod	Code on con-rod
	524	1	993.103.020.57	57
	530	2	993.103.020.58	58
	536	3	993.103.020.59	59
	542	4	993.103.020.60	60
542	548	5	993.103.020.61	61
548	554	6	993.103.020.62	62

Type 3

From engine no. M64/05 63 S 05848 / M64/06 63 S 52685 / M64/07 64 S 04238 /
M64/08 64 S 51181 / M64/20 63 S 85654 / M64/60 61 T 00932

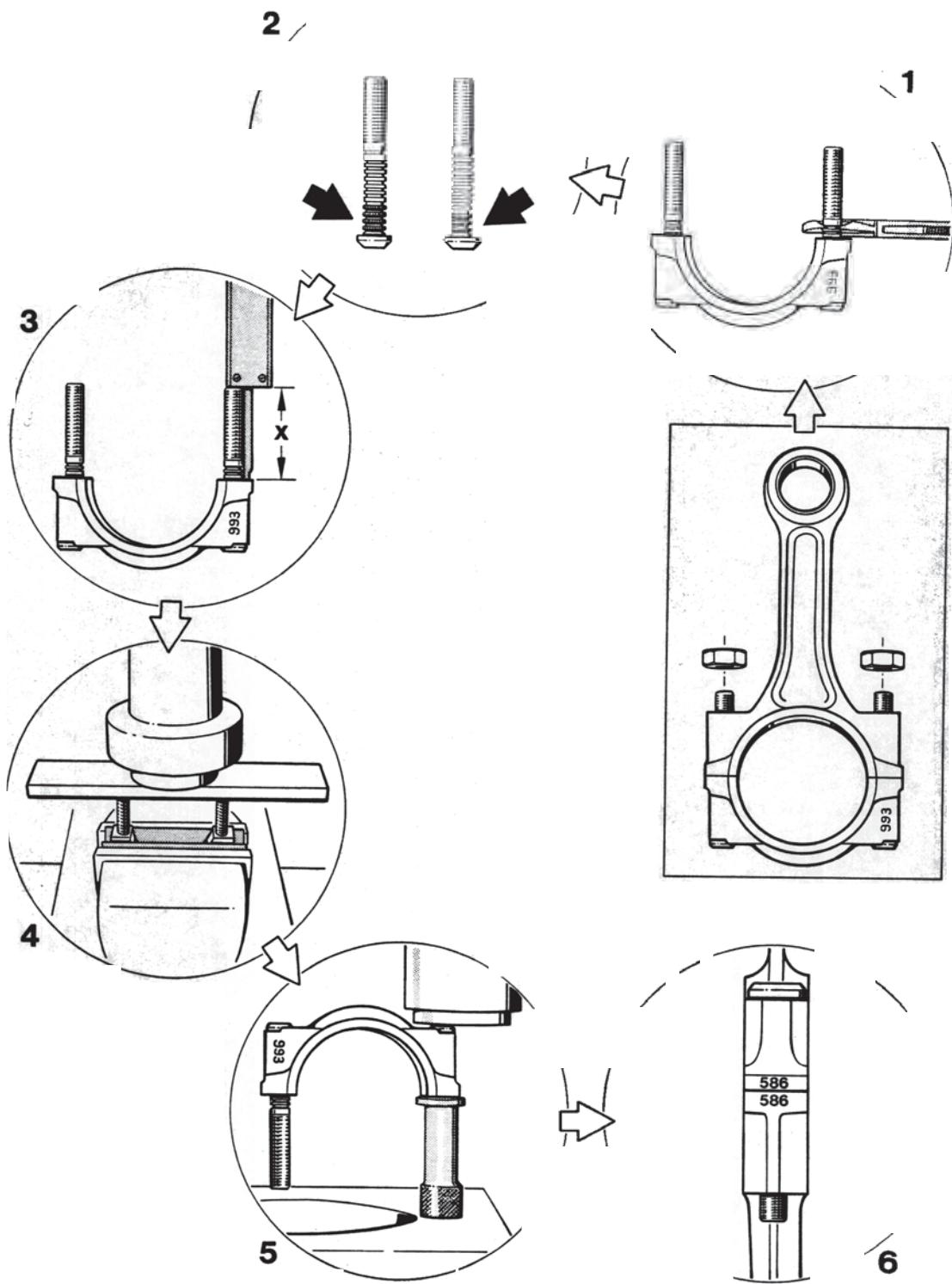
Weight from (grams)	Weight to (grams)	Weight group for spare part	Part no. of replacement con-rod	Code on con-rod
		1	993.103.020.64	64
	546	2	993.103.020.65	65
	552	3	993.103.020.66	66
	558	4	993.103.020.67	67
	564	5	993.103.020.68	68
	570	6	993.103.020.69	69

37 Dismantling and assembly of the crankshaft



No.	Designation	Qty.	Removal	Note: Installation
1	Oil seal	1		Replace
2	Bearing bushing for bearing No. 8	1		Apply oil to bushing
3	Sealing ring	1		Replace
4	Oil seal	1		Replace
5	Snap ring	1		
6	Distributor drive pinion	1		
7	Spacer ring	1		Observe correct installation position
8	Timing gear	1		Matched with intermediate shaft, fit only as an assembly
9	Woodruff key	1		
10	Connecting rod nut M 9 x 1.25	12		Tightening torque 1st tightening sequence: 30 Nm (22 ftlb.) Final tightening sequence: $1 \times 90^\circ \pm 2^\circ$ tightening angle, threads and seating face lightly oiled
11	Connecting rod	6		Observe installation position and weight
12	Big end bearing shell	12		Coat with oil
13	Connecting rod bolts	12		
14	Main thrust bearing shells 1	2		Coat with oil
15	Main bearing shells 2 - 7	12		Coat with oil
16	Crankshaft	1	Check for wear	Carry out sound check

13 40 38 Dismantling and assembling connecting rods



13 40 38 Dismantling and assembling connecting rods**Engine is dismantled**

No.	Operation	Instructions
	Determine type of knurled ring bolt	To determine if a 3-ring knurled bolt or a 4-ring knurled bolt has been fitted with the knurled ring bolt (connecting rod bolt) being pressed in place, the groove diameter has to be measured.
1	Measure dia. of groove 1	Former 3-ring knurled bolt: \varnothing Groove 1 = 7.95 to 8.20 mm New 4-ring knurled bolt: \varnothing Groove 1 = 7.70 to 7.85 mm
2	Difference between both types of knurled ring bolts	The visual difference between the 3-ring knurled bolt and the 4-ring knurled bolt is only detectable when the bolt is pressed out.
3	Determine elongation of knurled ring bolts	Before reassembling the connecting rods, make sure the elongation of the knurled ring bolts is checked. If dimension X (38.3 mm) is exceeded, the connecting rod bolts have to be replaced . Note: The bolts cannot be replaced on connecting rods fitted with 3-ring knurled bolts. In this case, the entire connecting rod assembly has to be replaced. The 4-ring knurled bolt is also available as a spare part.
4	Press out 4-ring knurled bolt	Clamp connecting rod cap in a machine vise, inserting aluminum sheet strips on both sides to protect the cap. Press out both 4-ring knurled bolts simultaneously.

No.	Operation	Instructions
5	Press in 4-ring knurled bolt	<p>Insert new 4-ring knurled bolt manually into former (old) splines.</p> <p>Note:</p> <p>To avoid damaging the separation joint, use an aluminum sleeve, e.g. from Special Tool set P 140 (cylinder retaining sleeves).</p> <p>Press in 4-ring knurled bolt until it is seated at the stop.</p>
6	Assemble connecting rod	<p>Always use new connecting rod nuts.</p> <p>When reassembling the connecting rod, always make sure the matching numbers are located on the same side.</p>
	Tightening specifications	<p>Apply a thin coat of oil to threads and seating surfaces.</p> <p>Initial tightening: 30 Nm (22 ftlb.)</p> <p>Final tightening: 1 x 90°</p>
	Checking	<p>Scribe a mark on connecting rod and connecting rod nut.</p> <p>Tighten to 60 Nm (44 ftlb.) to check the tight fit of the knurled ring bolt.</p> <p>If the knurled ring bolt starts to rotate at this torque or if a torque of 60 Nm (44 ftlb.) cannot be reached, the entire connecting rod assembly has to be replaced.</p>

13 59 19 Removing and installing crankshaft oil seal

Removal

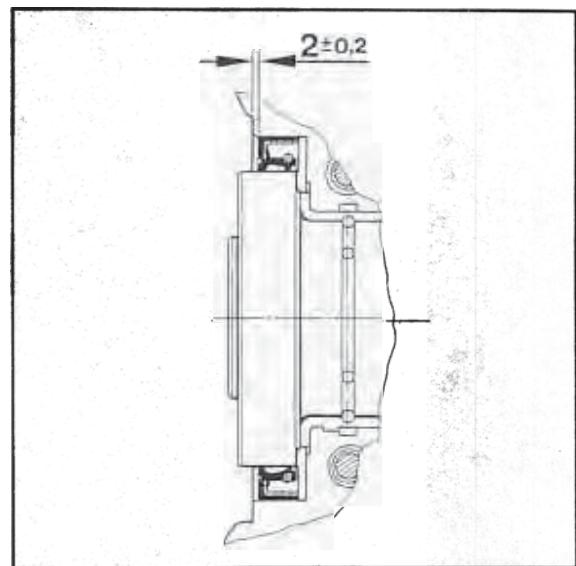
1. Deform oil seal at crankcase cutout using a drift or a cross-cut chisel and lever out with a screwdriver.

Note

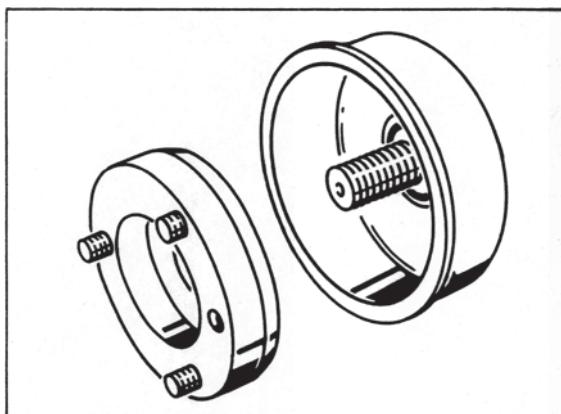
The oil seal must be pressed in until it is recessed **2 mm** below the flange of the crankcase.

Installing

1. Checking sealing lip running surface on crankshaft.
2. Clean oil seal seating surface in crankcase.
If required, deburr outer edge with a scraper and remove burrs.
3. Coat running surface for sealing lip with oil and install oil seal w. **assembly tool 9517/1** and **thrust piece 9517** special tools.



1732 - 13



1369 - 13

13 10 03 Measuring pistons and cylinders

Tolerance group	Cylinder Ø	Piston Ø
stamped		
0	100.000 - 100.007	99.970 - 99.980
1	100.007 - 100.014	99.977 - 99.987
2	100.014 - 100.021	99.984 - 99.994
3	100.021 - 100.028	99.991 - 100.001

Cylinder-to-piston clearance 0.02 - 0.03

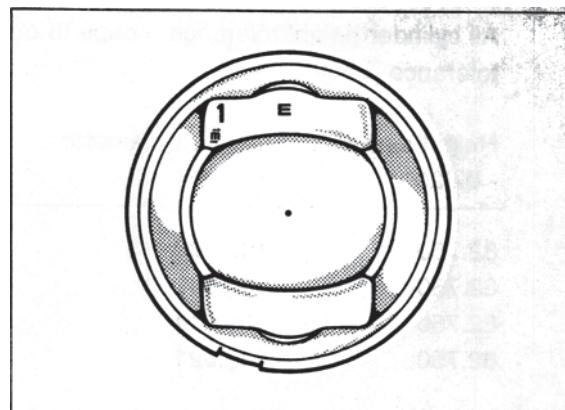
Piston identification

The following marks are stamped on the upper piston crown section (installation position):

Letter "E" in the middle (towards inlet), with change level ID (internal Mahle ID) to the right; the tolerance group (0, 1, 2, 3) is indicated to the left of the "E", and the weight class is indicated next to the tolerance group.

Note:

The signs -- (minus minus) to indicate the weight group may also appear in vertical direction.

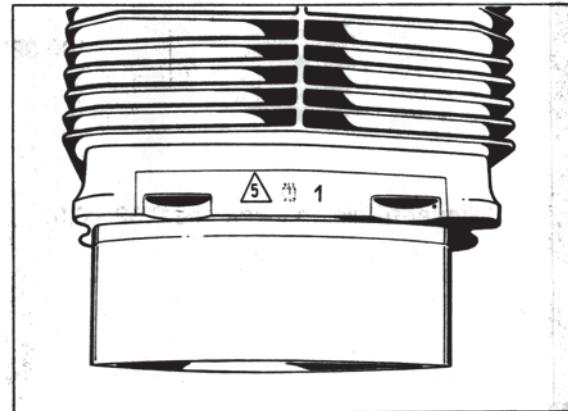
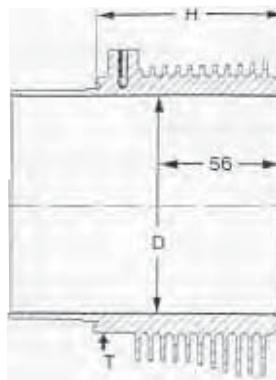


Cylinder identification

The following IDs are stamped in the opposite side of the knock sensor bridge mounting lug:

Cylinder dia. tolerance group,
e.g. group 0
and cylinder height tolerance group

e.g. height



All cylinder height tolerance groups (5 or 6) are further subdivided into the cylinder diameter tolerance group.

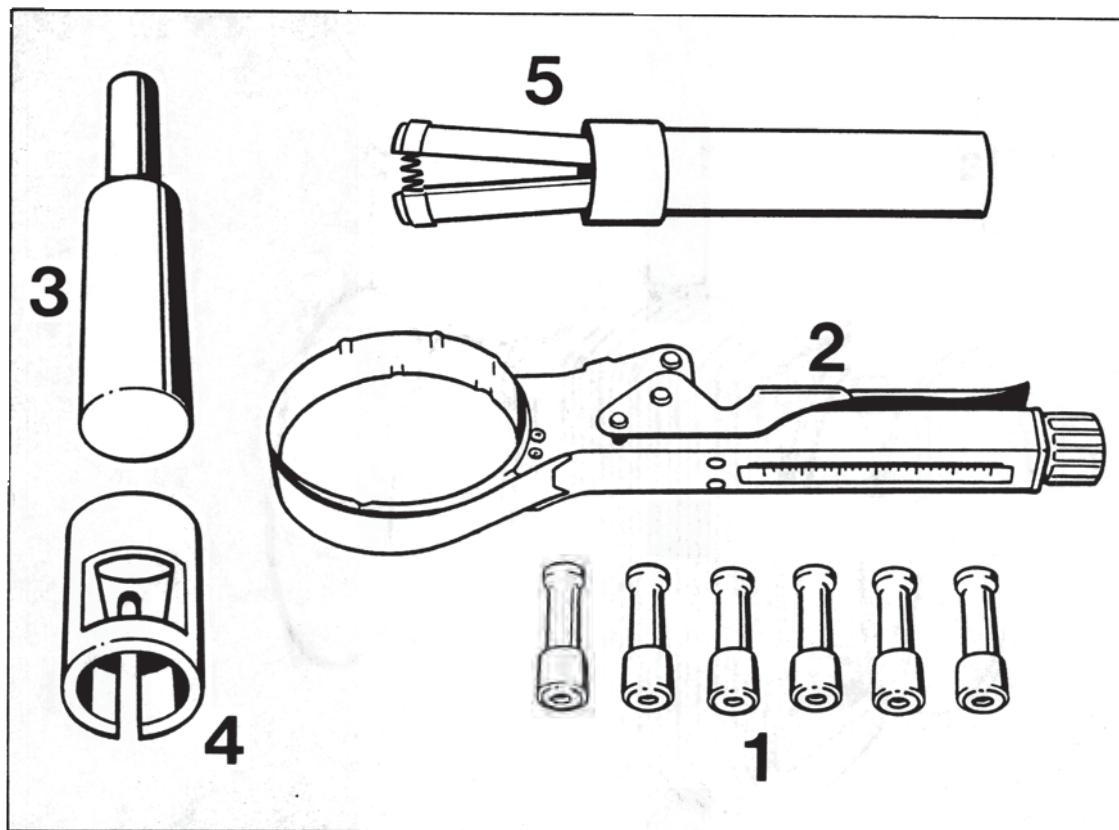
Height size H - 0.020	Cylinder diameter + 0.007	Stamped groups
82.750	100.000	0
82.750	100.007	1
82.750	100.014	2
82.750	100.021	3
82.770	100.000	0
82.770	100.007	1
82.770	100.014	2
82.770	100.021	3



Fit only cylinders of the same height group (5 or 6) to one single side of the engine.

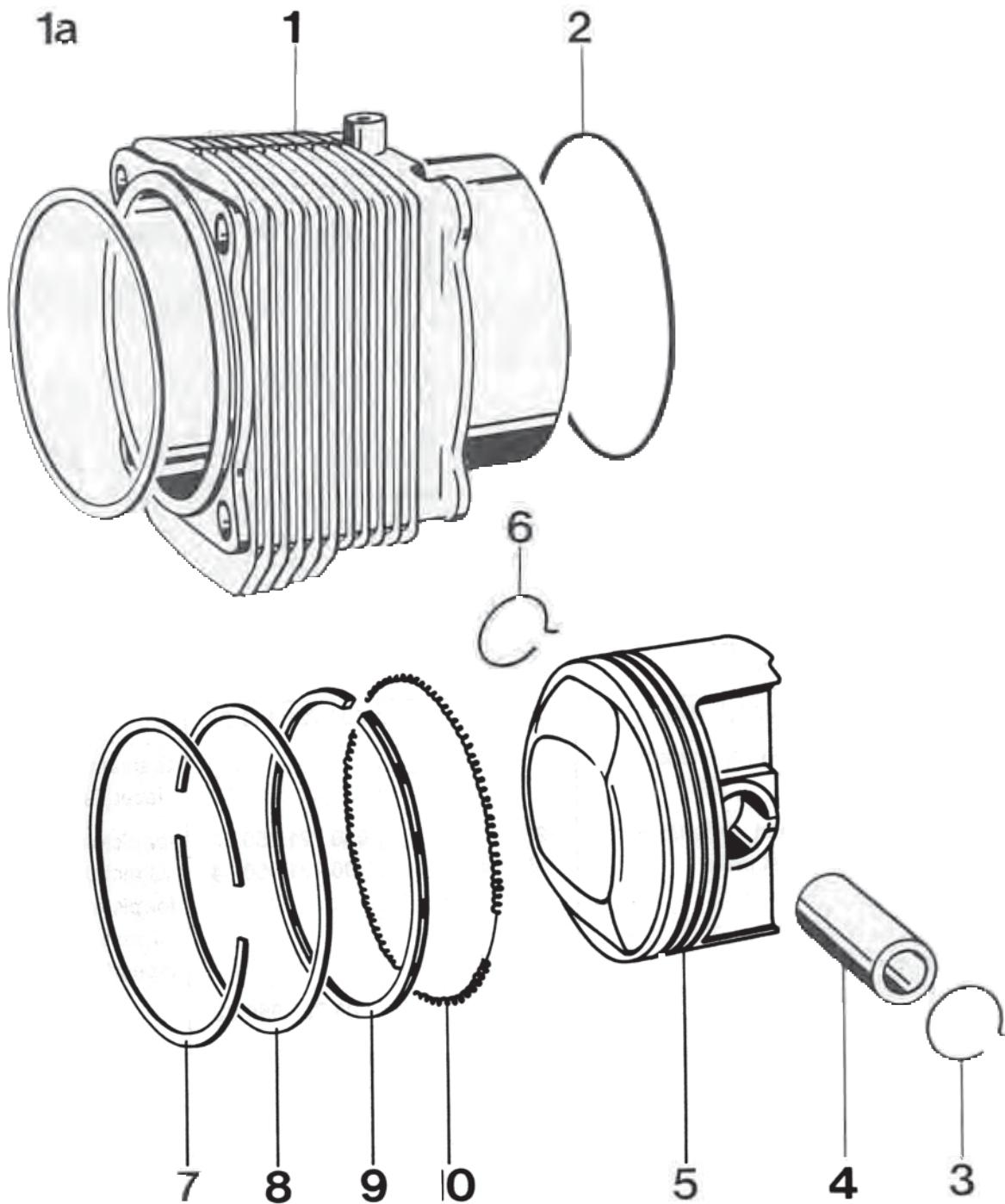
13 13 37 Dismantling and assembling pistons and cylinders

Tools



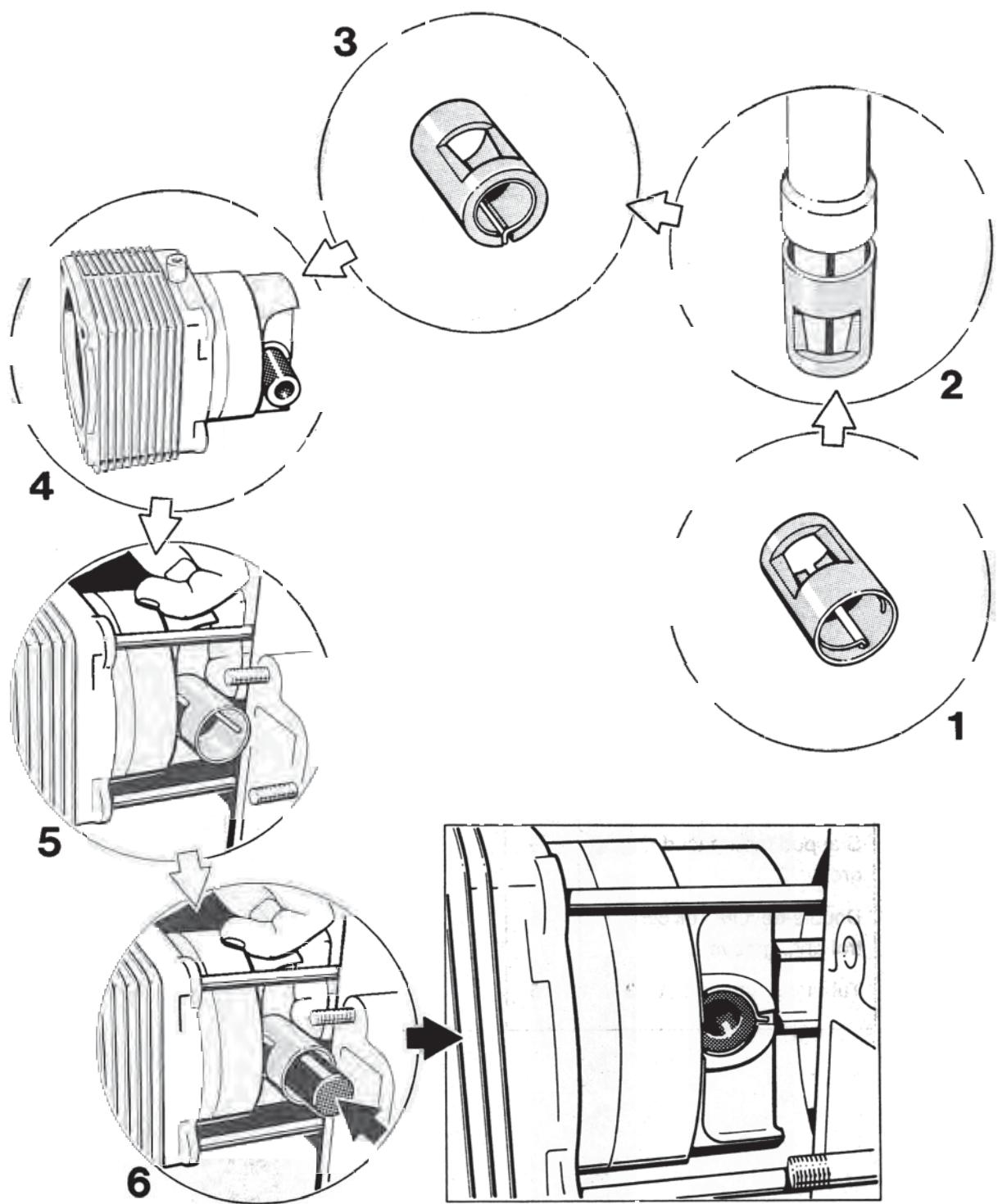
No.	Designation	Special tool	Order number	Explanation
1	Support for cylinder	P 140	000.721.140.00	
2	Piston ring compressor			Standard, e.g. Hazet 794-U-3
3	Front thrust piece from front thrust piece	9500 9500/4	000.721.950.00 000.721.950.04	for piston pin, 13 mm dia. for piston pin, 11 mm dia. (special-size piston pins)
4	Assembly sleeve	9500/2	000.721.950.02	
5	Assembly tool for snap ring	9500/3	000.721.950.03	For preassembly of snap ring to 9500/2

13 10 37 Dismantling and assembling piston and cylinder



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Cylinder	6	Mark installation position	Check, oil bore
1a	Cylinder head gasket	6		Always replace with new parts, fit dry
2	O-ring 102 x 2	6		Always replace with new parts
3	Snap ring	6	Lever out	Always replace with new parts, check for correct seating, use Special Tool 9500
4	Piston pin	6	Must remain assigned to the corresponding piston and must not be mixed even within the same engine. Observe this when dismantling and assembling the engine and mark parts accordingly	Observe inside dia., use suitable thrust pin
5	Piston	6	Mark installation position	Preassemble piston in cylinder
6	Snap ring	6	Lever out	Must always be replaced, preassemble in piston, make sure it is seated correctly. Use Special Tools 9500, 9500/2, 9500/3
7	Taper faced ring, groove 1	6		
8	Stepped taper faced ring, groove 2	6		
9	Double-bevelled oil control ring, groove 3	6		
10	Tubular spring, groove 3	6		

13 10 37 Dismantling and assembling pistons and cylinders

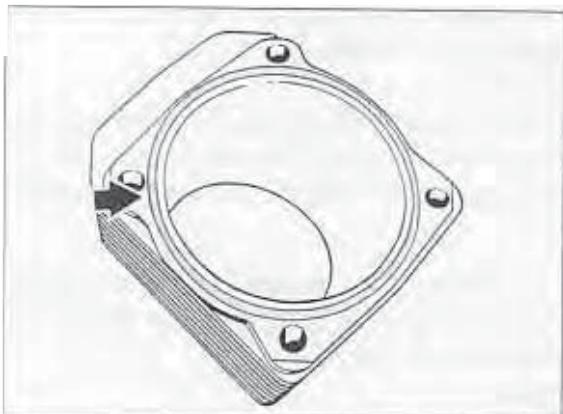


13 10 37 Dismantling and assembling pistons and cylinders

No.	Operation	Instructions
	Install snap ring	Place new snap ring manually into tapered assembly sleeve 9500/2
2	Engage snap ring	Using assembly tool 9500/3, push snap ring down until the snap ring engages audibly into the groove of the assembly sleeve 9500/2. Caution: Make sure the snap ring is preassembled with the tapered assembly sleeve on a solid support but only immediately before fitting the assembly to the piston pin bore.
3	Visual check	Remove assembly tool 9500/3 and visually check snap ring for correct seating in the groove of the tapered assembly sleeve 9500/2. Caution: The snap ring may pop out of the assembly sleeve — Be careful to avoid injury!
4	Preassemble pistons to cylinders	Preassemble pistons and cylinders on a plastic or wooden support (to protect the cylinder) off the engine.
5	Place preassembled cylinder on studs and place assembly sleeve into position	Place preassembled cylinder on studs. Place tapered assembly sleeve 9500/2 on piston pin bore.
6	Fit snap ring to piston	Insert plunger into tapered assembly sleeve. The smaller diameter of the plunger is used to provide guidance in the piston pin. Use plunger to press the snap ring into the piston pin snap ring groove in the piston. The snap ring must engage with an audible click. Note A helper should be available to press the snap ring into the piston.
	Visual check	Visually check snap rings for correct seating after fitting.

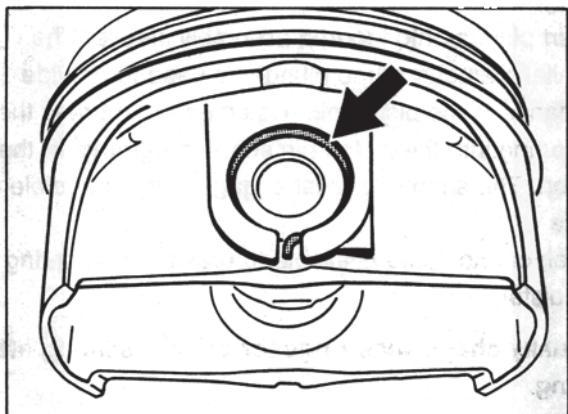
Assembly Note

1. Lift off cylinder head gasket only in this reinforced area (arrows) with a suitable tool. If required, soak sealant residues with adhesive remover, e.g. by Loctite, and remove carefully.



1011-13

2. The piston pins are fitted with circlips with rotation protection. Replace the circlips whenever the pistons have been dismantled.



1621-13

13 10 Pistons

Piston weight classes

The weight of the pistons has been changed for technical reasons. The new pistons are lighter. If it is necessary to replace individual pistons and cylinders during repair work, first check which pistons are installed.

The marks on the piston can be inspected by using a steel brush to remove deposits. Otherwise, the pistons must be weighed!

Distinguishing features:

Old „heavy“ piston

Stamp on piston crown: 11/0

New „light“ piston

Stamp on piston crown: 24/0

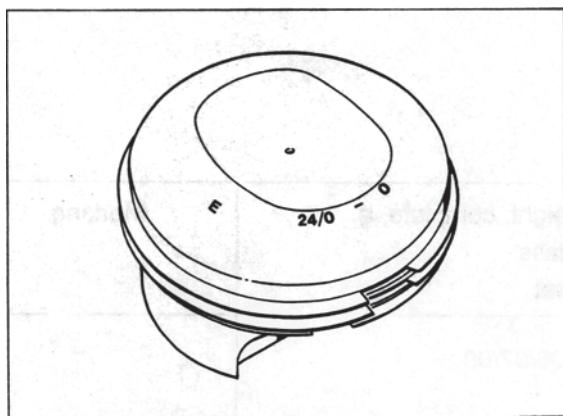
Compensating for weight differences

The new and the old pistons can be installed in the same engine.

However, the weight difference must be compensated.

Compensation is effected by installing a **14 g heavier replacement piston pin** (dimensions 23 x 11 x 54).

To install the piston pin, special tool **pressure piece 9500/4**, order no. 000 721 950 04, must be used.



1907-15

Only the new „light“ pistons are now available.

13 10 Pistons

Weight classes for „heavy“ pistons

Weight classes for **Mahle** pistons

Pistons weighed complete with fittings (piston pins, piston rings, snap ring)

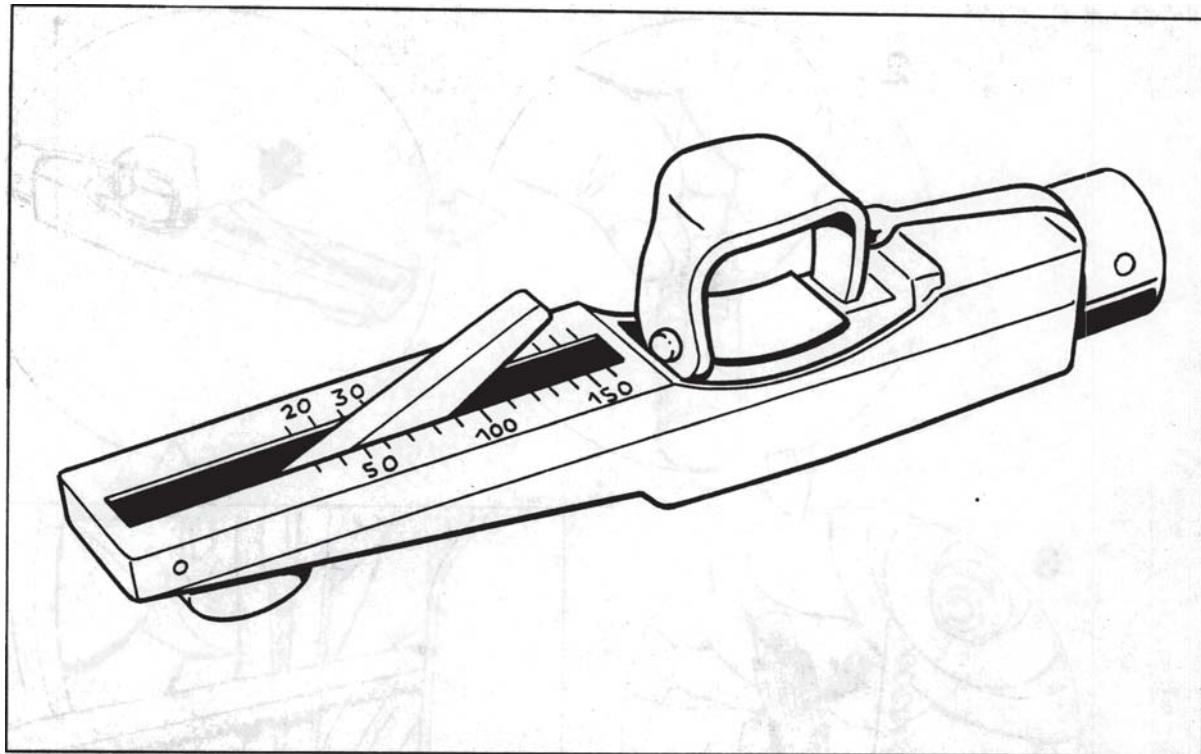
	Piston weight, complete, g Weight class within a set	Marking
Engine type	M 64/05/06/07/08	
Standard production	606 - 610 610 - 614	
max. weight difference 4 g	614 - 618 618 - 622	+ ++
For replacement parts max. diff. 8 g	606 - 614 614 - 622	-- or - + or ++

Weight classes for „light“ pistons

	Piston weight, complete, g Weight class within a set	Marking
Engine type	M 64/05/06/07/08	
Standard production	592 - 596 596 - 600	
max. weight difference 4 g	600 - 604 604 - 608	+ ++
For replacement parts max. diff. 8 g	592 - 600 600 - 608	-- or - + or ++

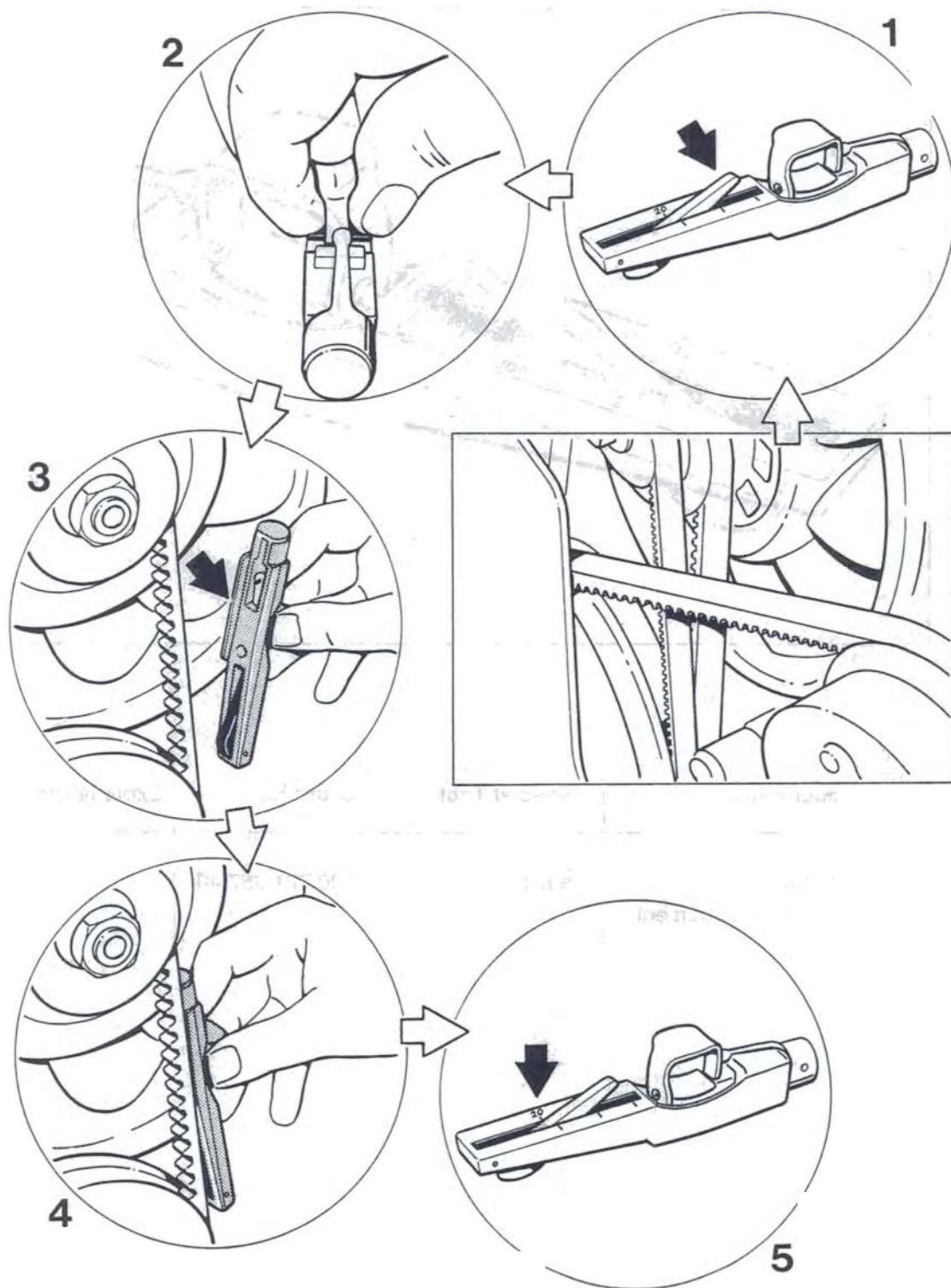
13 78 05 Checking and adjusting drive belts

Tool



1985-13

No.	Description	Special Tool	Order No.	Explanation
	Belt tension measuring instrument	9574	000 721 957 40	

Operating the measuring instrument

Operating the measuring instrument

No.	Operation	Instructions
	Prepare measuring instrument for testing	Lower pointer into measuring instrument.
2	Pick up measuring instrument	Grasp rubber strap between thumb and index finger.
3	Position measuring instrument	Position measuring instrument in center between pulleys on the drive belt. The lateral stop of the instrument must rest on the side of the V-belt.
4	Measure belt tension	Press pushbutton to apply uniform pressure in perpendicular direction on top of V-belt until the detent spring can be heard (or felt) to disengage. After the detent spring has disengaged, the measuring instrument or the pushbutton, respectively, must not be pressed anymore as the reading will otherwise be incorrect.
5	Read off measurement	Lift measuring instrument carefully off the V-belt.

Caution:

Do not push against instrument when lifting off the instrument as sudden impacts may alter the position of the pointer and may give a faulty reading.

Read off measurement (tensioning value) at the point of intersection of the pointer with the **upper scale** (KG scale).

Checking and/or adjusting alternator and fan wheel drive belt

Caution: Make sure the ignition key is pulled off whenever measurements are made.

Checking used drive belts:

Use belt tension measuring instrument (Special Tool 9574) to check tension.

A description of how to use the Special Tool is contained in Repair Group 13, page 13 - 30.

Retensioning the belt is only required if the belt tension displayed at the measuring instrument is less than 15 scale increments when the engine is cold and less than 20 scale increments when the engine is hot.

Retensioning the belt

Retension the belt as described in the General Adjustment Notes section.

Before measuring the belt tension, start engine and let engine idle briefly.

Tension:

Cold engine: 15 to 23 scale increments

Engine at operating

temperature: 20 to 28 scale increments

Fitting a new belt

When fitting a new belt, be sure to observe the correct **assembly sequence** in order to avoid any loss of belt tension during vehicle operation.

1. Fit new belt. Adjust tension by inserting or removing shims as required.
Shims are available for belt tensioning in thicknesses of 0.5 mm and 0.7 mm. The 0.7 mm shim is identified by a 2 mm dia. drill hole.
2. Before measuring the belt tension, start engine once more and run engine at idle briefly.

Tension:

Cold engine: 23 to 35 scale increments

3. Run engine at idle for approx. 15 minutes or test drive vehicle for approx. 10 miles.

Check tension again.

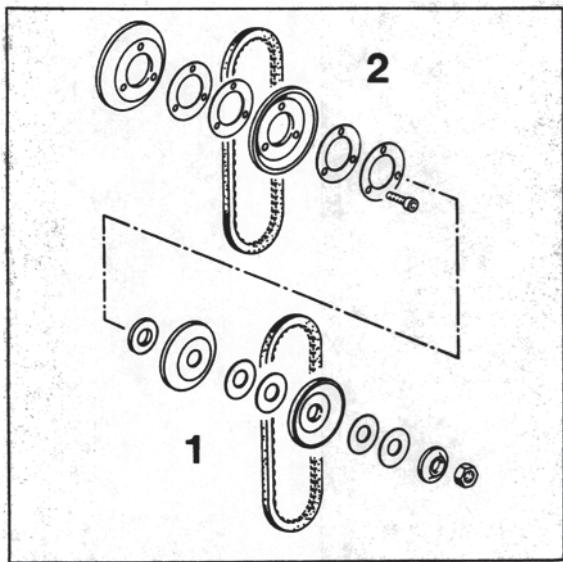
Specification: 28 to 40 scale increments

Retension if required.

Test requirement: Engine at operating temperature

General adjustment notes

Fan wheel and alternator have separate drives.

**Note**

Rotate engine only at lower belt pulley or by operating the starter. After completing all operations, check to make sure that hexagon head nut has been tightened sufficiently on alternator shaft.

1863-27

1 = Alternator drive components

2 = Fan wheel drive components

Adjusting the V-belts

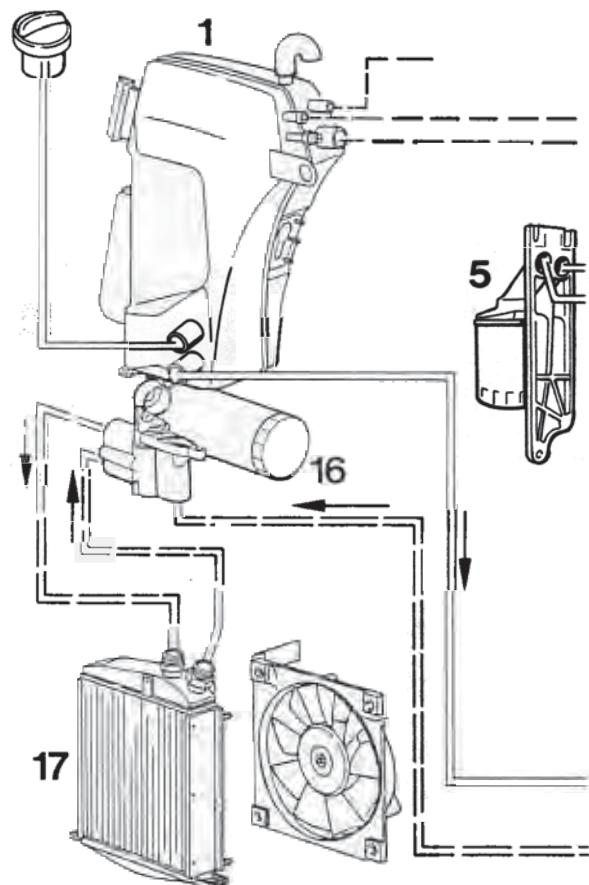
1. Use polygon wrench (999 571 052 02) to lock shaft and undo hexagon head nut. Remove shims and pulley half.
2. If belt tension is below specification, remove one shim from between pulley halves and refit in front of pulley half.
Tighten hexagon head nut to 50 ± 5 Nm.
3. Three additional M 6 screws have to be undone for V-belt and fan wheel.
4. Use only V-belts that have been approved by the manufacturer.

17 00 Lubrication (Engine oil circuit diagram)

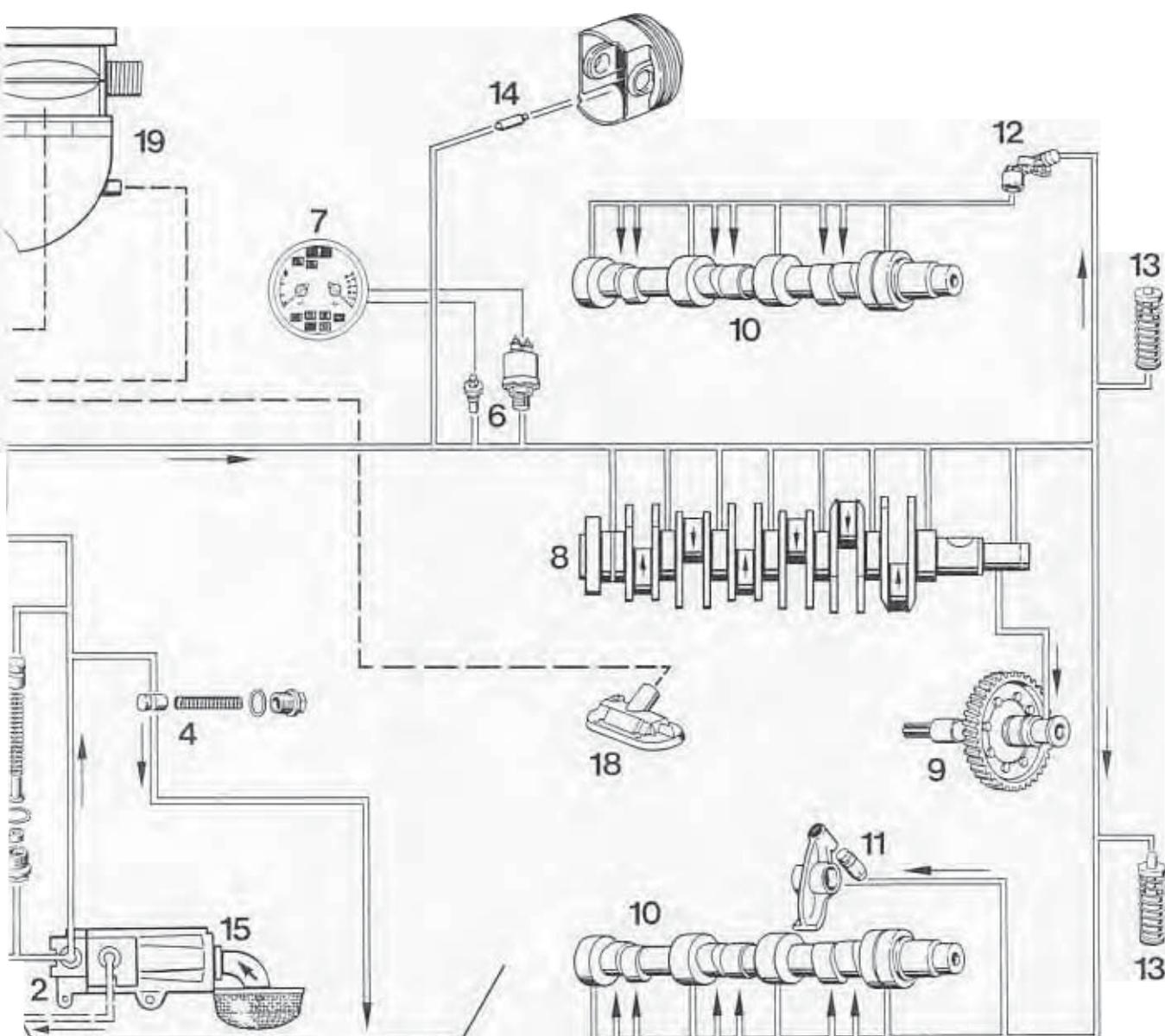
Components

- 1 Oil tank
- 2 Pressure pump section
- 3 Pressure relief valve (opens at 5.3 bar)
- 4 Safety valve (opens at 9 bar)
- 5 Bracket with oil filter
- 6 Oil pressure sensor / remote temperature sensor
- 7 Instrument cluster
- 8 Crankshaft
- 9 Intermediate shaft
- 10 Camshaft
- 11 Hydraulic valve lifter
- 12 Oil gallery (Camshaft housing / oil supply)
- 13 Chain tensioner
- 14 Oil jets for piston cooling (open at 3.0 bar)
- 15 Return pump section
- 16 Full flow oil filter with thermostat housing (opens to oil cooler at 83 °C)
- 17 Oil cooler with fan and temperature switch (fan is switched on at 110 °C)
- 18 Crankcase breather
- 19 Throttle body with intake shroud

A———
B=====
C-----
D———



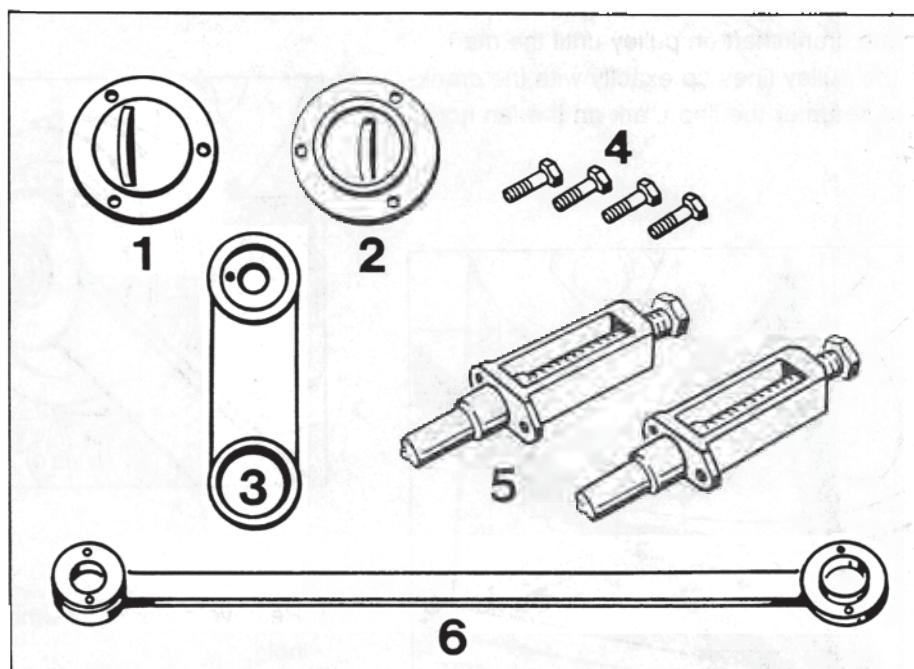
- A - Pressure oil circuit
 B - Return oil circuit
 C - Breather line
 D - Electrical system



15 05 06 Checking and adjusting camshafts

(Adjusting the timing)

Tools



1457-15

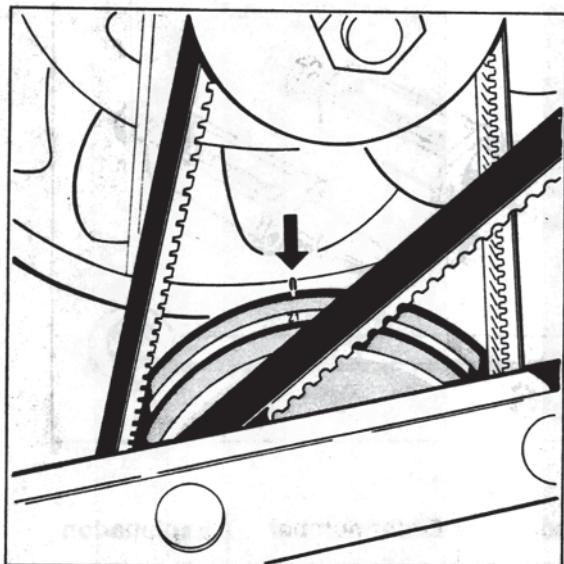
No.	Designation	Special tool	Order number	Explanation
1	Locking tool for LH camshaft	9551	000.721.955.10	install 2 fit bolts in the 6^{H7} holes in the three-hole flange
2	Locking tool for RH camshaft	9552	000.721.955.20	install 2 fit bolts in the 6^{H7} holes in the three-hole flange
3	Locking tool for crankshaft	9553	000.721.955.30	
4	Fit bolt (4 pieces)	9554	000.721.955.40	Install fit bolts in oval hole of three-hole flange
5	Auxiliary chain tensioner	9401	000.721.940.10	
6	Pulley retaining wrench	9548	000.721.954.80	

15 05 06 Checking and adjusting camshafts

(Adjusting the timing)

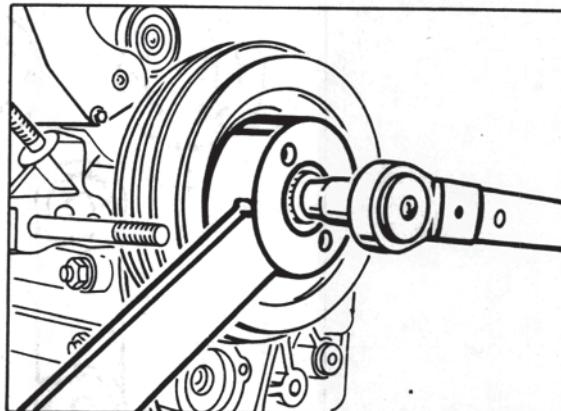
Approximate adjustment

1. Rotate crankshaft on pulley until the mark on the pulley lines up exactly with the crank-case seam or the line mark on the fan housing.

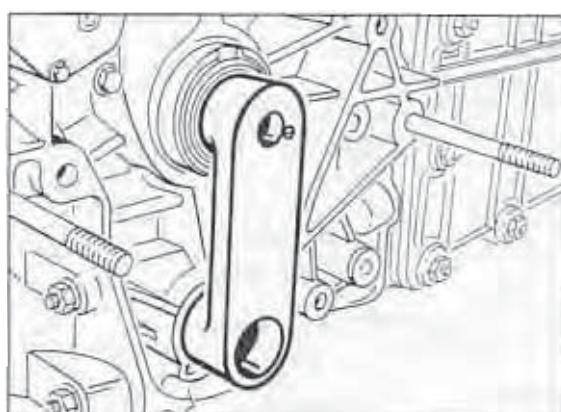


151-03

2. Remove pulley. Undo hexagon head bolt, having a helper lock the pulley with Special Tool 9548 (retaining wrench).



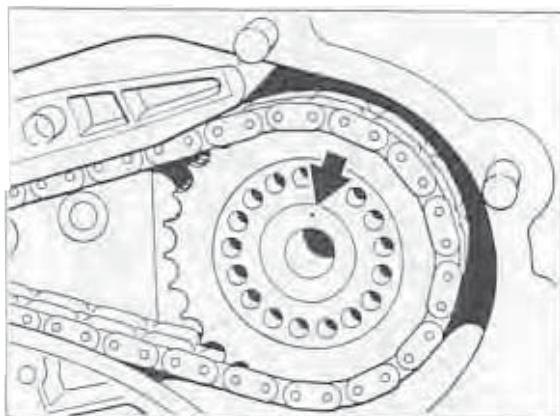
3. Remove cover of intermediate shaft access hole.
4. Place Special Tool 9553 (locking tool) into position.



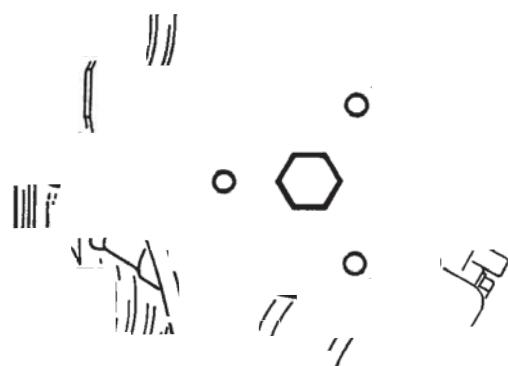
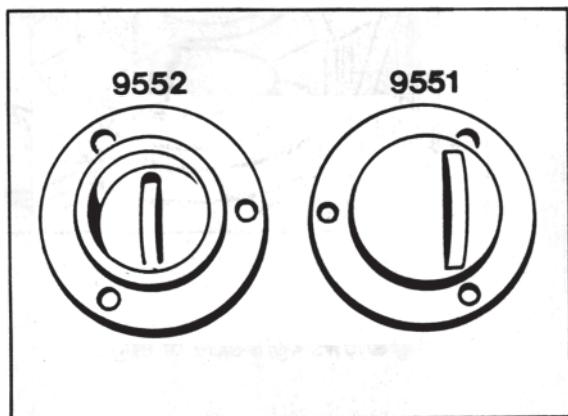
5. Turn both camshafts until punch mark faces up.

Note

If the mark is missing, rotate camshafts until woodruff key groove points up.



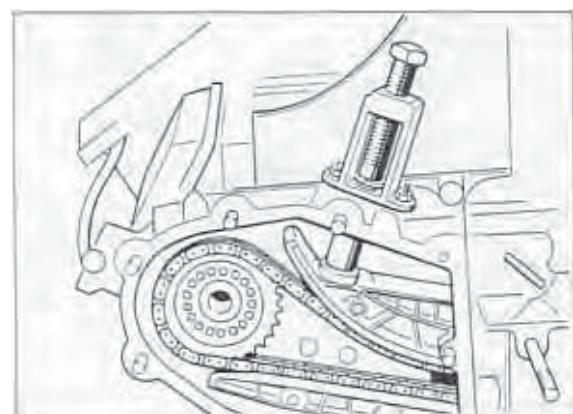
6. The camshafts may be aligned and rotated from the front (flywheel end) using Special Tools (locking devices) 9551 or 9552, respectively.

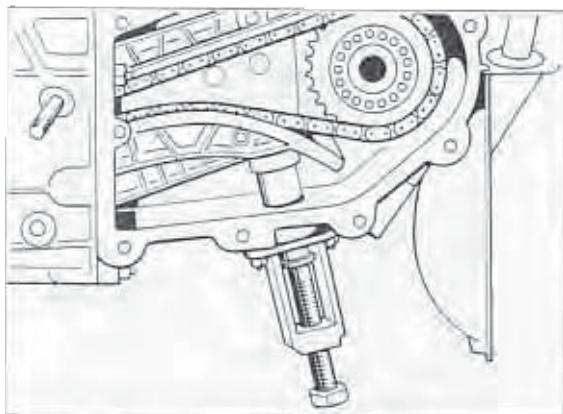


7. When the Z 1 mark on the pulley has been aligned with the seam and when the punch marks or woodruff key groove, respectively, point up, the engine is in the basic firing TDC for cylinder No. 1 and the overlap TDC for cylinder No. 4.

8. Fit auxiliary chain tensioner (Special Tool 9401).

Figure shows left-hand side of auxiliary chain tensioner





88-550

Note

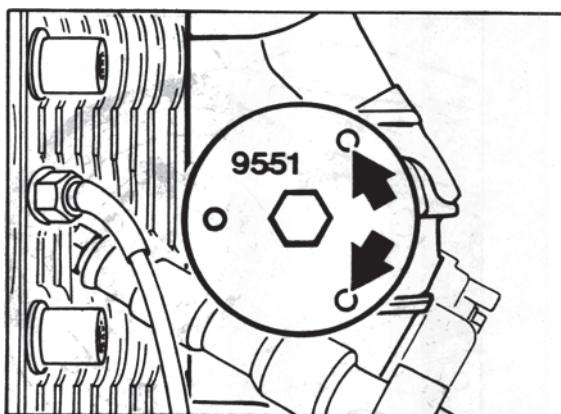
To adjust or check the timing, the mechanical auxiliary chain tensioners must be fitted with the specified preload. The recess on the plunger must just barely remain visible. Adjusting or checking the timing with a dial gauge is no longer required. The locking tools also serve as adjustment gauges.



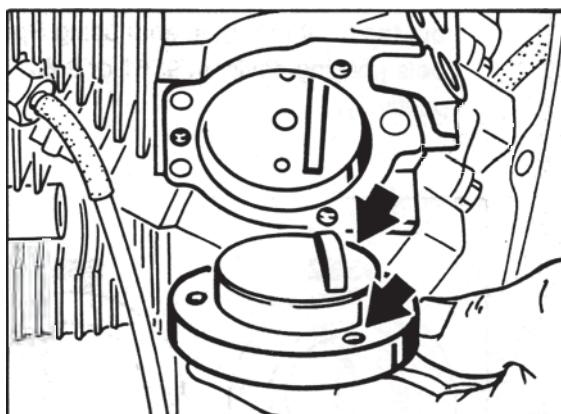
87-378

Precision adjustment

1. Place locking device 9551 on left-hand cam-shaft and locking device 9552 on right-hand camshaft and tighten them. Install fit bolts 9554 in oval hole in three-hole flange.



1465-15



1461-15

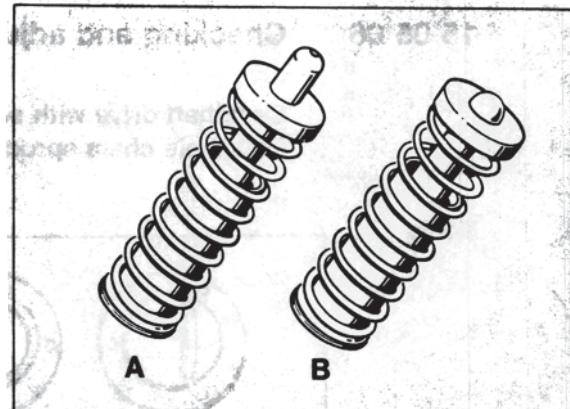
Drawing shows right side of engine

Note

Adjusting or checking the timing with a dial gauge is no longer required. The locking tools also serve as adjustment gauges.

Caution:

At the same time, the locating pin on the chain sprocket or chain sprocket flange is no longer required. However, at the start of production, the locating pin was installed on some engines.



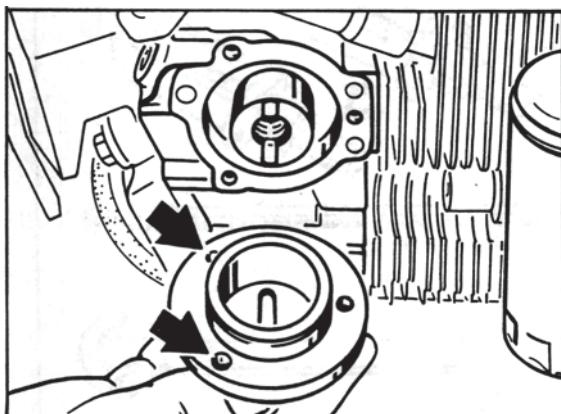
88-167

A - Left-hand chain tensioner. Oil supply hole
hole points up.

B - Right-hand chain tensioner. Oil supply hole points down.

Note

The spring retainers are additionally marked with „oben“ (top) and „unten links“ (bottom left) or „unten rechts“ (bottom right).



1460-15

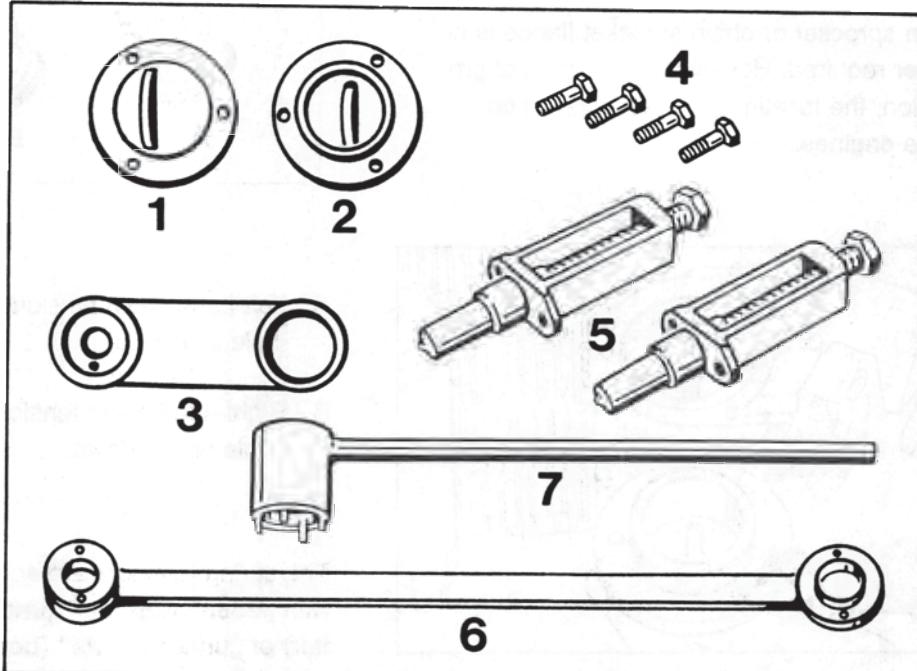
Drawing shows right side of engine

2. Apply a thin coat of **Optimoly HT** to hexagon head bolt threads. Tighten hexagon head bolts of left-hand and right-hand camshafts to 120 Nm (12 kpm).
 3. After the adjustment has been completed, remove the auxiliary chain tensioner and refit original chain tensioner. Observe installation position!

15 05 06 Checking and adjusting the camshafts

Camshaft drive with single-part chain sprocket flange
(four-hole chain sprocket) (adjust timing)

Tools



1457-15

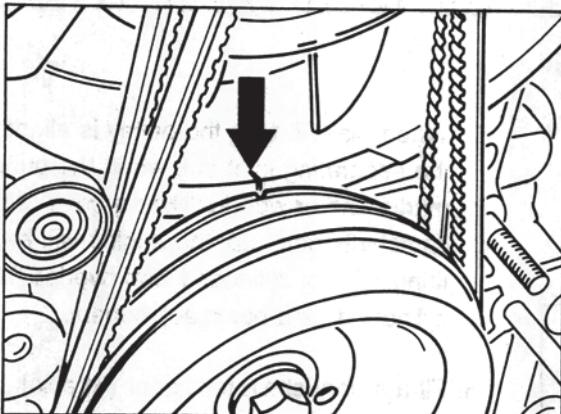
No.	Designation	Special Tool	Order Number	Explanation
	Locking device for left camshaft	9551	000.721.955.10	Install 2 fit bolts into 6 ^{H7} holes of three-hole flange
2	Locking device for right camshaft	9552	000.721.955.20	Install 2 fit bolts into 6 ^{H7} holes of three-hole flange
3	Crankshaft locking device	9553	000.721.955.30	
4	Fit bolt (4 ea.)	9554	000.721.955.40	
5	Auxiliary chain tensioner	9401	000.721.940.10	
6	Pulley retaining wrench	9548	000.721.954.80	
7	Retaining wrench	9582	000.721.958.20	

15 05 06 Checking and adjusting the camshafts

(Adjusting the timing)

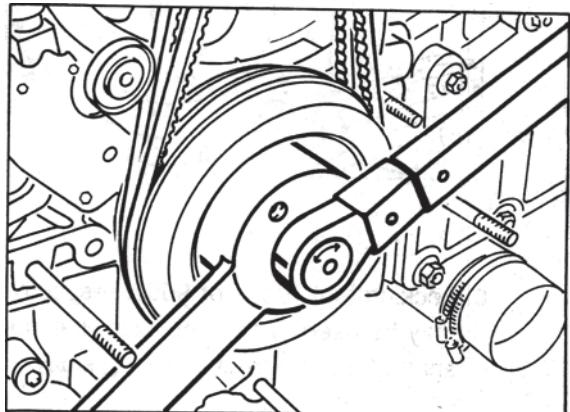
Basic adjustment

Rotate crankshaft at pulley until the pulley mark is exactly in line with the separating joint on the crankcase or the line mark on the blower housing.



151-03

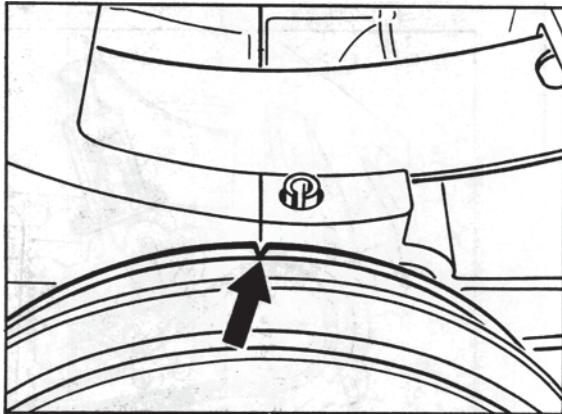
2. Undo hexagon head bolt, having a helper use Special Tool 9548 (locking wrench) to lock. Take off pulley.



1464-15

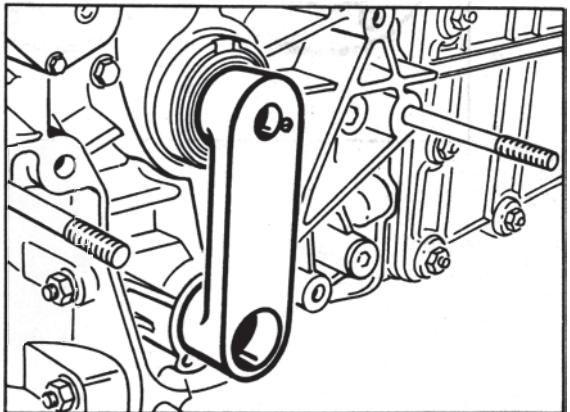
3. Take off A/C compressor bracket.

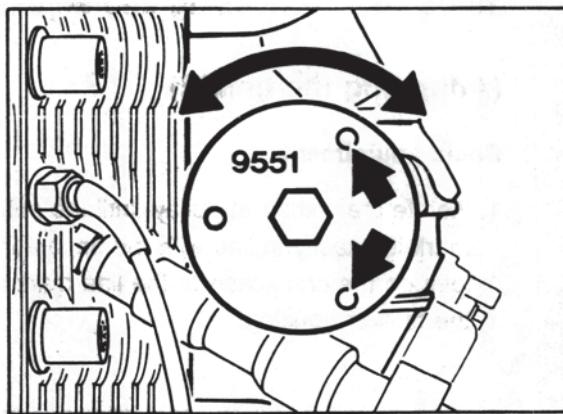
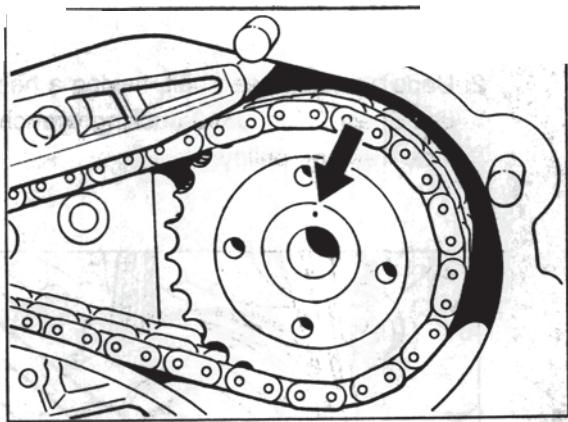
4. Place Special Tool 9553 (locking device) into position.



2160-15

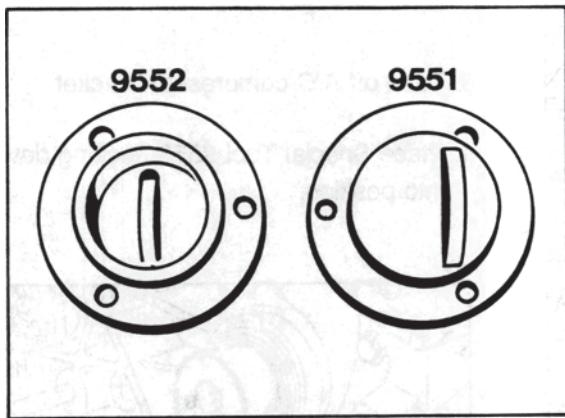
5. Turn both camshafts until punch mark points up.





1465-15

6. Locking tools 9551 or 9552, respectively, may be used to align or rotate the camshafts from the front (flywheel side).



1480-15

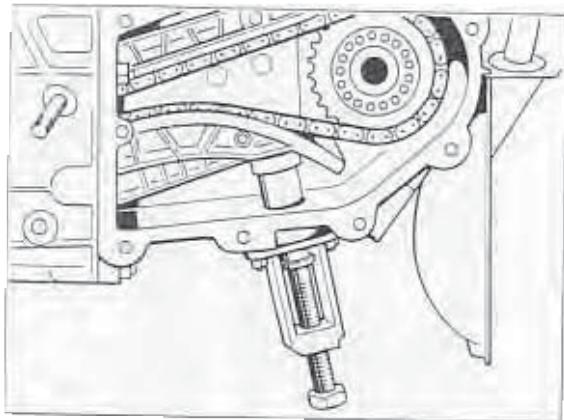
7. When mark Z 1 on the pulley is aligned with the separating joint and when the punch marks and/or woodruff key groove of the camshafts point up, the engine will be set to firing TDC of cylinder 1 and overlap TDC of cylinder 4 as a basic adjustment.

8. Fit auxiliary chain tensioner (Special Tool 9401).

Fig. shows auxiliary chain tensioner for left side



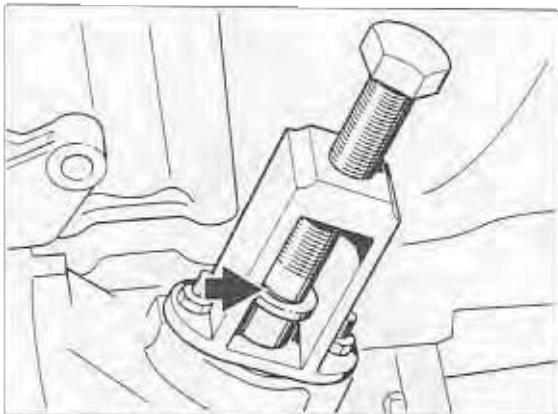
2172-15



88-550

Note

When adjusting or checking the timing, the mechanical auxiliary chain tensioners must be fitted with the specified preload. The groove machined on the thrust piece must be barely visible.



87-378

Precision adjustment

1. Place locking tool 9551 on left camshaft and locking tool 9552 on right camshaft and tighten them. Fit the fit bolts (2 ea.) to the three-hole flange (arrows).

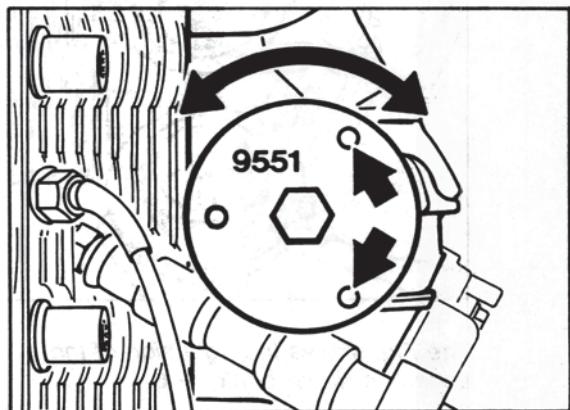
Note

Due to tolerances of the hole pattern of the camshaft housing, the adjustment procedure may differ in some cases:

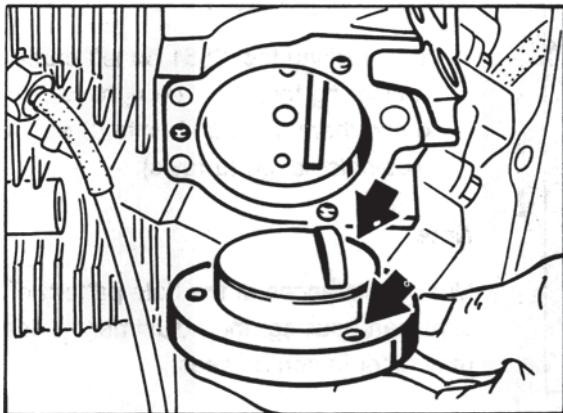
If the special tools cannot be fitted with 2 fit bolts each, use one fit bolt and one standard M6 bolt to locate them.

In extreme cases (large deviations of the mounting hole pattern on the camshaft housing), standard M6 bolts may be used to locate the special tools. (This will result in slight deviations of the camshaft timing).

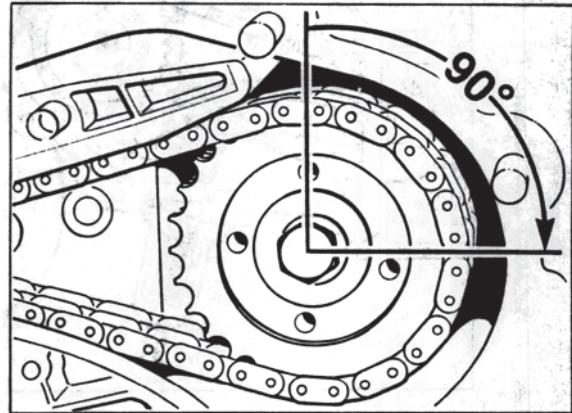
Before installing Special Tools 9551 + 9552, check for any burr formation at the 6 H7 holes and at the fit bolts. The fit bolts must be able to rotate in the holes.



1465-15



1461-15



2136-15

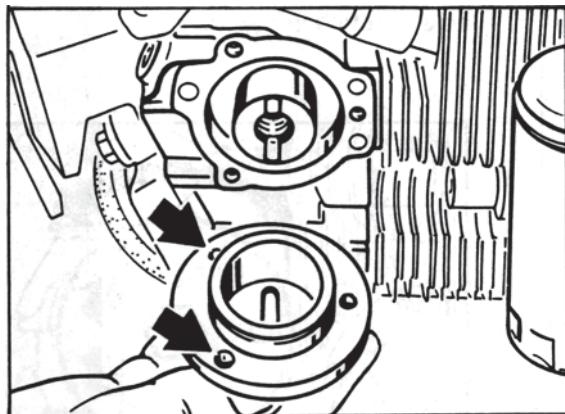
The Fig. shows the left side of the engine
Cylinder bank 1 - 3

Note

Adjusting and/or checking the timing with a dial gauge is no longer required. The locking tools are at the same time designed as timing adjustment gauges.

1st stage: Setting torque 20 Nm (15 ftlb.)
2nd stage: Tightening angle 90°

To release the strain on the chain drive and the locking tools, lock with locking wrench (Special Tool 9582) at the chain sprockets when tightening the bolts.

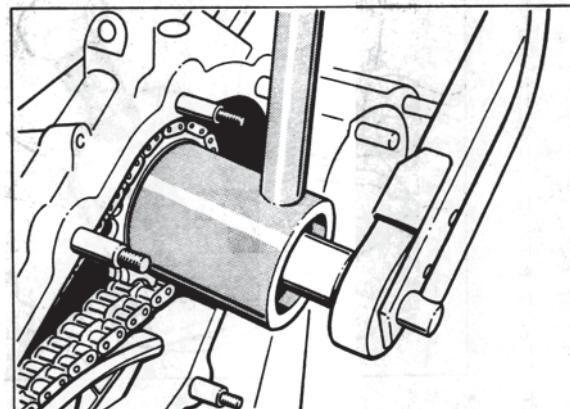


1460-15

The Fig. shows the right side of the
engine, cylinder bank 4 - 6

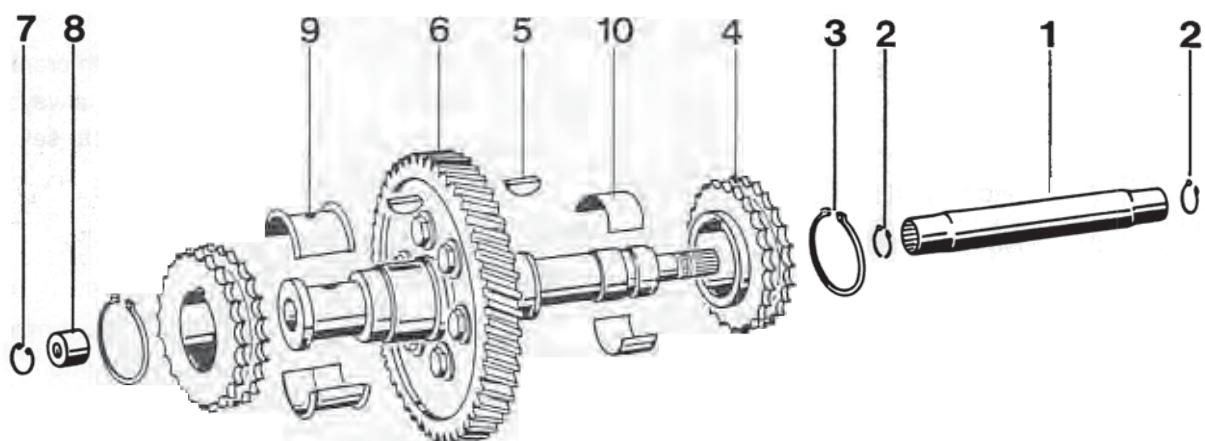
2. Coat threads of hexagon head bolts with a thin coat of **Optimoly HT**.

Tighten hexagon head bolts of left and right camshafts.



2137-15

After completing adjustment, take off auxiliary chain tensioner and refit original chain tensioner. Observe correct installation position.

15 30 37 Dismantling and assembling intermediate shaft

2001-15

No.	Designation	Qty.	Removal	Note: Installation
1	Union shaft	1		Check that shaft runout is within tolerances, shaft must move freely in longitudinal direction.
2	Snap ring 13 x 1	2		
3	Snap ring 36 x 1.75	2		Replace.
4	Chain sprocket		Press off, check teeth. Sprockets are available as spare parts.	Heat on heating plate, push into place to stop, observe installation position.
5	Woodruff key	2		
6	Intermediate shaft	1		Matched with crankshaft timing gear, always fit as a complete set.
7	Snap ring 16 x 1	1		
8	Plug, aluminum	1	Remove if bearing damage has occurred, clean bore.	
9	Thrust bearing	2		Sliding surface must be oiled, place into crankcase halves.
10	Bearing	2		Sliding surface must be oiled, place into crankcase halves.

Ergo 3.1.000

15 20 01 Checking intermediate shaft

Checking

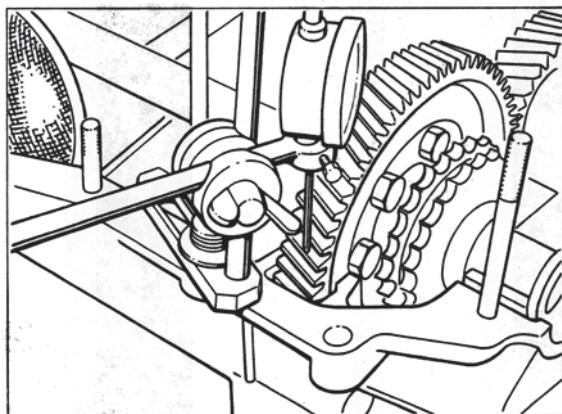
1. Visual inspection:

Check intermediate shaft gear and timing gear for wear.

2. Check circumferential backlash:

Fit crankshaft and intermediate shaft with new bearings in installation position. Fit VW 387 dial gauge bracket to crankcase mating surface. Take care not to damage sealing surface, use protective support if required.

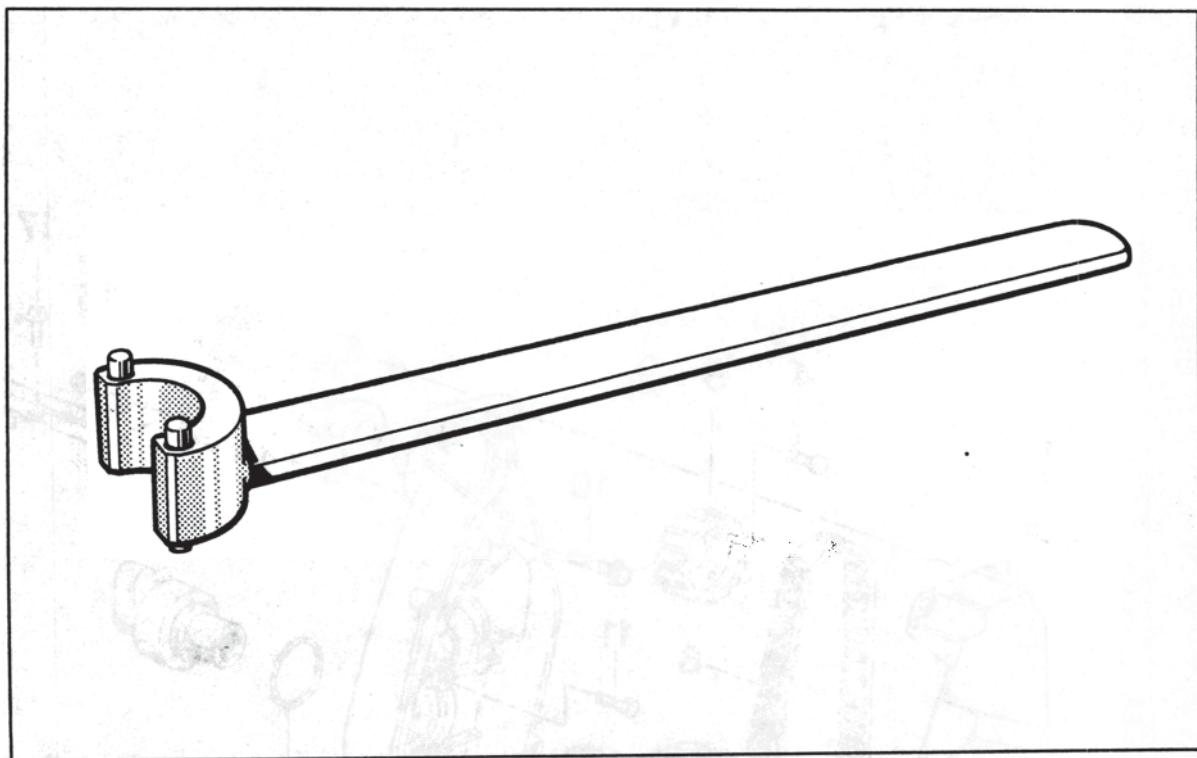
3. Align dial gauge with one gear tooth and determine backlash.



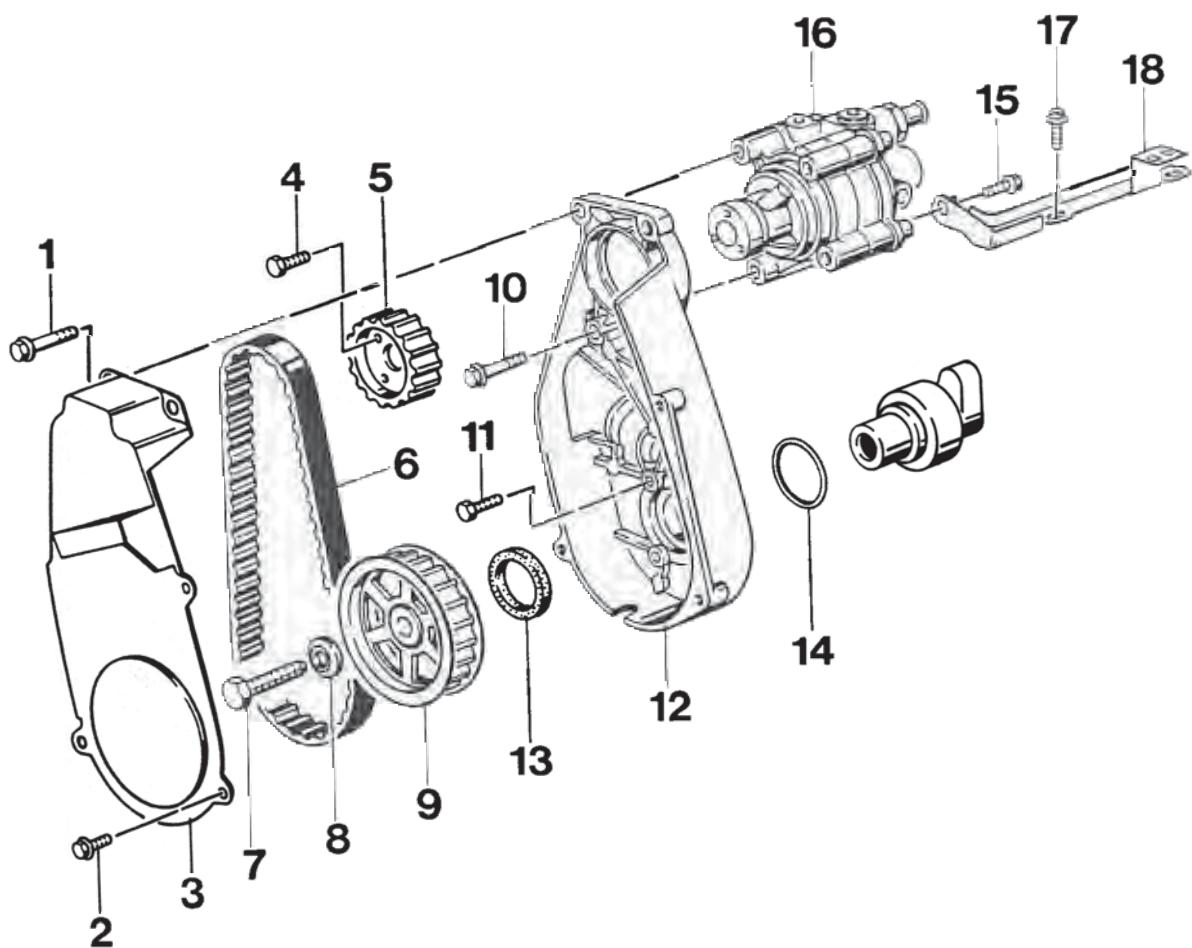
Circumferential backlash:

New dimension	0.035 - 0.084 mm
Wear limit	0.10 mm

Rotate intermediate shaft by 180° and repeat measurement.

15 38 19 Removing and installing camshaft housing seal**Tool**

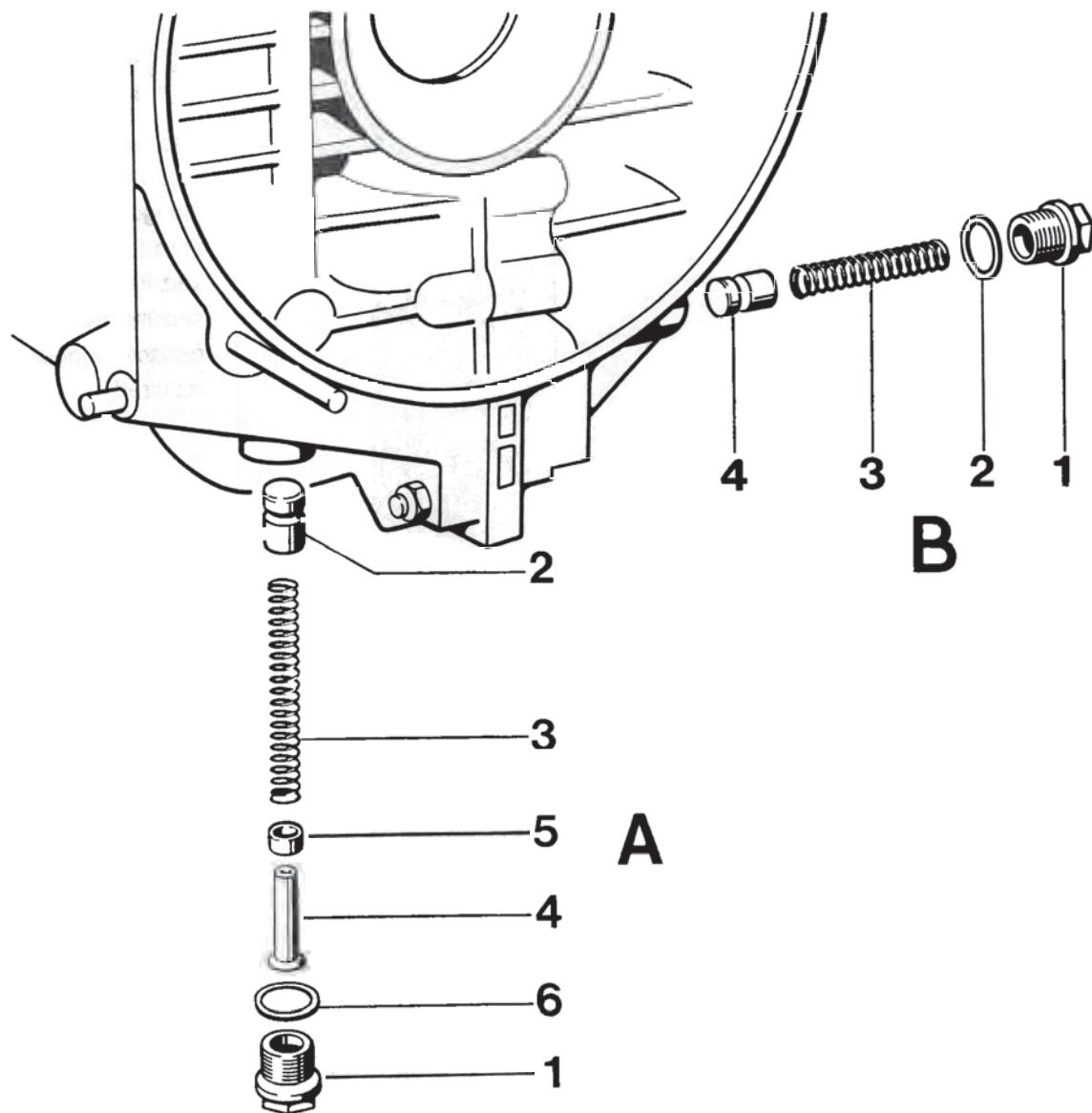
No.	Designation	Special Tool	Order No.	Explanation
1	Support assembly	9236	000.721.923.60	



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Combination screw M 8 x 30	2		
2	Combination screw M 6 x 16	3		
3	Cover	1		
4	Pan-head screw M 6 x 16, self-locking	3		Apply locking compound if required.
5	Gear	1		Install with toothed belt fitted in place.
6	Toothed belt	1	Mark installation position	Check, inspect visually for damage.
7	Hexagon-head bolt M 12 x 1.5 x 50	1		Tightening torque 120 Nm, use Special Tool 9236 to lock.
8	Washer A 13	1		
9	Gear	1		Install with toothed belt fitted in place.
10	Combination screw M 8 x 35	2		
11	Hexagon-head bolt M 6 x 28	3		
12	Support housing	1		
13	Shaft seal A 30 x 42 x 7	1		Drive in to stop, apply oil to sealing lip.
14	O-ring 40 x 4	1		Replace, oil lightly.
15	Combination screw M 8 x 16	1		
16	Power pump	1		
17	Combination screw M 6 x 18	2		
18	Mounting bracket	1		

Combination screw = Hexagon-head bolt with captive washer

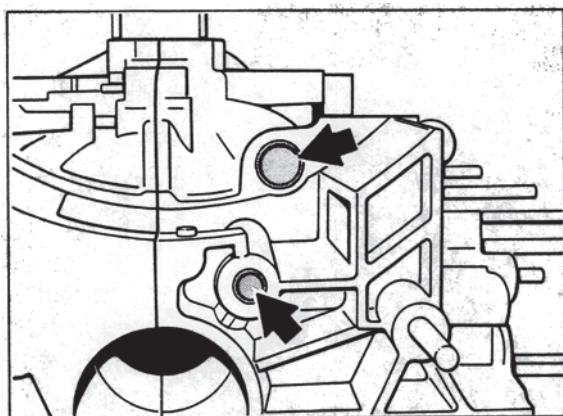
17 26 38 Removing and installing pressure regulating valves (Pressure relief valves)



No.	Designation	Qty.	Removal	Note: Installation
	Pressure relief valve A (Crankcase half, right-hand side)			
	Plug M 18 x 1.5	1		Tightening torque 60 Nm (44 ftlb.)
2	Plunger	1		Use wooden stick to pull out, if required. Check plunger and housing bore for signs of seizure. Remove seizure marks carefully, replace plunger if required
3	Thrust spring, 89 mm long	1		
4	Guide sleeve	1		
5	Spacer ring	1		
6	Seal A 18 x 24	1		Push onto guide sleeve Replace
	Safety valve B (Crankcase, left-hand side)			
	Plug M 18 x 1.5	1		Tightening torque 60 Nm (44 ftlb.)
2	Seal A 18 x 24	1		Replace
3	Thrust spring 70 mm long			
4	Plunger	1		Use wooden stick to pull out if required. Check plunger and housing bore for signs of seizure. Remove seizure marks carefully, replace plunger if required

17 10 30 Cleaning crankcase (oil passages)

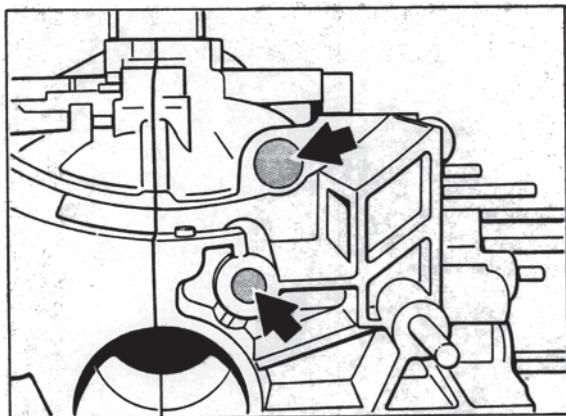
The oil passages in the crankcase are plugged (i.e. closed) with sheetmetal covers during production.



1872 - 17

If the sheetmetal covers have been removed e.g. to clean the oil passages after bearing damage has occurred, the sheetmetal covers have to be replaced with service aluminum plugs.

Sheetmetal covers have not been released as spare parts!



1873 - 17

Replacement aluminium plugs

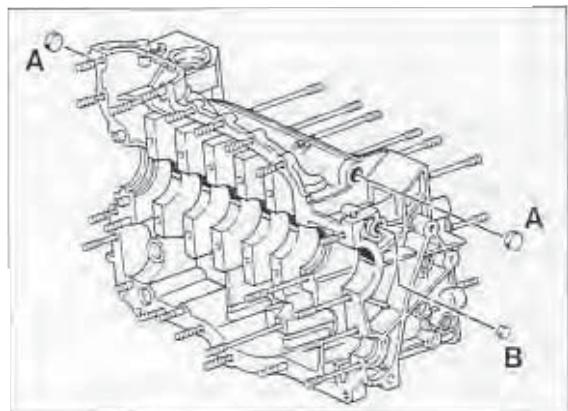
The following oversize plugs are available for repairs:

Plug (A):

\varnothing 23 mm, part no. 911 101 185 01 (2 plugs)

Plug (B):

\varnothing 14 mm, part no. 911 101 182 01



2250-17

Removal

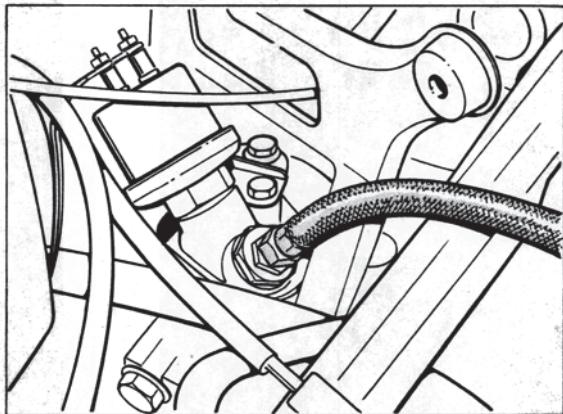
Drill out plug (using a 6.5 mm bit) and tap M8 thread. Pull out plug using a "home-made" extractor consisting of an M8 bolt, spacer ring and washer. Push out the opposite plug, for example using a 10 mm dia. pipe.

Installation

Apply Optimoly HT (copper paste) to plug and press plug in flush.

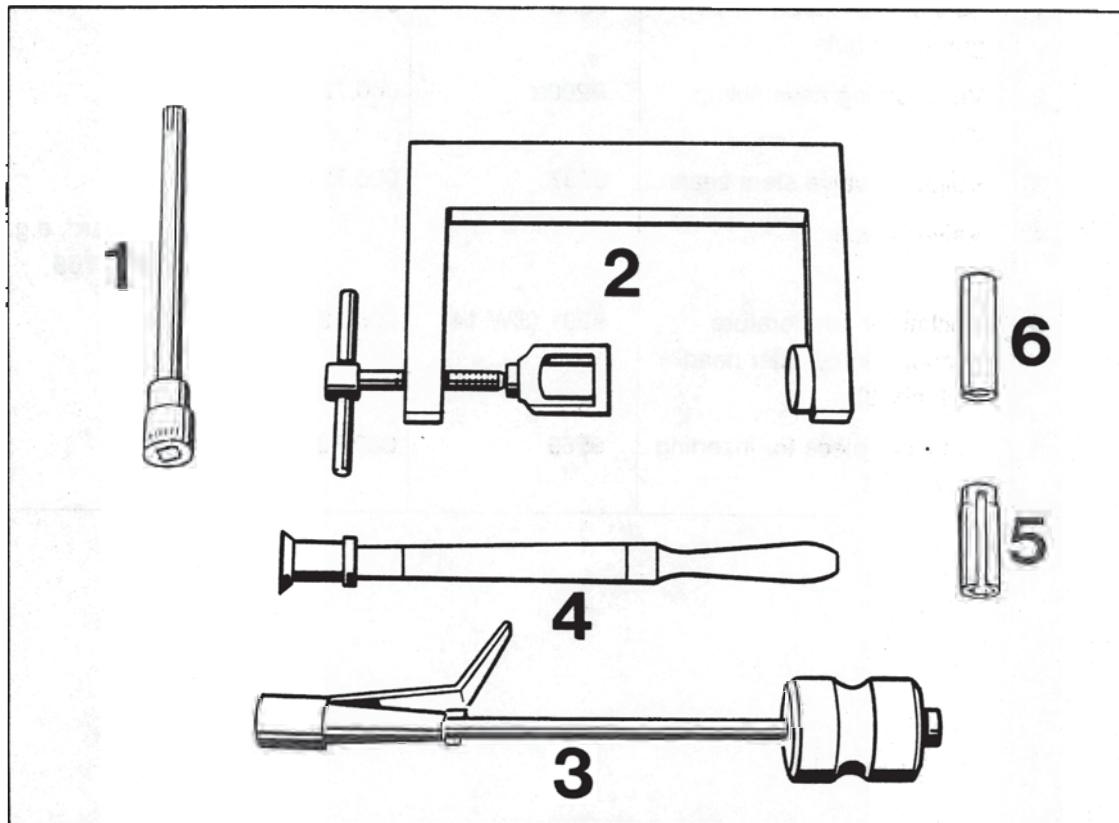
17 03 01 Checking oil pressure

1. Screw standard oil pressure tester or VW 1342 tester combined with M 10 x 1 fitting and M 14 x 1.5 flange into hole of temperature sender unit in base.



1874 - 17

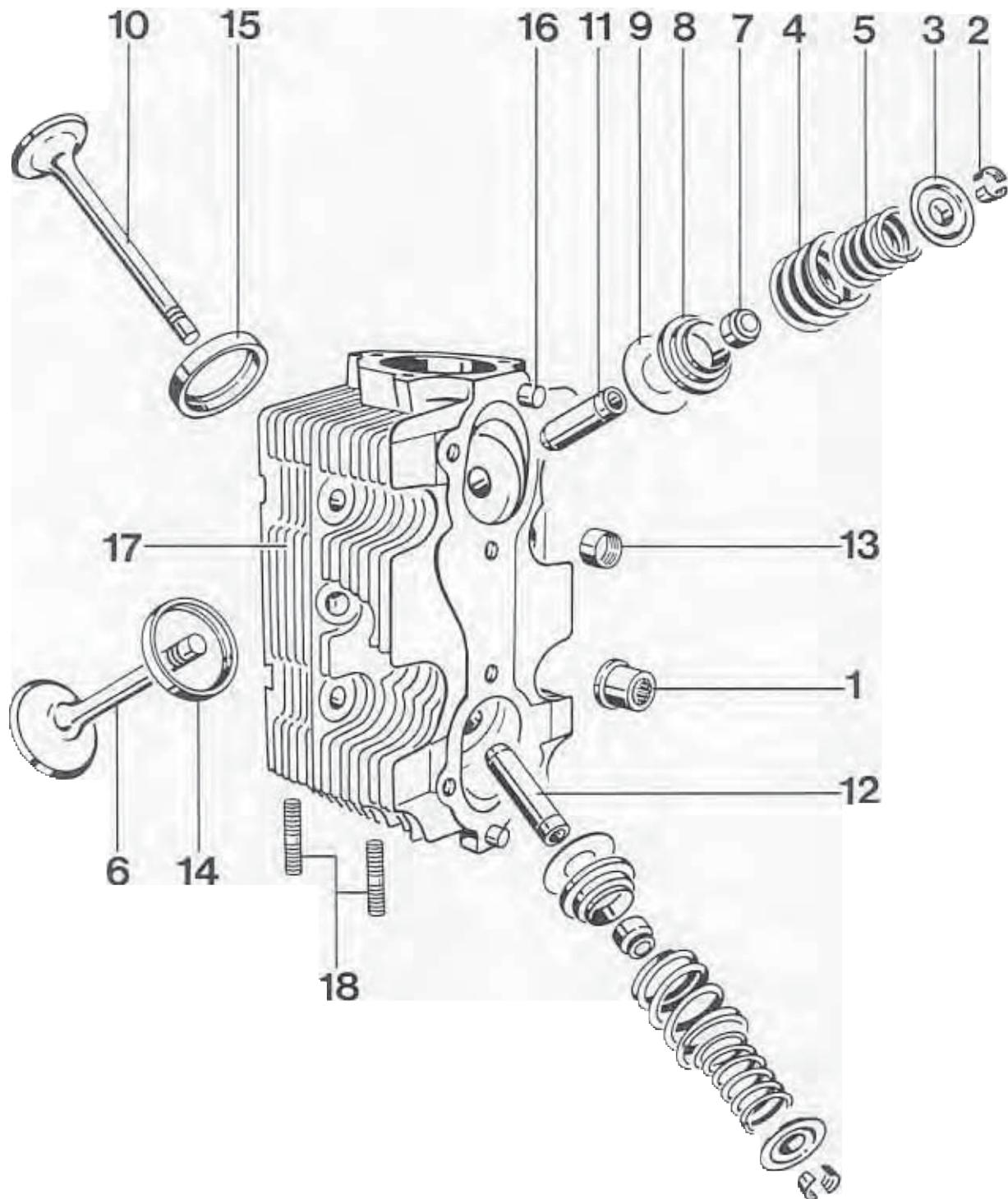
2. Warm up engine to operating temperature (80 °C to 90 °C oil temperature). Use oil temperature tester (Special Tool 9122 + 9122/2) to check temperature.
3. The oil pressure at idle speed must remain between 2.0 and 2.5 bar. Have a second person raise the engine speed to 2,500 rpm. Read off oil pressure on tester. The reading must be above 5 bar.
4. Fit temperature sender unit with new seal.

15 70 37 Dismantling and assembling cylinder head**Tools**

Tools

No.	Designation	Special tool	Order number	Explanation
1	Screwdriver insert for polygon head nuts	9295	000.721.929.50	
2	Valve spring assembling tool	P200a	000.721.200.10	
3	Puller for valve stem seals	3237	000.721.923.70	
4	Valve grinder			Standard, e.g. Hazet 765
5	Socket for temperature sensor II in cylinder head (cyl. no. 3)	9291 (SW 14)	000.721.929.10	
6	Pressure piece for inserting valve seal	9569	000.721.956.90	

70 17 D ntl ig an assembl ng cy inder head

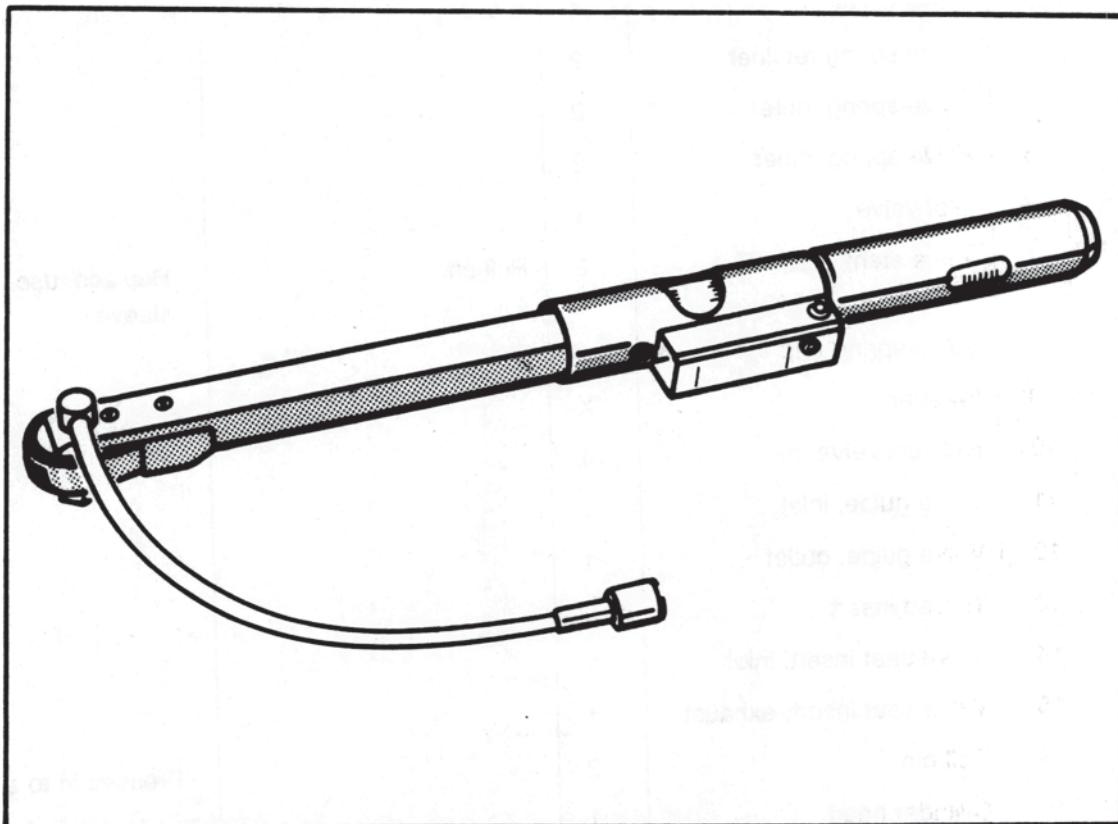


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Cylinder head nut	4	Use screwdriver insert for 9295 polygon-head nut	Apply a thin coat of Optimoly HT to cylinder head nut bearing surface
2	Valve collet	4		
3	Valve spring retainer	2		
4	Valve spring, outer	2		
5	Valve spring, inner	2		
6	Inlet valve	1		
7	Valve stem seal	2	Pull off	Replace, use assembly sleeve
8	Valve spring ring	2		
9	Washer	X		
10	Exhaust valve	1		
11	Valve guide, inlet	1		
12	Valve guide, outlet	1		
13	Thread insert	2		
14	Valve seat insert, inlet	1		
15	Valve seat insert, exhaust	1		
16	Roll pin	2		Pressed in to stop
17	Cylinder head	1		
18	Studs M 8 x 22	2		Fitted with Loctite 270, protruding length 23 - 0.5 mm. Screw studs with unmarked end into cylinder head (exhaust side)

Tightening the cylinder heads

Tightening method based on rotating angle

Tools



No.	Designation	Special tool	Order number	Explanation
	Gradoscope			Standard, e.g. Stahlwille No. 15/20

Tightening the cylinder heads

Tighten cylinder heads with tightening method based on rotating angle.

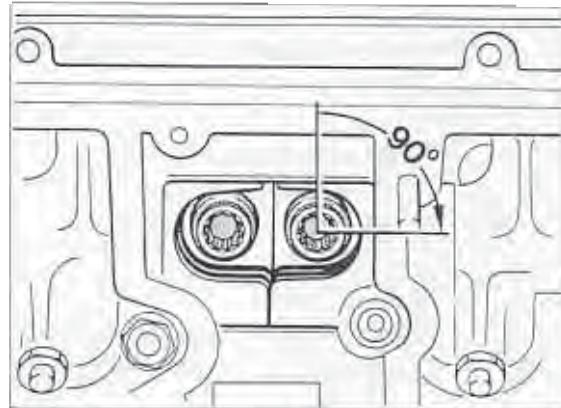
Assembly notes

1. Apply a thin coat of **Optimoly HT** (copper paste) to the stud threads.
2. Fit cylinder heads.
3. Apply a thin coat of **Optimoly HT** to the cylinder head nuts and tighten them as follows:

Tightening in two steps:

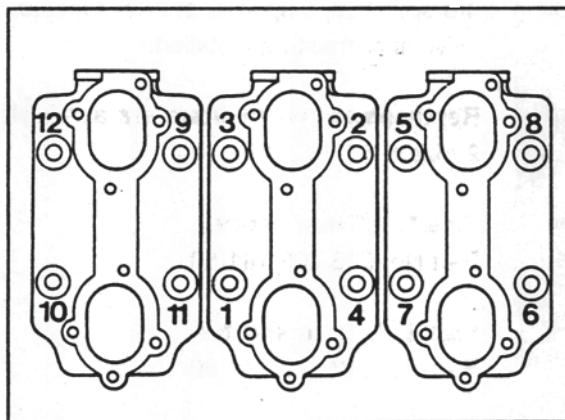
1st step: **20 Nm (18 ftlb.)** according to specified tightening sequence

2nd step: **$1 \times 90^\circ \pm 2^\circ$** in identical sequence

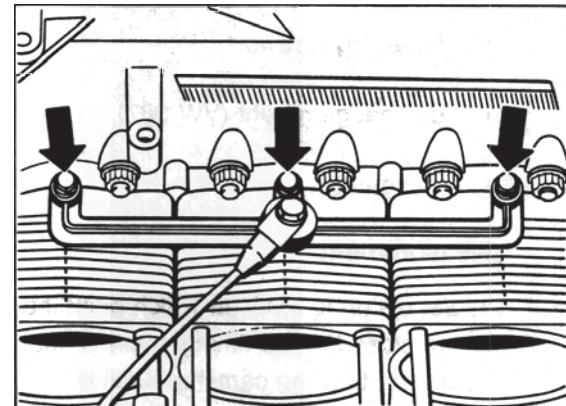


435-15

4. Tighten knock sensor bridges to a final torque of **9.7 Nm (7 ftlb.)**.



327-13



436-15

Note

The hexagon head bolts of the knock sensor bridge should only be screwed in manually before tightening the cylinder heads.

15 59 04 Measuring valve lifters

Each time valve seats or valves are machined, the lift of the valve lifters must always be measured.

The following parts are needed for the test assembly:

1 intake rocker arm

1 exhaust rocker arm

2 valve lifters

(the valve lifters must be free from oil;
clean them in petroleum spirit)

Note: These parts should only be used for checking valves and lifters and must therefore be appropriately marked and stored separately.

original rocker arm shafts

fastening screws

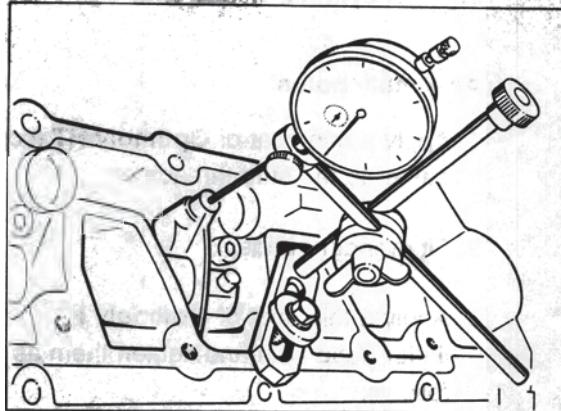
dial gauge mount (VW 387)

dial gauge

Measurement

Set piston to TDC, at which point the valves are closed. If the timing chain is not installed, turn the camshaft until the rocker arms are within the circle of the cam.

2. Push rocker arm by hand and read valve lift of dial gauge.



1908-15

The lift must be at least 0.2 mm on the intake rocker arm and 0.6 mm on the exhaust rocker arm.

If the valve lift measured is lower than the figure specified, a special, shorter replacement valve lifter must be installed.

Replacement valve lifters are available in 2 sizes:

Size 1: 0.5 mm shorter

Part No. 993 105 141 50

Size 2. 1.0 mm shorter

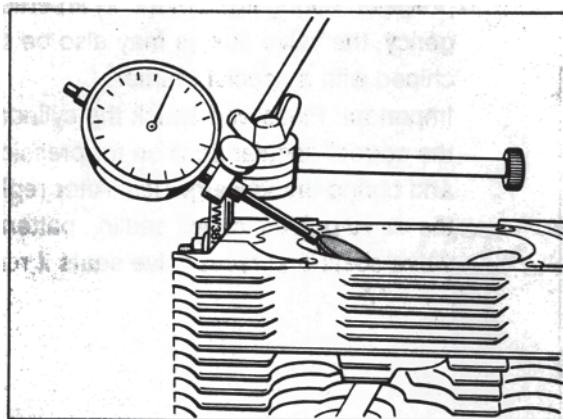
Part No. 993 105 141 60

Caution:

The lift must not exceed
1.85 mm on the intake rocker arm
or
2.25 mm on the exhaust rocker arm!

15 75 02 Checking valve guides

1. Clean valve guides thoroughly
2. Use a new valve to measure the tilting play.
3. Fit dial gauge holder VW 387 to cylinder head. The dial gauge must be aligned parallel to the valve head.



1763-15

4. The tilting play is measured at a valve lift of 10 mm (clearance from valve head to valve seat).

Wear limit for

inlet guide	= 0.80 mm
exhaust guide	= 0.80 mm

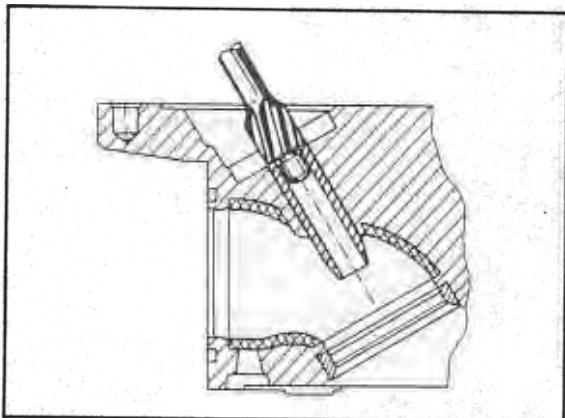
Note

Any ovality in the entry section of the valve guides may be disregarded.

15 75 56 Replacing valve guides

Removal

Working from the camshaft side, machine off protruding valve guide sections using a spot facer until the valve guides are flush with the cylinder head. Loosen guide with a sharp hammer blow and press out remainder towards combustion chamber using a press.



1761-15

Installation

The valve guide mounting bores in the cylinder head are widened slightly during removal of the old guides.

When fitting new guides, use oversize valve guides and adjust them accordingly (refer to measurement table).

1. Measure valve guide mounting bores.

2. Machine the outside diameter of the oversize valve guides on a lathe according to the bores in the cylinder head. Guideline for machining: 14.08 - 13.09.
The press fit for the inlet and exhaust valve guides must be 0.06 to 0.08 mm.

3. Coat machined valve guides with tallow and fit into cylinder head with a shop-made drift, working from the camshaft side.

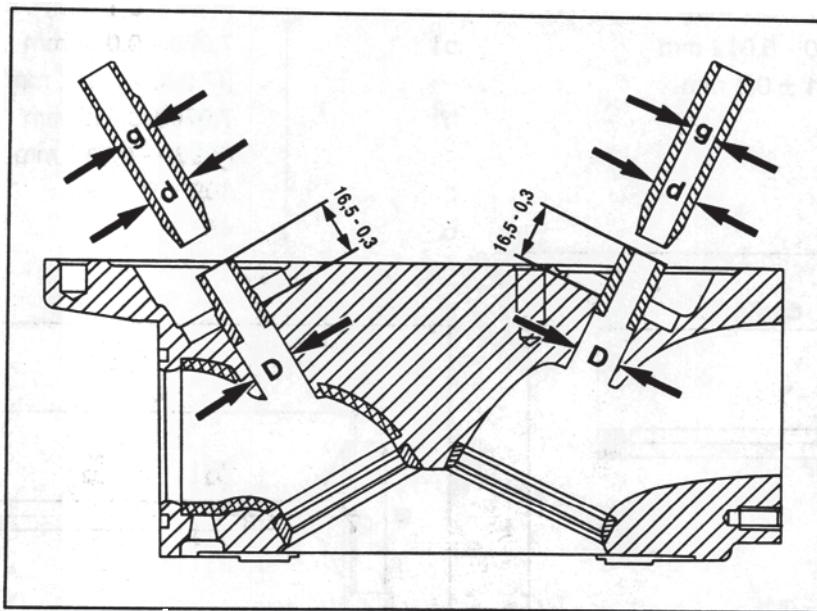
4. Bore inner valve guide dia. to a dimension of "g" = 8.00 to 8.015 mm using a broach or precision boring equipment. In an emergency, the valve guides may also be machined with a special reamer.

Important: Place and chuck the cylinder in the correct angular position for pressing in and boring the valve guides. After replacing the valve guides, check sealing pattern of valve seats and recut valve seats if required.

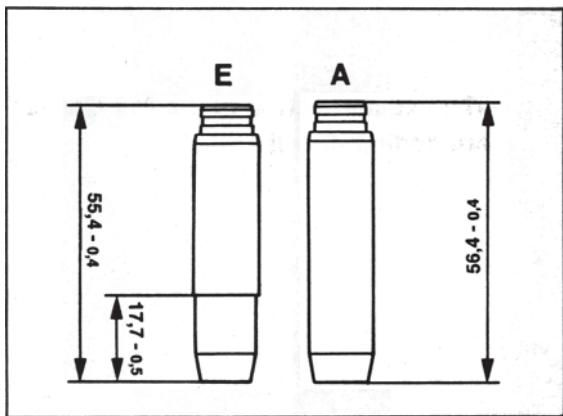
Dimensions for fitting the valve guides

Valve guide	Outside Ød* of valve guide	Bore Ø D of cylinder head
Standard (production)	13.060	13.000 - 13.018
1st oversize	13.260	13.000 - 13.200

* Machine valve guide Ø d to the respective bore Ø D - observe correct press fit.



How to tell the valve guides apart



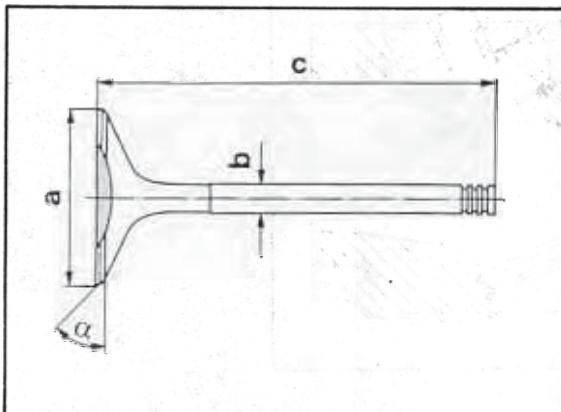
15 62 04 Measuring the valves

Valve dimensions

911 Carrera RS (values in brackets)

Inlet valve

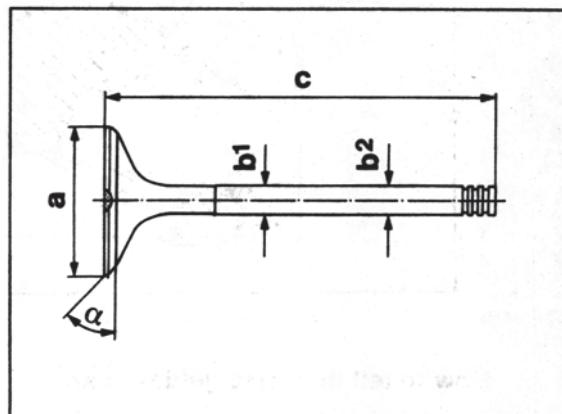
Dimension	Inlet valve (sodium-filled)
a	49 ± 0.1 mm (51.5 ± 0.1 mm)
b	$7.970 - 0.012$ mm
c	110.1 ± 0.1 mm
α	45°



1770 - 15

Exhaust valve

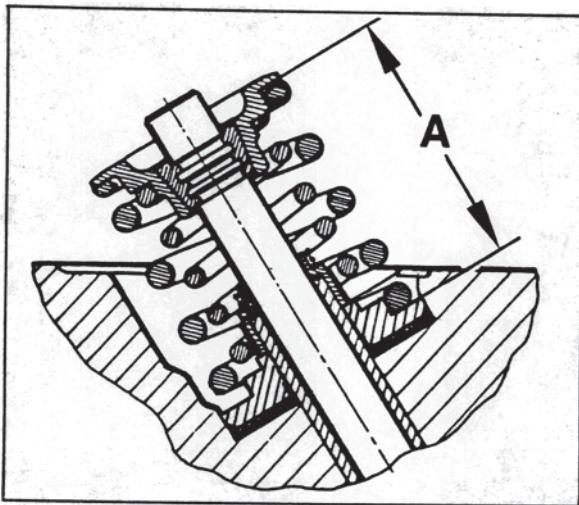
Dimension	Exhaust valve ($b^1 - b^2 = \text{tapered}$)
a	42.5 ± 0.1 mm (43.5 ± 0.1 mm)
b ¹	$7.950 - 0.012$ mm ($7.940 - 0.012$ mm)
b ²	$7.970 - 0.012$ mm ($7.960 - 0.012$ mm)
c	109 ± 0.1 mm
α	45°



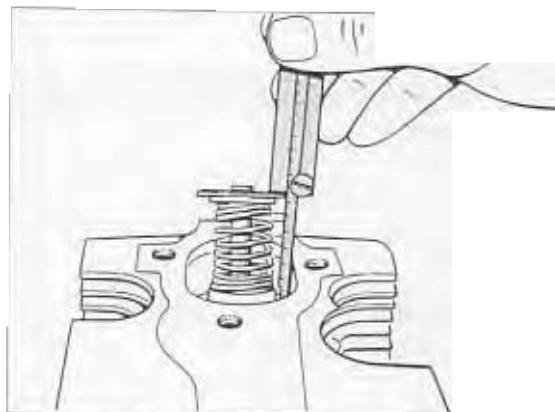
1771 - 15

The intake valves of the 911 Carrera (993) and the 911 Carrera RS are sodium-filled!

The exhaust valves of the 911 Carrera RS are sodium-filled!

15 65 06 Checking and adjusting installed length of valve springs**Installed length, dimension "A"**

2. Using a depth gauge, measure vertically from valve spring cap top surface to valve spring seat surface. Record measurement.

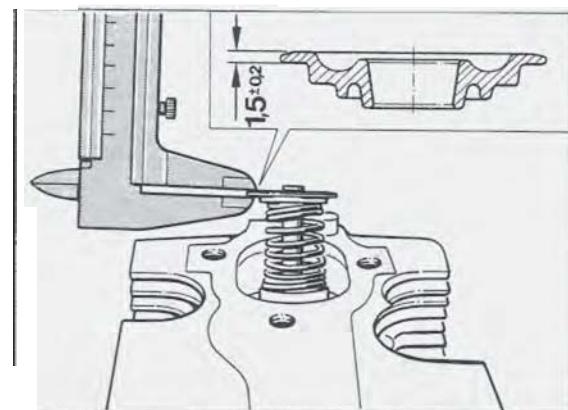


1. Assemble shims, valve spring support, valve, auxiliary spring, e.g. for oil thermostat (engine 928), part number 928.107.171.01, valve spring cap and valve keepers.

Note

If required, the spring may be shortened slightly to facilitate assembly.

3. Determine thickness of valve spring cap. Record measurement.



4. Determine actual dimension

Example for determining the actual dimension:

Inlet valve spring

Measured value	38,5
Thickness of valve spring cap	- 1,6
	36,9

Result:

The value of **36,9** is within the admissible tolerance.

Note

Take care not to confuse the parts after the measurement.

Engine

M 64 / 05 / 06 / 07 / 08

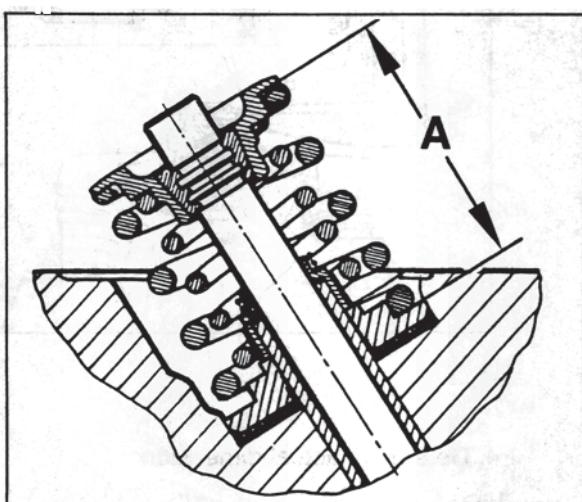
Engine

M 64 / 20 (RS)

Installation dimension specifications

Inlet valve A = 36,7 + 0,3 mm 37,2 + 0,3 mm

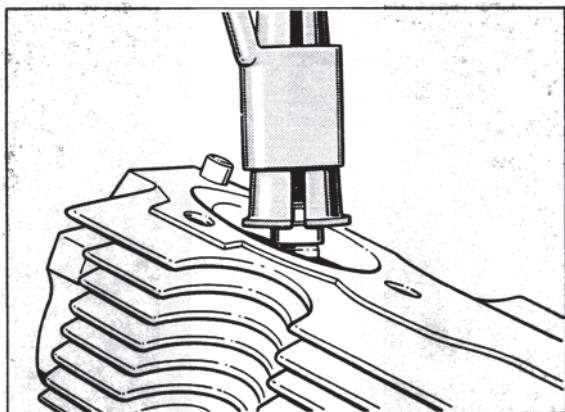
Exhaust valve A = 35,7 + 0,3 mm 35,8 + 0,3 mm



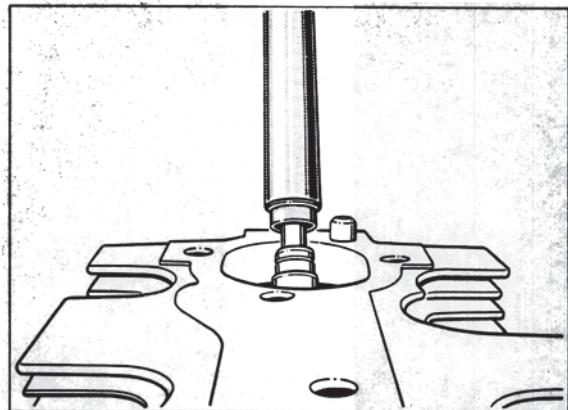
15 63 19 Removing and installing valve seal

Removal

Hook special tool 9237 into recess in valve seal and pull valve seal out.



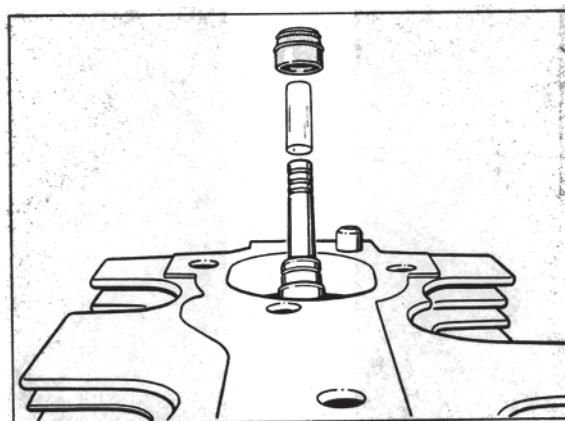
2204-15



2205-15

Installation

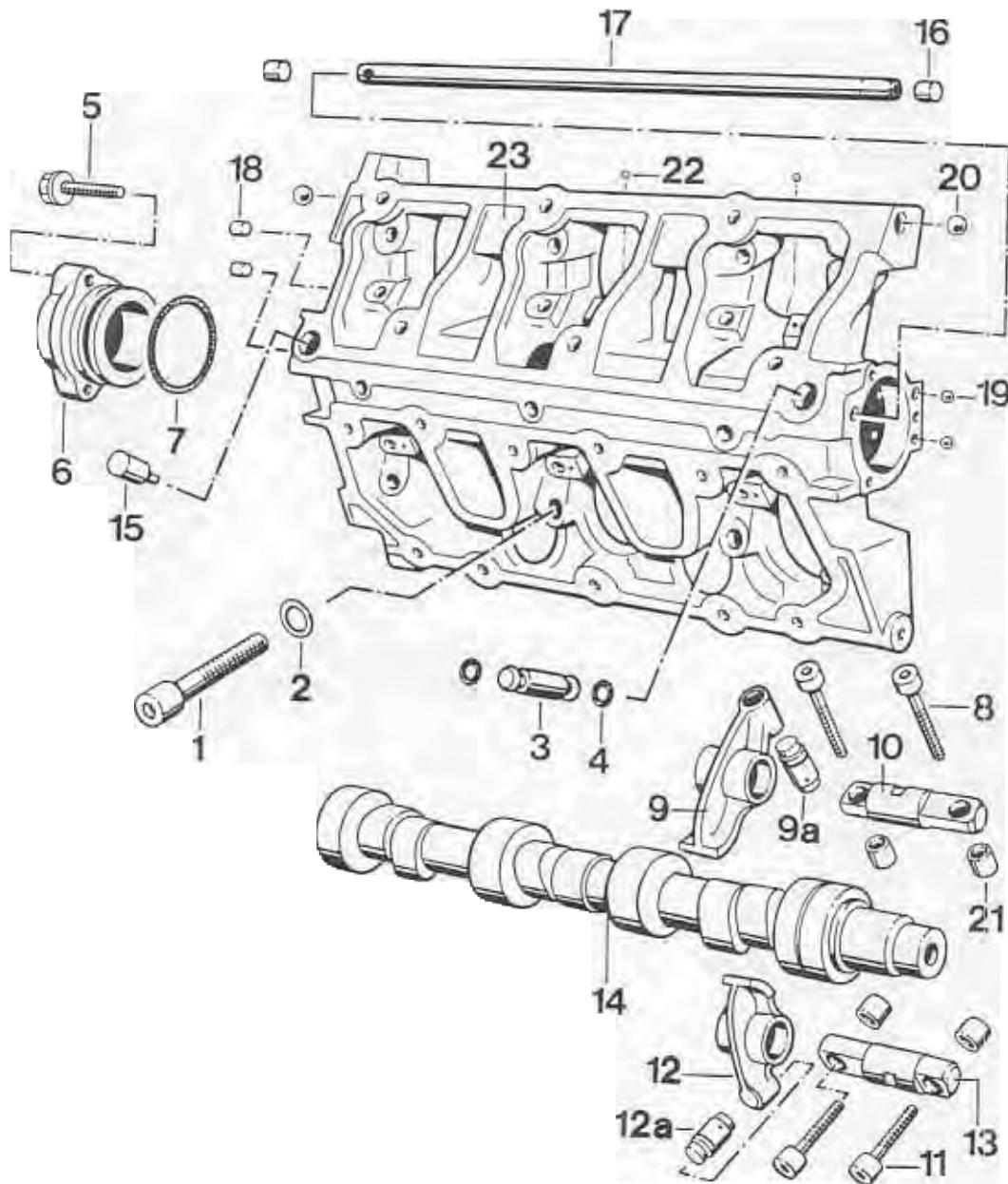
Install the washers and valve spring seats which have been determined. Push plastic mounting sleeve (8 mm dia.) onto valve stem. Oil seal lip and seat surface of valve seal, position it by hand and knock it carefully onto the valve guide using special tool 9569 (pressure piece). Remove plastic sleeve.



2203-15

15 03 37 Dismantling and assembling camshaft housings**Left-hand camshaft housing**

Note: Unless indicated otherwise, coat all aluminum plugs with Optimoly HT (copper paste) and press in flush. Do not use any other lubricant.



No.	Designation	Qty.	Removal	Note: Installation
1	Cylinder bolt (outer) M 8 x 55	12		Replace, coat threads with Loctite 574 if re- quired, tightening torque 23 Nm (17 ftlb.)
	Cylinder bolt (inner) M 8 x 30	6		
2	Washer, attached perma- nently to cylinder bolt (for item No. 1)			
3	Flange	1		
4	O-ring	3		Replace, lightly oiled
5	Hexagon head bolt with permanent washer (M 6 x 28, self-locking)	3		
6	Cover	1		
7	O-ring 40 x 4	1		Replace, lightly oiled
8	Cylinder bolt	6		Tightening torque 13 Nm (10 ftlb.)
9	Rocker arm (inlet)	3		Identification: Cap for valve lifter bore is punch- marked along its circum- ference
9a	Valve lifter	3	Pull out with suitable pliers but do not reuse	
10	Rocker arm shafts	3		Bearing surface oiled
11	Cylinder bolt	6		
12	Rocker arm (exhaust)	3		Bearing surface oiled
12a	Valve lifter	3	Pull out with suitable pliers but do not reuse	
13	Rocker arm shafts	3		Oil sliding surface, use hold-down tool to push against mating surfaces on both sides, then tighten cylinder bolts to 13 Nm

No.	Designation	Qty.	Note:	
			Removal	Installation
14	Camshaft, left-hand (cylinder bank 1 - 3)	1		Identification 993.247.07 embossed on face flange. Punch mark points up. Use locking device 9551
15	Plug with positioning tip	1	Drill open, pull off	Press in flush. Apply only Optimoly HT (copper paste) when fit- ting
16	Plug	2	Drill open, pull off	
7	Spray tube	1		Check oil spray bores, flush thoroughly, install in correct position (spray bores must point towards camshaft); position spray tube
18	Plug Ø 6.7	2		Press in flush
19	Ball Ø 6.35	2		Press in flush
20	Ball Ø 9.525	2		Only found on engines with air injection, other- wise bore is omitted
21	Adapter sleeve 9 x 11	12	If required, use vise-grip pliers to pull out	Check for correct seating
22	Ball Ø 3.969	6		Check if ball is not missing

Assembly notes

Removing and installing spray tube on cam-shaft housing

Note

In case of bearing damage and when rebuilding the engine, the spray tubes must always be removed and cleaned thoroughly. If bearings are damaged, the lateral oil ducts must also be cleaned (removed 6.7 mm dia. plug and opposite 6.3 mm dia. balls).

The ball may be pushed out with a threaded bar (M5) from the opposite side. **Balls that do not retain a press-fit should be replaced by a plug.**

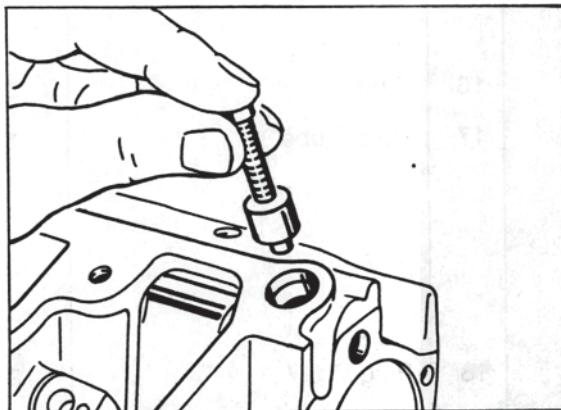
Removing the spray tubes

Removal

1. Pre-drill lateral plugs (8.15 mm dia.) and upper plug (12.5 mm dia.) with a 4.8 to 5 mm dia. drill to a depth of approx. 9 mm and tap in an M 6 thread with a bottoming tap. Pull out plug with M 6 screw and spacer sleeve.

Positioning spray tube with auxiliary tool

Turn original plug (Part No. 993.105.345.00) down to an outside dia. of 12.4 mm. Tap M 5 thread into plug and screw in suitable screws, e.g. M 5 x 35. Push spray tube into camshaft housing. Smaller bores (6 bores) face cam-shaft. Use auxiliary tool to position spray tube. Coat new plug with Optimoly HT and press in flush.



1592-15

Installation

Apply a coating of Optimoly HT to the new plug and press in flush.

Installation position of rocker arms

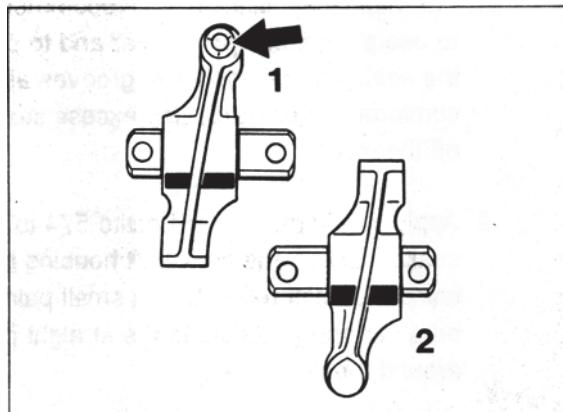
1 - Inlet rocker arm

Identification:

Valve lifter bore is drilled, plugged with cover and punched (arrow).

2 - Exhaust rocker arm

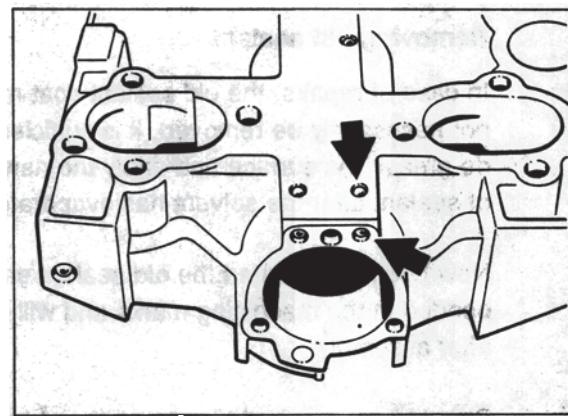
Valve lifter bore not drilled



1483-15

Checking presence of sealing balls

Balls (6) on camshaft housing sealing face, balls (2) on front face (pulley side). 2 lateral balls are only present on engine with air injection.



1629-15

Sealing the camshaft housing sealing face

Use only Loctite 574 to seal.

Loctite 574 hardens only when contact with metal is made and air ingress is prevented. After having applied the sealant, bolt up the crankcase sections within approx. 10 minutes since the sealant bead applied directly to the metal surface will otherwise start to cure.

Removing old sealant

In case of repairs, the old sealant coat must not necessarily be removed. It is sufficient to de-grease the surface and apply the new coat of sealant after the solvent has evaporated.

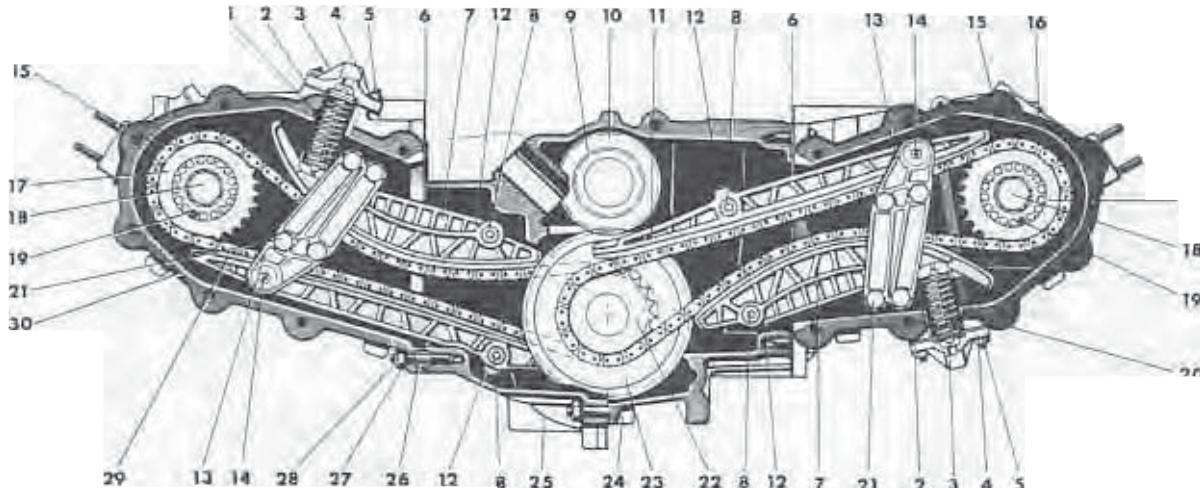
New Loctite will soften the old sealant embedded in the machining marks and will cure after assembly.

Should it be required to remove the old sealant, it is recommended to use a fine-mesh wire brush or Loctite adhesive remover 80646.

Applying sealant

1. For manual application, it is recommended to use a short-pile paint roller and to pour the sealant into a dish with grooves at its circumference (for squeezing excess sealant off the roller).
2. Apply a uniform coat of Loctite 574 to the sealing face of the camshaft housing by using the paint roller. Use a small paint brush to apply sealant to the straight pins around the bolt holes.

15 31 37 Dismantling and assembling chain housing with camshaft drive

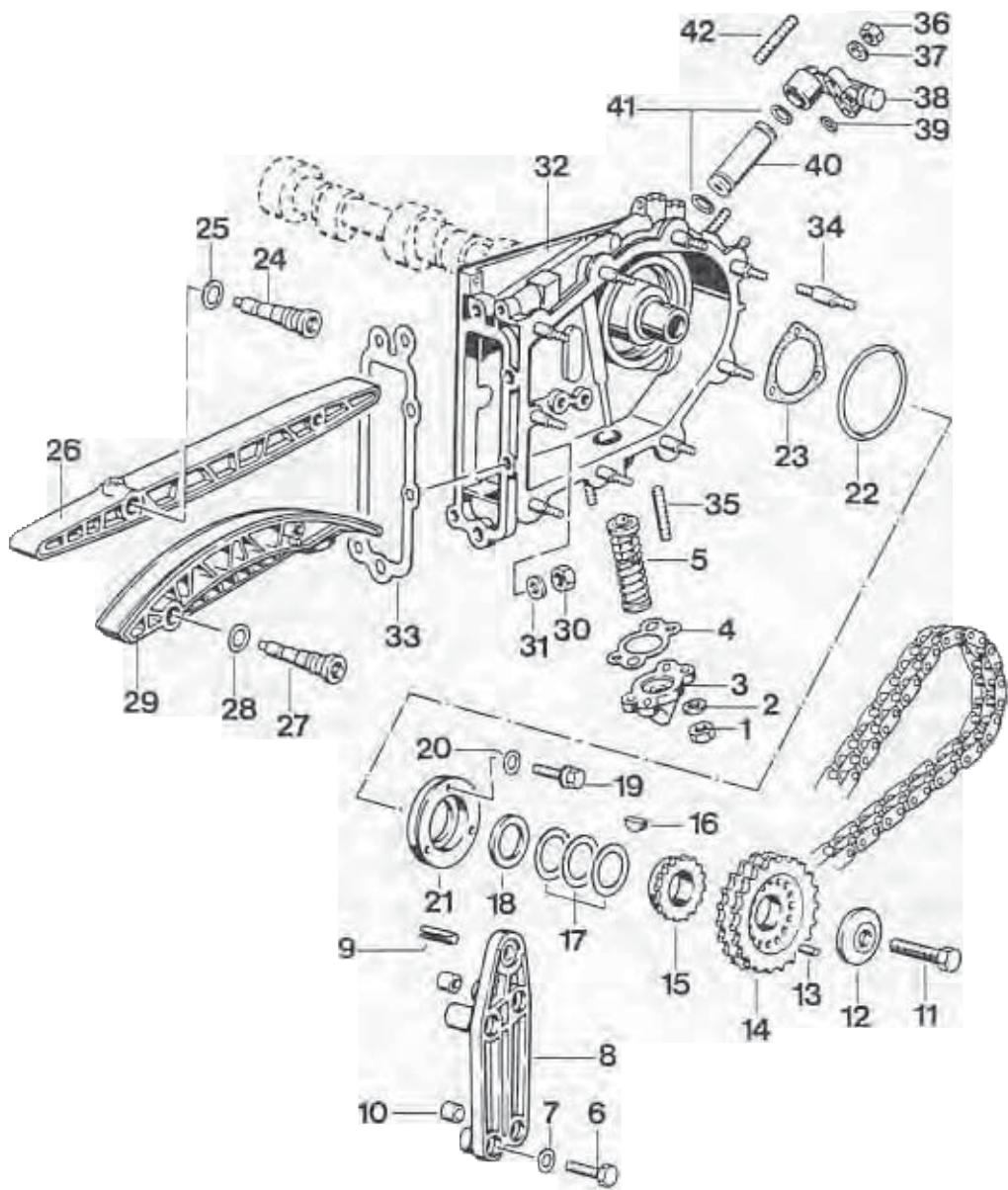


649

- | | |
|---------------------------------|---|
| 1 - Left-hand chain tensioner | 16 - Right-hand chain housing |
| 2 - Chain tensioner gasket | 17 - Chain sprocket z = 28 |
| 3 - Chain tensioner cover | 18 - Hexagon head bolt M 12 x 1.5 |
| 4 - Aluminum washer | 19 - Straight pin, 6 mm dia. |
| 5 - M 6 lock nut | 20 - Right-hand chain tensioner |
| 6 - Chain housing gasket | 21 - M 6 hexagon-head bolt |
| 7 - Tensioning rail | 22 - Chain sprocket z = 24 |
| 8 - Support stud | 23 - Intermediate shaft sprocket z = 60 |
| 9 - Distributor drive gear | 24 - Right-hand crankcase section |
| 10 - Crankshaft sprocket z = 35 | 25 - Left-hand crankcase section |
| 11 - Right-hand guide rail | 26 - Fit sleeve |
| 12 - Spring-loaded thrust piece | 27 - Aluminum washer |
| 13 - Bearing saddle | 28 - M 8 lock nut |
| 14 - Heavy type dowel pin | 29 - Left-hand guide rail |
| 15 - Duplex roller chain | 30 - Left-hand chain housing |

15 31 37 Dismantling and assembling chain housing with camshaft drive**Cylinder bank 4 - 6**

Set engine to firing TDC of cylinder no. 1
(overlap TDC of cylinder no. 4) before disman-
tling the housing. The punch marks on both
camshafts now face up.



No.	Designation	Qty.	Removal	Note: Installation
1	Lock nut	2		
2	Washer 6.4 x 14 x 3	2		
3	Cover	1		
4	Gasket	1		Replace
5	Chain tensioner	1		Oil supply bore points down. In addition, the spring retainers are marked with „oben“ (top) and „unten rechts“ (bottom right).
6	Hexagon head screw M 6 x 18	4		
7	Washer 6.4	4		
8	Support bracket	1	When levering off, take care not to damage the guiding edges of the guide rail	
9	Roll pin 10.5 x 43	1	Use vise-grip pliers to pull out of chain housing	Observe correct seating in chain housing
10	Adapter sleeve 8 x 8	2		Check for correct seating in support bracket
11	Hexagon head bolt M 12 x 1.5 x 50	1	Lock with suitable locking device	Apply a thin coat of Optimoly HT . Tightening torque 120 Nm (88 ftlb.), lock with locking device
12	Washer	1		
13	Straight pin	1	Use puller P 212 to pull out	
14	Sprocket	1	Take off chain	Check teeth for wear, deeper cutout in sprocket must face forward (towards flywheel)
15	Sprocket flange	1		

No.	Designation	Qty.	Note:	
			Removal	Installation
16	Woodruff key	1	Use diagonal cutting pliers to lift out	
17	Shim	X		Measure size. Determine parallelity of sprockets. In most cases 4 shims are required
18	Thrust washer	1		Install in correct position, cutout must face camshaft
19	Hexagon head bolt or screw and washer assembly	3		
20	Washer A 6.4 (refer to item 19)	3		
21	End cover	1		
22	O-ring	1		Replace. Check seating area in chain housing and deburr edge if required. Must be greased lightly along outside circumference. Do not twist when fitting
23	Gasket	1		Replace, apply a thin coat of Loctite 574 to both sides
24	Retaining stud	1		Tightening torque 31 Nm (23 ftlb.)
25	Seal A 16 x 20	1		Replace
26	Guide rail	1		Guide rail must engage audibly into groove in retaining stud
27	Retaining stud	1		Tightening torque 31 Nm (23 ftlb.)
28	Seal A 16 x 20	1		Replace

No.	Designation	Qty.	Removal	Note: Installation
29	Tensioning rail	1		Tensioning rail must engage audibly into groove in retaining stud
30	Lock nut	5		
31	Washer 8.4 x 18 x 3	5		
32	Chain housing (right-hand side)	1		Check O-ring seating area (No. 22) and deburr if required
33	Gasket	1		Must always be replaced. Coat both sides with Loctite 574
34	Collar pin	9		Tightening torque 7 Nm (5 ftlb.) , glued into place with Loctite 270
35	Stud 6 x 18	2		Bonded in with Loctite 270
36	Lock nut	2		Replace if required
37	Washer 6.4 x 14 x 3	2		
38	Flange (bridge)	1		
39	Seal 6 x 25	1		Replace
40	Sleeve	1		
41	Seal 6.7 x 3.53	2		Replace
42	Stud M 6 x 20	1		Bonded in with Loctite 270

15 31 37 Drive with single-part chain sprocket – flange unit (4-hole chain sprocket)

Note

Description from page 15 - 20a onwards

In combination with the use of 4-hole chain sprockets, the following parts are no longer installed on the camshaft drive.

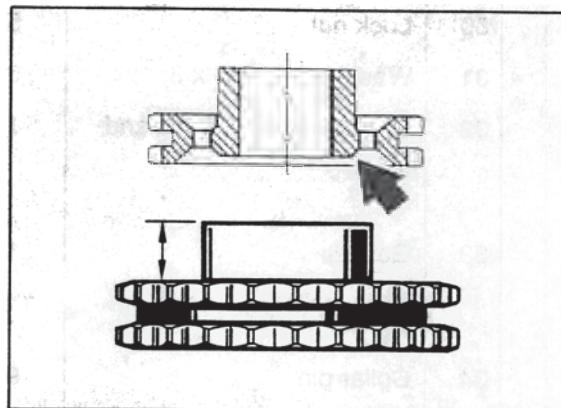
thrust washer

compensation washers (measurements to ensure that the parts are parallel are therefore no longer required)

Woodruff key

chain sprocket flange

straight pin

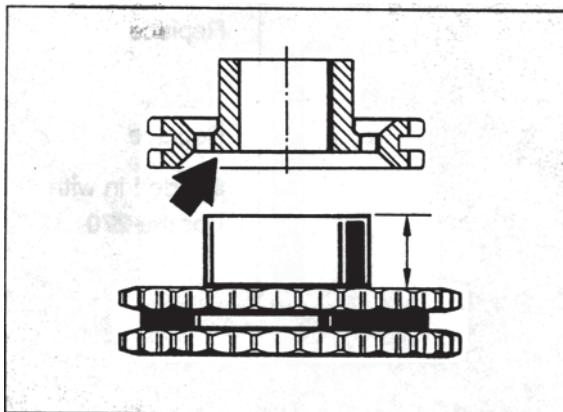


2153-15

Right chain sprocket / cylinders 4 - 6

part no. 993 105 546 02

Distinctive feature: high collar (arrow)
low flange



2165-15

Left chain sprocket / cylinders 1 - 3

part no. 993 105 546 01

Distinctive feature: flat collar (arrow)

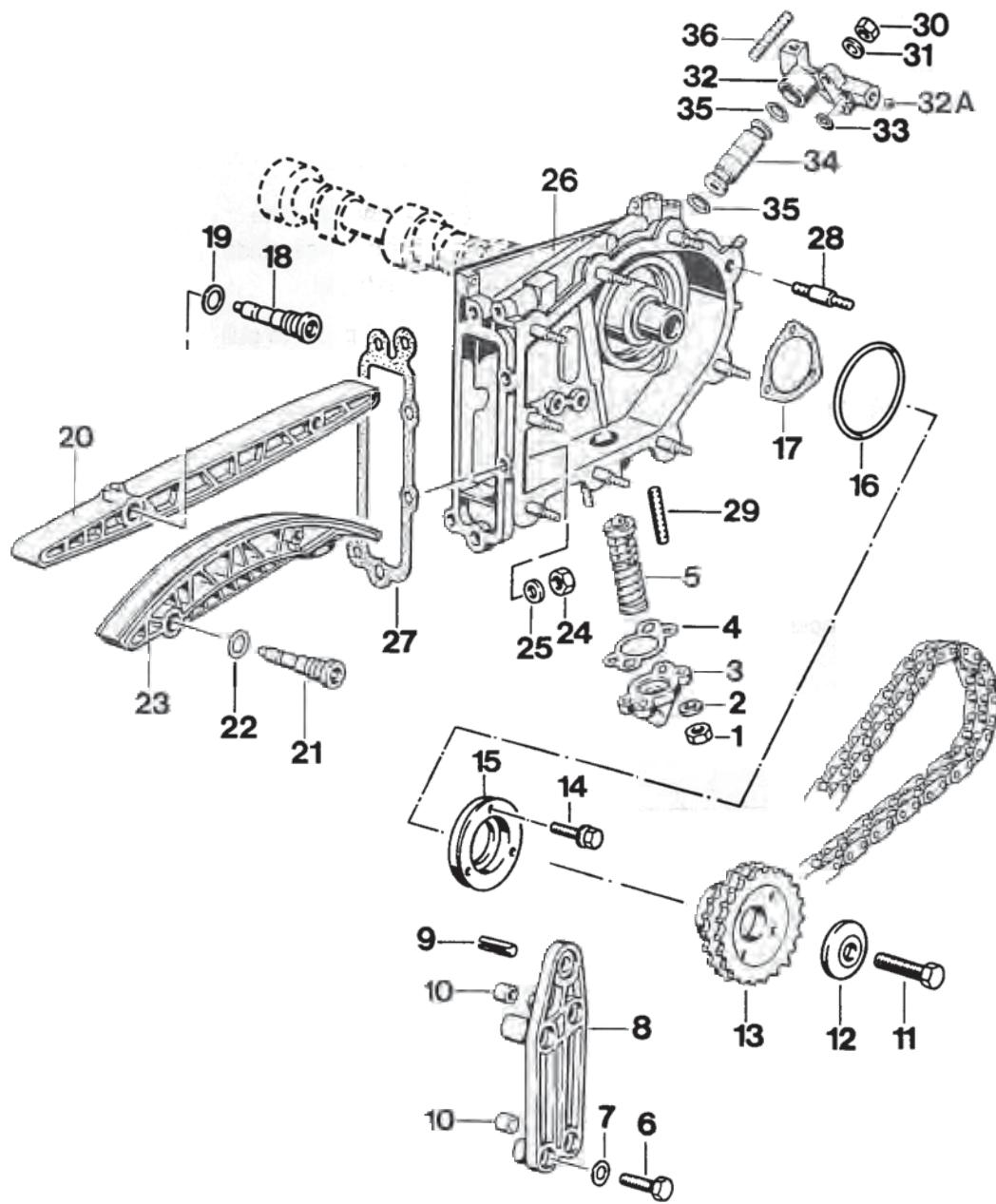
high flange

15 31 37 Dismantling and assembling chain housing with cam drive

Camshaft drive with single-part chain sprocket flange (four-hole chain sprocket)

Cylinder bank 4 - 6

Before dismantling, set engine cylinder 1 to firing TDC (overlap TDC of cylinder 4). Punch marks of both camshafts now point up.



No.	Designation	Qty.	Removal	Note:	
					Installation
1	Lock nut	2			
2	Washer 6.4 x 14 x 3	2			
3	Cover	1			
4	Gasket	1		Replace	
5	Chain tensioner	1		Oil supply hole points down, spring cups are also marked "top" and "RH bottom" for identification	
6	Hexagon head bolt M 6 x 18	4			
7	Washer 6.4	4			
8	Bearing bracket	1	When levering off, take care not to damage guide edges of slide rail		
9	Roll pin 10.5 x 43	1	Use vise-grip pliers to pull out of chain housing	Check for correct seating in chain housing	
10	Sleeve 8 x 8	2		Check for correct seating in bearing bracket	
11	Hexagon head bolt M 12 x 1.5 x 50	1	Use locking device to lock	Use locking device to lock	
12	Washer	1			
13	Chain sprocket	1	Lift off chain	Check teeth for wear, fit to camshaft with chain placed into position.	

No.	Designation	Qty.	Note:	
			Removal	Installation
14	Screw/washer assy. with captive washer	3		
15	End cover	1	Press off between chain casing and camshaft housing using a suitable tool	
16	O-ring	1		Replace. Check mounting area in chain housing and deburr edges if required. Grease outer circumference lightly. Do not twist when refitting
17	Gasket	1		Replace
18	Retaining pin	1		Tighten to 31 Nm (23 ftlb.)
19	Seal A 16 x 20	1		Replace
20	Slide rail	1		Slide rail must be felt to engage into the groove of the retaining pin
21	Retaining pin	1		Tighten to 31 Nm (23 ftlb.)
22	Seal A 16 x 20	1		Replace
23	Tensioning rail	1		Tensioning rail be felt to engage into the groove of the retaining pin
24	Lock nut	5		
25	Washer 8.4 x 18 x 3	5		
26	Chain housing	1		Check seating area of O-ring (No. 18) and deburr if required
27	Gasket	1		Must always be replaced, coat both sides with Loctite 574
28	Flanged pin	9		Tighten to 7 Nm (5 ftlb.), bonded in place with Loctite 270

No.	Designation	Stück	Note:	
			Removal	Installation
29	Stud 6 x 18	2		Bonded in place with Loctite 270
30	Lock nut	2		Replace if required
31	Washer 6.4 x 14 x 3	2		
32	Flange (saddle)	1		
32A	Ball	1		
33	Seal 6 x 2.5	1		Replace
34	Pressure oil pipe	1		
35	Seal 8.2 x 2.8	2		Replace
36	Stud M 6 x 20	1		Bonded in place with Loctite 270

15 05 Camshafts, timing

Engine type M 64/05/06

Engine type M 64/ 20

Camshafts

Camshaft LH	993.105.247.07	993.105.247.41
Cylinder bank 1...3		
Camshaft RH	993.105.246.07	993.105.246.41
Cylinder bank 4...6		

Identification on
front face of

LH camshaft	993.247.07	993.247.41
RH camshaft	993.246.07	993.246.41

Timingfor 1 mm valve lift
and zero clearance

Inlet opens	1° crankshaft BTDC	5° crankshaft BTDC
Inlet closes	240° crankshaft ABDC	238° crankshaft ABDC
Exhaust opens	225° crankshaft BBDC	230° crankshaft BBDC
Exhaust closes	2° crankshaft ATDC	2° crankshaft ATDC

15 31 37 Determining parallelity of chain sprockets

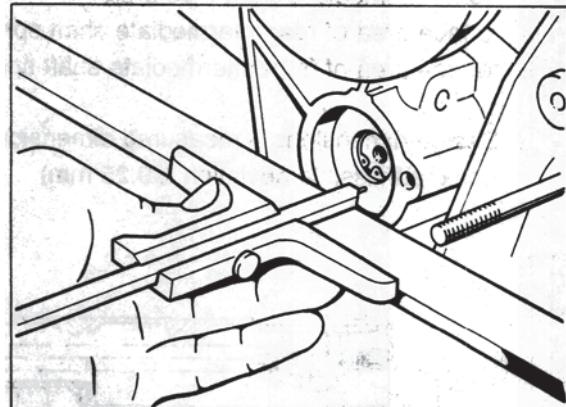
The parallelity offset between the driving sprocket on the intermediate shaft to the driven sprocket on the camshaft must not exceed ± 0.25 mm max. Before measuring, move the intermediate shaft in axial direction towards the flywheel to make sure the support collar of the bearing is seated correctly.

To adjust the sprockets, insert or remove shims, Part No. 901.105.561.00 (shim thickness 0.5 mm). Usually, three shims are required below the left-hand sprocket (cylinders no. 1 - 3), and four shims are required below the right-hand sprocket (cylinders no. 4 - 6).

Adjustment

Tighten hexagon head bolts of sprockets to approx. 30 Nm (22 ftlb.), using Special Tool 9551 or 9552 (camshaft locking tools) to lock.

Determine dimension "A" from crankcase front edge or ruler, respectively, to intermediate shaft face area.



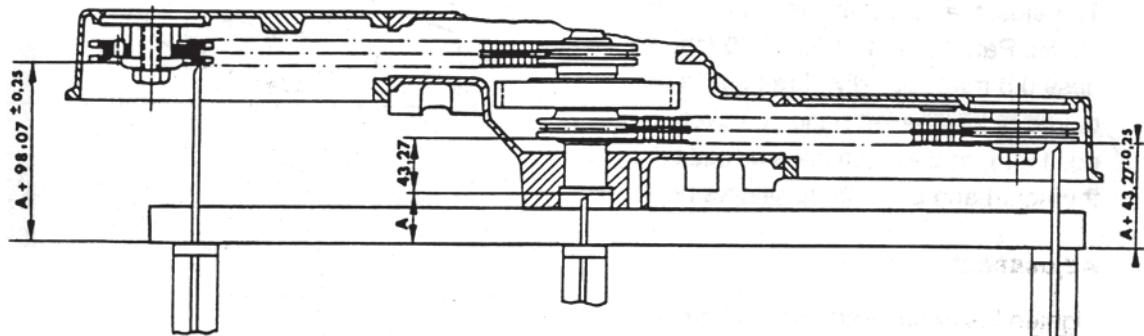
1307-15

Design dimensions of drive sprockets on intermediate shaft
from intermediate shaft face area -

to face area of rear intermediate shaft sprocket (cyls. no. 1 - 3) = 98.07 mm

to face area of front intermediate shaft sprocket (cyls. no. 4 - 6) = 43.27 mm

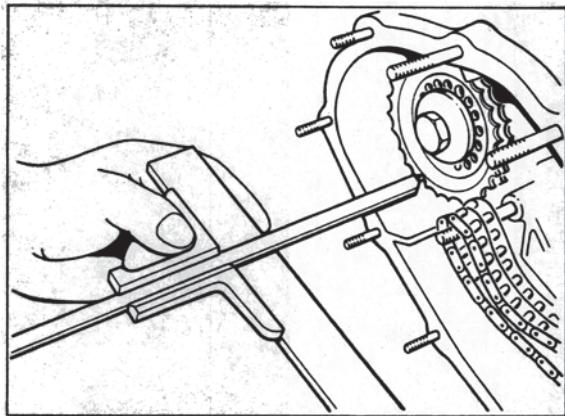
Design dimensions + measured dimension "A" is equal to position of sprockets on camshafts
(max. admissible deviation ± 0.25 mm).



1304-15

Example: Measured dimension "A" = 35.5 mm

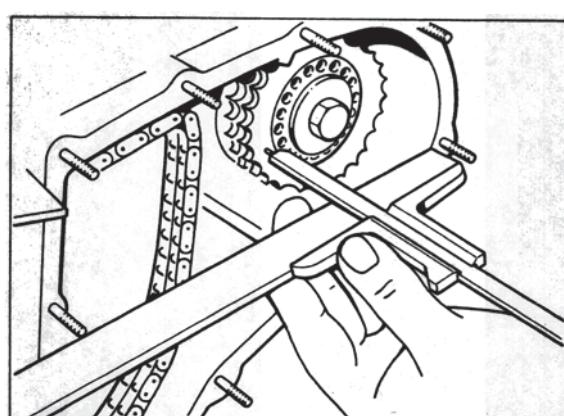
$$\begin{aligned} \text{The value of the sprocket of cyls. no. 1 - 3 then equals: } & A + 98.07 = \\ & 35 + 98.07 = 133.57 \pm 0.25 \text{ mm} \end{aligned}$$



1305-15

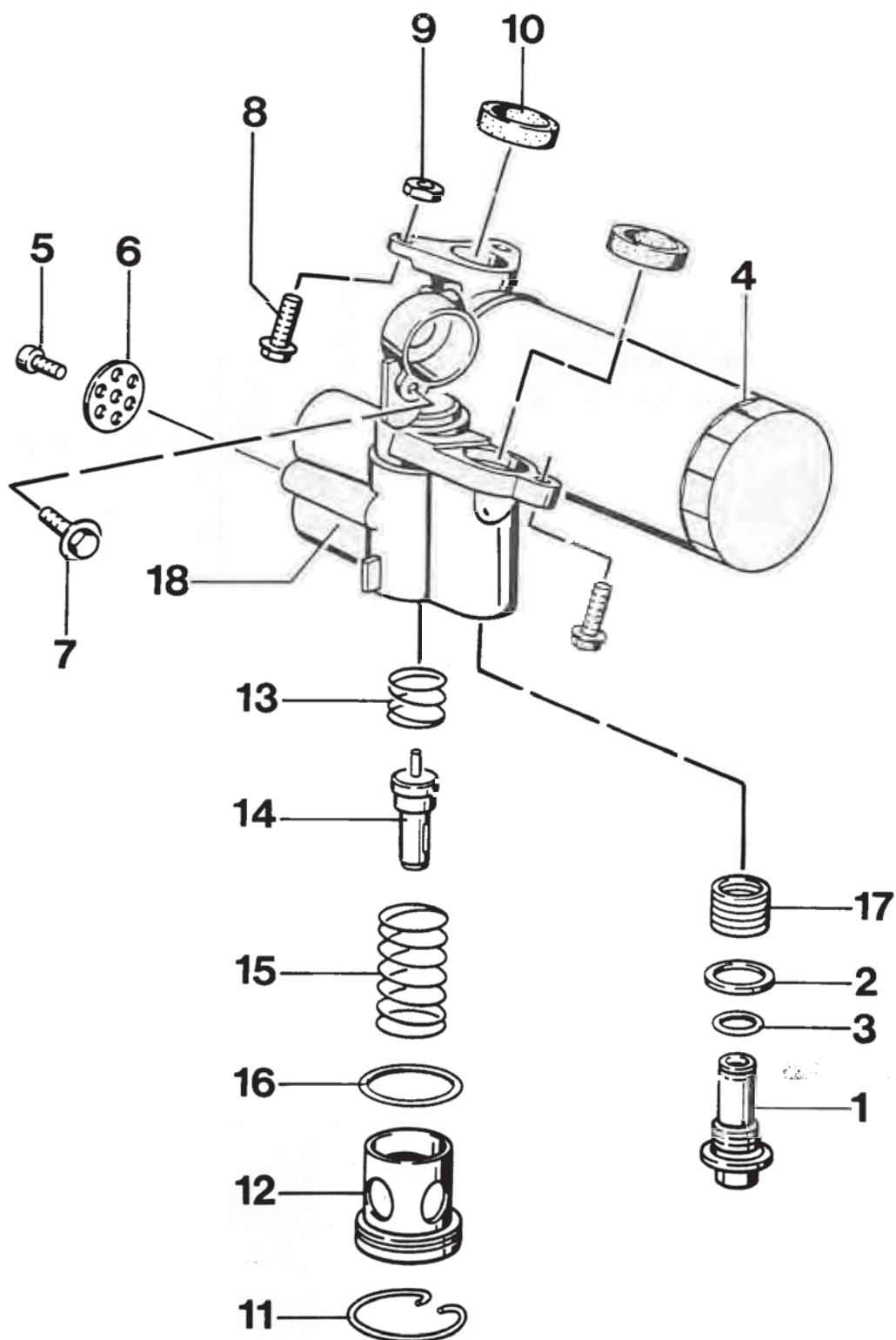
The value for the sprocket of cyls. no. 4 - 6 then equals:

$$\begin{aligned} & A + 43.27 = \\ & 35 + 43.27 = 78.77 \pm 0.25 \text{ mm} \end{aligned}$$



1306-15

17 37 37 Dismantling and assembling oil temperature regulator housing



No.	Designation	Qty.	Removal	Note: Installation
1	Oil drain plug	1		Tighten to 50 + 5 Nm.
2	Seal A 22 x 27	1		Replace.
3	O-ring 11 x 2.5	1		Replace.
4	Oil filter	1	Use Special Tool 9204.	Use Special Tool 9204.
5	Pan-head screw M 6 x 12	1		
6	Washer 6.5 x 28 x 2.0 (Lock washer for oil lines)	1		Domed side faces outside.
7	Combination screw M 6 x 16	1		
8	Pan-head screw M 6 x 18	3		
9	Hexagon-head bolt	3		
10	Seal	2		Replace, oil lightly.
11	Snap ring A 40.9	1		
12	Cover	1		
13	Compression spring, short	1		
14	Regulator insert	1		Check.
15	Compression spring	1		
16	O-ring 32 x 2.5	1		Replace.
17	Threaded insert M 20 x 1.5 x 15	1		Replace.
18	Oil temperature regulator housing	1		

Combination screw = Hexagon-head bolt with captive washer

Repair Manual

**911 Carrera 4
(993)**

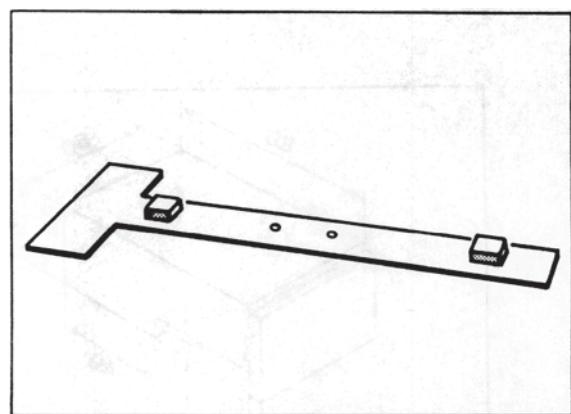
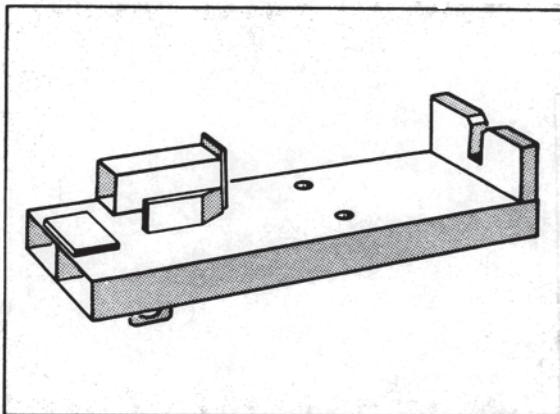
**Volume I:
General
Engine**

I General / Engine

10	Engine, Crankcase, Engine Mounts	
10 01 19	Removing and installing the engine 10 - 101

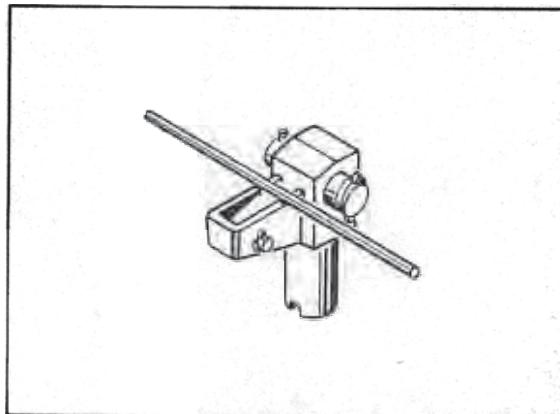
10 01 19 Removing and installing the engine

Special Tools



440-10

442-10

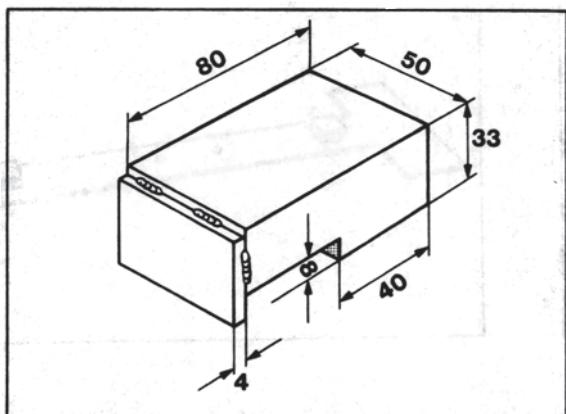


441-10

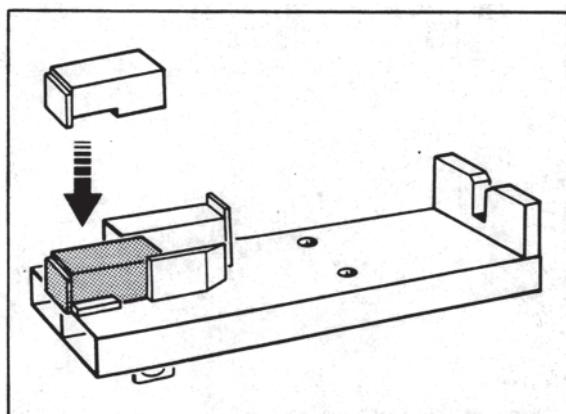
No.	Designation	Special Tool	Order No.	Description
1	Engine mounting plate	9111/3	000.721.911.13	Attach auxiliary support
2	Adapter for engine mounting plate	9111/1	000.721.911.11	
3	Support plate	9111/2	000.721.911.12	

Auxiliary support for Special Tool 9111/3, attach engine mounting plate

The auxiliary support should be fabricated in the shop



1775-10



1776-10

10 01 19 Removing and installing the engine

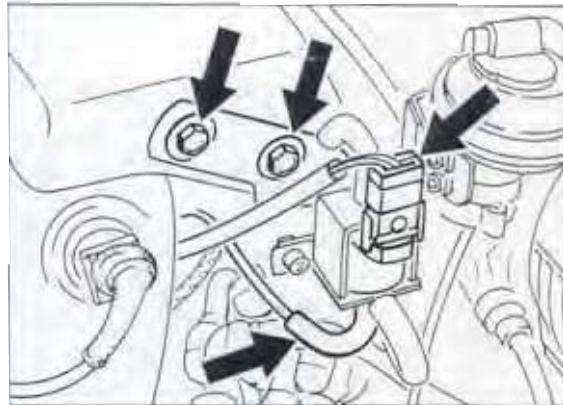
The engine and transmission assembly is removed as a unit from below.

Removal

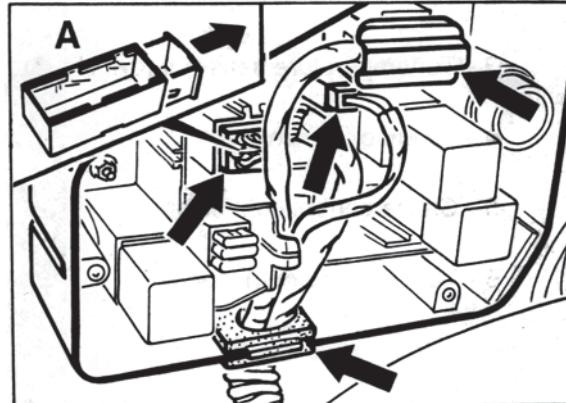
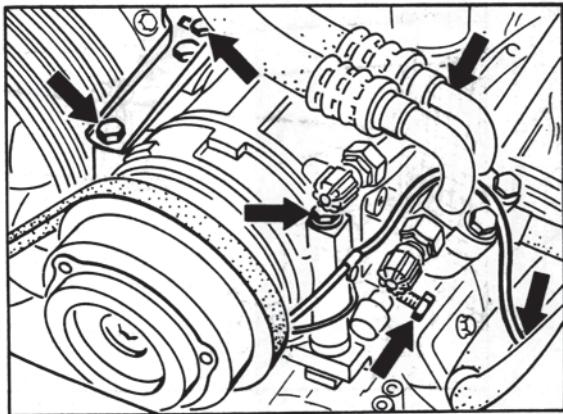
Raise vehicle at jacking points.

Disconnect battery ground cable

3. Place a suitable protective cover or a piece of hose on upper lock section protruding from engine compartment cover (to avoid injury). Place rear protective cover into position.
4. Disconnect connector, remove air conditioning compressor from console and leave it attached to the hoses connected to it. The compressor can be placed on a suitable rigid support on the left-hand side panel.



7. Remove cover of electrical system in engine compartment. Disconnect connectors carefully (to avoid breakage).

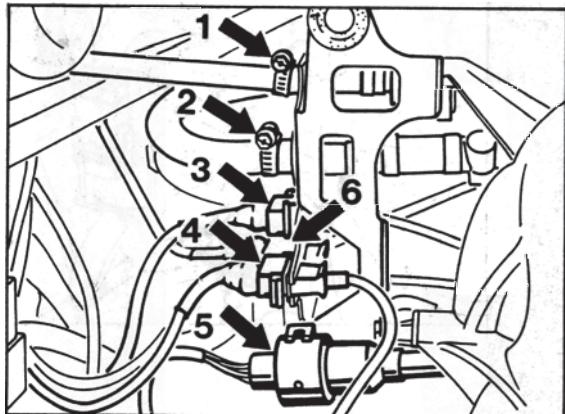


Note

Unlatch connector A before pulling off.

5. Remove complete air cleaner assembly.
6. Remove switch-over flap (fresh air / engine air) and rear heater blower.

8. Disconnect the following connectors or wires in left front engine compartment area:



1458-10

- To carbon canister

2 - To brake booster

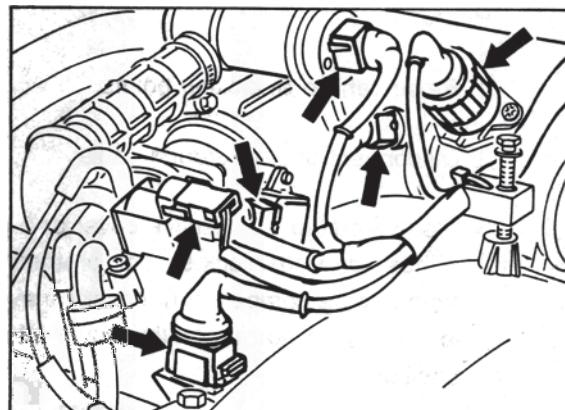
3 - To temperature sensor II (cyl. No. 3)

4 - To knock sensor

5 - Cruise control connector

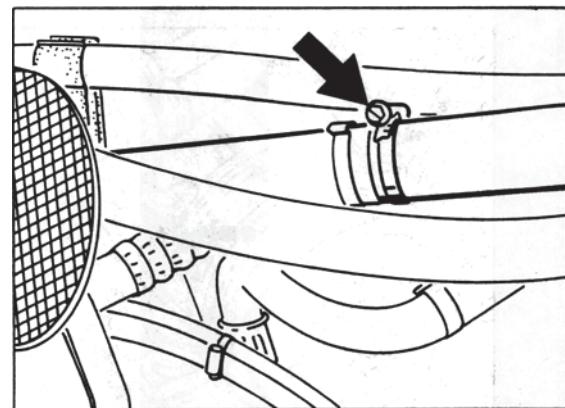
6 - To reference mark sender

9. Undo hexagon head bolt and take off wiring bracket. Disconnect connectors. (Take care not to damage connector seal).



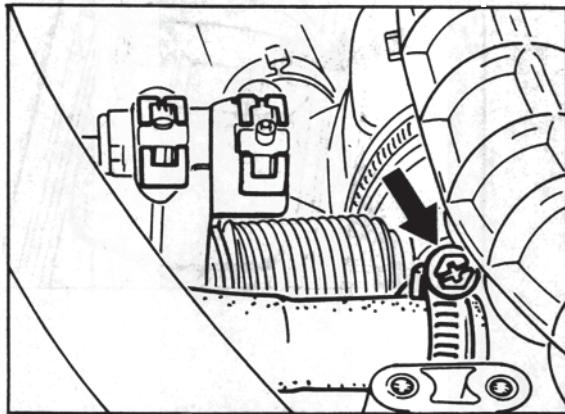
1475-15

10. Pull off both hose connections of crankcase / oil reservoir breather.



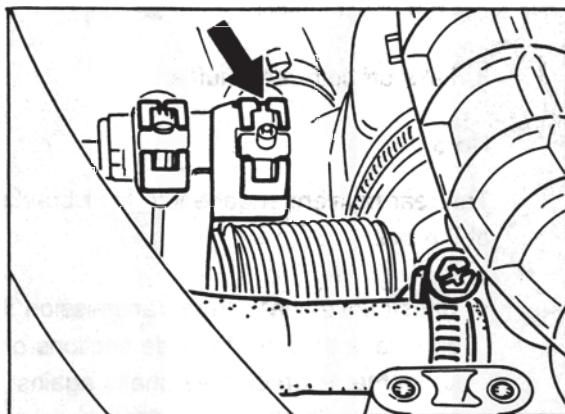
1594-10

11. Detach breather hose from resonance flap housing.



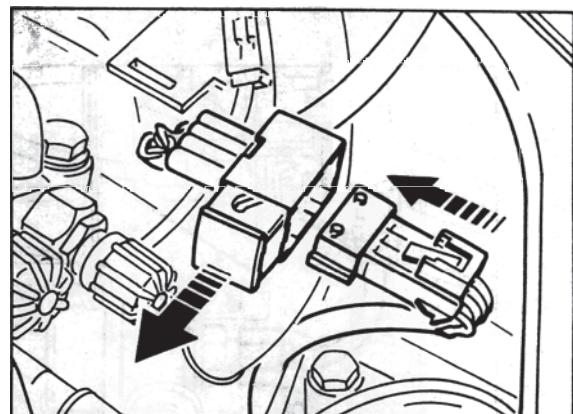
2024A-10

12. Release throttle operating cable. Push rubber grommet out of bracket.



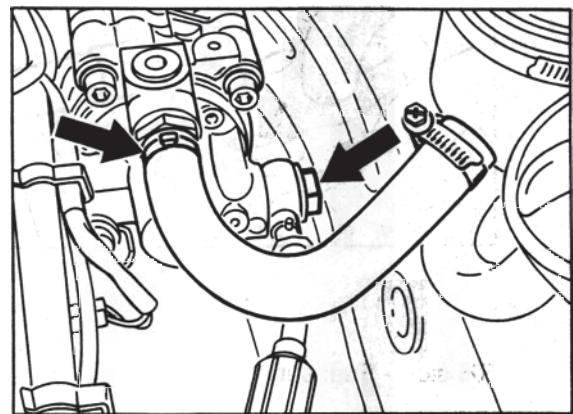
2024B-10

13. Pull off cover, unlatch oxygen sensor connector and pull off connector.



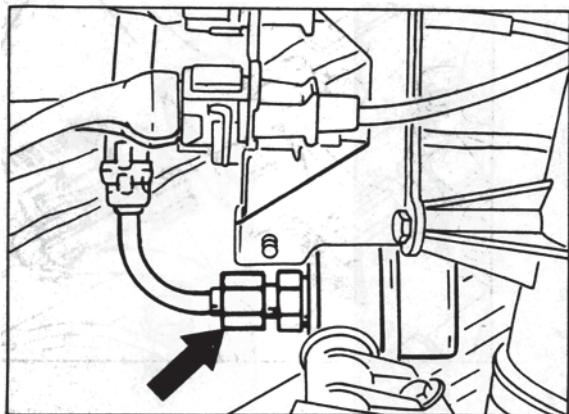
1630-15

14. Drain power steering pump tank (draw off fluid). Pull off spark plug connectors of cyl. No. 4 and cyl. No. 5. Place suitable container under power steering pump. Undo hoses and catch spilling fluid. Plug all openings immediately (to prevent dirt ingress).

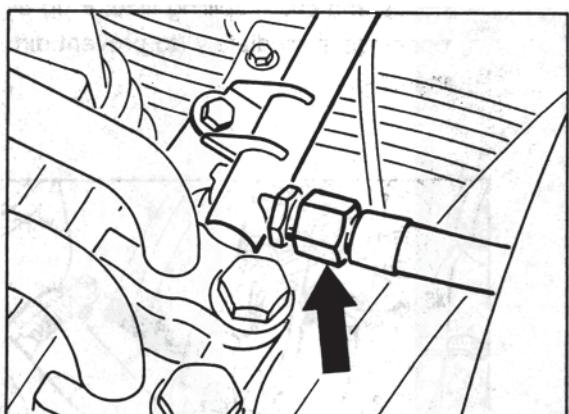


230-10

15. Undo fuel return and fuel supply lines, using a second wrench to lock. Catch overflowing fuel in a suitable pan.

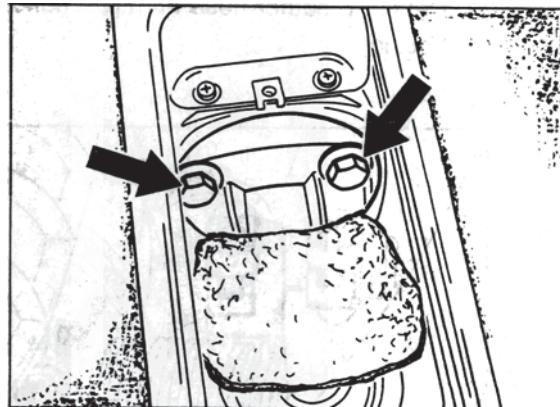


LH side - Fuel return



RH side - Fuel supply

16. Remove rear oddments tray from center tunnel console. The fastening screw is located under the rubber insert. Flip damping tab over. Remove cover. Unscrew central tube to transmission fastening bolts.

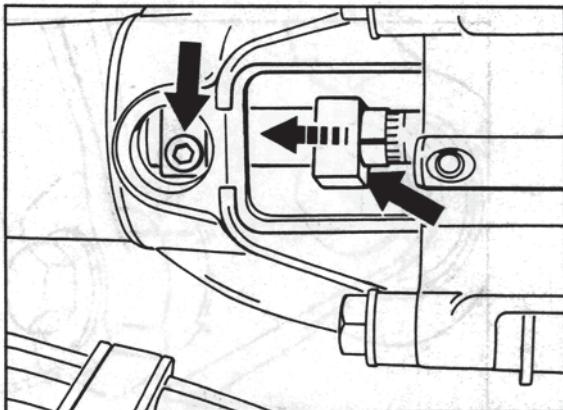


2025-10

Assembly operations with vehicle raised off the ground:

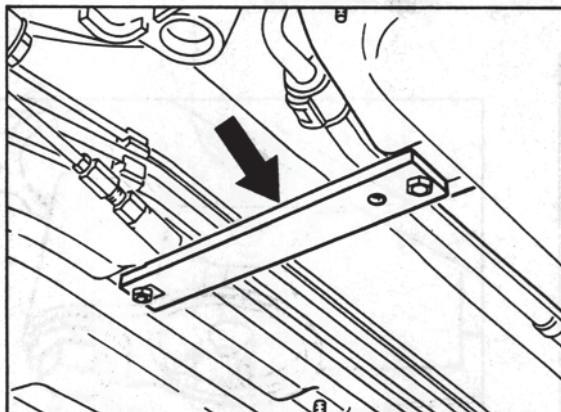
1. Take off undertrays of engine, transmission and central tube.
 2. Release ball clamps and remove tailpipes from rear mufflers.
 3. Take off both rear mufflers.
- Note**
- The rear mufflers engage into their brackets at the top.
4. Unbolt drive shafts from transmission flange and place them on the side sections of the subframe. **Protect** drive shafts against damage, e.g. with short hose sections.
 5. Push rubber boot forward over shift rod coupling and release fit bolt.

6. Unscrew both Allen bolts from clamping sleeve and push clamping sleeve forward on central shaft.



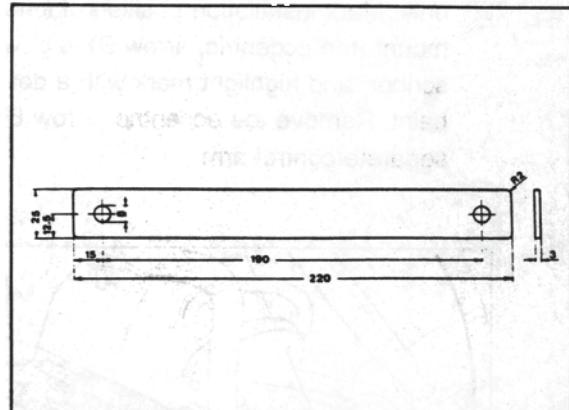
2023-10

7. Install shop-made flat iron bar tool. (To support central tube when unbolting the tube).



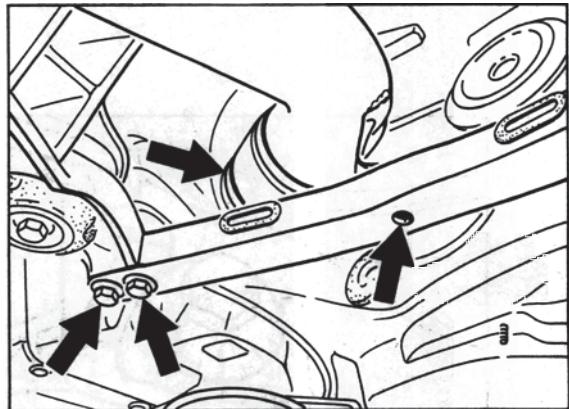
2022-10

Diagram of shop-made tool



2029-10

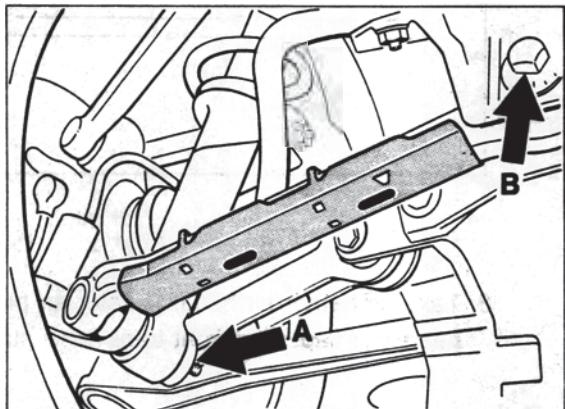
8. Take off heater air hoses, heater air pipes, heater air flaps and front transverse strut.



1616-10

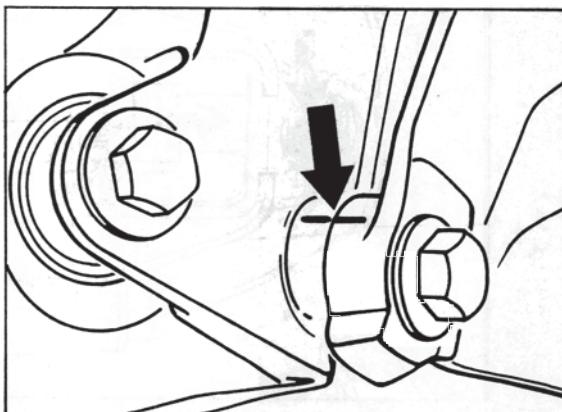
9. Remove complete stabilizer bar assy.

10. Separate toe arms (arm No. 2) at both ends. Slacken outer mounting (arrow A) only. Mark installation position of inner mount (toe eccentric, arrow B), e.g. with a scribe, and highlight mark with a dot of paint. Remove toe eccentric (arrow B) and separate control arm.



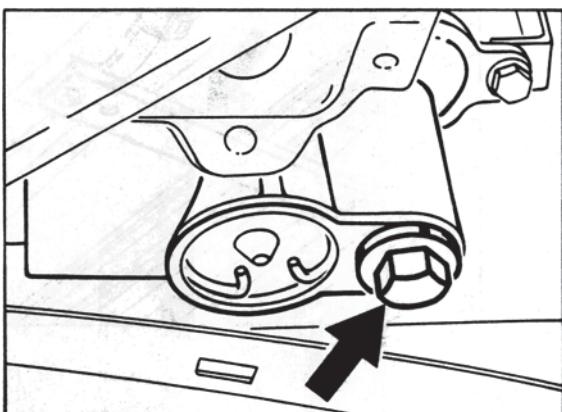
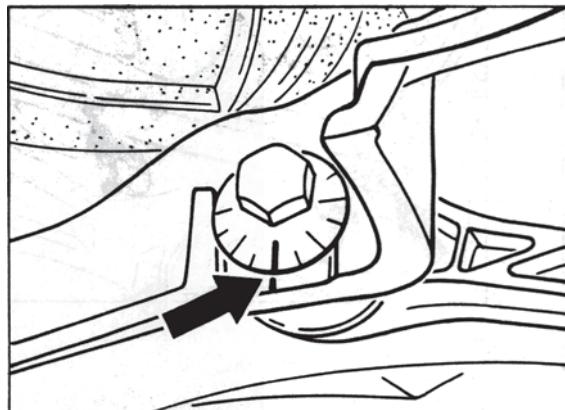
11. Mark position of rear crossmember.

Remove crossmember (four mounting bolts).



1482-10

12. Undo right-hand sill cover and drain engine oil from thermostat housing. When the engine has to be rebuilt, also drain oil from crankcase.



1454-03

13. Undo ground strap between body and starter motor from lower starter mount.

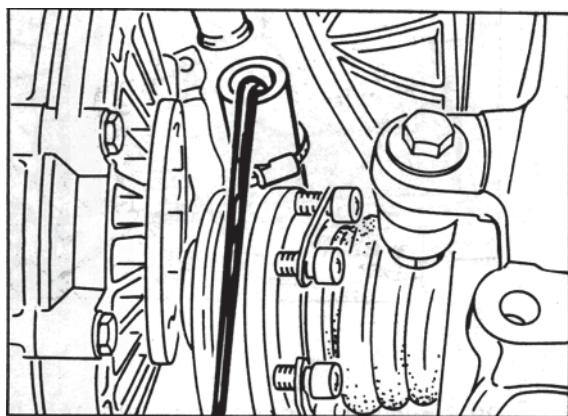
14. Release wire No. 30 from starter.

15. Unbolt clutch slave cylinder and suspend to one side complete with the fluid line remaining connected.

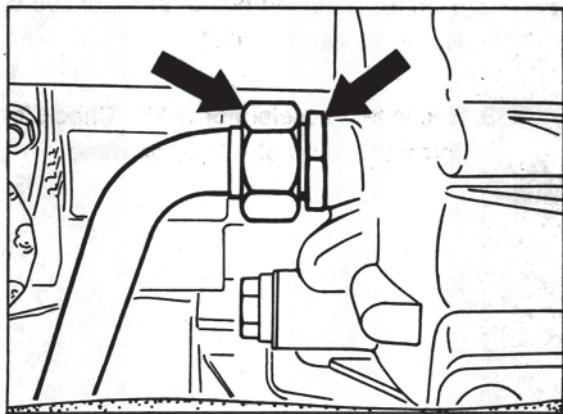
16. Separate oil return line from transmission.

17. Undo oil return line, using a second wrench to lock. Plug oil return line (36 A/F) and screw-in flange (32 A/F).

18. Release hose clamp from oil supply line and catch remaining oil in a pan.



2028-10



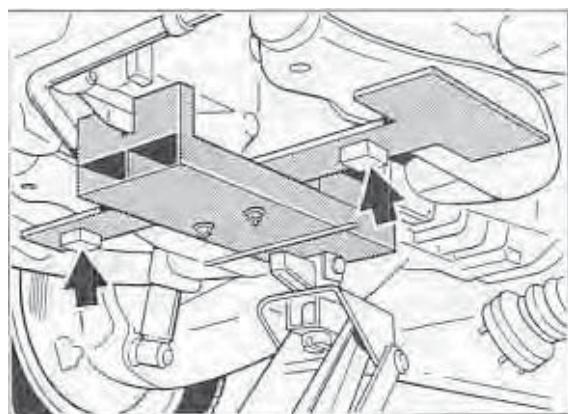
1598-10

19. Place jack with engine support plate under vehicle, placing jack under light preload.

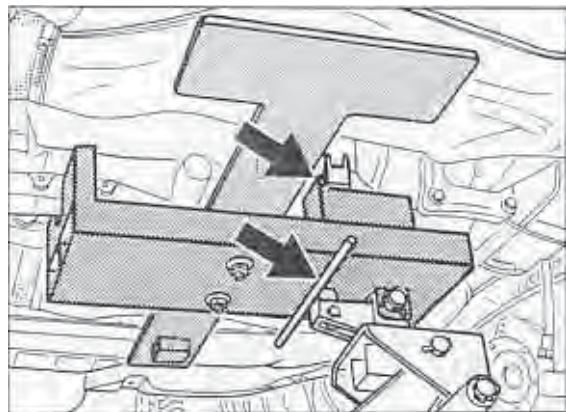
Note

a. Notice position of support plate. Lock lever in horizontal position.

b. The support blocks of the support plate point downward.



1381-10



459-10

20. Undo transmission crossmember (6 bolts).
Unbolt engine mount (use long socket).
21. Take off inspection cover of assembly cutouts for engine mount in rear engine end plate and undo hexagon head nuts from engine mounts.
22. Lower engine/transmission assembly until central tube rests on the shop-made flat iron bar.
23. Lower engine/transmission unit further.
Move or place right-hand drive shaft over starter. Take care not to damage lower spark plug socket (cyl. No. 3) and clutch housing breather pipe and accelerator cable when lowering the assembly.

Caution

When the vehicle is placed on its wheels, the rear cross member and both arms No. 2 should be installed to ensure stability of the vehicle.

Note

Do not actuate the clutch pedal when the slave cylinder has been removed. **Attach a note to this effect inside the vehicle.**

Installation

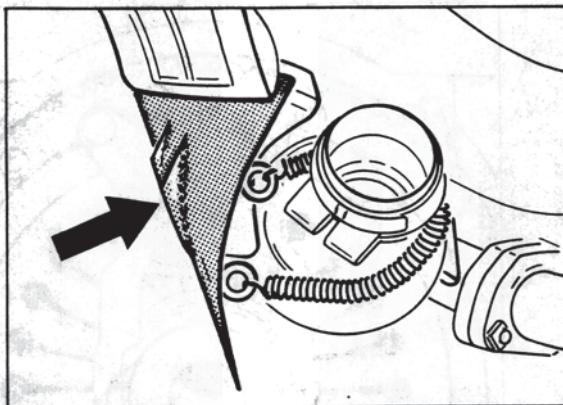
When refitting the engine, observe the following:

1. Check all hoses and oil lines to make sure all plugs have been removed completely - **particularly in the elbow sections of the hoses and oil lines.**
2. Tighten fastening bolt of selector rod coupling to 23 Nm (17 ftlb.).
3. Reconnect accelerator cable. Check for correct location of rubber grommet.

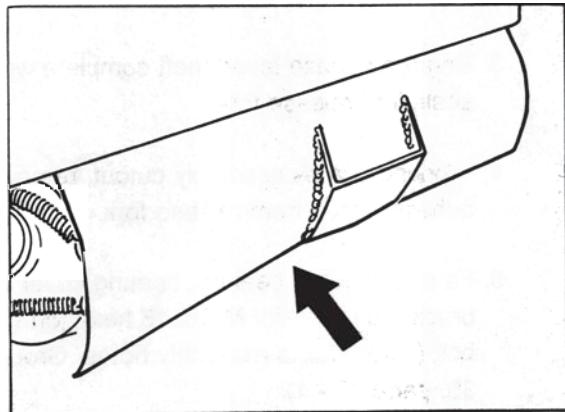
4. Install engine compartment rubber seal between body and engine paneling. Take care to fit rubber seal correctly.
5. Check for correct positioning of inner rubber seals of connectors.

Caution

To protect the paneling against damage when removing and installing the engine unit, attach a shop-made sheetmetal panel to the rear muffler that will allow the power unit to slide off without causing damage.



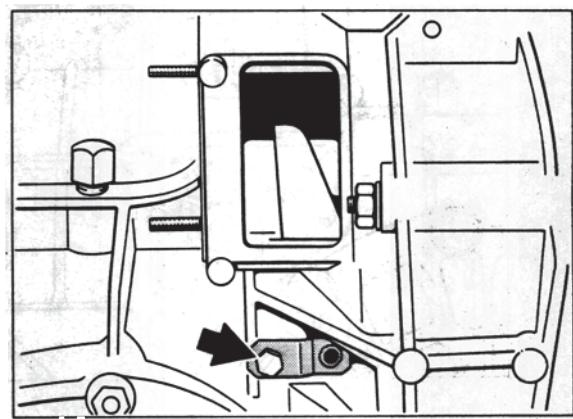
2034-10



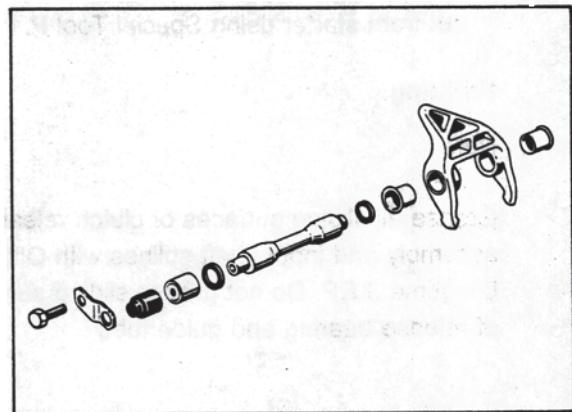
2035-10

Unbolting and refitting the engine

1. Take wire off the starter and detach wire from reverse light.
2. Remove M 6 x 16 hexagon head bolts, bracket and bearing cover. Pull out release lever shaft with M 6 x 40 hexagon head bolt.



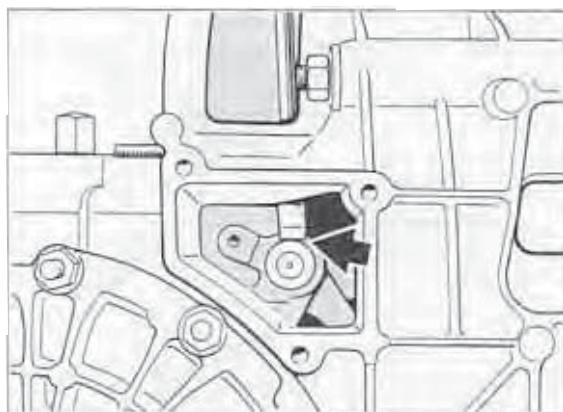
1391-10



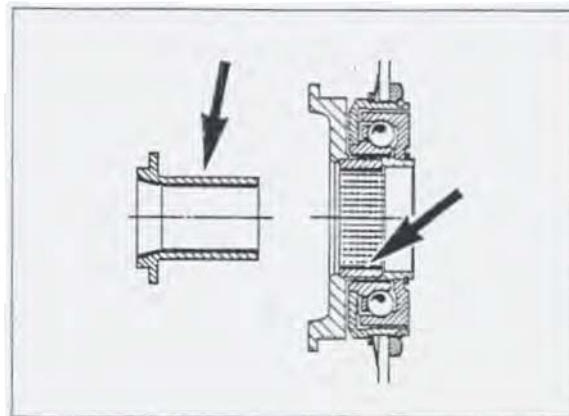
1388-10

Removing the bearing cover

Working across rectangular aperture, use a suitable screwdriver to push bearing cover (of clutch bellhousing) out of bearing hole.



1865-30

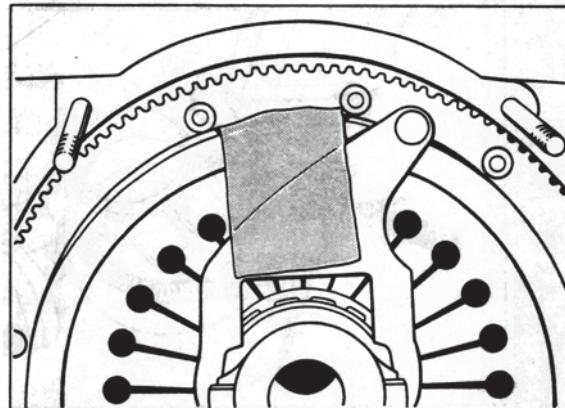


1867-30

3. Undo four mounting nuts and separate transmission from engine. Undo upper mounting nut from starter using Special Tool P 1119.

Refitting

Grease all sliding surfaces of clutch release assembly and input shaft splines with Olista, Longtime 3 EP. Do not grease sliding surface of release bearing and guide tube

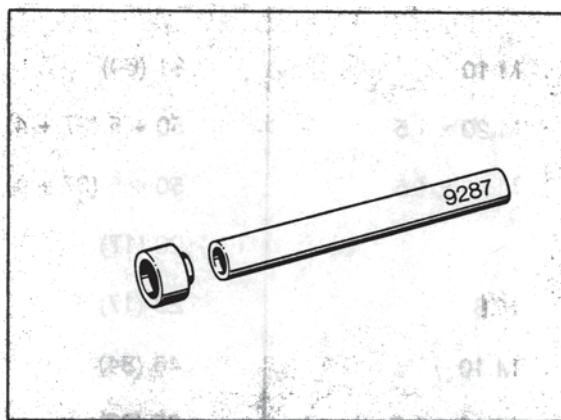


1390-10

2. Fit transmission to engine.
3. Engage release lever shaft complete with seals into release fork.
4. Working across assembly cutout, remove adhesive tape from release fork.
5. Fit needle roller bearing, bearing cover and bracket and fit with M 6 x 16 hexagon head bolt (also refer to assembly notes, Group 30, page 30 - 1).

Note**Fitting bearing cover**

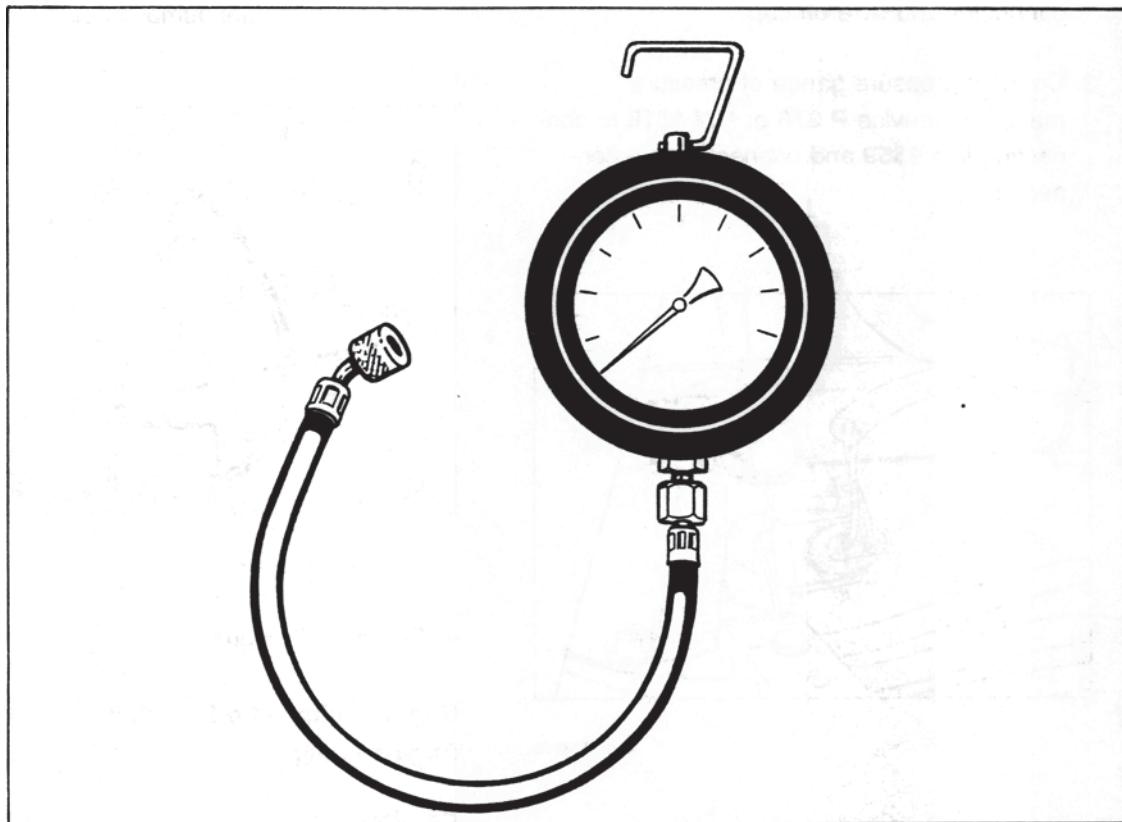
Locate bearing cover with assembly mandrel,
e.g. Special Tool 9287 (mandrel for removing
actuator of headlight beam adjuster) and push
cover carefully home to stop.



1866-30

10 Tightening torques: Removing and installing the engine

Location	Thread	Tightening torque Nm (ftlb.)
Engine to engine mount	M 12	85 (63)
Transmission support to body	M 12	46 (34)
Drive shaft to transmission flange	M 10	81 (60)
Thermostat housing drain plug	M 20 x 1.5	50 + 5 (37 + 4)
Crankcase drain plug	M 20 x 1.5	50 + 5 (37 + 4)
Shift rod (fit bolt)		23 (17)
Stabilizer bar to crossmember	M 8	23 (17)
Stabilizer mount to spring strut	M 10	46 (34)
Control arm 2 to crossmember (eccentric)	M 12 x 1.5	85 (63)
Control arm 2 to toe control arm	M 12 x 1.5	85 (63)
Rear crossmember to side sections	M 12 x 1.5	120 (88)
Front crossmember to side sections	M 10	65 (48)
Pressure pipe to power pump	M 14	30 (22)
Drive shaft to transmission	M 10	81 (60)
Wheel to wheel hub	M 14	130 (96)
Fuel return pipe		35 (26)
Fuel feed pipe		35 (26)
Starter motor to transmission		46 (34)

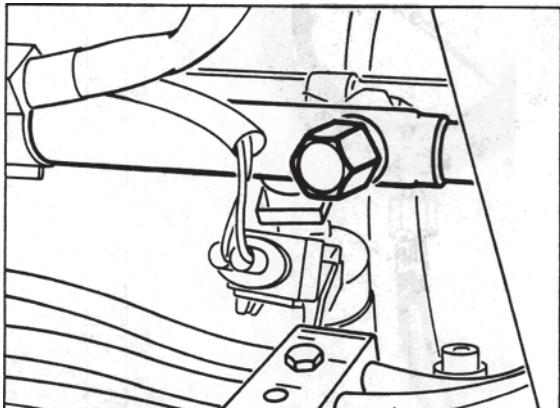
20 02 01 Checking fuel pressure**Special tools**

1731-20

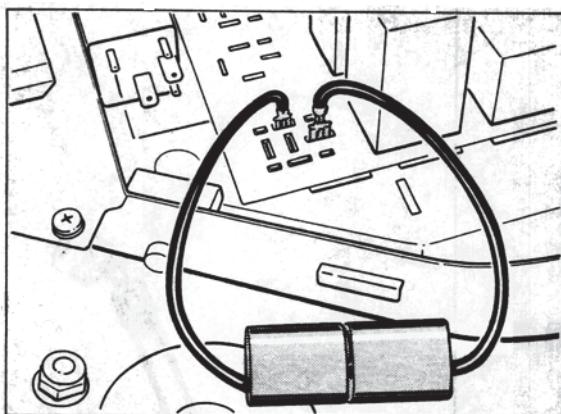
No.	Designation	Special tool	Order number	Explanation
1	Pressure gauge for pressure measuring device	P 378 or V.A.G. 1318	000.721.378.00 Z 40 11 WE	
2	Connecting line	9559	000.721.955.90	

20 02 01 Checking fuel pressure

1. Remove heater fan from left-hand rear engine compartment area.
2. Detach cap from fuel collection pipe test connector and take off cap.
3. Connect pressure gauge or pressure measuring device **P 378** or VW 1318 to connecting line **9559** and connect to test connector.
4. Pull DME relay (R53) off the Central Electrical System and use a fuse-protected shop-made jump lead to connect pin 30 to pin 87 b (identifications 3 and 7 on Central Electrical System). The fuel pump should now operate.



1743-20



1728-20

4. Test specifications:

Engine switched off	3.8 ± 0.2 bar
Engine idling	3.3 ± 0.2 bar

Caution

The plastic cap at the test connector must always be replaced by a new brass cap (Part No. 993.110.218.01).

The seal in the brass cap **cannot** be replaced. The brass cap must therefore be used only **once**.

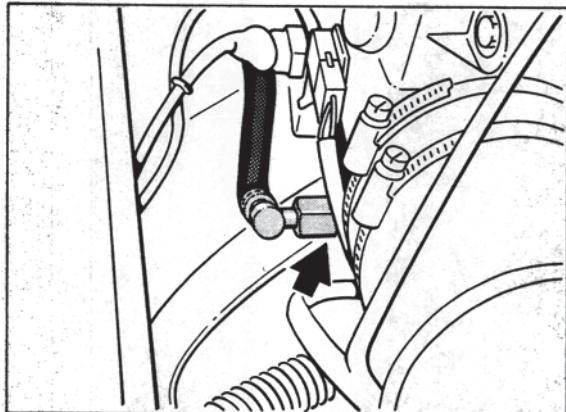
Tighten new brass cap to 2.5 + 0.5 Nm
(1.8 + 0.4 ftlb).

20 66 01 Checking fuel pump delivery

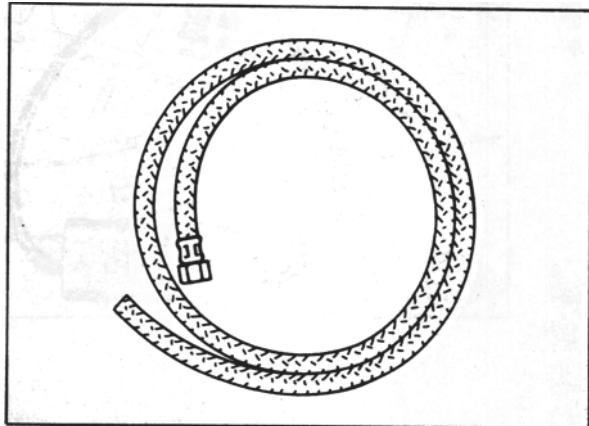
Requirements:

Fuel filter and voltage supply o.k.

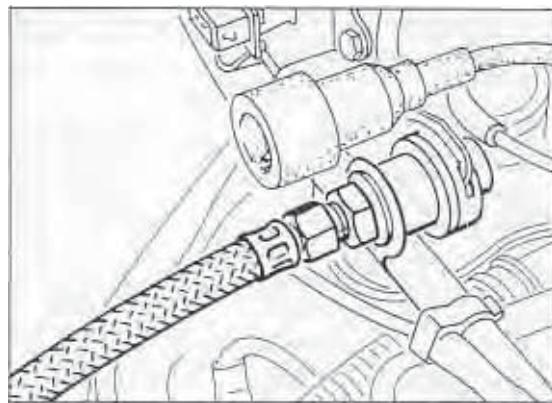
1. Remove heater fan from left-hand rear engine compartment area.
2. Undo fuel return pipe from branch piece, using a second wrench to lock. Drain remaining fuel into a suitable container.
3. Connect Special Tool, connecting hose 9507, Part No. 000.721.950.70, and route it into a fuel measure.



1729-20

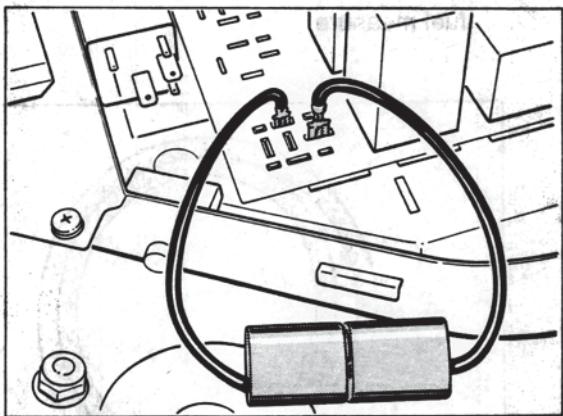


1742-20



1744-20

4. Pull DME relay (R53) off the Central Electrical System and use a fuse-protected shop-made jump lead to connect pin 30 to pin 87 b (identifications 3 and 7 on Central Electrical System). The fuel pump should now operate.



1728-20

5. Allow fuel to drain into a fuel measure for 30 seconds.

Minimum fuel delivery 850 cc/30 sec,
i.e. at least 850 cc of fuel should have collected in the fuel measure after 30 seconds have elapsed.

24 04 Test specifications

Engine type M 64/05/06

Engine type M 64/20 (values in brackets)

Test	Test and adjustment specifications		Remarks
Electric fuel pump			
Delivery rate	at least 850 c.c./30 s		
Fuel pressure (engine off)			
Fuel pump relay jumpered	3.8 ± 0.2 bar		
Test value at idle	approx. 3.3 ± 0.2 bar		
Leak test			
Minimum pressure after 20 mins.	3.0 bar		
	without catalytic converter	with catalytic converter	
Idle speed rpm *	800 ± 40* (960)	800 ± 40* (960)	* The idle speed can only be checked. No idle adjustment.
CO values	0.5...1.0	0.4...1.2*	* Measured upstream of catalytic con- verter, oxygen sensor connector not disconnected. No CO adjustment.
HC values ppm	≤ 300	≤ 300	

Idle speed of engine type M 64/06 Tiptronic with driving range selected: 750 ± 40 rpm

24 04 Checking idle speed and CO level

Vehicles with catalytic converter

Engine type M 64/05/06

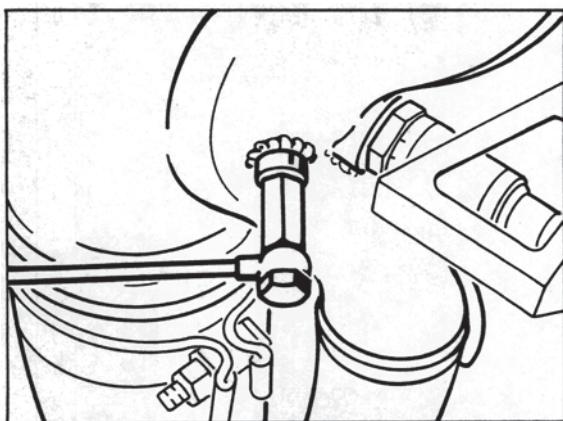
Note

Idle and CO level adjustment is no longer possible on vehicles fitted with a catalytic converter. The oxygen sensor is not disconnected during the idle CO test.

Test requirements

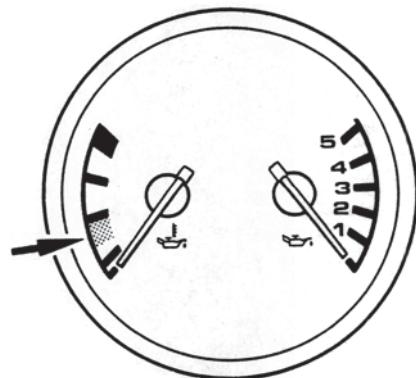
Engine in perfect mechanical condition. Loads must be switched off during the checks. Run check as quickly as possible to keep the intake ducts from heating up and causing faulty CO level readings. Ambient temperature 15...35 deg. C.

1. Fit exhaust gas adapter to test connector of catalytic converter.



1419-24

2. Warm up engine to operating temperature (70...90 deg. C oil temperature).



129-03

3. Do not disconnect oxygen sensor connector. Connect CO meter and additional rev counter to manufacturer's instructions.

CO check value: 0.4...1.2%

Idle speed: 800 ± 40 rpm

24 04 Checking idle speed and CO level

Vehicles without catalytic converter

Engine type M 64/05/06

Note

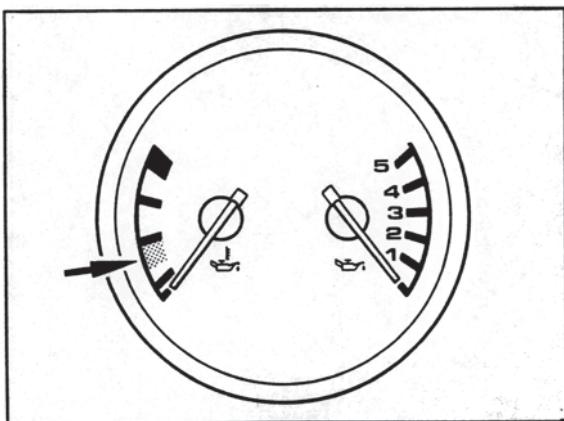
No provision for idle speed adjustment is made anymore. Adjustment on the throttle body is therefore omitted.

Idle CO adjustment

Adjustment requirements

Perfect mechanical condition of engine. Loads must be switched off during the checks. Run check as quickly as possible to keep the intake ducts from heating up and causing faulty CO level readings. Ambient temperature 15...35 deg. C.

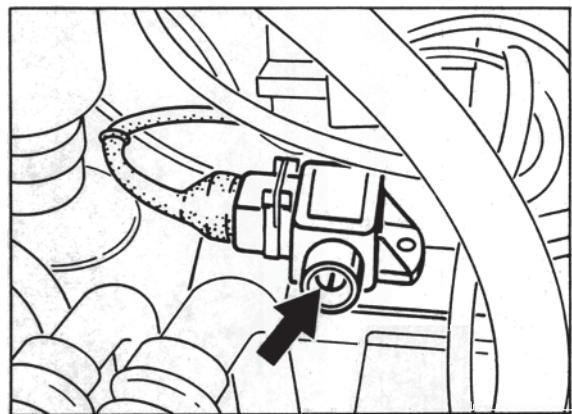
1. Warm up engine to operating temperature (70...90 deg. C oil temperature).



129/03

2. Check CO level. If the CO level is not within the specified range, correct the setting at the CO adjustment screw

3. The CO potentiometer is located behind the cover on the carrier plate for plug connections on the right-hand rear side of the engine compartment. Remove plugs from access hole to CO adjustment screw.



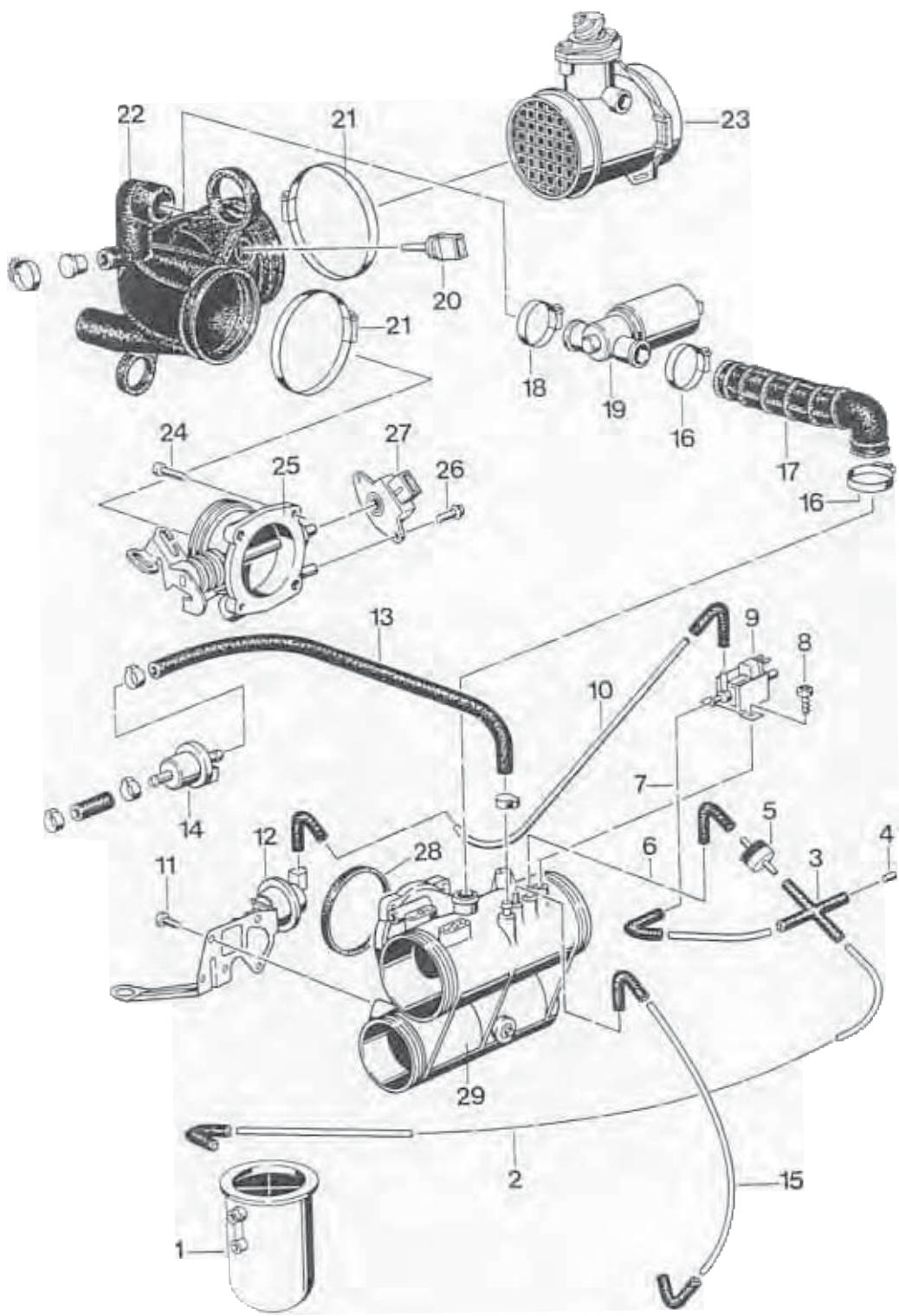
1418-24

CO adjustment: 0.5...1.0%
Right-hand turn - richer mixture
Left-hand turn - leaner mixture

Checking idle speed

1. Connect separate rev counter according to manufacturer's instructions.

Idle speed: 800 ± 40 rpm

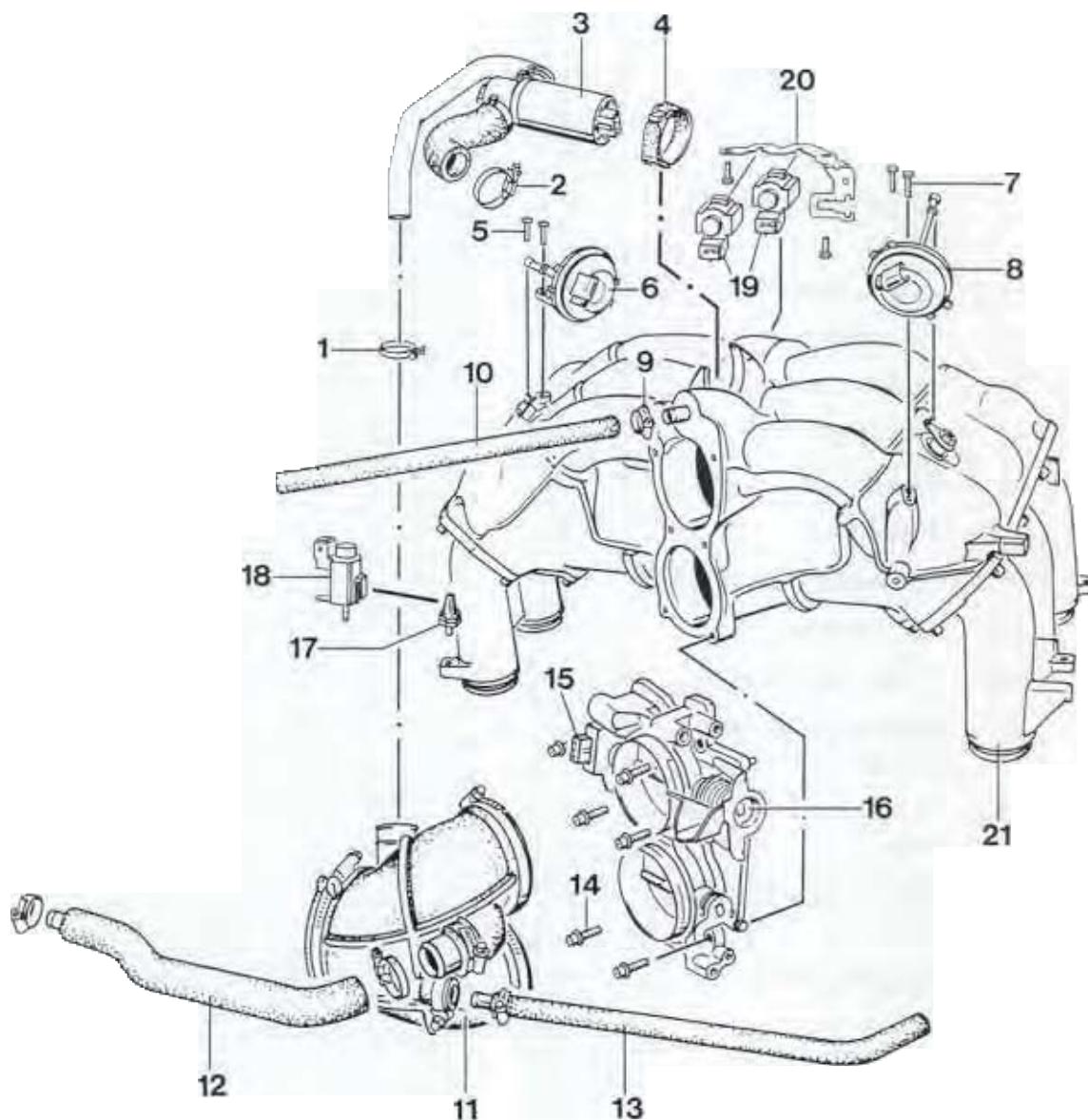
24 46 19 Removing and installing intake distributor (injection system components)

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Vacuum accumulator	1		
2	Vacuum line	1		
3	Branch piece	1		
4	Plug 4.0 x 10	1		
5	Check valve	1		Check for free flow (flow is only possible in one direction). Black side faces intake distributor
6	Line to intake distributor (RH connection)	1		
7	Line to vacuum shift valve	1		
8	Oval-head screw M 5.0 x 12	2		
9	Vacuum shift valve	1		
10	Line to vacuum modulator	1		
11	Oval-head screw	5		
12	Vacuum modulator for tuning flap	1		
13	Line	1		
14	Tank vent	1		May be checked via "Drive links" menu item. Observe correct flow direction! Arrow points towards intake distributor
15	Line to fuel pressure regulator (length 580 mm)	1		
16	Hose clamp 25 - 40/9	2		

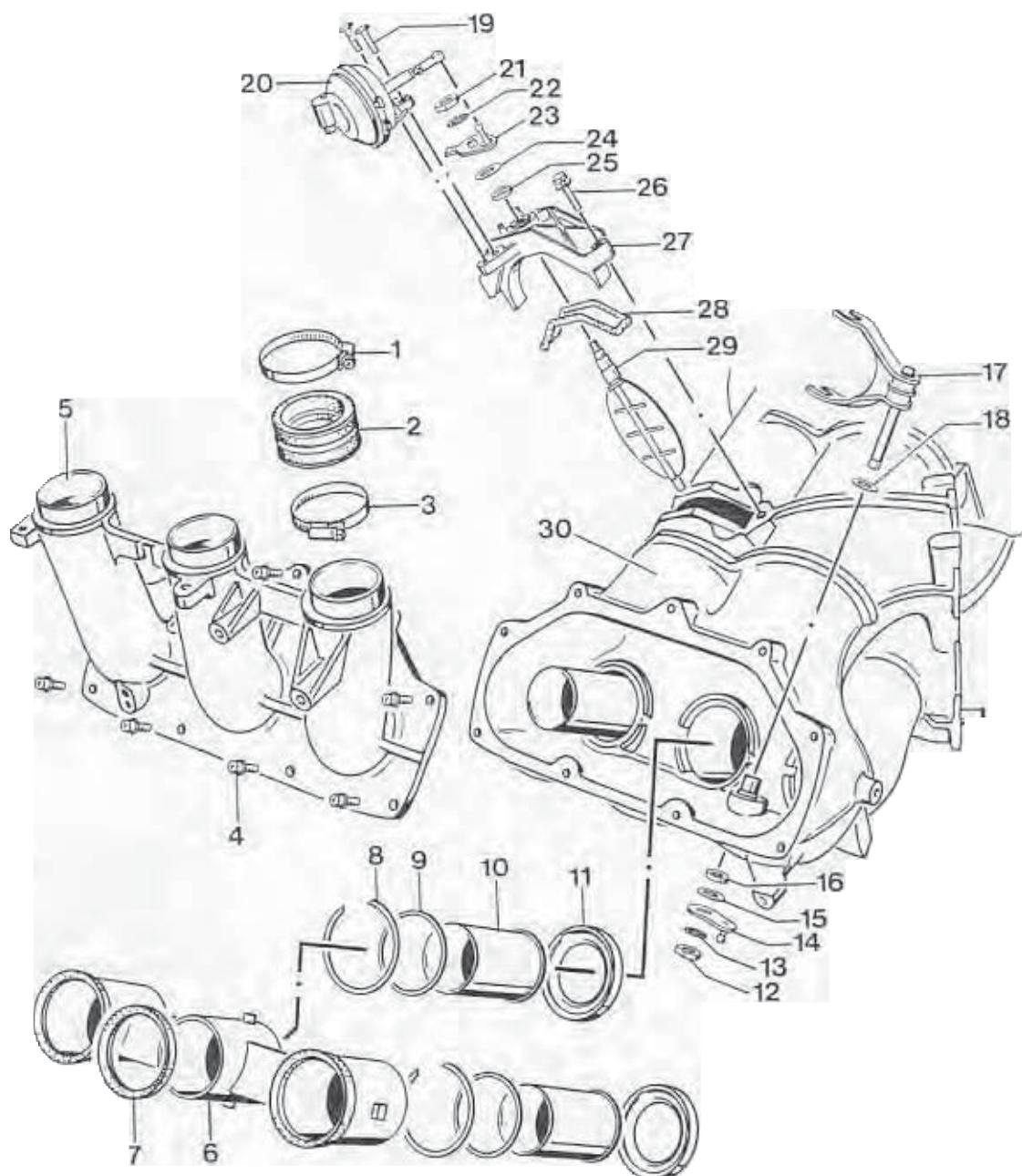
No.	Designation	Qty.	Removal	Note: Installation
17	Hose	1		Check for correct seating
18	Hose clamp 25 - 40/9	1		
19	Idle speed control	1		
20	Intake air temperature sensor	1		Grease sparingly, e.g. with Contifix. May be checked with "Actual values" menu item
21	Hose clamp	2		
22	Cowl	1		
23	Air flow sensor	1		
24	Pan head screw M 5 x 18	4		
25	Throttle body	1		
26	Screw M 4 x 10	2		
27	Throttle potentiometer	1		May be checked with "Actual values" menu item
28	Seal	1		Must always be replaced
29	Intake distributor	1		Check that tuning flap does not bind

24 46 37 Dismantling and assembling intake distributor

911 Carrera RS engine with Varioram induction system (M 64 / 20)



No.	Designation	Qty.	Removal	Note:
				Installation
1	Hose clamp	1		
2	Hose clamp	1		
3	Idle speed control	1		
4	Rubber shroud	1		
5	Countersunk screw M 5 x 16	2		tightening torque 5.6 Nm (4.1 ftlb)
6	Vacuum capsule	1		
7	Countersunk screw M 5 x 16	2		tightening torque 5.6 Nm (4.1 ftlb)
8	Vacuum capsule	1		
9	Hose clamp	1		
10	Molded hose	1		
11	Hose clamp	1		
12	Molded hose	1		
13	Molded hose	1		
14	Combination Allen screw	6		
15	Potentiometer	1		
16	Throttle valve assembly	1		
17	Guide pin for air filter housing	2		
18	Solenoid valves for slide valves	2		
19	Solenoid valve for tuning flap	1		
20	Induction system	1		Degrease seal surface of throttle valve flange and apply Loctite 574 sealant with velour roller.



2210-24

No.	Designation	Qty.	Removal	Note: Installation
1	Hose clamp	6		
2	Rubber sleeve	6		Inspect for damage.
3	Hose clamp	6		
4	Combination Allen screw M 6 x 20	9		tightening torque 9.7 Nm (7.2 ftlb), tighten screws working crosswise. Degrease seal surface and apply Loctite 574 sealant with velour roller.
5	Intake pipe, lower section	2		
6	Slide valve	2		Oil bore slightly. Install in correct position with rounded central platform facing center of intake pipe.
7	Seal ring	6		
8	Snap ring	6		
9	Cup spring	6		Install with flat side towards upper section of intake pipe.
10	Pipe nozzle	6		
11	Seat ring	6		
12	Hexagonal nut	2		tightening torque 7 Nm (5.2 ftlb), hold wrench against forked rocker shaft when tightening.
13	Lock washer	2		
14	Lever	2		
15	Shim 8.1 x 14.5 x 0.5	2		
16	Shaft seal ring G8 x 12 x 9	2		Replace. Closed side must face intake pipe, i.e. open side is visible.

No.	Designation	Qty.	Note:	
			Removal	Installation
17	Forked rocker for slide valve.	2		Observe marking. Rockers are marked "R" for right and "L" for left.
18	Shim 8.1 x 14.5 x 0.5	2		
19	Countersunk screw M 5 x 16	2		Tightening torque 5.6 Nm (4.1 ftlb)
20	Vacuum capsule	1		
21	Hexagonal nut	1		tightening torque 7 Nm (5.2 ftlb)
22	Lock washer 8.4	1		
23	Lever for tuning flap	1		
24	Shim 8 x 14 x 1	1		
25	Shaft seal ring G8 x 12 x 3	1		Replace. Closed side must face intake pipe, i.e. open side is visible.
26	Hex head screw M 6 x 25	2		
27	Tuning flap housing	1		
28	Seal ring	1		
29	Tuning flap	1		
30	Intake pipe, upper section	1		Degrease seal surface.

Note

All moving parts must be oiled slightly for installation.

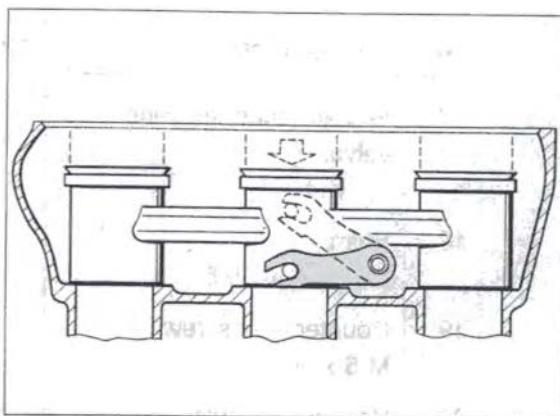
Installation instructions

Install shaft seal ring for forked rocker of slide valve.

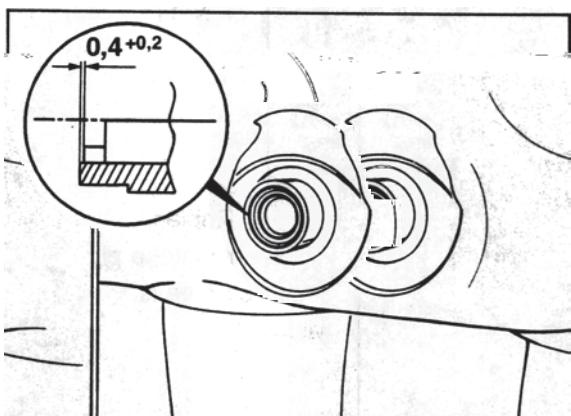
Installation

The closed side must face the intake pipe, i.e. the open side must be visible.

Ensure that the seal ring is pressed in to the correct depth.



2224-24



2223-24

Hook forked rocker onto slide valve.

Installation

In order to prevent the slide valve from becoming unhooked, the forked rocker must be installed with the intake pipe upper section turned over. The forked rockers are marked "R" and "L". The intake pipe must not be turned over until the upper section has been bolted to the lower section (installation position).

The illustration shows the cutout in the turned over intake pipe upper section for cylinders 1 - 3.

Removing and installing vacuum reservoir

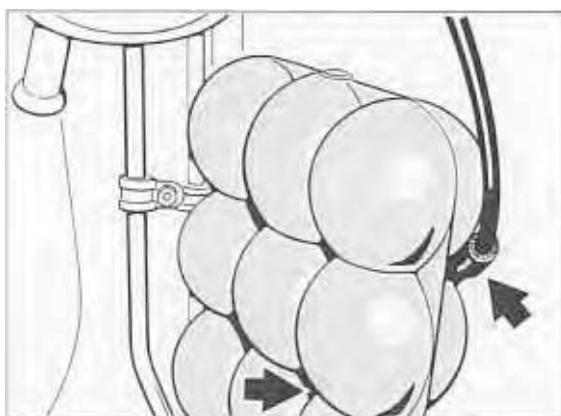
Note

The vacuum reservoir is below the rear left wheel housing, near to the carbon canister.

Installation instructions

Install connection in correct position on vacuum reservoir. Install vacuum hose without stress.

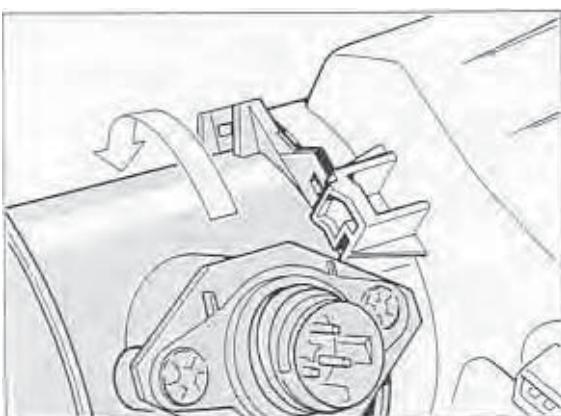
Tighten fastening screw to 3 Nm (2.2 ftlb).



2220-24

Disconnect air filter housing from air mass sensor.

Disconnect air filter housing from air mass sensor in engine compartment. To do so, turn air mass sensor in direction of arrow (towards front of vehicle) to unhook bayonet mounting. For installation, apply a thin layer of assembly lubricant to rubber seal.



2221-24

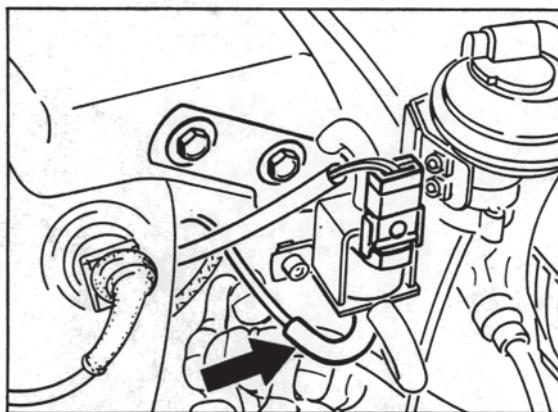
24 00 01 Fuel system - checking vacuum system for leakage

General

If there are leakages in the vacuum system, the variable induction system may not operate correctly and there may be a reduction in engine power output.

Leakage test

1. Run engine until operating temperature (70...90°C oil temperature) is reached.
2. Remove vacuum hose from solenoid valve (fresh air /engine air) switchover flap.
Attach special tool 9160/1 to open end of hose (on vehicles not equipped with a switchover flap, the plugged hose end is under the intake system).



2027-10

3. Start engine. Hold engine speed at 2500 rpm for about 10 sec. to build up vacuum.
4. Turn off ignition

5. Test functions of slide valve actuator.
A second person is needed for this work.

Turn on ignition.

As you turn the ignition on, the second person must observe the movements of the two levers on the intake pipe.

If the levers are moved as the ignition is switched on, the slide valves and vacuum capsules will operate correctly.

If the levers do not move, the vacuum system, the vacuum capsules or the slide valves may be faulty.

6. Pressure maintenance test on vacuum system.

The ignition is still switched on.

After the completion of items 3 to 5, the vacuum in the vacuum system must still be at least 0.64 bar. The pressure drop over about 3 minutes must be no more than 0.02 bar.

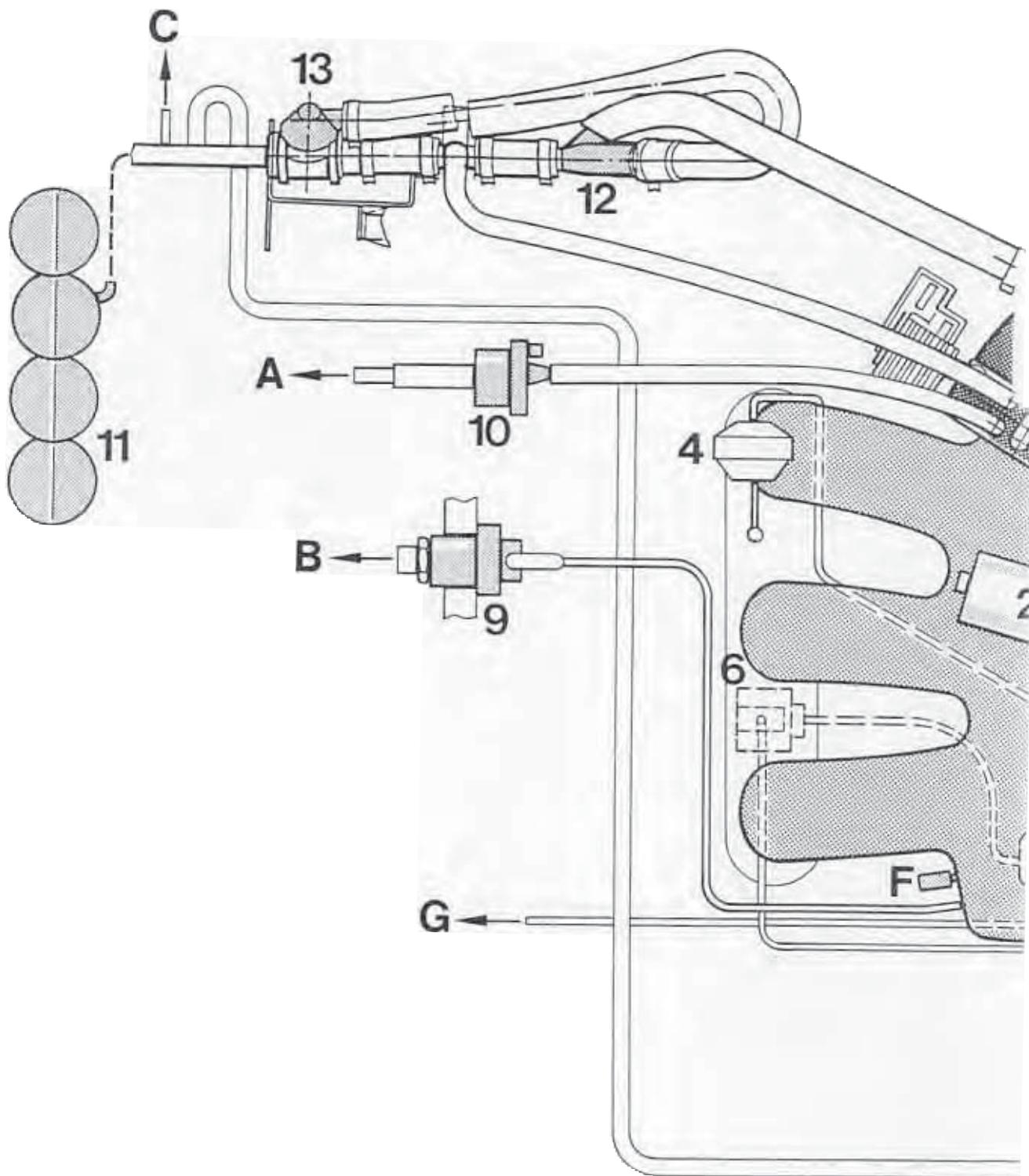
If the pressure drop is higher, the entire system must be checked for mechanical faults.

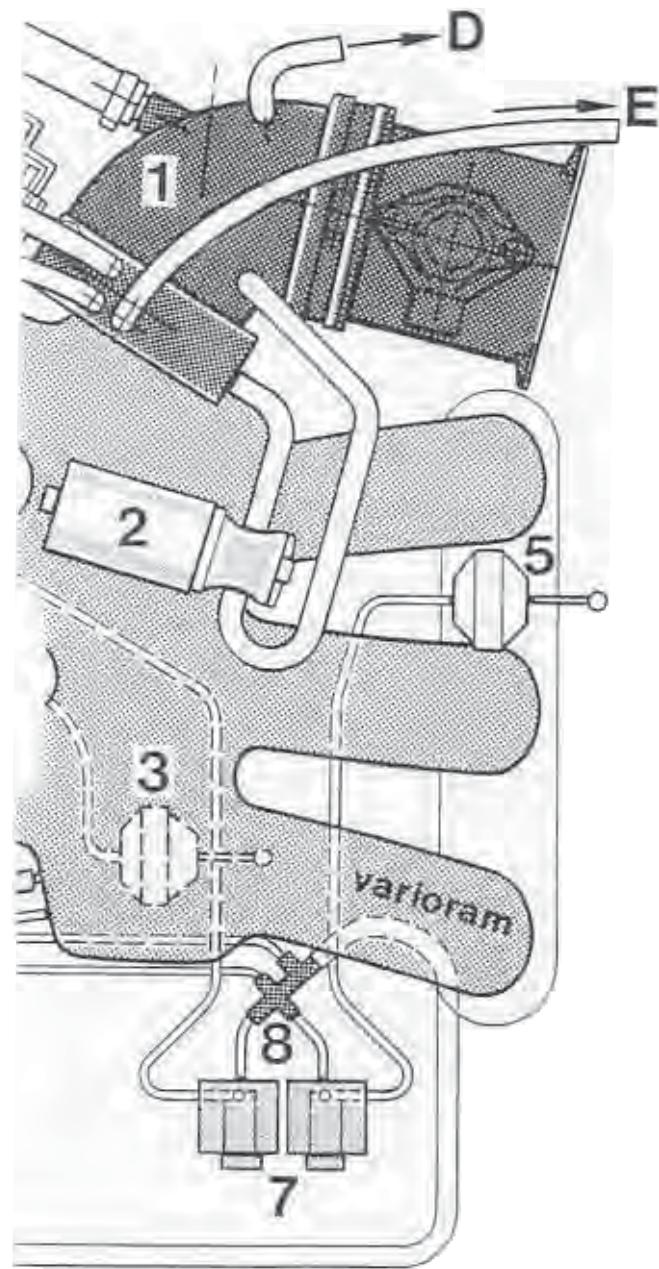
7. After the test has been completed, re-connect vacuum hose to solenoid valve.

24

Hose connection schematic

911 Carrera RS engine M 64/20

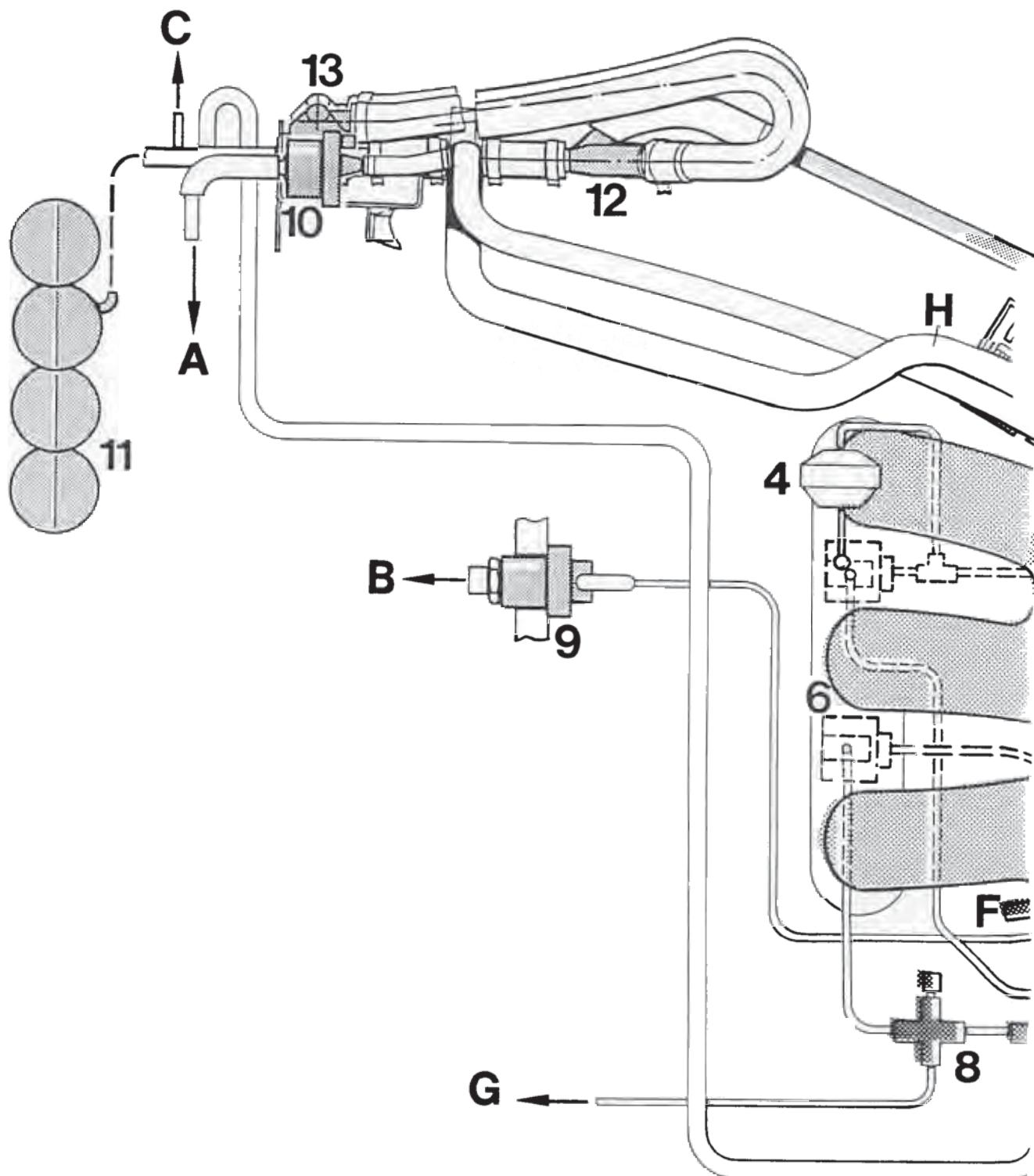


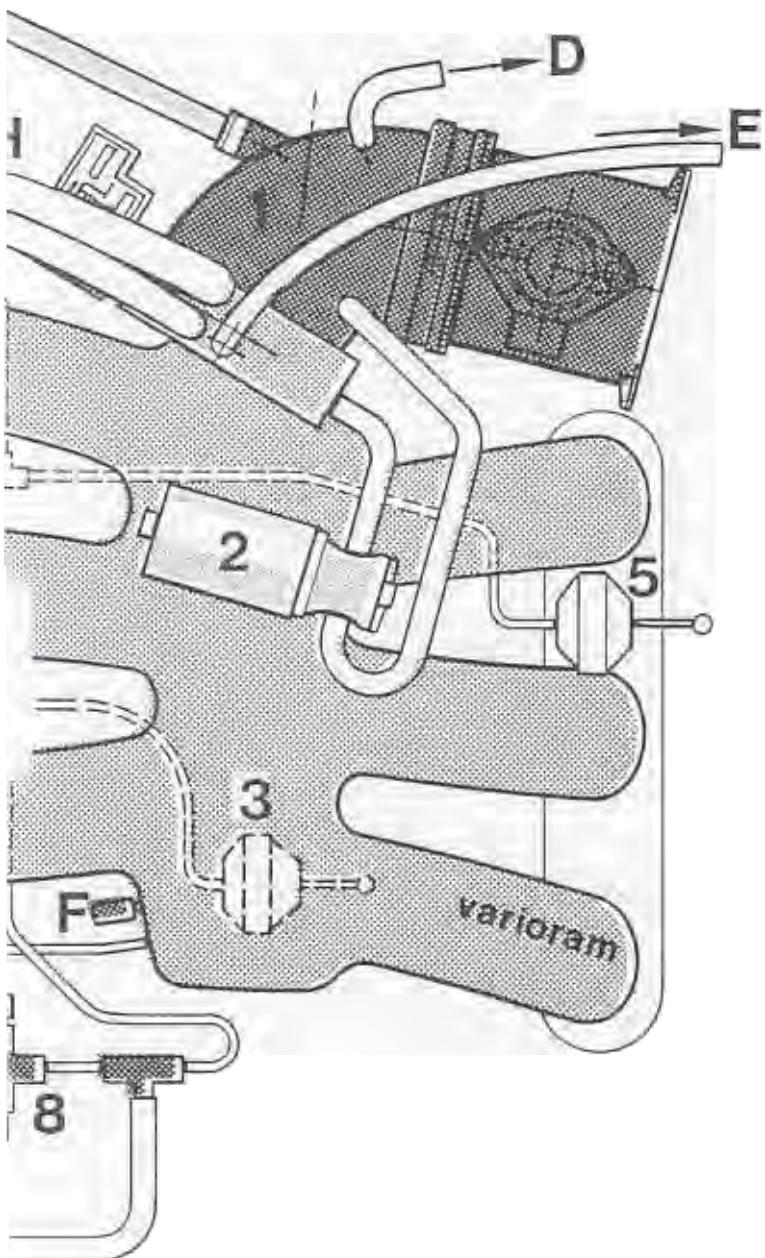


Designation

- 1 = Throttle valve assembly with hot film air flow sensor
- 2 = Idle speed control
- 3 = Vacuum capsule for tuning flap
- 4 = Vacuum capsule for left slide valve
- 5 = Vacuum capsule for right slide valve
- 6 = Solenoid switchover valve for tuning flap
- 7 = Solenoid switchover valves for left and right slide valves
- 8 = Distributor
- 9 = Fuel pressure regulator
- 10 = Tank ventilation valve
- 11 = Vacuum reservoir for variable induction system
- 12 = Jet pump with throttle
- 13 = Check valve
- A → to carbon canister
- B → Fuel return line
- C → Vacuum line for heater / A/C unit bypass valve actuator
- D → to oil tank
- E → to oil tank
- F → Emission test connection
- G → Vacuum line for fresh air / engine air switchover flap

911 Carrera, M 64/21-24 engine
Model year 96



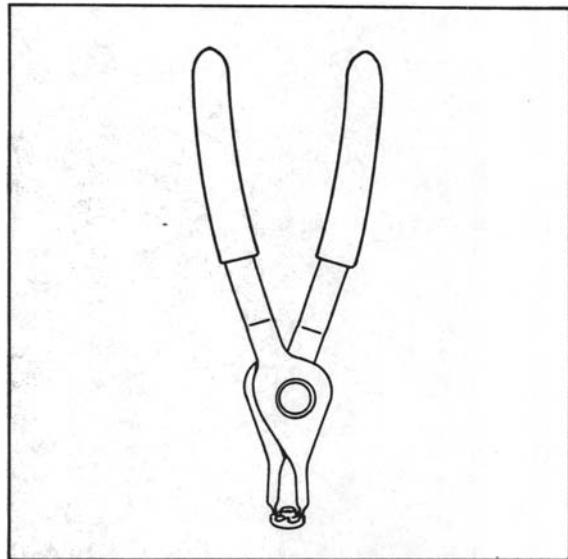
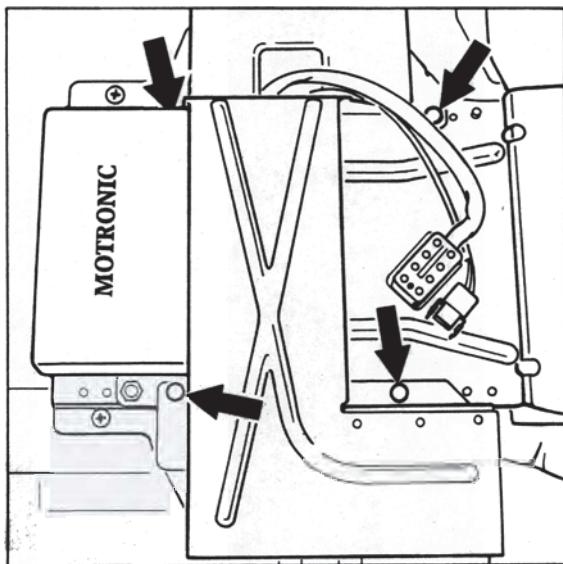


Designation

- 1 = Throttle body with hot-film mass air flow sensor
- 2 = Idle speed control
- 3 = Vacuum modulator for resonance flap
- 4 = Vacuum modulator for left selector sleeve
- 5 = Vacuum mod. for right selector sleeve
- 6 = Electronic switch-over valve for resonance flap
- 7 = Electronic switch-over valve for LH/RH resonance flap
- 8 = Branch piece
- 9 = Fuel pressure regulator
- 10 = Tank vent
- 11 = Vacuum tank for switching / intake unit
- 12 = Twin-type sucking jet pump with throttle (single-type pump on all-wheel vehicles)
- 13 = Check valve
- A -> to active-carbon canister
- B -> Fuel return line
- C -> Vacuum line for control of recirculating-air flap heater and air conditioner
- D -> to oil tank
- E -> to oil tank
- F -> Connector for special exhaust emission check
- G -> Vacuum line for control of recirculating-air flap (fresh air / engine air)
- H -> Vacuum line to twin-type sucking jet pump (on all-wheel vehicles, bore of throttle body is sealed).

24 70 19 Removing and installing DME control unit**Removal**

1. Remove driver's seat.
2. Remove shear bolts using a cross cut chisel and remove cover (access protection).



2219-24

Installation

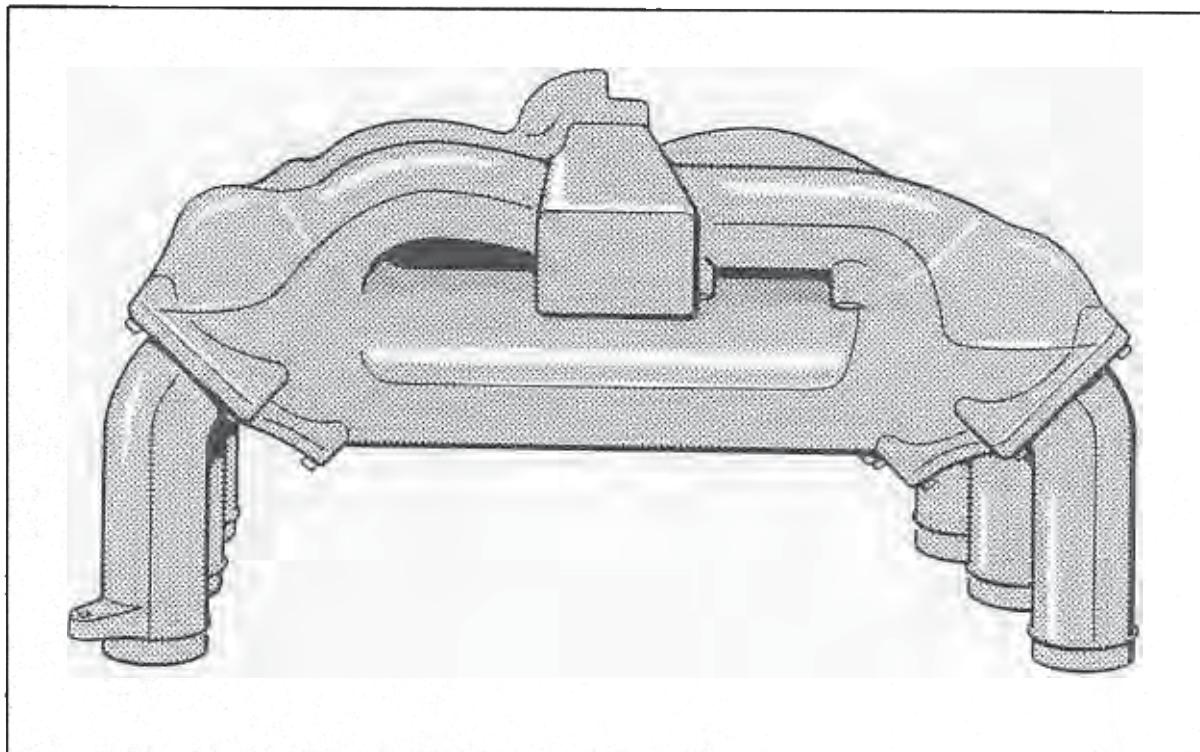
Break off new M 6 x 13 shear bolts,
part no. 999 074 051 02 using an
E6 Torx socket wrench.

Removing and installing control unit on RS vehicles**Removal**

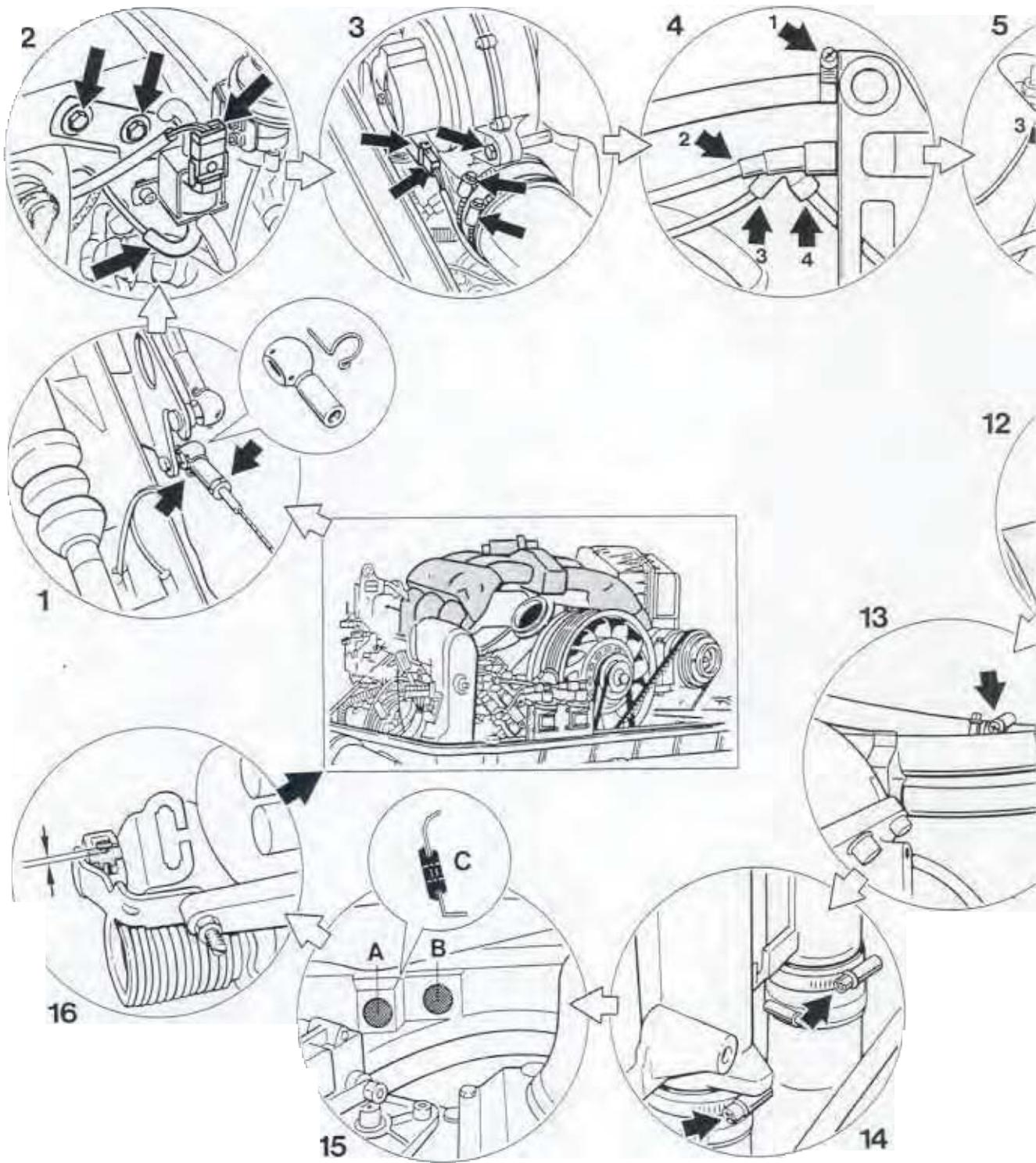
Loosen flanged nut using a cross cut chisel.

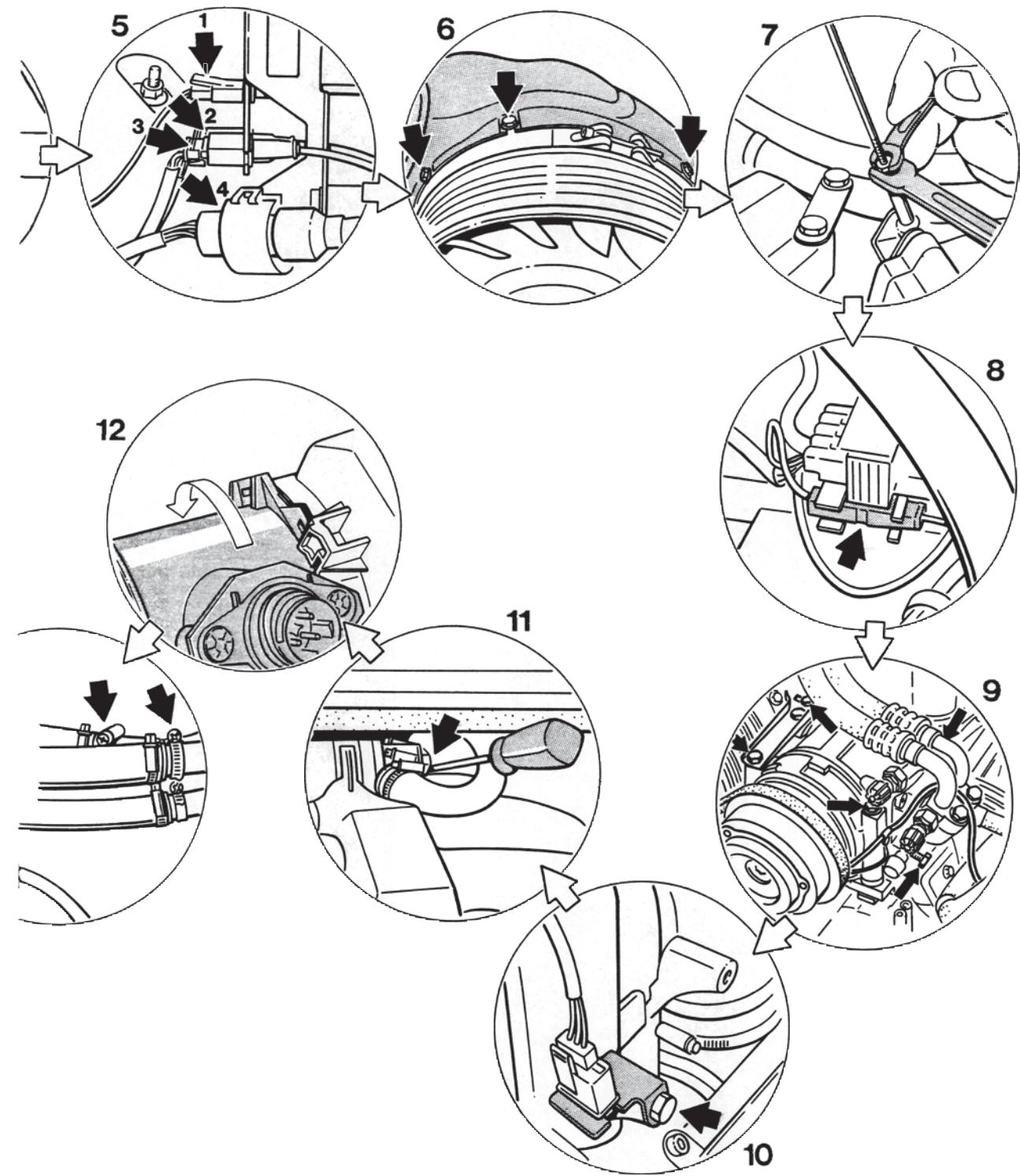
Installation

Tighten new M5 flanged nut with stop teeth (part no. 999 507 472 02) using snap ring pliers, e.g. Hazet 4843a-12.

24 46 19 Removing and installing intake distributor**Engine installed - M64/21-24 engine**

Removing and installing intake distributor





Removing and installing intake distributor

Removing intake distributor

No.	Operation	Instructions
1	Disconnect accelerator cable	Remove floor mat and pedal floor board. Separate accelerator pedal from push rod. Slacken lock nut on ball socket. Unhook securing bracket on ball socket. Remove ball socket and lock nut from accelerator cable; count and note down the number of revolutions. Remove engine and transmission undertray and extract accelerator cable from guide.
2	Remove fresh air blower	Loosen vacuum hose, plug connection and fastening screws and remove fresh air blower.
3	Remove rear heater blower	Loosen hose clamps, tie-wraps, plug connection and fastening screws (2 pcs.). Remove heater blower from bracket by pulling it backwards.
4	Remove vacuum hoses	Disconnect the following hoses in the left front corner of the engine compartment: 1 - to active-carbon canister 2 - to vacuum tank 3 - to recirculating-air flap heater and air conditioner 4 - to electronic switch-over valves of resonance flap and to selector sleeves in intake distributor.
5	Separate plug connections	Disconnect the following lines in the left front corner of the engine compartment: 1 - to reference mark sender, black connector 2 - to temperature sensor (cyl. 3), white connector 3 - to knock sensor, green connector 4 - plug connection cruise control
6	Remove intake cowl from cooling fan	Slacken fastening screws (M6x15) and remove intake cowl.

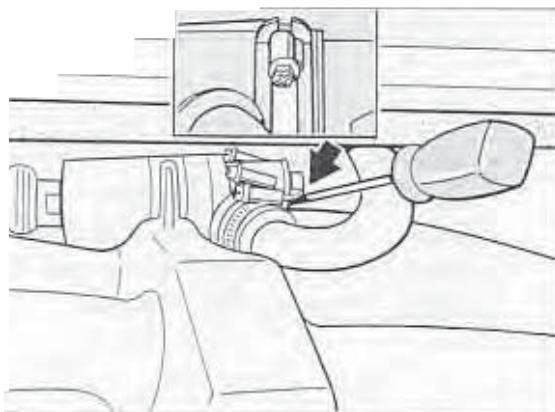
No.	Operation	Instructions
7	Disconnect tie rod at cruise control actuator	On vehicles with cruise control (M454) the tie rod must be disconnected as well. Hold the suction pipes of cyl. 1-3 from the left and the right and slacken lock nut (A/F5.5). Use an A/F8 wrench for locking. (For better representation: chart shows engine removed).
8	Separate electrical plug connections	Unclip connectors from connector take-up plate. Separate plug connection.
9	Remove A/C compressor	Slacken lock nut and unscrew setting bolt. Unscrew four fastening screws. Remove square nuts. Put compressor aside with lines sealed. Use appropriate support.
10	Separate plug connection knock sensor	Press lock bracket and unplug connector. Slacken hexagon-head screw and remove entire lower part of connector including support.
11	Loosen hose clamp ahead of mass air flow sensor/intake cowl connection	Use cross-head screw driver to loosen hose clamp, e.g. Wiha type, order no. 153-1 (350 mm long).
12	Separate mass air flow sensor from air cleaner housing	Due to the limited space available, the mass air flow sensor and the air cleaner housing must be separated in the engine compartment. To do so, turn mass air flow sensor in direction of arrow (direction of travel) while locking the air cleaner housing (bayonet lock).
13	Disconnect oil hoses	Slacken and remove hose clamps of upper oil hoses. Unclip oil hoses from support.
14	Remove intake distributor	Slacken upper hose clamps of intake pipes. Lift intake system briefly and seal bores on lower flange using appropriate plugs immediately. Lift out intake system. At the same time, remove accelerator cable from front engine paneling.

Installing intake distributor

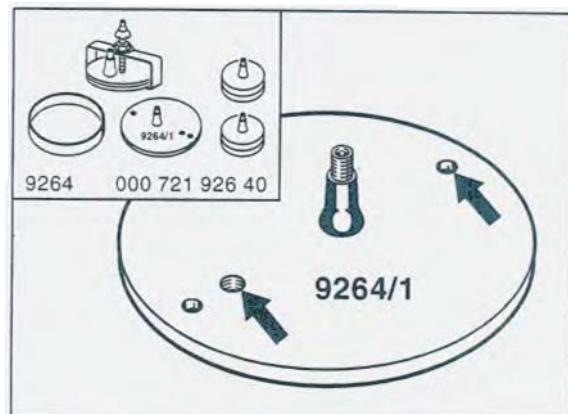
No.	Operation	Instructions
15	Install accelerator cable.	Fit rubber sleeve (C) into take-up bore of accelerator cable; observe correct position. Bore (A) for accelerator cable for Tiptronic transmission. Bore (B) for accelerator cable for manual transmission. Remove plugs from intake channels and check channels for foreign substances. Install intake system with pre-assembled accelerator cable.
16	Adjust operating rod for cruise control	Prerequisite: Throttle fully closed and accelerator cable load-free. Slacken lock nut on operating rod (wrench size 5.5 mm). Adjust operating rod; in off-position, the distance between the take-up part of the operating rod and the upper stopper must be 1 mm. Re-lock hexagon nut.

24**Checking components of injection system for leaks**

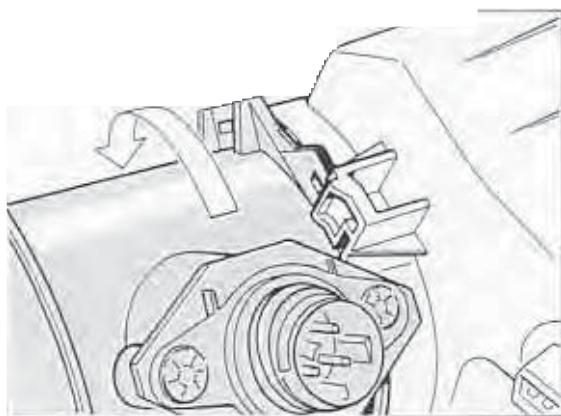
1. Remove air cleaner cap and air cleaner element.
2. Remove hose clamp from mass air flow sensor using cross-head screw driver, e.g. Wiha type, order no. 153-1 (350 mm long).
4. Lever off snap ring and remove protective grating.
5. Fix sealing plate 9264/1 to hot-film mass air flow sensor using M4x40 screws and washers.



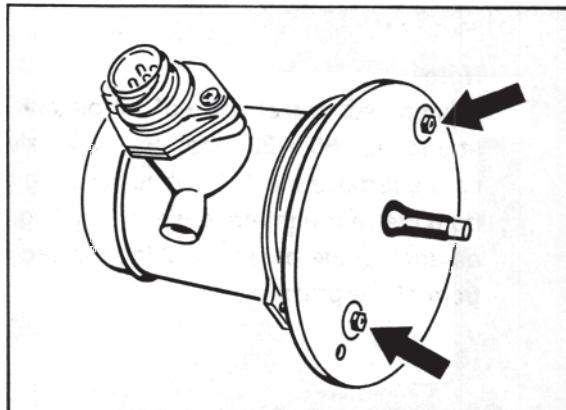
!354-24



3. Due to the limited space available, the mass air flow sensor and the air filter housing must be separated in the engine compartment. To do so, turn mass air flow sensor in direction of arrow (direction of travel) while locking the air cleaner housing (bayonet lock).

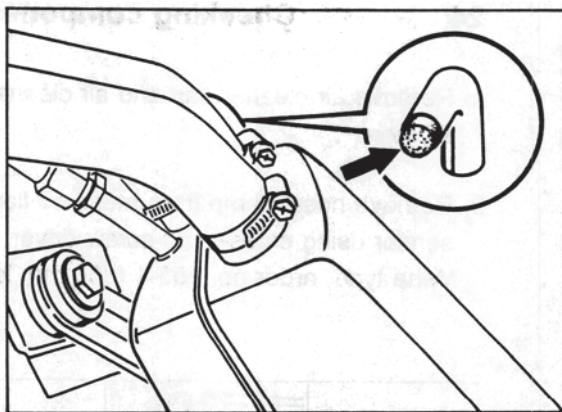


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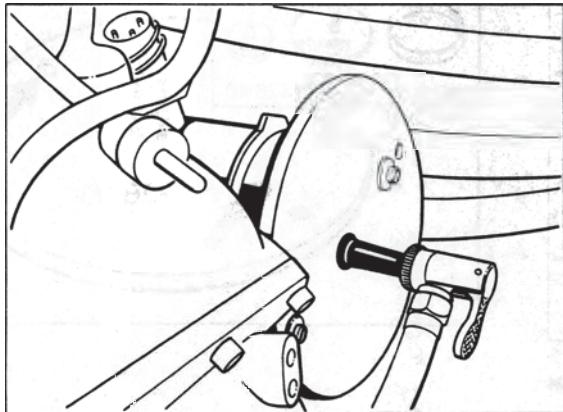


Check the position of the hot-film mass air flow sensor on the sealing plate before tightening the screws; no light gap must be detectable during visual inspection.

6. Generate a pressure of approx. 0.5 bar. With this pressure generated, a clearly audible blowing sound indicates major leaks whereas minor leaks can be made visible using a leak detection spray.



2060-20



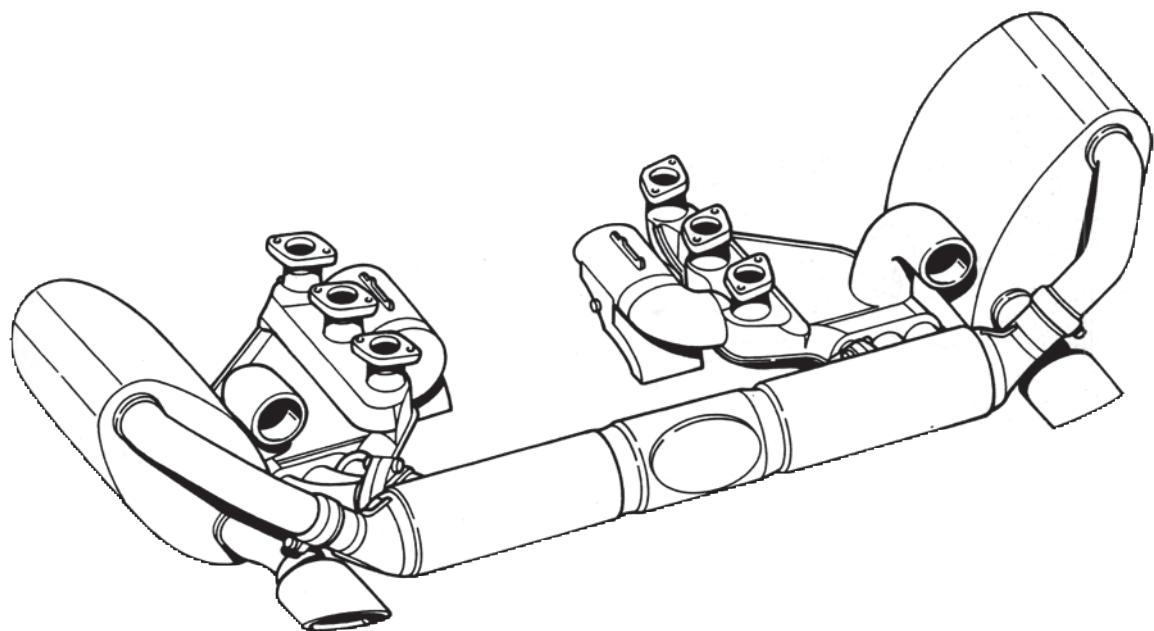
2352-24

Remove the plug after completing the leak test. Before attaching the mass air flow sensor to the intake system, assemble the mass air flow sensor and the air cleaner housing in the engine compartment.

Note

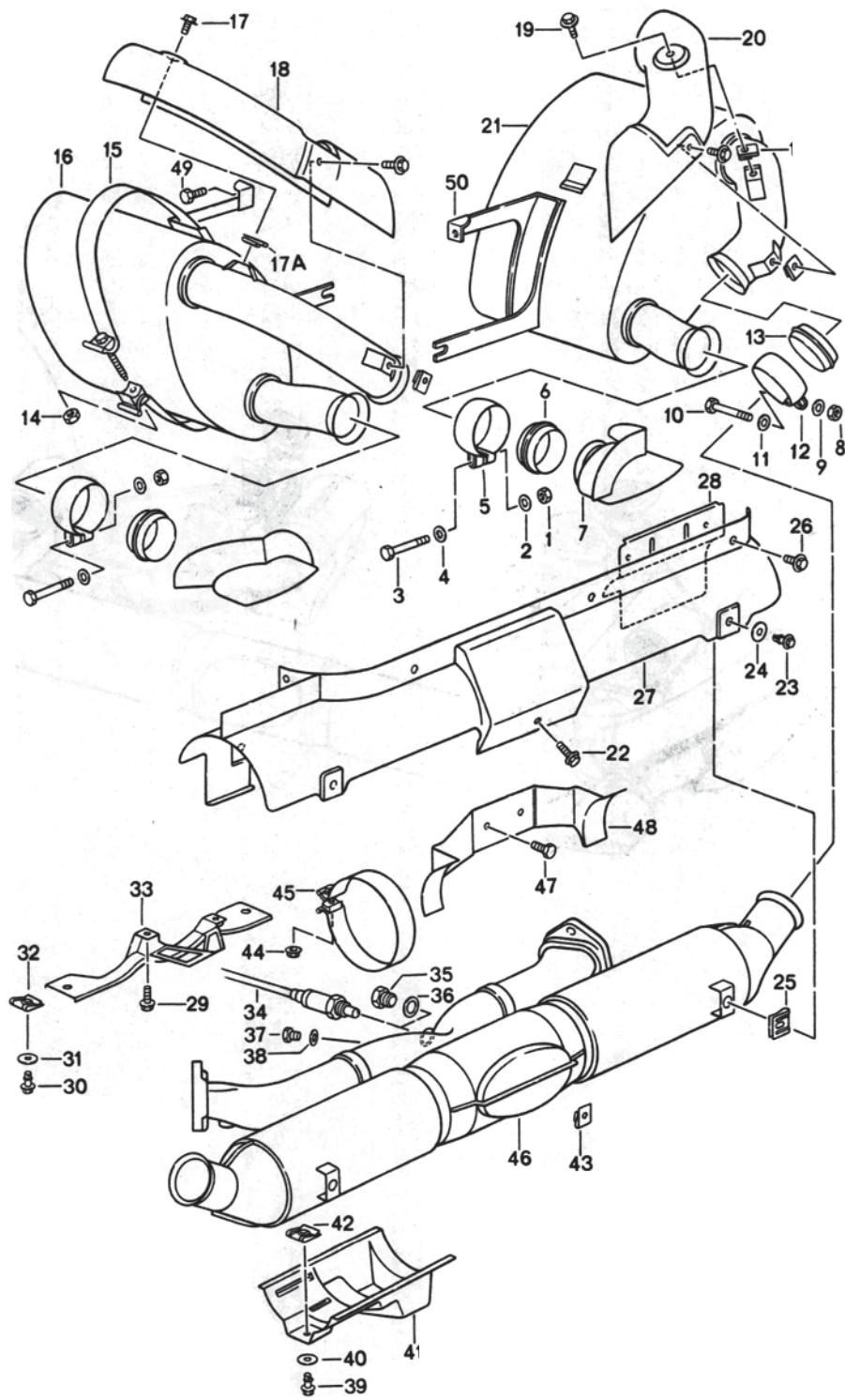
The pressure relief valve of the oil tank opens at approx. 180 ± 20 mbar. Seal the valve; to do so, remove the front wheel housing liner from the rear right-hand wheel housing. Use an appropriate plug to seal the molded hose from of the pressure relief valve.

26 01 55 Replacing exhaust system



1777 - 26

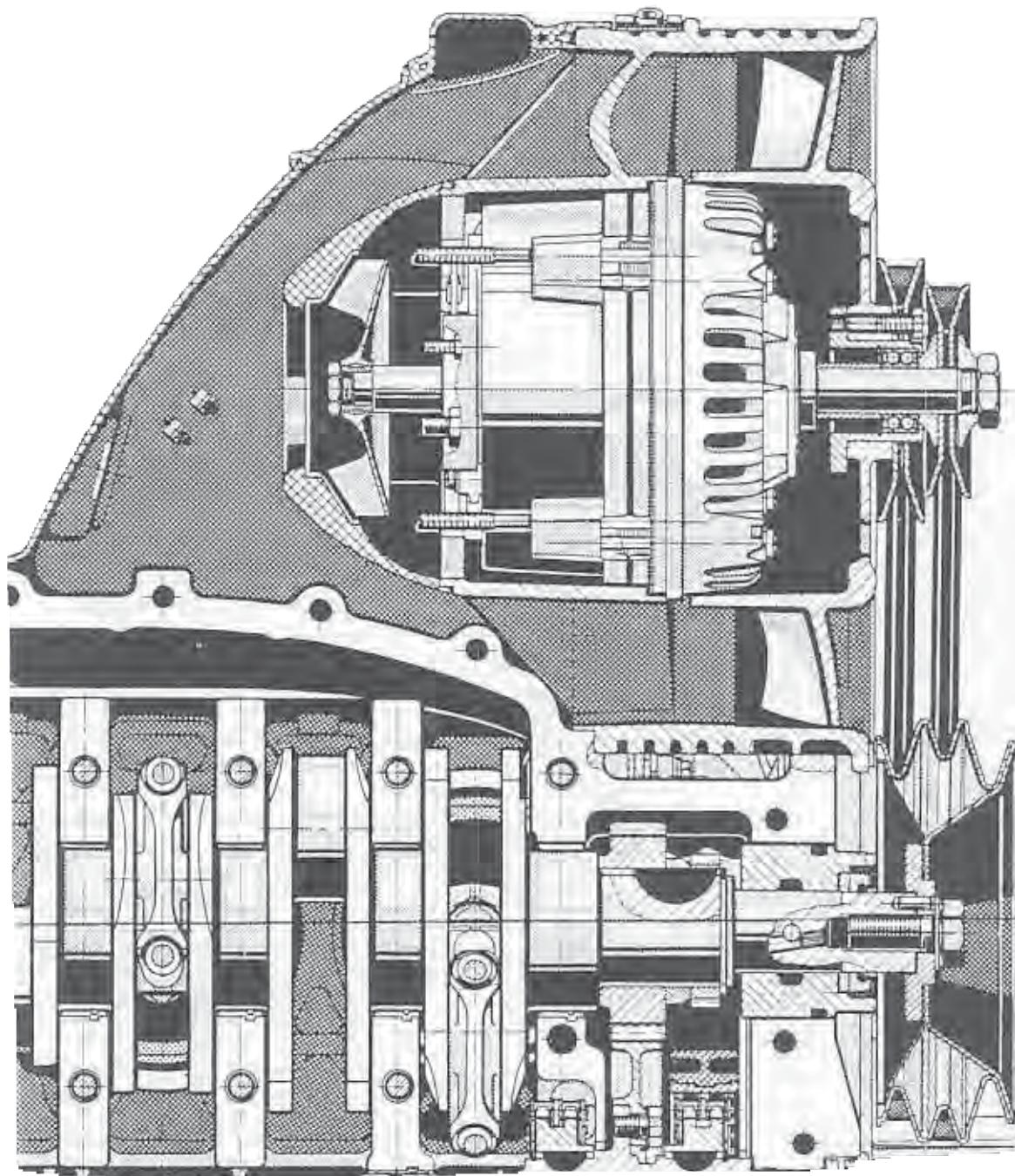
26 0 55 Replacing exhaust system



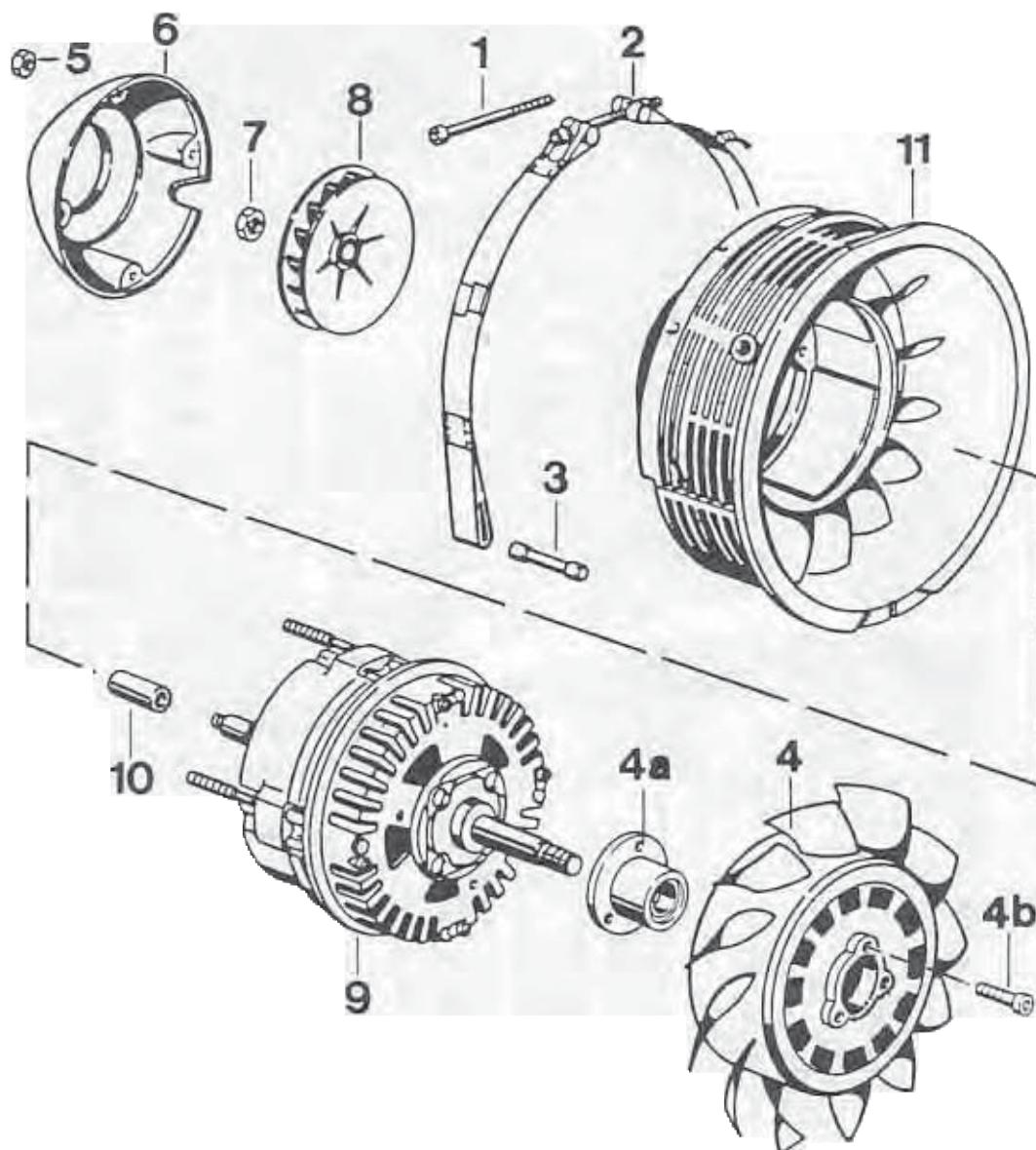
No.	Designation	Qty.	Removal	Note:	Installation
1	Lock nut	2			Check, replace if required
2	Washer 8.4 x 17 x 3.1	2			
3	Hexagon head bolt	2			
4	Washer 8.4 x 17 x 3.1	2			
5	Clamp	2			
6	Seal	2			Align correctly
7	Tailpipe	2			Align
8	Lock nut	2			
9	Washer	2			
10	Hexagon head bolt M 8 x 60	2			
11	Washer	2			Align correctly
12	Clamp	2			
13	Seal	2			Align
14	Lock nut	2			Check, replace if required
15	Tightening strap	2			
16	Muffler	2	Lift out and disengage		Engage, check for correct positioning and check visually
17	Combination screw	2			
17a	M 6 nut retainer	2			
18	Heat shield	1			
19	Combination screw	2			
19a	Nut retainer	2			
20	Heat shield	1			
21	Muffler	1			
22	Combination screw	1			
23	Plug stud M 6 x 12	4			
24	Washer	4			

No.	Designation	Qty.	Note:	
			Removal	Installation
25	Bracket	4		
26	Combination screw M 6 x 14	5		
27	Heat shield	1		
28	Heat shield	1		
29	Combination screw M 6 x 14	2		
30	Plug stud	2		
31	Washer	2		
32	Bracket	1		
33	Bracket for lock plug	1		
34	Oxygen sensor	1		
35	Plug M 18 x 1.5	1		
36	Seal	1		Replace
37	Plug M 8 x 1	1		
38	Seal	1		Replace
39	Lock plug	1		
40	Washer	1		
41	Catalytic converter cover (only for Japan versions)	1		
42	Bracket	1		
43	Nut retainer	1		
44	Lock nut	2		Check, replace if required
45	Tightening strap	2		
46	Catalytic converter	1		
47	Combination screw	2		
48	Bracket	1		
49	Combination screw M 8 x 20	2		
50	Bracket for muffler	2		Check

!7 Remove the top



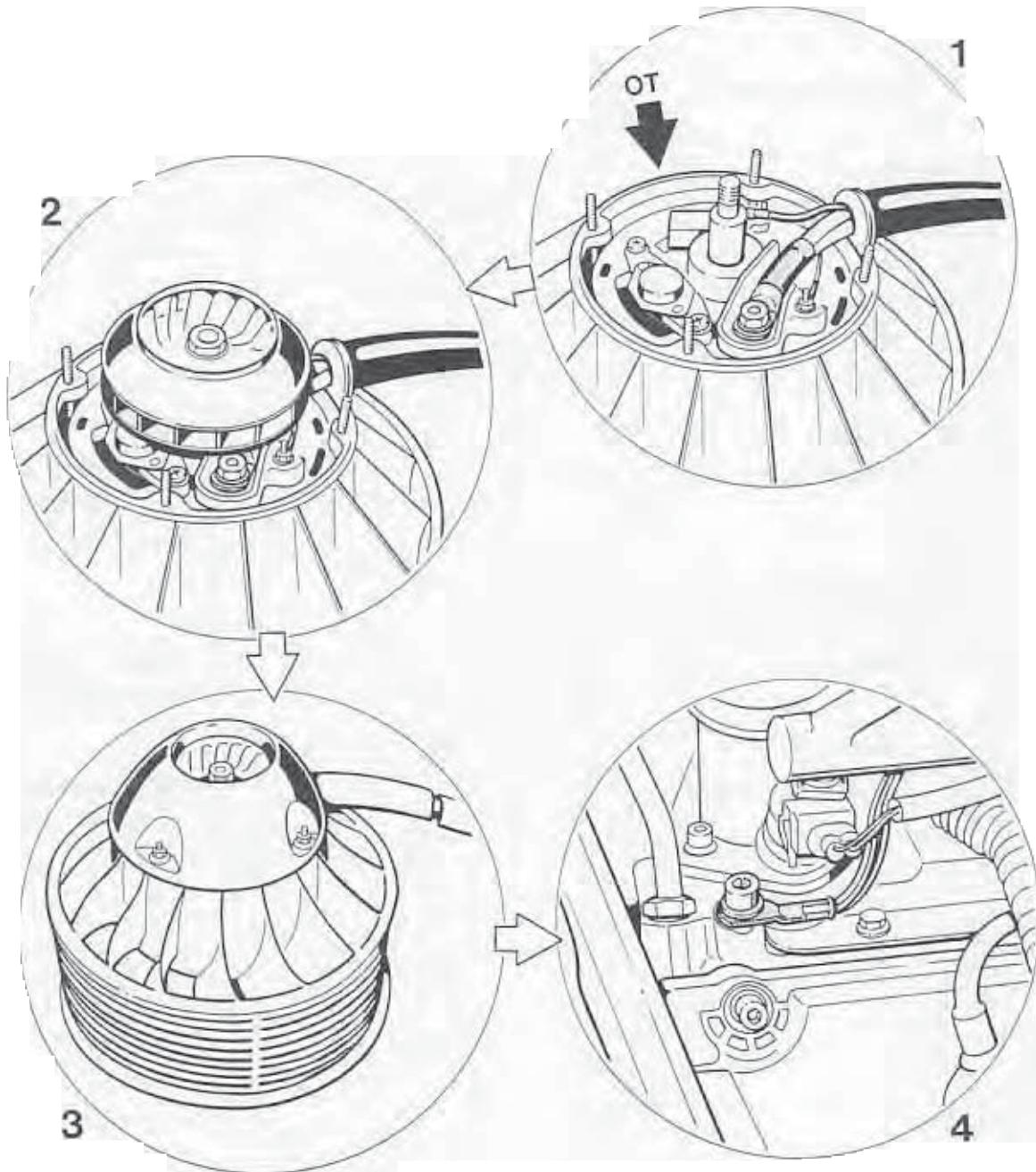
27 22 19 Removing and installing alternator



27 22 19 Removing and installing alternator

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Pan-head screw M 8 x 55	1		Tightening torque 8 Nm (6 ftlb.)
2	Restraining strap	1		Observe correct installation position
3	Pin	2		
4	Fan wheel	1	Pull off	
4a	Hub with bearing	1		Heat fan wheel slightly
4b	Pan-head screw M6 x 30	3		
5	Fastening nut	4		
6	Air guide cowl	1		Install in correct position
7	Hexagon-head nut	1		Apply Loctite 270 to lock. Tightening torque 14 ± 1 Nm ($10 \pm .7$ ftlb.)
8	Fan wheel for alternator cooling	1		
9	Alternator	1		Observe correct installation position
10	Spacer sleeve	1		
11	Cooling fan housing	1		Observe correct installation position

27 22 19 Removing and installing alternator



27 22 19 Removing and installing alternator

Removing alternator

No.	Operation	Instructions
	Disconnect battery	Unscrew negative terminal clamp from battery and cover battery
	Take off fan belt	Remove protective cap. Undo hexagon-head nut (24 mm A/F) and use a polygon wrench (from car tool kit) to lock.
	Press off fan wheel	Press fan wheel off the alternator, using puller VW 202 if required. Adapt both puller hooks to fit.

Installing alternator

No.	Operation	Instructions
1	Fit alternator in cooling blower housing	Fit alternator. Make sure terminal B+ and terminal D + are opposite the TDC line mark (located on the edge of the cooling blower housing).
2	Fit fan wheel for alternator cooling	Apply a thin coat of Loctite 270 to alternator shaft threads and tighten hex nut to $14 \pm 1 \text{ Nm}$ ($10 \pm .7 \text{ ftlb.}$).
3	Fit air guide cowl	Grease rubber grommet of alternator wiring harness prior to fitting the air guide cowl, e.g. with Contifix tire assembly compound. Press air guide cowl cutout into rubber grommet and tighten air guide cowl with four lock nuts.
4	Reconnect ground cable	Position ground cable on camshaft housing (in area of cylinder No. 3) and tighten to 23 Nm (17 ftlb.).
	Align cooling housing with crankcase	Place cooling blower housing onto crankcase locating pin. Press in cooling blower housing to stop (in direction of travel) and tighten restraining strap at the same time.

Note:

If the alternator has been fitted correctly, the wiring harness must exit from the air guide cowl towards the right (seen in direction of travel).

27 78 05 Checking and adjusting alternator and fan wheel drive belt

Caution: The ignition key should always be pulled off during the measurement.

Checking used drive belts:

Use belt tension measuring instrument (Special Tool 9574) to check tension.

A description of how to use the Special Tool is contained in Repair Group 13, page 13 - 30.

Retensioning the belt is only required if the belt tension displayed at the measuring instrument is less than 15 scale increments when the engine is cold and less than 20 scale increments when the engine is hot.

Retensioning the belt

Retension the belt as described in the General Adjustment Notes section.

Before measuring the belt tension, start engine and let engine idle briefly.

Tension:

Cold engine: 15 to 23 scale increments

Engine at operating

temperature: 20 to 28 scale increments

Fitting a new belt

When fitting a new belt, be sure to observe the correct **assembly sequence** in order to avoid any loss of belt tension during vehicle operation.

1. Fit new belt. Adjust tension by inserting or removing shims as required.
Shims are available for belt tensioning in thicknesses of 0.5 mm and 0.7 mm. The 0.7 mm shim is identified by a 2 mm dia. drill hole.
2. Before measuring the belt tension, start engine once more and run engine at idle briefly.

Tension:

Cold engine: 23 to 35 scale increments

3. Run engine at idle for approx. 15 minutes or test drive vehicle for approx. 10 miles.

Check tension.

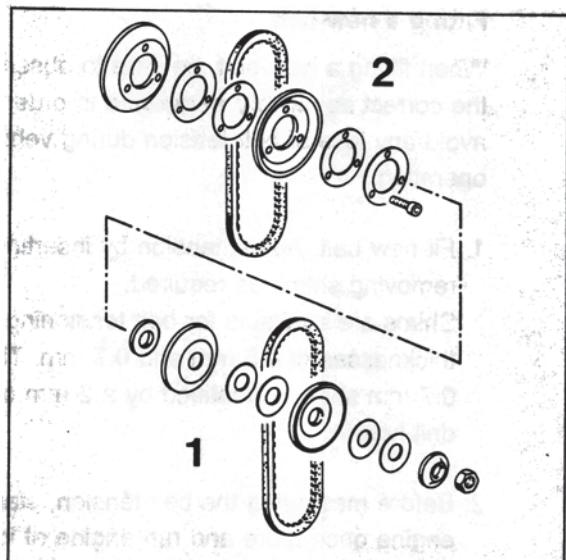
Specification: 28 to 40 scale increments

Retension if required

Test requirement: Engine at operating temperature

General adjustment notes

Fan wheel and alternator have separate drives.



1863-27

1 = Alternator drive components

2 = Fan wheel drive components

Adjusting the V-belts

1. Use polygon wrench (999 571 052 02) to lock shaft and undo hexagon-head nut. Remove shims and pulley half.
2. If belt tension is below specification, remove one shim from between pulley halves and refit in front of front pulley half. Tighten hexagon-head nut to 50 ± 5 Nm.
3. Three additional M 6 screws have to be undone for V-belt and fan wheel.

4. Use only V-belts that have been approved by the manufacturer.

Note

Rotate engine only at lower belt pulley or by operating the starter. After completing all operations, check to make sure that hexagon-head nut has been tightened sufficiently on alternator shaft.

27 60 19 Removing and installing starter (manual transmission)

Removal

1. Disconnect battery and cover terminal and battery, respectively.
2. Remove power unit guard. Loosen and remove hot-air pipe located next to the transmission.
3. Undo and separate drive shaft on differential flange.
4. Undo wires of terminal 30 and terminal 50 from solenoid. Undo wire clamp of terminal 30 from body and remove tie-wrap from starter.
5. Undo hexagon head socket nut of upper starter mount, using 3/8 in. tools (e.g. Stahlwille tools):
INHEX socket 10 mm (49/10)
two short extensions (427)
transverse handle (425)
ratchet (435)
extension pipe (shop-made)
6. Undo hexagon socket head nut bolt with transverse handle and extension (shop-made) from right-hand side. Retain the tool on the starter above the transmission with your right hand.
7. The hexagon socket head nut can be unbolted with the ratchet assembled to the above tools. Undo lower fastening bolt and remove complete with ground cable.
8. Take starter out of its support and turn it until the solenoid points towards the half-shaft. Remove starter from below.

Installation

1. The wire from terminal 30 to the alternator must be attached to the starter with two tie-wraps. Fit protective cap to wire clamp.
Tightening torque of hexagon socket-head nut 46 Nm (34 ftlb.).
2. When fitting the halfshaft flange on the transmission end, make sure the mating faces are absolutely clean and free from grease. Apply a thin coating of Optimoly HT (copper paste) to the bolt threads only.
Tightening torque of halfshaft flange: 81 Nm (60 ftlb.).

27 60 19 Removing and installing starter (Tiptronic)

Removal

1. Disconnect battery and uncover terminal or battery.
2. Remove engine guard and rear underside panel. Disconnect hot air pipe to left and right of transmission
3. **Slacken** transmission mount bolts **only** (6 bolts) and lower by approx. 10 mm.
4. Disconnect wire from solenoid terminals 30 and 50. Undo wire clamp of terminal 30 from body and tie-wrap from starter. Undo suction oil pipe from body side member.
5. Using 3/8 inch tools (8 mm INHEX insert), undo hexagon head socket bolts from starter and remove ground strap.
6. Lift starter out of support and rotate starter pinion towards engine oil filter.
Rotate starter approx 180 deg. along longitudinal axis (solenoid now faces transmission). Carefully take out starter from below.

Installing

1. Use two tie-wraps to tie wire for alternator terminal 30 to starter housing. Fit protective cover to terminal.

Tightening torques:

Hexagon socket head bolts M 10:	46 Nm (30 ftlb.)
Transmission mount to body (six M 10 bolts):	46 Nm (34 ftlb.)

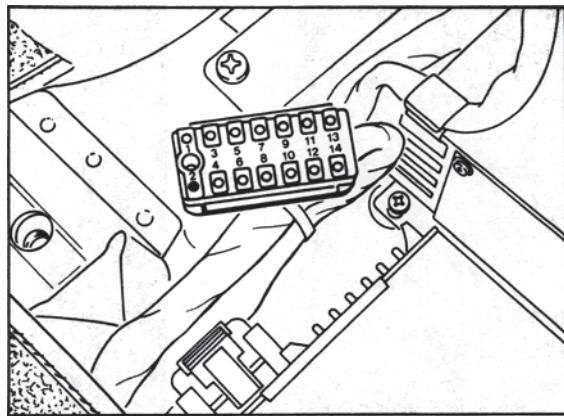
27 82 01 Troubleshooting the cruise control's control unit

Checking the multiple plug of the cruise control's control unit

Note

When cruise control malfunctions occur, the first item to be checked is fuse no. 19 in the central electrical system. The brake light is protected by the same fuse.

1. Remove right seat.
2. With the ignition off, remove the multiple plug from the control unit.



2299-27

3. Connect measuring instrument (voltmeter) to terminal 12 (ground) and terminal 1 (plus) of the multiple plug. Turn ignition on.

Display = battery voltage

4. Connect measuring instrument to terminal 12 and terminal 3.

Display = battery voltage

Press "AUS" key (OFF) on control switch.

Display = 0 volts

5. Connect measuring instrument to terminal 12 and terminal 4.
Display = 0 volts

Press "EIN/BESCHLEUNIGEN" key (ON/ACCELERATE).
Display = battery voltage

6. Connect measuring instrument to terminal 12 and terminal 6.

Display = 0 volts

Press "AUFNAHME" key (RECORD).

Display = battery voltage

7. Connect measuring instrument to terminal 12 and terminal 8.

Display = 0 volts

Operate brake

Display = battery voltage

8. Connect measuring instrument to terminal 1 (plus) und terminal 14.

Display = battery voltage

Operate clutch (switch interrupts)

Display = 0 volts

9. Connect measuring instrument (oscilloscope) to terminals 12 and 11. Turn left rear wheel manually. The measuring instrument displays square wave signals.

Continue inspection of cruise control actuator if no faults can be detected.

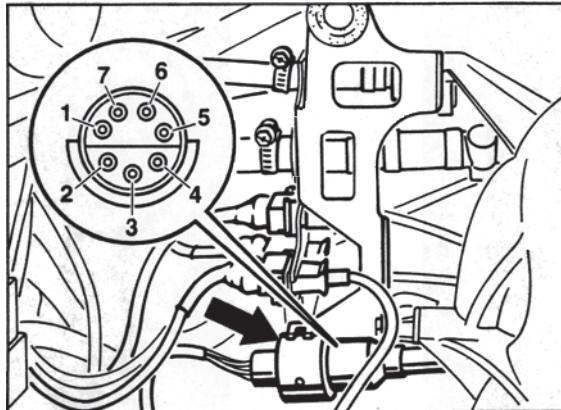
27 84 01 Troubleshooting the cruise control actuator

Checking the multiple plug of the cruise control actuator

Note

To inspect the multiple plug of the cruise control actuator, the rear heater blower must be removed for better accessibility. The ignition remains switched off.

1. Separate plug connection in engine compartment.



1458-27

2. Connect measuring instrument (ohmmeter) to terminal 1 and terminal 7 of the plug section of the actuator (motor resistance).

Display = 3 to 15 Ω

3. Connect measuring instrument to terminal 2 and terminal 4 (potentiometer +).

Display = 2 to 4 k Ω

4. Connect measuring instrument to terminal 2 and terminal 3 (potentiometer slide).

Display = 2 to 4 k Ω

5. Connect measuring instrument to terminal 5 and terminal 6 (clutch actuator).

Display = 30 to 40 Ω

If the measurements show no fault, the wire harness to the cruise control's control unit must be checked.

If required, replace the control unit.

Removing and installing cruise control actuators

Note

Observe the following when removing the cruise control actuator:

Up to model year 1995, the left-hand intake distributor must be removed;
as of model year 1996, the entire Varioram intake system must be removed.

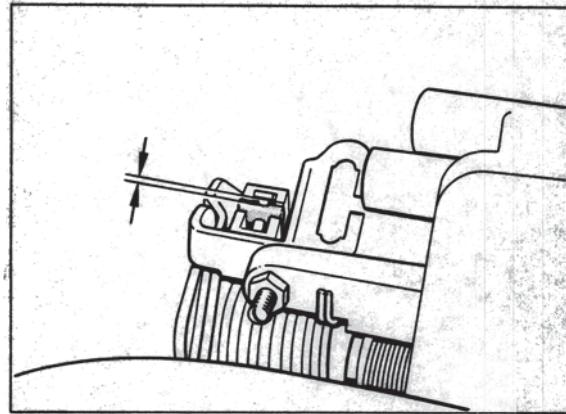
27 88 05 Checking and adjusting tie rod for cruise control

Prerequisite:

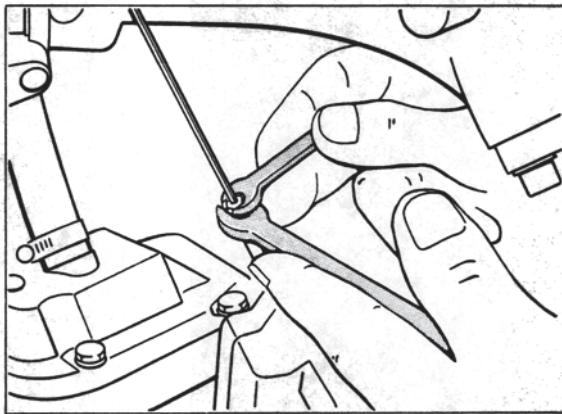
The throttle must be fully closed and the accelerator cable must be load-free!

Adjusting

1. Remove fresh air blower and rear heater blower.
2. Separate the plug connections in the left front corner of the engine compartment, slacken and remove the vacuum hoses and the holder.
3. Hold the suction pipes of cyl. 1-3 from the left and the right and slacken lock nut (A/F5.5). Use an A/F8 wrench for locking.



2356-27



2355-27

For better representation, the engine has been removed in this chart.

4. Adjust operating rod; in off-position, the distance between the take-up part of the operating rod and the upper stopper must be 1 mm. Re-lock hexagon nut.

Repair Manual

**911 Carrera
(993)**

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Transmission
Manual**

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Engine		
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	Engine – Crankshaft, pistons	13
	Engine – Cylinder head, valve drive	15
	Engine – Lubrication	17
	Engine – Cooling	19
	Fuel, exhaust system, engine electrical system	2
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Transmission	Automatic transmission – Torque converter	32
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	Airbag Diagnosis	68
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Preface

Structure

The "Technical Literature" for the "911 Carrera (993)" model is basically structured as before, i.e. the structure follows the familiar repair groups.

A new feature is that the structure includes the main groups **0 to 9** and the main group **D**.

Main groups:	0	Complete vehicle – General
	1	Engine
	2	Fuel, exhaust, engine electrical system
	3	Transmission
	4	Chassis
	5	Body
	6	Body equipment, outside
	7	Body equipment, interior
	8	Air conditioning
	9	Electrical system
	D	Diagnosis

Layout

The layout in the below items remains unchanged throughout the repair manual

1. Table of tightening torques
2. Special tools required
3. Exploded views
4. Legends for the exploded views
5. Assembly notes / use of special tools

As a new feature, however, the former item 6 (Repair group diagnosis) is no longer filed in the volume corresponding to the respective repair group. The **Diagnosis test plans / diagnosis procedures** have been combined in a **separate Diagnosis volume** broken down according to the main groups 0 to 9.

Another new feature is that the contents of the "Service Information Technik" are indicated in the Repair Manual. This brochure concentrates on a description of the design and function of components and of the new features introduced for a particular model year.

Service Number

All major repair procedures and repair descriptions are identified by a two- or four-digit **Service Number** completed by two additional digits to identify the work that corresponds to the first six digits of the working position number in the Working Times and Damage Catalog.

Example: 30 37 37 Dismantling and assembling clutch control shaft

Explanation: 30 37 37 50 (full working position number)

Repair group
here: Clutch, control

Component designation
here: Clutch control shaft

Activity
here: Dismantling and assembling

Index
here: Removed

Presentation in the various documents

- | | |
|-------------|---|
| 30 37 37 50 | Working position no. from
Working Times and Damage Catalog ,
consisting of repair group, component designation, activity and index |
| 30 37 37 | Six-digit number in Repair Manual ,
consisting of repair group, component designation and activity |
| 30 37 | Service number in Service Information ,
consisting of repair group and component designation |

Goal

The introduction of a service number in the "technical literature" is intended to facilitate standardization and positive identification to allow direct cross-referencing among the various documents. This is of particular importance with regard to the use of electronic media.

II Manual transmission

The Repair Manual of the 911 Carrera (993) also includes the 911 Carrera 4 manual (993 four-wheel drive). The 911 Carrera (993) is the basic model covered by the repair operations described in this Manual. "911 Carrera (993)" is also indicated in the header of each page.

Descriptions of repair operations that deviate for the 911 Carrera 4 will be included after the respective 911 Carrera section. The repair descriptions of both models are separated by a cover page. All pages included after the cover page (separation sheet) have the "911 Carrera 4" heading. To facilitate distinction, the page numbering will start with 200.

3 Transmission

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30 Clutch, Control

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30 56 01	Checking clutch drive plate for wear	30 - 5
30 52 19	Removing and installing release bearing	30 - 7
30 52	Identification of clutch pressure plates	30 - 11
30	Pedals - adjustment overview	30 - 13
30	Disassembling and assembling pedals	30 - 15

34 Manual Transmission, Controls, Case

34 35 27	Removing and refitting the transmission	34 - 1
34 35 37	Dismantling and assembling transmission	34 - 3
34 55 19	Dismantling and assembling front transmission cover	34 - 17
34 52 37	Dismantling and assembling gear housing	34 - 23
34 37 37	Dismantling and assembling transmission housing	34 - 27
34	Adjusting gear shift	34 - 31

35 Manual Transmission - Gears, Shafts, Internal Controls

35 50 19	Removing and installing input shaft oil seal	35 - 1
35 19 37	Dismantling and assembling tensioning plate	35 - 3
35 40 19	Removing and installing input shaft	35 - 7
35 40 37	Dismantling and assembling input shaft	35 - 15
35 59 37	Dismantling and assembling output shaft	35 - 21
35 75 19	Removing and installing 5th gear (transmission is installed)	35 - 23

39	Final Drive, Differential, Differential Lock	
39 09 19	Removing and installing differential 39 - 1
39 09 37	Dismantling and assembling differential . .	. 39 - 5
39 08 15	Adjusting drive set 39 - 11

Survey of contents of Service Information Technik '95

The Service Information gives a detailed description of the technical features of the new 911 Carrera.

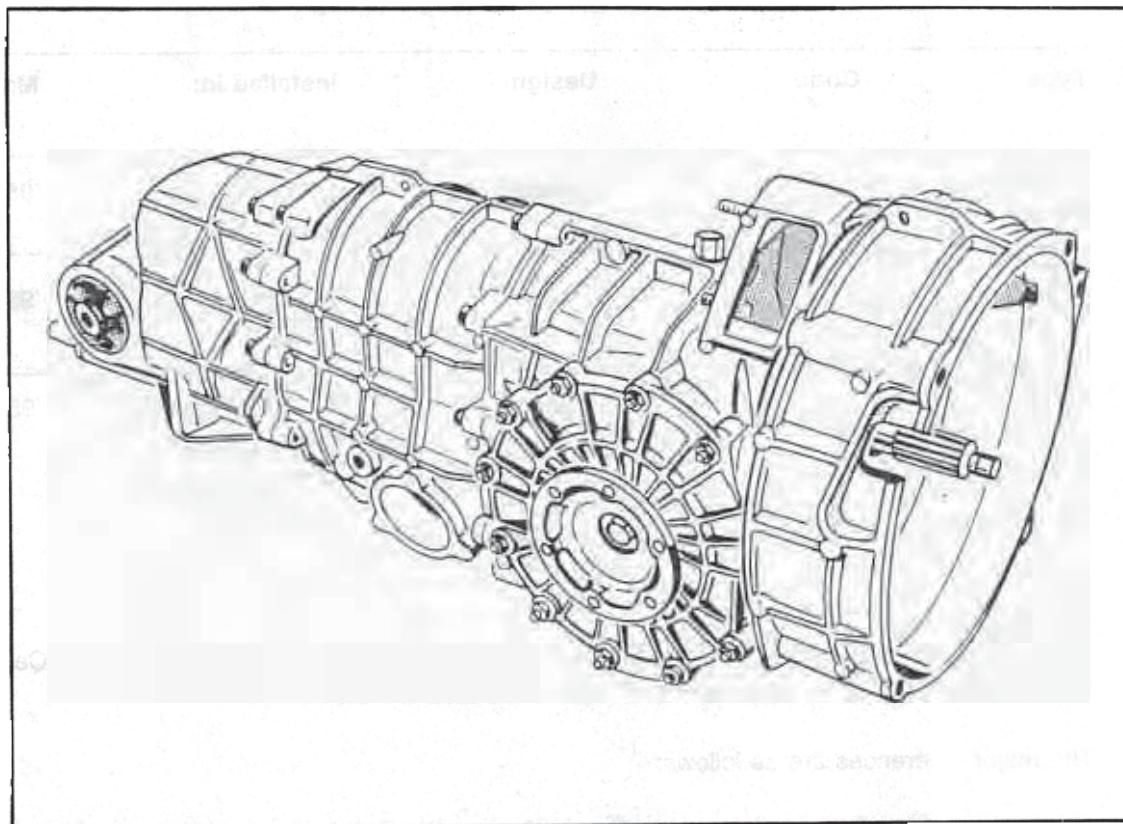
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3 Technical data

6 speed manual transmission G 50 / 20 / 21 for 911 Carrera (993)



Type	Equipment	installed in:	Model year
G 50/21	6 speed	911 Carrera worldwide except USA, CH. A	'94...'96
G 50/20	6 speed	911 Carrera USA, CH, A	'94...'96
		911 Carrera worldwide	'97

3 Technical data

6-speed manual transmission, type G 50/31/32/33 for 911 Carrera RS

Type	Code	Design	installed in:	Model year
G50/31		6-speed	911 Carrera RS (basic vehicle)	'95/'96
G50/32		6-speed	911 Carrera RS (Clubsport)	'95/'96
G50/33		6-speed	911 Carrera RS (basic vehicle and Clubsport) Switzerland	'95/'96

Apart from a few differences, the transmission of the Carrera RS has a similar design to Carrera transmissions G50/20/21; the repair procedures are also similar.

The major differences are as follows:

different gear ratios

- 2nd gear wheel splined to drive shaft
 - steel/molybdenum synchronizer ring (type G50/32 only)
 - limited-slip differential as standard equipment (locking values 40 % under acceleration,
65% under deceleration)
- harder gearbox bearing

3 Technical data

Structure of transmission numbers

G5021
T

Transmission type

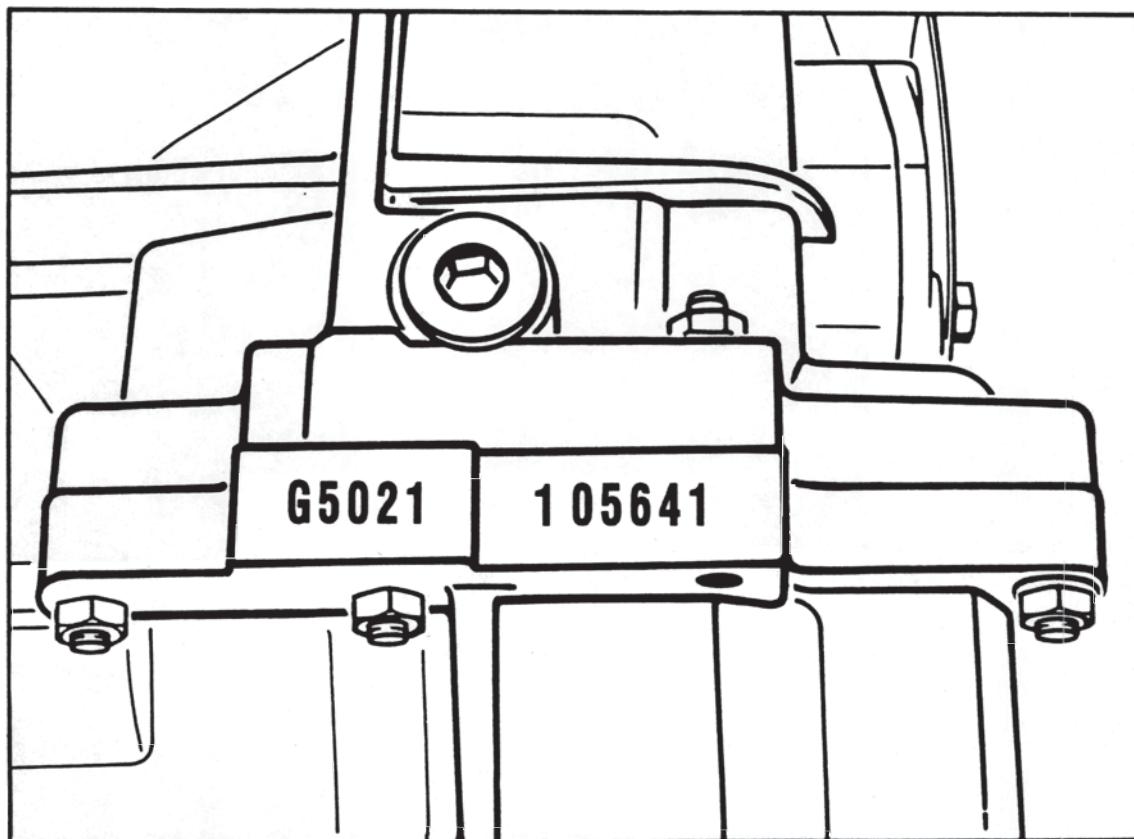
1
T

Index of variations
within the assembly no.

05641
T

Serial no.
e.g. 05641

1 = normal differential
2 = limited slip differential



3 Technical data

Manual transmission for 911 Carrera (993)

General data	Manual transmission	G 50 / 21 / 20
Transmission ratios	G50/21 $Z_1 \ Z_2 = Z_2 : Z_1$	G50/20 $Z_1 \ Z_2 = Z_2 : Z_1$
1st gear	$11 : 42 = 3.818$	$11 : 42 = 3.818$
2nd gear	$20 : 43 = 2.150$	$21 : 43 = 2.048$
3rd gear	$25 : 39 = 1.560$	$27 : 38 = 1.407$
4th gear	$33 : 41 = 1.242$	$34 : 38 = 1.118$
5th gear	$37 : 38 = 1.027$ $41 : 42 = 1.024^*$	$38 : 35 = 0.921$ $42 : 39 = 0.928^{**}$
6th gear	$39 : 32 = 0.820$	$40 : 31 = 0.775$
Rev. gear	$14 : 40 = 2.857$	$14 : 40 = 2.857$
Final drive	Hypoid bevel-gear drive with 16 mm offset	
Transmission Final drive	$9 : 31 = 3.444$	$9 : 31 = 3.444$
Capacity	3.6 liter multigrade transmission oil SAE 75 W 90 of API classification GL 5 (or MIL-L 2105 B)	

* introduction 15 December 1994

** introduction 7 December 1994

3 Technical data

Manual transmission for Carrera RS

General data	Manual transmission G 50 / 31 / 32 / 33		
Ratios	G50/31 $Z_1 \ Z_2 = Z_2 : Z_1$	G50/32 $Z_1 \ Z_2 = Z_2 : Z_1$	G50/33 $Z_1 \ Z_2 = Z_2 : Z_1$
1st gear	$13 : 41 = 3.154$	$13 : 41 = 3.154$	$13 : 41 = 3.154$
2nd gear	$20 : 40 = 2.000$	$20 : 40 = 2.000$	$20 : 40 = 2.000$
3rd gear	$23 : 35 = 1.522$	$23 : 35 = 1.522$	$27 : 38 = 1.407$
4th gear	$33 : 41 = 1.242$	$29 : 36 = 1.241$	$34 : 38 = 1.118$
5th gear	$41 : 42 = 1.024$	$32 : 33 = 1.031$	$37 : 36 = 0.973$
6th gear	$39 : 32 = 0.821$	$35 : 29 = 0.829$	$39 : 32 = 0.821$
Reverse	$14 : 40 = 2.857$	$14 : 40 = 2.857$	$14 : 40 = 2.857$
Final drive	Hypoid bevel final drive with 16 mm offset		
Final drive ratio	$9 : 31 = 3.444$	$9 : 31 = 3.444$	$9 : 31 = 3.444$
Filling capacities*	3.6 l multi-grade transmission oil SAE 75 W 90, API specification GL 5 (or MIL-L 2105 B)		

*933 GT 2 (transmission type G 50/53) only Veedol SAF 44.

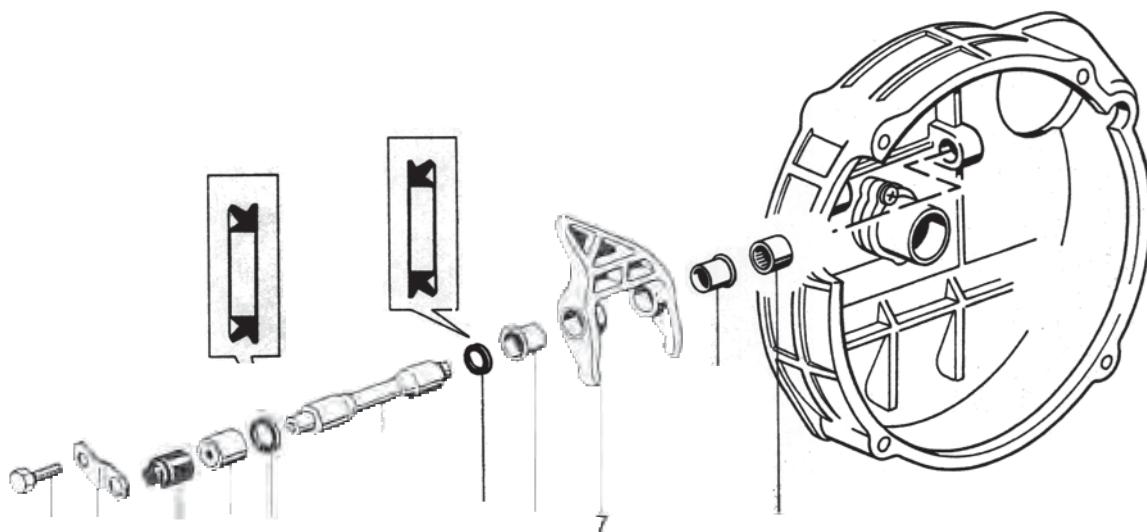
3 Technical data

Tightening torques for manual transmission and transmission mounts

Location	Thread	Tightening torques Nm (ftlb.)
Oil drain and oil filler plugs	M 22 x 1.5	30 (22)
Hexagon head nuts at: Front and side transmission cover, gear and transmission housings. Tensioning plate	M 8	23 (17)
Clamping plate to front transmission cover	M 6	10 (7)
Hexagon head nut / input shaft	M 22 x 1.5	200 (147)
Hexagon head nut / input shaft	M 30 x 1.5	250 (184)
Hexagon head nut / output shaft	M 30 x 1.25	300 (220)
Hexagon head nut / shift fork	M 8	23 (17)
Reverse light switch to gear housing	M 18 x 1.5	35 (26)
Guide tube to transmission housing	M 6	10 (7)
Selector gate to tensioning plate	M 6	10 (7)
Collar nut / return gear II	M 8	35 (26)
Vent to transmission housing	M 14 x 1.5	35 (26)

Location	Thread	Tightening torques Nm (ftlb.)
Hexagon head bolt / halfshaft flange	M 10	44 (32)
Oil cup to tensioning plate	M 5 (micro-sealed)	6 (4)
Ring gear to differential housing (Hexagon head bolt with serrated mating surface)	M 12 x 1.25	200 (148)
Transmission mount to body	M 10 x 70	46 (34)
Transmission mount to transmission (lock nut)	M 12 x 1.5	85 (63)
Longitudinal mount to transmission	M 12 x 1.5 x 65	85 (63)
Longitudinal mount to transmission (lock nut)	M 10	30 (22)

30 37 37 D smantling assem lin clutch trol haft



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hexagon head bolt M 6 x 16	1		
2	Bracket	1		
3	Bearing cover	1		Pack with grease (use Olista Longtime 3 EP)
4	Needle-roller bearing with assembly hole	1		Install in correct position, assembly hole points towards outside
5	Release lever shaft	1	Pull out with hexagon head screw M 6 x 40	Do not grease plastic bushing bearing surface
6	Sealing ring	2		Check, replace if required, install in correct position
7	Release lever	1		
8	Plastic bushing	2		Do not grease
9	Needle-roller bearing without assembly hole	1		

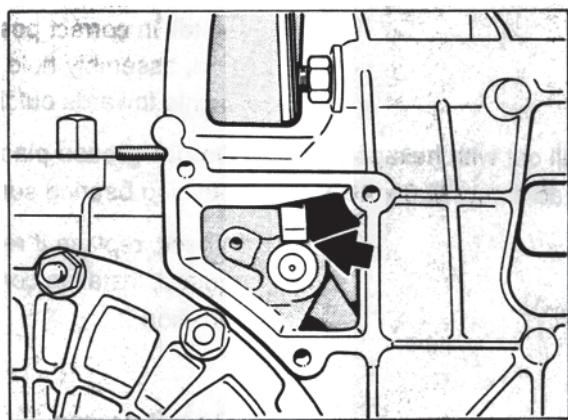
Note

Lubricate all sliding surfaces of the clutch release mechanism - except for the items indicated in the list - with Olista Longtime 3 EP, Part No. 000.043.024.00.

Assembly notes

Removing bearing cover

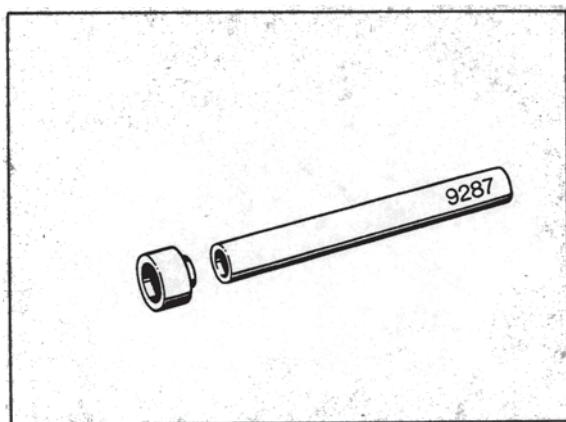
Insert a suitable screwdriver across rectangular cutout (of clutch bell housing) and push bearing cover out of bearing hole.



1865-30

Installing bearing cover

Locate bearing cover with assembly mandrel, e.g. Special Tool 9287 (drift for headlamp beam range adjusters) and carefully press in to stop.



1866-30

30 56 01 Checking clutch drive plate for wear

(clutch drive plate removed)

Checking:

Using a depth gage or sliding calipers, measure distance X from surface of lining to rivet head.

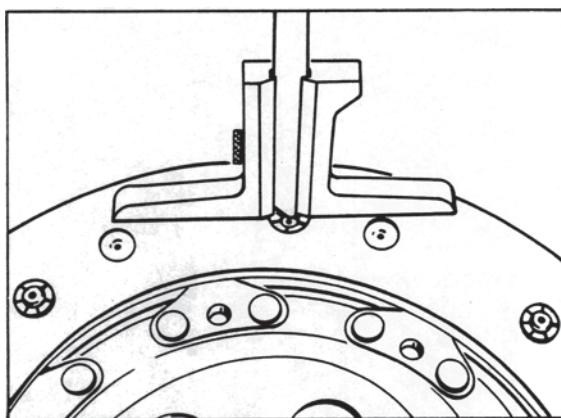
Note

Measure only at the beaded-over side of the rivet head.

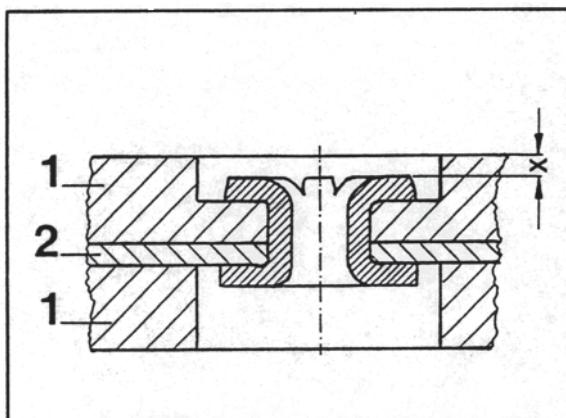
Wear limit X is **0.3 mm** (see drawing).

When the drive plate is new, this dimension is approx. 1.0 mm.

Note that **lining wear is not linear**, i.e. not at a steady rate throughout the clutch's operating life. The way in which the lining material beds down and is compressed initially suggests that greater lining wear is taking place, but as the car is driven further, the rate of wear declines considerably.



645-30

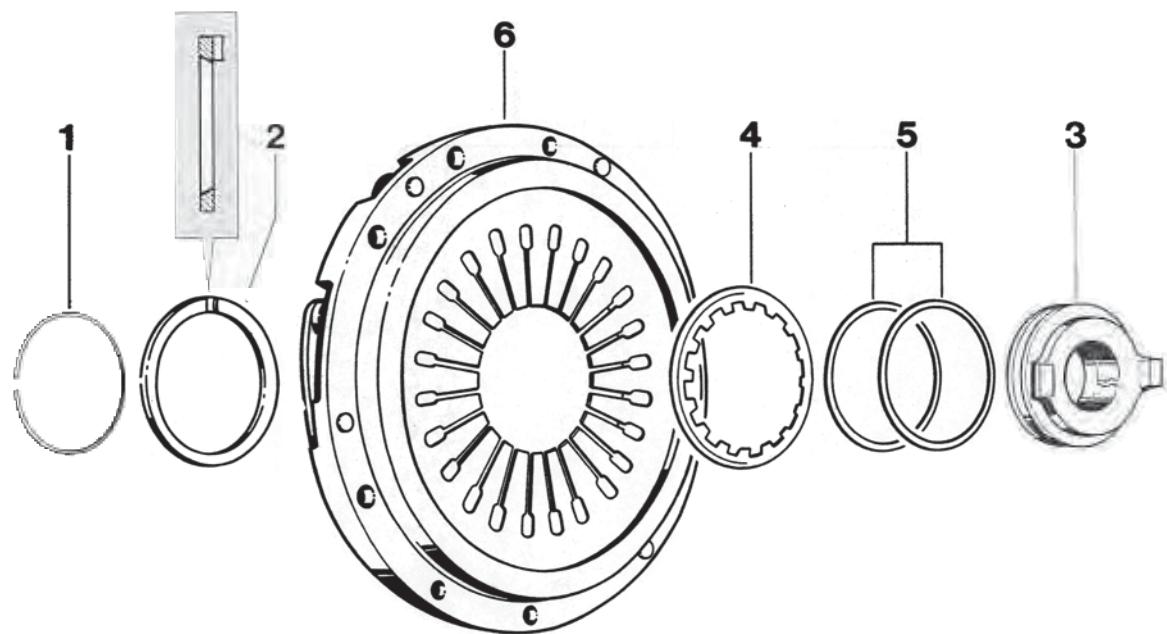


646-30

1 - Lining

2 - Drive plate/lining spring

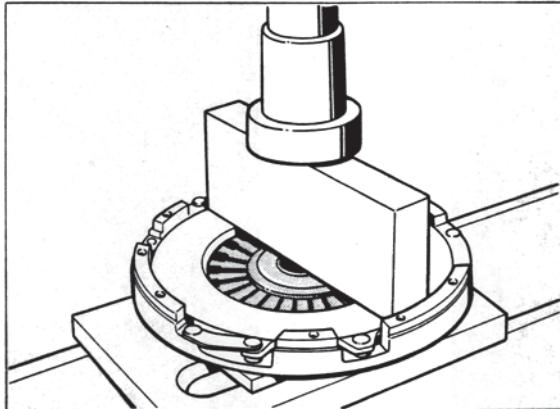
30 52 19 Removing and installing release bearing



No.	Designation	Qty.	Removal	Note: Installation
	Snap ring	1	use pointed pliers to remove, pressing down thrust plate in a press	observe correct seating of snap ring
2	Thrust washer	1		groove must face snap ring
3	Release bearing	1	check, do not wash out, just wipe with a dry cloth	
4	Spring washer	1	install in correct position	
5	Spacer	2		always insert 2 spacers
6	Thrust plate	1		check for wear, replace if required

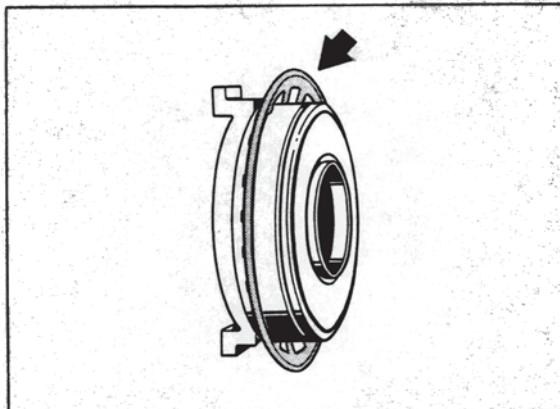
Assembly notes

1. The snap ring can only be fitted with a shop press. Use a wooden block as a thrust piece.



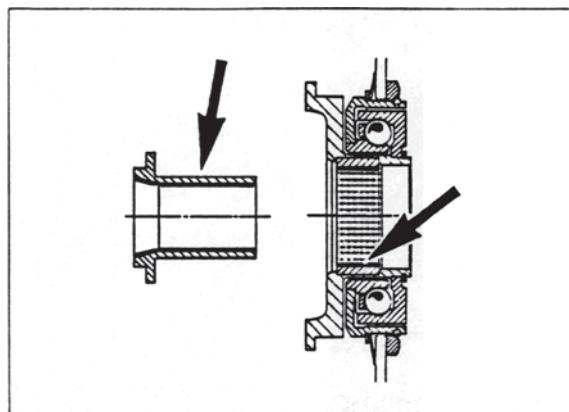
1000-30

2. Install spring washer in correct position.



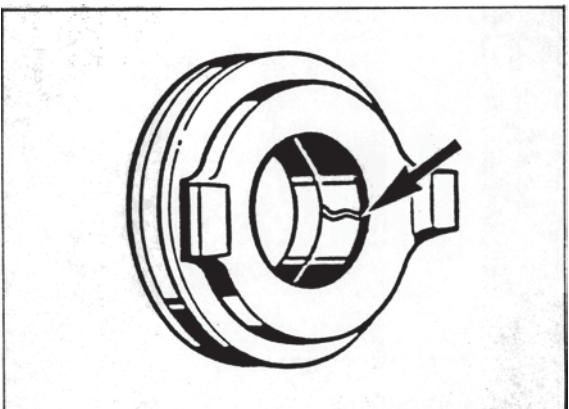
1001-30

3. Do not grease sliding surfaces of release bearing and guide tube.



1867-30

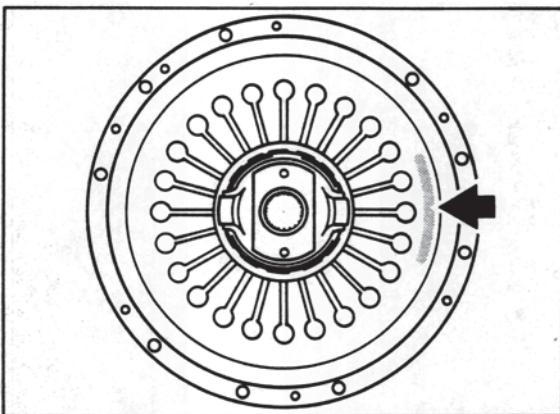
4. The guide sleeve is slotted (uneven outline - see arrow).



1868-30

30 52 Identification of clutch pressure plates

To avoid confusion, the pressure plates are color-marked for positive identification.



836-30

Color marking:

968	Green
911 Carrera 2/4	Blue
911 Carrera (993)	No mark
911 Turbo 3.6	Red

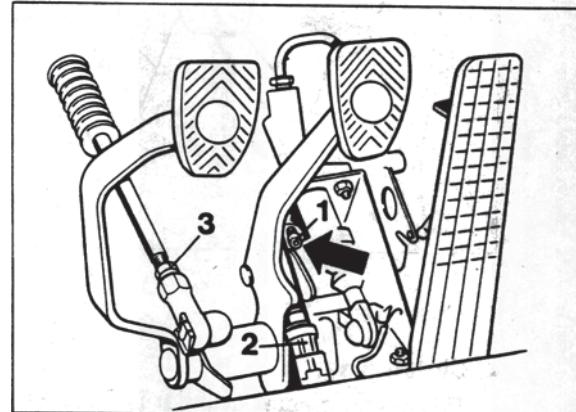
30 Pedals - adjustment overview

Adjusting clutch pedal

Note

The following points are prerequisites for proper operation of the clutch and must be observed when adjusting the pedals:

- Proper bleeding of the hydraulic clutch system
- Tightness of the hydraulic system
- Proper setting of the servo spring
- Returning of pedal to initial position
- Pedal travel limited by properly adjusted floor board stopper
- Installation position of pedals in accordance with standard situation.



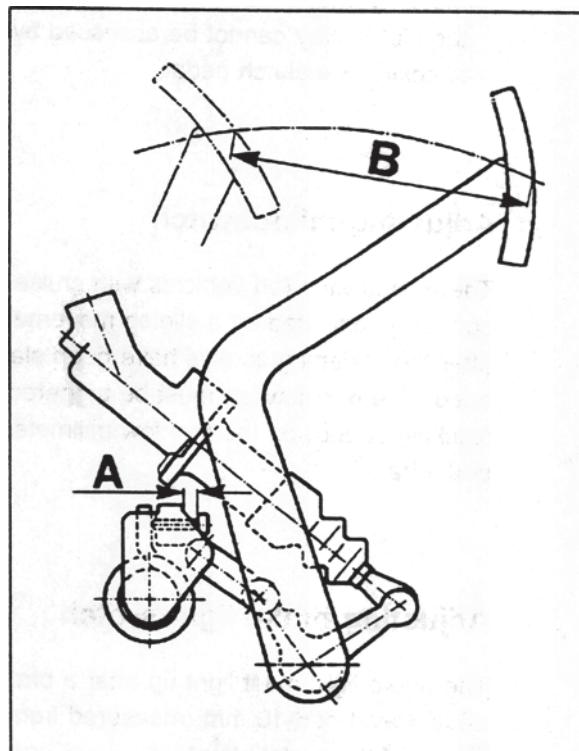
Checking and adjusting work

1. Checking the pedal return (returning force)

Try to return the pedal to its initial position by applying at least 30 N (spring scale). The pedal must not yield. If it does yield (= insufficient returning force), the servo spring pre-load must be reduced or set to the dimension A = 6 mm (see 2.).

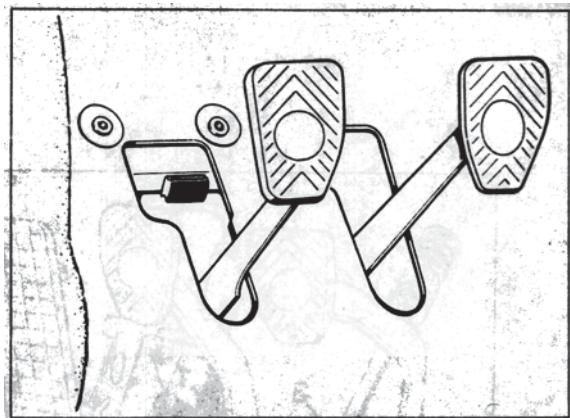
2. Setting servo spring (dim. A = 6 mm).

The servo spring is set by turning the hexagon socket head bolt **arrow / no. 1** (chart 1097-30). The distance (dimension A / figure 1113-30) between the inner face of the bolt head and the rocker must be **6 mm**.



3. Checking pedal travel (dim. B = 150 mm).

Measured from the center of the pedal plate, the pedal travel must be **150 mm + 5 mm**. If necessary, adjust or limit the pedal travel on the floor board stopper (fig. 1098-30 on p. 30-14).



1098-30

4. Clutch play.

The clutch master cylinder is fitted with an internal stopper. The push rod and the clutch pedal are always pressed against this stopper by the servo spring. Due to automatic hydraulic readjustment of the clutch, the clutch play cannot be assessed by checking the clutch pedal.

Adjusting microswitch

The microswitch (on vehicles with cruise control) is adjusted by a sliding movement after the fastening screws have been slackened. The microswitch must be triggered (clicking sound) on the first few millimeters of pedal travel.

Adjusting brake light switch

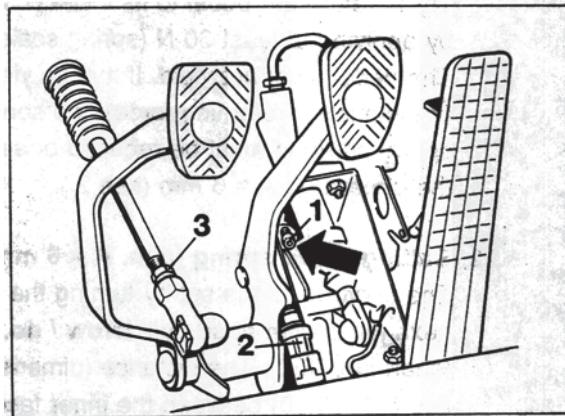
The brake light must light up after a brake pedal travel of 6-16 mm (measured from the center of the pedal plate).

If the brake light lights up after a brake travel of less than 6 mm, the brake light switch (2) must be turned to the right until it responds within the range of tolerance. Do not damage the electric wire and the plug. If the adjustment range of the brake light switch is not sufficient, the brake pedal must be adjusted at the ball joint of brake push rod 3 (by shortening push rod).

If the brake light lights up after a pedal travel of more than 16 mm, the brake pedal must be adjusted at the ball joint of the brake push rod (by extending push rod) until the brake pedal switch responds within the range of tolerance.

Note

Usually, the brake pedal plate is roughly at the same height as the clutch pedal plate (plus/minus 3 mm).



1097-30

Throttle operation

Check for smooth operation and at wide open throttle.

30 Disassembling and assembling pedals

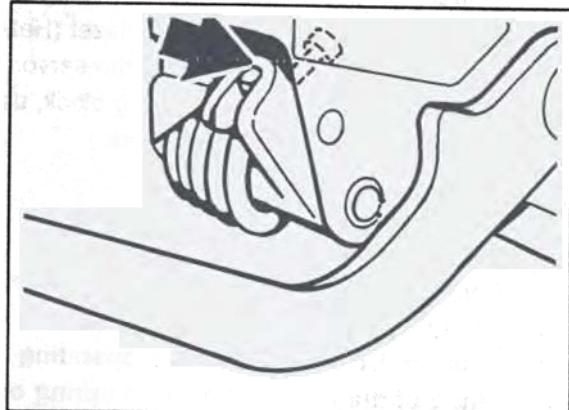
Includes: removing and installing pedals

Important note

Remove the pedals together with the clutch master cylinder.

To do so, slacken the hydraulic lines on the clutch master cylinder. **Release servo spring partially** (move clutch pedal into de-clutched position).

Plug the hydraulic lines or clamp off the supply line using a commercially available hose clamp. Also plug the connecting bores of the clutch master cylinder.

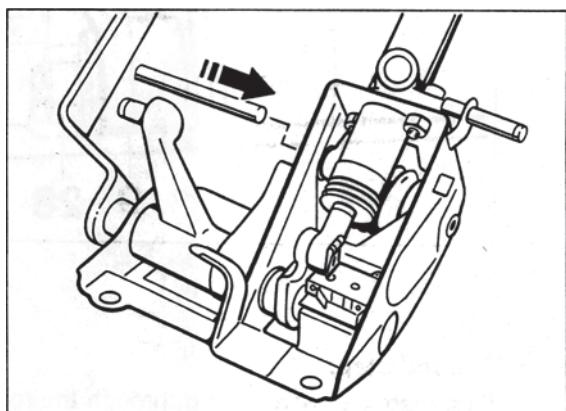


2358-30

Disassembling pedals

1. Mount brake pedal of pedal system onto a vise – **using protective jaws** –.
2. Turn adjustment screw for the servo spring to the left (counter-clockwise), until the leg of the servo spring fits closely to the rocker (arrow).

3. Remove clutch master cylinder. Then lock rocker / servo spring. To do so, move clutch pedal into **de-clutched position**. In this position, operate clutch pedal (by pulling it backwards), until an auxiliary tool (steel pin with 8 mm Ø) can be inserted from the side into the bore of the rocker.



2357-30

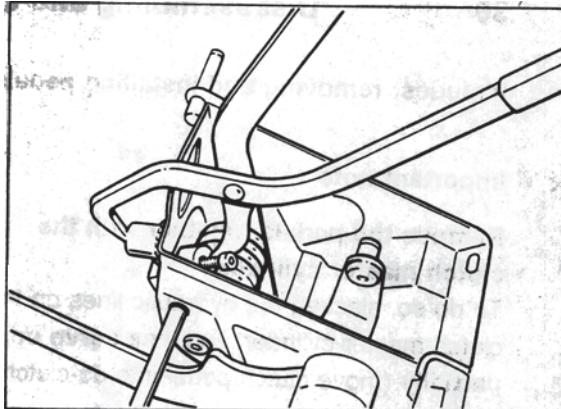
4. Release servo spring in two steps.

Use an appropriate spring tensioning tool, e.g. brake spring pincers by Hazet (Hazel no. 797) to load and release the servo spring. To protect the mounting block, use a liner when applying the pincers.

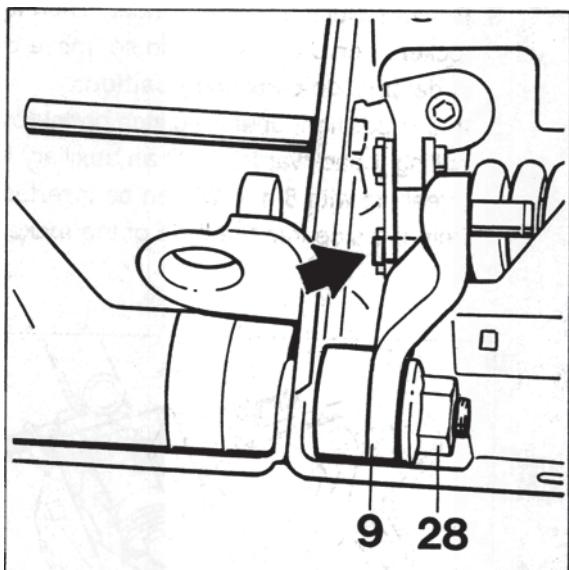
First step:

Remove the support pin (arrow) on lever no. 9 using a screw driver.

Caution: Do not get into the operating range of the rocker, the servo spring or the levers with your fingers or hands.



2366-30



2370-30

Second step:

First load the servo spring through the rocker until the auxiliary tool (steel pin with 8 mm Ø) can be removed easily from the bore of the rocker. Then release the servo spring by opening the pincers.

5. On vehicles with cruise control:

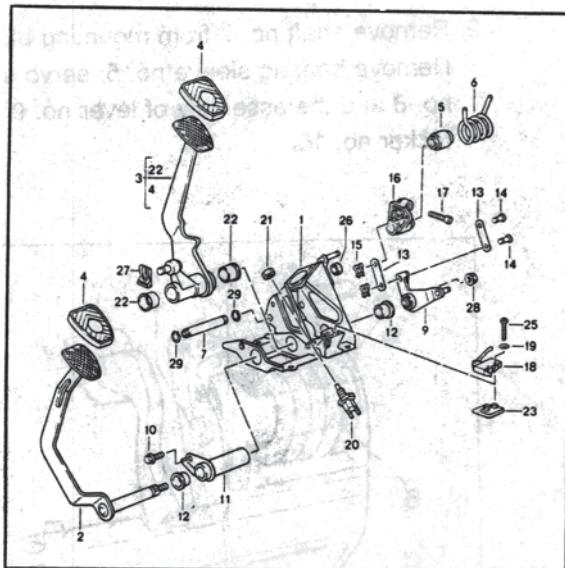
Mark position of microswitch.
Remove microswitch.

6. Slacken fastening nut no. 28 on operating lever no. 9.

Remove lever from clutch pedal shaft – through the lateral bore on the mounting block – using a copper or brass mandrel. If lever can be removed, continue with item 8.

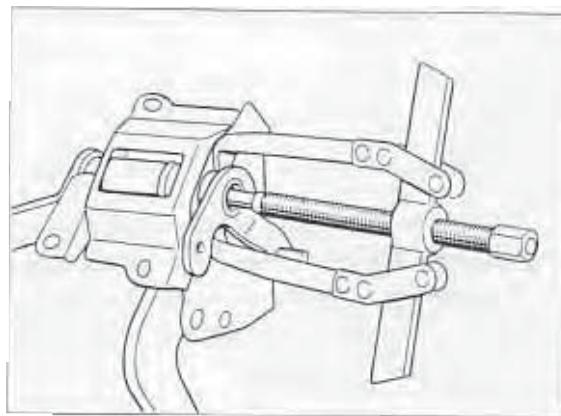
Important note

If lever no. 9 cannot be removed from the clutch pedal shaft without damaging the clutch pedal shaft (which may occur due to tolerances), continue with item 7.



2348-30

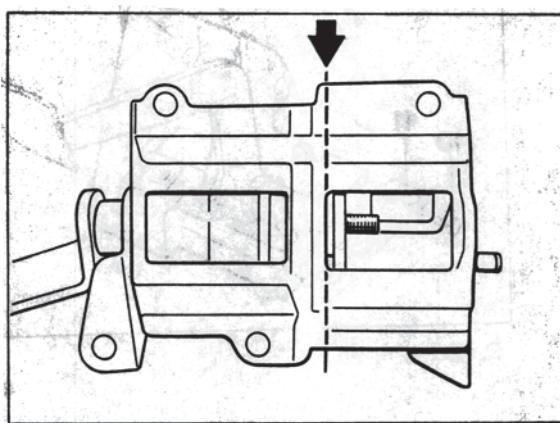
7. If lever no. 9 cannot be removed from the clutch pedal shaft without damaging the clutch pedal shaft (which may occur due to tolerances), part of the mounting block must be sawed off (arrow / dotted line). Then remove the lever using a commercially available two-claw puller.



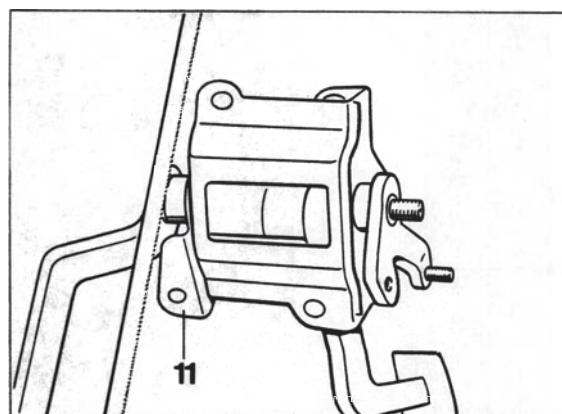
2360-30

If the lever cannot be removed with a puller, the clutch pedal shaft must be destroyed. To do so, separate clutch pedal from pedal shaft (by sawing) with bearing tube no. 11 slackened (screw no. 10 removed).

If lever no. 9 can be reused (see – Note – on page 30-18), remove the lever from the pedal. To do so, use plate VW 401 and an appropriate bushing, e.g. Matra 40-503.



2359-30



2361-30

8. Lift out clutch pedal shaft with clutch pedal.

Note

If the pedals were disassembled because of the complaint – **sometimes the clutch pedal does not return fully** –, replace lever no. 9 (fig. 2348-30 / new, modified version with optimized kinematics).

> **Distinguishing old and new levers**

Part number on part.

> **Previous version:**

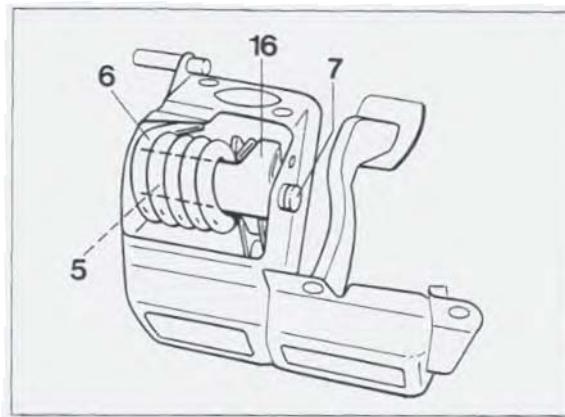
**Part no. 993 423 519 00 or
993 423 519 01** (gold-colored).

> **Modified / new version:**

Part no. 993 423 519 02 (olive).

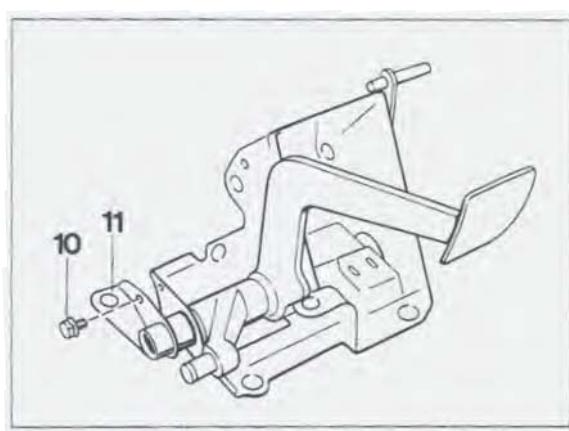
In the beginning, the modified, new levers were golden as well.

9. Remove shaft no. 7 from mounting block.
Remove bearing sleeve no. 5, servo spring no. 6 and the assembly of lever no. 9 and rocker no. 16.



2365-30

10. Remove bearing pipe no. 11 and brake pedal.



2363-30

Assembling pedals

1. Check all parts, replace any parts, if required.

If the bushings must be replaced, use an appropriate mandrel for removal or installation. **Coat all bearings and slide faces with a Teflon-compatible low temperature grease – e.g. Glissando by DEA (Texaco).**

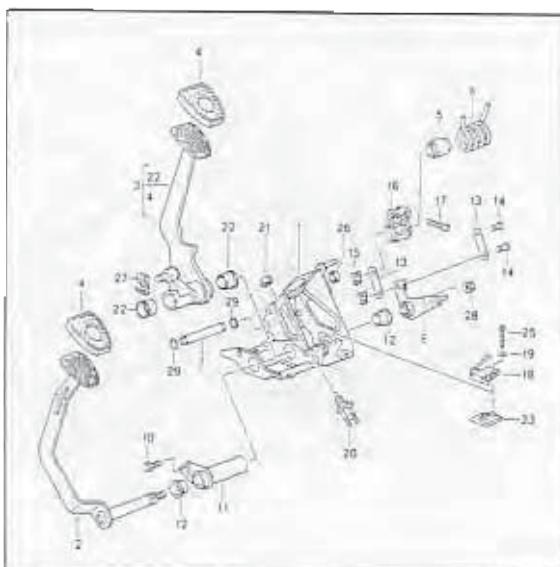
2. Insert brake pedal into mounting block. If necessary, fit a shim (arrow) between the brake pedal and the mounting block (to compensate for the axial play). The shim is not always present.

When replacing the mounting block or the brake pedal, determine the thickness of the shim (if present and/or required):
With the brake pedal installed, determine by trial and error which shim can be inserted. There are shims with two different thicknesses available.

Insert bearing tube no. 11.

Insert screw no. 10, but do not tighten it yet.

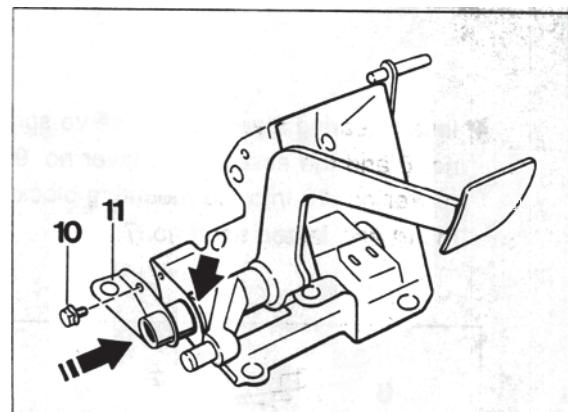
Important: Tighten screw no. 10 only after installing the pedals.



2348-30

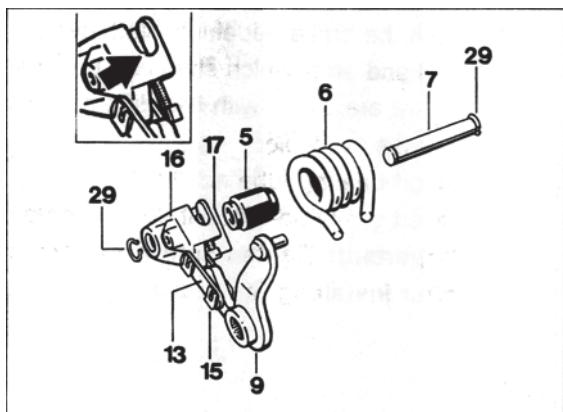
Note

Check the mounting block for deformations (might stem from removal of lever no. 9). If necessary, remove the mounting block.



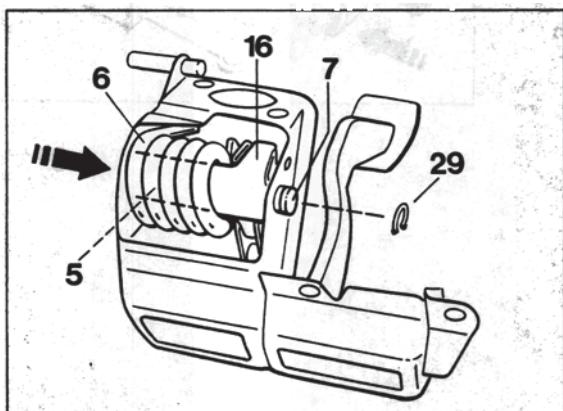
2363/1-30

3. Preassemble lever no. 9, rocker no. 16 and connecting pieces no. 13. If necessary (after installation of a new rocker), turn adjustment screw no. 17 until the leg of the servo spring fits closely to the rocker (arrow). **Install only levers no. 9 with optimized kinematics.** See note on p. 30-18.



2364-30

4. Insert bearing sleeve no. 5, servo spring no. 6 and the assembly of lever no. 9 and rocker no. 16 into the mounting block. Insert and fasten shaft no. 7.

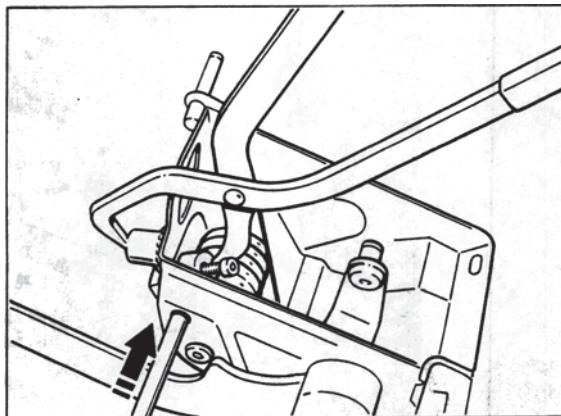


2365/1-30

5. To preload the servo spring, mount the brake pedal of the completed pedal system onto a vise – **using protective jaws.**

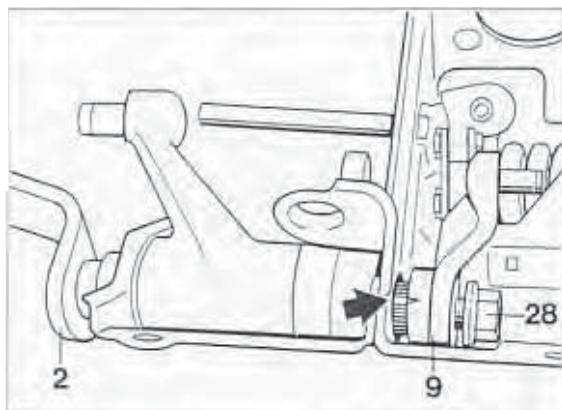
6. **Preload servo spring as follows:**

Use an appropriate spring tensioning tool, e.g. brake spring pincers by Hazet (Hazet no. 797), to preload the servo spring until an auxiliary tool (steel pin with 8 mm Ø) can be inserted into the bore of the rocker from the side. To protect the mounting block, use a liner when applying the pincers.



2366/1-30

7. Insert clutch pedal shaft with clutch pedal no. 2.
Fit lever no. 9 **in its correct position** to the clutch pedal shaft (notch on lever must face tooth gap of shaft).
Fit fastening nut no. 28.
Do not tighten fastening nut yet, (see next item).



2367-30

8. Remove **auxiliary tool** (steel pin to preload servo spring) from rocker. To do so, move clutch pedal backwards (towards clutch position) **carefully and only slightly**. Remove the steel pin as soon as it is no longer under load.

Then tighten fastening nut no. 28, tightening torque **34 Nm**.

Note

If the auxiliary tool (steel pin) is not removed with utmost care or if the fastening nut is tightened with the auxiliary tool still inserted, the rocker may get damaged in the area of the bore.

9. On vehicles with cruise control, install the microswitch.
 10. Install the clutch master cylinder.
 On vehicles with cruise control, adjust the microswitch by sliding it into the proper position.
 The microswitch must be triggered (clicking sound) on the first few millimeters of pedal travel.

If the clutch master cylinder does not fit closely to the mounting block, rework the mounting block's contact surface using a plastic hammer.

11. When replacing the mounting block, re-install those parts of the old mounting block that are required.

12. Set adjustment screw of servo spring (no. 17) to the dimension of 6 mm (see page 30-13).

13. **Install** pedals **with the servo spring released partially** (clutch pedal in de-clutched position).

Important note

Then tighten screw of bearing tube (see item 2 on page 30-19).

14. Connect lines of hydraulic clutch system to clutch master cylinder. Bleed clutch system.

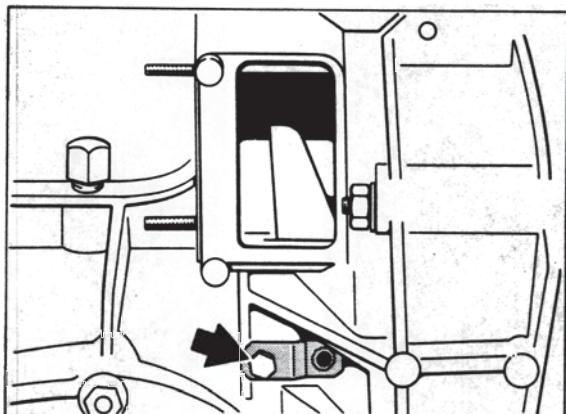
Note

Carry out adjustments, e.g. adjusting brake light switch, and inspections, e.g. limiting / adjusting pedal travel.

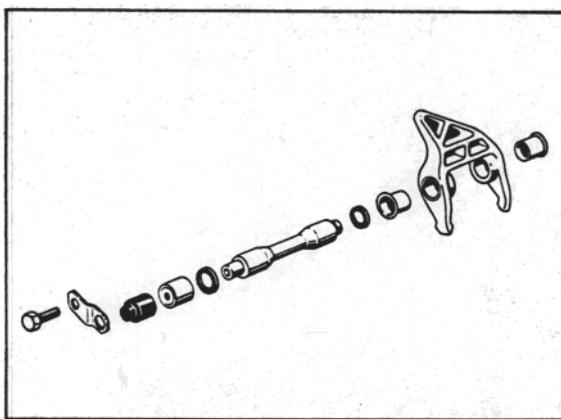
The adjustment jobs are described on pages 30-13 and 30-14.

34 35 27 Removing and refitting the transmission**Removing the transmission**

- Remove wire from starter and wire from reverse light switch.
2. Remove M 6 x 16 hexagon head bolt, bracket and mount cover. Pull out release lever shaft using an M 6 x 40 hexagon head bolt.
3. Undo four fastening nuts and separate transmission from engine. Undo upper fastening nut from starter using Special Tool P 119.



1391-10



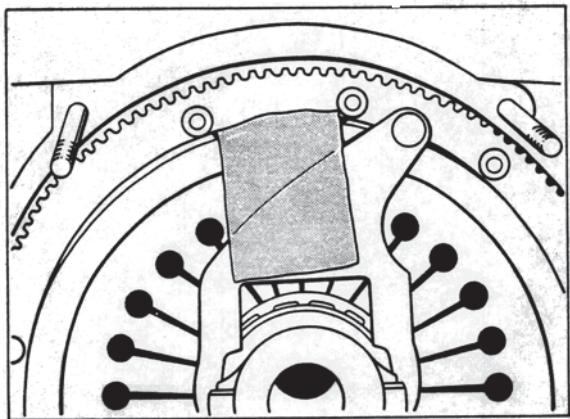
1388-10

Refitting the transmission

Note:

Apply a very thin coat of Olista Longtime 3 EP to input shaft splines (for corrosion protection only).

Engage release fork into release bearing and use a suitable length of adhesive tape to locate it provisionally in installation position.

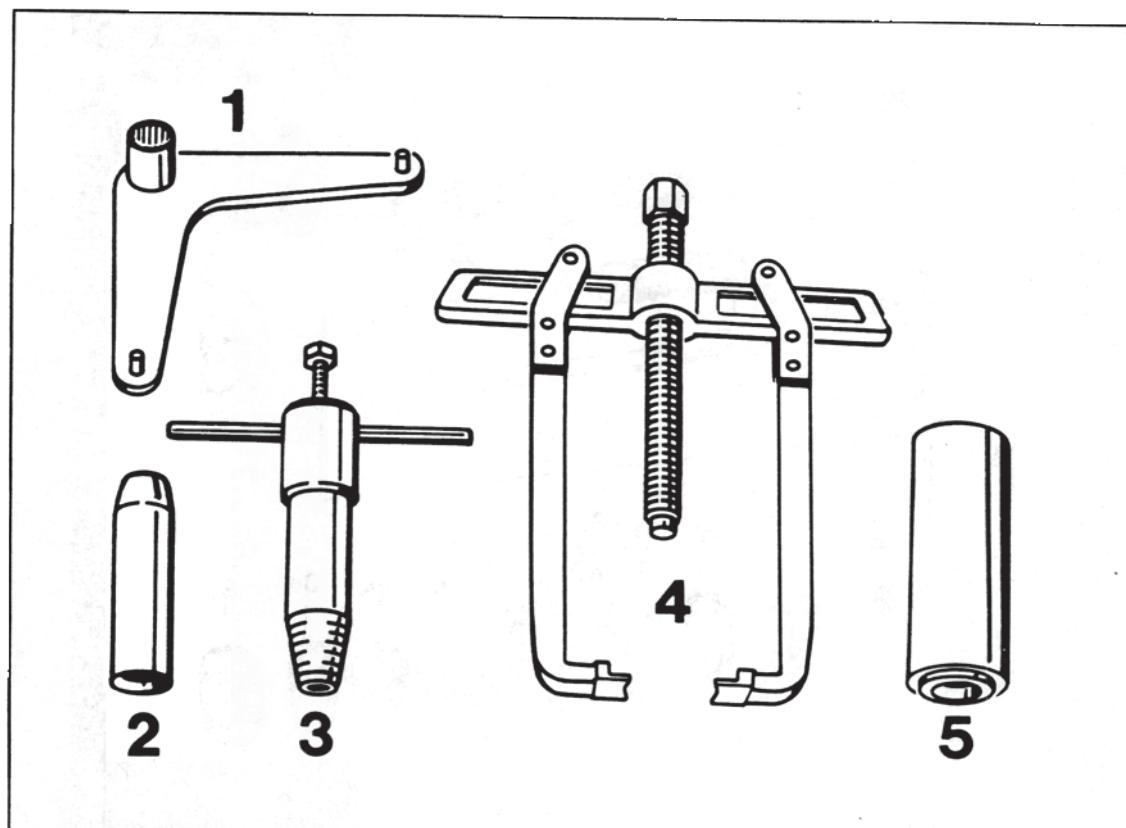


1390-10

2. Refit transmission to engine.
3. Engage release lever shaft with seals into release fork.
4. Remove locating tape from release fork across assembly hole.
5. Install needle-roller bearing, mount cover and bracket and tighten down with M 6 x 16 hexagon head bolt (also refer to assembly notes, Group 30, page 30 - 1).

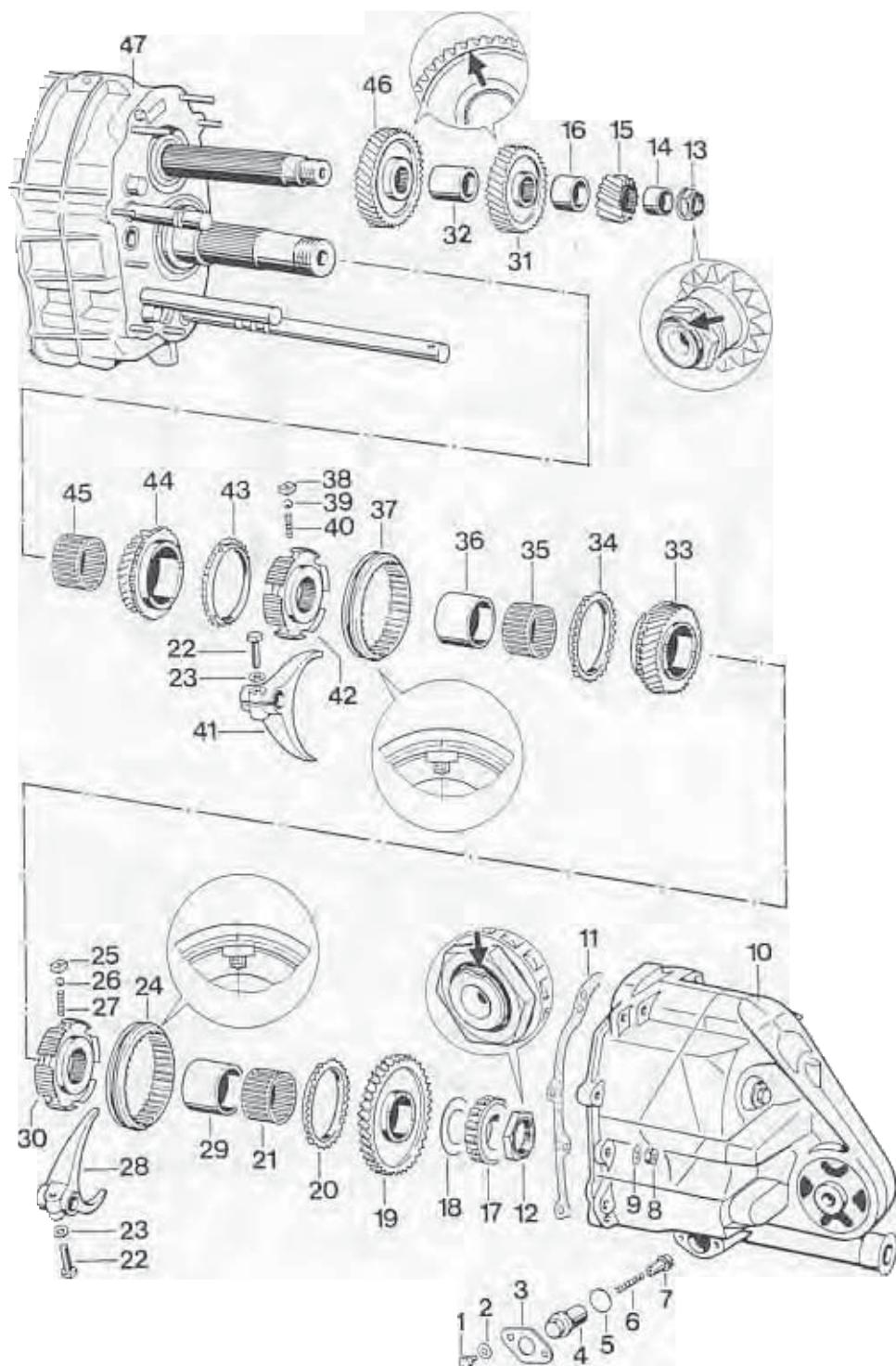
34 35 37 Dismantling and assembling transmission

Tools



No.	Designation	Special tool	Order number	Explanation
1	Bracket	9253	000.721.925.30	
2	Assembling sleeve	9255	000.721.925.50	
3	Puller set	9251	000.721.925.10	
4	Puller	-	-	use arms of puller 9284
5	Pressure piece	9256	000.721.925.60	

34 35 37 Dismantling and assembling transmission



No.	Designation	Qty.	Removal	Note:
				Installation
1	Hexagon head bolt	2		Tighten to 10 Nm (7 ftlb.)
2	Washer	2		
3	Clamping plate	1		
4	Eccentric bushing	1		Adjust
5	Seal	1		Replace
6	Thrust spring	1		
7	Locking bushing	1		
8	Hexagon head nut	10		Tighten to 23 Nm (17 ftlb.)
9	Washer	10		
10	Front transmission cover	1		
11	Seal	1		Replace
12	Hexagon nut*	1	Lock input shaft with Special Tool 9253 and en- gage 6th gear	Tighten to 250 Nm (184 ftlb.), Upset flange to lock
13	Hexagon nut*	1	Lock input shaft with Special Tool 9253 and en- gage 6th gear	Tighten to 140 Nm (103 ftlb.), Upset flange to lock
14	Inner bearing race	1	Pull off across fixed gear- wheel No. 15	Heat to approx. 120 °C
15	Fixed gear (reverse)	1		
16	Spacer sleeve	1		
17	Cylindrical roller bearing	1	Pull off across loose gear- wheel No. 19	Heat to approx. 120 °C
18	Thrust washer	1		
19	Loose gearwheel (reverse)	1		
20	Synchronizer ring	1	Mark for reinstallation	Check for wear. Fit with the same gear- wheel (cogs must face dri- ver dogs)

No.	Designation	Qty.	Note:	
			Removal	Installation
21	Needle bearing cage	1	Mark for reinstallation	Fit with the same gearwheel
22	Hexagon head bolt	2		Tighten to 23 Nm (17 ftlb.)
23	Washer	2		
24	Shift sleeve	1	Lift off along with shift fork No. 28. Take care not to lose synchromesh parts.	Center the centerpunch marks relative to the driver dogs. Offset side faces loose gearwheel No. 19
25	Driver dog	3		Domed end faces shift sleeve
26	Ball	3		
27	Spring	3		
28	Shift fork (reverse)	1		Adjust so that play is barely felt with reverse engaged. When neutral is engaged, the synchronizing ring must be able to rotate freely.
29	Inner race**	1	Pull off across guide sleeve No. 30	Heat to approx. 120 °C
30	Guide sleeve (with snap ring)	1		Open end of snap ring must not be located in the driver dog area. Install in correct position complete with shift sleeve and shift fork (snap ring faces loose gearwheel No. 33)
31	Fixed gearwheel (5th gear)	1		Identification groove faces fixed gearwheel No. 15. Do not confuse with fixed gearwheel No. 46

No.	Designation	Qty.	Note:	
			Removal	Installation
32	Spacer sleeve	1		
33	Loose gearwheel (5th gear)	1		Do not confuse with loose gearwheel No. 44
34	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel (cogs face driver dogs)
35	Needle bearing cage	1	Mark for reinstallation	Fit with the same gearwheel
36	Inner race**	1	Mark for reinstallation. Pull off with arms of Special Tool 9284 across loose gearwheel No. 44	Fit with the same gearwheel. Heat to approx. 120 °C
37	Shift sleeve	1		Center the centerpunch marks relative to the driver dogs
38	Driver dog	3		Domed side faces shift sleeve
39	Ball	3		
40	Spring	3		
41	Shift fork (5th and 6th gears)	1		Adjust. In the neutral position, the shift sleeve must be set exactly in the middle between the loose gearwheels
42	Guide sleeve	1		Install complete with shift sleeve and shift fork

No.	Designation	Qty.	Note:	
			Removal	Installation
43	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel (cogs face driver dogs)
44	Loose gearwheel (6th gear)	1		Do not confuse with loose gearwheel No. 33
45	Needle roller bearing cage	1	Mark for reinstallation	Fit with the same gearwheel
46	Fixed gearwheel (6th gear)	1		Identification groove faces fixed gearwheel No. 31. Do not confuse with fixed gearwheel No. 31
47	Transmission	1		

Transmission shafts without recesses for securing the hexagon nuts have been installed since September 1995.

Self-locking hexagon nuts are used on these shafts, and these nuts must **always** be replaced in every transmission repair.

** As a result of tolerances, the bearing inner rings (no. 29 and 36) may either form a force fit on the shaft or have a certain amount of play.

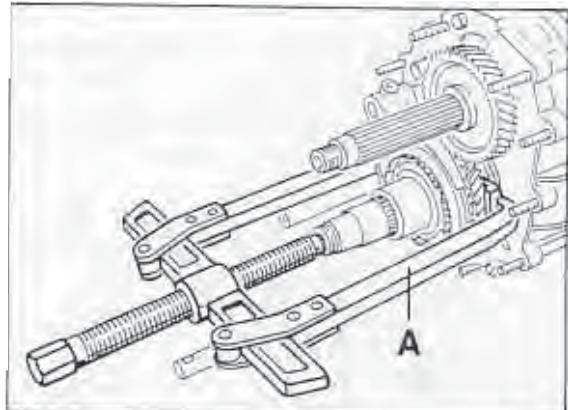
Dismantling and assembly notes

Note

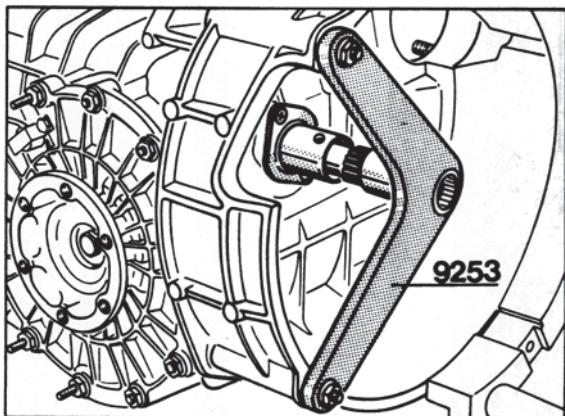
If the shift rods are moved across the neutral or gear latching positions when the transmission is dismantled or assembled, the small intermediate locks (see page 35 - 13) may drop out inadvertently.

Dismantling

- Engage 6th gear, lock input shaft with Special Tool 9253 and release hexagon head nuts for output and input shafts.



1641-34



503-34

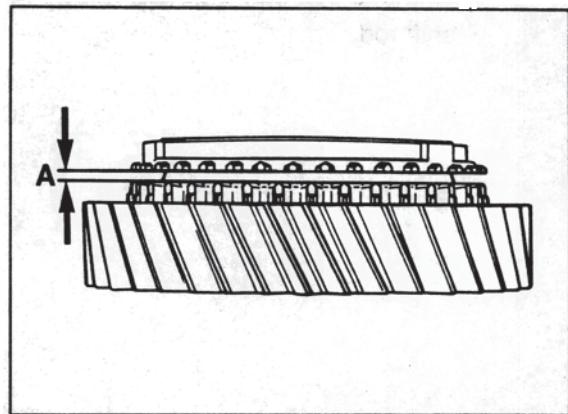
- Engage fourth gear and pull off inner race of needle roller bearing (5th gear).

A = Arms of puller 9284

Assembly

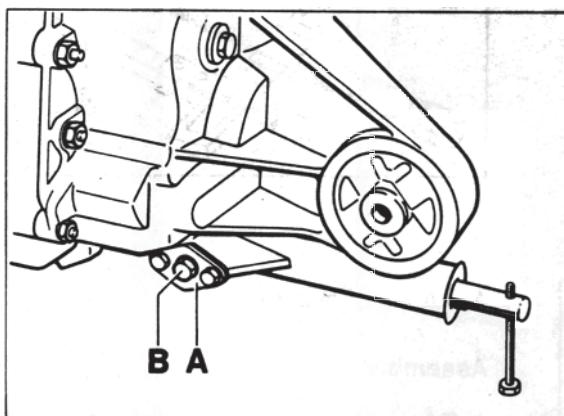
- To check synchronizing rings, push rings onto the tapers of the gearwheels and measure gap "A" with a feeler gauge.

Installation dimension (new) = min. 0.9 mm
Wear limit = 0.6...0.7 mm



518-35

2. Engage fourth gear and fit all gearwheels.
3. Adjust inner shift rod until all gears may be preselected freely without notching. To adjust, undo hexagon head bolts of tensioning plate and rotate eccentric bushing.



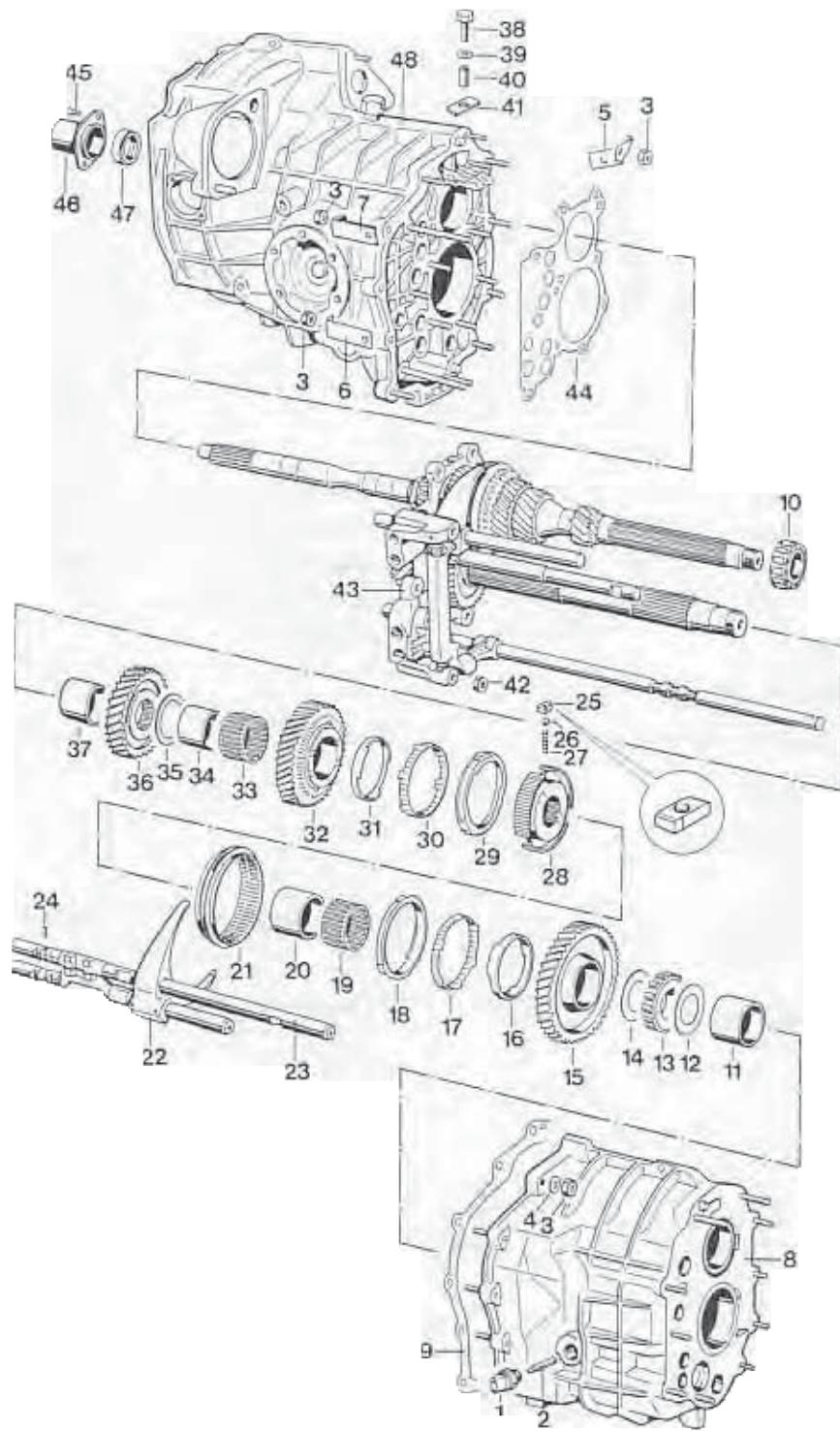
527-34

A = Tensioning plate

B = Eccentric bushing

4. To check, shift through all gears, using a long M 8 bolt that is screwed into the inner shift rod.

34 35 37 Dismantling and assembling transmission



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Reverse light switch	1		Tighten to 35 Nm (26 ftlb.)
2	Plunger	1		Stepped end faces switch
3	Hexagon head nut	10		Tighten to 23 Nm (17 ftlb.)
4	Washer	10		
5	Retaining bracket	1		
6	Retaining bracket (straight)	1		
7	Retaining bracket (domed)	1		
8	Gear housing	1		
9	Gasket	1		Replace
10	Cylindrical roller bearing	1	Pull off	Heat to approx. 120 °C
11	Inner race	1	Mark for reinstallation. Pull off across loose gearwheel No. 15. Observe clearance at reverse shift rod	Fit with the same gear- wheel. Heat to approx. 120 °C
12	Thrust washer	1		
13	Cylindrical roller bearing	1		Heat to approx. 120 °C
14	Thrust washer	1		
15	Loose gearwheel (1st gear)	1		
16	Friction ring	1	Mark for reinstallation	Fit with the same gear- wheel
17	Tapered ring	1	Mark for reinstallation	Fit with the same gear- wheel. Tabs must engage in the cutouts in the loose gearwheel

No.	Designation	Qty.	Removal	Note: Installation
18	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel. Drivers must engage in the cutouts in the tapered ring. Three lugs face driver dogs
19	Needle roller bearing		Mark for reinstallation	Fit with the same gearwheel
20	Inner race	1	Shift rods in neutral position. Pull out shift rod for reverse gear. Pull off across loose gearwheel No. 32. Mark for reinstallation.	Fit with the same gearwheel. Heat to approx. 120 °C
21	Shift sleeve	1		Insert complete with guide sleeve and shift rods. The missing tooth of the internal teeth of the guide sleeve (No. 28) must be aligned exactly above the oil bore of the output shaft.
22	Shift rod with pinned shift fork	1		
23	Shift rod (reverse)	1		
24	Spacer	1		Apply stiff grease to insert into shift rod
25	Driver dog	3		Place into correct position
26	Ball	3		
27	Spring	3		

No.	Designation	Qty.	Note:	
			Removal	Installation
28	Guide sleeve	1		Missing tooth of internal teeth must be placed exactly above oil bore of output shaft
29	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel. Drivers must engage into the cutouts in the tapered ring. The lugs face the driver dogs.
30	Tapered ring	1	Mark for reinstallation	Fit with the same gearwheel. Tabs must engage into the cutouts in the loose gearwheel
31	Friction ring	1	Mark for reinstallation	Fit with the same gearwheel
32	Loose gearwheel (2nd gear)	1		
33	Needle roller bearing	1	Mark for reinstallation	Fit with the same gearwheel
34	Inner race	1	Mark for reinstallation. Pull off across fixed gearwheel No. 36	Fit with the same gearwheel. Heat to approx. 120 °C
35	Thrust washer	1		
36	Fixed gearwheel (3rd gear)	1		Large flange faces thrust washer No. 35
37	Spacer sleeve	1		
38	Hexagon head bolt (micro-sealed)	1		Must always be replaced. Tightening torque 6 Nm (4 ftlb.)
39	Washer	1		
40	Spacer sleeve	1		

No.	Designation	Qty.	Note:	
			Removal	Installation
41	Retaining plate	1		
42	Hexagon head nut	10		Tighten to 23 Nm (17 ftlb.)
43	Tensioning plate with gear set	1		
44	Adjusting washer "S ₃ "	X	Note number and thickness for reinstallation	Redetermine thickness if required
45	Oval-head screw	2		Tighten to 10 Nm (7 ftlb.)
46	Guide tube	1		
47	Shaft seal	1	Refer to page 35 - 1	Do not fit until gear set has been fitted (refer to page 35 - 1)
48	Transmission housing	1		

Note

Due to the tolerances (transition fit), the inner bearing rings (nos. 11, 20 and 34) may have clearance or press-fit on the shaft.

Modifications to the synchromesh and the shift sleeve for 1st and 2nd gear are described on page 35 - 14.

Dismantling and assembly notes

Dismantling

Note

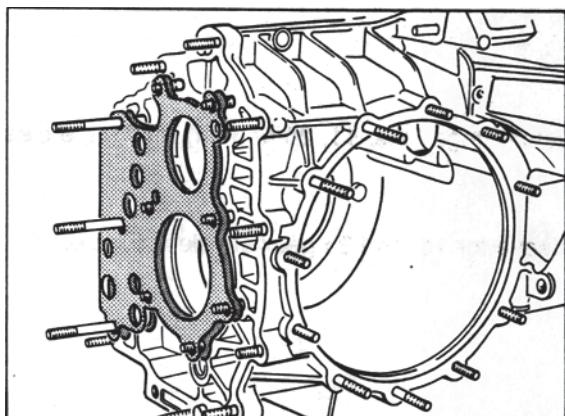
To facilitate assembly, do not remove the complete gear set assembly but partially dismantle the installed drive pinion.

Note

Do not move shift rods across the neutral or gear stop position as this may cause the small spacers to drop out inadvertently (refer to page 35 - 13).

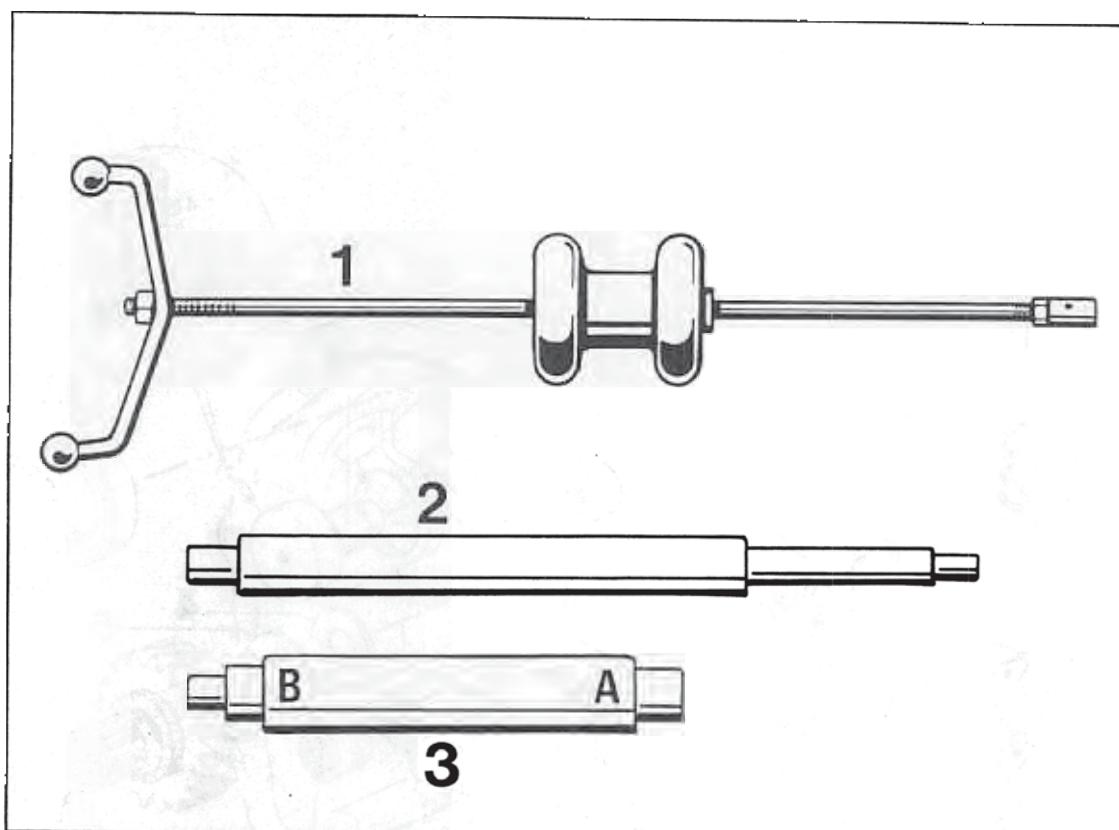
Assembly

1. The number of adjusting shims "S3" noted during dismantling or the number of adjusting shims noted when the drive pinion was adjusted should be placed onto the studs in the housing until the equivalent thickness is obtained.



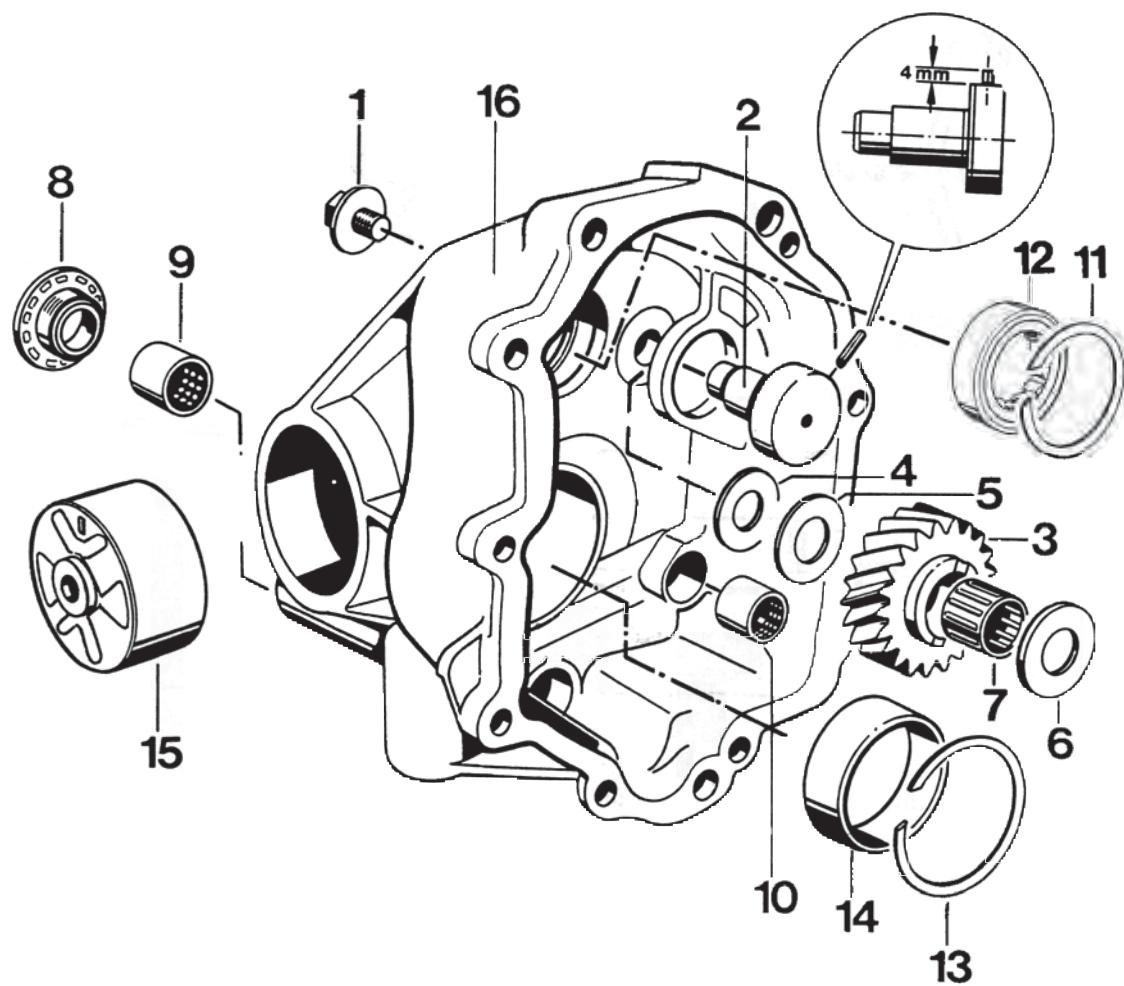
506-34

2. Fit fully assembled gear set complete with inner shift rod and tighten tensioning plate fastening nuts to **23 Nm** (17 ftlb.) (refer to page 35 - 7).

34 55 37 Dismantling and assembling front transmission cover**Tools**

No.	Designation	Special tool	Order number	Explanation
1	Punch	VW 771		
2	Mandrel	9515	000.721.951.50	
3	Mandrel	9254	000.721.925.40	

34 55 19 Dismantling and assembling front transmission cover

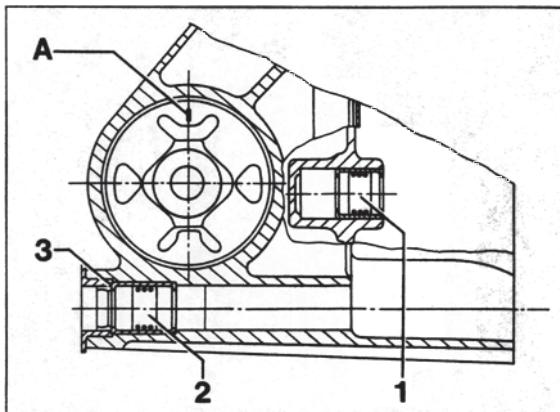


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hexagon-head bolt	1		Torque: 35 Nm (26 ftlb.)
2	Bolt with pin	1		Insert in correct position
3	Reverse idler gear	1		Small collar points towards hexagon-head bolt (no. 1)
4	Thrust washer (2.0 mm)	1		
5	Thrust washer (1.5 mm)	1		Do not confuse with washer no. 4
6	Thrust washer (1.5 mm)	1		Do not confuse with washer no. 4
7	Needle-roller assembly	1		
8	Shaft seal	1		Pack the area between dust lip and sealing lip with grease (e.g. Optimol HT2 + 2 EP); press in to stop with mandrel 9254 (p. A)
9	Ball sleeve (long)	1	Press out from the inside, using a suitable mandrel (e.g. 9515)	Press in to stop with Special tool 9254 (p. B)
10	Ball sleeve (short)	1	Pull out with a suitable internal puller (e.g. Schrem 14 - 20) and punch VW 771	Press in to stop with Special tool 9254 (p. A)
11	Retaining ring	1		
12	Cylindrical roller bearing	1	Pull out with suitable internal puller (e.g. Schrem 30 - 40)	Heat cover to approx. 120 °C and press in to stop
13	Retaining ring	1		

No.	Designation	Qty.	Note:	
			Removal	Installation
14	Outer bearing race	1	Pull out with suitable internal puller (e.g. Schrem 50 - 60)	Heat cover to approx. 120 °C and press in to stop
15	Transmission bearing	1	Press out with suitable pipe section	Press in to correct position
16	Front transmission cover	1		

Notes on assembly

1. Press in ball sleeves, shaft seal and transmission bearing to correct position.



1642-34

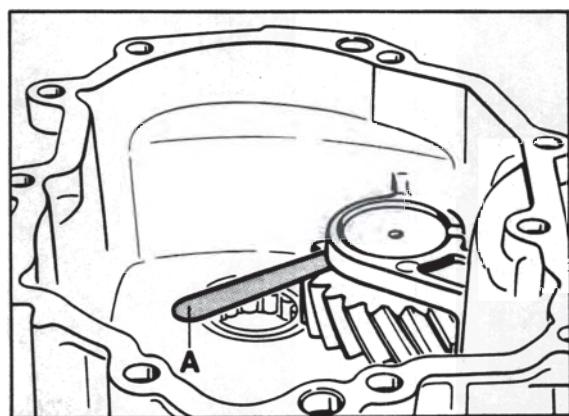
1 - Short ball sleeve (press in flush)

2 - Long ball sleeve

3 - Shaft seal

A - Assembly mark (must point upwards)

2. Reassemble reverse idler gear with thrust washers and bolt in correct position (refer to exploded view). With thrust washers and bolt located correctly, the end clearance of the reverse idler gear is 0.15...0.35 mm.



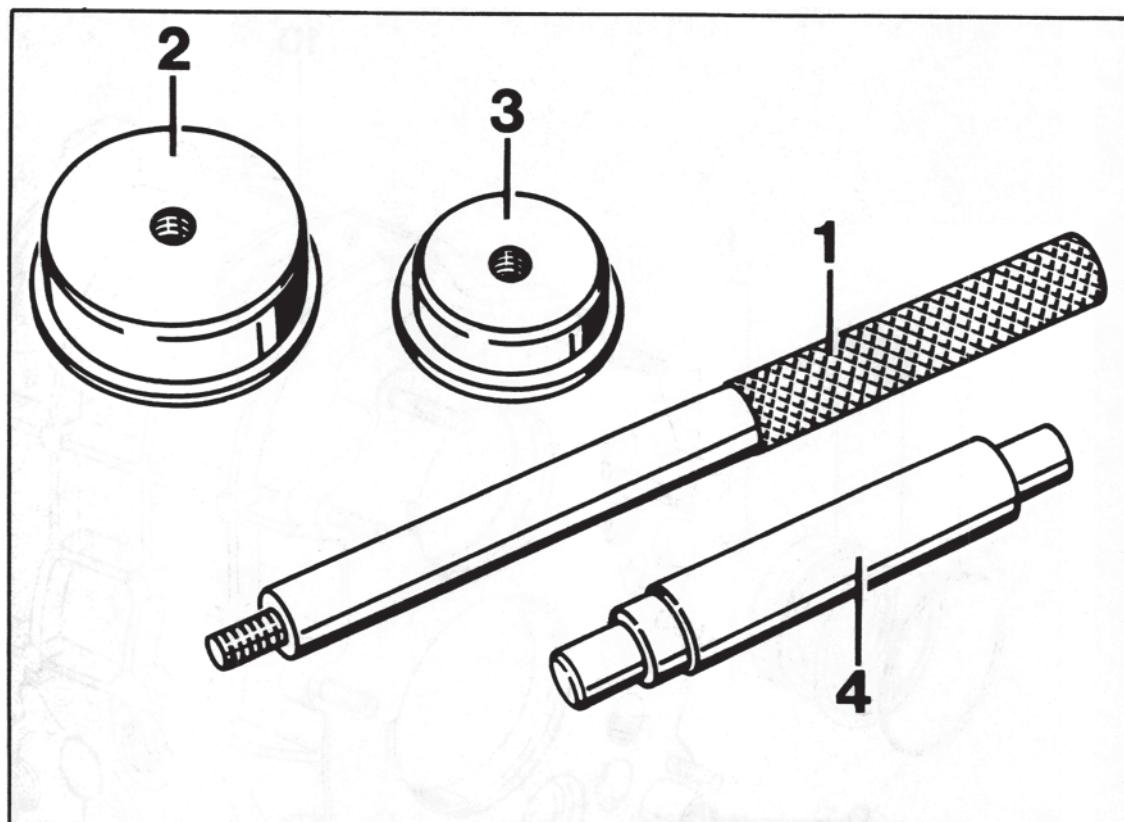
520-34

A = Feeler gauge

3. Check end clearance of reverse idler gear with feeler gauge.

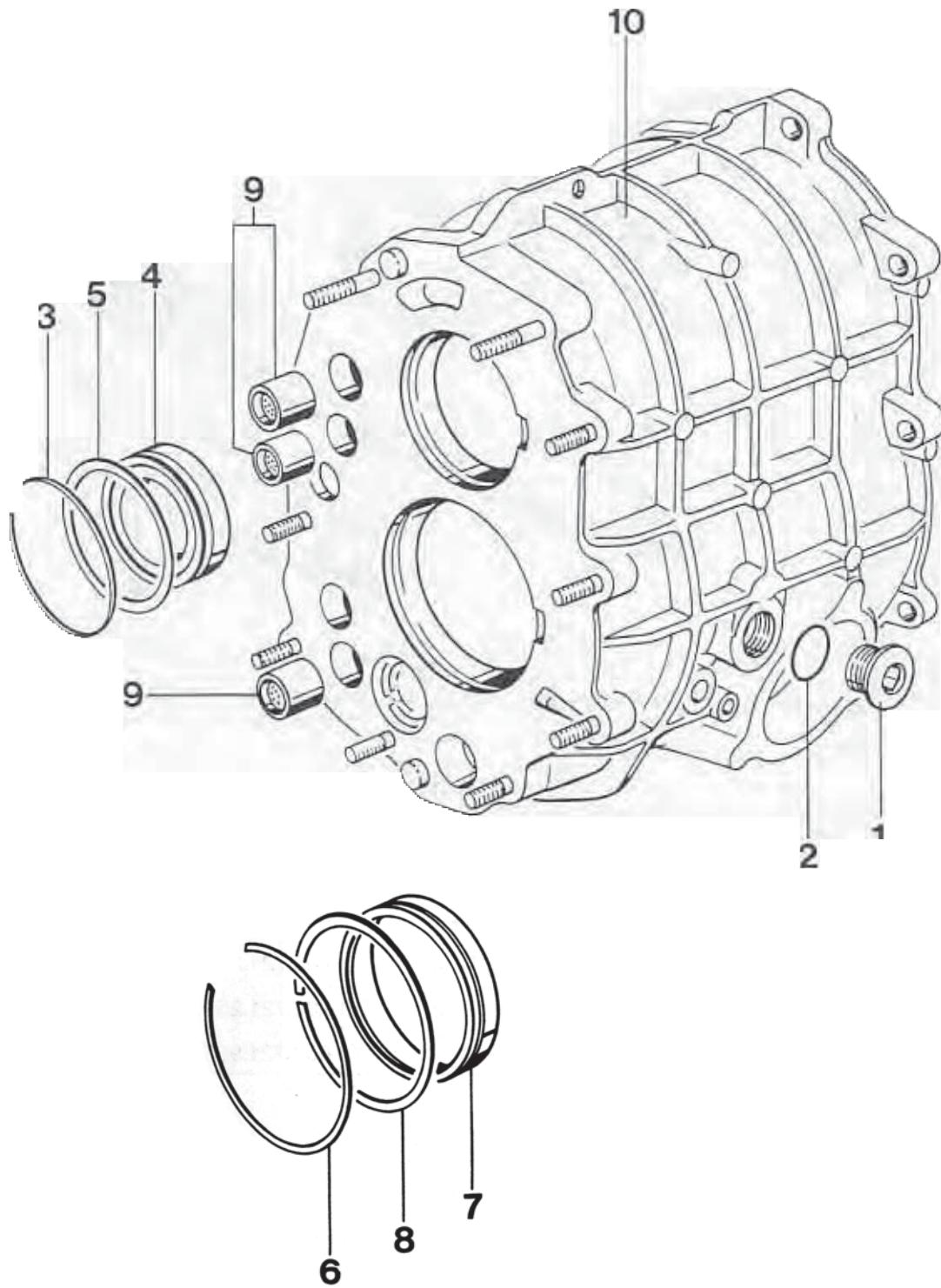
34 52 37 Dismantling and assembling gear housing

Tools

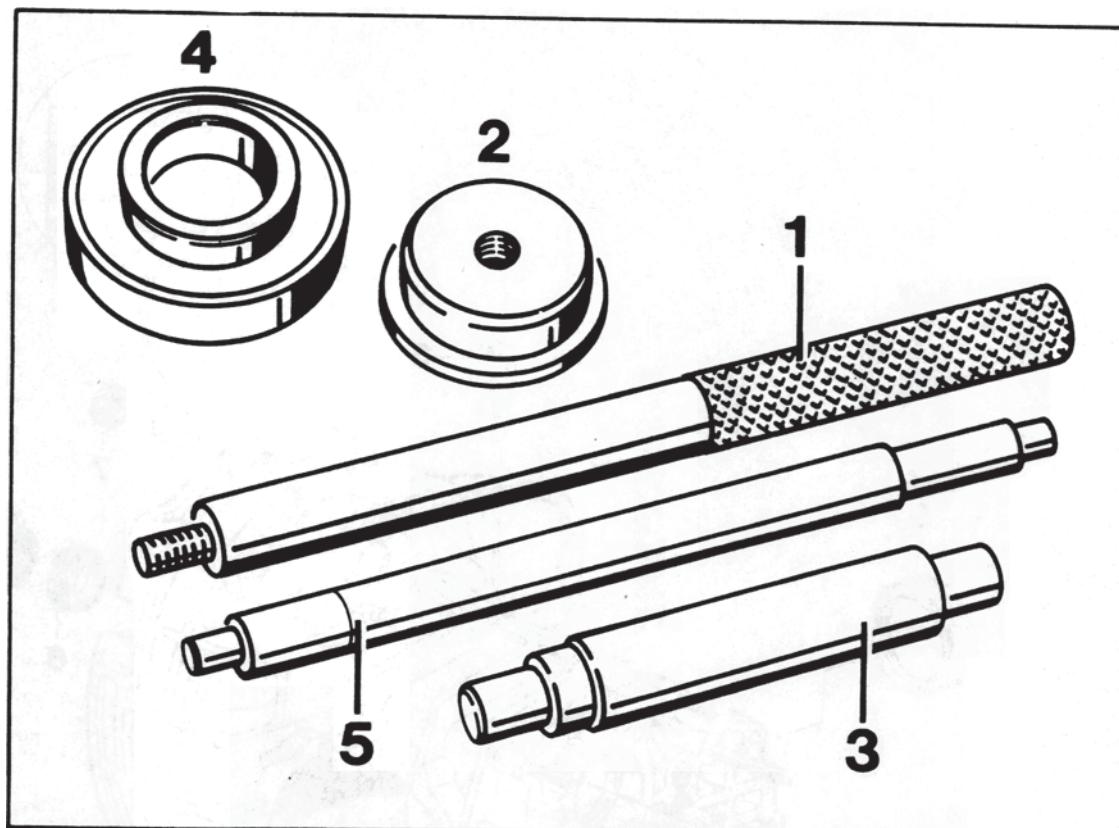


No.	Designation	Special tool	Order number	Explanation
1	Mandrel	P 254	000.721.254.00	
2	Thrust piece	P 254 a	000.721.254.10	
3	Thrust piece	P 254 b	000.721.254.20	
4	Mandrel	9254	000.721.925.40	

34 52 37 Dismantling and assembling gear housing

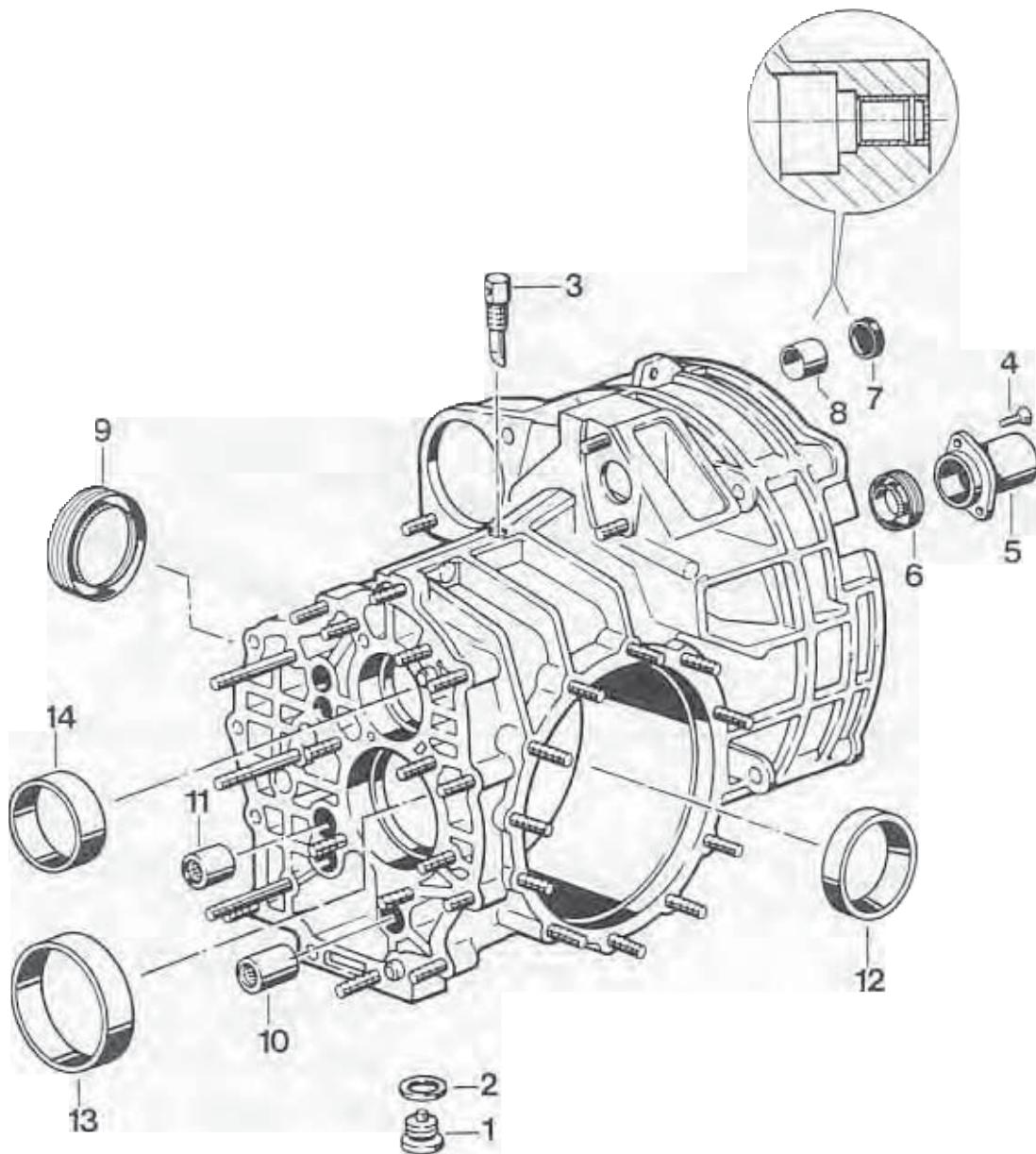


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Plug	1		Torque: 30 Nm (22 ftlb.)
2	Seal	1		Replace
3	Retaining ring	1		
4	Bearing outer race	1	Working from inside, press out with Special Tools P 254 and P 254 b	Press in with Special Tools P 254 and P 254 b
5	Snap ring	1		
6	Retaining ring	1		
7	Bearing outer race	1	Working from inside, press out with Special Tools P 254 and P 254 b	Press in with Special Tools P 254 and P 254 b
8	Snap ring	1		
9	Ball sleeve	3	Press out with suitable mandrel	Press in flush with Special Tool 9254
10	Gear housing	1		

34 37 37 Dismantling and assembling transmission housing**Tools**

No.	Designation	Special tool	Order number	Explanation
1	Mandrel	P 254	000.721.254.00	
2	Thrust piece	P 254 b	000.721.254.20	
3	Mandrel	9254	000.721.925.40	
4	Thrust piece	9252	000.721.925.20	
5	Mandrel	9515	000.721.951.50	

34 37 37 Dismantling and assembling transmission housing



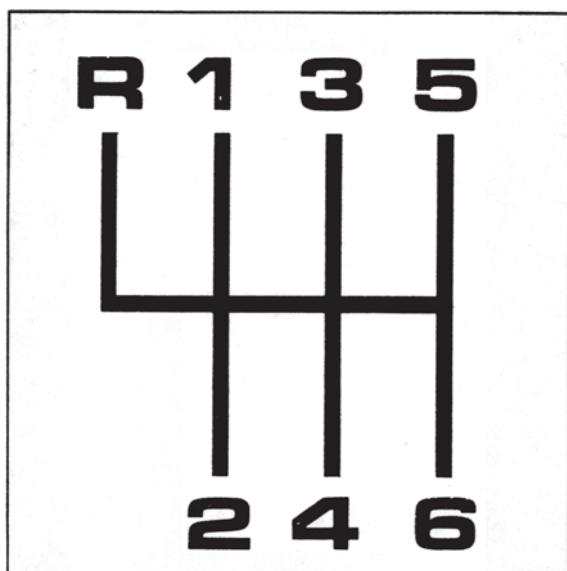
No.	Designation	Qty.	Note:	
			Removal	Installation
	Plug	1		Clean, tighten to 30 Nm (22 ftlb.)
2	Seal	1		Replace
3	Vent	1		Tighten to 35 Nm (26 ftlb.). The hole in the hexagon head must face the front transmission cover
4	Oval-head screw	2		Tighten to 10 Nm (7 ftlb.)
5	Guide tube			
6	Shaft seal	1		Do not fit until the gear set has been fitted (also refer to page 35 - 1)
7	Cover	1		
8	Bushing	1	Push out with drift 9515, working from inside towards outside	Do not grease or oil and do not clean with solvents (e.g. benzene). Push in from inside with drift 9515 until it is seated against the stop.
9	Shaft seal			Push in with Special Tool 9252 until it is seated against the stop. Pace space between dust lip and sealing lip with grease (e.g. Optimol HT2 + 2EP)
10	Ball sleeve (long)	1	Pull out with suitable internal puller (e.g. Schrem 14 - 20)	Press in flush with Special Tool 9254
11	Ball sleeve (short)	4	Pull out with suitable internal puller (e.g. Schrem 14 - 20)	Press in flush with Special Tool 9254

No.	Designation	Qty.	Note:	
			Removal	Installation
12	Bearing outer race	1	Heat transmission housing to approx. 120 °C and remove race with suitable drift	Heat transmission housing to approx. 120 °C and press in with suitable thrust piece
13	Bearing outer race	1	Heat transmission housing to approx. 120 °C and remove race with suitable thrust piece (e.g. VW 513)	Heat transmission housing to approx. 120 °C and press in with suitable thrust piece (e.g. 9247/4) until it is seated against the stop
14	Bearing outer race	1	Heat transmission housing to approx. 120 °C and pull put with suitable internal puller (e.g. Schrem 50 - 60)	Heat transmission housing to approx. 120 °C and press in with Special Tools P 254 and P 254 b until it is seated against the stop
15	Transmission housing	1		

34

Adjusting gear shift

1. Set the shift lever to the neutral position.
The lever will automatically move to the 3rd/4th gear plane (no adjustment possible).



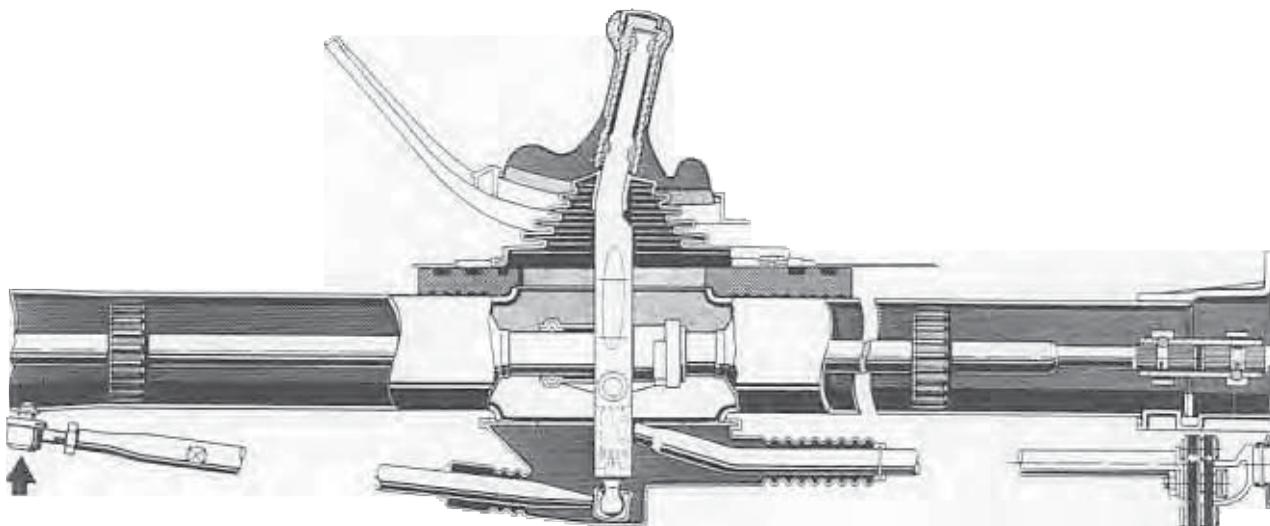
2049A-34

2. If the gearshift is correctly adjusted, there should be no longitudinal inclination on the lower part of the lever, which is curved at the top. The lower 90° part should be at right angles to the central tube or transmission tunnel.

3. Checking the adjustment: shift through all the gears. whichever gear is selected, there must be about the same space between the front and rear consoles.

4. If necessary, correct the adjustment on the ball of the adjustable guide tube (arrow). One turn of the ball corresponds to a change of about 3 to 5 mm in the angle of the shift lever.

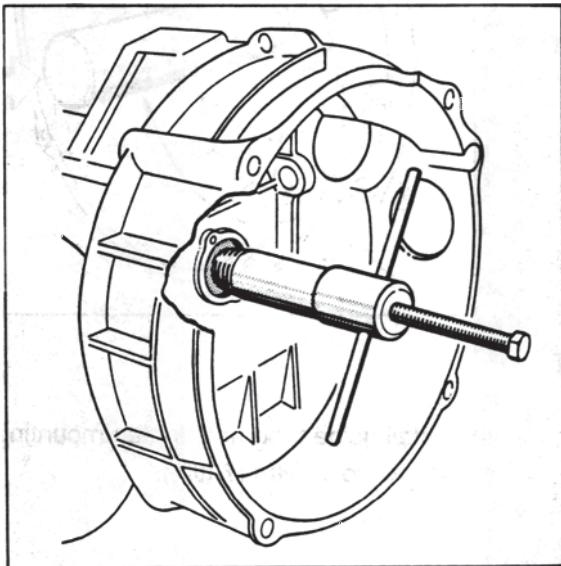
Caution: When tightening the lock nut, make sure that you do not twist the balls in relation to each other.



Drawing 644A shows the four-wheel drive version. On the rear-wheel drive version, the ball of the guide tube (arrow) is installed on a transverse strut attached to the front axle cross member.

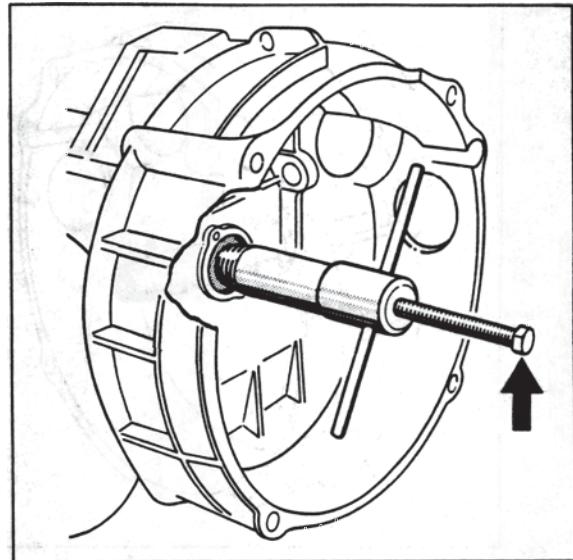
35 50 19 Removing and installing input shaft oil seal**Removing**

1. Remove engine/transmission assembly and separate transmission from engine.
2. Remove release bearing guide tube.
3. Screw Special Tool 9251 firmly into the oil seal.



1652-34

4. Screw in the hexagon-head bolt and pull out oil seal.



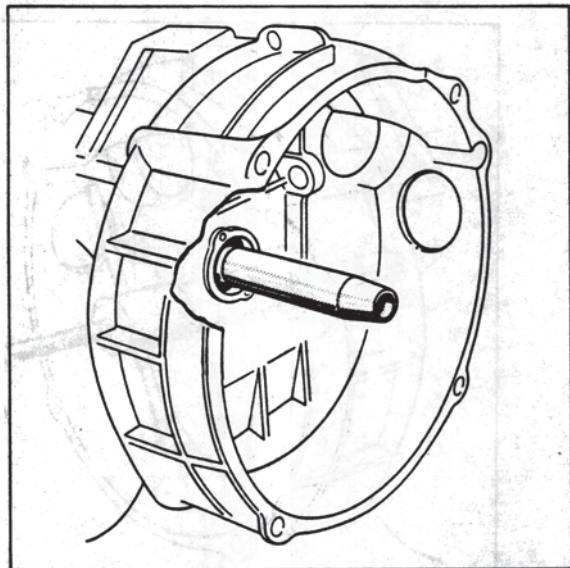
1653-34

Note

If the helical tension spring jumps out when removing the seal, use a wire hook to pull it off the input shaft.

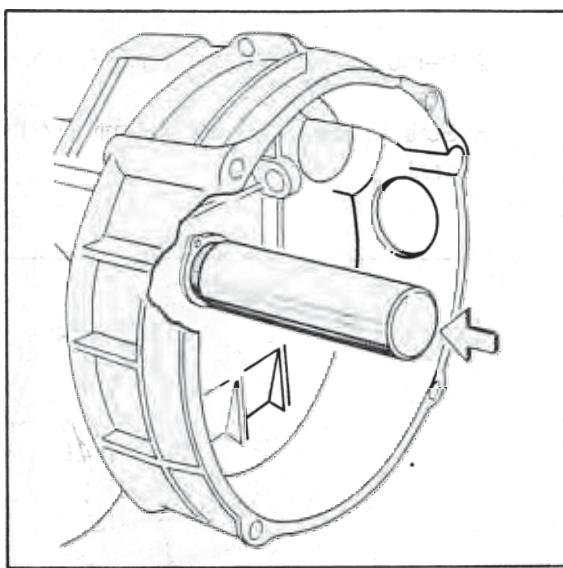
Installing

1. Push assembling sleeve 9255 onto the input shaft splines.



1654-34

3. Use Special Tool 9256 to drive the oil seal into place.

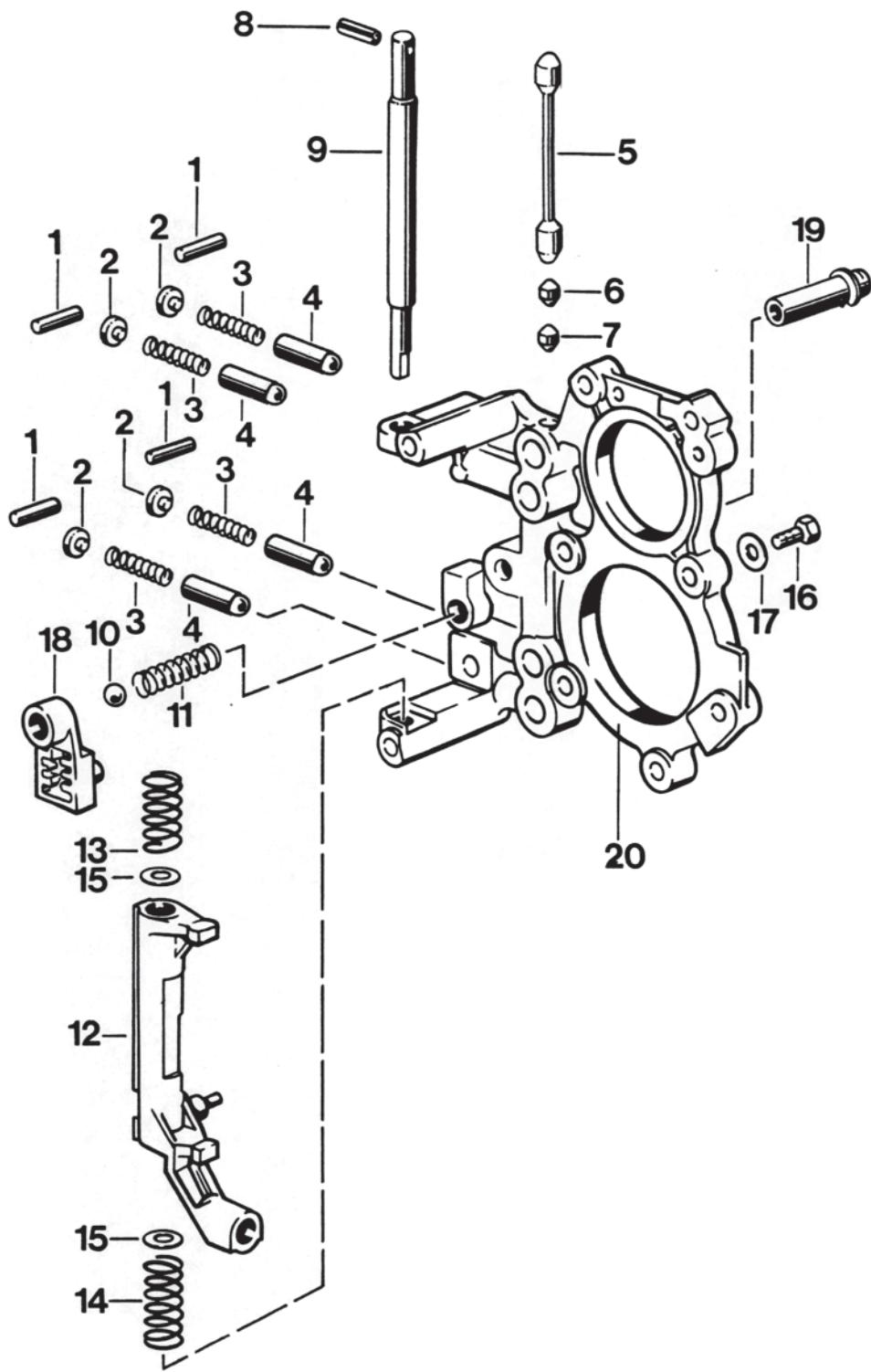


1655-34

2. Pack oil seal area between dust lip and sealing lip with grease (e.g. Optimol HT 2 + 2 EP).

4. Install guide tube and tighten mounting screws to **10 Nm** (7 ftlb.).

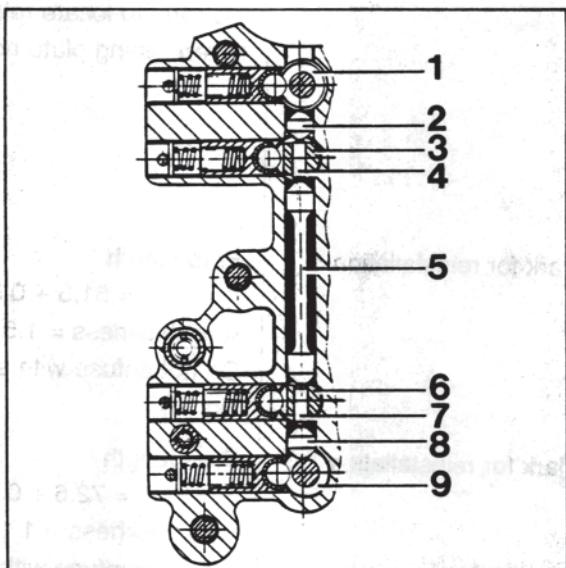
35 19 37 Dismantling and assembling tensioning plate



No.	Designation	Qty.	Removal	Note: Installation
1	Straight pin	4	With the shift rods fitted, the springs (No. 3) are under load	
2	Washer	4		
3	Thrust spring	4		
4	Locking bush	4		
5	Lock (long)	1		
6	Lock (short)	1		
7	Lock (short)	1		
8	Roll pin	1		
9	Bearing shaft	1		Install in correct position, use 8 mm dia. locating mandrel to locate relative to tensioning plate hole
10	Ball	1		
11	Thrust spring	1		
12	Deflection lever	1		
13	Thrust spring	1	Mark for reinstallation	Free length $= 51.3 + 0.5$ mm wire thickness = 1.5 mm. Do not confuse with spring No. 14
14	Thrust spring	1	Mark for reinstallation	Free length $= 72.6 + 0.5$ mm wire thickness = 1.1 mm. Do not confuse with spring No. 13
15	Shim	2		

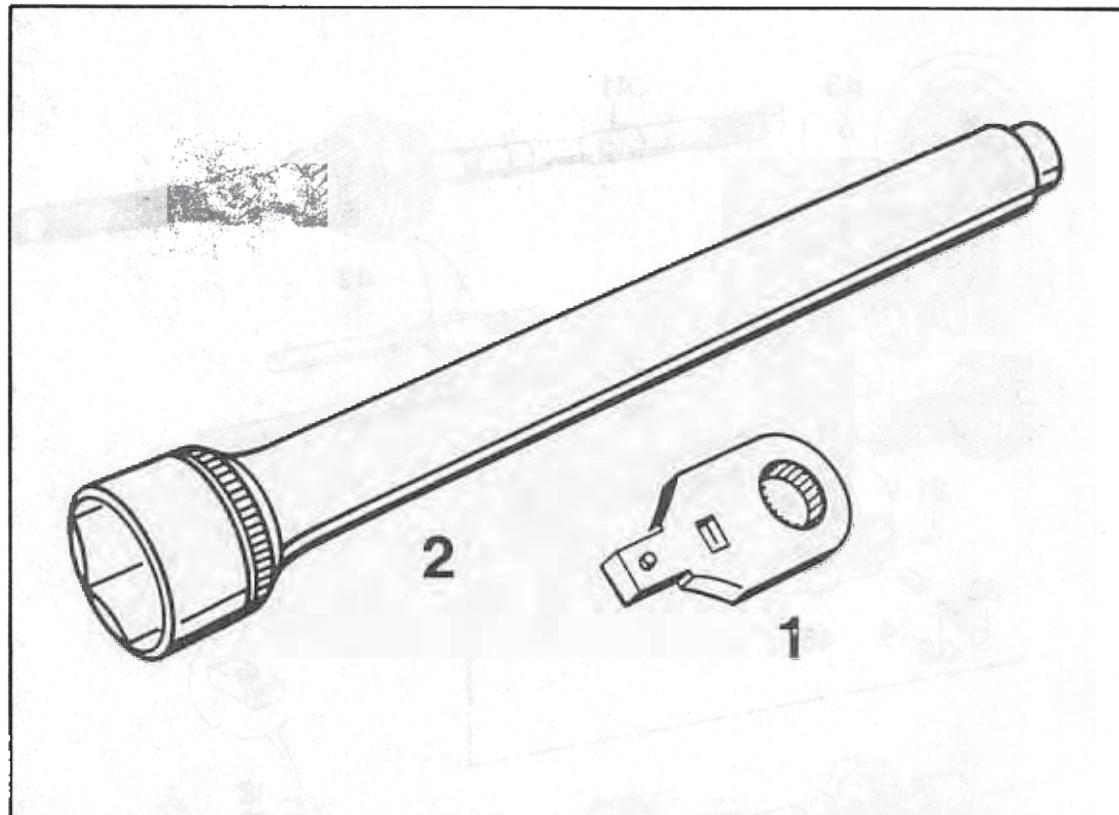
No.	Designation	Qty.	Removal	Note: Installation
16	Hexagon head bolt	1		Tighten to 10 Nm (7 ftlb.)
17	Washer	1		
18	Selector gate	1		
19	Adapter sleeve with snap ring	1	Press out with suitable drift	Press in with suitable drift until it is seated against the stop
20	Tensioning plate	1		

Installation position of the locks



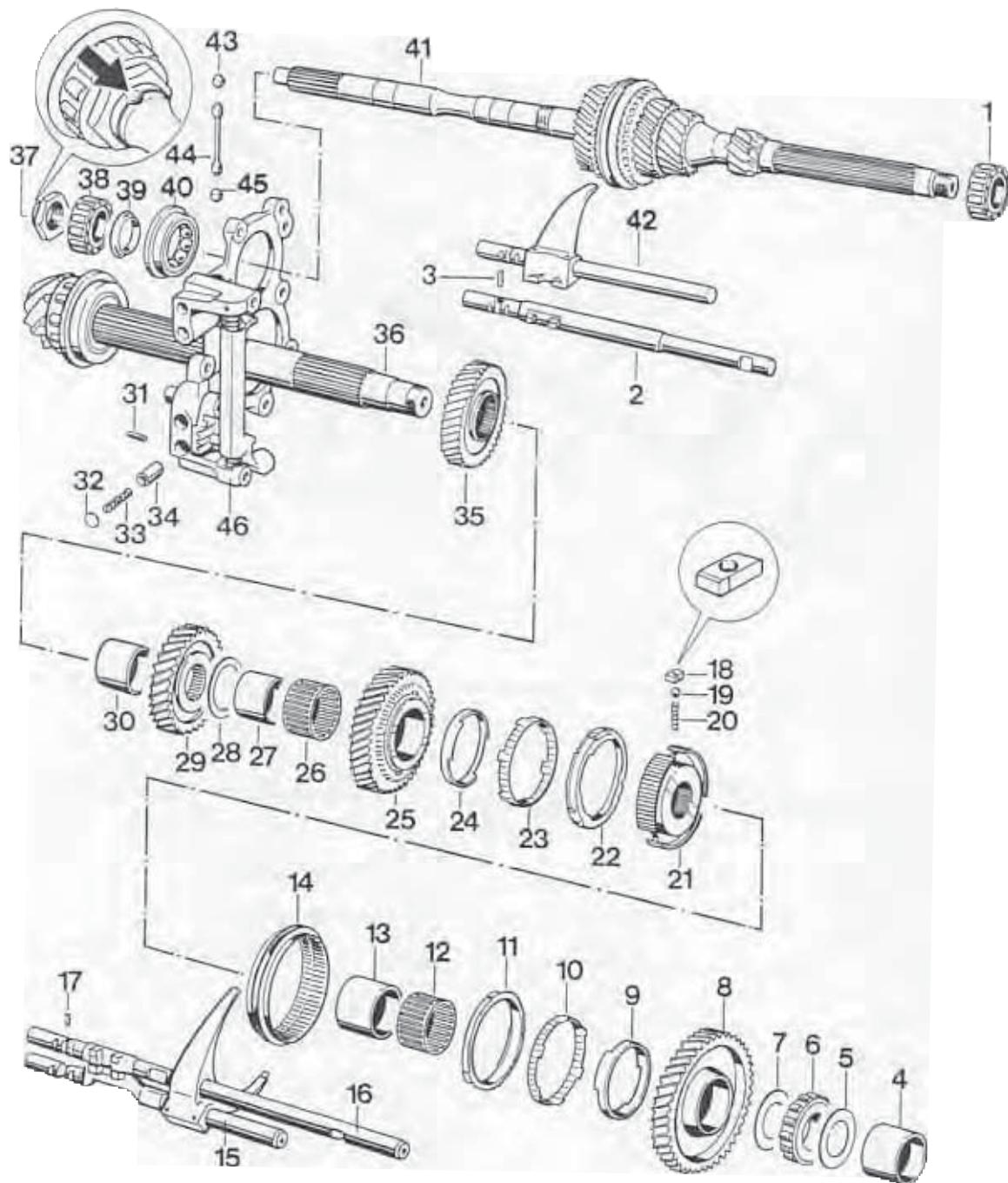
35 40 19 Removing and installing input shaft

Tools



No.	Designation	Special tool	Order number	Explanation
1	Insert	9282	000.721.928.20	
2	Socket	9105	000.721.910.50	

35 40 19 Removing and installing input shaft



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Cylindrical roller bearing	1		Heat to approx. 120 °C
2	Shift rod (5th and 6th gear)	1	Shift rods in neutral position	
3	Spacer	1		Coat with stiff grease to insert
4	Inner race	1		Fit with the same gearwheel. Heat to approx. 120 °C
5	Thrust washer	1		
6	Cylindrical roller bearing	1		Heat to approx. 120 °C
7	Thrust washer	1		
8	Loose gearwheel (1st gear)	1		
9	Friction ring*	1		Fit with the same gearwheel
10	Tapered ring	1		Fit with the same gearwheel. Tabs must engage into the cutouts in the loose gearwheel
11	Synchronizing ring*	1		Check for wear. Fit with the same gearwheel. Drivers must engage in the cutouts in the tape-red ring. Three lugs face the driver dogs.
12	Needle roller bearing	1		Fit with the same gearwheel
13	Inner race	1		Fit with the same gearwheel. Heat to approx. 120 °C

* see page 35 - 14

No.	Designation	Qty.	Note:	
			Removal	Installation
14	Shift sleeve*	1		Insert complete with guide sleeve and shift rods. Make sure the missing tooth of the internal teeth of the guide sleeve (No. 21) is aligned exactly above the oil bore of the output shaft.
15	Shift rod with pinned shift fork	1		
16	Shift rod (reverse)	1		
17	Intermediate lock	1		Coat with stiff grease to insert
18	Driver dog	3		Install in correct position
19	Ball	3		
20	Spring	3		
21	Guide sleeve	1		Missing tooth of the internal splines must be exactly above the oil bore of the output shaft
22	Synchronizing ring*	1		Check for wear. Fit with the same gearwheel. Drivers must engage into the cutouts in the tapered sleeve. Three lugs face the driver dogs.

* see page 35 - 14

No.	Designation	Qty.	Note:	
			Removal	Installation
23	Tapered ring	1		Fit with the same gearwheel. Tabs must engage into the cutouts in the loose gearwheel
24	Friction ring	1		Fit with the same gearwheel
25	Loose gearwheel (2nd gear)	1		
26	Needle roller bearing	1		Fit with the same gearwheel
27	Inner race	1		Fit with the same gearwheel. Heat to approx. 120 °C
28	Thrust washer	1		
29	Fixed gearwheel (3rd gear)	1		Large collar faces thrust washer No. 35
30	Spacer sleeve	1		
31	Straight pin	4		
32	Washer	4		Guide lug faces spring
33	Thrust spring	4		
34	Latch	4		
35	Fixed gearwheel (4th gear)	1		Large collar faces four-point bearing
36	Output shaft	1		
37	Flange nut**	1	Undo with Special Tools 9282 and 9105	Tighten to 250 Nm (184 ftlb.). Upset the flange to lock
38	Cylindrical roller bearing	1	Press off across 2nd gear fixed gearwheel	Heat to approx. 120 °C
39	Bearing inner race	1		Heat to approx. 120 °C

No.	Designation	Qty.	Note:	
			Removal	Installation
40	Four-point bearing	1		
41	Output shaft	1		Insert complete with pinned shift rod / shift fork (No. 42)
42	Shift rod with pinned shift fork	1		
43	Lock (short)	1		
44	Lock (long)	1		
45	Lock (short)	1		
46	Tensioning plate	1		

** Transmission shafts without recesses for securing the hexagon nuts have been installed since September 1995.
 Self-locking hexagon nuts are used on these shafts, and these nuts must **always** be replaced in every transmission repair.

Removal and installing notes

Removal

3. Observe installation position of locks.

Note

Parts No. 1 to 30 are removed with the tensioning plate remaining fitted (refer to page 34 - 11).

Installation

Using a suitable flat iron bar, clamp tensioning plate in a vise in such a manner that the hole for the shift rod locks is horizontal.

2. Check synchromesh of 1st and 2nd gears.

To do so, place friction ring, tapered ring and synchronizing ring in correct position onto gearwheel. Check gap "A" with a feeler gauge.

Old design:

installation dimension (new) =

1.3 to 1.95 mm

wear dimension = 1.0 mm

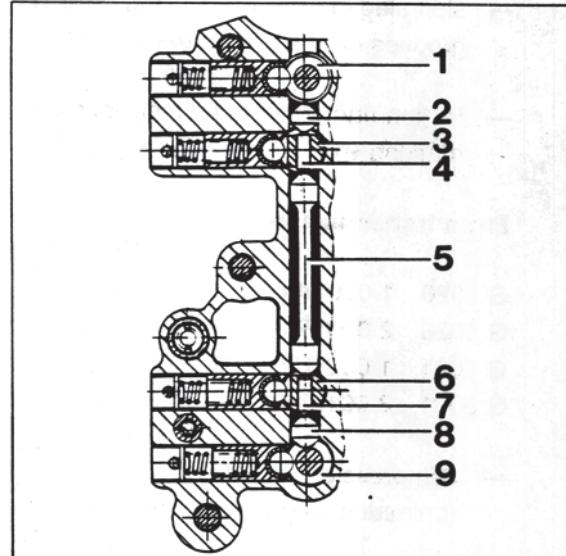
New design:

installation dimension (new) = 1.5 to 2.0 mm

wear dimension = 1.2 mm

(see page 35 - 14)

1709-35



1 = Shift rod 3rd and 4th gear

2 = Lock (short)

3 = Shift rod 5th and 6th gear

4 = Intermediate lock

5 = Lock (long)

6 = Reverse shift rod

7 = Intermediate lock

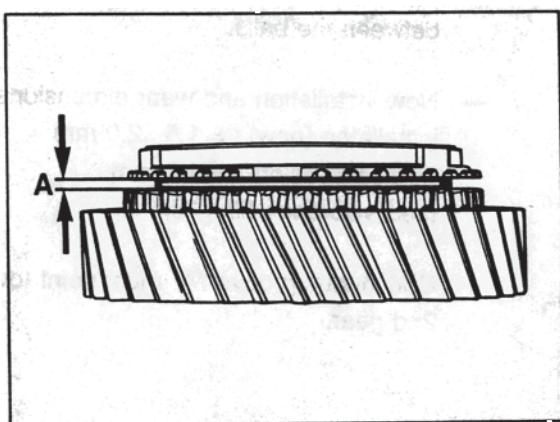
8 = Lock (short)

9 = Shift rod 1st and 2nd gear

Note

After fitting the shift rods, do not move them across the neutral or gear latch positions as this may cause the small intermediate locks to drop out inadvertently.

To avoid inadvertent movement of the shift rods, lock shift rods by engaging 4th gear.



1701-35

Modified synchromesh on 1st and 2nd gear

The following parts have been modified:

Friction ring

- shift sleeve (with three plunge-milled grooves on the inside teeth).
- friction ring (changed dimensions and marking 94)

From transmission no.:

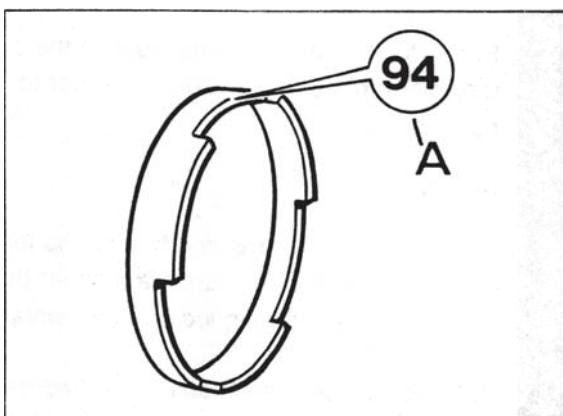
G 5020 1 000 884

G 5020 2 000 883

G 5021 1 002 186

G 5021 2 001 230

compression spring
(unloaded length 16.22 mm)



1904-35

A = marking

From transmission no.:

G 5020 1 000960

G 5020 2 000927

G 5021 1 002238

G 5021 2 001294

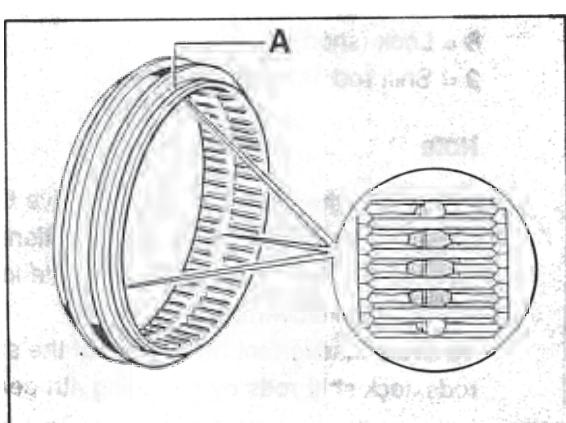
Shift sleeve

Note

Old and new parts must **not** be installed together in the same transmission. As only the modified parts are now available, all the modified parts must be installed in the event of repair work. The following points must be noted:

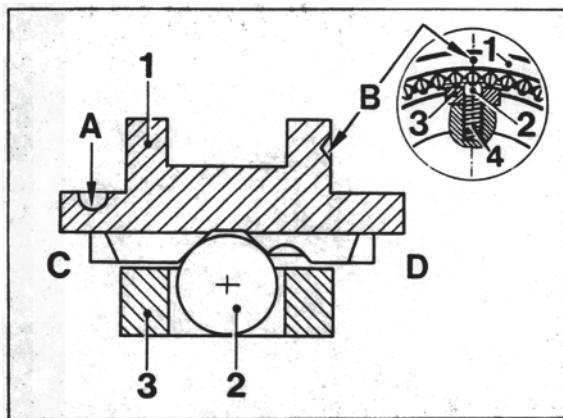
Install the shift sleeve on the guide sleeve with the punch marks "B" centered between the balls.

- New installation and wear dimensions
installaton (new) = 1.5...2.0 mm
wear dimension = 1.2 mm
(see also page 35 - 13)
- Continuous groove "A" must point towards 2nd gear.



*A = distinctive groove
(must point towards 2nd gear)*

1905-35



1906-35

1 = shift sleeve

2 = ball

3 = driver dog

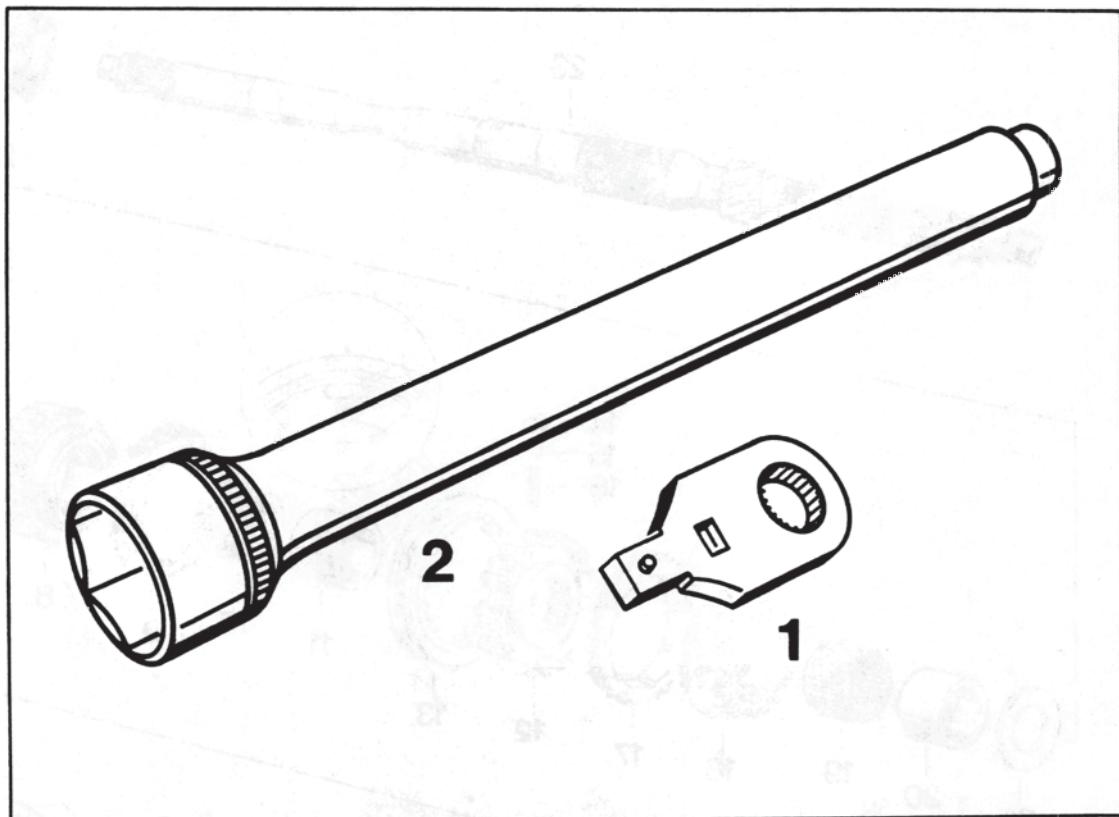
4 = spring

A = groove

B = punch mark

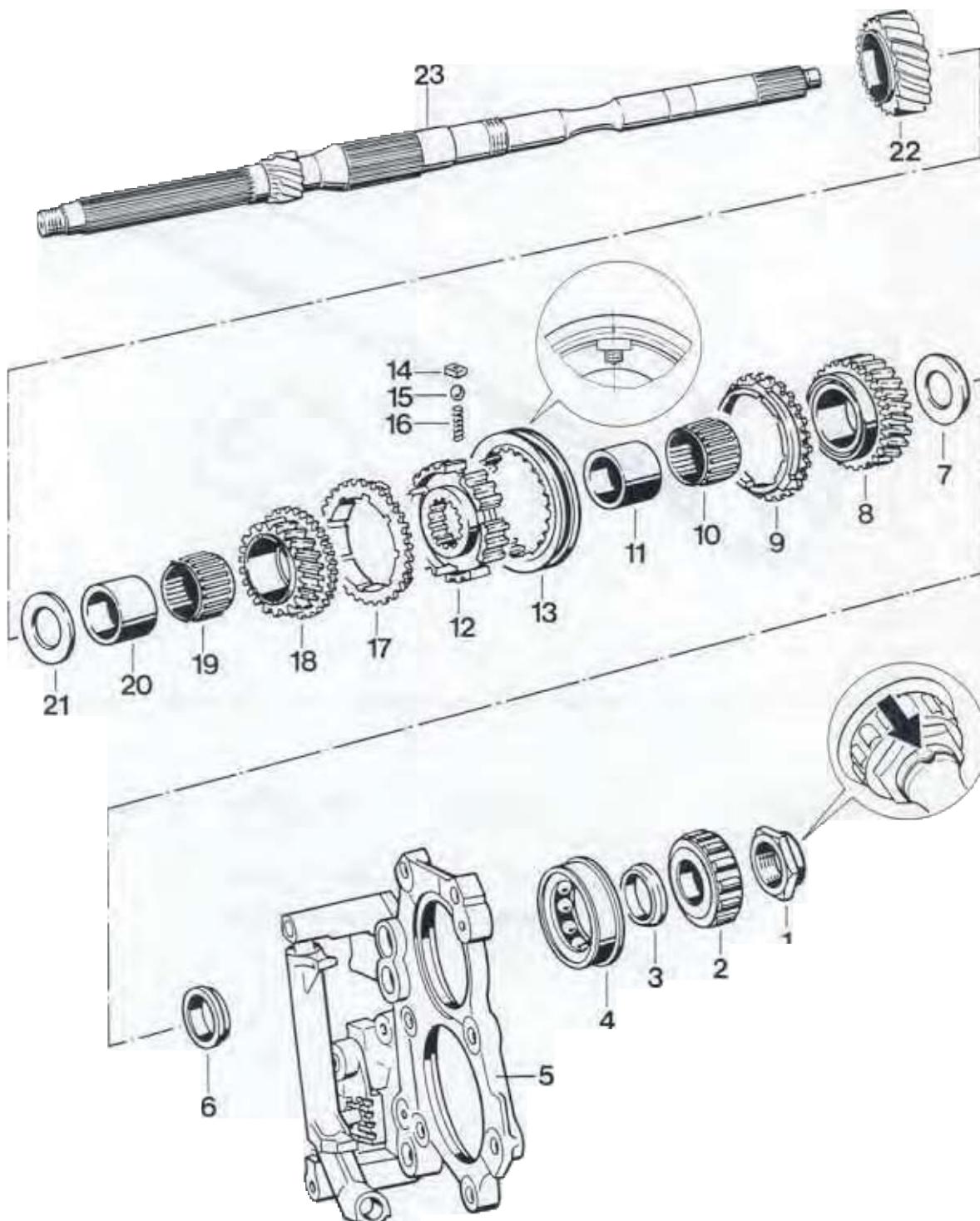
C = 2nd gear side

D = 1st gear side

35 40 37 Dismantling and assembling input shaft**Tools**

No.	Designation	Special tool	Order number	Explanation
1	Insert	9282	000.721.928.20	
2	Socket	9105	000.721.910.50	

35 40 37 Dismantling and assembling input shaft



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hexagon head nut (see note on Page 35 - 19)	1	Undo with Special Tools 9282 and 9105	Use Special Tools 9282 and 9105 and tighten to 250 Nm (184 ftlb.). Upset flange to lock
2	Cylindrical roller bearing	1	Press off with suitable separating device (e.g. Kukko 17-1) across 2nd gear fixed gearwheel	Heat to approx. 120 °C
3	Bearing inner race	1	Press off with suitable separating device (e.g. Kukko 17-1) across 2nd gear fixed gearwheel	Heat to approx. 120 °C
4	Four-point bearing	1		
5	Tensioning plate	1		Clamp in a vise (use protective jaws), insert lock (long), engage 5th gear and install input shaft with pinned shift rod/shift fork
6	Bearing inner race	1	Press off with suitable separating device (e.g. Kukko 17-1)	Heat to approx. 120 °C
7	Thrust washer	1		Large, face-ground side faces needle cage
8	Loose gearwheel (4th gear)	1		Replace only in pairs
9	Synchronizing ring	1	Mark for reinstallation	Check for wear, install in correct position using the same gearwheel (lugs face the driver dogs)

No.	Designation	Qty.	Note:	
			Removal	Installation
10	Needle-roller assembly	1	Mark cage	Install with the same gear-wheel
11	Inner race	1		Heat to approx. 120 °C
12	Guide sleeve	1	Remove complete with shift sleeve	Install complete with shaft sleeve and synchromesh components
13	Shift sleeve (3rd and 4th gear)	1	Make sure synchromesh components do not pop out.	Observe installation position, install complete with guide sleeve and synchromesh components. Center the centerpunch marks relative to the driver dogs
14	Driver dogs	3		Install in correct position, domed side faces shift sleeve
15	Ball	3		
16	Spring	3		
17	Synchronizing ring	1	Mark for reinstallation	Check for wear, install in correct position with the same gearwheel (lugs face the driver dogs)
18	Loose gearwheel (3rd gear)	1		Replace only in pairs
19	Needle-roller assembly*	1	Mark for reinstallation	Fit with the same gearwheel
20	Inner race*	1		Heat to approx. 120 °C and press into place
21	Thrust washer (1.85 mm thick)*	1		
22	Fixed gearwheel (2nd gear)*	1	Press off with suitable separating device (e.g. Kukko 17-0)	Replace only in pairs. Flange faces gearwheel of 1st gear
23	Input shaft	1		

* See note on page 35 - 19

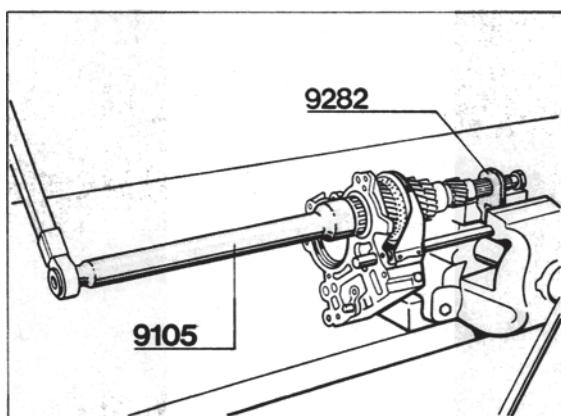
Dismantling and assembling notes

Note

Since 1 October 1994, the fixed wheel of second gear (no. 22) has been firmly fixed to the drive pinion; the needle cage (no. 19) runs directly on the polished shaft. The thrust washer (no. 21) and the inner ring (no. 20) are no longer fitted.

Dismantling

1. Mount retaining plate 9282 in vise, fit input shaft and undo hexagon-head nut with Special Tool 9105.



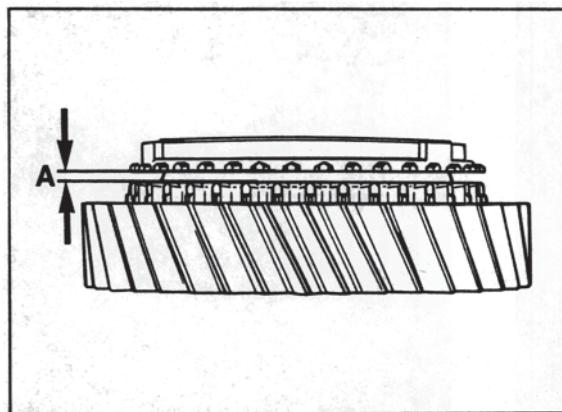
535-35

2. Use a suitable tool (e.g. Kukko 17 - 1) to press all parts off the input shaft over the 2nd gear wheel.

Assembling

1. To inspect synchronizing rings, press rings onto the gear wheel tapers and use a feeler gauge to measure gap "A".

Assembly dimension (new)	= 0.9 mm min.
Wear limit	= 0.6 to 0.7 mm



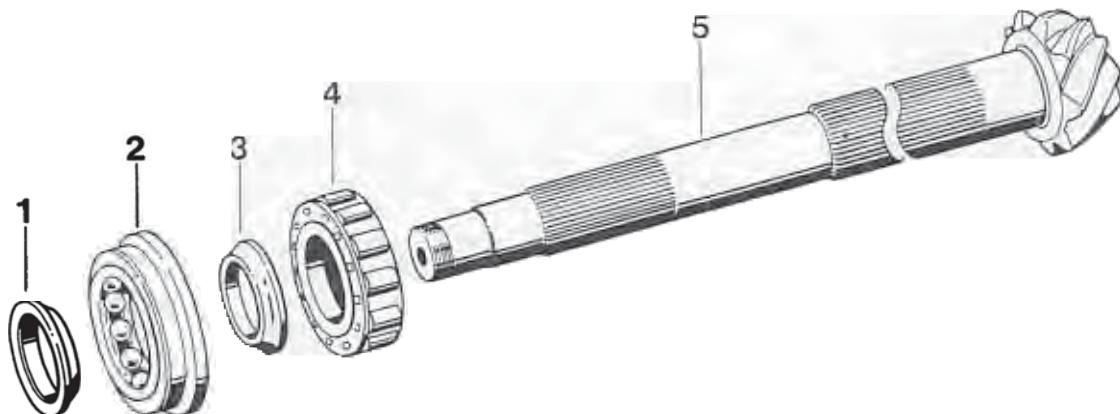
518-35

Note

Transmission shafts without recesses for securing the hexagon nuts have been installed since September 1995.

Self-locking hexagon nuts are used on these shafts, and these nuts must **always** be replaced in every transmission repair.

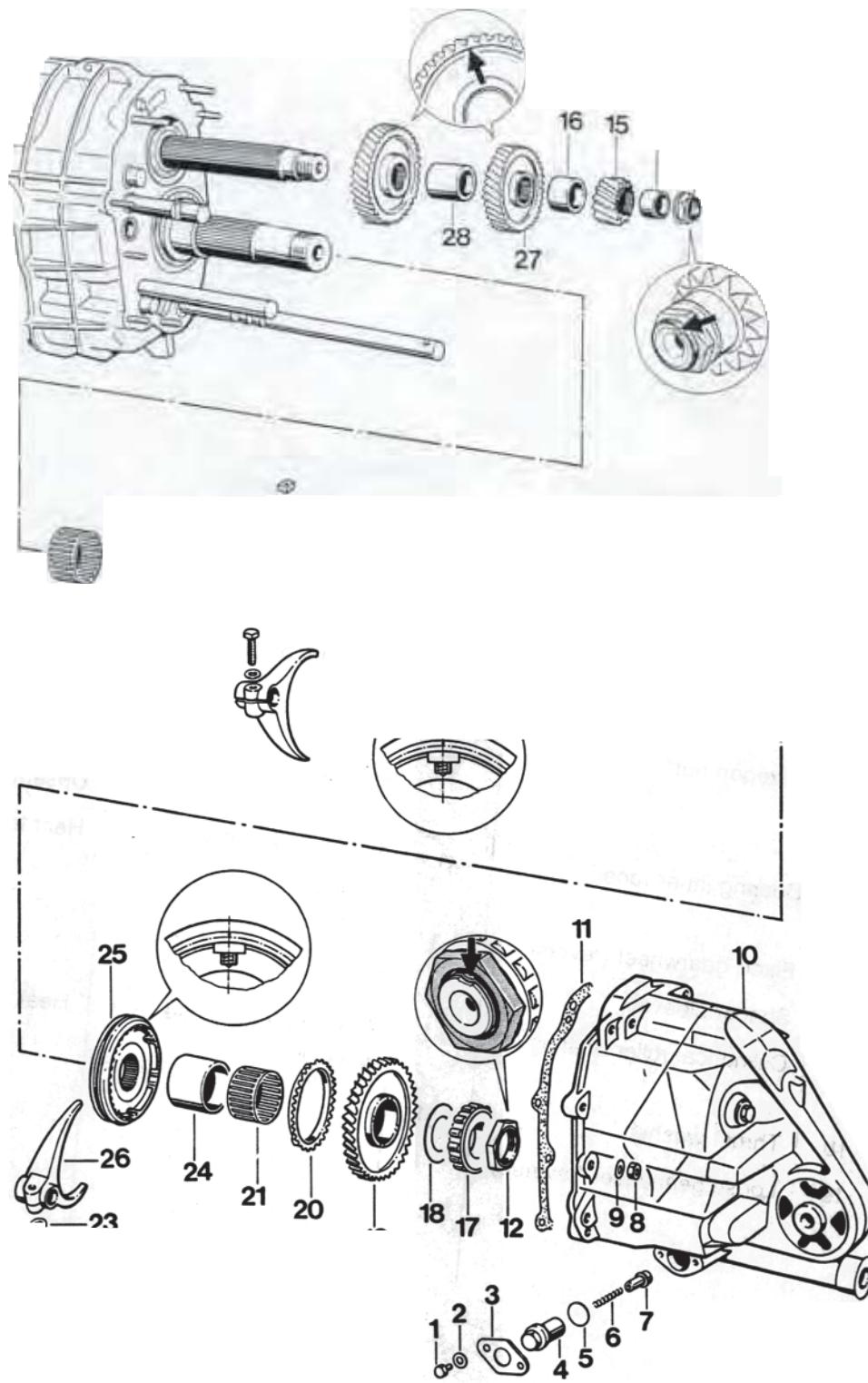
35 59 37 Dismantling and assembling output shaft



1698-35

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Bearing inner race	1	Mark for reinstallation, press off with suitable separating device (e.g. Kukko 15 - 17)	Do not confuse with inner race No. 3 , heat to approx. 120 °C and press into place
2	Four-point bearing	1		
3	Bearing inner race	1	Mark for reinstallation, press off with suitable separating device (e.g. Kukko 15 - 17)	Do not confuse with inner race No. 1, heat to approx. 120 °C and press into place
4	Cylindrical roller bearing	1	Press off with suitable separating device (e.g. Kukko 15 - 17)	Heat to approx. 120 °C and press into correct position using a suitable pipe section (e.g. VW 519)
5	Output shaft	1		Observe matching number. Readjust if required

35 75 19 Removing and installing 5th gear (transmission is installed)



No.	Designation	Qty.	Removal	Note:	
					Installation
1	Hexagon-head bolt	2			Tighten to 10 Nm (7 ftlb.)
2	Washer	2			
3	Clamping plate	1			
4	Eccentric bushing	1		Adjust	
5	Seal	1		Replace	
6	Thrust spring	1			
7	Locking bush	1			
8	Hexagon head nut	10			Tighten to 23 Nm (17 ftlb.)
9	Washer	10			
10	Front transmission cover	1	Remove complete with transmission support		
11	Gasket	1		Replace	
12	Hexagon nut*	1	Engage 4th gear and apply handbrake	Replace. Tighten to 300 Nm (221 ftlb.). Upset flange to lock	
13	Hexagon nut*	1	Engage 4th gear and apply handbrake	Replace. Tighten to 200 Nm (147 ftlb.). Upset flange to lock	
14	Bearing inner race	1	Pull off across fixed gear-wheel No. 15	Heat to approx. 120 °C	
15	Fixed gearwheel (reverse)	1			
16	Spacer sleeve	1			
17	Cylindrical roller bearing	1	Pull off across loose gear-wheel No. 19	Heat to approx. 120 °C	
18	Thrust washer	1			
19	Loose gearwheel (reverse)	1			

No.	Designation	Qty.	Note:	
			Removal	Installation
20	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel (Cogs face driver dogs)
21	Needle cage	1	Mark for reinstallation	Fit with the same gearwheel
22	Hexagon-head bolt	1	Determine installation position of shift fork, measuring from shift rod face to shift fork stop and record measurement.	Tighten to 23 Nm (17 ftlb.)
23	Washer	1		
24	Inner race	1	Remove, press off across guide sleeve if required and pull off with a suitable puller.	Heat to approx. 120 °C.
25	Shift and guide sleeve	1	Engage 4th gear and take off carefully complete with shift fork. Take care not to lose synchromesh components.	Install in correct position. The stepped side of the shift sleeve faces loose gearwheel No. 19
26	Shift fork (reverse)	1		Adjust so that play at shift sleeve is barely noticeable with reverse engaged. The synchronizing ring must rotate freely in neutral position.
27	Fixed gearwheel (5th gear)	1		Identification groove for fixed gearwheel No. 15
28	Spacer sleeve	1		
29	Loose gearwheel (5th gear)	1		

No.	Designation	Qty.	Note:	
			Removal	Installation
30	Synchronizing ring	1	Mark for reinstallation	Check for wear. Fit with the same gearwheel. Cogs face driver dogs.
31	Needle-roller cage	1	Mark for reinstallation	Fit with the same gear-wheel.

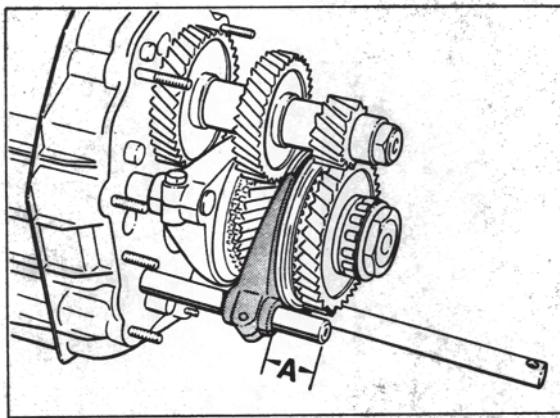
* Transmission shafts without recesses for securing the hexagon nuts have been installed since September 1995.

Self-locking hexagon nuts are used on these shafts, and these nuts must **always** be replaced in every transmission repair.

Removal and assembly notes

Removal

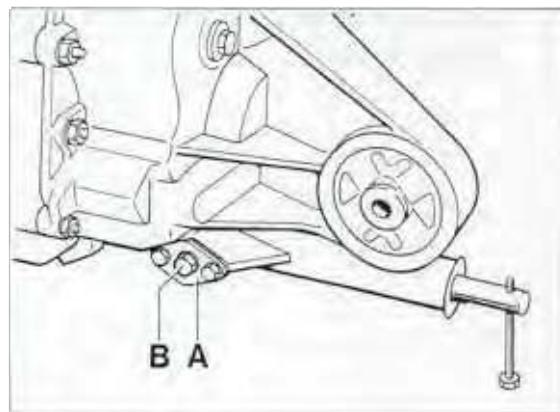
1. Remove engine guard and rear underside panel.
2. Drain transmission oil.
3. Remove crossbrace.
4. Disengage shift rod coupling from inner shift rod.
5. Support transmission on general-purpose transmission jack and unbolt transmission support from body.
6. Lower engine-transmission assembly only so far that the assembly will **not** rest on the stabilizer bar.
7. Determine installation position of reverse shift fork for reinstallation, measuring dimension "A" with depth gauge.



1791-35

Installation

1. Tighten hexagon head nuts of drive pinion and input shaft to specified torque and lock the nuts.
2. Adjust reverse shift fork to the dimension "A" determined during removal and check adjustment (refer to explosion drawing No. 26).
3. Adjust inner shift rod so that all gears can be selected freely without binding. To achieve this, undo hexagon-head bolts of clamping plate and turn eccentric bushing.



527-34

A = Clamping plate
B = Eccentric bushing

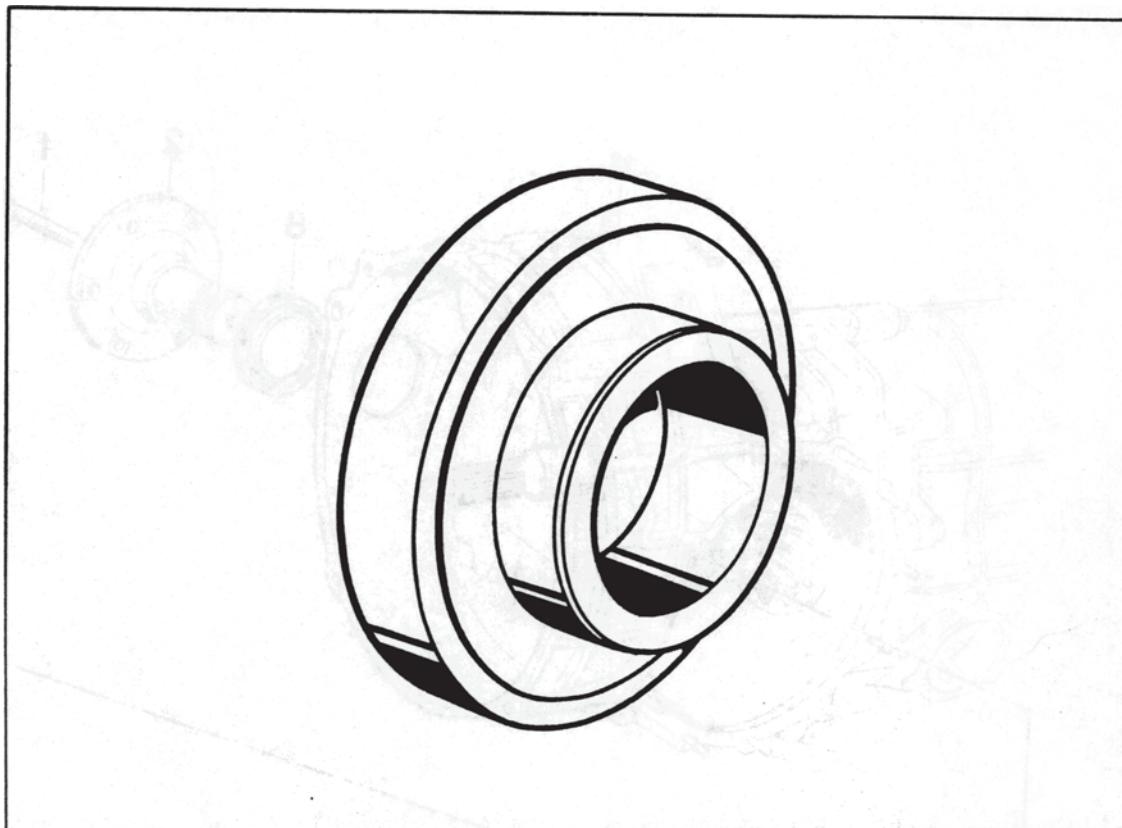
4. Screw a long M 8 bolt into the inner shift rod and shift through all gears to check operation.

5. Place engine-transmission assembly onto general-purpose transmission jack and raise into installation position. Attach transmission support to body ($M_A = 46 \text{ Nm} / 34 \text{ ftlb.}$).

Note

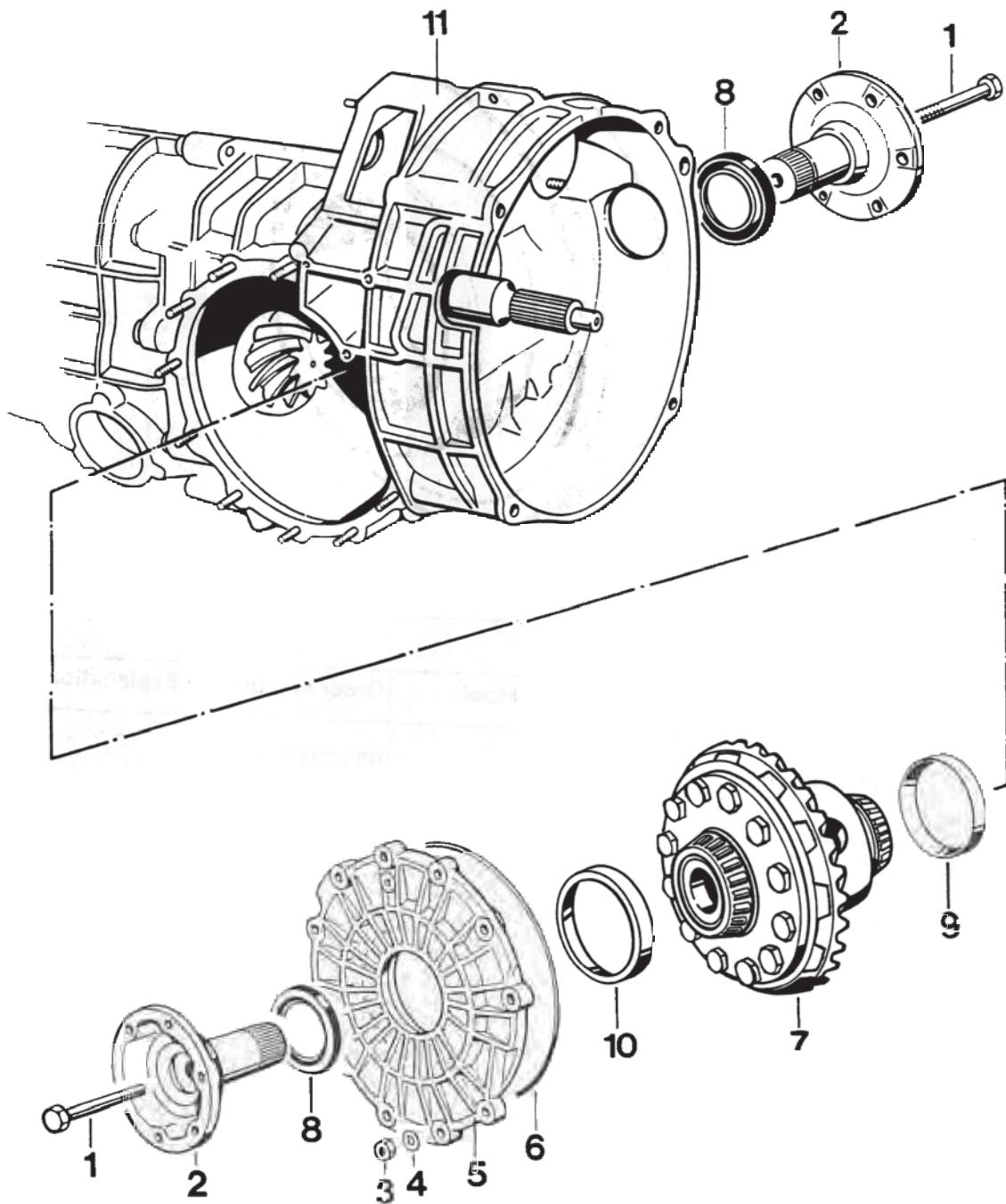
Check engine compartment rubber seal between body and engine paneling for correct seating. If required, unbolt transmission support from body once more, correct seal position and refit transmission support.

6. Fit shift rod coupling to inner shift rod.
 $M_A = 18 \text{ Nm} (13 \text{ ftlb.})$, apply Loctite 270 to lock.
7. Fill in transmission oil (refer to Vol. I, page 03-28).

39 09 19 Removing and installing differential**Tools**

No.	Designation	Special tool	Order number	Explanation
	Thrust piece	9252	000.721.925.20	

39 09 19 Removing and installing differential

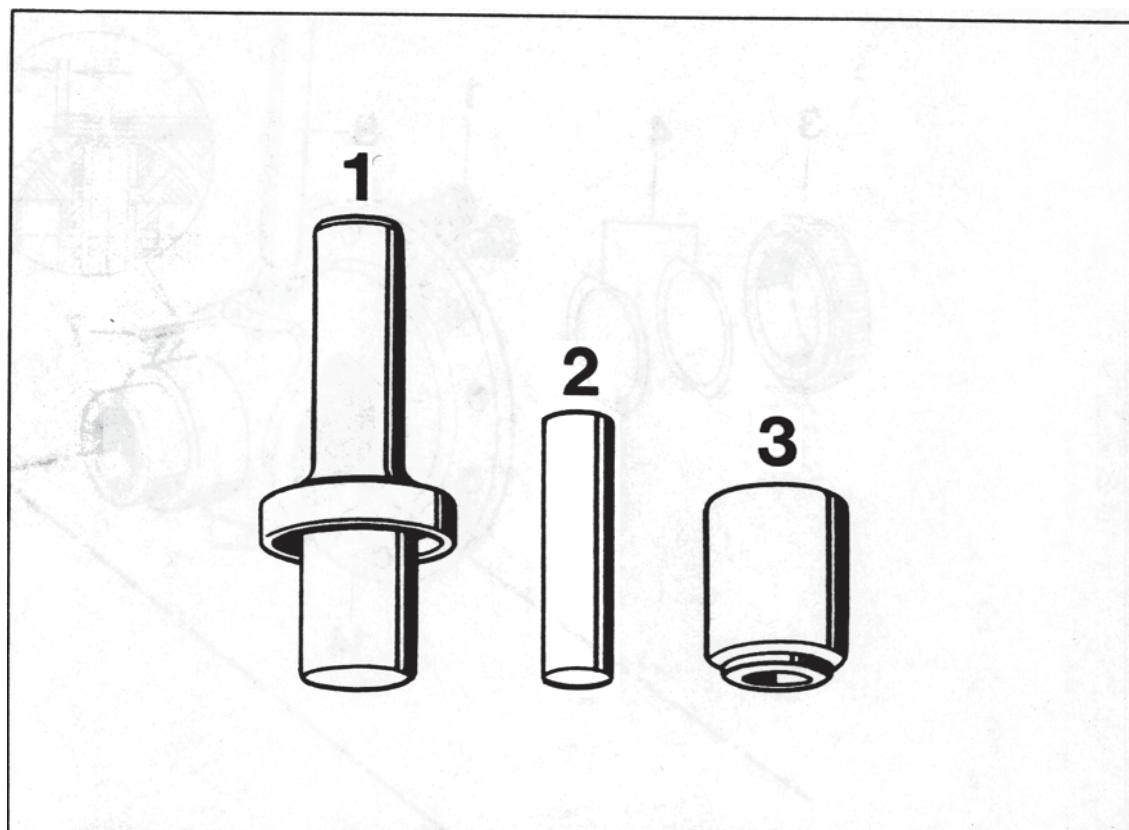


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hexagon head bolt	2		Tighten to 44 Nm (32 ftlb.)
2	Joint flange*	2		
3	Hexagon head nut	11		Tighten to 23 Nm (17 ftlb.)
4	Washer	11		
5	Cover	1		
6	O-ring	1		Replace, oil lightly, do not twist
7	Differential or limited-slip differential	1		Readjust if required
8	Seal	2		Pack space between dust and sealing lips with grease (e.g. Liqui ämoly Pu 53). Use thrust piece 9252 to press in until it is seated against the stop
9	Bearing outer race	1	Pull out with suitable internal puller (e.g. Kukko 21 - 8)	Press in with suitable thrust piece
10	Bearing outer race	1	Pull out with suitable internal puller (e.g. Kukko 21 - 9)	Press in with suitable thrust piece
11	Transmission housing	1		

* The halfshaft flange and seal ring can also be removed and installed with the transmission installed.

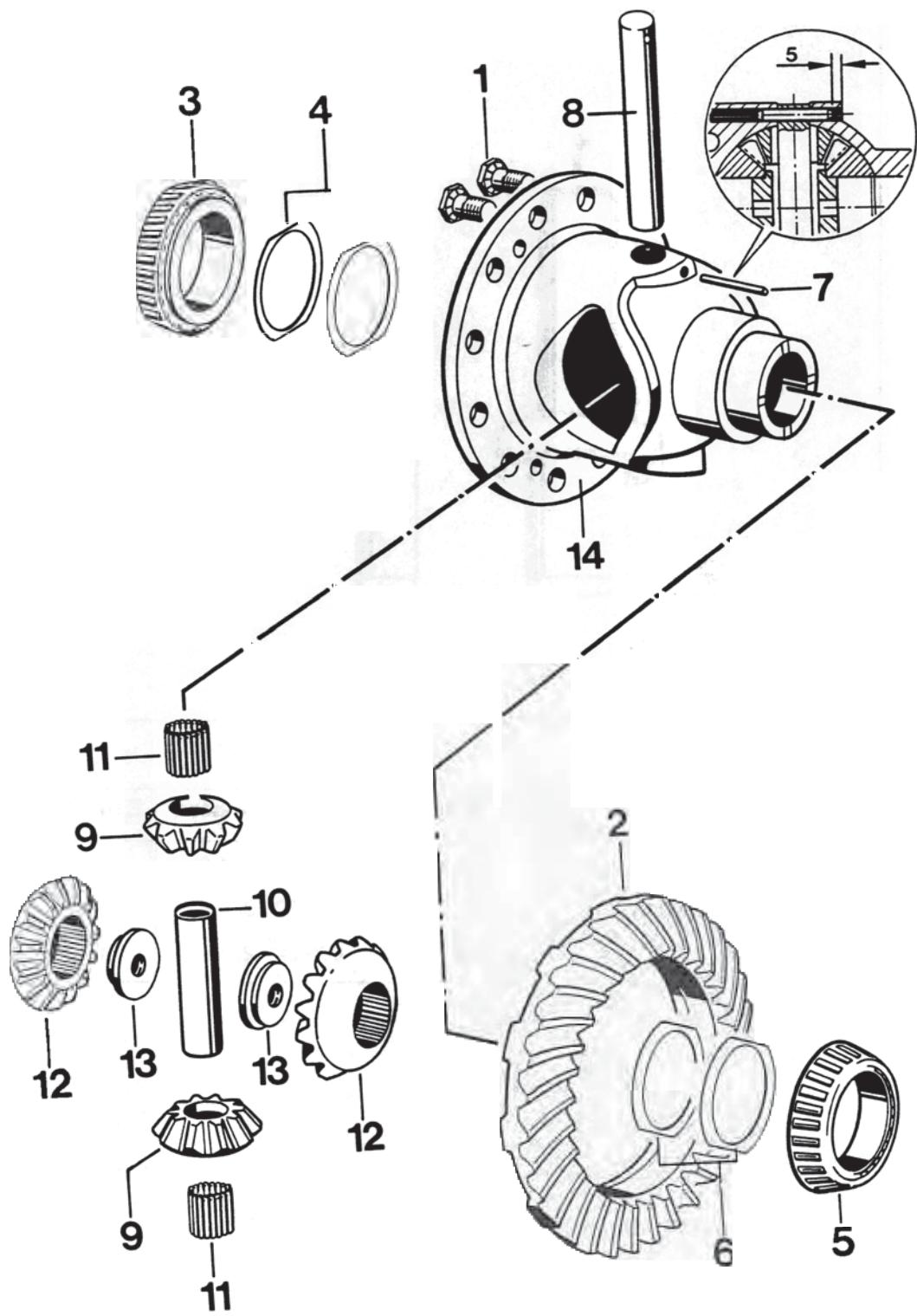
39 09 37 Dismantling and assembling differential

Tools



No.	Designation	Special tool	Order number	Explanation
1	Thrust piece	P 264 b	000.721.264.20	
2	Centering mandrel	9289	000.721.928.90	
3	Thrust piece	P 263	000.721.263.00	

39 09 37 Dismantling and assembling differential



No.	Designation	Qty.	Removal	Note:
				Installation
1	Hexagon head bolt (with ribbed seating surface)	12		Must always be replaced. Threads must be dry and free from grease. Tighten to 200 Nm (148 ftlb.).
2	Ring gear	1		Threaded holes for ring gear bolts must be dry and free from grease. Observe matching number. Readjust if required.
3	Tapered roller bearing inner race	1	Pull off with suitable puller and P 263	Press on with P 264 b
4	Adjusting shim	X	Mark for reinstallation	Redetermine thickness if required
5	Tapered roller bearing inner race	1	Pull off with suitable puller and P 263	Press on with P 264 b
6	Adjusting shim	X	Mark for reinstallation	Redetermine thickness if required
7	Spiral pin	1		Press into correct position
8	Pin	1		
9	Bevel pinion	2		Always replace as a set (with shaft bevel gears)
10	Spacer sleeve	1		
11	Needle roller sleeve (31 individual needle rollers each)	2	Take care not lose any needle rollers	Apply stiff grease to install
12	Shaft bevel gear	2		Always replace as a set (with bevel pinion)
13	Threaded piece	2		
14	Housing	1		

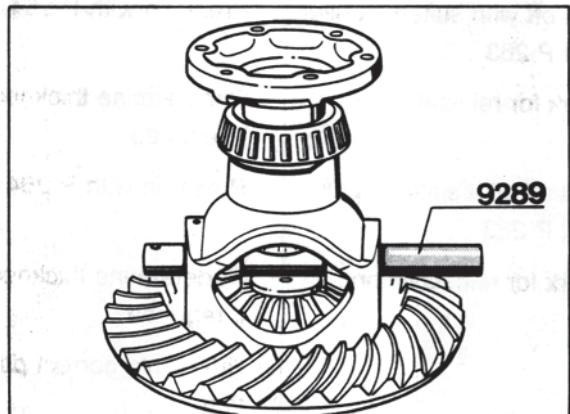
Dismantling and assembly notes

Note

The small bevel pinions are supported in two needle roller sleeves consisting of 31 individual needle rollers each.

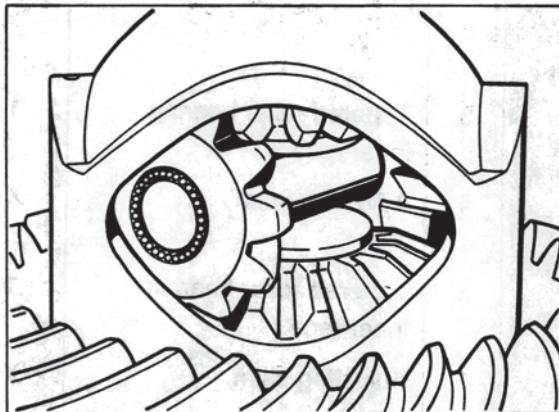
Dismantling

1. Press out pin with centering mandrel **9289**.



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2. Using the centering mandrel, rotate bevel pinion relative to housing openings and lift out carefully, taking care not to lose any needle rollers.

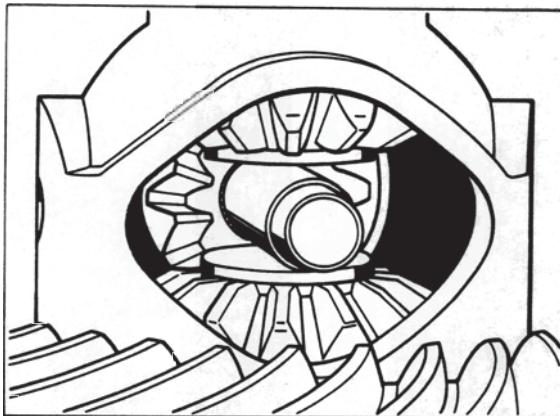


540-39

Assembly

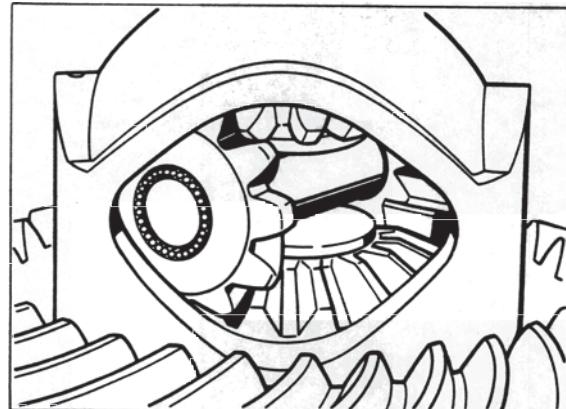
1. Insert differential gears complete with pressed-in threaded washers across the large opening in the differential housing and locate with halfshaft flanges.

2. Preassemble one bevel pinion with 31 needle rollers, centering mandrel **9289** as well as the spacer sleeve and insert across opening in the housing.



541-39

4. Rotate bevel pinion with centering mandrel until the bores in the housing line up with each other.



540-39

3. Complete second bevel pinion with 31 needle rollers and push carefully onto centering mandrel, taking care not to lose any needle rollers.

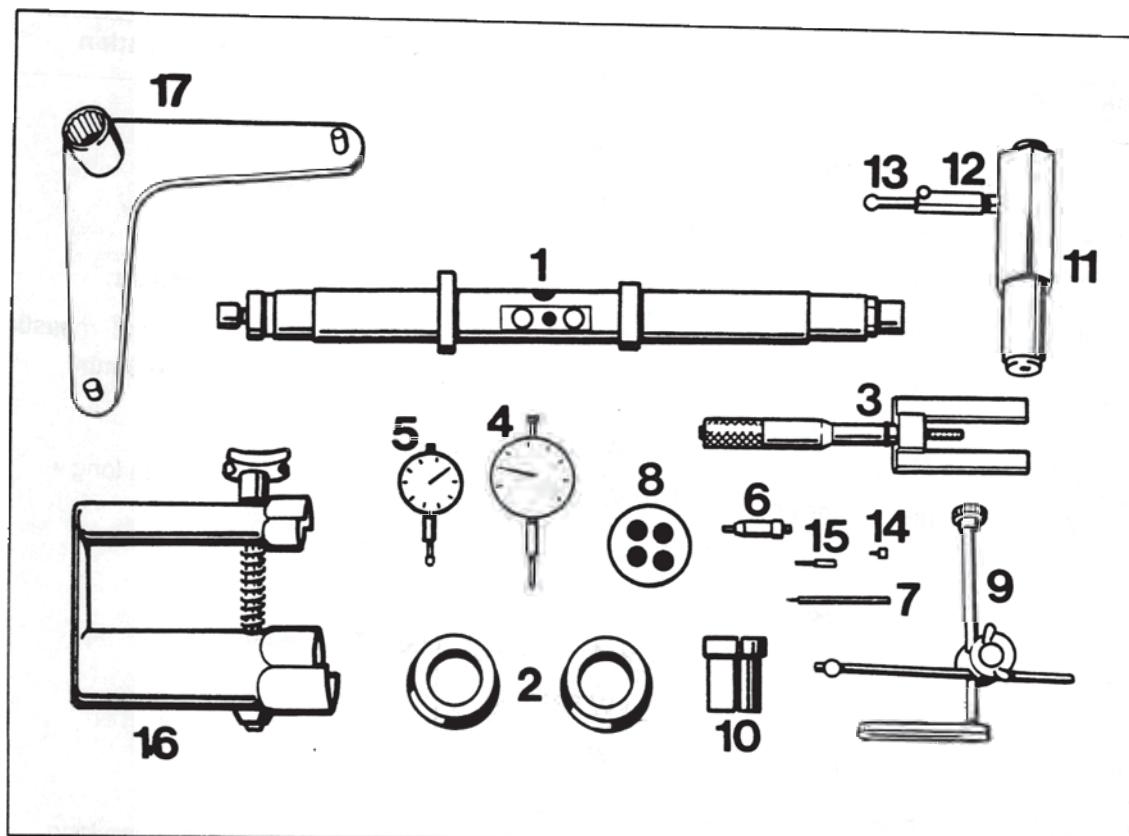
Note

To facilitate assembly, apply stiff grease to place needle rollers into position.

5. Press differential pin into correct position, take off centering mandrel and lock pin according to specifications.

39 08 15 Adjusting drive set

Tools



39 08 15 Adjusting drive set

Tools

No.	Designation	Special tool	Order number	Explanation
1	Measuring mandrel	VW 385/1		
2	Centering disks	9109	000.721.910.90	
3	Master gauge	VW 385/30		
4	Dial gauge	-		Standard
5	Dial gauge	-		Standard, measuring range 3 mm
6	Gauge plunger	VW 385/14		
7	Dial gauge extension	VW 385/56		30 mm long
8	Gauge block plate	9281	000.721.928.10	
9	Dial gauge bracket	VW 387		
10	Clamping sleeve	9145	000.721.914.50	
11	Adjusting device	VW 521/4		
12	Measuring lever	VW 388		
13	Gauge plunger	VW 388		
14	Dial gauge extension	VW 382/10		6.0 mm long
15	Dial gauge extension	VW 385/15		9.3 mm long
16	Clamping device	9562	000.721.956.20	
17	Holder	9253	000.721.925.30	

Practical procedure when readjusting the drive set

If it is necessary to adjust drive pinion and ring gear, follow the below sequence to ensure an efficient working procedure:

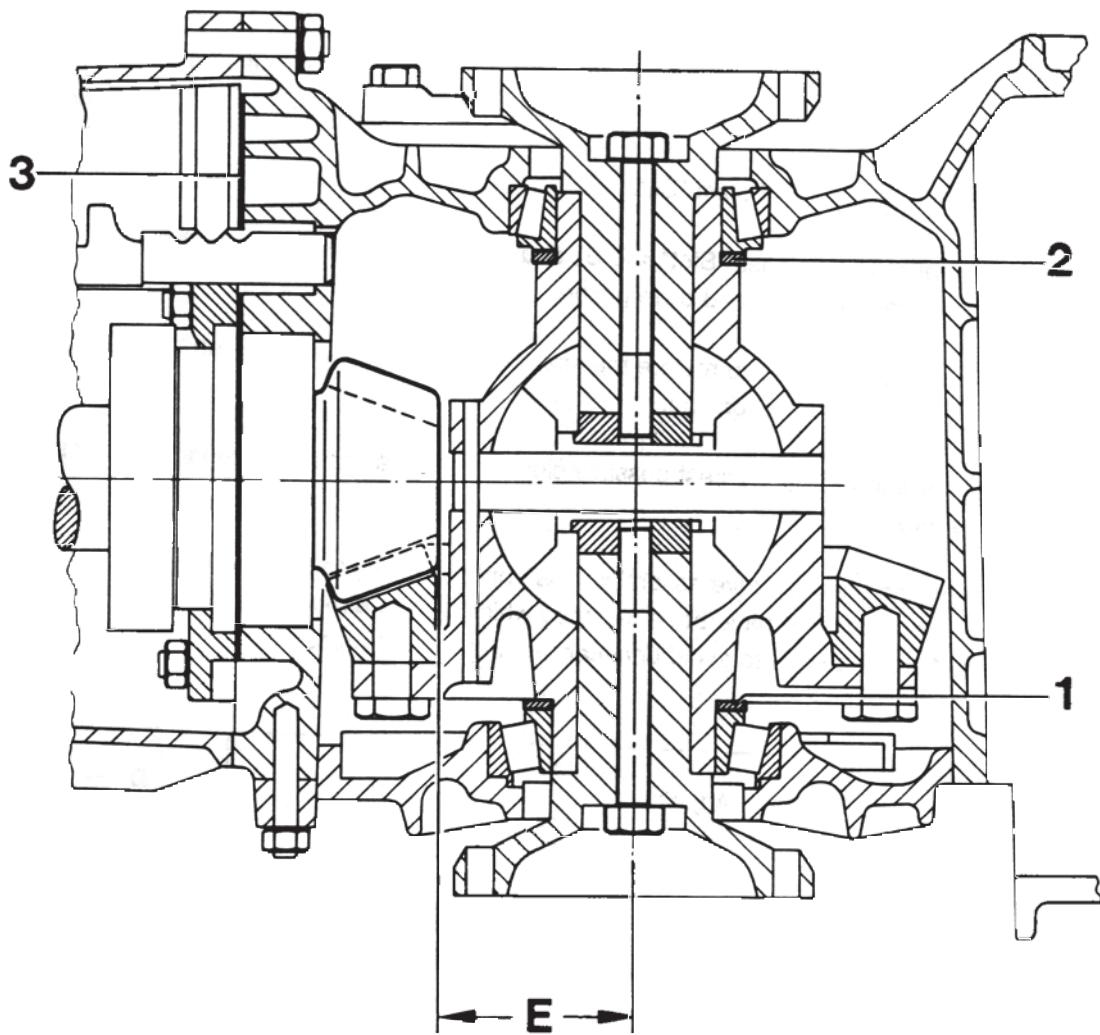
1. Determine the total thickness of shims "Stot" (S_1 plus S_2) for the specified preload on the tapered roller bearings/differential.
2. Determine the thickness of shim " S_3 ".
3. Split the total shim thickness "Stot" into S_1 and S_2 so that the specified circumferential backlash is present between ring gear and drive pinion.

The aim of this adjustment is to restore the smoothest running position which has been achieved on test equipment in the production line.

To achieve correct results, greatest possible cleanliness for all assembly work and measuring procedures is essential.

When assembling the final drive assembly, it is only necessary to readjust drive pinion and ring gear or drive set if components have been replaced which have a direct influence on the adjustment. Refer to the following table to avoid unnecessary adjustment procedures.

Replaced component	Adjust: Ring gear ($S_1 + S_2$)	Drive pinion (S_3)
Transmission case	x	x
Lateral transmission cover	x	
Large cylindrical roller bearing and four-point bearing for drive pinion	x	x
Drive set	x	x
Differential housing	x	
Tapered roller bearing for differential	x	



1 – Shim S₁

2 – Shim S₂

3 – Adjusting shim S₃

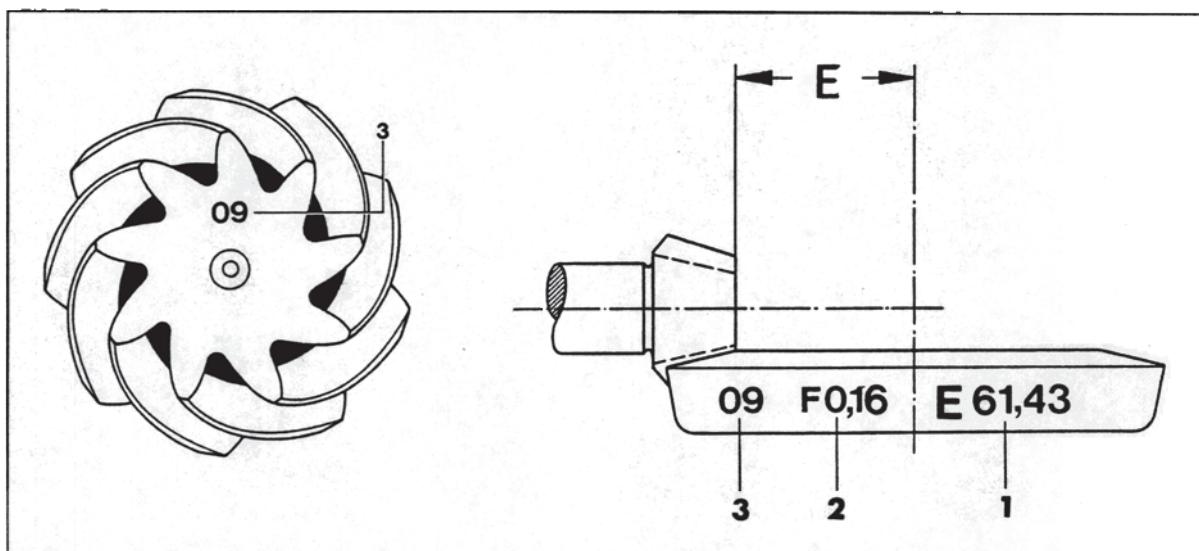
E – Setting value

Correct results may only be achieved if assembly work and measuring procedures are carried out carefully and with maximum cleanliness.

Adjusting drive set

General

The setting of drive pinion and ring gear is a determining factor for the service life and smooth running of the rear-axle drive. Drive pinions and ring gears that have been checked for good tooth contact pattern and low noise in both directions of rotation on special test equipment are therefore matched during production. The position at which smoothest running can be achieved is determined by shifting the drive pinion axially, and embossed on the ring gear as setting value "E".



1 = setting "E" (e.g. 61.43 mm)

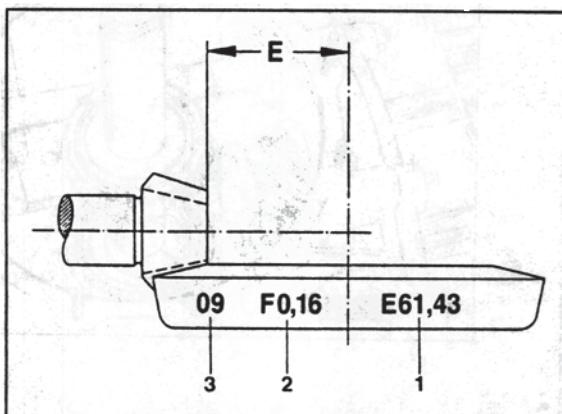
2 = circumferential backlash "F"
(e.g. 0.16 mm)

3 = matching number

39 08 15 Adjusting drive pinion

Note

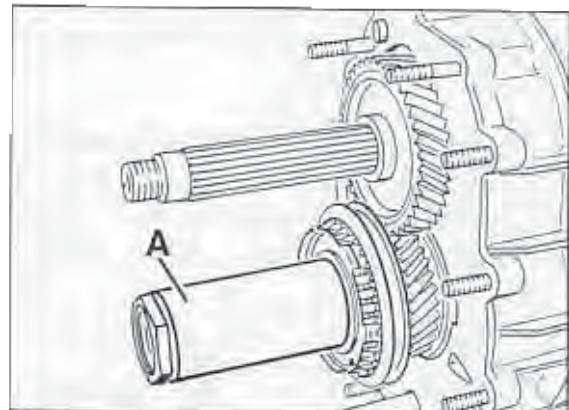
The setting value "E" is indicated on the ring gear.



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1 = Setting value "E"

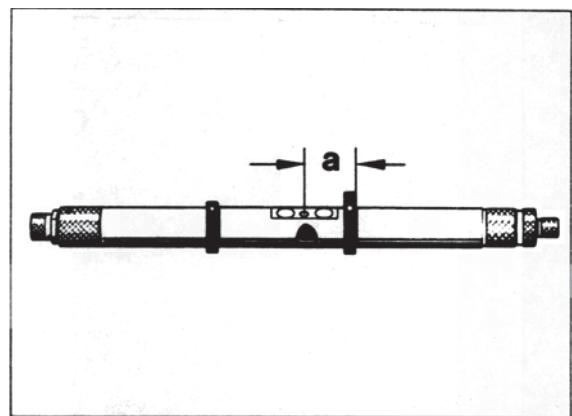
1. Install complete gear set without "S₃" shims and tighten all tensioning plate hexagon-head nuts to **23 Nm** (17 ftlb.).
2. Fit gear housing and locate with three nuts.
3. Install and engage sixth gear.
4. Block input shaft with Special Tool **9253** and tighten drive pinion collar nut to **300 Nm** (221 ftlb.).



2018-39

A = Suitable pipe section

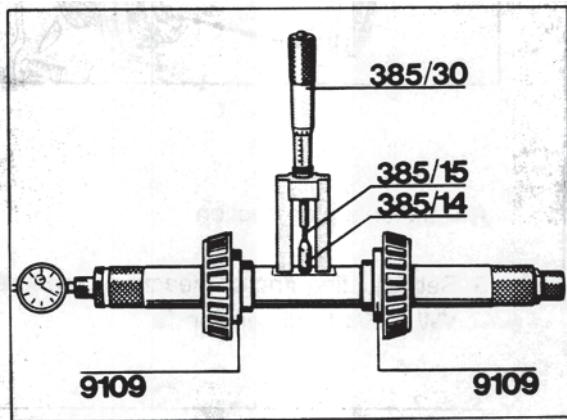
5. Set adjusting ring of measuring mandrel **VW 385/1** to dimension "a".



223-39

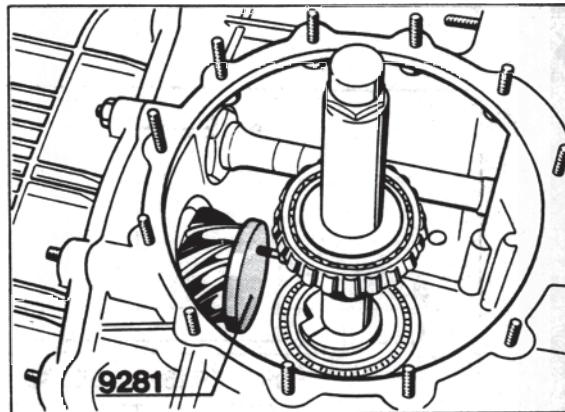
a = approx. 65 mm

6. Assemble measuring mandrel with centering disks 9109, tapered roller bearing, plunger VW 385/14 and dial gauge extension VW 385/15.
7. Set measuring mandrel with master gauge 385/30 to the setting value (61.43 mm in the example). Set dial gauge (3 mm measuring range) to zero with 1 mm preload.



543-39

8. Put gauge block plate 9281 on drive pinion head and insert measuring mandrel into transmission case. Dial gauge extension is located in the area of the gauge block plate.



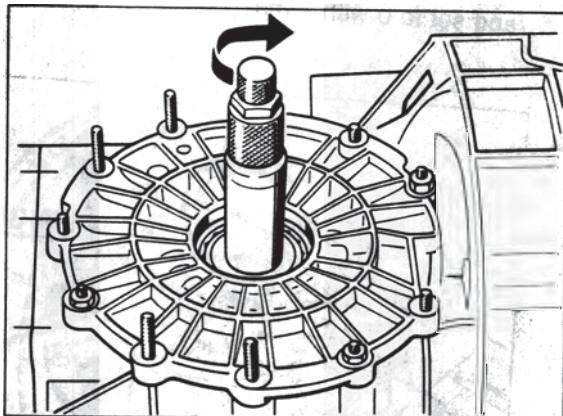
544-39

9. Fit lateral transmission cover without O-ring and tighten crosswise with 4 nuts.

Note

Do not use a hammer when fitting the lateral transmission cover (the gauge block plate held by magnets might fall off). Fit cover in installation position only by tightening the nuts uniformly.

10. Pull second centering disk with spindle towards the outside until the measuring mandrel can just be turned by hand.



545-39

11. Turn measuring mandrel carefully until the dial gauge extension is vertical to the face of the drive pinion head. At this point, the pointer of the dial gauge reaches maximum deflection (reverse point) and the dial gauge must be read.

Note

The measured value always deviates from the set dimension clockwise (the smaller pointer on the dial gauge is between 1 and 2), i.e. if the dial gauge is set with a preload of 1 mm, the value deviating from 1 is taken as shim thickness "S₃".

Example:

If the small pointer on the dial gauge is between 1 and 2 and the large pointer indicates 0.37 mm, then 0.37 mm is the shim thickness (with 1mm gauge preload) to be inserted. Always round up or down to the nearest 0.05 mm (e.g. 0.37 mm to 0.35 mm).

12. After inserting the necessary shims, check the setting value "E" again. A deviation of ± 0.03 mm is permissible.

Adjusting ring gear

Determine total shim thickness "S tot."
 $(S_1 + S_2)$.

The ring gear must be adjusted, if the:

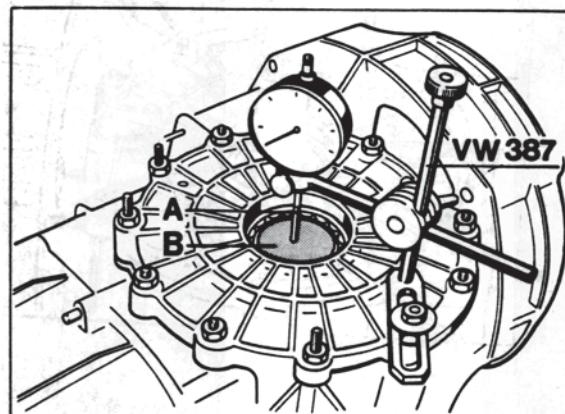
transmission case,
 lateral transmission cover,
 tapered roller bearing for differential,
 differential housing or drive set
 have been replaced.

Note

The drive pinion must be removed to determine the preload of the differential tapered roller bearings.

1. Make sure that the bearing outer races of the tapered roller bearings are well seated in the transmission case or lateral transmission cover, respectively.
2. Fit one spacer ring (2.5 mm thick) on the ring gear side and on the opposite side of the differential to be used.
3. Insert differential into transmission case and rotate several times.
4. Fit lateral transmission cover without seal and tighten all hexagon-head nuts to 23 Nm (17 ftlb.).
5. Put gauge block plate VW 385/17 on the collar of the differential.

6. Fasten universal dial gauge holder VW 387 with dial gauge and extension to the case and set to 0 with 2 mm preload.



546-39

A = Dial gauge extension (approx. 30 to 40 mm long)
 B = Gauge block plate VW 385/17

7. Move differential up and down. Read off backlash on the dial gauge and note.

Note

Do not turn differential while measuring backlash as this will give an incorrect reading.

8. Calculate "S tot.".

$$\text{"S tot."} = \text{Fitted shim thickness} \\ + \text{Measured value} \\ + \text{Pressure fit of tapered roller bearing}$$

Example

Thickness of shims inserted	5.00 mm
Measured value	0.75 mm
Pressing (constant value)	0.40 mm
"S tot."	<u>6.15 mm</u>

9. Remove differential, pull off both tapered roller bearings and split calculated shim thickness "S tot." as follows.

Select spacer S_1 0.70 mm thinner and S_2 0.70 mm thicker as a starting point for subsequent adjustment of the backlash.

Example

Total shim thickness of spacers
 $S_1 + S_2 = 6.15 \text{ mm}$

Thickness of spacer S_1

$$\begin{array}{r} 6.15 \text{ mm} \\ \hline 2 \\ \hline \end{array} \quad \begin{array}{l} = 3.075 \text{ mm} \\ - 0.700 \text{ mm} \\ \hline 2.375 \text{ mm} \end{array}$$

Thickness of spacer S_2

$$\begin{array}{r} 6.15 \text{ mm} \\ \hline 2 \\ \hline \end{array} \quad \begin{array}{l} = 3.075 \text{ mm} \\ + 0.700 \text{ mm} \\ \hline 3.775 \text{ mm} \end{array}$$

Note

Spacers are available in thicknesses of 1.6 to 3.1 mm in increments of 0.10 mm.

By using a 0.25 mm shim, the shim thicknesses may be graduated in increments of 0.05 mm.

The calculated shim thicknesses must be rounded up or down for plausible dimensions that will not alter the total thickness S_1 and S_2 .

Example:

Calculated thicknesses

$$S_1 + S_2 = 2.375 + 3.775 = 6.15 \text{ mm}$$

Rounded thicknesses

$$S_1 + S_2 = 2.35 + 3.80 = 6.15 \text{ mm}$$

Measure shims with a micrometer in several places. Permissible deviation 0.02 mm. Also check shims for burrs and damage.

Adjusting circumferential backlash

Note

The backlash to be set is embossed on the ring gear.

1. Mount gear set using shims "S₃" determined while adjusting the drive pinion.

Note

Make sure that the collar nut of the drive pinion is tightened to **300 Nm** (221 ftlb.) before measuring backlash.

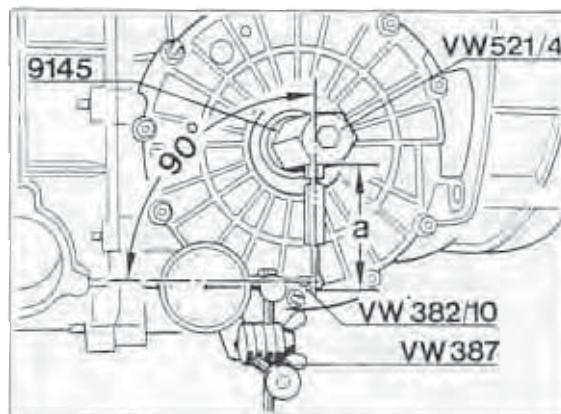
2. Insert differential with tapered roller bearing and shims (S₁ + S₂) into the housing.
3. Fit lateral transmission cover and tighten all hexagon-head nuts to **23 Nm** (17 ftlb.).

Note

Always make sure that there is a certain amount of backlash when tightening the nuts. Never allow the drive pinion to seize.

4. Assemble measuring lever VW 388 and adjusting device VW 521/4 and adjust lever length to 80 mm with the plunger. Refer to dimension "a" in the picture.
5. Insert adjusting device with clamping sleeve (Special Tool 9145) into the differential and clamp firmly.
6. Rotate differential in both directions several times to settle the tapered roller bearings.

7. Fit universal dial gauge holder with flat extension in such a way as to produce a right angle between dial gauge axis and lever.



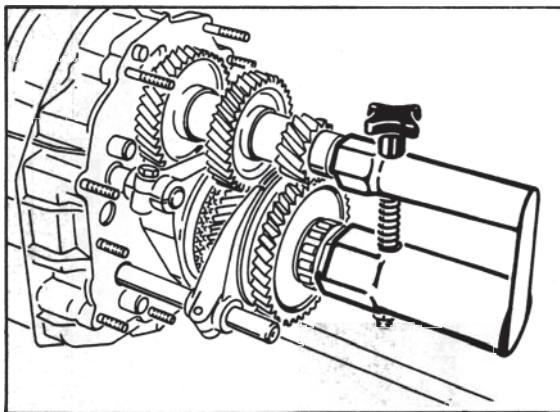
548-39

Dimension "a" = approx. 80 mm

8. Turn ring gear carefully at the clamping screw of the adjusting device as far as the stop and set the dial gauge to zero. Turn back ring gear and read off circumferential backlash. Note down the reading.

Note

When carrying out measurements, the drive pinion must be blocked with Special Tool 9562.



1710-39

9. After turning the ring gear a further 90° , repeat measuring procedures three times.
The measured values must not deviate from one another by more than 0.03 mm.

Note

The backlash to be adjusted is embossed on the ring gear. A deviation of ± 0.03 mm is permissible

10. If the required backlash cannot be obtained, replace spacers ($S_1 + S_2$) again.
The total shim thickness ("S tot.") must not be altered, however.