
Workshop Manual

911

Carrera 4

Structure of the Workshop Manual

This Workshop Manual describes all of the important operations for which special instructions are required to ensure proper completion. This manual is essential for shop foremen and mechanics who need this information to keep the vehicles in safe operating condition. The basic safety rules, of course, also apply to all repairs on vehicles, without exception.

Breakdown of the Workshop Manual

1. Overview of repair groups
2. Record 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 diagrams
4. Legends for the exploded diagrams
5. Notes on assembly/application of special tools
6. Diagnosis for the repair groups

The Workshop Manual will be updated regularly by means of supplements which must be filed immediately to maintain the usefulness of the manual. Appropriate entries must be made in the record sheet to prove that the manual is complete.

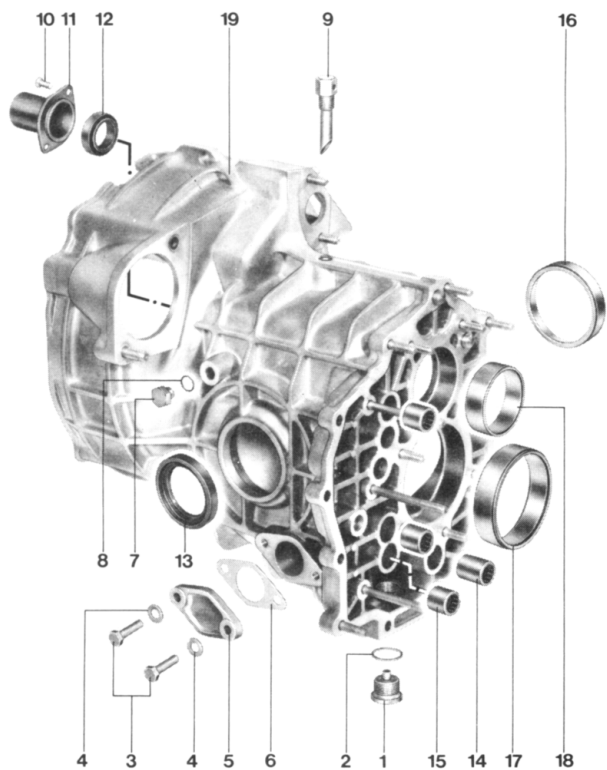
The content of this Workshop Manual will be supplemented with Technical Information Bulletins, which will be integrated into the manual from time to time.

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

Layout of the exploded diagram

A 34 **B** Manual Transmission, Controls, Case **C** 911 Carrera 4

Disassembling and assembling transmission



34 - 128 **D** Disassembling and assembling transmission **E** Printed in Germany - VII, 1988 **F**

C 911 Carrera 4 **B** Manual Transmission, Controls, Case **A** 34

No	Description	Qty.	Note when:	
			Removing	Installing
1	Screw plug	1		Clean, tighten with 30 Nm
2	Sealing ring	1		Replace
3	Hexagon head screw	2		Tighten with 23 Nm (17 ftlb)
4	Washer	2		
5	Flange	1		
6	Seal	1		Replace
7	Screw plug	1		Tighten with 23 Nm (17 ftlb)
8	Sealing ring	1		Replace
9	Breather	1		Tighten with 35 Nm (26 ftlb). Observe installation position
10	Fillister head screw	2		Tighten with 10 Nm (7 ftlb)
11	Guide tube	1		
12	Rotary shaft seal	1		Only install after assembling the gear set (also refer to Page 34-113)
13	Rotary shaft seal	1		Drive into position with Special Tool 9252. Pack space between sealing lips with Küüber Silubrin Grease S
14	Spherical sleeve	1	Pull out with a suitable internal puller (e.g. Schrem 14-20)	Press in with Special Tool 9254

Disassembling and assembling transmission **F** Printed in Germany - VII, 1988 **E** 34 - 128 **D**

- A - Repair group, numbers
- B - Repair groups, text
- C - Type of vehicle to repaired
- D - Page number
- E - Operation
- F - Impressum, supplement number, year of printing
- G - Diagram item number in the order of disassembling
- H - Special notes to be observed when installing or removing

The notes on assembly/application of special tools which are given after the exploded diagram are always arranged in the order of text → diagram.

List of Repair Groups **Carrera 4**

General	Technical Data	Page 0.1
Repair Groups		Group
Volume 1	Maintenance, Self-diagnosis	03
Engine, Maintenance	Engine, Crankcase, Suspension	10
	Engine, Crankshaft, Pistons	13
	Engine, Cylinder Head and Valve Drive	15
	Engine, Lubrication	17
	Engine, Cooling	19
	Fuel Supply	20
	Fuel System, Electronic Injection	24
	Exhaust System/Emission Controls	26
	Starter, Power Supply, Cruise Control	27
	Ignition System	28
	Diagnosis	
Volume II	Clutch, Controls	30
Transmission (manual)	Clutch	32
	Manual Transmission, Controls, Case	34
	Manual Transmission, Gears, Shafts	35
	Differential, Transaxle System, All-Wheel Drive	39
	Diagnosis	
Volume III	Clutch, Controls	30
Transmission (automatic)	Torque Converter	32
	Automatic Transmission, Controls, Case	37
	Automatic Transmission, Gears, Shafts	38
	Differential, Transaxle System	39
	Diagnosis	
Volume IV	Front Wheel Suspension	40
Chassis	Rear Wheel Suspension, Axle Shaft	42
	Wheels, Tires, Alignment	44
	Antiblock System	45
	Brakes, Mechanical	46
	Brakes, Hydraulics, Regulator, Booster	47
	Steering	48
	Diagnosis	
Volume VI	Body-Front Section	50
Body	Body-Center Section	51
	Body-Rear Section	53
	Lids	55
	Doors	57
	Electric Sunroof	60
	Hardtop	61
	Bumpers	63
	Glasses, Window Control	64
	Exterior Equipment	66
	Interior Equipment	68
	Seats	72
	Seat Covers	74
	Volume VI	Heater
Heating, Ventilation, Air Condition	Ventilation	85
	Air Conditioner	87
	Diagnosis	
	Instruments, Fuel Gauge, Alarm System	90
	Radio, Telephone, On-board-computer	91
	Windshield Wipers and Washer	92
	Exterior Lights, Lamps, Switches	94
	Interior Lights	96
	Diagnosis	
	Volume VII	Wiring
Electrics		
Wiring Diagrams		

Survey of Information Published in Technical Manual beginning in 1985

**6
Cyl.**

1

	TI/ QI	No.	911 C2/C4	911	911 Turbo	Remarks, Model, Also refer to...	Date
1985							
- Oil Pump with Intake Plate and Filter Screen	T	1/85	●	●		New version	29.04.85
- Camshaft Sprocket Installation	Q	1/85	●	●		Threads not lubricated with oil	10.04.85
- Engine Carrier/Engine Mounts	Q	2/85	●	●		Optimoly HT	07.06.85
- Scrapping Exhaust Valves	Q	3/85				Sodium filled valves	13.08.85
1986							
- Thermo Valve Temperature Switch	Q	1/86	●	●		Hose routing	18.04.86
- Leakage Lower Valve Cover Gasket	Q	2/86	●	●		1987 Models on	20.06.86
- Oil Pressure Swith Oil Pressure Warning Lamp Flickers	Q	3/86	●	●		1984 Models on	07.07.86
- New Nuts and New Cylinder Head Tightening Specifications	T	1/86	●	●		Torque angle	30.12.86
- Modification on Bypass Valve	T	2/86	●	●		Noise	30.12.86
1987							
- Oil Pipes Chain Tensioner	Q	1/87	●	●		1987 Model/leakage	18.06.87
1988							
1989							
- Additional Sealing on Crankcase	T	1/89	●	●		Silastic 732 RTV	22.05.89
- Protection and Conservation Agent for Engines / Type 959	T	2/89				Type 959: VW-Part No.: AKR 320 KD 604	31.05.89
- Thightening Torque of Conrod Nuts	T	3/89	●	●		New grade 12.9: 15 Nm and 2 x 90°	20.12.89
1990							
- Camshaft housing cover	T	1/90	●	●		Additional washers: 6,2x20x4 (aluminium)	28.02.90
◆ = Conversion instructions or workshop campaign ▼ = Brochure ⊕ = Supplement or change for TI/QI							



SERVICE

Date
30.04.90
VKQPI

Survey of Information Published in Technical Manual beginning in 1985

6
Cyl.

2

	TI/ QI	No.	911 C2/C4	911	911 Turbo	Remarks, Model, Also refer to...	Date
1985							
- Misfiring Because of Ground Strap Corrosion	Q	1/85		●			15.02.85
- Fuel Injector Survey L-Jetronic	Q	2/85		●			15.02.85
- Throttle Housing	Q	3/85		●		Bypass air screw	10.04.85
- Corroded Spark Plug Connectors	Q	4/85		●	●		10.04.85
- Settings of DME Control Units	T	1/85		●			18.07.85
- List of Factory Tested an Approved Spark Plugs	T	2/85		●	●	Invalid/...TI-1/86	08.07.85
- Retrofitting - Catalysor	T	◆	3/85	●			20.12.85
- Retrofitting - Catalysor	T	◆	4/85	●			20.12.85
- Retrofitting - Catalysor	T	◆	5/85	●		Invalid/...TI-1/87	20.12.85
1986							
- Ignition Delay Relay	Q	1/86				● 1985-1986 Models/ Relay voltage 9 volts	16.01.86
- List of Factory Tested an Approved Spark Plugs	T	1/86		●		● Invalid/...TI-1/88	30.04.86
- BatterieDischarging	Q	2/86		●		● Removing battery	18.04.86
- Mixture Preparation Engine Stalls While Declutching	Q	3/86		●		1986 Model/"mixture too rich"	20.06.86
- Catalytic Converter Cars Poor Pickup	Q	4/86		●			20.06.86
- Engine Damage Engine Repairs	Q	5/86		●		● Foreign particles in in- take system	20.06.86
- Information for Cars with Catalytic Converter	T	2/86		●			26.06.86
- Turbocharger Compressor Wheel Damage	Q	6/86				● foreign particles	10.10.86
- Faulty Wire Bridge - Terminal 28 Lean Hesitation, CO Adjustment	Q	7/86		●		Terminal 28/resistance	25.11.86
1987							
- Additional Air Pump Maintenance	Q	1/87				● Fuel return line	20.02.87
- Troubleshooting Fuel System/Engine Electrical System	Q	2/87		●		● Plug connections (cleanliness)	20.02.87
◆ = Conversion instructions or workshop campaign ▽ = Brochure ⊕ = Supplement or change for TI/QI							



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Date	
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6
Cyl.

2

	TI/ QI		No.	911 C2/C4	911	911 Turbo	Remarks, Model, Also refer to...	Date
- Engine Power Fuel/Air Mixture	Q		3/87		●		1986-1987 Models/ term. 28/oxygen sensor	31.03.87
- Troubleshooting Temperatur Sensor	Q	◆	4/87		●		NTC II	22.05.87
- Service Installation - Catalytic Converter	T	◆	1/87		●			25.10.87
- Starting Motor Transmission Cars	Q		5/87		●		1987 Model/115 mm	31.08.87
- Battery Discharging	Q		6/87		●	●	Only coupe/inside lights	16.10.87
- Battery Discharging New Cars	Q		7/87		●	●	Checking battery con- dition	24.11.87
1988								
- Fuel Grade Exhaust System	Q		1/88		●	●	Exhaust tailpipe dis- coloration/unleaded	19.02.88
- Survey of Factory Tested and Approved Spark Plugs	T		1/88		●	●		06.07.88
- Survey of Control Units	T		2/88		●	●		06.07.88
- Fuel/Air Mixture Throttle Valve Housing	Q		2/88		●		Hose to thermo valve disconnected	19.09.88
- Starter Starter Gear Ring	Q		3/88		●		911 Turbo starter gear- ring/...QI-5/87	30.12.88
1989								
- Unleaded Gasoling Regular RON 91 / Euro Premium RON 95 / Premium RON 98	T		1/89	●	●	●	Fuel grade table.	31.01.89
- New Catalytic Converter Conversion Kit 930.113.911.03	T		2/89		●		...with plastic filling tube.	12.06.89
- Spark Plug connectors which are hard to remove	T		3/89	●			Engine Nos.: 62 K 00607 to 62 K 00788	02.05.89
- DME Control Unit	T	◆	4/89	●			...with green dot.	08.06.89
- Lighting up of Warning Signs and Faults in DME Fault Memory	T		5/89	●			Carrera 4	12.06.89
- Service Installation of Catalytic Converter	T	◆	6/89	●			Carrera 4 M'89 (K) 964.113.911.00	05.10.89
- Fuel Hose to Rear Fuel Pump	T	◆	7/89			●	Hose laid differently.	13.11.89

◆ = Conversion instructions or workshop campaign
 ▽ = Brochure
 ⊕ = Supplement or change for TI/QI



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Date
30.04.90

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Survey of Information Published in Technical Manual beginning in 1985

**6
Cyl.**

2

	TI/ QI		No.	911 C2-C4	911	911 turbo	Remarks, Model, Also refer to...	Date
1990								
- Cable harness connector at the air-flow sensor	T	◆	1/90	●			Cable cluster mounted in tight loop.	21.02.90
- Securing heat shield to exhaust system	T		2/90	●			...coat with Optimoly HT	31.08.90
- Engine Temperature Sensor (NTC) II	T		3/90		●		M'84 (E)-'89 (K) spare part: 930.606.915.00	16.11.90
◆ = Conversion instructions or workshop campaign ▽ = Brochure ⊕ = Supplement or change for TI/QI								



SERVICE

Date	
30.04.90	31.12.90
VKQPI	

The workshop manual of the Carrera 4 also includes that for the Carrera 2. The Carrera 4 acts as the basis for description of the repairs in the manual. "Carrera 4" also appears on every page in the header line.

Deviating descriptions for repairs on the Carrera 2 follow those of the Carrera 4. These repair descriptions for both models are separated by a yellow sheet.

"Carrera 2" appears on all pages in the header line after the separating sheet. The page number starts with 100 as an additional distinction.

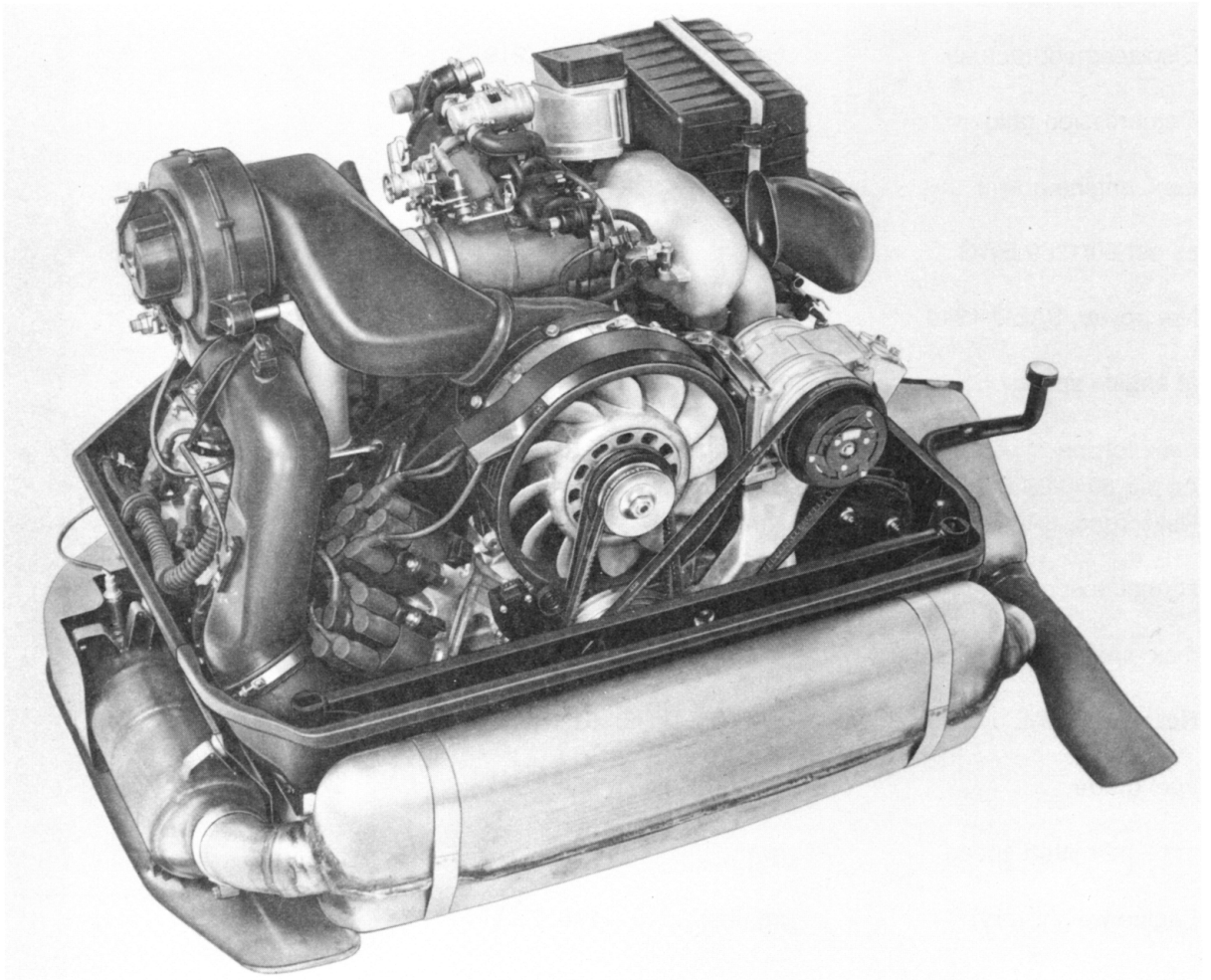
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911

Carrera 4



88/100

Technical Data - 911 Carrera 4

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

Note: USA values in brackets (engine type M 64/01)

Drive unit

Internal engine designation		M 64/01
Number of cylinders		6
Bore	mm (in.)	100 (3.94)
Hub	mm (in.)	76.4 (3.01)
Displacement (actual)	cm ³ (in. ³)	3600 (219.7)
Compression ratio		11.0 : 1
max. engine power	kW (HP)	184 (250)
as per 80/1269 EWG		
Net power, SAE J 1349	kW (HP)	184 (247)
at engine speed	rpm	6100
max. torque	Nm (kpm)	310 (31.6)
As per 80/1269 EWG		
Net torque, SAE J 1349	Nm (ftlb)	310 (228)
at engine speed	rpm	4800
max. specific power output	kW/l (PS/l)	51.1 (69.4)
Net power, SAE J 1349	kW/l (PS/l)	51.1 (68.6)
Fuel grade	RON (MON)	95/85
max. permitted speed	rpm	6700
Engine weight (dry)	kg (lbs)	240 (529)

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, supported by 8 bearings
Crankshaft bearings	Friction bearings
Connecting rods	Forged
Conrod 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 V formation
Valve timing	One overhead camshaft each on right and left
Camshaft	Cast
Camshaft drive	Double chain
Valve clearance	0.10 mm (inlet, exhaust cold)
Timing	Inlet opens 4 degrees before TDC Inlet closes 56 degrees after BDC Exhaust opens 44 degrees before BDC Exhaust closes 4 degrees after TDC
Intake system	With controlled tuning flap

Engine cooling

Type	Air-cooled system
Blower drive	Via V-belts from the crankshaft
Transmission ratio: crankshaft/blower	approx. 1:1.60
Air delivery rate	1010 l/sec at 6100 rpm of the crankshaft

Engine lubrication

Type	Dry sump lubrication with isolated oil reservoir
Oil cooling	Thermostatically controlled, front oil cooler in the front right-hand fender, 2-stage electric blower
Oil filter	In the return line
Oil pressure at $n = 5000$ rpm	approx. 5.0 bar at 90 degrees 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

Single-branch system joined together outside the heat exchanger, 3-way catalytic converter with closed-loop Lambda control, intermediate and final mufflers, partial encapsulation of the engine

Emission control

Closed-loop Lambda control with 3-way catalytic converter (metal carrier).

Heating

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

Fuel system

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

Electrical system

Interference suppression		ECE-R 10 and 72/245/EEC
Battery voltage	V	12
Battery capacity	Ah	72
Alternator output	A/W	115/1610 3-phase current
Ignition		DEE, dual ignition, knock sensor controller
Firing order		1 - 6 - 2 - 4 - 3 - 5
Ignition timing control		via DME
Spark plugs		Bosch FR 5 DTC
Spark gap	mm (in)	0.8 ± 0.1 (0.032 ± 0.004)

Body construction

Integral steel body, rear spoiler, coupé

Dimensions (at DIN curb weight)

Length	mm	4250	
Width	mm	1652	
Height	mm	1320	
Wheel base (design)	mm	2272	
Front track			with rim
	mm (in.)	1380 (54.1)	6J x 16
Rear track	mm (in.)	1374 (54.1)	8J x 16
	mm (in.)	1369 (53.9)	7J x 16

Dimensions

Ground clearance (at max. permitted weight)	mm	120
Ramp angle (at max. permitted weight)	12.0	degrees
Front overhang angle (at max. permitted weight)	12.5	degrees
Rear overhang angle (at max. permitted weight)	12.0	degrees

Weights (as per DIN 70020)

Front curb weight	kg (lbs)	600 (1322)
Rear curb weight	kg (lbs)	850 (1872)
Total curb weight	kg (lbs)	1450 (3194)
max. total weight	kg (lbs)	1790 (3943)
max. front axle load	kg (lbs)	760 (1674)
max. rear axle load	kg (lbs)	1050 (2313)
max. roof load including roof rack	kg (lbs)	75 (165) with original Porsche roof transport system
max. trailer load, without brakes*	kg (lbs)	500 (1101)
max. trailer load, with brakes*	kg (lbs)	1200 (2643)
max. car/trailer weight	kg (lbs)	2990 (6586)
max. drawbar load	kg (lbs)	75 (165)

*Up to 16% gradient

Filling capacities

Engine	Only use 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 the oil dipstick as per Owner's Manual
Transmission with differential	Front axle 1.2 l Rear axle 3.8 l
Fuel tank	approx. 77 l (approx. 10 l reserve)
Brake-fluid reservoir	approx. 0.75 l
Washer fluid for windshield and headlights	approx. 7.4 l
Intensive washing	approx. 0.7 l
Power-assisted steering	approx. 1.0 l

Performance

Top speed	km/h (mph)	260 (162)
Acceleration from 0-100 km/h	s	5.9
Kilometer from standing start	s	25.5

Hill climbing

Manual transmission

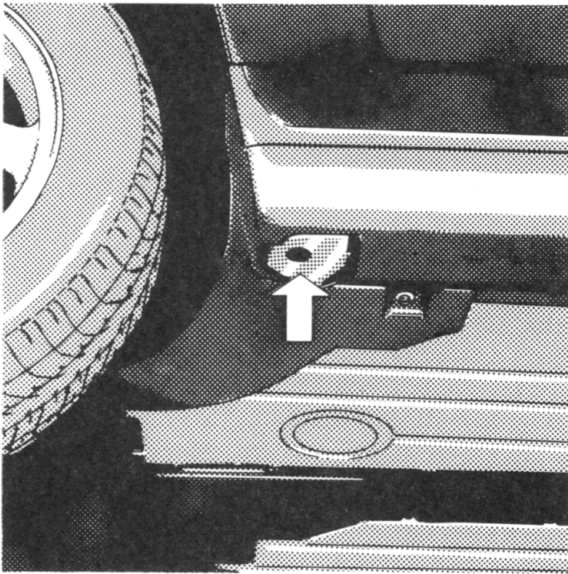
In %	1. gear	86%
	2. gear	41%
	3. gear	24%
	4. gear	15%
	5. gear	11%

Raising the vehicle

The vehicle must only be lifted using the illustrated jacking points. When driving onto a lifting platform, make sure that there is enough clearance between the platform and the vehicle.

front

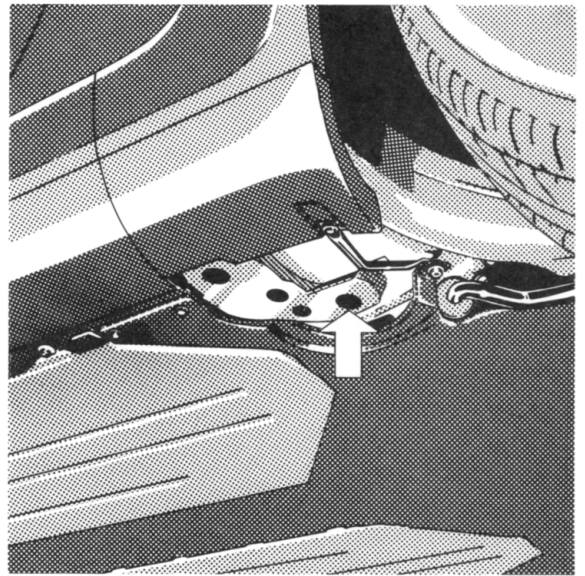
At the jacking point



132/03

Rear

At the jacking point



133/03

Maintenance Schedule

The recommended Service Intervals apply under normal driving conditions and do not take into account any Optional Equipment. Dusty areas require more frequent checking and possible replacement of the air filter element. Tyre, clutch and brake wear as well as the condition of the engine oil are all largely dependent on driving habits, and are also affected by arduous operating conditions; this could mean shorter intervals between services and replacement of parts. This applies, naturally, also to: "Battery: check fluid level and, if necessary, top up."

Vehicles with a low yearly mileage (kilometres) should be serviced at least once a year. The extent of maintenance can depend on the driving conditions. Your Official Porsche Centre will be pleased to inform you of the contents of the yearly service check. As part of this servicing, after the first 2 years the Porsche Dealer will make out a Status Report. This is intended to ensure that the conditions for the Long-life guarantee are not jeopardized. If required by the condition of the vehicle, a full upper- and lower-body cleaning may be necessary.

Exchange and new spare parts receive the same contents of service as components of new vehicles.

The terms "inspect" and "check" include all associated work such as adjustments, readjustments, corrections and replenishment. They do not include the repair, replacement or overhaul of components or assemblies.

3 000 to 4 000 km / 2 000 to 2 500 miles Servicing

Front axle: check toe adjustment incl. tyre condition, tyre pressure	3
Diagnosis System: read out system faults	5
Change engine oil and oil filter	6
Check valve clearance	7
V-belt: check tension	10
Visual inspection for leaks: oils and fluids	12
Windscreen washer, headlight washer: check function, fluid level and nozzle adjustment, regard antifreeze content for the winter season	23
Lighting system: check function	23
Brake hoses and lines: visual inspection for leaks, clearance; damage, check brake fluid level	14
Transmission / axle drives: Visual inspection for leaks, check oil levels	19
Exhaust system: visual inspection for leaks and damages	20
Check screw connections for tightness and attachment	20
Exhaust emissions test on vehicles without catalytic converter. Perform system adaptation	26

Test drive:

Brake pedal and hand brake, brake power assist unit, clutch, automatic speed control, steering, heating, air conditioner and instruments: check function	-
Drive train, longitudinal- and lateral limited slip differential: check for noises and operation	29
Visual inspection for leaks: oils and fluids	29

Service every 20 000 km / 12 000 miles

Diagnosis system: read out system faults	5
Change engine oil and oil filter	6
Check valve clearance	7
V-belt: check condition and tension	10
Toothed belt for power-steering pump: check condition	11
Change spark plugs	11
Visual inspection for leaks: oils and fluids	12
Air filter: replace filter element	12
Crankcase ventilation: check tightness of hose connections	12
Fuel system: visual inspection for leaks, damages, clearance and tightness of hose connections	12
Intake air: check hoses, lines and connections for tightness	12
Hand brake: check free travel of hand brake lever	13
Brake pedal: check play of brake pedal.	
Brake hoses and lines: visual inspection for leaks, clearance, damage, and corrosion. Check brake fluid level.	14
Brake system: visual inspection of brake pads and discs	15
Hydraulic clutch actuator: visual inspection for leaks, check final position of clutch pedal	17
Throttle actuator: check cables, linkages and joints for smooth running, full throttle opening and resonanz flap movement	16
Steering gear: check screw connections for tightness	
Visual inspection of the bellows for damage	18
Tie rod links: check play, tightness and dust caps	
Power-assisted steering: visual inspection for leaks and check fluid level	18
Ball joints: visual inspection of dust caps for damage	
Wishbone: check screw connections for tightness	19
Transmission, axle drives: visual inspection for leaks, check oil levels	19
Drive shafts: visual inspection of sleeves for leaks and damage	19

Service every 20 000 km / 12 000 miles

Exhaust system: visual inspection for leaks and damages, check screw connections for tightness and attachment	20
Tyres: check condition, correct tyre pressure	20
Door arrester: check function and lubricate	20
Door hinges: lubricate	20
Check door-, front hood locks and safety hooks on front hood for tightness and function	20
Safety belt: check function and condition	21
Seals for doors, hood and roof: remove abraded rubber, apply suitable agent to lubricate seals	21
Check function of the vehicle lighting. All headlights: check setting	23
Horn: check function	23
Windscreen washer, headlight washer: check function, fluid level and nozzle adjustment, regard antifreeze content for the winter season	23
Intensive cleaner: check function and fluid level	24
Battery: check fluid level	24
All other electrical equipment as well as control- and warninglights: check function	24
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Exhaust emission unit: check if catalytic converter, oxygen sensor and channeled filler inlet are positioned, visual inspection of all electrical connections, check function of oxygen sensor	25
Ignition circuit 1 and 2: check function	25
Exhaust emissions test: test CO content (measure before and behind the catalytic converter if equipped), Perform system adaptation	26

Test drive:

Brake pedal and hand brake, brake power assist unit, clutch, automatic speed control, steering, heating, air-conditioner and instruments: check function	29
Drive train, longitudinal- and lateral limited slip differential: check for noises and operation	29
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Additional service every 40 000 km / 24 000 miles

Change fuel filter	29
--------------------	----

Additional service every 80 000 km / 48 000 miles

Manual transmission and axle drives: change oil	30
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Yearly service after the first 2 years

File Status Report for Long-life guarantee	-
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Service every 2 years

Change brake fluid	31
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Front axle:

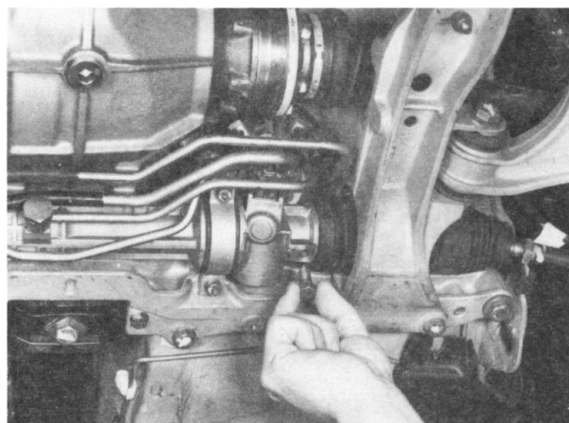
Checking the toe

Use a visual or electronic axle measuring unit to check and/or adjust the toe. Refer to the operating instructions for the respective axle measuring unit for the measuring procedure. The following preconditions must be fulfilled before checking the toe for the front axle:

- Curb weight of car according to DIN 70020 = ready-to-drive car with full fuel tank, spare wheel and tools.
 - Correct joint and wheel bearing play (wheel bearing play cannot be adjusted).
 - Correct tire pressure
1. Bounce the vehicle at rear and front axles 2-3 times and allow to return under its own power.
 2. Check the front toe with the steering wheel in the straight ahead position and adjust the tie rods if necessary. (Refer to the next page for wheel alignment values).

Necessary preparations

First check whether the steering wheel is off-set in relation to the steering gear. This requires removing the underside trim panel and centering the steering gear in middle position with Special Tool 9116. If adjustment is necessary, try to get the optimum position for the steering wheel. Then remove ST 9116.



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Clamp the steering wheel in middle position before adjusting toe.



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Wheel alignment values

The following values apply at curb weight as per DIN 70020 (vehicle with full fuel tank, spare wheel and tools).

	Specification and tolerance	max. deviation between left and right
Front axle		
Toe (total) - unpressed	+ 25' ± 5'	only influenced by replacing the steering arms
Toe difference angle at 20° lock	- 40' ± 30'	
Camber	0° ± 10'	10'
Caster	4° 25' ± 15'	15'
Rear axle		
Toe per wheel	+ 15' ± 5'	10'
Camber	- 20' ± 10'	20'

Tire condition / inflation pressure

Tires constitute a safety element and they can only fulfill the demands made on them if the inflation pressure is correct and there is adequate tread depth.

The specified inflation pressures are minimum pressures; under no circumstances should the tire pressure be allowed to sink below these levels as this will not only detrimentally affect the driving behavior, but also increases the risk of serious tire damage.

Valve caps protect the valves from dust and dirt and therefore prevent leakage. Always screw caps on tightly and replace any that are missing.

For safety reasons, a tire-pressure check should always be accompanied by a visual inspection to ensure adequate tread depth and a check for objects piercing the tire, slits, cuts, cracks and bulges in the side wall (cord break).

Inflation pressure with the tires cold (summer and winter tires).

Front 2.5 bar
Rear 3.0 bar

Collapsible spare wheel
front/rear 2.5 bar

Diagnosis system:

Read 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-pole socket outlet.



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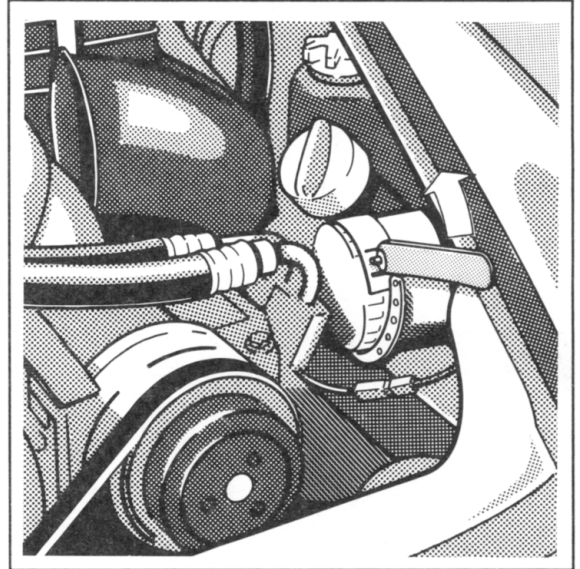
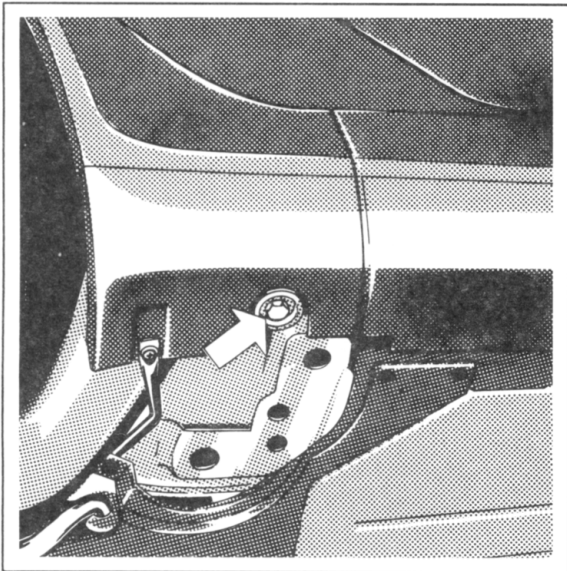
Also refer to repair group 03, self-diagnosis for operating instructions.

Replacing engine oil and filter

Precondition:
engine at operating temperature

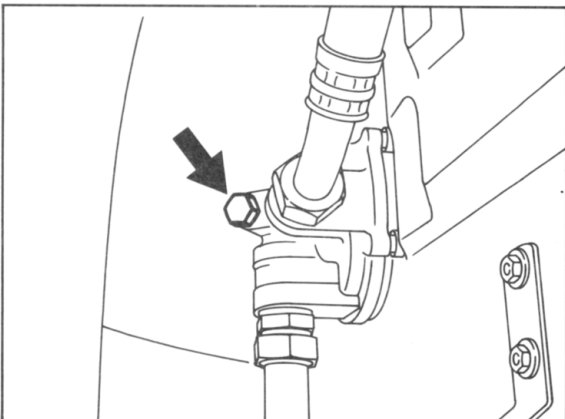
1. Remove engine guard. Undo the drain plugs in the crankcase and thermostat housing and drain out the engine oil.

Drain plug - thermostat housing



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2. Undo oil drain plug at oil filter console and drain remaining used oil into a suitable container.



3. Undo the oil filter with a standard clamping band, e.g. Hazet 2171 - 2. Catch any remaining oil.
4. Clean the drain plug. Always replace the sealing rings. Tightening torque for the drain plug on the crankcase 70 Nm (52 ftlb). Drain plug on the thermostat housing 65 Nm (48 ftlb) and oil filter console plug 31 Nm (23 ftlb).
5. Apply a light film of oil to the seal on the oil filter, install by hand, turning until the seal makes contact. Finally, tighten by a further approx. 1/2 turn.
6. Fill with approx. 6 liters of engine oil. Run the engine at idle and top up with approx. 3 liter. The oil-change volume amounts to approx. 9 liter. Only use approved engine oils. Refer to the Technical Information Handbook.

Check the oil level at operating temperature and at idle speed. Check the engine, oil reservoir, lines and front oil cooler for leaks (visual inspection)

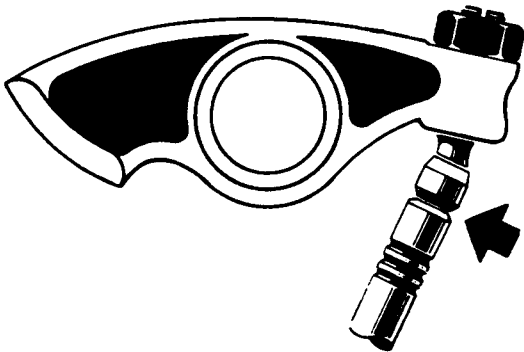
Checking and adjusting the valve clearance

Note

Always check or adjust the valve clearance with the engine cold (approx. 20 °C). Check by inserting the feeler gauge between the end face of the stem and the cap of the valve adjusting screw.

If the spark plugs are not removed when the valves are adjusted, the engine must only be rotated at the bottom pulley or at the internal multi-tooth end of the generator shaft.

Check hex nut on alternator shaft for tight fit after the adjustment has been completed.



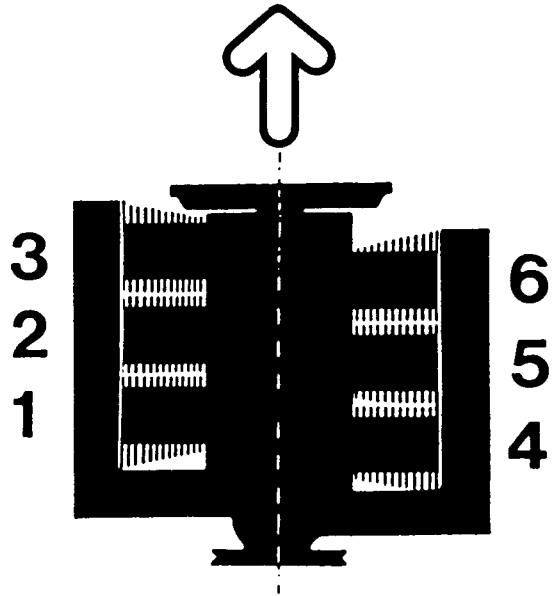
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Valve clearance with the engine cold:

Intake	0.1 mm
Exhaust	0.1 mm

The clearance is adjusted according to the firing order 1 - 6 - 2 - 4 - 3 - 5. The piston for the respective cylinder must be in top dead center of the compression stroke as both valves are then closed. The TDC marking for each cylinder can be found on the pulley.

Cylinder designation

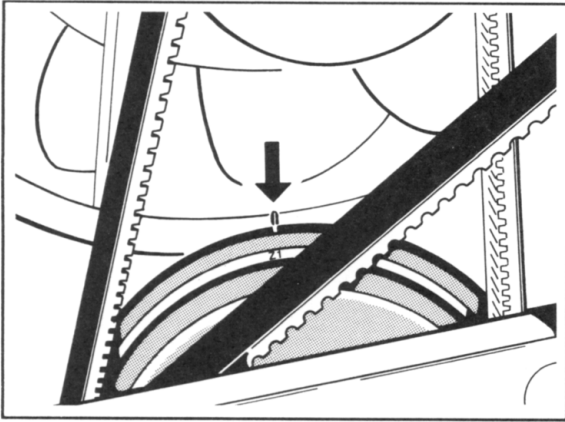


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Firing order 1 - 6 - 2 - 4 - 3 - 5

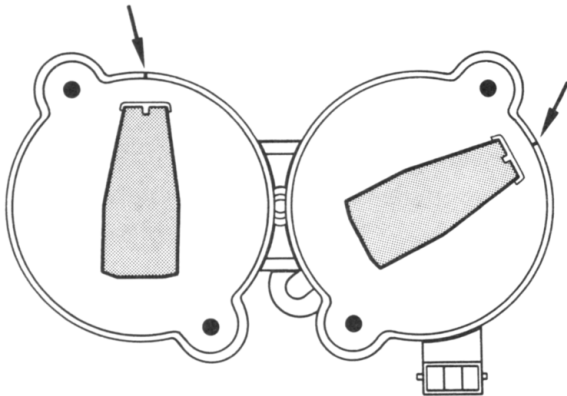
1. Cylinder 1 is the first to be adjusted. For this, turn the crankshaft to the right with the V-belt pulley until both valves of the cylinder are closed (overlapping cylinder 4) or until the distributor arm is aligned with the marking on the distributor housing. The TDC marking (Z1) on the pulley must be level with the crankcase seam or the locating mark on the blower housing.

TDC marking - pulley



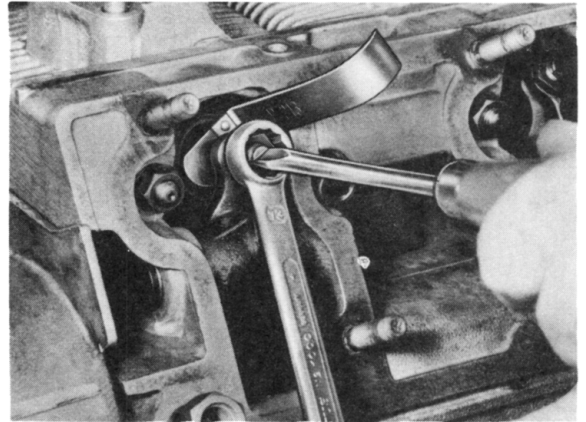
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Distributor marking - cylinder 1



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2. Check the valve clearance with P 213 b; if necessary, undo the hexagon nut on the adjusting screw and correct the valve clearance by turning the adjusting screw with a suitable screwdriver, hold the adjusting screw firmly and tighten the counternut.



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3. Check the clearance again.
4. Now, continue turning the crankshaft clockwise with the pulley as far as the next marking (120°). The valves for cylinder 6 can be adjusted in this position.
5. Turn the crankshaft to the next marking (120°) to bring cylinder 2 to firing point.
6. Repeat this procedure accordingly to adjust the other valves (cylinders 4, 3 and 5).
7. Always replace the valve-cover seals and the self-locking nuts.
Tightening torque 9.7 Nm (7 ftlb)

The following assembly operations must be carried out before adjusting valves:

Assembly work from above:

1. Remove the rear wheels
2. If the vehicle is fitted with a catalytic converter, separate the plug connection to the Lambda probe, removing the hot-air blower beforehand.

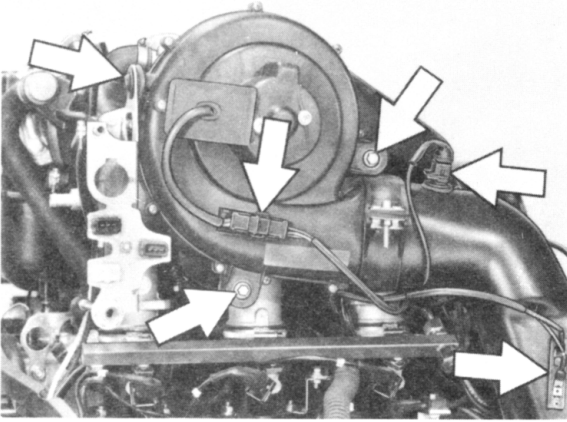
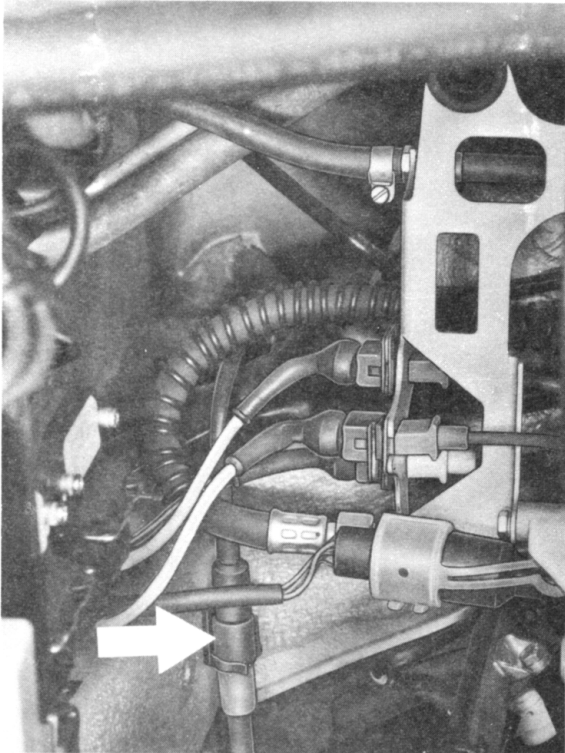


Illustration shows the engine removed

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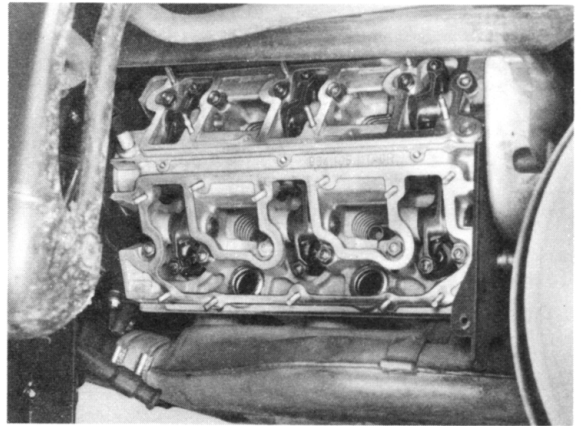
3. Push the probe cable with rubber grommet downwards through the engine paneling on the left-hand side.
4. Undo the front fastening screws on the engine side paneling beforehand.
(4 screws M 6 x 10)

Assembly work from below.

1. Remove the engine guard.
2. Remove the exhaust system complete (except heat exchanger).
3. Remove the side encapsulation panels from the engine.
4. Undo the side engine paneling.
5. Disconnect the spark plug sockets from the upper and lower ignition circuits.
6. Remove the valve covers for intake and exhaust.

Note

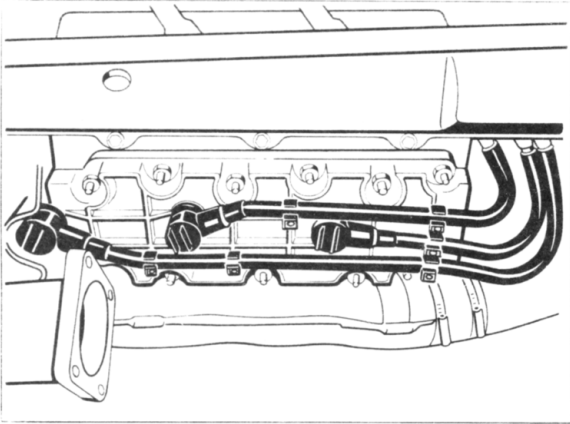
The clearance for intake and exhaust valves can now be checked and/or adjusted from below.



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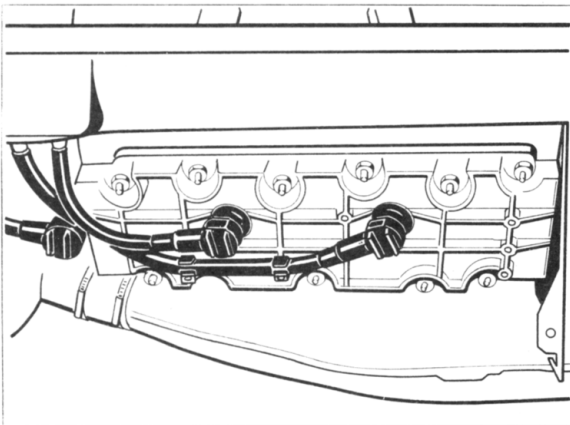
Installation of ignition leads on exhaust valve covers differs, so that valve covers must not be mixed up when installed.

Check for perfect seating of spark plug connectors and routing of ignition leads.



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Left Side – Cyl. 1 - 3



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Right Side – Cyl. 4 - 6

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.

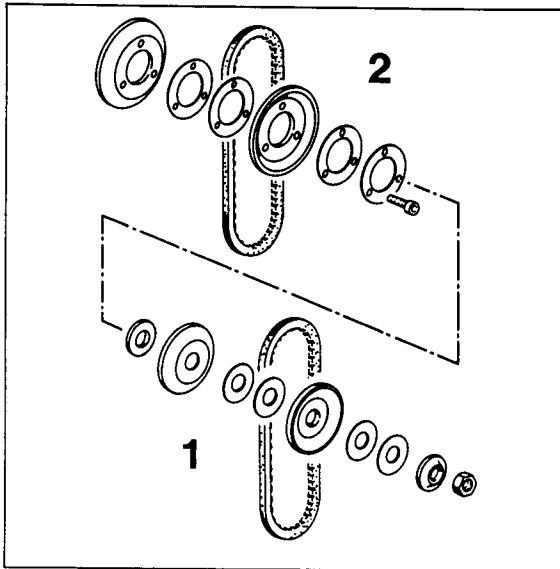
Test requirement: Engine at operating temperature

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.



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- 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.

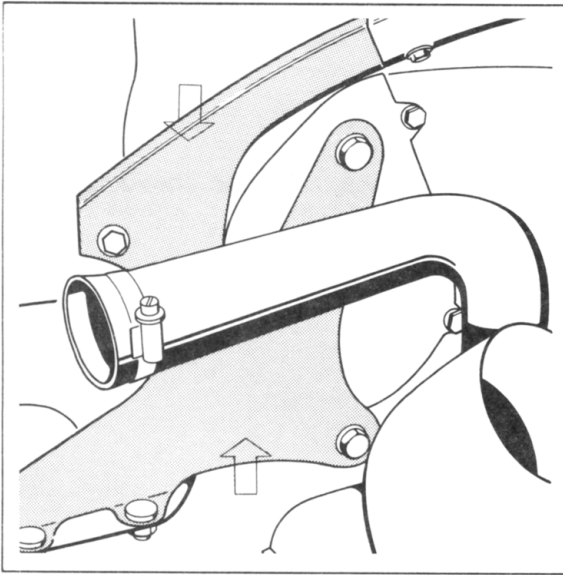
Note

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.

V-belts for the power steering pump:

Check condition

1. Remove the engine guard.
2. Undo the final-muffler bracket and remove from the final muffler and engine. Remove the left-hand top engine cover panel and the toothed-belt guard.



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3. Check the toothed belt for wear and damage by cranking the engine. The belt tension is not adjustable.

Replacing spark plugs:

Unscrew spark plugs with standard commercially available socket wrench insert from Messers. Snap-on Order Nr. S 97 06 and extension Snap-on, Order No. FXW4.

Replacing the spark plugs for the upper ignition circuit

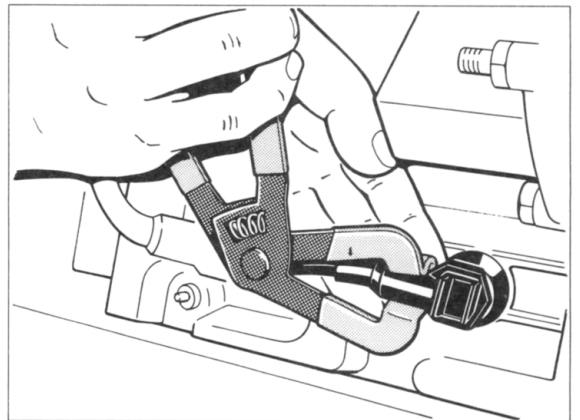
1. Remove the heating blower
2. Remove the air-filter cover and filter insert

Replacing the spark plugs for the lower ignition circuit

1. On vehicles with catalytic converter, separate the plug connection for the Lambda probe, removing the hot-air blower beforehand.
2. Push the probe cable with rubber grommet downwards through the left-hand side engine paneling.
3. Remove the exhaust system complete (separating point downstream of catalytic converter)
4. Remove the side engine encapsulation panels.

Note

1. Do not use any lubricant on the plug thread.
2. With spark plugs which are difficult to remove, use Special Tool (disassembly clamp) 9513, order no. 000.721.951.30



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Visual inspection for leaks:

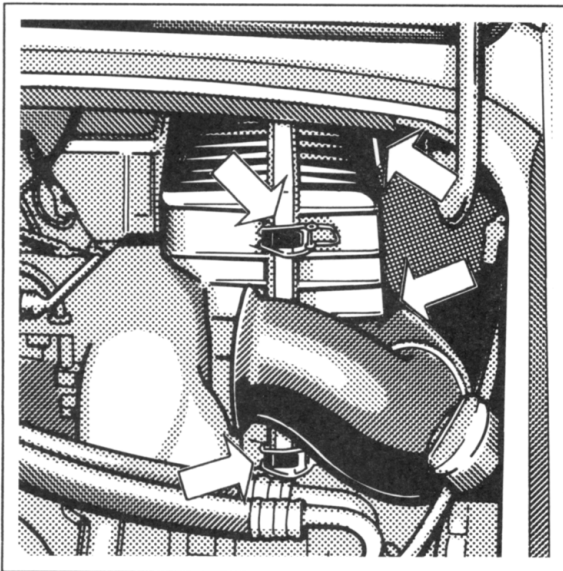
Oils, fluids

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

Air filter:

Replacing the filter insert

1. Release the retaining clips and remove the housing cover with filter insert.
2. Take out the filter insert and clean the inside of the filter housing with a non-fibrous cloth.
3. Install a new filter insert.
(Fins in horizontal position).



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Crankcase ventilation

Check that all hose connections are securely fitted

Fuel system:

Visual inspection for leaks, damage, free flow and secure fitting of the line connections

Intake air guide:

Check that hoses, lines and connections are fitted securely

Check that the hose connections are fitted securely through-out the entire intake system

Parking brake:

Check the free movement of the parking-brake lever

The parking brake is fitted with asbestos-free brake pads. This type of parking brake must never be adjusted in such a way that the brake pad has to "grind itself free" in operation.

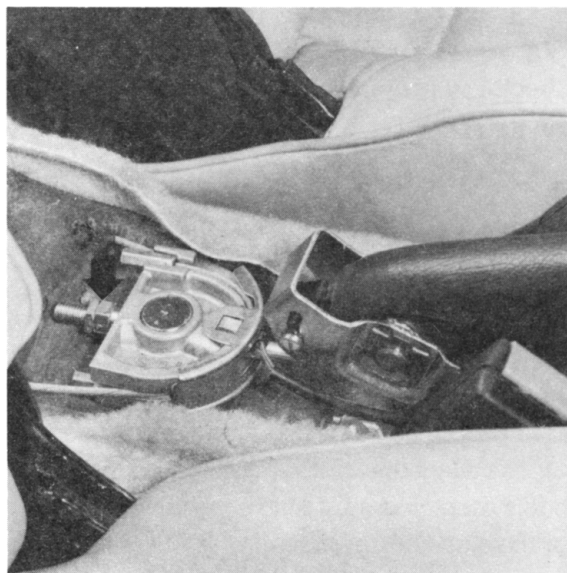
If it is possible to raise the lever by more than 4 notches, using average force, without any sign of a braking effect, the parking brake needs adjustment.

Adjusting the parking brake:

1. Remove the rear wheel.
2. Release the parking brake and push the disk-brake pads on rear wheels back until the brake disk can be turned freely.
3. Undo the adjusting nuts on the turnbuckle (arrow) until the cable is slack.

Note

Remove the tray behind the brake lever (2 fastening screws) to gain access to the turnbuckle.



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4. Insert a screwdriver through the hole in the brake disk and turn the adjusting device until the wheel is locked. Then undo the adjusting device again until the wheel can be turned freely, *then undo by a further 2 notches.*
5. Pull up the brake lever by 2 notches and turn the adjusting nut on the turnbuckle until both wheels can still just be turned by hand.
6. Release the parking brake and check whether both wheels turn freely.

Foot brake:

Check the play in the brake pedal

The brake pedal has no stop. As the brake pedal has no support facility in the initial position if the brake push-rod is adjusted correctly, the permanently set air play in the brake unit is guaranteed. If the brake pedal plate is pushed down by hand, you can feel a push rod play of approx. 8 mm.

If the push rod is adjusted at the swivel head (3), this alters the position of the brake pedal. In this case, you must also check the setting for the stop-lamp switch.

The push rod is correctly adjusted if the plate of the brake pedal is approximately level (± 3 mm with the plate on the clutch pedal. (Clutch pedal in initial position).

Check the setting for the stop-lamp switch

The stop lamp must light up after the brake pedal has travelled 6 - 16 mm (measured at middle of the pedal brake).

If the stop lamp lights up with less than 6 mm travel, turn the stop-lamp switch (2) to the right until it responds within the tolerance-range. (Do not damage electric cables and connectors). If the adjusting range of the stop-lamp switch is inadequate, adjust the brake pedal with the swivel head on the push rod (shorten the push rod).

If the stop-lamp switch lights up after 16 mm travel, adjust the brake pedal with the swivel head on the push rod, (lengthen the push rod) until the stop lamp switch responds within the tolerance range.



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Check the brake-fluid level

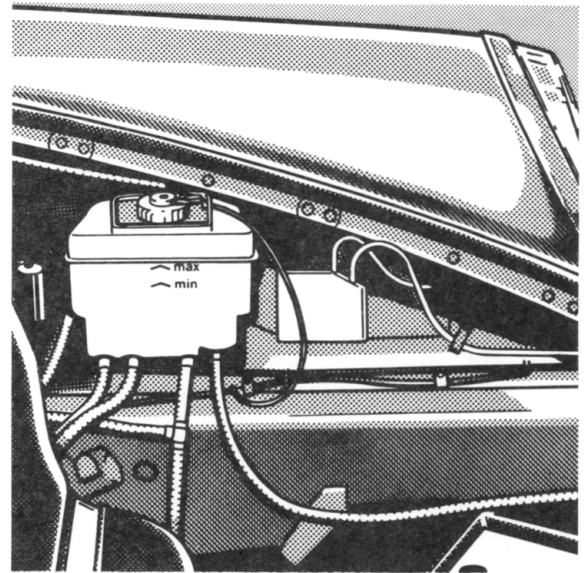
1. With the ignition switched on, pump the brake pedal repeatedly until the electric motor in the pump unit can be heard to start.

Note

The pump unit is located at the front of the luggage compartment and supplies the brake booster and the valve block for the differential lock (interaxle and wheel-to-wheel) via a diaphragm pressure accumulator.



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Brake system:

Visual inspection, checking the brake pads and brake disks for wear

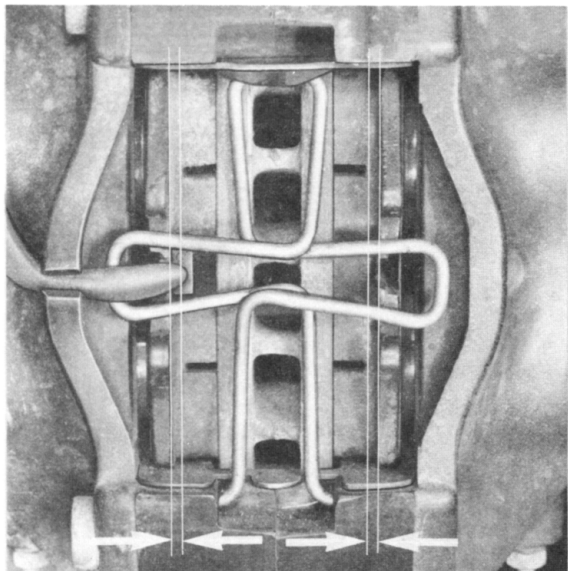
Note

Brake pads must be replaced for the complete axle when the brake- pad warning lamp lights up, but at the latest when the pads have worn down to 2 mm. If the brake-pad wear is indicated by the warning lamp, the warning contact (sensor including cable and connector) must also be replaced. It is possible to avoid replacing the warning contact if the brake pads are replaced when worn down to 2.5 mm at the latest. Warning contacts must be replaced if the core of the cable has been exposed. If only the plastic part of the warning contacts has been rubbed, however, it is not necessary to replace it.

2. Once the pump unit has switched off, the brake-fluid level must be between the min. and max. markings on the reservoir. Never fill to above the max. marking as brake fluid may be discharged through the vent line. Only use brake fluid DOT 3 or DOT 4 (SAE J 1703).

1. Remove the wheels to check the brake pads.
2. Check the brake pads for wear by means of a visual inspection.

The wear limit has been reached when the brake pad is worn down to 2 mm.



Throttle control:

Check bowden cables, linkages, joints for smooth operation. Check the tuning flap and full-throttle position.

Checking the tuning flap:

Each time the ignition is switched on, the tuning flap is opened and closed once by a vacuum.

The opening and closing noise can be heard in the engine compartment.

Hydraulic clutch control:

Visual inspection for leakage, check final position of the pedal

The clutch pedal has no stop. It is in its initial position when the master cylinder is in its initial position.

The push rod cannot be adjusted.

The preload on the servo spring, however, can be adjusted. The servo spring must fulfill 2 functions: to assist the pedal force and return the pedal.

If the clutch pedal does not return correctly, reduce the preload on the servo spring slightly. To do this, undo Allen screw No. 1 slightly until you can find a good compromise between return and pedal-force assistance.



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Steering gear:

Check that the screw connections are secure. Inspect the boots for damage

Tie rod knuckles:

Check play, fastening and dust caps

Check that all connections to the steering gear and tie rods are secure and that the dust caps, boots and joints are in working order and do not leak.

The rubber dust caps and boots on the steering gear and the tie rods may be damaged by outside influences, e.g. stone throw or during assembly work. If a rubber cap is damaged, the joint or tie rod must be replaced as the joint may be destroyed by the penetration of dirt or moisture.

Power-assisted steering

Visual inspection for leaks and checking the fluid level

General

Insufficient oil in the hydraulic system causes damage to the power-assisted steering. As a result of the high oil pressure in hydraulic system, even small leaks can lead to a drain on the fluid and damage the servo pump.

Grunting noises when locking the steering or foam in the reservoir indicate lack of oil and/or aspirated air. Before filling the reservoir, however, any leaks on the intake side must be repaired and the faulty part replaced on the pressure side.

Note

The tension of the toothed belt is not adjustable but check its condition.

Check the steering system for leaks (visual inspection)

With the engine at idle, turn the steering wheel to the stop and hold it there. This causes the greatest possible line pressure to build up.

Check all line connections for leaks in this position, tighten if necessary.

Carry out this test for max. 10 s. If the test period is longer, make a short pause after approx. 10 s.

Check the fluid level for the power-assisted steering

The reservoir with a transparent upper part is installed on the right-hand side of the engine compartment. With the engine at idle, check the ATF-fluid (ATF-Dexron II D) without moving the steering. The correct level is between the min. and max. marks on the reservoir.



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Axle joints:**Visual inspection for damage to the dust caps**

Check the dust caps for the axle joints (ball joints) on the wheel suspension as follows:

- Drive the vehicle onto the lifting platform, steering lock released.
- Turn the front wheels as far as the stop.
- After cleaning, carry out a visual inspection of the visible areas to the left and right. Press the rubber caps back with your fingers and look for concealed cracks.
- After turning the front wheels to the stop in the other direction, check the remaining rubber caps.

Note

It is not possible to carry out a visual inspection on a small area around the brake cover panels. Check this area by touch.

If a rubber cap is found to be leaky, the respective joint must be replaced as it will be destroyed by the penetration of dirt or moisture.

Axle links:

Check that screw connections are secure

Transmission/final drive

Visual inspection for leaks, check oil level

(Refer to Page 03-30 for notes on this)

Drive shafts:

Visual inspection for leaks and damage to the boots

Exhaust system:

Visual inspection for leaks and damage, check that screw connections are fitted securely and examine the mounting

1. Check that the exhaust flange is fitted securely and inspect the entire exhaust system for leaks.
2. Check that the mounting on the heat exchanger / cylinder head flange is fitted securely.
3. Check that all flange connections in the exhaust system as well as the Lambda probe and emission test plug are fitted securely.
4. Check that all screws on the flange, primary muffler (catalytic converter) / heat exchanger are fitted securely. Inspect the mounting points for the exhaust system.

Tightening torques:

- 1 - Heat exchanger - cylinder head 23 Nm (17 ftlb)
- 2 - Flat flange gasket between the left-hand side of the heat exchanger and catalytic converter 23 Nm (17 ftlb)
- 3 - Spherical flange straps 20.5 Nm (15 ftlb)
- 4 - Clamping band for the intermediate muffler 14 Nm (10 ftlb)

Tires:

Check condition, inflate to correct pressure

Refer to the check for the "front axle" on Page 03-4.

Door arrester:

Check function and lubricate

Functional check:

When the door is opened completely, it must be retained by the door arrester. The retaining force (35 N) of the door arrester must be overcome to close the doors.

The door arrester must not make any noise when opening and closing the door.

Lubrication:

Küber Costrak AK 6/300, part number 999.917.751.00

Oil the door hinges

Check that the doors and the safety catch for the front hood are fitted securely and are in working order

Test for secure fit:

The fastening screws for the door lock, front hood lock and rear hood lock, as well as the fastening nuts for the upper parts of the front and rear hood locks must be tightened with 9.7 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.

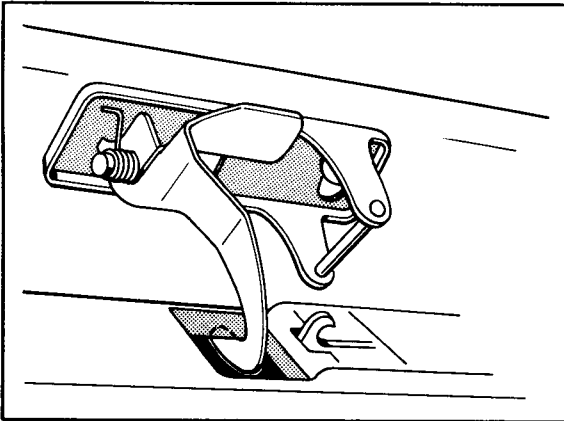
Front and rear hood locks.

When the hoods (front and rear) are closed, the hood locks must engage as the upper part of the locks are inserted and must disengage again when the hood release is pulled.

Safety catch - front hood

Once the hood release has been pulled, the front hood must be held down by the safety catch. At its lowest point, the safety catch must hook into the retaining plate.

When the hood is open, the retractor spring must pull the safety catch back to the baseplate on the upper part of these locks as far as the stop.



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Safety belts:**Check function and condition****Functional check:**

When the belt strap is pulled evenly, it must roll smoothly from the seat belt retractor through the guide fitting, and the plug-in latch of the safety belt must be heard to engage in the lock. The seat belt retractor must block if the belt strap is pulled jerkily.

Condition check:

The belt strap must be inspected for damage. It must be replaced if there is any damage in the form of cuts, fraying, separating seams, etc.

Seals for doors, hoods and roof:

Remove scuffed rubber, apply a suitable preservative to maintain seals

Cleaning:

Remove scuffed rubber and soiling with benzine.

Care:

Maintain seals with glycerine, talcum or similar preservatives.

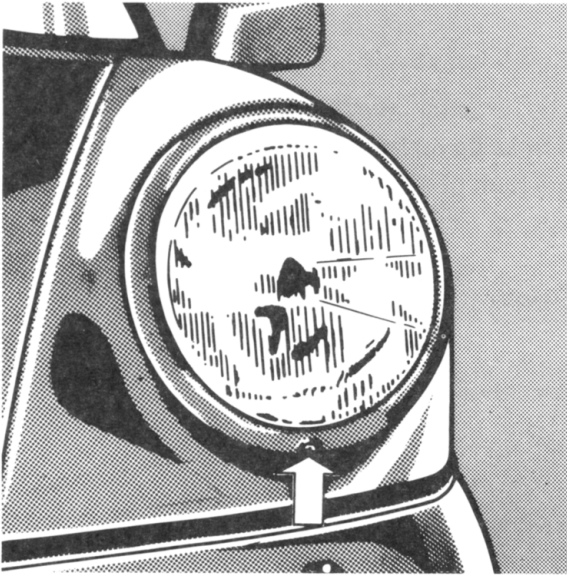
Checking the lighting system:

Adjust headlights

Note

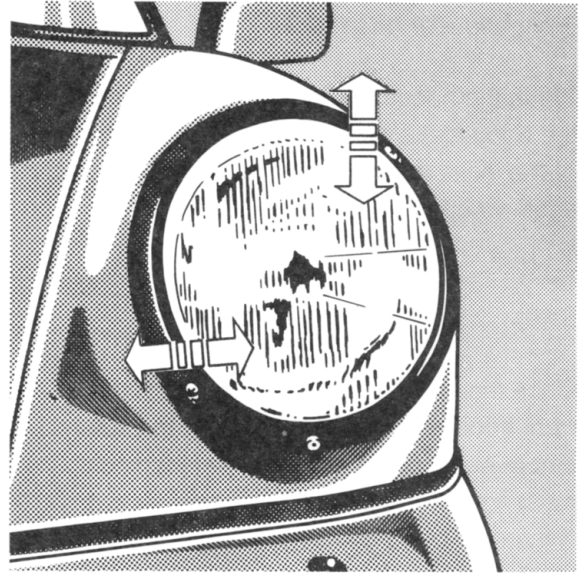
Not for USA vehicles

1. Undo the fastening screw holding the trim ring.



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2. Ease the trim ring back at the bottom with a hardwood spatula or similar.
3. Clean the lens and switch on dipped beam.
4. Using a headlight aiming device, adjust the headlights with the vehicle in running condition (full fuel tank, driving seat occupied or loaded with 75 kg, tires inflated to the correct pressure).

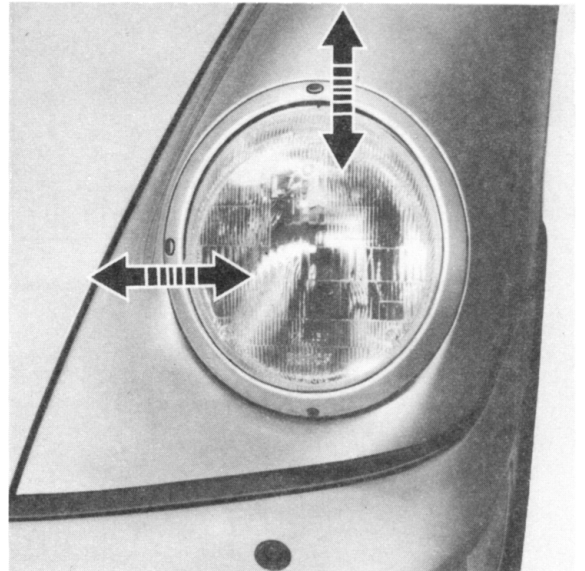


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Note

Adjust vehicles with headlight vertical aim control with the control switch in position 0.

USA vehicles

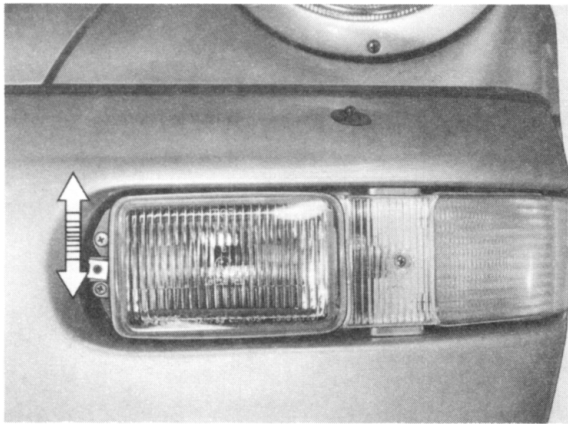


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Checking the lighting system:

Adjust fog lamps

1. Undo the cover.
2. Using a light aiming device, adjust the fog lamps with the vehicle in running condition (full fuel tank, driving seat occupied or loaded with 75 kg, tires inflated to the correct pressure).



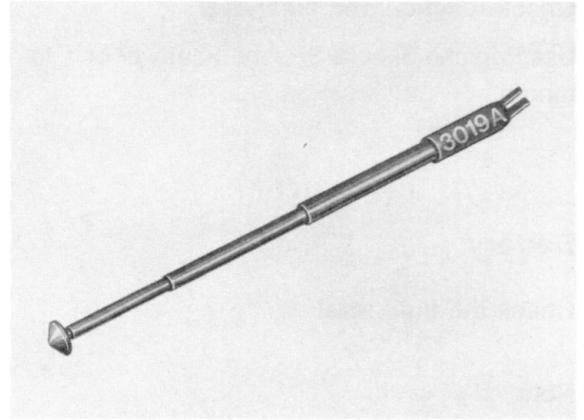
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Windshield washer, headlight wiper - washer:

Check function, fluid levels and nozzle adjustment

Adjust the headlight washer nozzles

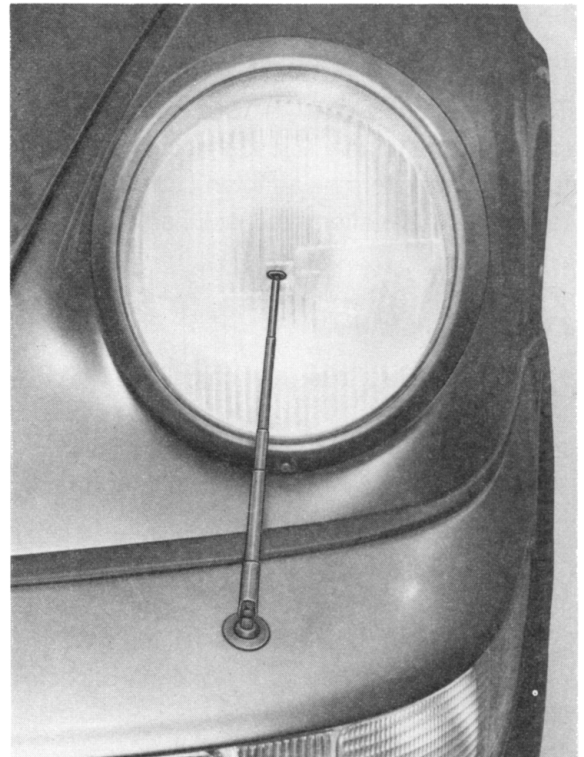
Special adjusting tool 3019 A



8501

1. Insert the special tool into the spray nozzle. Turn the nozzle insert with the tool so that the telescopic extension points towards the middle of the lens.

Activate the cleaning process and check the spray jet.



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Intensive washing:**Check function and fluid level**

Use Porsche Special Silicone Remover only to top up.

Battery:**Check the fluid level****Note**

The battery must always be disconnected from the vehicle wiring before starting any work on the electric system, to prevent possible short circuits. The battery must not, however, be disconnected when the engine is running.

1. Open the front hood.
2. Remove covers.
3. Undo the ground terminal and pull off.

Note

The system adaption in the DEE control unit is lost when the battery is disconnected. The system must therefore be adapted using the System Tester 9288 after the check has been completed.

Check the fluid level

1. Check the fluid level in each cell.
2. If the fluid level has fallen below the minimum level marking, top up to the maximum level marking with distilled water.

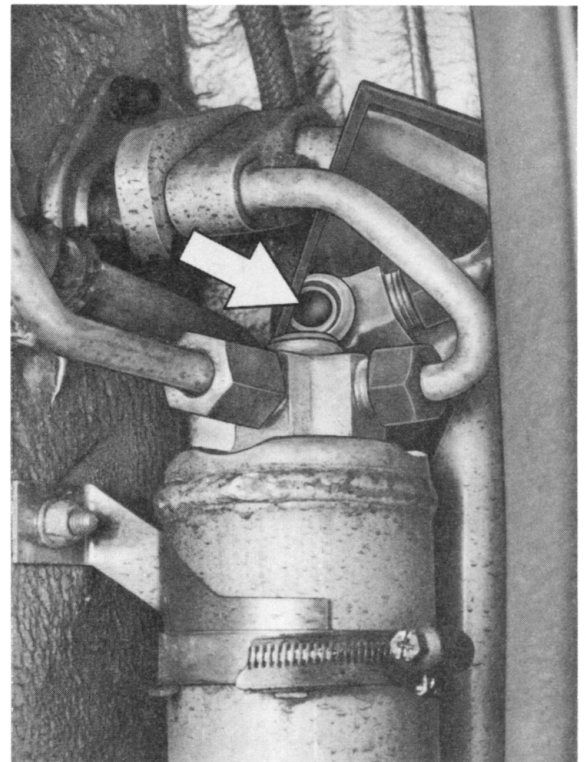
Note

If the acid level is too low, this will reduce the capacity of the battery and shorten its service life.

Check that all other electrical equipment, pilot lights and warning lamps are in working order

Heating, ventilation and air-conditioning system:**Check function and coolant level**

1. Remove the rear wheel-house panel front left.
2. Using a mirror, it is now possible to look into the inspection window on the fluid reservoir.



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3. Start the engine and switch on the air-conditioner. If the system is filled correctly, gas bubbles rise briefly when the system is switched on and off. If gas bubbles are visible for a longer period, there is not enough coolant in the system. In this case, top up the coolant.

Emission control system:

Check that catalytic converter, Lambda probe and restricted filler inlet are present, visual inspection of all electrical connections and line connections, check that the Lambda probe is in working order.

Precondition:

The fault memory of the DEE control unit has been read out (Tester 9268/9288).

No fault indicated in the fuel or ignition system.

Components – visual inspection

Lift the vehicle, check that catalytic converter and Lambda probe are present.

Check that the restricted filler inlet is present.

Check the vacuum line connections to the pressure regulator and pressure attenuator for leaks and secure fitting.

Ignition circuits 1 and 2:

Check the function

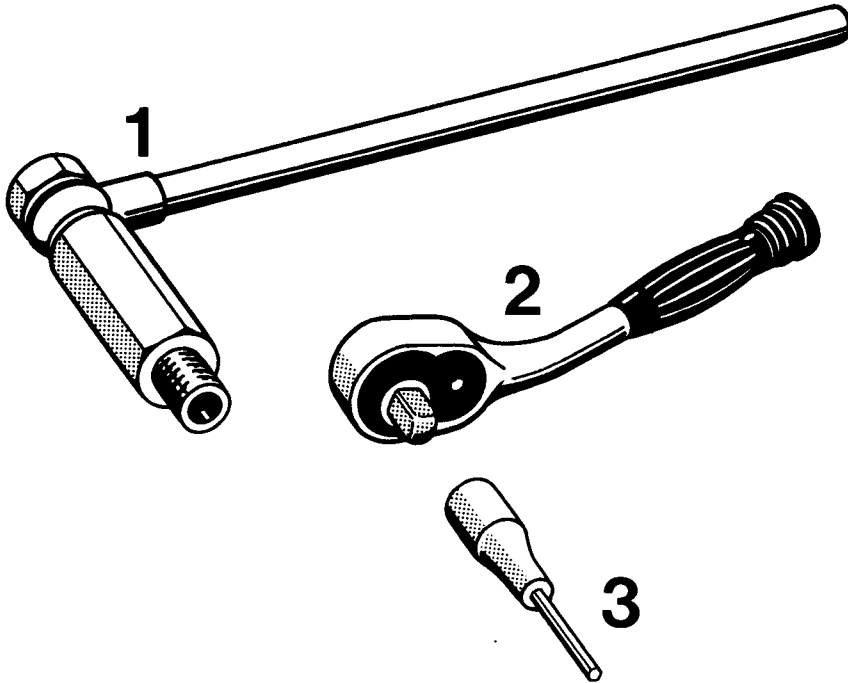
1. Measure the CO and HC values with the engine at operating temperature and both ignition circuits in operation.
2. Switch off the engine and disconnect the plug from the final stage of ignition circuit I.
3. Start the engine and measure the CO and HC values.
4. Switch off the engine, connect the plug for ignition circuit I and disconnect the plug from the final stage of ignition circuit II.
5. Start the engine and measure the CO and HC values.

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

Exhaust test:

Checking idle speed - adjusting CO

Tools



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No.	Description	Special Tool	Order number	Remarks
1	Exhaust adapter			Standard from: e.g. Sun Electric, Bosch; refer to the Workshop Handbook
2	Ratchet 1/4 inch to adjust the CO value	W 166	W 166	
3	Insert for Allen screw	W 165	W 165	

Exhaust test:

Checking idle speed/CO – with catalytic converter

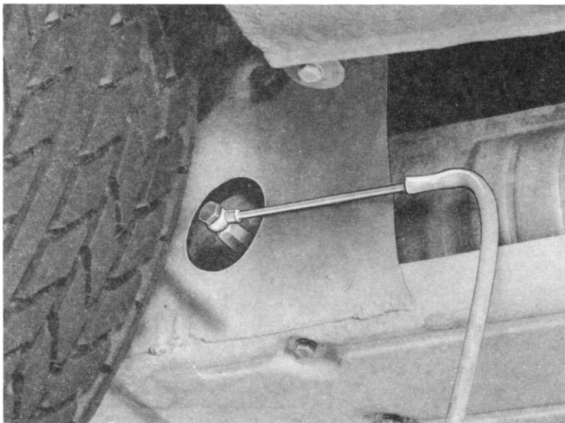
Note

It is no longer possible to adjust the idle speed and CO value for vehicles with catalytic converters. Do not disconnect the Lambda probe for the idle speed/CO check.

Precondition

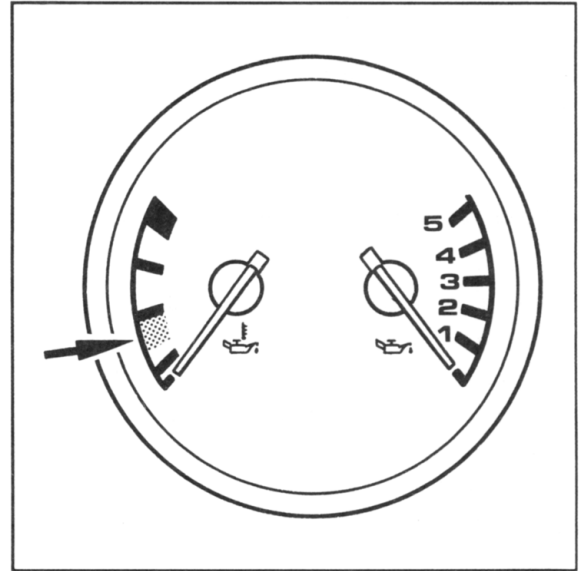
Engine in faultless mechanical condition. Consumers must be switched off during the checking work. Carry out checking operations as fast as possible to ensure that the intake channels do not heat up and falsify the CO value. Ambient temperature 15 - 35° C (59 - 95 °F).

1. Mount the exhaust adapter onto the test connector of the catalytic converter.



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2. Warm the engine up to operating temperature (70 - 90° C (158 - 194 °F) oil temperature)



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3. Do not separate the connector for the Lambda probe. Connect the CO tester and separate rev. counter according to the manufacturer's instructions.

CO control value	0.4 - 1.2 %
Idle speed	880 ± 40 rpm

Exhaust test:

Checking the idle speed - Adjusting the CO without catalytic converter

Note

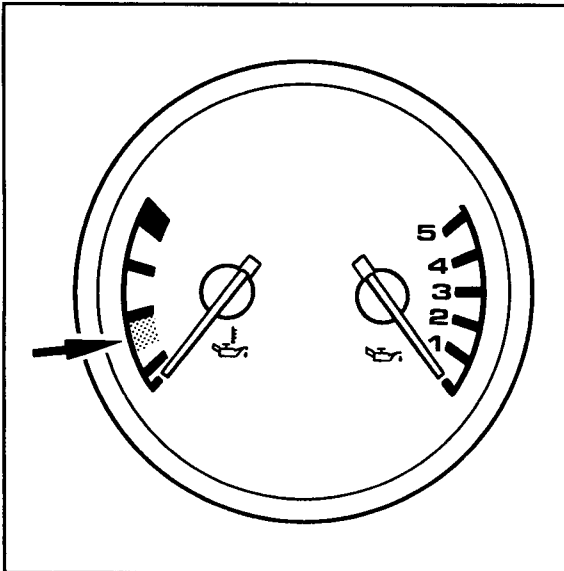
It is no longer possible to adjust the idle speed. The adjustment to the throttle housing is therefore not applicable.

Adjusting the idle speed/CO

Precondition

The engine must be in faultless mechanical condition. Consumers must be switched off during the adjusting operations. Carry out adjustments as quickly as possible to ensure that the intake channels do not heat up and falsify the CO value. Ambient temperature 15 - 35°C (59 - 95 °F)

1. Warm the engine up to operating temperature (70 - 90° C (158 - 194 °F) oil temperature).



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2. Check the CO content. If the CO content is not within the prescribed values, correct the setting of the air-flow sensor.

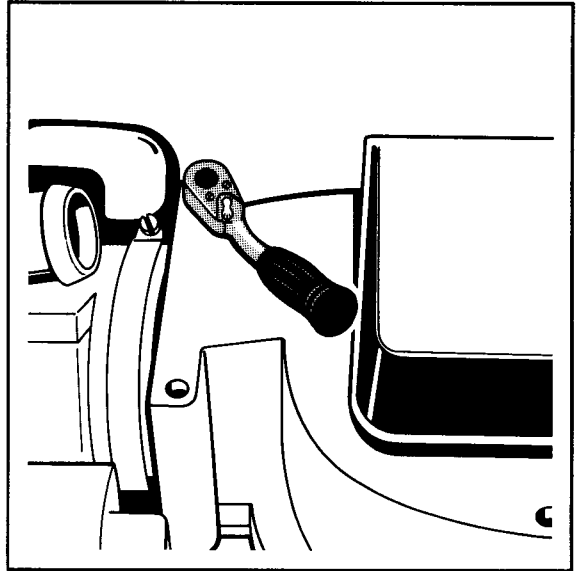


Illustration shows engine removed.

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CO setting value: 0.5 - 1.0 %

Turn to the right - richer mixture

Turn to the left - leaner mixture

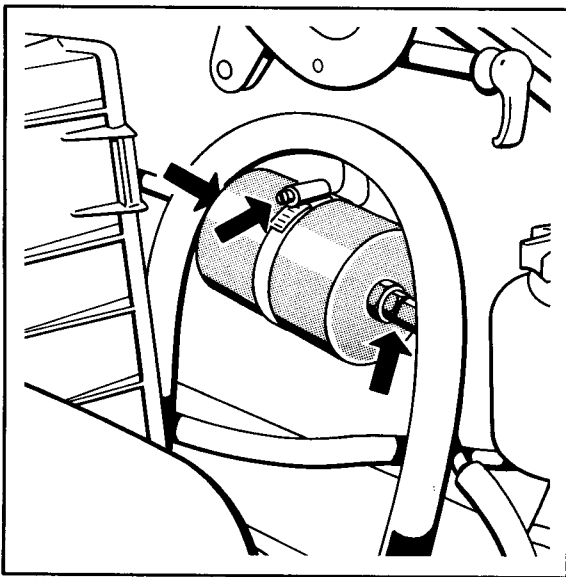
Checking the idle speed

1. Connect a separate rev. counter according to the manufacturer's

instruction. Idle speed 880 ± 40 rpm

Replace the fuel filter:

1. Release the clamps holding the air-filter cover and remove the housing cover with filter insert.
2. Undo the fuel lines, bracing under all circumstances. Catch escaping fuel.
3. Undo the strap and remove the fuel filter.



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4. Install new filter. Observe the direction of flow = direction of arrow.
5. Start the engine and check the fuel lines and filter for leaks.

Check that fuel lines and fuel-injection lines are secure and not leaking.

Test drive:

Drive train, differential locks (inter-axle and wheel-to-wheel)

Check for noises and function

A visual indication of the differential-lock control is given by the yellow differential-lock function control lamp on the full-lock pushbutton.

A control is also possible during normal driving by virtue of irregularities in the road surface.

Visual inspection for leaks:

Oils and fluids

It is advisable to make the test drive without the engine guard so that engine/transmission can be checked for leaks and to avoid additional assembly work if any leaks are found.

The speed must not exceed 150 km/h.

Replacing transmission oil (Manual transmission and front final drive)

Filling capacities:

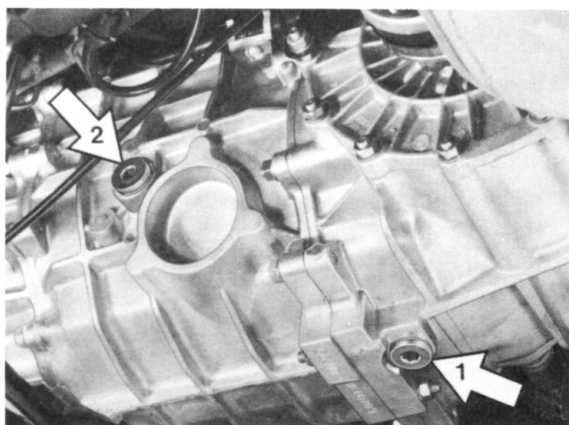
Manual transmission: approx. 3.8 l

Front final drive: approx. 1.2 l

Oil grade:

Transmission oil SAE 75 W 90 of API classification GL5 (or MIL-L-2105 B)

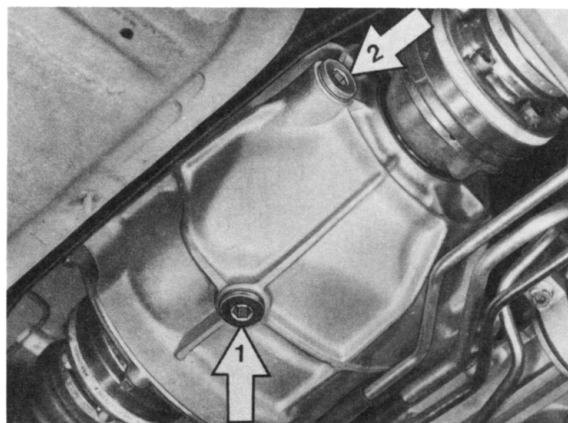
1. Remove the front underbody panel and engine guard.
2. Drain the oil with the vehicle level and transmission at operating temperature.



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Manual transmission

- 1 - Drain plug with magnet
- 2 - Filler plug



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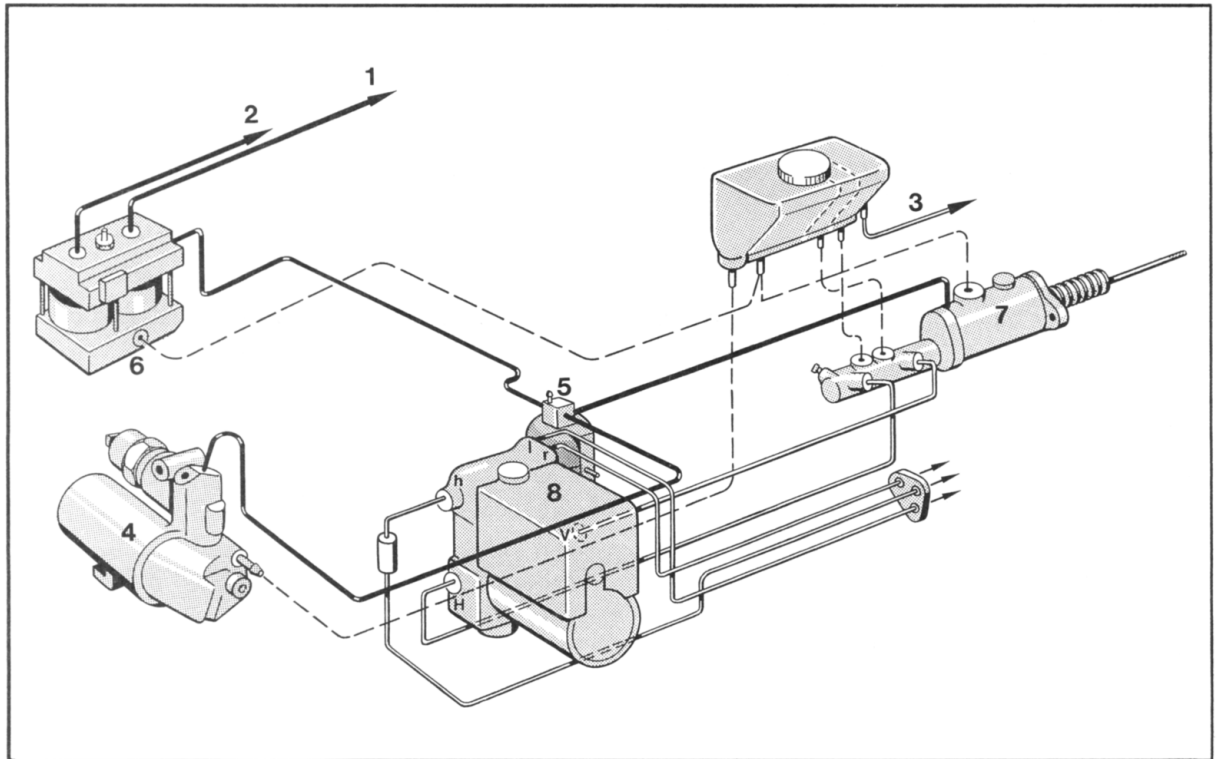
Front final drive

- 1 - Drain plug with magnet
- 2 - Filler plug
3. Clean filter plug and drain plug, replace seals and tighten with 30 Nm (22 ftlb).
4. With the vehicle level, fill with transmission oil until the filler plug overflows.

Replacing Brake Fluid / Bleeding Brakes and Lock Control

General Information

Since brake master cylinder circuits, consisting of the push rod circuit (for front axle) and intermediate piston circuit (for rear axle) with the ABS hydraulic control unit, are completely independent of the booster circuit (brake booster and lock control), brake fluid replacing and bleeding procedures are divided into different jobs (see next page).



709//1

- ==== Brake master cylinder circuits (exception 3)
- ==== Booster circuit (brake booster and lock control)
- - - - Return / feed or intake end
- 1 + 2 To axial and lateral lock cylinders (Q and L)
- 3 Feed to clutch master cylinder
- 4 Pump assembly
- 5 Pressure reservoir
- 6 Valve assembly (solenoids for axial and lateral locks)
- 7 Brake booster
- 8 ABS hydraulic control unit

Notes

- Only use new DOT 3 or DOT 4 (SAE J 1703) brake fluid.
Total brake fluid change volume = approx. 1.6 liters.
- Brake fluid must be replaced at least every two years.
- Brake fluid supply tank is divided into chambers from about the middle downwards.

Procedures / Division

1. Replace brake fluid (brakes, lock control and clutch).
2. Bleed lock cylinders and pressure pipes, *insofar as the hydraulic system had been disconnected after the valve assembly for lock operation.*

Described in Rep.-Group 47.

3. Bleed lock or brake booster circuit, *insofar as parts of the booster circuit had been replaced or the system (including intake end of the pump assembly) had been disconnected.*

Described in Rep.-Group 47.

Ref. 1: (Replacing Brake Fluid)

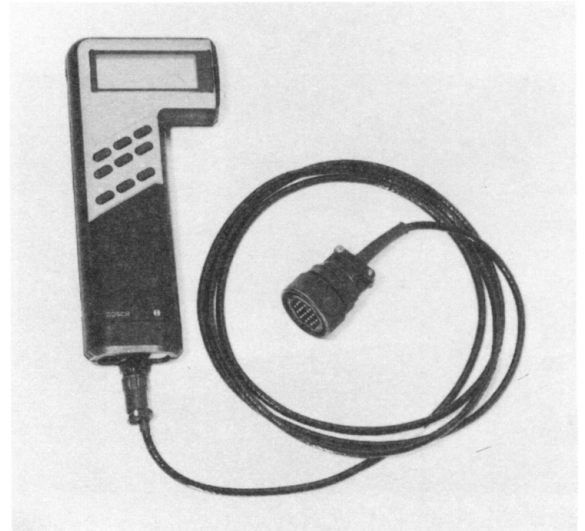
Replacing brake fluid is divided into two steps.

- Step 1: Replace brake fluid for the brake master cylinder circuit and clutch hydraulic system (conventional).
- Step 2: Replace brake fluid for the booster circuit (brake booster and lock control). This requires activating the lock solenoids with a 9288 System Tester and removing the brake fluid from each lock cylinder.

Use of an electric filling and bleeding machine is recommended to guarantee fast and practical **replacement of the brake fluid**.

- Pour new brake fluid in the supply tank until the level reaches the upper edge. Connect bleeder on the supply tank. **Clamp the overflow hose (venting) with a hose clamp.** Switch on bleeding machine.
- A bottle must be used to catch the escaping brake fluid and therefore be able to check it for dirt and air bubbles as well as to determine the brake fluid consumption. Change volume for each wheel: approx. 250 cc. Bleed on both bleeder valves of each wheel.
- Also drain about 50 to 100 cc of brake fluid on the bleeder valve of the clutch slave cylinder.
- **Switch off and disconnect the bleeding machine.** Remove hose clamp on the overflow hose (venting).

- Connect System Tester 9288 in conjunction with connecting lead 9288/1 in the diagnostics socket in the passenger's footwell (underneath a cover). **Turn on ignition and tester. Select type of vehicle and PDAS system afterwards. Then go into the drive menu.**



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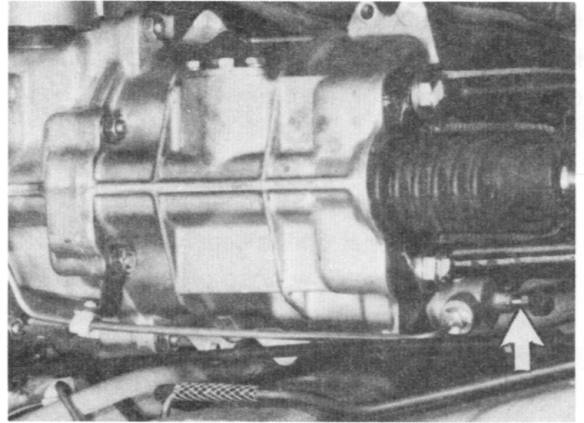
Note

The rear underside trim panel must first be removed for the next step (booster circuit). If applicable for reasons of space, unscrew and also remove the engine splash guard. In addition, the battery should be in well charged condition.

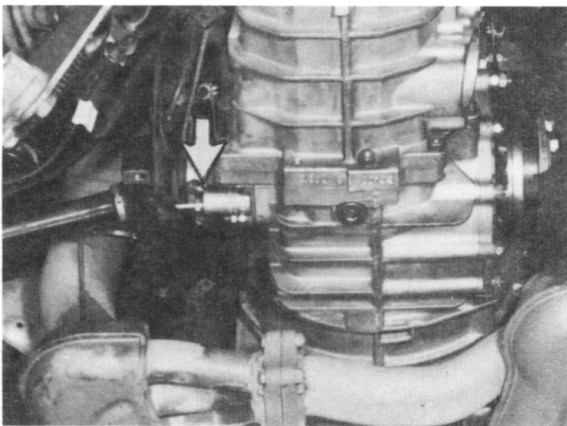


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- **Select the bleeding position in the drive menu.** Unscrew bleeder valve on the lateral lock cylinder and **drain about 250 to 300 cc (max. 300 cc) of brake fluid** after pressing the start key displayed in the tester.
Press stop key and tighten the bleeder valve.
Go into the pressure discharging position with the tester.

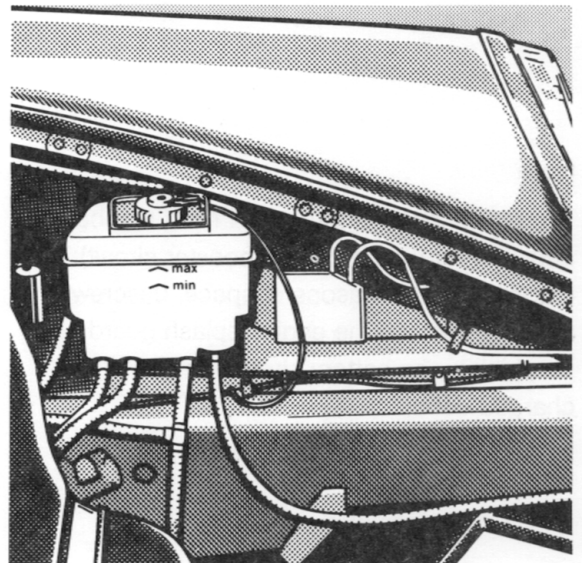


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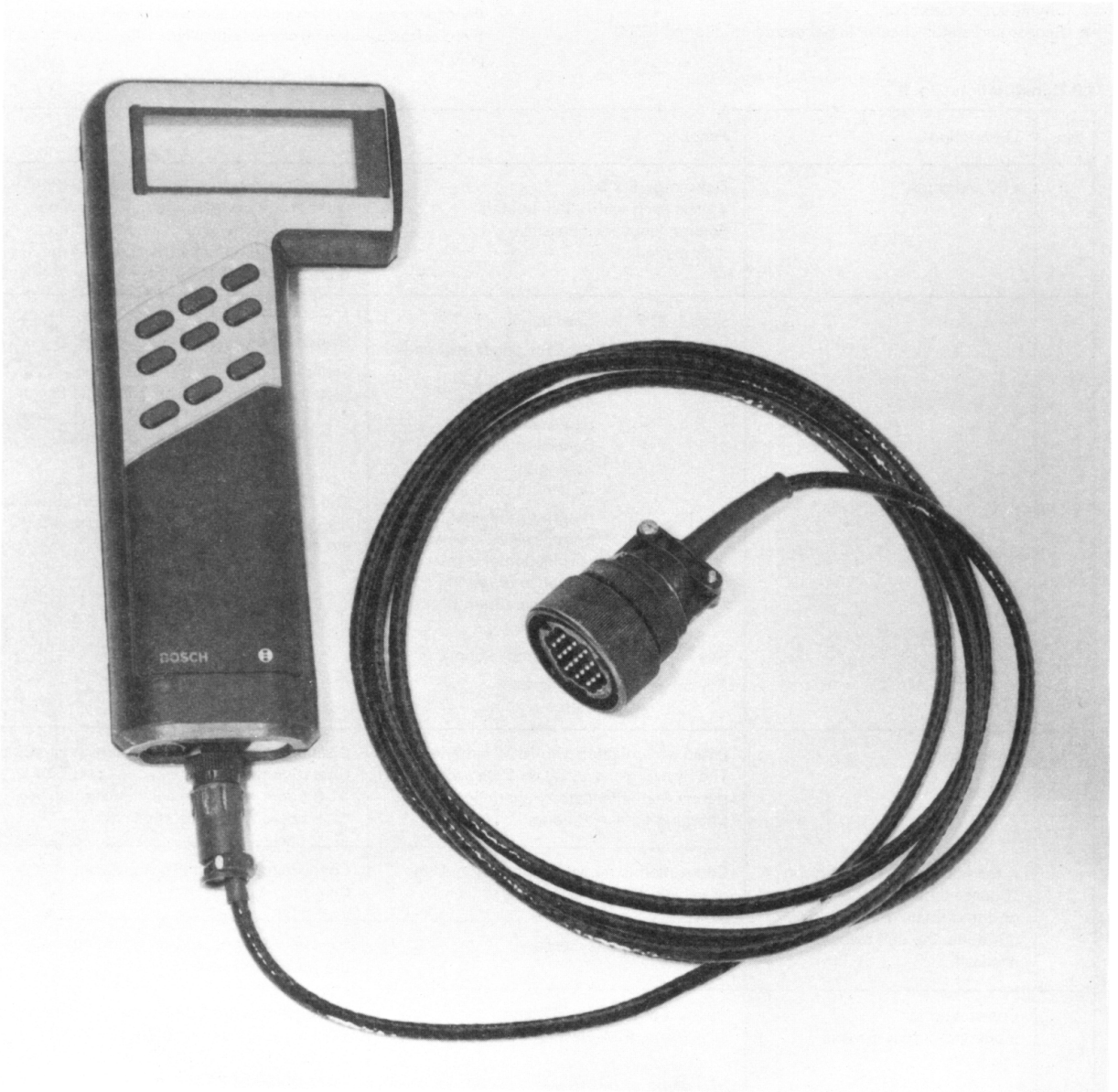
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- Disconnect system tester.
- Correct the brake fluid level.
This requires operating the brake pedal first so many times (with the ignition on) until the pump assembly is operated.
Correct the brake fluid level only after the pump assembly has been switched off.
Never pour in so much brake fluid that the level is above the "max." mark.
- **Pour in new brake fluid.** Operate the brake pedal several times while the ignition remains turned on.
- Afterwards activate the solenoids again with a 9288 System Tester (bleeding position in the drive menu) and **drain about 200 cc of brake fluid** on the bleeder valve of the **axial lock cylinder**.



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Operating instructions for System Tester 9288



1. General information

1.1 Application

The Systemtester 9288 (BOSCH KTS 301) is a microprocessor-controlled self-diagnosis tester.

All systems which have a diagnosis interface as per ISO Standard can be tested with this tester. The following tests are possible:

- Reading out the fault memory
- Testing of the actuators
- Testing the circuit inputs
- System adaptation
- Engine-knock detection
- Sensor and status checks, tire-pressure monitoring (RDK)

The Systemtester 9288 is a high-quality piece of electronic equipment. In order to prevent damage to the equipment as a result of improper use, please read the information in the operating instructions carefully and comply with it.


In addition, the instructions (specifications) of the vehicle manufacturer are also to be observed.

If the tester should fail, check the following points before sending it in for repair:

1. Has the tester been operated incorrectly?
2. Is the battery sufficiently charged?
3. Is the adapter cable OK?

(Please note when checking the adapter cable that a highly sensitive electronic matching circuit is installed in the vicinity of the 19-pole plug).

1.2 Construction (Fig. 1)

No.	Description	Function	Remarks
1	LCD indicator	Dot matrix 5 x 8 4 lines each with 20 characters Foreign languages possible Illumination	If the Systemtester 9288 is switched on without the program module, following the self-test the tester switches off automatically and informs the user that the program module is not fitted.
2	Keyboard	Keys 1, 2, 3 = Selection key Keys < > = Previous page/ next page Key H = Help menu, e.g.: Illumination Screens stored Control-unit overview Setting up printer Switching off unit Key N = Return to the next higher program level following termination of a test sequence or, during a test sequence, return to the last display Key ↗ = Storing indication Key ↖ = Playing back stored reading	Switching on: = Press any key Switching off: = 180 s after last depression of a key or if no data stream flows across the serial interface. The last field in the top right-hand corner is filled completely, this means that this is a stored figure and not an actual, real-life figure.
3	Power supply	Fitted accumulator with NiCd batteries. The Systemtester 9288 must be switched off during the initial battery charging process. Charging time > 8 hours	Discharged upon delivery. Following charge: Operating time: 4 – 8 hours without scale illumination 1 – 2 hours with scale illumination
	If the voltage is not sufficient, "Charge battery" appears on the display. If this is not done, the unit switches itself off.	Connection to vehicle battery by means of vehicle-specific adapter lead (see 1.4)	Connection through ISO-interface Charging voltage supply
		Battery charger (accessory)	For test operation and for charging the NiCd batteries.
4	Connection for input and output devices	Connection facility for Printer e.g. Epson, IBM, Hewlett Packard (HP)	The Systemtester 9288 transmits data with the following configurations: 8 data bits / 1 start bit / 1 stop bit / No parity (for printer matching)
5	Connection for vehicle specific adapter lead	Reading out the data	Input for flashing-code support
6	Plug-in programme module (see also Figure 2)  C-MOS ! Do not touch plug !	Operating system LCD drive Keyboard Interface communication Computations and data conversions	Plug in module: remove rubber protector, insert module fully.

1.3 Battery charger run off mains voltage (Figure 3)

– Accessory –

Item 1 Charger with connecting cable, 1.5 m long

Item 2 8-pin AMP plug

1.4 Vehicle-specific adapter cable

Porsche No. 000 721 928.81

1.5 Connecting lead (Figure 4)

– Self-fabrication –

for printer, programme load station or similar unit.

For interface-trunk assignment, see manual of corresponding unit.

Printer cable for standard D 25

BOSCH No. 1 684 465 193

Printer cable for EPSON

BOSCH No. 1 684 465 194

2. Connection

The following points must be observed:

- No gear must be engaged on the vehicle (Automatic transmission in position N-P) – Danger of Accident !
- ALL work on the vehicle must only be carried out with the ignition switched off.

After having connected the vehicle-specific adapter cable, the instructions listed under "3" are displayed on the Systemtester 9288:

2.1 Charging with the battery charger (Fig. 3)

Connecting the Systemtester 9288 to the battery charger. (Fig.1, pos. 5).

2.2 Diagnosis

Connecting the Systemtester 9288 to the diagnosis plug in the vehicle by means of the vehicle-specific adapter cable.

Switch on the tester and proceed according to the instructions displayed.

2.3 No diagnosis possible (see page 03 - 43)

3. Testing

Scope of module:

Guidance through the menu, communication with the ECU, reading out the error memory and selection of the "Help" menus, actuator diagnosis, circuit inputs and system adaptation, engine-knock detection, sensor and event check for the tire-pressure monitor (RDK).

3.1 Reading-out the error memory

Connect the Systemtester 9288 (see 2.)

Switch on the Systemtester, (possible with every key!)

Display:

```

PORSCH
Eprom modul   eng
Mod. intro.  xx.xx.xx
    
```

If a specific instruction does not appear in a display, it is always possible to proceed by pressing the button >.

Due to the fact that the Systemtester 9288 can store error displays (see Chapter 3.7), the following display will appear if errors have been stored in the image memory:

```

Stored displays
erased ?
1 = yes
3 = no
    
```

Key 3

Display:

```

Print out
displays:           H
continue:           >
    
```

H = Help menu (see 3.6) or key 1

Display:

```

Vehicle types
1 = 944 S
2 = 911 Carrera 4
3 = 928 S 4
    
```

Selection of the vehicle type with key 1, 2 or 3.

After the vehicle type has been selected, the following instruction appears:

```

Connect adapter
cable to veh. plug.
Ignition "ON".
After completion:  >
    
```

The following then appears:

```

Wait for
Data
Break off test:    N
    
```

After a short pause, the Systemtester 9288 reports all the systems that are installed in the particular vehicle. If a system is preceded by "#", this means that at least 1 error is stored in that particular system.

Examples:

```

Installed systems
1 = # LH
2 = # EZK
3 =   RDK
    
```

The particular system can be selected by means of key 1, 2 or 3.

After selection (for instance with key 1), the following display appears:

```

LH
System:  L01 LH-JET
Ser. No.: 92861812313
RB. No.: 0280002507
    
```

After pressing the key >, a selection menu is displayed:

```

Menu
1 = Fault memory
2 = Drive links
3 = Input signals >
  
```

```

< Menu
1 = System adaptation
  
```

In the example – press key 1. There then follows the display of the number of errors which are stored (if any).

```

Number of faults
→ 2 ←
  
```

Proceed with key >

```

Additional info to
every display with
key 1
continue: >
  
```

Proceed with key >

Error output:

```

1: Engine
temperature sensor 2
Short to ground
not present
  
```

If key 1 is pressed instead of the > key, the corresponding error code display appears (the last two digits of the flashing code).

```

Fault code: - 14 -
  
```

Proceed with key >

Further errors are displayed (if they exist):

```

2: Idle contact

Short to ground
present
  
```

If key 1 is pressed instead of key > the corresponding error-code display appears (the last two digits of the flashing code).

```

Fault code: - 12 -
  
```

After the last displayed error, the following instruction appears:

```

Repair fault accord-
ing to repair
instructions
Continue: >
  
```

Proceed with key >

```

Fault repaired ?
1 = yes
3 = no
  
```

Return to display "No. of errors" with key 3.

Proceed with key 1:

```

Fault memory
1 = Erase
3 = Do not erase
  
```

If key 3 is pressed:

= Return to menu "error memory".

The error memory is not erased!

Proceed with key 1:

```

Fault memory
has been cleared

Return: N
  
```

The test scope "Read-out error memory" is terminated at this point.

3.2 Actuator diagnosis

If an actuator is selected, this is triggered by the ECU so that it can be checked for correct functioning.

The various actuators components are gone through one after the other and are selected with the > key.

Operate the Systemtester 9288 as described under 3.1 until the following menu display appears:

```

Menu
1 = Fault memory
2 = Drive links
3 = Input signals >
  
```

After pressing key 2, the display for the first actuator appears:

```

Injector
to activate
1 = Start
Continue: >
  
```

If key > is pressed, the next actuator is selected.

Pressing key 1 results in the following instruction:

```

Can injectors be
heard / felt ?
1 = yes
3 = no
  
```

Key 1 selects the next actuator (e.g. idle actuator). Following instruction:

```
Repair fault according to repair instructions
Continue: >
```

After pressing key >, the following display appears:

```
Injector to activate
1 = Start
Continue: >
```

Proceed with key 1

```
Can injectors be heard / felt ?
1 = yes
3 = no
```

Proceed with key 1 to the next actuator.

```
Idle stabilizer to activate
1 = Start
Continue: >
```

Proceed with key 1

```
Can idle stabilizer be heard / felt ?
1 = yes
3 = no
```

By pressing key 1, the next actuator is selected. After pressing key 3, the next instruction appears:

```
Repair fault according to repair instructions
Continue: >
```

Proceed with key >

```
Idle stabilizer to activate
1 = Start
Continue: >
```

After pressing key 1, the following display appears:

```
Can idle stabilizer be heard / felt ?
1 = yes
3 = no
```

By pressing key 1, the next actuator is selected. The actuators are selected one after the other and triggered until the following display appears:

```
Drive link test completed
Return: N
```

By pressing the key N, the operator is returned to the menu.

3.3 Circuit inputs

In addition to the actuators, the Systemtester 9288 can also check circuit inputs. To this end, operate the Systemtester 9288 in accordance with 3.1 until this menu display appears:

```
Menu
1 = Fault memory
2 = Drive links
3 = Input signals >
```

Press key 3

```
Idle contact
1 = Start
Continue: >
```

By pressing key > the next circuit input is selected.

The next display appears when key 1 is pressed.

```
Activate accl. pedal
Idle contact
- closed -
Continue: >
```

Operate the accelerator pedal, the following display appears:

```
Activate accl. pedal
Idle contact
- open -
Continue: >
```

The next circuit input is selected by pressing key >. Repeat until this display appears:

```
Input signals testing completed
Return: N
```

Press key N for return to menu

3.4 System adaptation

When the function "System adaptation" is triggered, the ECU registers the basic air requirement of the engine.

To this end, operate the Systemtester 9288 as per 3.1 until the following menu display appears:

```
Menu
1 = Fault memory
2 = Drive links
3 = Input signals >
```

Proceed with key >

```
< Menu
1 = System adaptation
```

Proceed with key 1

Prerequisite:
Eng. at oper. temp.
with all consumers
and ignition off.

Proceed with key >

System adaptation
1 = Start

Return: N

If key N is pressed
= return to menu.

If key 1 is pressed:

Start engine !

Following engine start there appears:

System is being
adapted

Please wait !

After approx. 30 secs there appears:

System adaptation
completed

Return: N

If it is impossible to carry out system adaptation (idle contact not closed, or defective), the following display appears:

No system adaptation
possible
Idle contact ?

Return: N

After completion of the system adaptation, return to the menu with key N.

3.5 Engine-knock registration

The engine-knock registration function can only be triggered through the EZK or DME control unit.

To this end, operate the Systemtester 9288 as described in 3.1 until the following display appears:

Installed systems
1 = # LH
2 = # EZK
3 = RDK

The particular system can be selected by means of key 1, 2 or 3.
For instance with key 2 the following display appears:

EZK
System: E01EZK
Ser. No.: 92861812415
RB. No.: 0227400154

Proceed with key >

The following menu display appears:

< Menu
1 = Fault memory
2 = Knock registration

Proceed with key 2

Condition:
Engine at operating
temperature >

Proceed with key >

< Start knock
registration before
test drive >

Proceed with key >

< A normal test
drive is a pre-
requisite >

Proceed with key >

< Stop the test
drive only if the
display with the no.
of knocks comes on.

Proceed with key >

Knock registration
1 = Start

Return: N

Pressing key 1 activates the engine-knock counter:

Knock registration
in progress

Please wait!

The knock counter registers 10,000 ignitions before the display with the actual number of combustion "knocks" appears.

```

Number
Knocks:      xxx
Combustion:  xxxxx
Continue:    >
    
```

Proceed with key >

```

Knock registration
completed

Return:      N
    
```

If knock registration is impossible (due to lack of engine-speed signal), the following display appears:

```

No knock regist-
ration possible.
RPM signal ?
Return:      N
    
```

Following completion of the knock registration test, return to the menu with key N.

3.6 Help menu

The "Help" menu can be selected from every display by pressing key H. Return to the initial display with key N.

```

Help menu
1 = Illumination
2 = Display stored
3 = Ctrl. unit chart >
    
```

Proceed, for instance with key 1:

Key 1:

The scale illumination is switched on and the tester returns to the previous display.

Or with key 2:

```

Data display stored
1 = Print
2 = Clear
    
```

Proceed with key 1

Stored displays are printed out (If printer connected).

Proceed with key 2

Stored displays are erased.

With the "Help" menu, for instance

```

Help menu
1 = Illumination
2 = Display stored
3 = Ctrl. unit chart >
    
```

if the key > is pressed, a further section of the "Help" menu is displayed:

```

< Help menu
1 = Printer setting
2 = Switch off equip.
3 = Baud Rate
    
```

Proceed for instance with key 1

```

Printer setting
1 = IBM
2 = HP Quiet Jet
3 = EPSON
    
```

The selection of the printer results in the tester being set up for the printer type in question.

3.7 Store measurement displays (Key ⇄)

Using key ⇄, all displays can be stored manually.

The following displays are stored automatically:

- ECU-Identity
- Installed systems
- All existing errors

When the memory limit is reached, the following instruction is displayed:

```

Data display mem.
full !

Return:      N
    
```

3.8 Show stored measurement displays (Key ⇄)

Using the keys ← or →, the stored displays for the selected system can be shown.

The stored displays can be called up by means of the ⇄ key.

The system selection (LH - EZK - RDK) takes place with the keys 1, 2 or 3.

4. Service and wear parts (BOSCH)

Fig.	BOSCH Part No.	Designation	Comment
1/3	1 687 335 002	NC- battery	9pole
4/1	1 684 483 152	Plug	
4/2	1 684 485 170	Socket	
4/3	1 680 552 005	Screwed cap	
	1 684 465 193	Printer cable (Standard D 25)	
	1 684 465 194	Printer cable (EPSON)	

4.1 Service parts (Porsche)

Designation	Porsche Part No.	Special tool No.
Systemtester 9288	000.721.928.80	9288
Adapter cable	000.721.928.81	9288/1
Battery charger	000.721.928.82	9288/2
Module (D)	000.721.928.84	9288/4
Module (GB/USA)	000.721.928.85	9288/5
Module (F)	000.721.928.86	9288/6
Module (I)	000.721.928.87	9288/7
Module (E)	000.721.928.88	9288/8

Operating conditions for start of diagnosis

Systems	Ignition on Engine standing still	Engine running
964		
Motronic	yes	to n < 2000 rpm
ABS/lock	yes	no
Tiptronic	yes	to n < 1500 rpm
Airbag	yes	yes
Alarm system	yes	yes
Heating*	yes	yes

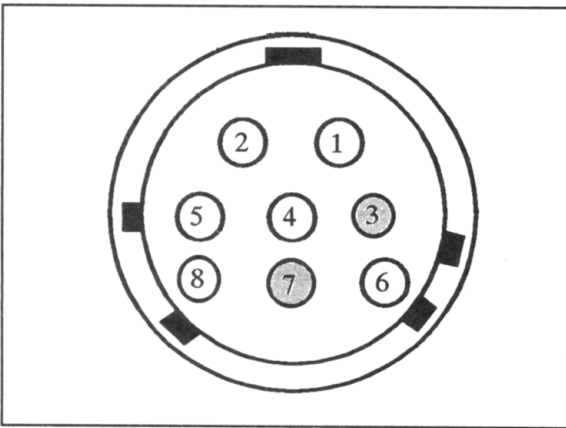
- * Mixing chamber temperature RH/LH < 80 °C
 Rear fan temperature < 95 °C
 Oil temperature < 105 °C

No diagnosis possible

If the System Tester 9288 cannot enter the diagnosis, check the following items:

Note: If the DME relay is faulty, no diagnosis is possible (engine cannot run). Power is supplied to some control units of the diagnosable systems via the DME relay !

- **Check adapter cable 9288/1 for continuity**
Check K and L wires to adapter lead 9288/1 for continuity.
Socket 3 (8-pin connector) to pin 7 (19-pin socket).
Socket 7 (8-pin connector) to pin 8 (19-pin socket).



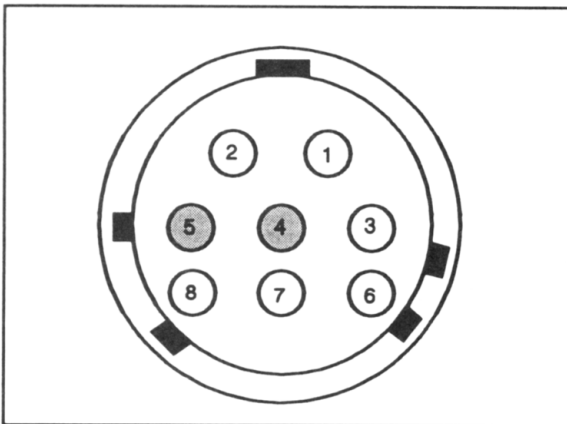
Socket 3 = L lead

Socket 8 = K lead

1211 - 03

Connector at tester

- **Check power supply**
Check ground and terminal 15 of adapter cable 9288/1 for power supply.



Socket 4 = Ground

Socket 5 = Terminal 15

1211 - 03

Connector at tester

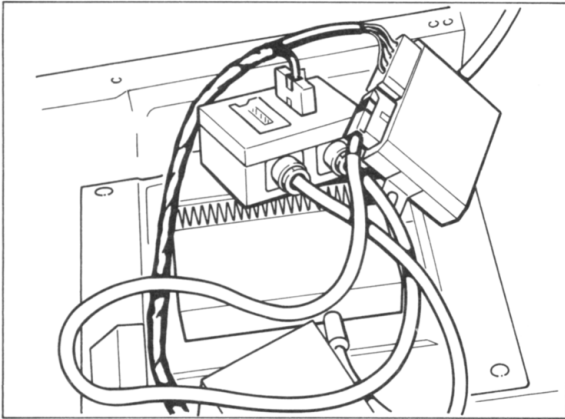
- Check K and L leads with oscilloscope and Special Tool 9540

Checking the L lead:

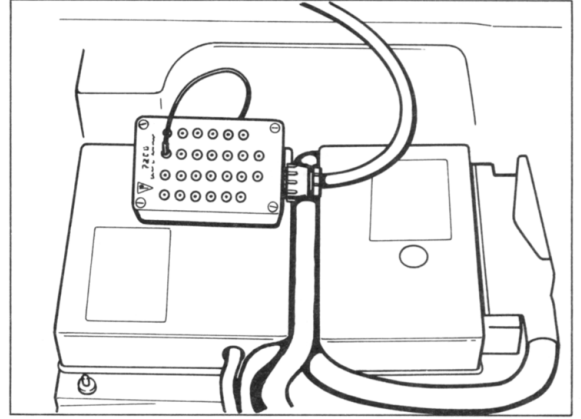
Disconnect connector 2 (yellow) from alarm control unit. Connect Special Tool 9540 between alarm control unit and connector 2. Connect oscilloscope to Special Tool 9540, socket 14 (L lead). Check L lead, turning ignition on and switching System Tester 9288 on. Start diagnosis (trigger).

Checking the K lead:

Same procedure as for L lead, but connect to socket 15 for K lead instead of socket 14 for L lead.

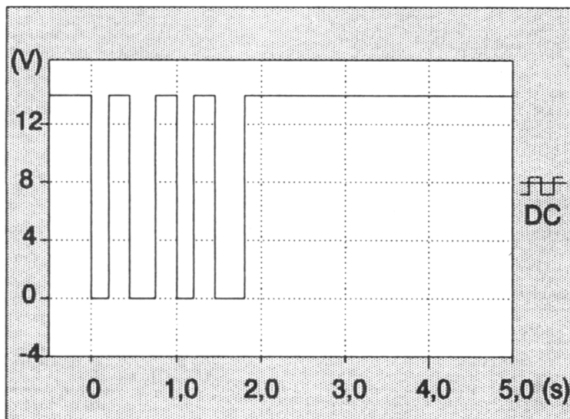


1214 - 03



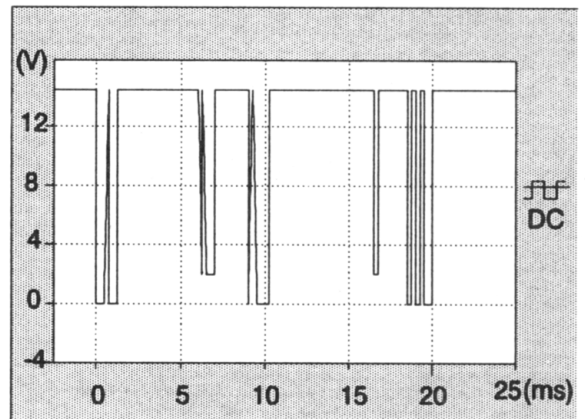
1215 - 03

In case of the L lead, the following signal must be displayed:



1212 - 03

In case of the K lead, the following signal must be displayed:



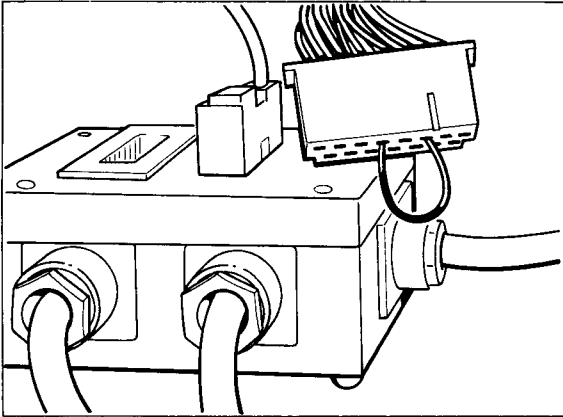
1213 - 03

Note: If the displayed signals differ from the above, this may be due to interference caused by a control unit connected to the K and L leads (for diagnosable systems, refer to wiring diagram). Pull off control unit connectors one after another and repeat test of K and L leads. Start with alarm control unit, as described above. After the last control has been disconnected, one of the control units disconnected earlier must be reconnected since otherwise no signal will be present anymore.

If the airbag control unit is disconnected, control of the DME relay and, hence, of terminal 15 of the DME control unit is interrupted.

Note: The on-board computer (tachometer) is connected to the K and L leads, but is not a diagnosable component. It may cause the above interference, though!

- **Disconnect alarm control unit and fit jumper**



1216 - 03

Disconnect connector 1 (black) from alarm control unit. Connect jumper to connector 1 of the alarm control unit, pin 4 and pin 6

Recheck signals of K and L leads, as described above

- **Disconnect other control units**
Disconnect next control unit, turn ignition on, switch tester on and off and start diagnosis (trigger again).
Check signals of K and L leads.
Repeat process until all control units have been checked.
- **Check K and L leads for shorts to ground**
- **Check each control unit for continuity to diagnosis socket**

Tightening torques for the engine

Location	Thread	Tightening torque Nm (ftlb)
Crankshaft/crankcase		
Connecting rod bolt (marked 12,9)	M 9 x 1.25	
First stage:		15 (11)
Second stage:		2 x 90° ± 2° Angle of rotation
Oil pump	M 8	23 (17)
Crankcase - screw connection (Tension rod union)	M 10 x 1.25	50 (37)
Hexagon nuts or hexagon head screws on the crankcase	M 8	23 (17)
Flywheel to crankshaft	M 10 x 1.25	90 (66)
Two-mass flywheel to crankshaft	M 10 x 1,25 x 70	85
Driving plate to crankshaft (Tiptonic)		90
V-belt pulley to crankshaft	M 14 x 1.5	235 (173)
Screw plug - relief and safety valve	M 18 x 1.5	60 (44)
Oil drain plug	M 20 x 1.5	70 (51)
Screw neck in the left crankcase half (oil return to the oil tank)	M 22 x 1.5	70 (51)
Screw neck in the right crankcase half (oil feed to the oil pump)	M 24 x 1.5	90 (66)

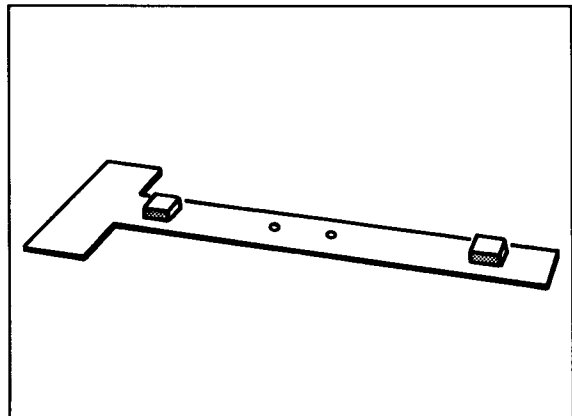
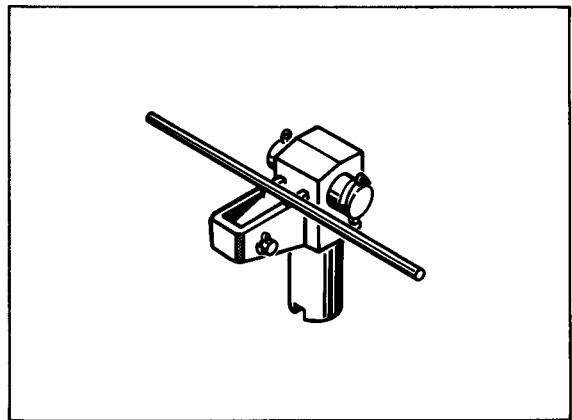
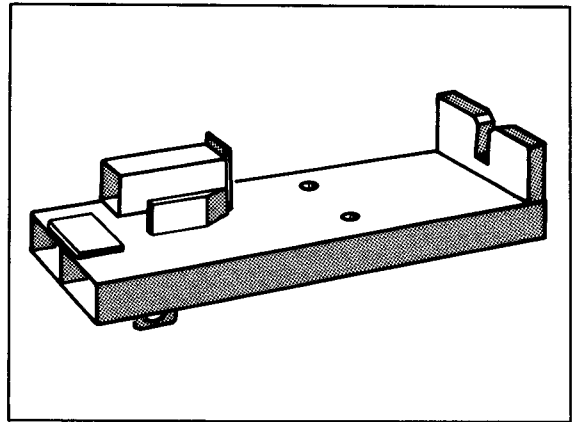
Location	Thread	Tightening torque Nm (ftlb)
Cylinder and cylinder head		
Cylinder head bolt		
First stage:		15 (11)
Second stage:		1 x 90° ± 2° Angle of rotation
Camshaft housing / cylinder head	M 8	23 (17)
Antiknock bridge to cylinder bank	M 6	9.7 (7)
Knock sensor to antiknock bridge		20 ± 5 (15 ± 3)
Engine - NTC to cylinder head 3		10 - 12 (max. 15) (7 - 9 (max. 11) ftlb)
Rocker shaft	M 7 Allen	20 (15)
Spark plugs	M 14 x 1.25	20 - 30 (15 - 22)
Timing		
Sprocket to camshaft	M 12 x 1.5	120 (88)
Gear wheel / power steering pump to camshaft		120 (88)
Collar bolt (slide rail and tension blade to crankcase)		30 (22)
Chain housing to crankcase		23 (17)
Cover for chain housing		5.5 (4)
Valve cover to camshaft housing	M 6	9.7 (7)
Bearing bridge/chain housing		9.7 (7)

Location	Thread	Tightening torque Nm (ftlb)
Blower		
Restraining strap		8 (6)
Alternator pulley (Carrera RS)		50 ± 5 (37 ± 3) 40 (29.5)
Pulley half / impeller	M 6	9.7 (7)
Fan wheel for alternator cooling		14 ± 1 (10)
Exhaust system		
Heat exchanger cylinder head		23 (17)
Heat exchanger - primary muffler or catalytic converter		23 (17)
Primary muffler / catalytic converter - intermediate muffler (spherical clip)		25 - 30 (18 - 22)
Intermediate muffler - final muffler (spherical clip)		25 - 30 (18 - 22)
Restraining strap to intermediate muffler		14 (10)
Lambda probe to catalytic converter	M 18 x 1.5	50 - 60 (37 - 44)
Screw plug on catalytic converter	M 8 x 1	15 (11)
Belt monitor		
Bracket to crankcase	M 6	15 - 20 (11 - 15)
Belt monitor bracket	M 6	9.7 (7)
Fuel system		
Cap nut on the fuel distribution line	M 12 x 1.5	12 (9)
Tank sensor		30

Location	Thread	Tightening Torque Nm (ftlb)
Clutch - two-mass-flywheel		
Two-mass flywheel to crankshaft	M 10 x 1.25 x 70	85 (62)
Primary flywheel to cover plate	M 7 x 34	22 (16)
Primary flywheel to secondary flywheel	M 8 x 21	35 (26)
Pressure plate	M 8 x 40	23 (17)

Removing and installing the engine

Special Tools



No.	Description	Special Tool	Order number	Remarks
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	
	Crow's foot wrench	9501	000.721.950.10	36 mm A/F

Removing and installing the engine

The engine/transmission assembly is removed complete from below.

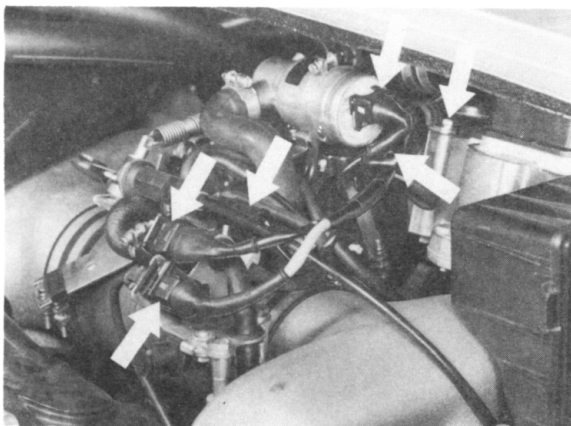
Removing

1. Raise the vehicle at the jacking points.

Note:

Adjust the right-hand rear jacking point in such a way that the transmission guard can be removed later.

2. Disconnect the battery ground cable.
3. Disconnect the plug for the differential lock control/pump assembly (in the area of the luggage compartment lock panel).
4. Disconnect the plugs (5) from the intake distributor and remove the cable clip from the air-flow sensor.



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5. Remove the hot-air blower

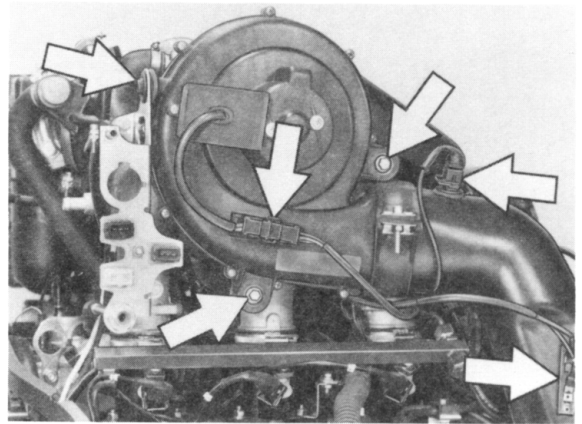
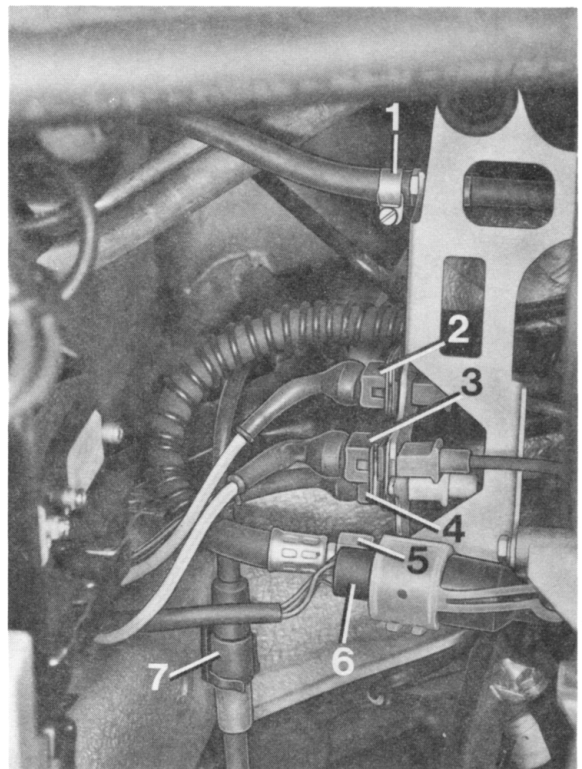


Illustration shows engine removed

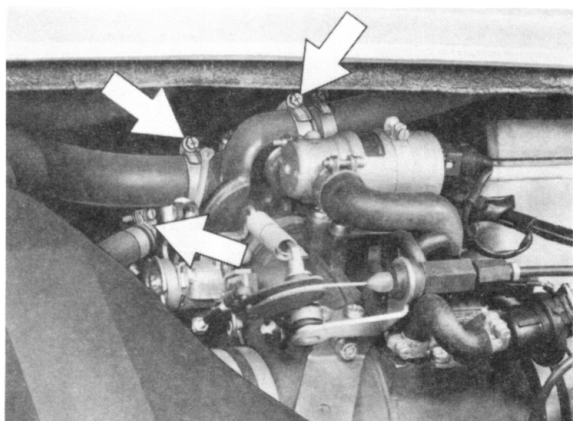
88/288

6. Disconnect the following plug connections / lines on the left-hand side of the engine department



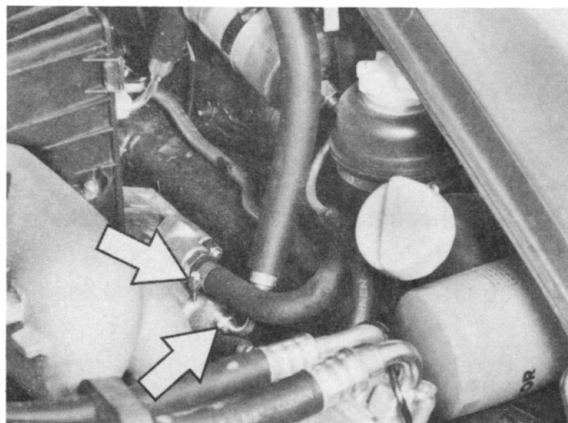
88-500

- 1 - To the carbon canister
 - 2 - To the reference mark sensor
 - 3 - To the knock sensor
 - 4 - To temperature sensor II (cylinder 3)
 - 5 - Fuel return line*
 - 6 - Plug connection - cruise control
 - 7 - Plug connection - Lambda probe
- * To prevent fuel running out if the fuel tank is full, join the disconnected line to Special Tool 9507 connection line, order No. 000 721 950 70 and pinch the connection line with a standard hose clamp.
- 7. Remove the cover from the engine electrics board. Pull off both multiple connectors.
 - 8. Pull off both ignition cables 4 and the plugs from the dual ignition distributor.
 - 9. Pull off the plug from the pulley control unit.
 - 10. Disconnect the vent line.



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- 11. For vehicles with air-conditioner, disassemble the compressor from the console and, with lines still connected, laid it on the adequately protected left-hand rear fender.
- 12. Remove the air filter cover with filter insert.
- 13. Disconnect the fuel supply line to the fuel filter, while bracing. Catch the escaping fuel.
- 14. Empty the reservoir for the power steering pump. Draw-off fluid.
 - a. Undo the hose clip and pull off the upper line, catch any oil.
 - b. Release the lower line and remove with bracket, catch any oil.



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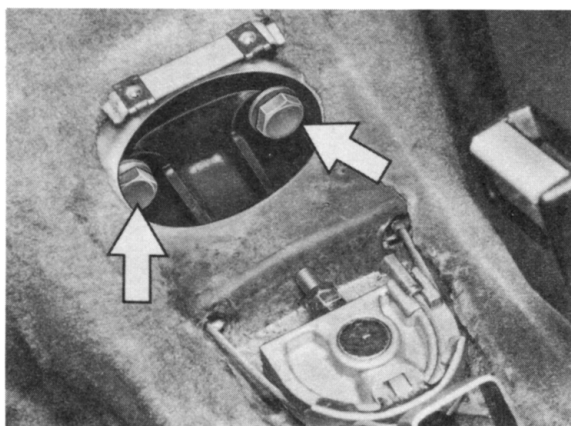
- 15. Remove the rear wheel.

16. Undo the upper fastening screw for the central pipe - transmission; for this, remove the rear tray from the transmission tunnel console. Remove the layer of PVC and take off the cover.

Note

The cover can also be pushed out from below.

Illustration shows section without console.

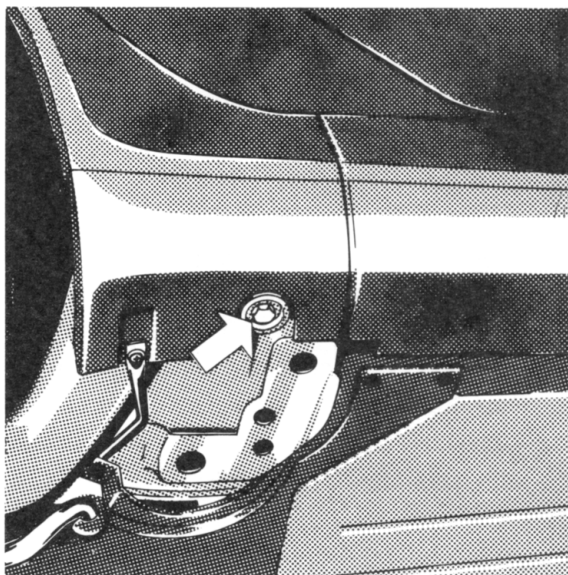


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17. Disconnect the throttle operating cable from the reverse-transfer lever of the foot controls, and remove the spherical head.
18. Remove engine, transmission and central pipe guard.
19. Drain engine oil from the thermostat housing.

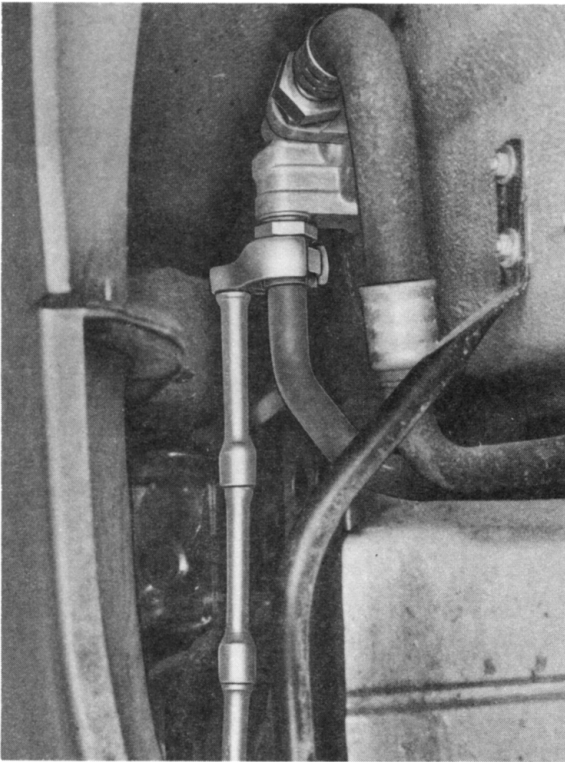
Note

If an engine is being overhauled, also drain the engine oil from the crankcase.



122-03

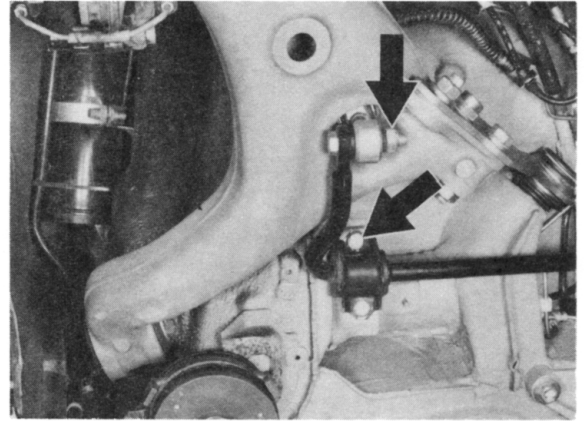
20. Undo the oil line in the rear right-hand wheel house with Special Tool 9501, bracing under all circumstances. Remove the retaining clip for the line from the wheel house. Block the line.



88/501

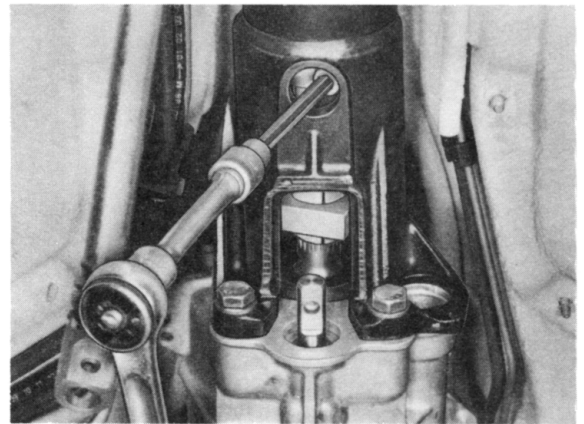
21. Disconnect the drive shaft at the flange from the differential. Left-hand side: remove the profiled sheet beforehand.
22. Detach the heater lines from the heat exchanger.
23. Disconnect the ground strap between body and starter from the lower starter fastening point.
24. Disconnect cable terminal 30 from the starter.
25. Detach the clutch slave cylinder and, with line still attached, lay aside.

26. Remove stabilizer.



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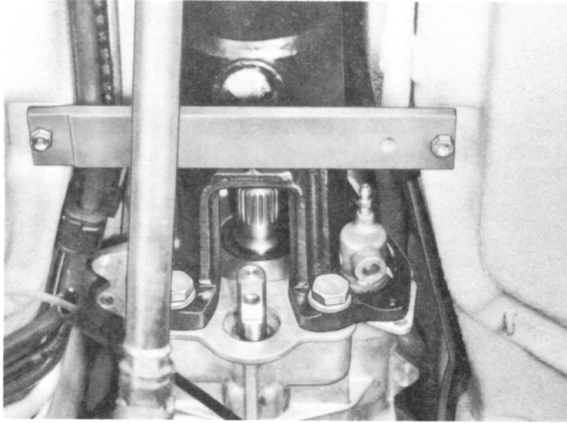
27. Pull the rubber sleeve forwards over the shift rod coupling and undo the body-fit screw.
28. Undo both Allen screws for the clamping sleeve and slide the sleeve forwards along the central shaft.



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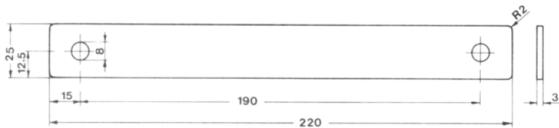
29. Pull the throttle operating cable out of the guide tube in the floor group.

30. Mount a self-made flat steel tool. (To support the central tube when disconnecting the flange).



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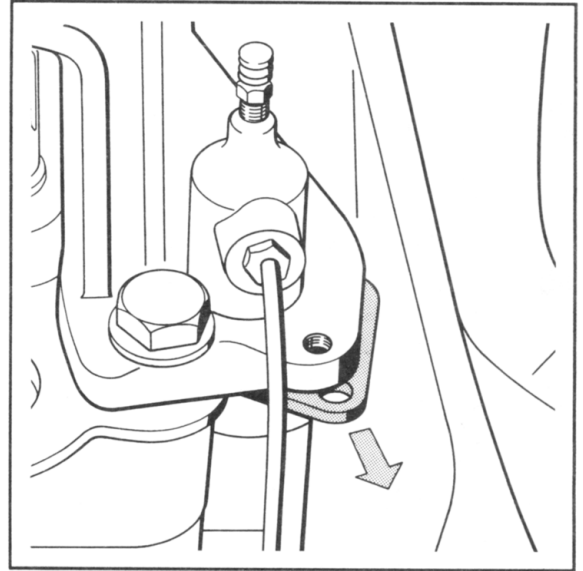
Sketch of the self-made tool



156-10

31. Undo the fastening nuts from the slave cylinder for the wheel-to-wheel differential lock. Do not undo the line.

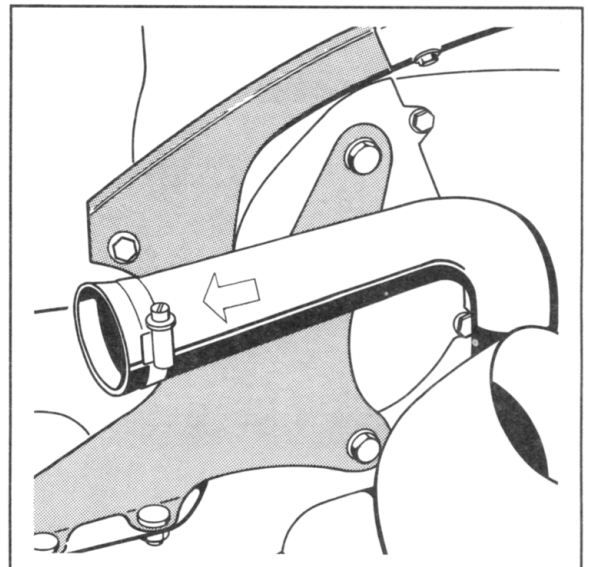
32. Undo the Allen screw from the slave cylinder for the interaxle differential lock and pull out the lock. Do not undo the line.



148-10

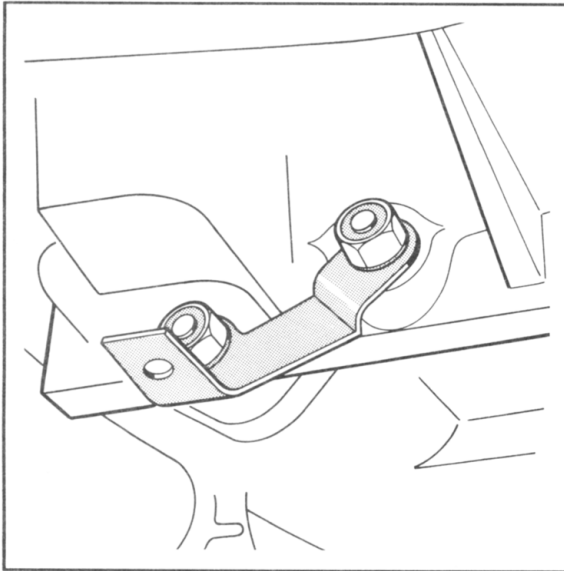
33. Unclip the connecting line at the transmission and suspend both cylinders on one side with the lines still connected.

34. Undo the oil hose from the oil line in the rear right-hand wheel house and block the oil line.



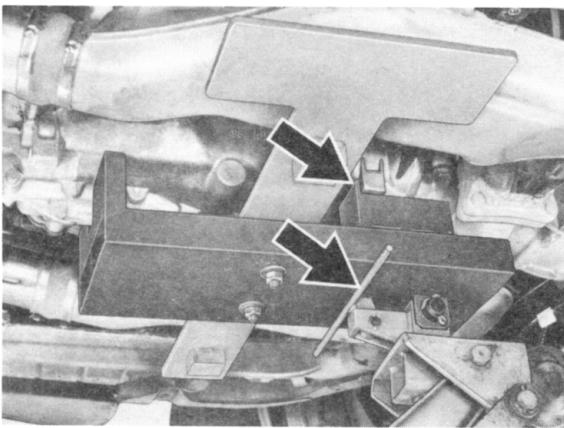
146/03

35. Undo the bracket for the engine guard, remove it and retighten the hexagon nuts or hexagon screws. (Contact surface for the engine mounting plate)



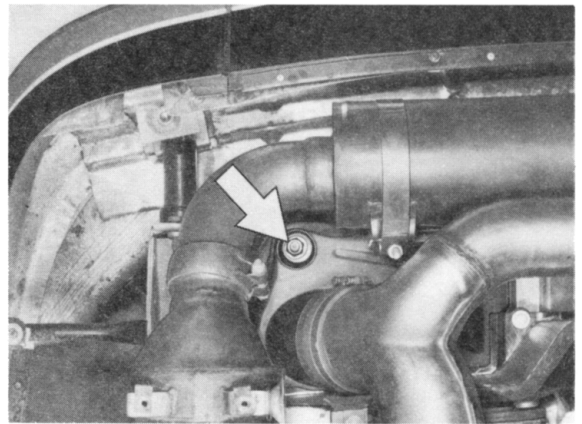
147-10

36. Position the jack with engine mounting plate under the vehicle with a certain amount of preload. Make sure that the adapter is in the right position. (Engine/transmission horizontal)



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37. Undo the lower fastening screws from the central transmission pipe flange.
38. Undo the transmission cross members (6 screws).
39. Remove the cap from the engine mount assembly hole in the rear engine cover panel and undo the hexagon nuts from the engine bearings from below.



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40. Lower the engine/transmission assembly until the central tube makes contact with the self-made flat steel tool. Pull off the multiple connector from the air-flow sensor.
41. Pull the engine/transmission assembly slightly to the rear and lower carefully.

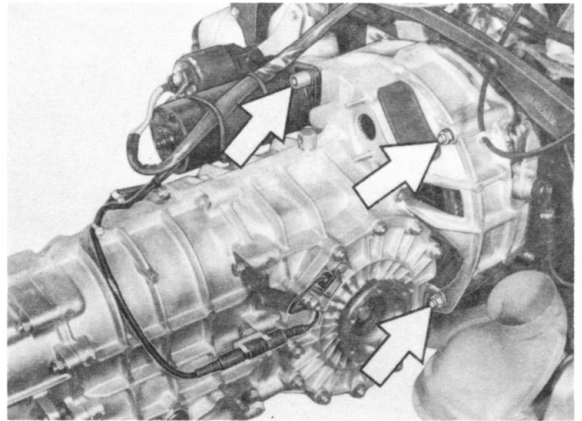
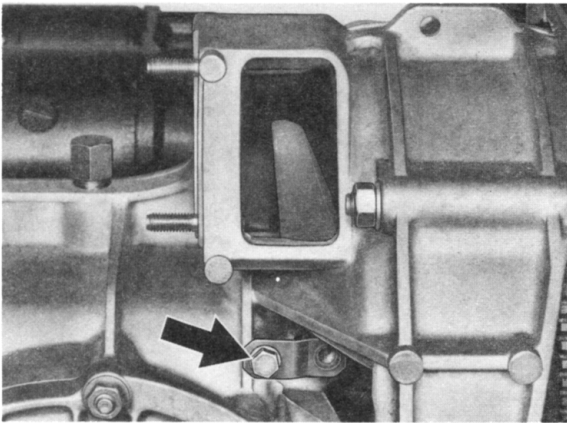
Note:

Pay attention to the drive shafts and slave cylinder.

Engine/transmission assembly, separating and joining

Separating:

1. Disconnect the cable from the starter and the cable from the switch for the backup lamp.
2. Undo the hexagon head screw. Remove the bracket and cap. Pull out the clutch release shaft with hexagon head screw M 6 x 40.



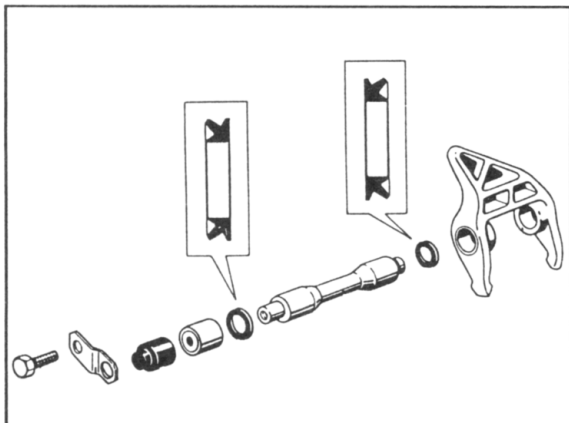
88-513

Joining

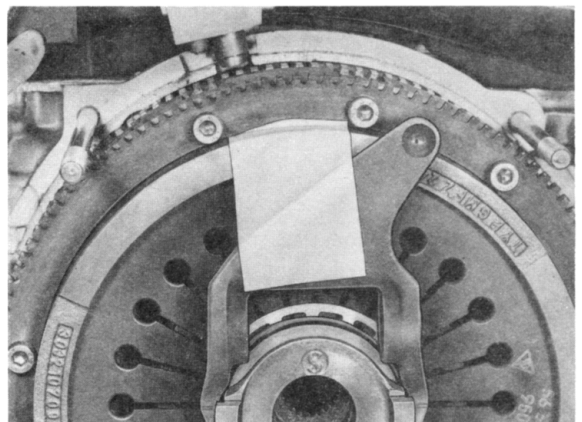
Note:

Lubricate all sliding surfaces of the clutch release mechanism and the gear teeth of the drive shaft with Olista Longtime 3 EP.

1. Guide the clutch release fork in the release bearing and fix in the installation position provisionally with suitable adhesive tape.



30-1



2. Flange-mount the transmission to the engine.
3. Guide the clutch release shaft with sealing rings into the release fork.
4. Remove the adhesive tape through the assembly hole.
5. Install needle bearing, cap and bracket and secure with fastening screw (M 6 x 16).

Installing

The following points must be observed during installation.

1. Do not pinch the heating lines, slide on to the heat exchanger shortly before the engine/transmission assembly has reached the correct installation position.
2. Make sure that the inner rubber seal of the connector is seated correctly.

Note:

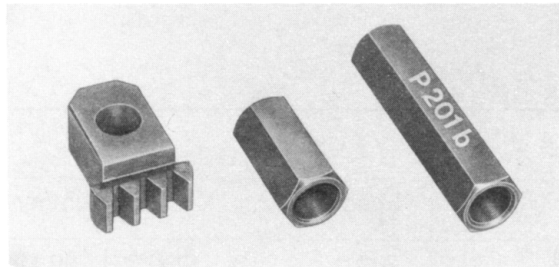
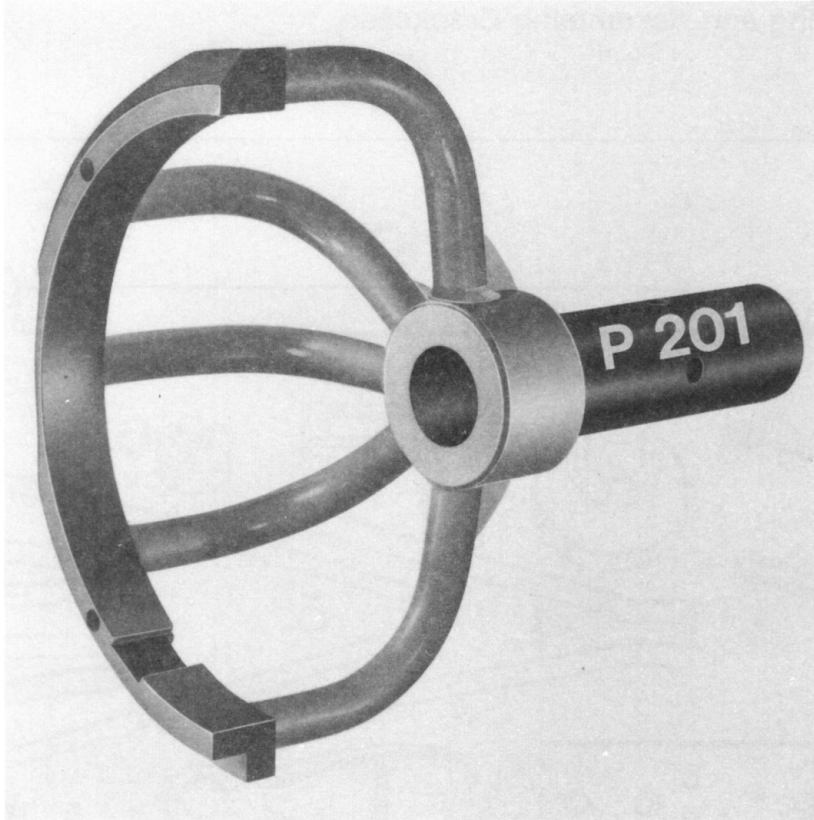
Pack the cap with grease. Also refer to notes on installation in Volume 3, Group 30, Page 30 - 1.

Tightening torques: removing and installing the engine/transmission assembly

Location	Thread	Tightening torque Nm (ftlb)
Engine mount to engine bearing	M 12	85 (62)
Transmission mount to body	M 12	46 (34)
Central tube to transmission	M 12	85 (52)
Twin clamping sleeve to the central shaft		75 (65)
Shift rod (body-fit screw)		23 (17)
Drive shaft to transmission flange		42 (31)
Stabilizer to stabilizer mount	M 10	46 (34)
Oil drain plug in thermostat housing		60 (44)
Oil drain plug in crankcase		70 (51)
Oil line to oil filter housing		80 (59)

Disassembling and Assembling Crankcase

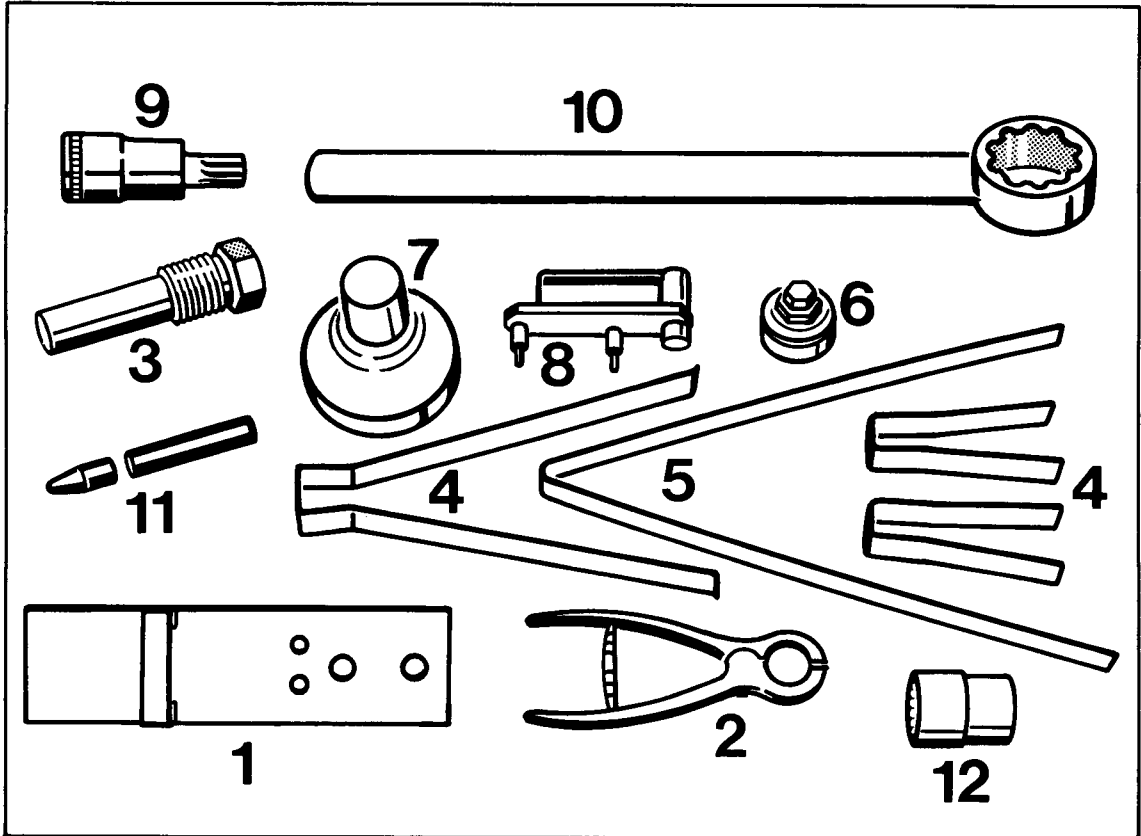
Engine Holder



No.	Description	Special Tool	Order Number	Remarks
1	Engine holder	P 201	000.721.201.00	Old version with three or four arms should no longer be used in the interest of safety. Mount engine holder on right crankcase section (cyl. 4 ... 6). Use spacers.
2	Toothed element and mounting parts	P 201 b	000.721.201.20	

Disassembling and Assembling Crankcase

Tools

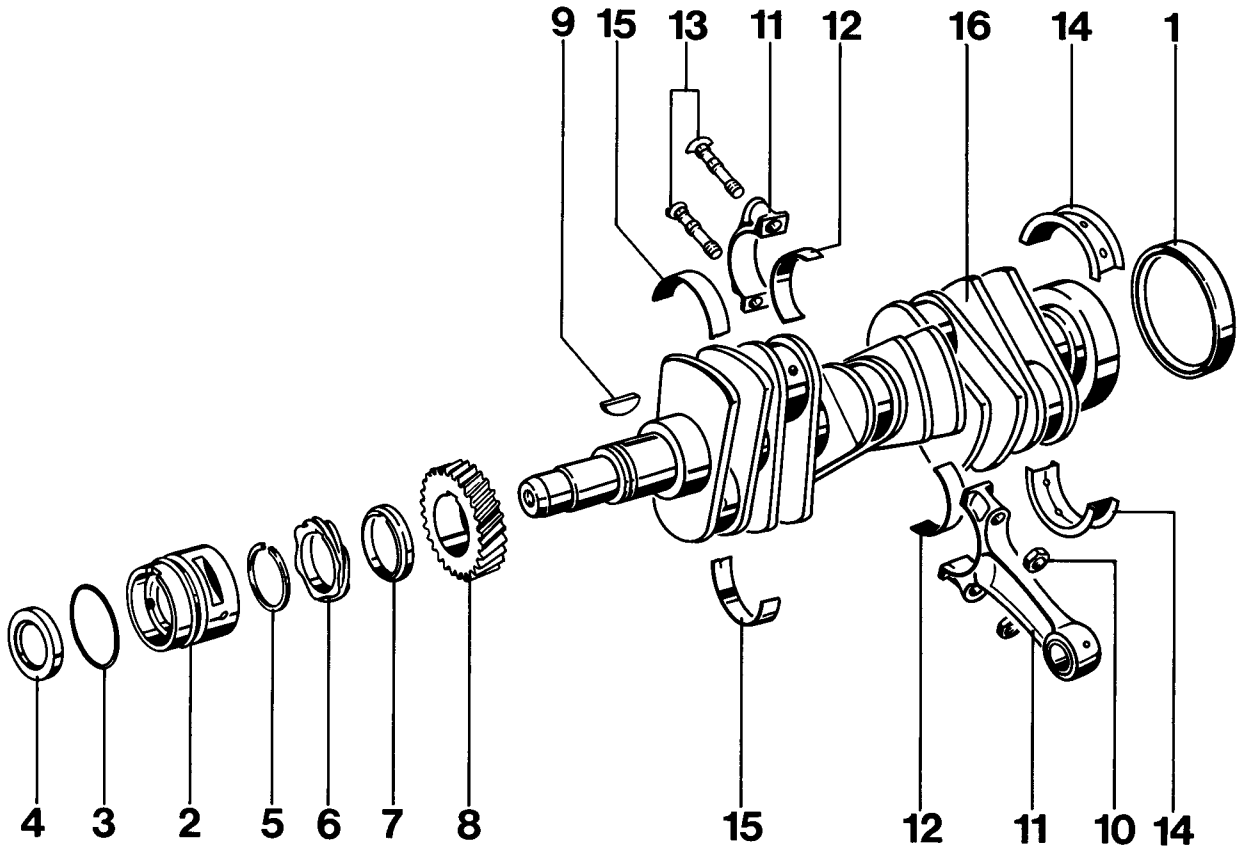


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No.	Description	Special Tool	Order Number	Remarks
1	Holding plate	209 a	000.721.209.10	Bolt crankshaft on holding plate with multiple-tooth socket bolts, Part No. 928 102 152 01.
2	Circlip pliers			Standard
3	Extracting bolt	9285/1	000.721.928.51	
4	Straps (conrods)	P 221	000.721.221.00	
5	Strap (timing chain)	P 222	000.721.220.00	

No.	Description	Special Tool	Order Number	Remarks
6	Pulling tool for seal (pulley end)	P 216 a	000.721.216.10	
7	Pressing tool for seal (flywheel end)	9126	000.721.912.60	
8	Installing tool for flywheel	P 238 b	000.721.238.20	
9	Multiple-tooth screwdriver socket		standard	
10	Holder for pulley	9290	000.721.929.00	
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)	

Disassembling and Assembling Crankshaft



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No.	Description	Qty.	Note When:	
			Removing	Installing
1	Radial oil seal	1		Replace
2	Sleeve for bearing no. 8	1		Lubricate with oil
3	Round seal	1		Replace
4	Radial oil seal	1		Replace
5	Circlip	1		
6	Drive gear for distributor	1		
7	Intermediate ring	1		Check installed position
8	Timing gear	1		Matched with intermediate shaft, only install together
9	Woodruff key	1		
10	Conrod nut M 9 x 1.25	12		Replace. Tightening torque: Initial: 15 Nm (11 ft. lbs.) Final: $2 \times 90^\circ \pm 2^\circ$ torque angle, threads and bearing surfaces lubricated lightly with oil
11	Connecting rod	6		Check installed position and weight
12	Conrod bearing shell	12	Inspect for wear	Lubricate with oil
13	Conrod bolts	12		Always replace
14	Thrust main bearing shells no. 1	2	Inspect for wear	Lubricate with oil
15	Main bearing shells no. 2-7	12		Lubricate with oil
16	Crankshaft	1	Inspect for wear	

Crankshaft - Standard and Repair Dimensions

Sizes	Main bearing dia. d 1	Big end bearing dia. 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 dia. d 4	Timing gear fit dia. d 5	Support dia. d 6	Guide bearing with 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 bearing surface for oil seals to dimensions 29.670 and 89.580 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 $R = 0.2$ to 0.5 .

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

Surface treatment requirements: Gas carbonitrided PN 2063.

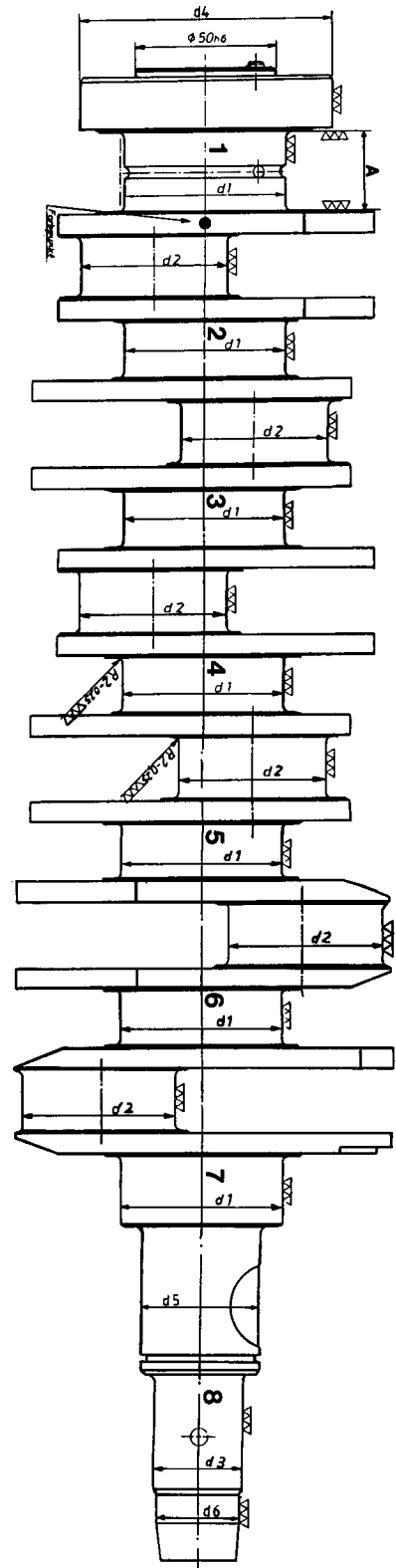
Do not straighten main bearings 3 and 5 after nitriding treatment.

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

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

Color coding of repair stages:

- | | |
|------------------|-----------------|
| 1st repair stage | blue color dot |
| 2nd repair stage | green color dot |

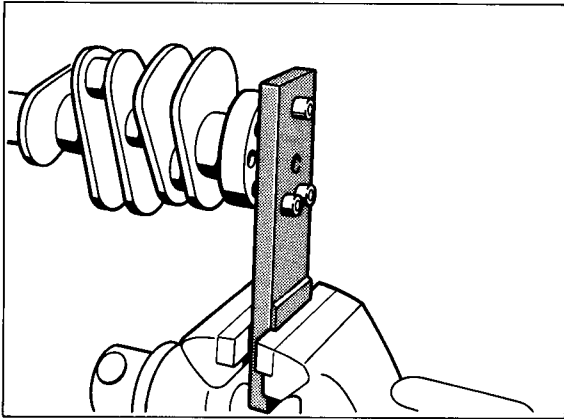


1008-30

Disassembling and assembling the crankshaft

Disassembling

1. Screw crankshaft onto special tool retaining plate P 209a with 3 fillister head screws, Spare part No. 928 102 151 01. Before this, the clamping sleeve (6 x 16) must be removed with grip pliers or a hole drilled in the retaining plate to accommodate the clamping sleeve.



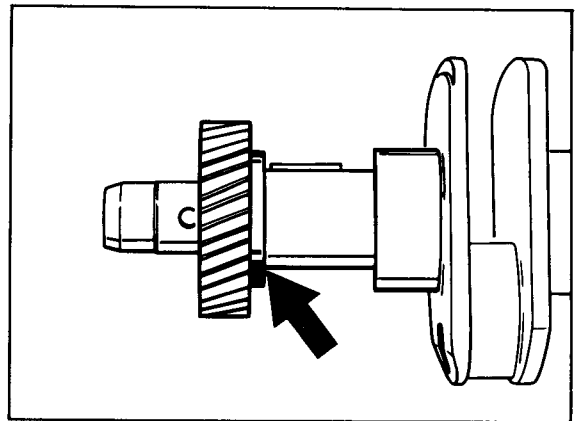
446-13

2. Undo and remove the con rods. Use socket wrench insert M 14 (hexagon).
3. Remove circlip at distributor drive wheel with snap ring pliers.
4. Pull off ignition distributor drive wheel, intermediate piece and control wheel with a standard commercial puller.
5. Remove Woodruff key. Slight score grooves on the seat surfaces can be carefully removed, but the press fit must not be impaired by this.

6. Check crankshaft for eccentricity, cracks and wear. Perform sounding test. If necessary, replace crankshaft. The crankshaft main bearing and the crankshaft bearing journals can be reground twice.

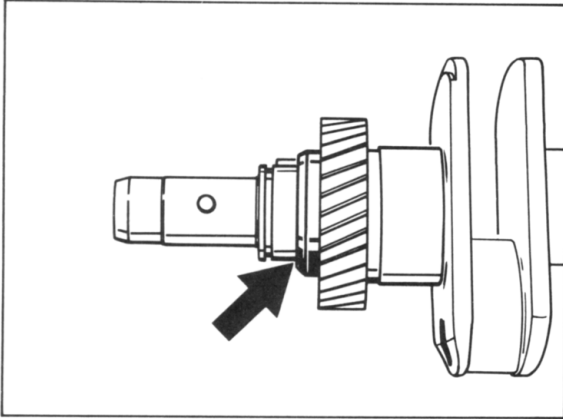
Assembly

1. Clean the crankshaft thoroughly. Flush through oil bores with a hand pump using benzine. By means of a visual inspection, check whether the oil duct is sealed at the bearings and face end (aluminium plugs).
2. Fit Woodruff key for control wheel and distributor drive wheel.
3. Heat the control wheel in an oil bad or on a heating plate up to approx. 150 °C and push onto the crankshaft journal up to the stop. The collar of the control wheel must face bearing 7.

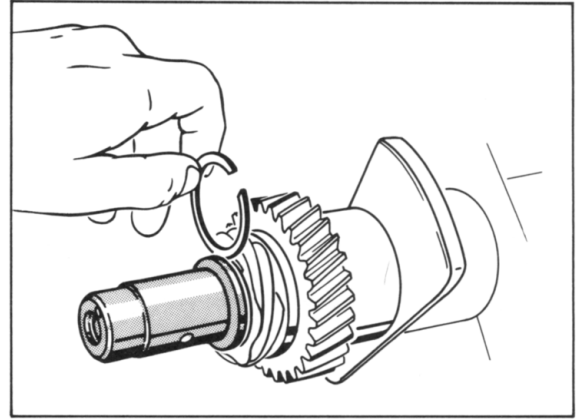


447-13

4. Heat up the intermediate ring and push on up to the stop. The chamfer points to bearing 8.



448-13

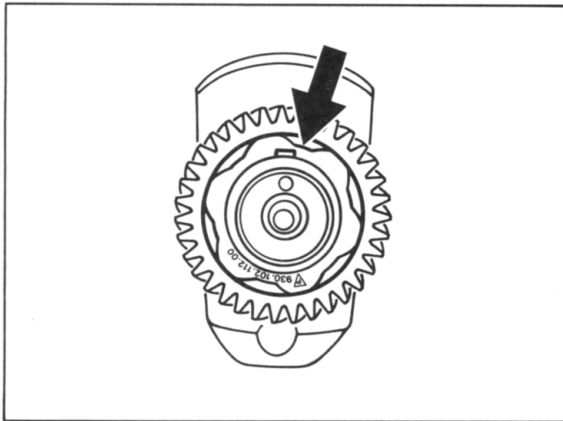


450-13

The following circlips are available:

Part number	Thickness mm	Identification
901.102.148.00	2.4	bright
901.102.148.01	2.3	blue-tempered*
901.102.148.02	2.2	yellow/brown-tempered
901.102.148.03	2.1	black-finished

5. Heat up the ignition distributor drive wheel to approx. 100°C and push on up to the stop. The Porsche trademark and part number point to bearing 8.



449-13

* circlip used most for initial assembly

6. Select the appropriate circlip by an insertion test. The circlip must be installed so that it is free of play.

Connecting Rod Weight Groups

Connecting rods are divided into different weight groups.

Pertinent weight groups are indicated by the final digit of the part number.

This final digit is inscribed in the shank of connecting rods which are supplied for replacements.

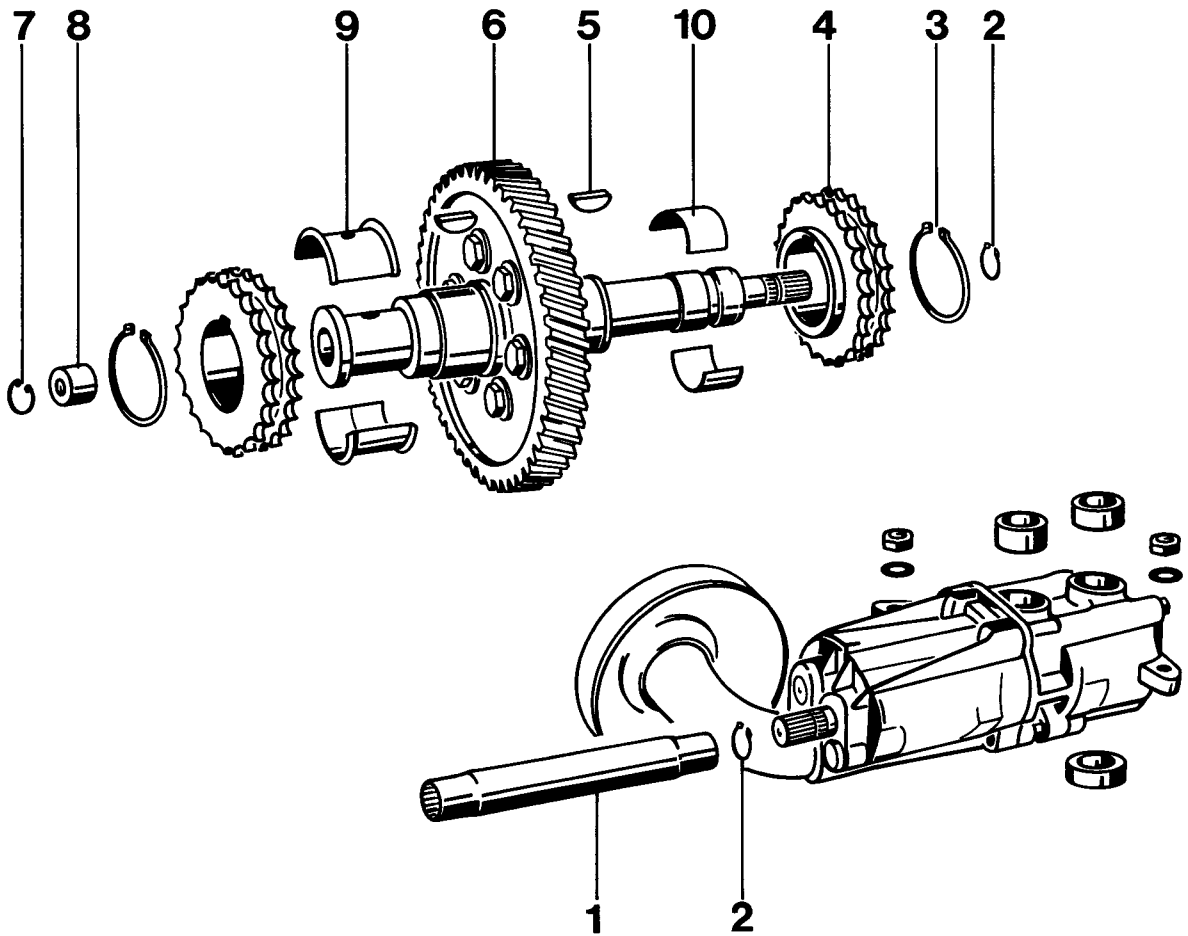
Weight above g	to g	Weight Group for Service	Service Conrod Part Number	Connecting Rod Code
615	624	3	964.103.020.53	53
624	633	4	964.103.020.54	54
633	642	5	964.103.020.55	55
642	651	6	964.103.020.56	56
651	660	7	964.103.020.57	57
660	669	8	964.103.020.58	58
669	678	9	964.103.020.59	59
678	687	10	964.103.020.60	60
687	696	11	964.103.020.61	61

Note

Only connecting rods, the difference in weight of which does not exceed 9 grams, may be installed in one engine. Weigh a complete connecting rod, but without bearing shells, to determine a weight group.

Connecting rod codes for Service parts are inscribed electrically.

Dismantling and assembling intermediate shaft

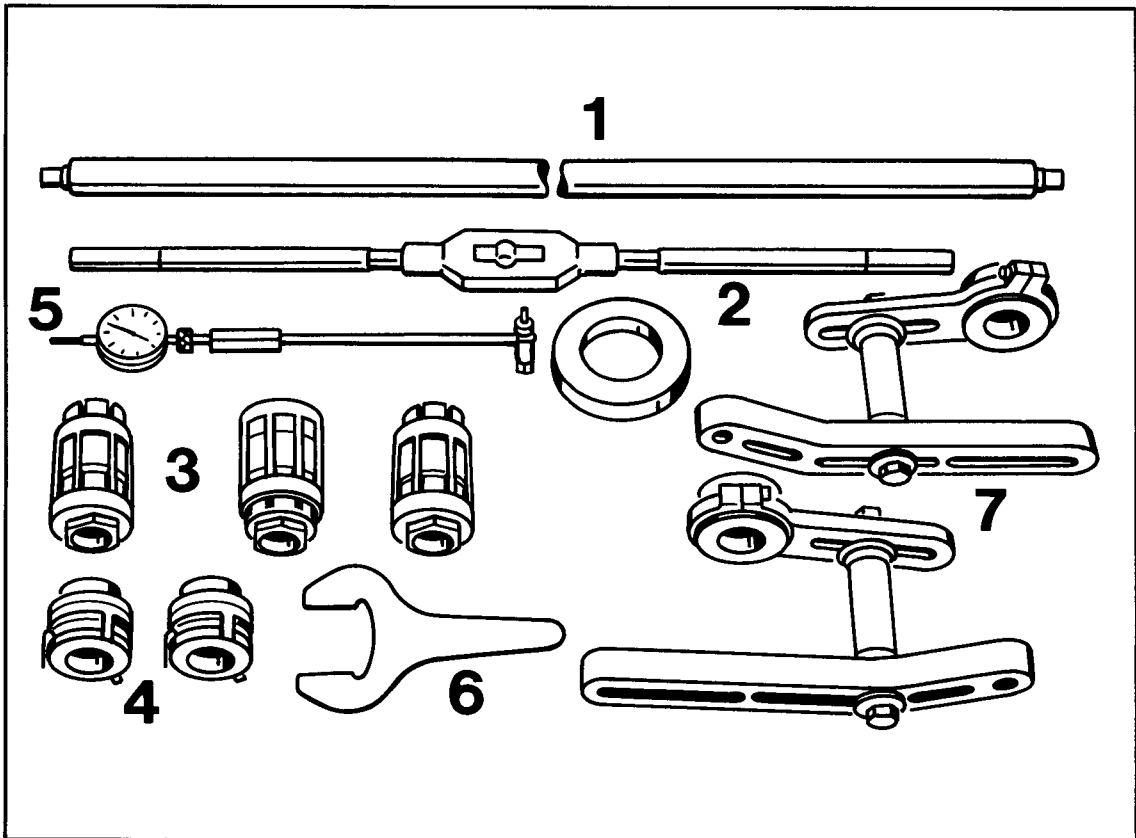


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No.	Designation	Qty.	Note:	
			Removal	Installation
1	Connecting shaft	1		check for smooth running
2	Snap ring 13 x 1	2		
3	Snap ring 36 x 1.75	2		
4	Chain sprocket	2	press off, check teeth. Chain sprockets available as spare parts	heat on heater plate, press on to stop, observe installation position
5	Woodruff key	2		
6	Intermediate shaft	1		matched with crankshaft gear, fit both parts as a unit
7	Snap ring 16 x 1	1		
8	Plug, aluminium	1	remove in case of bearing damage	
9	Thrust bearing	2		
10	Bearing	2		

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)

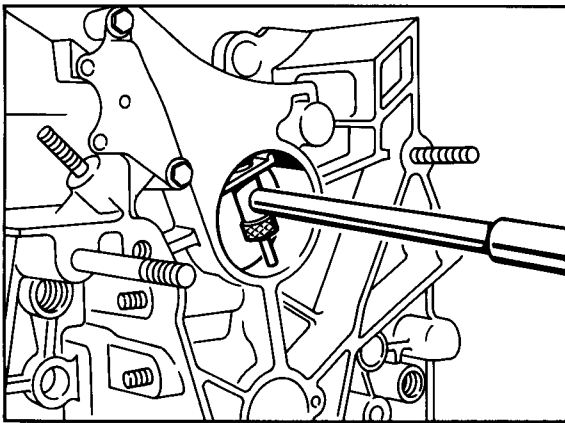
Measuring and repairing the crankcase

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.



931-13

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.

Reworking and reaming

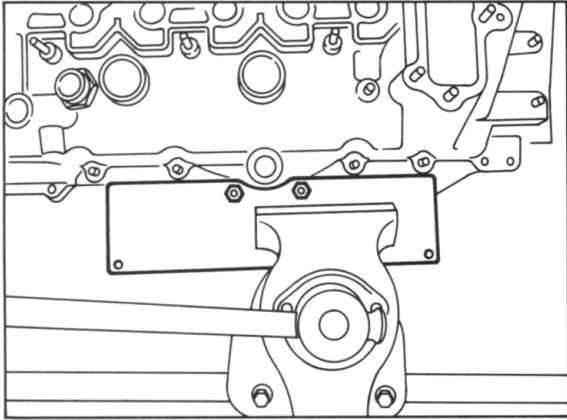
General

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

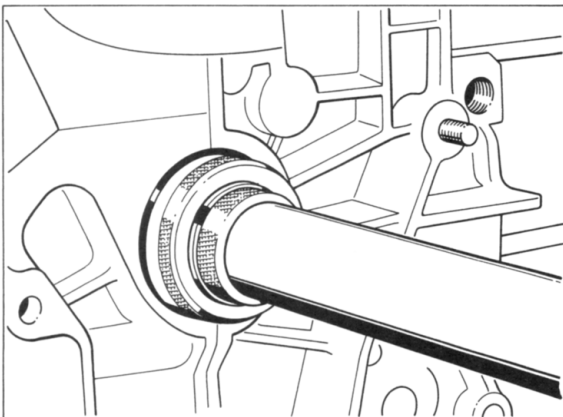
1. Fit shop-made tool to crankcase and tighten in a vise.



932-13

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

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

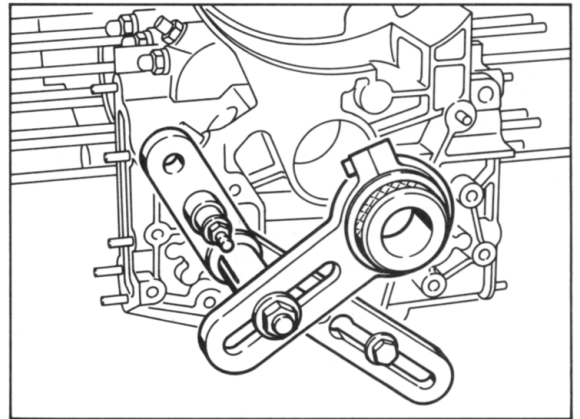


933-13

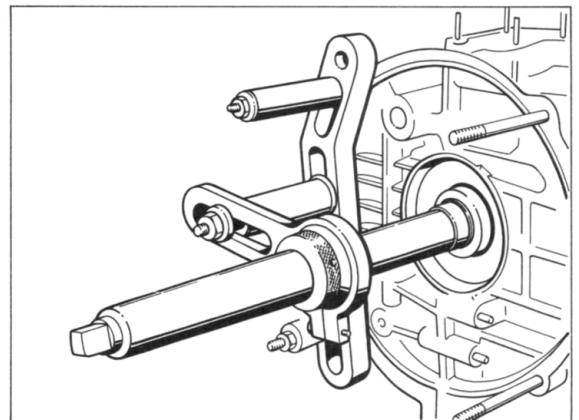
4. Now attach and align both guides for support of the guide rod.

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.



934-13

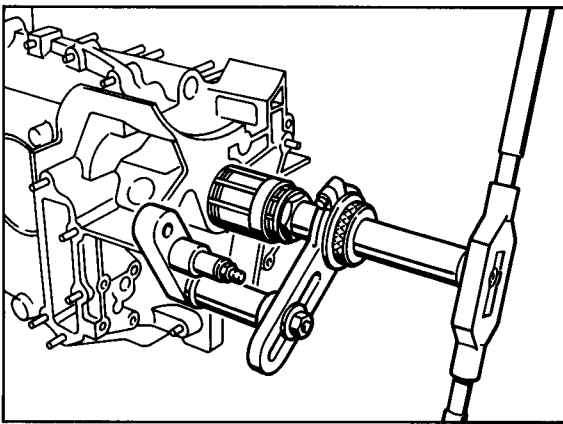


935-13

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.

Note

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

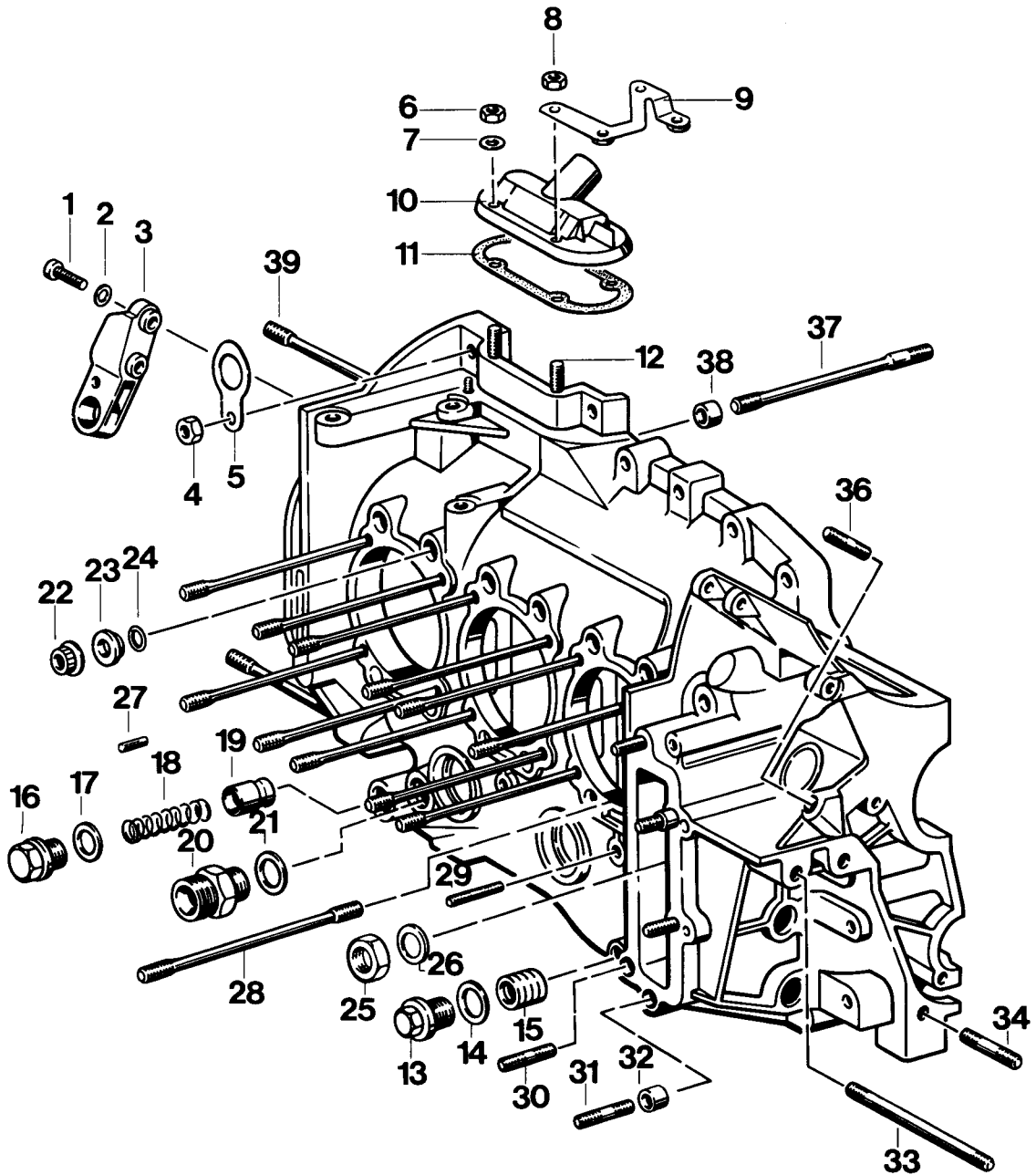


936-13

Dismantling and assembling crankcase sections

Left-hand crankcase section

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



997-13

No.	Designation	Qty.	Note:	
			Removal	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 release 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	11		replace, oil lightly
25	Hexagon head nut M 10 x 1.25 (at main bear- ing 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
37	Stud M 10 x 1.25 / M 11 x 169	2		bond in place with Loctite 649, projection length 116 + 0.5 mm

No.	Designation	Qty	Note:	
			Removal	Installation
38	Adapter sleeve	2		projection length 9.5 ± 0.3 mm
39	Stud	2		projection length 105 mm

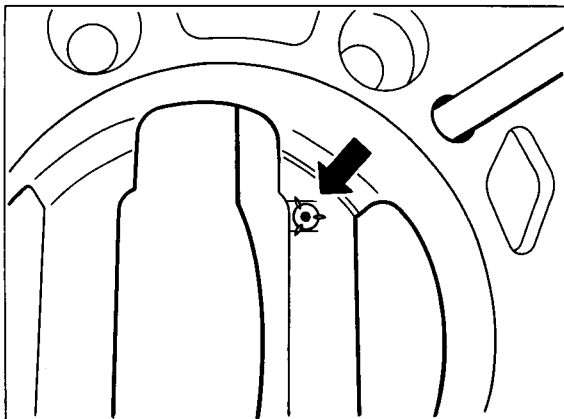
Replacing oil spray jets for piston cooling

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

Note

Heat surrounding area of spray jet to facilitate removal.

- 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.
- Peen circumference of spray jet.



999-13

No.	Designation	Qty.	Note:	
			Removal	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 towards pulley

No.	Designation	Qty.	Note:	
			Removal	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 nut	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 circumferential 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		

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.

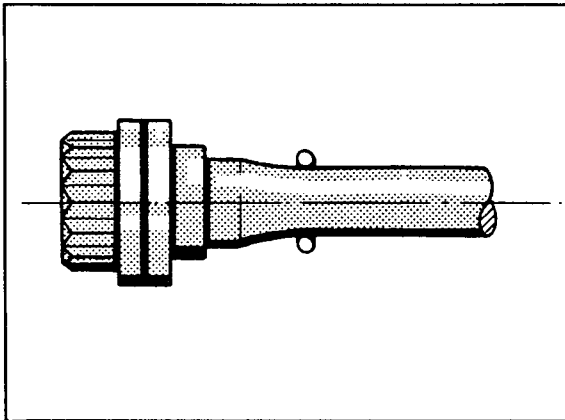
Note

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.)!

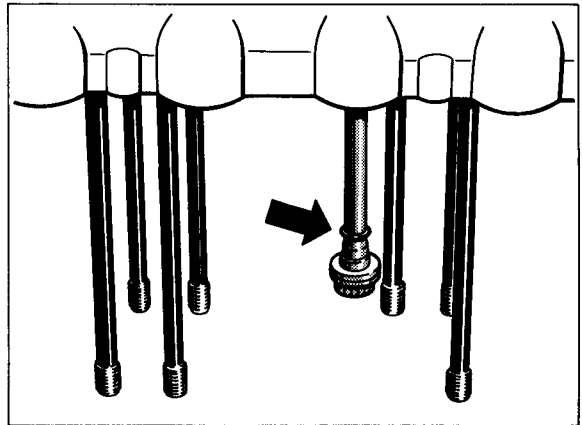


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Prepare left and right crankcase sections for assembling. Coat mating surfaces and bearing seats of the left section lightly with Loctite No. 574.

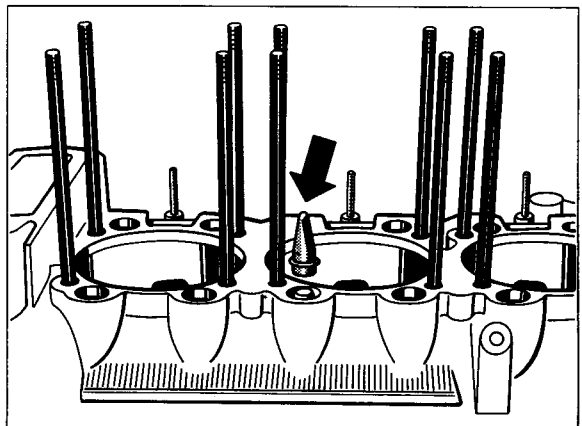
Assemble the sections and tighten the outer crankcase M 8 nuts until there is contact between both mating surfaces.

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



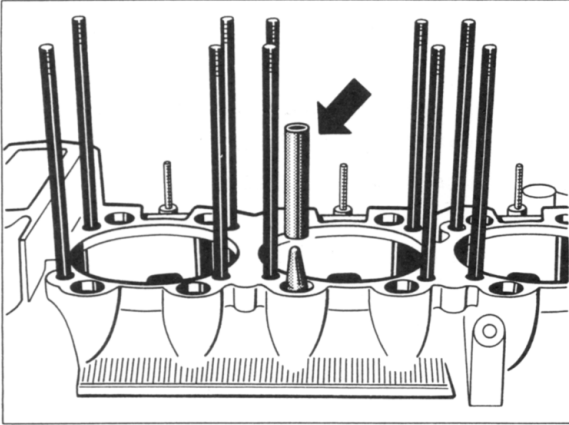
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5. Slide the tapered adapter with mounted and lubricated round seal on the threaded end.



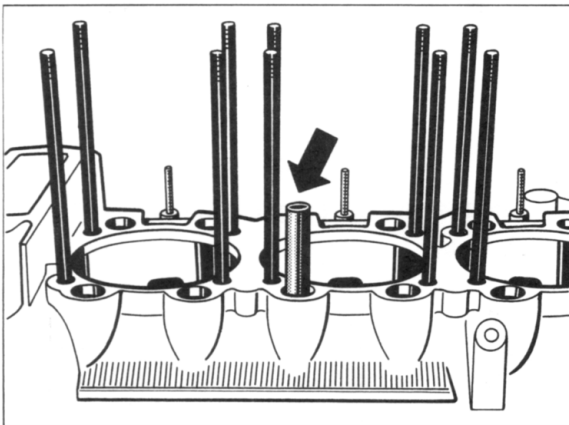
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6. Push round seal carefully off the tapered sleeve, using the A side (thin wall) of the cylinder sleeve.



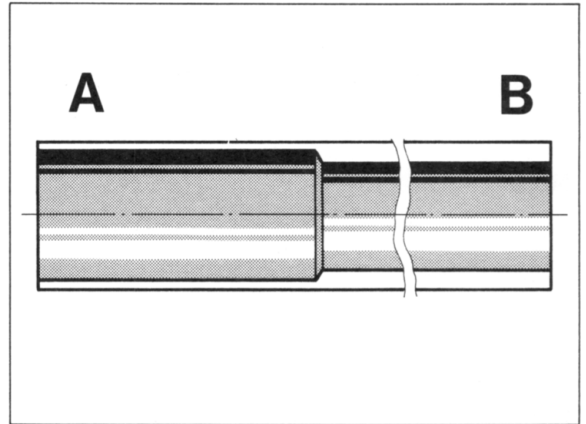
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7. Remove tapered sleeve and use B side (thick wall) of cylinder sleeve to push round seal carefully into end position, locking at the bolt head to keep it from rotating.



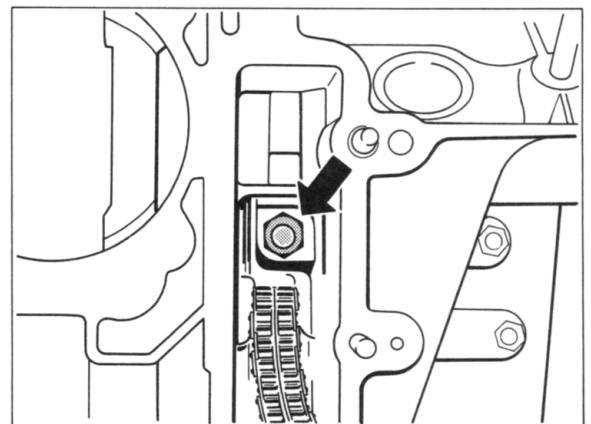
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Assembly sleeve 9511



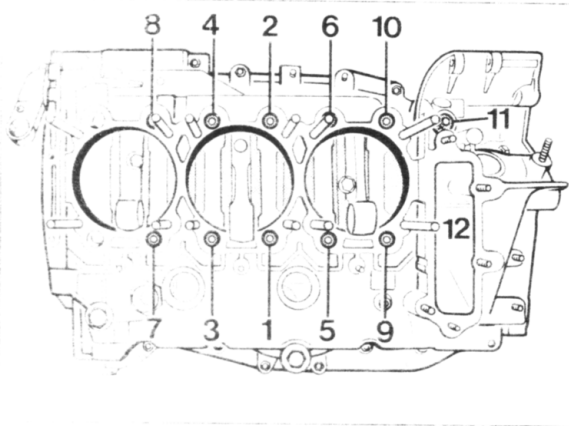
335/13

8. Fit sealing washers (dry) and use B-side of cylinder sleeve to press somewhat more.
9. Lightly tighten the multiple-tooth nuts (with threads oiled) manually.
10. Proceed accordingly for the two studs on the right-hand crankcase section (bearing 1 area).
11. Fit M 10 x 1.25 hexagon nut and A 10.5 washer to stud, with rounded side facing the hexagon nut.

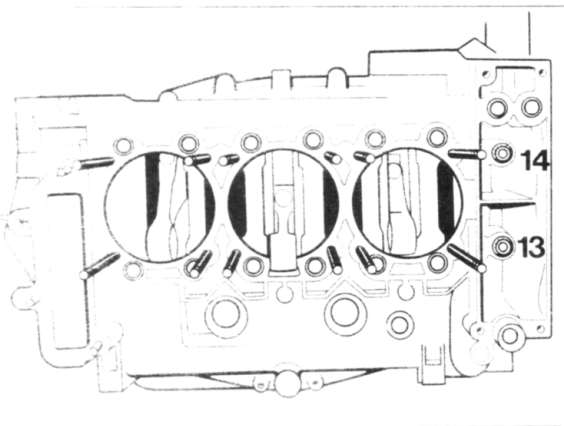


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12. Tighten tie bolts or studs with 50 Nm. Pay attention to tightening sequence.



302-13

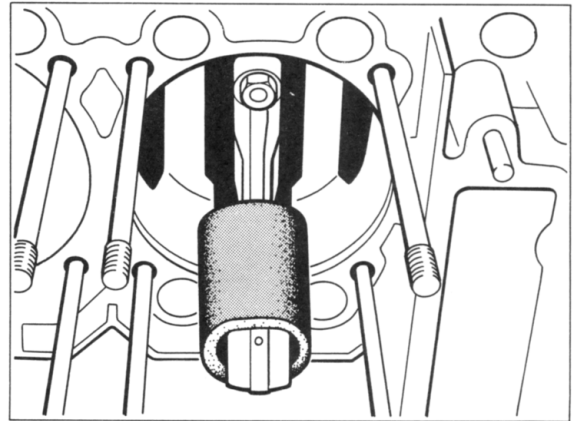


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13. Tighten outer case screw connection with 25 Nm.

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

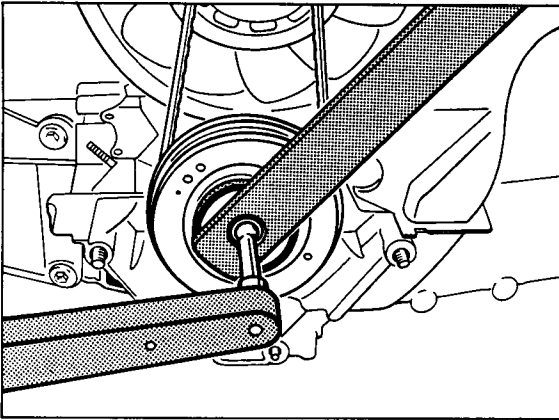
Note

When tightening the bolts, a second person should counter-hold under all circumstances so that the O-rings are not damaged when the tie bolts are turned. Use M 14 sockets from Messrs. Snap on.

Removing and Installing Pulley with Vibration Damper

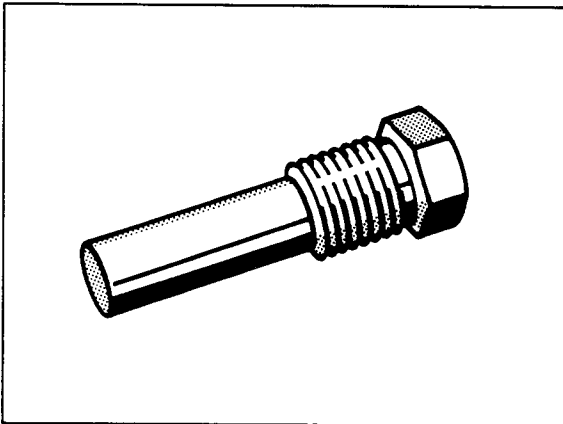
Removing

1. Unscrew hexagon head bolt, having a second person counterhold with Special Tool 9290 (holding wrench).



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2. Pull off pulley with Special Tool 9285/1 (extracting bolt).



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Installation

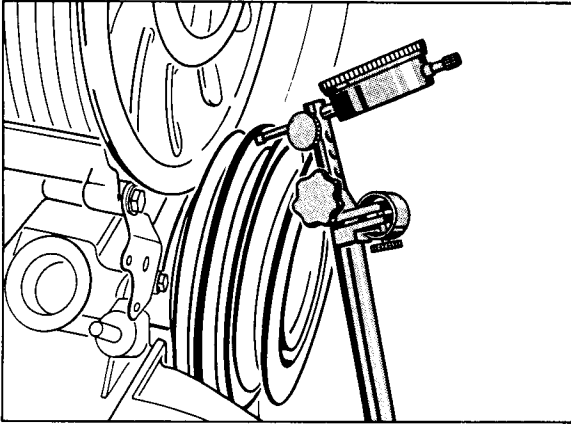
1. Before fitting the pulley to the crankshaft journal, the crankshaft taper and the taper on the vibration damper **must** be degreased. Freon, acetone or benzine may be used as degreasing agents.
2. The bolt head mating surface on the vibration damper and the threads and mating surface of the hex bolt head should be given a thin coat of oil.

Note

If these instructions are not observed, the friction force required at the taper cannot be generated.

3. Fit pulley and tighten hexagon head bolt (M 14 x 1.5 x 40) to 235 Nm (174 ftlb.), using retaining wrench 9290 to lock.

3. Mount dial gage and holder, e.g. VW 387.



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4. Check pulley for runout, straightening with a copper hammer if necessary.
Max. permissible lateral runout: 0.5 mm.

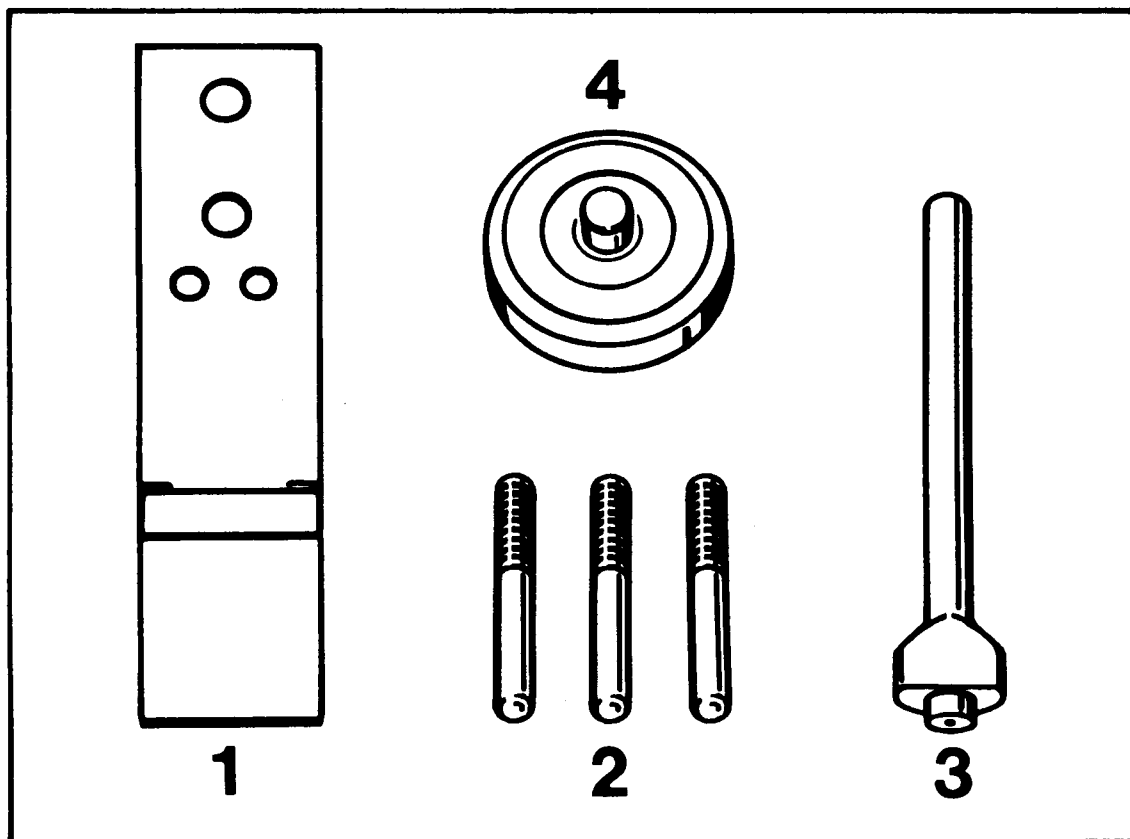
Note

The hammer must only knock in the inside shell, since otherwise the rubber cord of the vibration damper would be destroyed.

5. Recheck tightness (235 Nm = 170 ft. lbs.) after straightening.

Dismantling and assembling double-mass flywheel

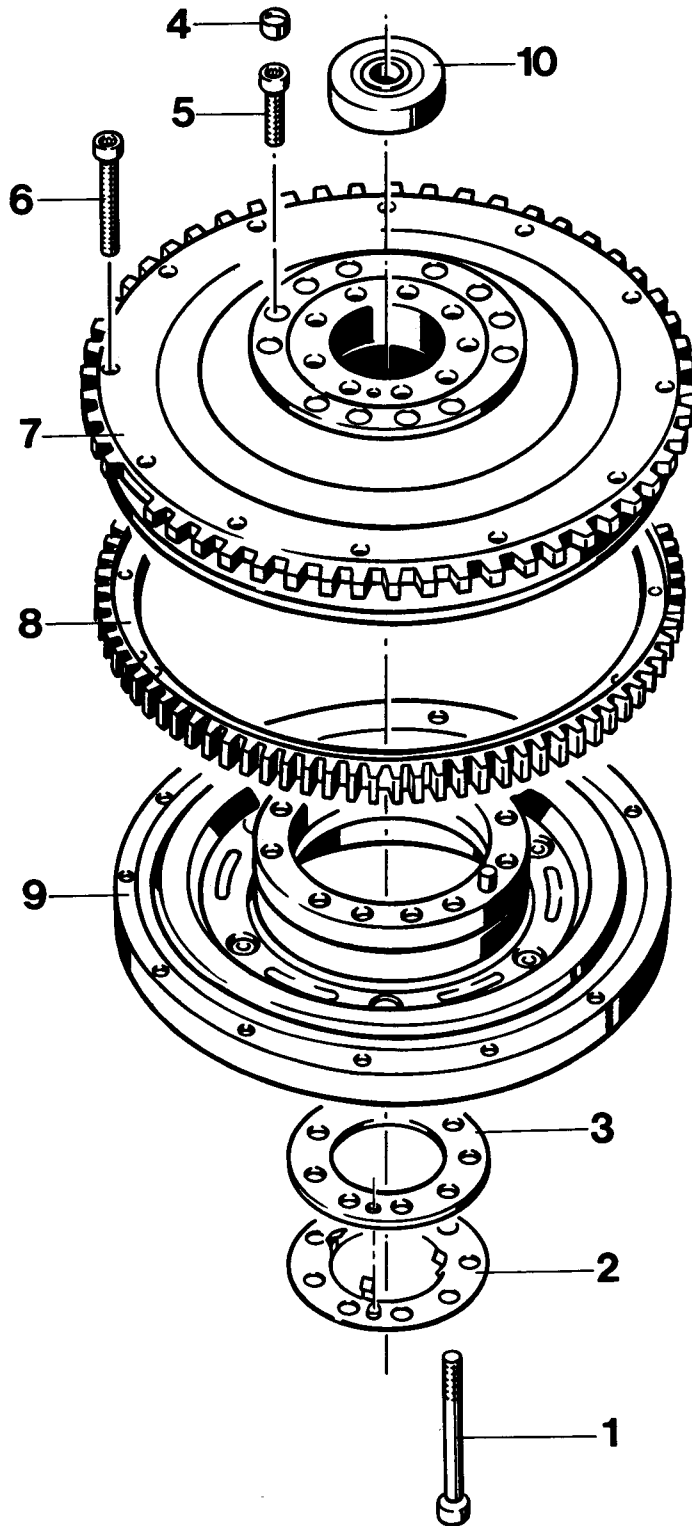
Tools



636 - 13

No.	Designation	Special tool	Order number	Explanation
1	Retaining plate	209 a	000.721.209.10	
2	Centering pins (3)	9520	000.721.952.00	
3	Driving-in arbor	9521	000.721.952.10	
4	Thrust block	9522	000.721.952.20	

Dismantling and assembling double-mass flywheel

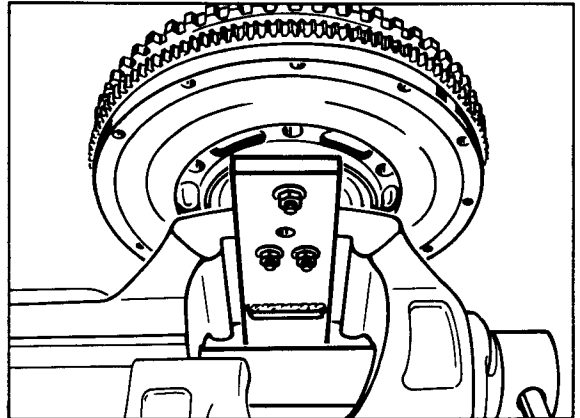


596-13

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Machine screw M 10 x 1.25 x 70 mm	9		Renew Tightening torque 85 Nm (63 ftlb)
2	Washer	1		Renew; insert folded-over lug in hole in spring washer
3	Spring washer	1		Renew
4	End cap	12		Renew
5	Machine screw M 8 x 1 x 21 mm	12		Renew Tightening torque 35 Nm (26 ftlb)
6	Machine screw M 7 x 34 mm	12		Renew Tightening torque 22 Nm (16 ftlb)
7	Primary flywheel	1		
8	Starter gear ring	1		Check teeth; note correct location in locking collets (3)
9	Secondary flywheel	1		
10	Deep-groove ball bearing	1		Drive in to full depth with thrust block 9522

Dismantling and assembling double-mass flywheel

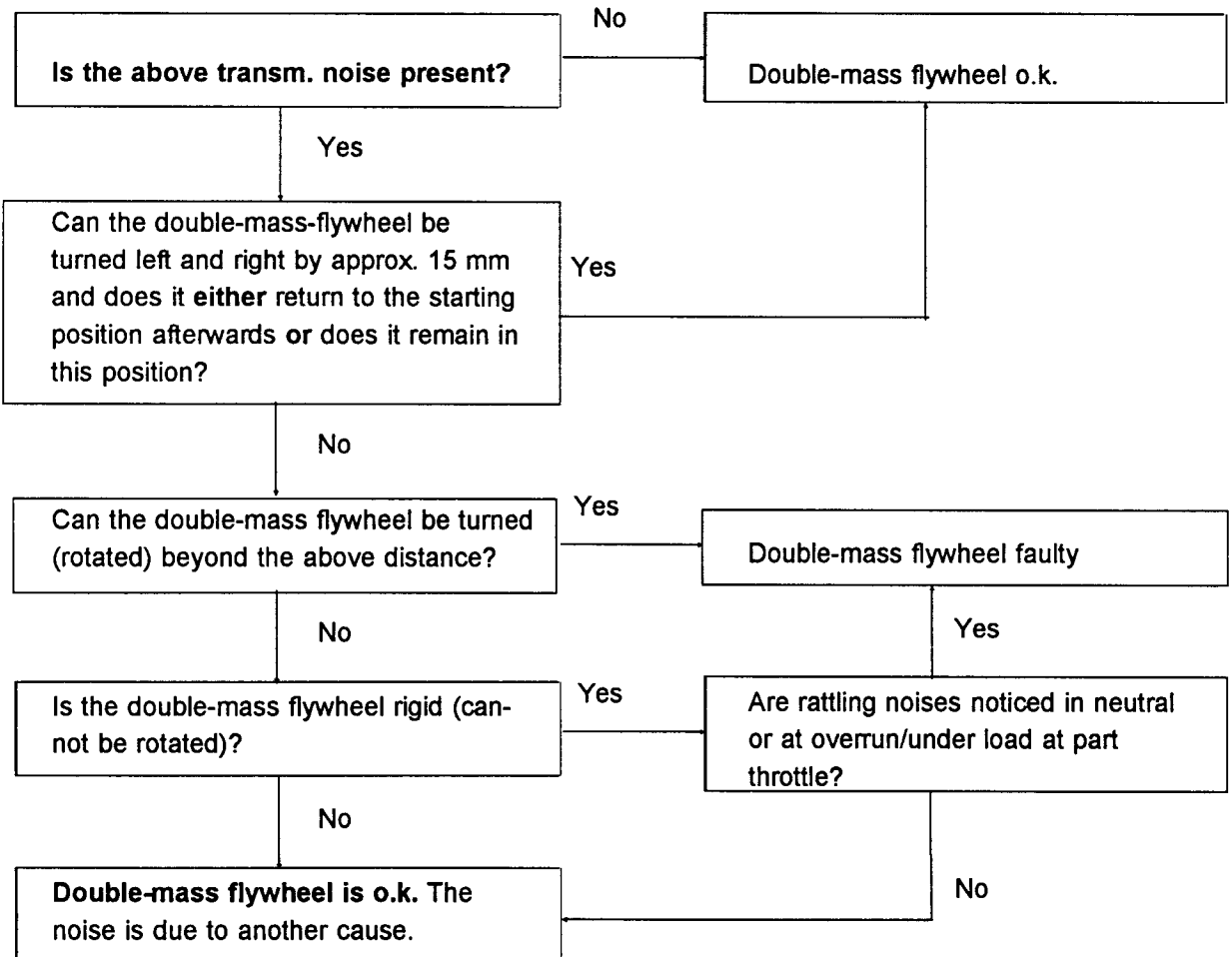
Bolt double-mass flywheel to retaining plate **P 209 a** (special tool) with three M 8 x 100 mm hex bolts. Insert aluminum washers under the bolt heads.



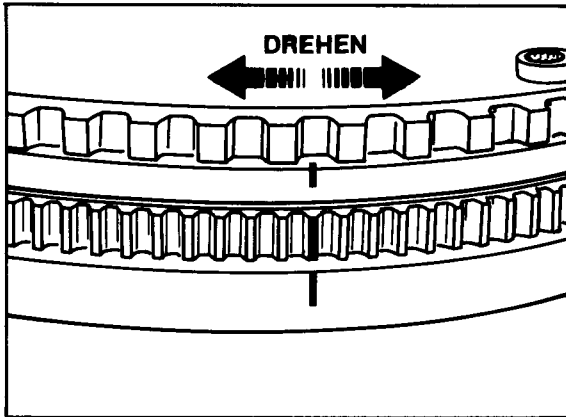
637-13

Checking

As a rule, the double-mass flywheel should only be checked if transmission rattle is present at idle or in overrunning/load mode or if respective customer complaints are received.

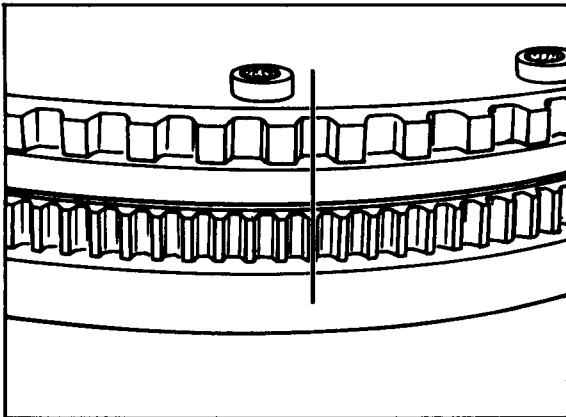


Direction of rotation of secondary flywheel



Note

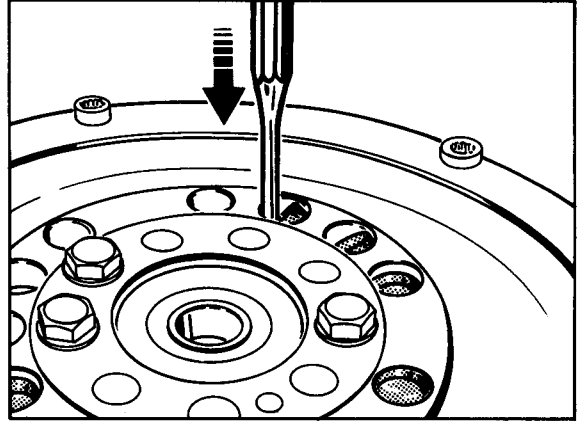
To facilitate subsequent reassembly, mark relative position of parts with a color pen.



638-13

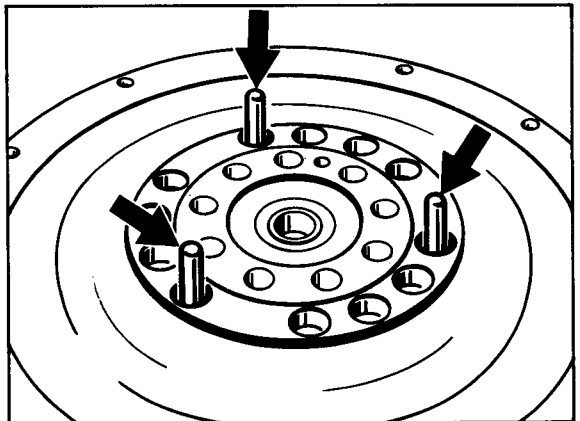
Dismantling

1. Take off the end caps. Do not drill them out, but tilt each cap in its hole by striking it vertically at the edge with an arbor.



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2. Unscrew the inner and outer ring bolts and take out the internal and external polygon head bolts.
3. Screw in the three centering pins (special tool 9520) at equal distances apart.



641-13

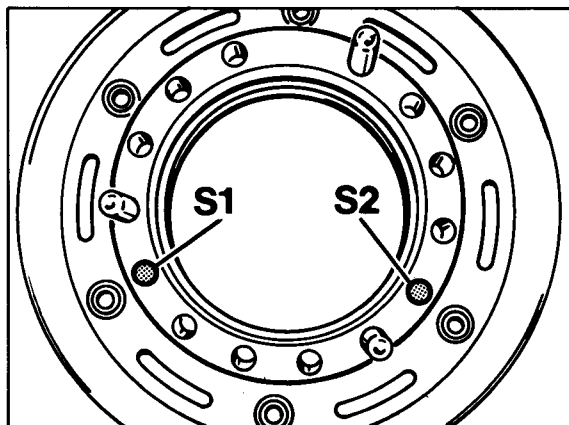
4. To separate the components of the double-mass flywheel, lower the complete unit firmly on a suitable hardwood surface with the screwed-in centering pins facing down. If necessary repeat this movement until the components have separated.
5. Knock the starter gear ring off with a plastic-headed hammer, holding the cover plate under it firmly at the same time.

Note

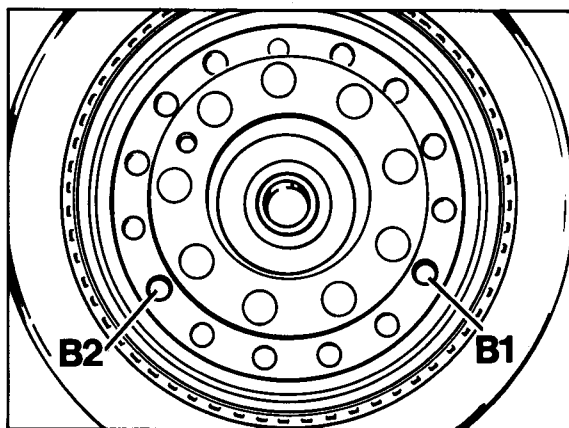
The cover plate must not be taken off, as there is a precisely weighed quantity of silicone grease inside.

Assembling

1. Insert the starter gear ring into the locating sleeves (3).
2. With centering pins 9520 (3) screwed in, place the primary flywheel on the secondary flywheel. It is important for centering pins S1 and S2 to engage in holes B1 and B2. Before assembling, align both sections as illustrated. The 3 centering pins make it easier to bring them together.

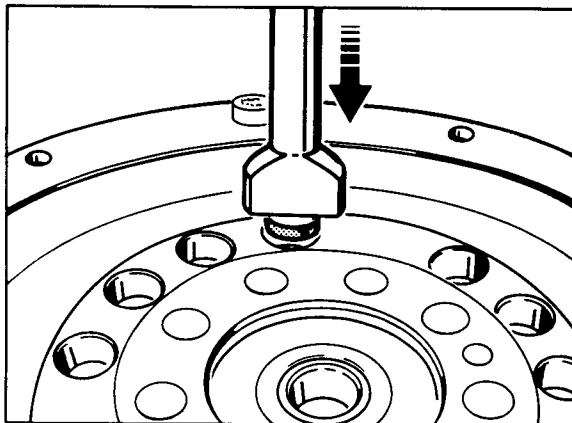


642 - 13



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3. Place the new end caps on the pin of driving-in arbor 9521 and drive it in as far as the arbor will reach. Do not drive it in any deeper or else the covers will make contact with the screw heads behind them.



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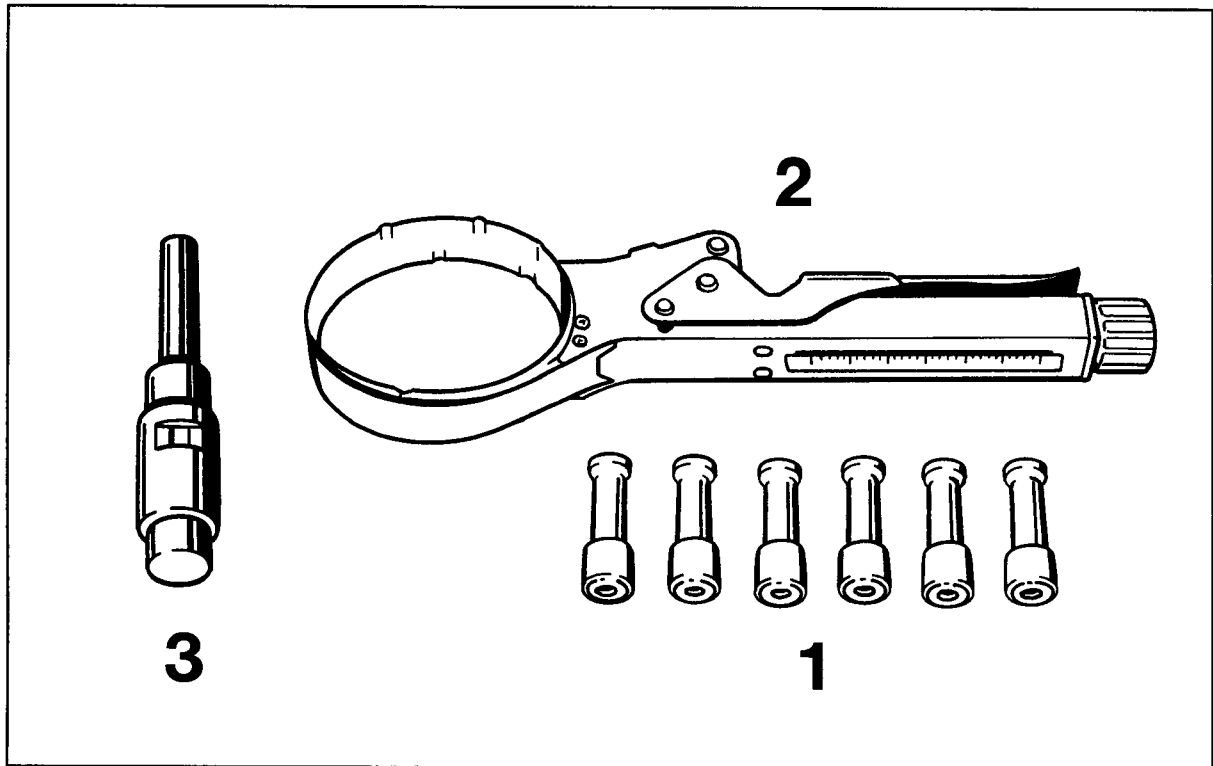
Note

When repairing the clutch, replace **only those** components that are actually faulty and **avoid replacing the double-mass flywheel if this is still fully operative.**

In addition, **no check** of the double-mass flywheel is required when working on the clutch.

Disassembling and Assembling Pistons / Cylinders

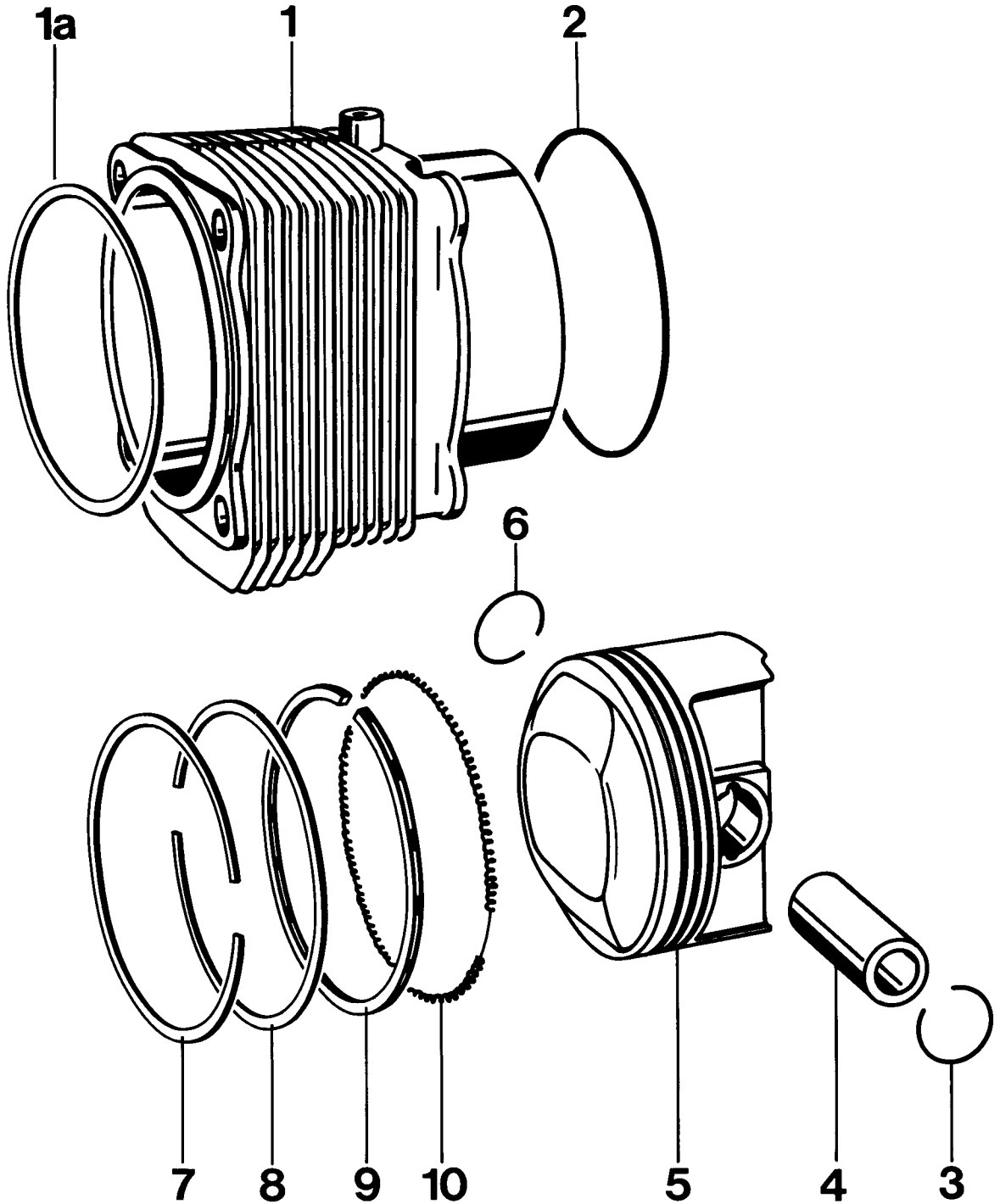
Tools



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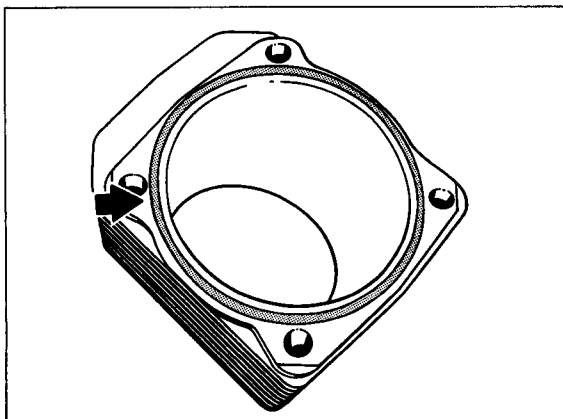
No.	Description	Special Tool	Order Number	Remarks
1	Holder for cylinder	P 140	000.721.140.00	Standard, e.g. Hazet 794-U-3
2	Piston ring compressor			
3	Installing tool for piston pin circlips.	9500	000.721.950.00	
	Pressure plunger	9500/1	000.721.950.01	

Dismantling and assembling pistons and cylinders



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	Wrist pin	6	Must remain allocated to the corresponding piston. Do not mix with parts from another cylinder, even within the same engine. When dismantling and assembling the engine, observe this procedure and mark parts accordingly.	Observe inside dia., use suitable thrust pin
5	Piston	6	Mark installation position	
6	Snap ring	6	Lever out	Always replace with new parts, check for corr. seating, use Sp. Tool 9500
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		

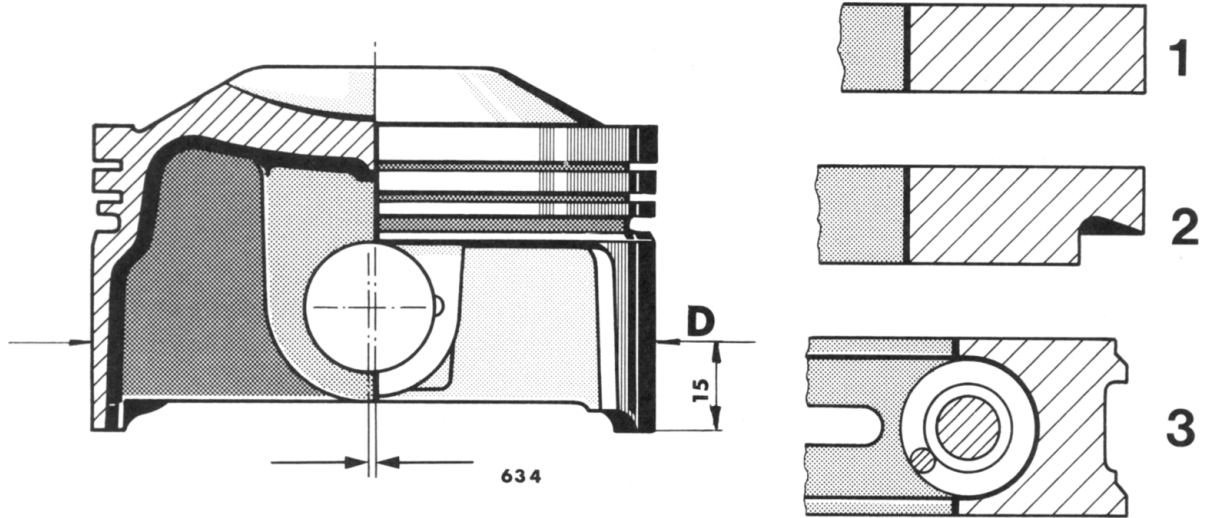
Assembly Note



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

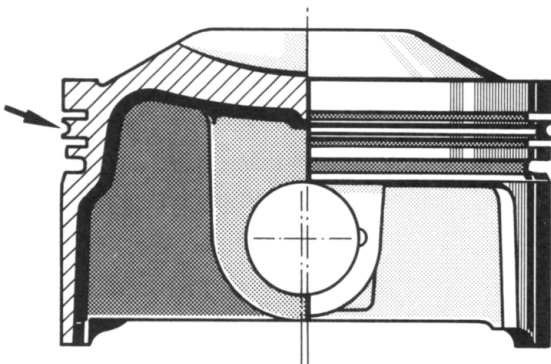
1011-13

Piston



- 1 - Groove 1 – Taper face ring
- 2 - Groove 2 – Stepped taper face ring
- 3 - Groove 3 – Double-bevelled ring with rubber-hose lined spring

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**Note**

Modified pistons were introduced in the course of Model Year 1990.
Distinction:
Groove (arrow) in ring land no. 1

Pistons and cylinders – Dimensions and identification

Tolerance group	Cylinder dia.	Piston dia.
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

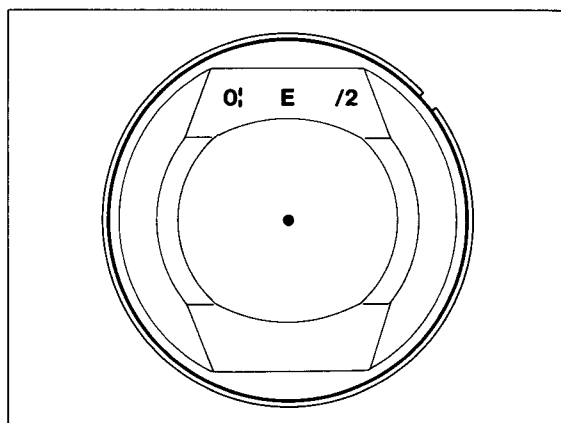
Piston identification

The following piston identifiers are stamped on the opposite piston crown section (installation position):

Letter "E" in the middle (towards inlet side), with identifier change level, internal Mahle code; the tolerance group (0, 1, 2 or 3) is indicated to the left next to the "E", with the weight group indicated next to the tolerance group.

Note:

The -- signs (minus/minus) for weight group identification may also be indicated in a vertical plane.



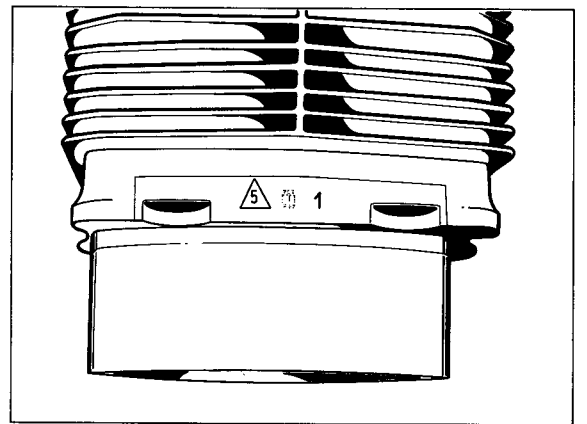
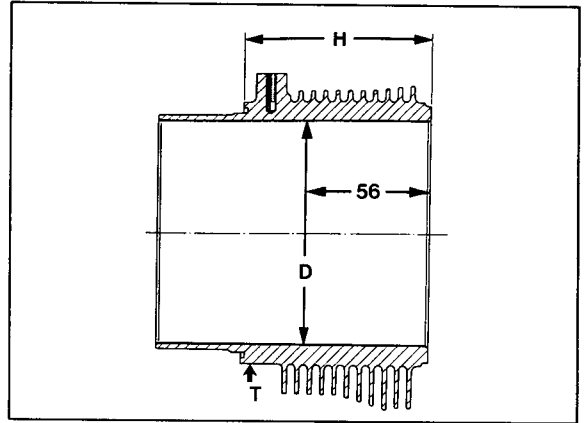
1006-13

Cylinder identification

The following identifiers are stamped on the side opposite to the mounting casting (knock sensor bridge):

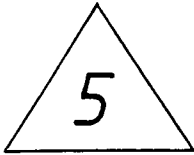
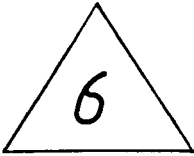
Cylinder diameter tolerance group,
e.g. group 0
and cylinder height tolerance group

e.g. height 



1010-13

Each cylinder height tolerance group (5 or 6) is subdivided further into the cylinder diameter tolerance group.

Height dimension H - 0.020	Cylinder diameter + 0.007	Group stampings	
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

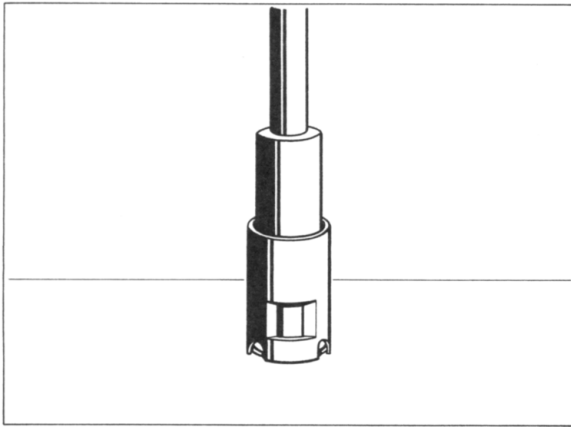
Only cylinders belonging to the same height group (5 or 6) may be fitted on one and the same cylinder bank.

Installing Piston Pin Circlips with Special Tool 9500 and 9500/1

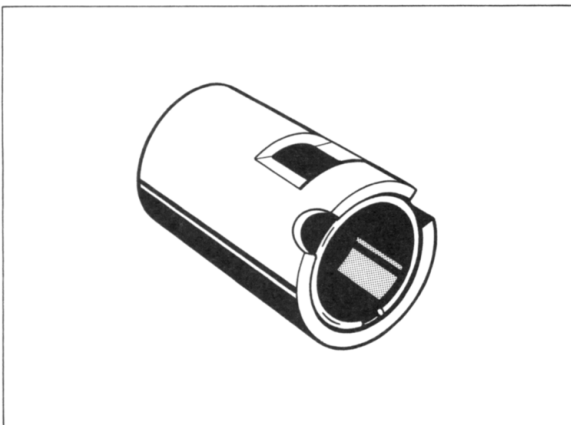
Pre-assembling

Pre-assembling the circlip in the tapered assembly sleeve should always be performed on a solid surface and only immediately before installation in the piston pin boss.

1. Place circlip in the tapered assembly sleeve that its opening is opposite the opening (window) in the tool and press forward with the pressure pad until the ring snaps in the groove of the tool.



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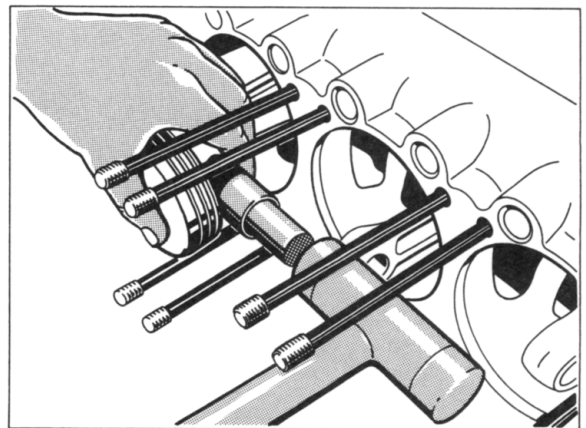
Note

The pressure pad may only be guided into the sleeve again after it has been applied on the piston pin boss.

Incorrect handling of the pressure pad could cause the circlip to spring out of the tapered sleeve. Danger of injury!

Installation on Piston

Apply the assembly sleeve on the piston pin boss and knock or press circlip into groove of the piston with the pressure pad. The small diameter end of the pressure pad serves as a guide in the piston pin.

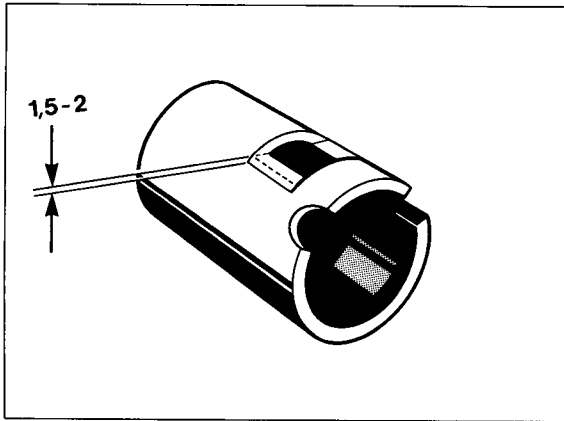


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Note

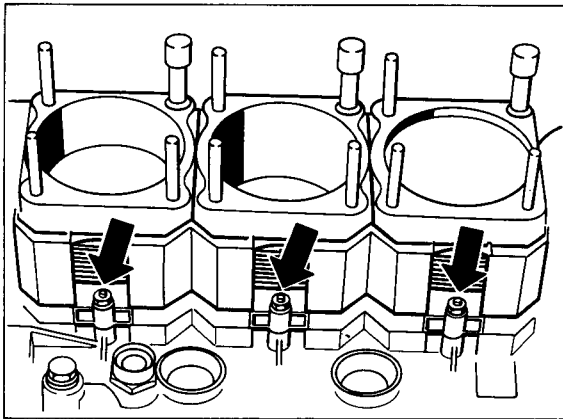
For weight reasons, piston pins with a smaller diameter (12 mm) are fitted on request. In this case, the pressure plunger (Special Tool 9500/1) must be used in conjunction with the sleeve of Special Tool 9500.

Due to a modification to the wrist pin area, the aperture (window) of the Special Tool may require reworking by approx. 1.5 to 2 mm.



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Assembling the cooling air duct for cylinders

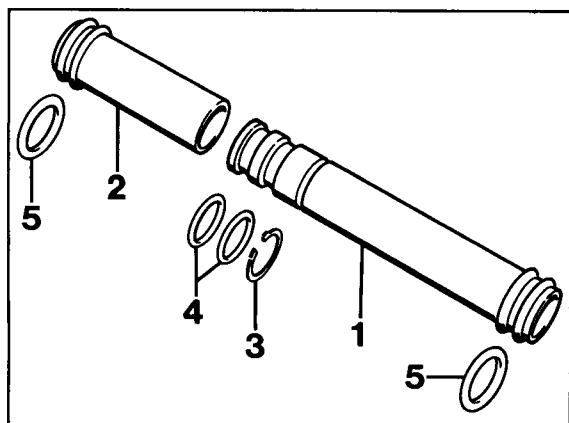


439-13

Removing and installing two-piece oil return pipes

Note

Apart from the single-piece oil return pipes, two-piece oil return pipes are supplied for repair purposes to allow the return pipes to be replaced without removing and dismantling the engine. When rebuilding the engine, however, single-piece oil return pipes should be fitted as before.



- 1 Oil pipe, long
- 2 Oil pipe, short
- 3 Snap ring
- 4 O-rings
- 5 Round seal

Removal

1. Remove left-hand heat exchanger. Right-hand heat exchanger may remain fitted on the engine.
2. Cut single-piece oil return pipe in the center using a sheetmetal cutter. Catch oil remaining in the pipe.
3. Remove pipe sections. Clean sealing faces on crankcase and camshaft housing.

4. Preassemble two-piece oil return pipe, i.e. fit O-ring and round seal and coat lightly with tire assembly paste (e.g. Contifix). Press snap ring out of groove and push approx. 40 mm onto the pipe. Assemble both pipes.
5. Fit assembled pipes to engine and press them apart so that the round seals are seated in the sealing faces and the snap ring groove is free.

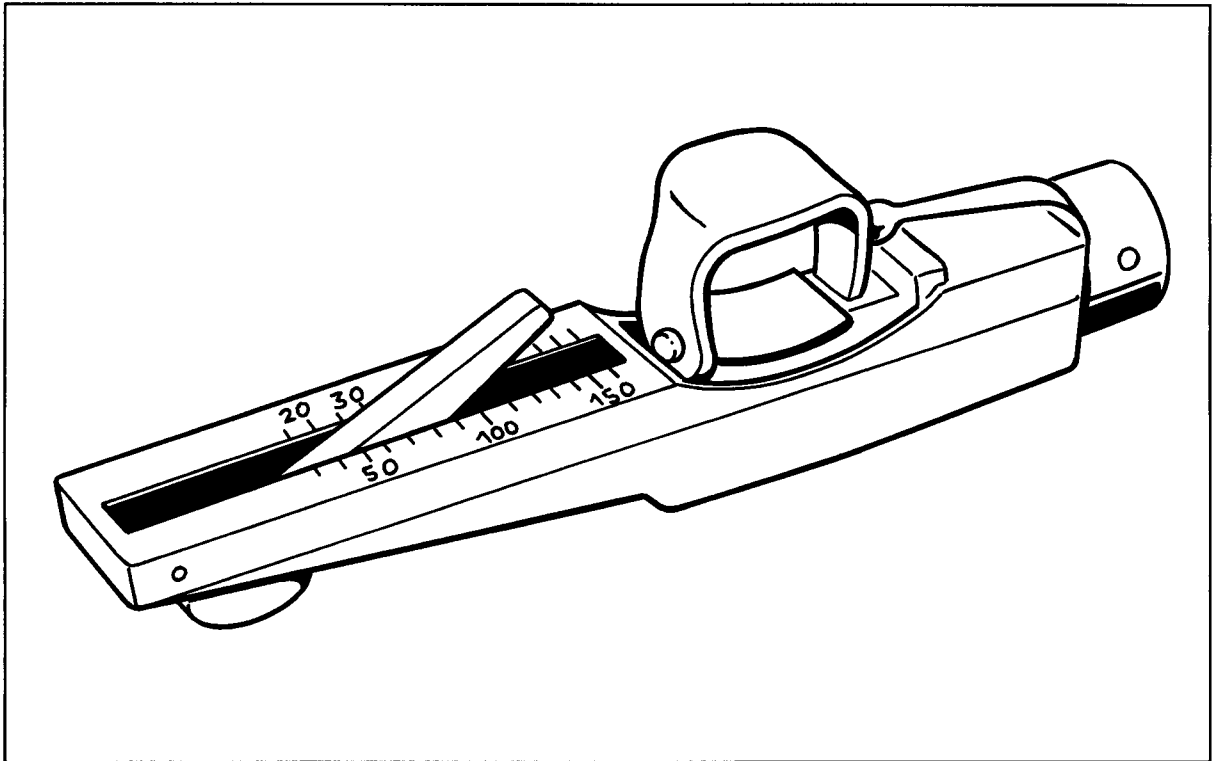
Note

Insert short oil tube towards crankcase.

6. Reinsert snap ring into groove. Rotate assembled pipe slightly to ensure proper seating of the round seals.

13 78 05 Checking and adjusting drive belts

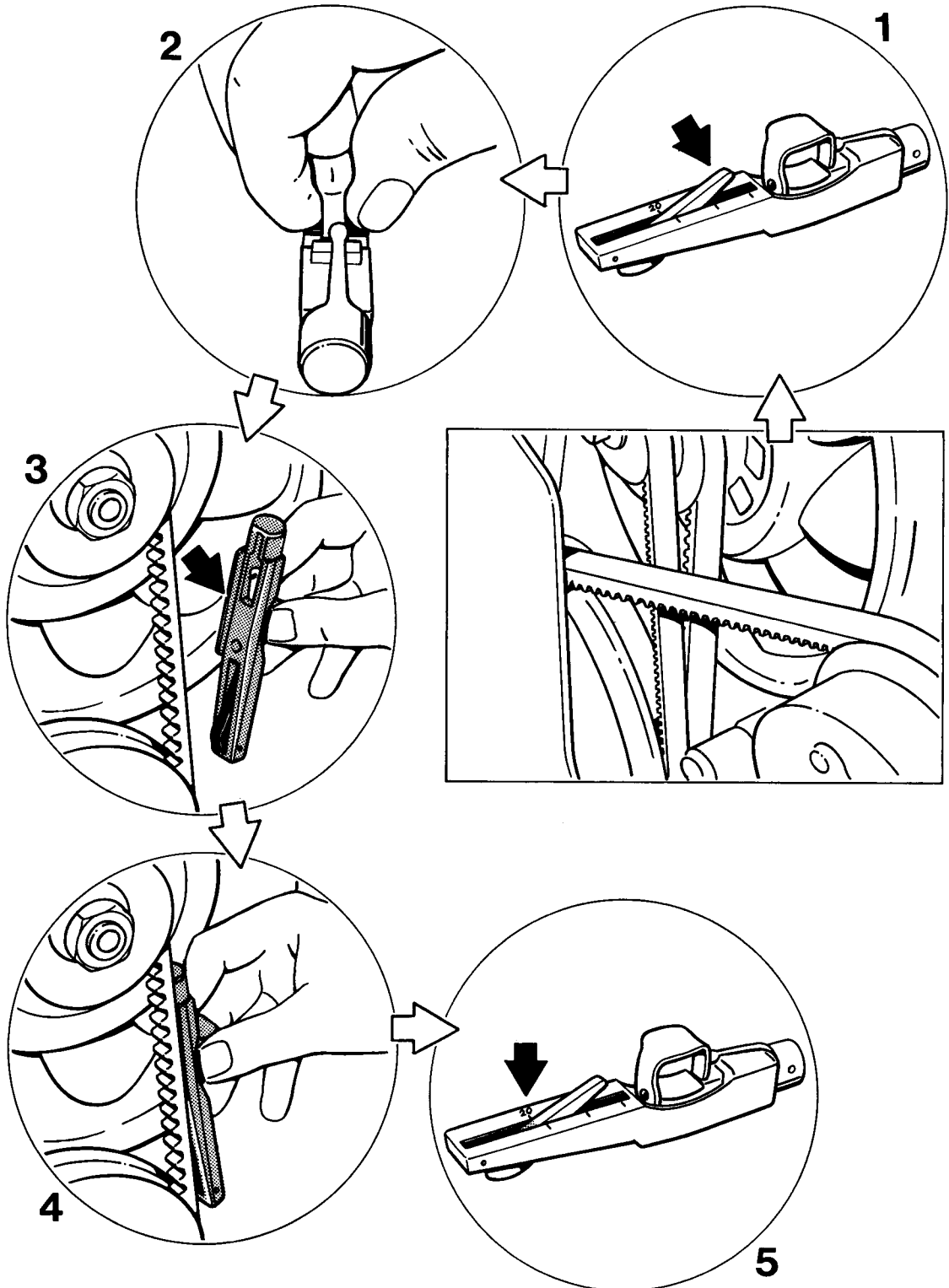
Tool



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
1	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.

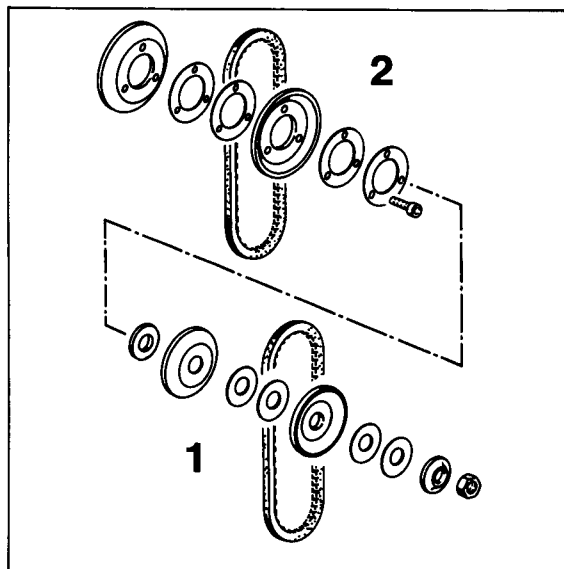
Check tension again.

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.



1863-27

- 1 = Alternator drive components
2 = Fan wheel drive components

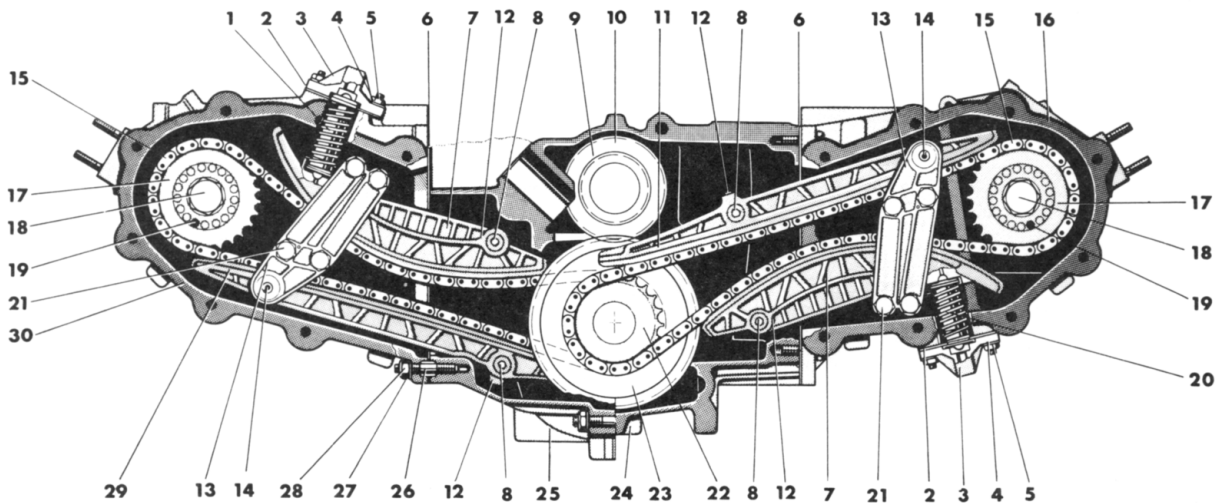
Adjusting the V-belts

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.

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.

Engine timing



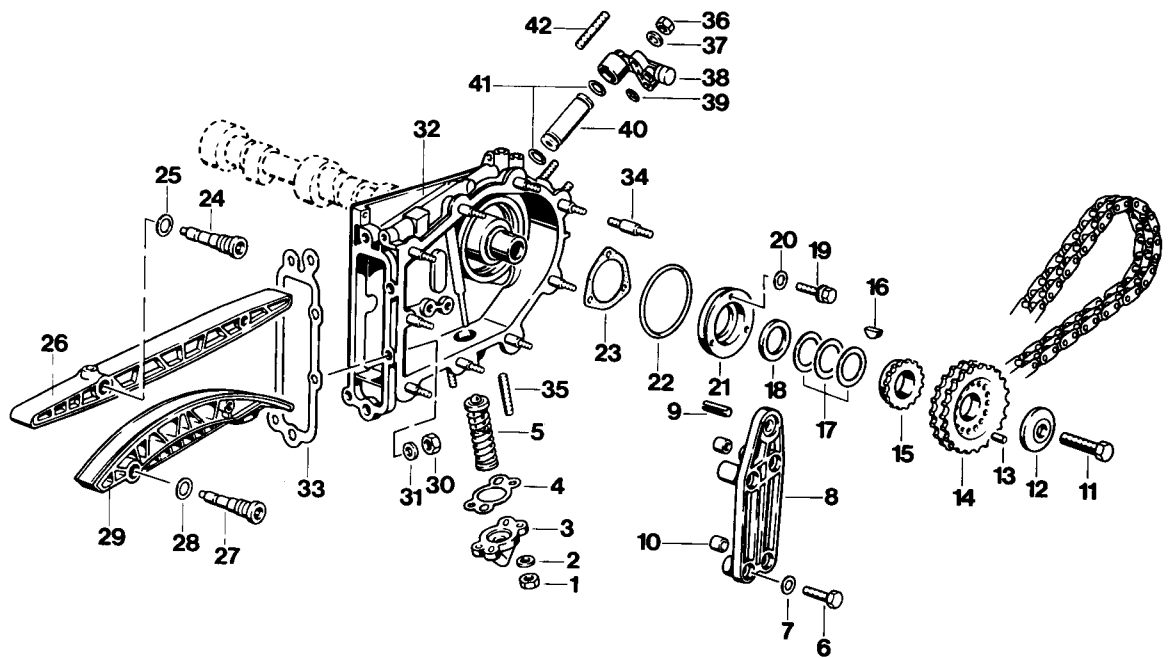
649

- | | |
|---|------------------------------------|
| 1 - Left-hand chain tensioner | 16 - Chain housing, right |
| 2 - Seal for chain tensioner | 17 - Sprocket $z = 28$ |
| 3 - Cover for chain tensioner | 18 - Hexagon head screw M 12 x 1.5 |
| 4 - Aluminium washer | 19 - Straight pin, 6 mm diameter |
| 5 - Lock nut M6 | 20 - Chain tensioner, right |
| 6 - Seal for chain housing | 21 - Hexagon head screw M6 |
| 7 - Tensioner blade | 22 - Sprocket $z = 24$ |
| 8 - Bearing pin | 23 - Idle shaft gear $z = 60$ |
| 9 - Distributor drive gear | 24 - Crankcase half, right |
| 10 - Timing gear on the crankshaft $z = 35$ | 25 - Crankcase half, left |
| 11 - Slide rail, right | 26 - Adapter sleeve |
| 12 - Sprung plunger | 27 - Aluminium washer |
| 13 - Bearing bridge | 28 - Lock nut M8 |
| 14 - Rollpin | 29 - Slide rail, left |
| 15 - Duplex roller chain | 30 - Chain housing, left |

Dismantling and assembling chain housing with camshaft drive

Cylinder bank 4 - 6

Before dismantling, set cylinder no. 1 of engine to firing TDC (corresponds to overlapping TDC of cylinder No. 4). Punch marks of both camshafts point up.



1115-15

No.	Designation	Qty.	Note:	
			Removal	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 feed bore points down; in addition, the spring retainers are marked with „top“ and „RH bottom“
6	Hexagon head bolt M 6 x 18	4		
7	Washer 6.4	4		
8	Support bracket	1	When levering off, avoid damaging the guiding edges of the guide rail	
9	Roll pin 10.5 x 43	1	Use mole wrench to pull out of chain housing	Check for 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		Apply a thin coat of Optimoly HT to threads, tighten to 120 Nm (88 ftlb), use wrench 9191 to lock
12	Washer	1		
13	Roll pin	1	Use puller P 212 to pull out	
14	Chain sprocket	1	Take off chain	Check teeth for wear, the deeper groove on the sprocket faces forward (towards flywheel)
15	Sprocket flange	1		
16	Woodruff key	1	Lift out using diagonal-cutting pliers	

No.	Designation	Qty.	Note:	
			Removal	Installation
17	Shim	X		Measure dimensions, determine parallelity of sprockets; usually two washers are required (cylinders 4 to 6)
18	Thrust washer	1		Install in correct position, groove points towards camshaft
19	Hexagon head bolt or screw with captive spring washer	3		
20	Washer A 6.4 (refer to No. 19)	3		
21	End cover	1		
22	O-ring	1		Replace, check seating area in chain housing and deburr edges if required, do not twist when fitting and keep greased along circumference
23	Gasket	1		Replace, apply a thin coat of Loctite 574 on both sides
24	Retaining pin	1		Tightening torque 31 Nm (23 ftlb)
25	Seal A 16 x 20	1		Replace
26	Guide rail	1		Guide rail must engage into groove of retaining pin with an audible click
27	Retaining pin	1		Tightening torque 31 Nm (23 ftlb)
28	Seal A 16 x 20	1		Replace
29	Tensioning rail	1		Tensioning rail must engage into groove of retaining pin with an audible click
30	Lock nut	5		

No.	Designation	Qty.	Note:	
			Removal	Installation
31	Washer 8.4 x 18 x 3	5		
32	Chain housing (RH side)	1		Check seating area of O-ring (no. 22) and deburr if required
33	Gasket	1		Always replace with new part
34	Collar pin	9		Tightening torque 7 Nm (5 ftlb), bonded in place with Loctite 270
35	Stud 6 x 18	2		Bonded in place 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 B M 6 x 20	1		Bonded in place with Loctite 270

Determining parallelity of chain sprockets

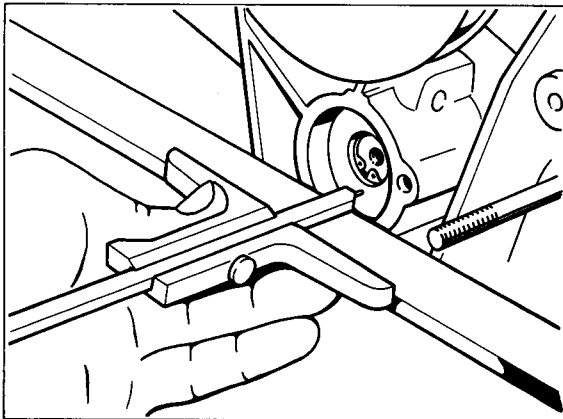
The parallelity offset between the driving sprocket on the intermediate shaft and the driven sprocket on the camshaft must not exceed $\pm 0,25$ mm max. Before measuring, move the intermediate shaft in axial direction towards the flywheel to make sure the support collar of the bearing is seated correctly.

To adjust the sprockets, insert or remove shims, Part No. 901.105.561.00 (shim thickness 0.5 mm) as required. As a rule, three shims are required below the left-hand sprocket (cyl. bank No. 1 to 3), and four shims are required below the right-hand sprocket (cyl. bank No. 4 to 6).

Adjustment

Tighten hexagon head bolts of sprockets to approx. 30 Nm (22 ftlb), using Special Tool P 9191 to lock.

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



1307 - 15

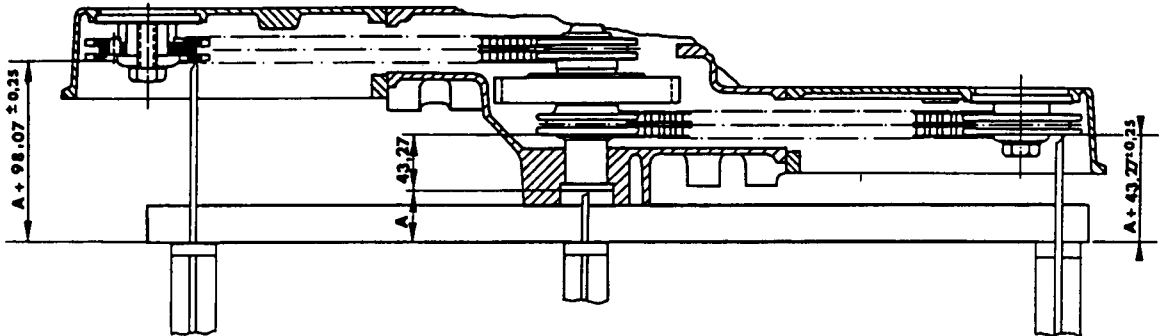
Design dimensions of sprockets on intermediate shaft

from intermediate shaft face area

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

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

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

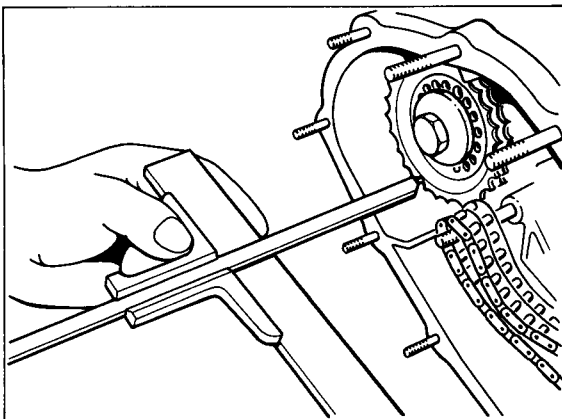


1304 - 15

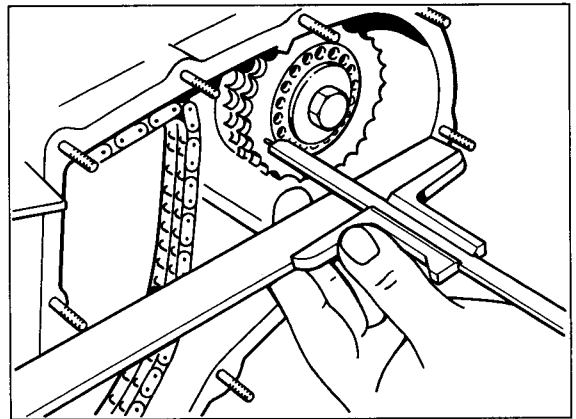
Example: Measured dimension "A" = 35.5 mm

The value for the sprocket of cyls. No. 1 to 3 then equals: $A + 98.07 =$

$$35 + 98.07 = 133.57 \pm 0.25 \text{ mm}$$



1305 - 15



1306 - 15

The value for the sprocket of cyls. No. 4 to 6 then equals

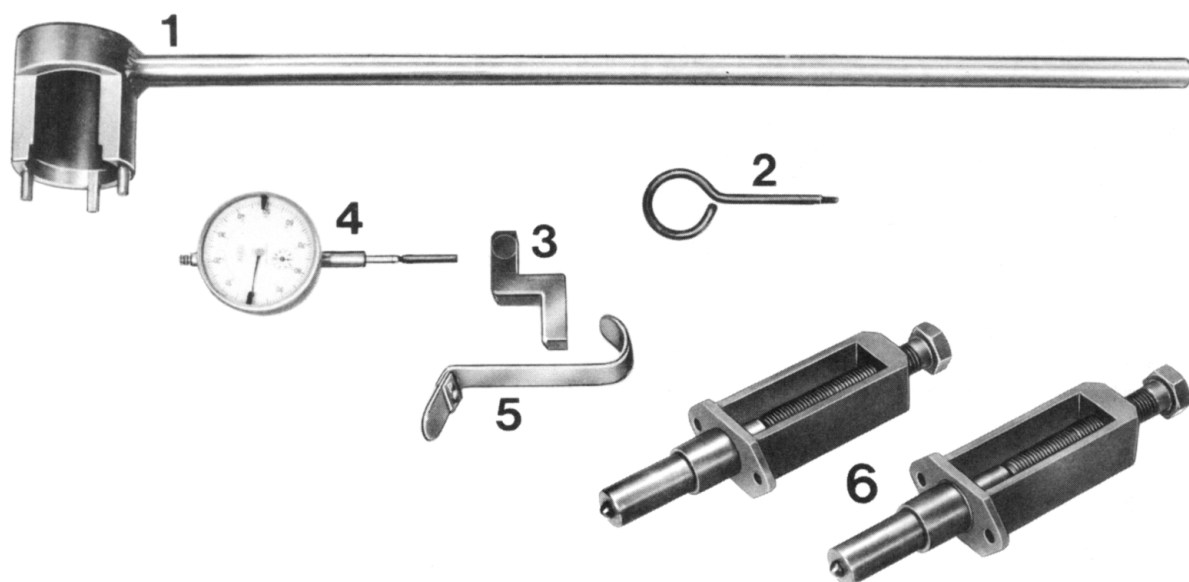
$$A + 43.27 =$$

$$35 + 43.27 = 78.77 \pm 0.25 \text{ mm}$$

Adjust timing gear after the required shims have been determined.

Adjusting the timing

Tools



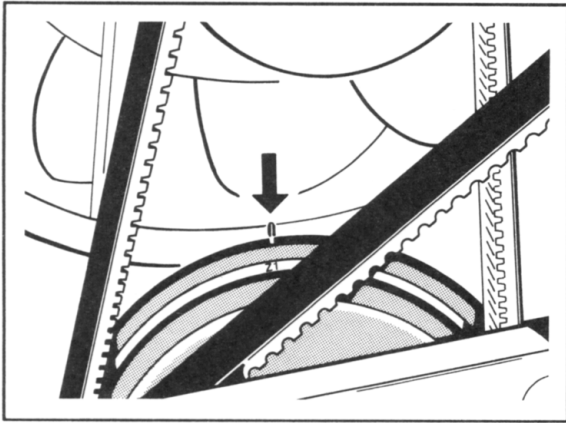
7694

No.	Description	Special Tool	Order number	Remarks
1	Support wrench for sprockets	9191	000.721.919.10	
2	Puller	P 212	000.721.212.00	
3	Dial gauge holder	P 207	000.721.207.00	
4	Dial gauge with feeler			Standard feeler approx. 40 mm long
5	Feeler gauge	P 213 b	000.721.213.20	
6	Auxiliary chain tensioner	9401	000.721.940.10	

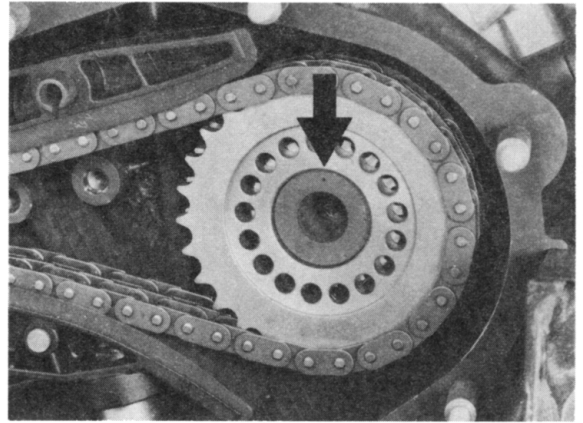
Adjusting the timing

Rough adjustment

1. Turn the crankshaft until the marking on the pulley is exactly aligned with the seam of the crankcase or with the locating mark on the blower housing.



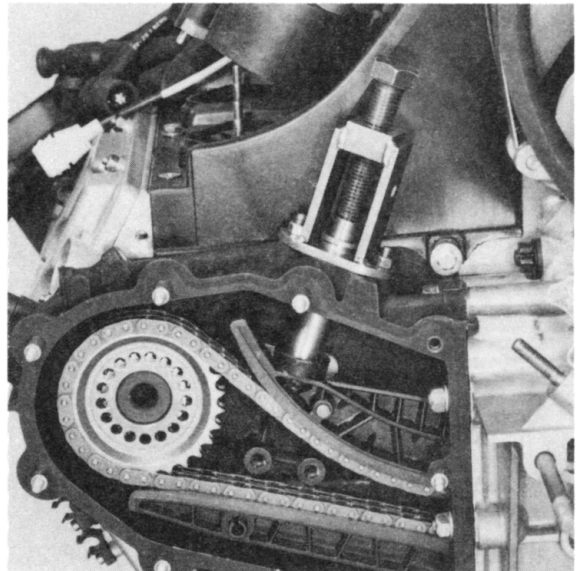
151-03



88-552

4. Mount the auxiliary chain tensioner, Special Tool 9401.

Illustration shows left-hand side of the auxiliary chain tensioner



88-551

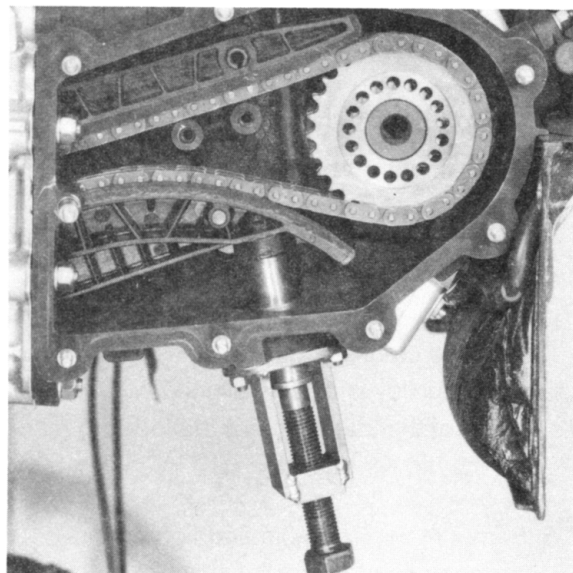
2. Position both camshafts with the punched marking pointing upwards.

Note

If this mark has not been punched, turn the camshaft until the feather-key groove points upwards.

3. Once the Z 1 marking on the pulley has been aligned with the seam and the punched marks or feather-key grooves on the camshafts are pointing upwards, the engine is in the basic ignition TDC for cylinder 1 and overlapping TDC cylinder 4.

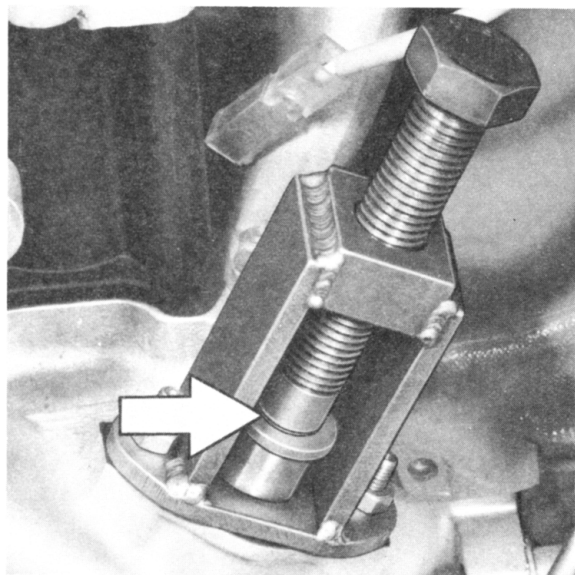
Illustration shows the right-hand side of the auxiliary chain tensioner



88-550

Note

When adjusting or checking the timing, the auxiliary mechanical chain tensioner must be installed with the specified preload. The recess on the plunger may just be visible.



87-378

5. In the basic position (Item 3), one hole on the sprocket is exactly aligned with a hole on the sprocket flange. Insert the fixing pin through these exactly aligned holes.

6. Apply the hexagon head screws for the sprockets lightly. Brace with Special Tool P 9191.

Note

Apply a fine film of Optimoly HT to the thread of the hexagon head screws.

Note

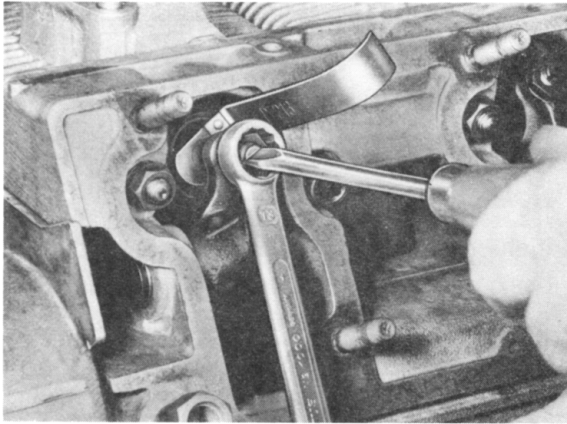
If one of the camshafts has moved out of the basic position, proceed as follows:

Remove the fixing pin from the camshaft which is in the basic position, to prevent it being turned during the following adjustment. Move the displaced camshaft into the basic position with Special Tool P 9191 (with the punched mark pointing upwards).

Remove the sprocket fastening screw and fixing pin and turn the crankshaft until it again reaches the Z 1 mark.

Fine adjustment

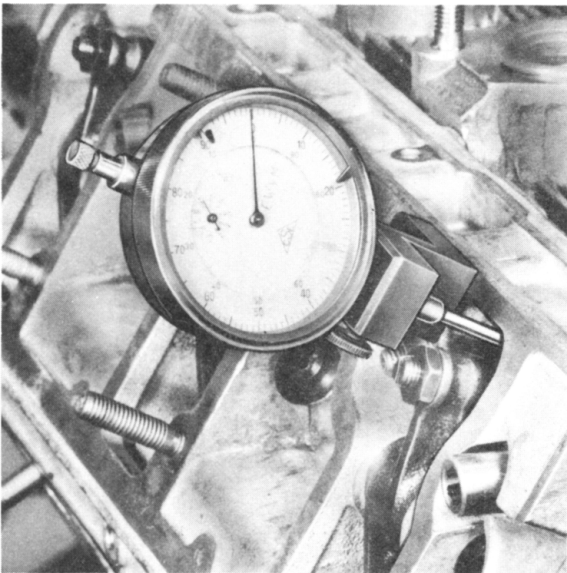
1. Check the valve clearance and set to 0.10 mm exactly with feeler gauge B 213 b. To adjust the timing, it is sufficient if the valve clearance of the intake valves for cylinders 1 and 4 are exactly correct.



88 - 7720

Adjusting the camshaft, left (cylinder 1)

2. Fasten the dial gauge to the stud bolt on the camshaft housing with holder P 207. Set the dial gauge to 0 on the spring seat from intake valve with the valve closed and with approx. 10 mm preload.



7723

3. Now turn the crankshaft slowly from Z 1 (TDC) approx. 1 turn clockwise, observing the dial gauge. Turn until you reach the middle value of the adjusting tolerances.

Adjusting specification

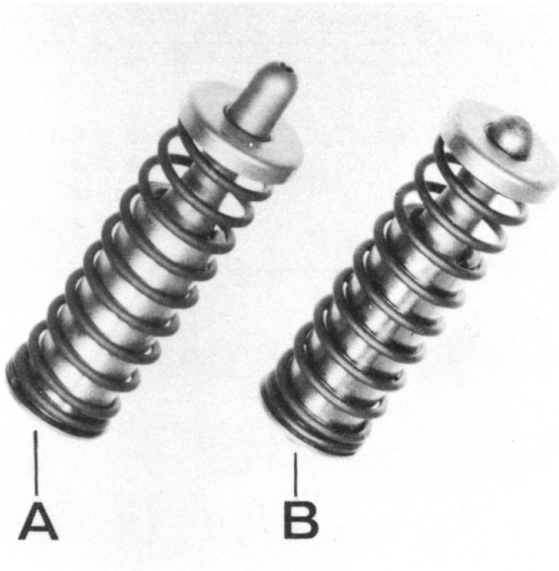
Engine M 64/01: 1.26 ± 0.1 mm

4. Undo the hexagon head screw from the left-hand sprocket, remove the sprocket and pull the fixing pin out with Special Tool P 212.
5. Turn the crankshaft until the visible marking on the pulley is exactly aligned with the seam of the crankcase or the locating mark on the blower housing.
6. Remount the fixing pin and tighten the hexagon head screw lightly while bracing.
7. Turn the crankshaft two turns (720°) clockwise and check the adjustment. The value shown on the dial gauge must now be within the specified adjusting tolerance.
8. Finally tighten the hexagon head screw for the left-hand camshaft with 120 Nm (88 ftlb) with a second mechanic bracing with Special Tool P 9191.

Adjusting the camshaft, right (cylinder 4)

1. Adjust cylinder 4 to ignition TDC (overlapping cylinder 1).
2. Repeat the adjustment procedure as described under fine adjustment Items 2 to 8 for cylinder 4.

- Once the adjustment has been completed, remove the auxiliary chain tensioner and install the original chain tensioner. Observe the installation position.



88-167

A - Left-hand chain tensioner. Oil feed hole points upwards.

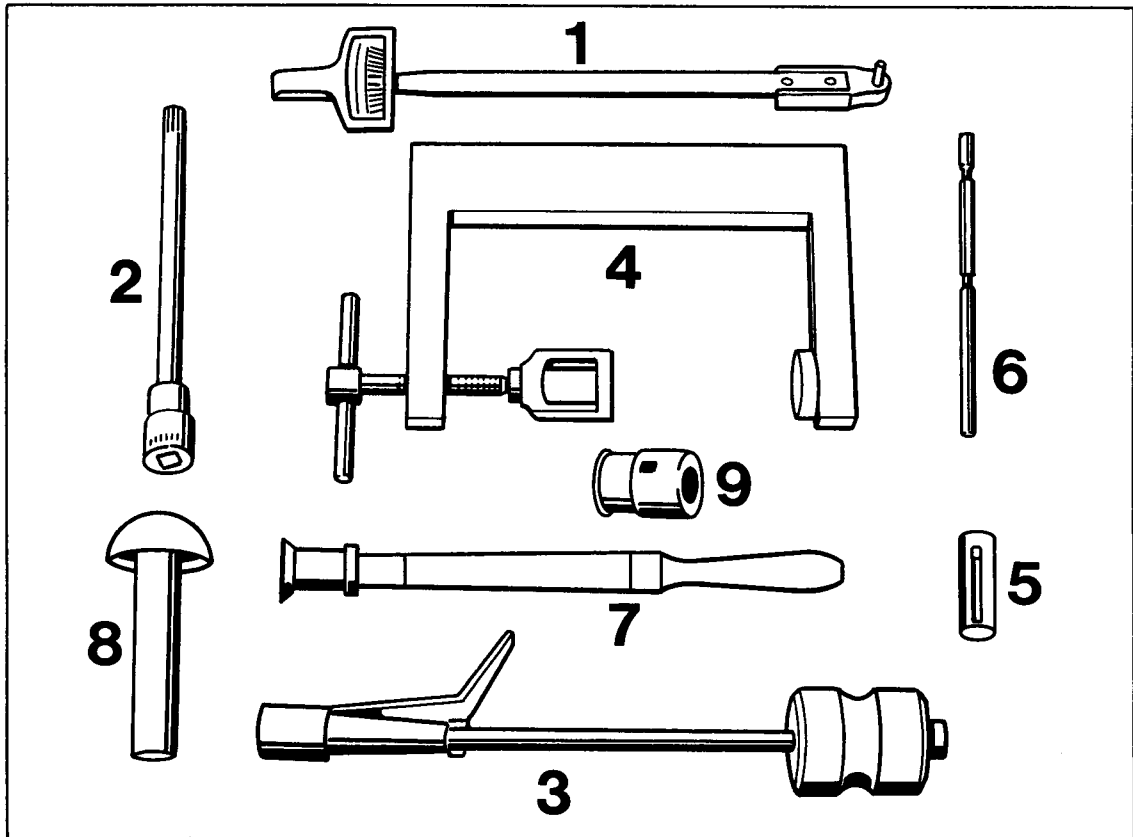
B - Right-hand chain tensioner. Oil feed hole points downwards.

Note

The chain tensioner spring seats are also marked with "top" and "bottom left" or "bottom right".

Camshafts, timing

Type	Camshaft Left SP No.	Camshaft Right SP No.	Identification code on the face end of the camshaft		Inlet valve stroke at overlapping TDC with 0.1 mm valve clearance	Timing with 1 mm valve clearance
			Left	Right		
M 64/01 M 64/02	964 105 247 07	964 105 246 09	964 247 07	964 246 09	1,26 ± 0,1	I. open 4' bef TDC I. close 56' aft. BDC Ex. open 44' bef BDC Ex. close 4' aft. TDC

Disassembling and Assembling Camshaft Housing, Cylinder Head**Tools**

317/15

No.	Description	Special Tool	Order Number	Remarks
1	Torque wrench with socket and bits			Standard, Stahlwille 73 Nm V/3 and 49-5
2	Screwdriver socket for multi-tooth nuts	9295	000.721.929.50	
3	Pull for valve stem seals	3047	Matra 3047	
4	Valve spring installing tool	P200a	000.721.200.10	
5	Wrench socket for temperature sensor II in calinderhead (cyl. 3)	9222/1	000.721.922.21	
6	Go/no-go mandrel for valve guides	P206	000.721.206.00	
7	Valve grinder			Standard, e.g. Hazet 79
8	Pressure pad for pressing in valve stem seals	10 - 204	10 - 204	
9	Valve spring adjusting tool	P10c	000.721.010.30	

Dismantling and assembling camshaft housing

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Molded seal (inlet side)	6		Check, replace if required
2	Molded seal (outlet side)	2		Replace
3	Cylinder bolt M 7 x 48	12		Tightening torque 20 Nm (15 ftlb), use second wrench to lock
4	Bushing with hex socket head	12		
5	Bushing	12		
6	Rocker arm shaft	12		
7	Hexagon head nut M 8 x 1	12		
8	Adjusting screw	12		
9	Rocker arm	12		Check for wear and score marks
10	Camshaft	2		Check for wear and score marks
11	Flange	2		
12	O ring 6.7 x 3.53	4		Replace
13	Plug	4		When fitting, coat with Optimoly HT
14	Lock pin to locate the oil spray tube	2		When fitting, coat with Loctite 270, drive in level or to a depth of 0.5 mm below the sealing surface, respectively
15	Spray tube	2		Check oil spray bores, flush thoroughly
16	Plug 4.63	2		When fitting, coat with Loctite 270
17	Plug	2		When fitting, coat with Optimoly HT
18	Cover for camshaft bearings	2		When fitting, coat with Loctite 270, press in level
19	Camshaft housing	2		Check bearing surfaces for wear and score marks

Assembly instructions

Removing and installing spray tube at the camshaft housing

Note

In case of bearing damage and when rebuilding the engine, always remove and clean the spray tubes thoroughly.

Removal

1. Drill lateral plugs to a depth of approx. 9 mm using a 4.8 to 5 mm dia. drill and cut in an M 6 thread using a bottoming tap. Pull out plug with an M 6 bolt and a spacer sleeve.

The lock pins used to hold the spray tube in place are factory-fitted in forward direction (pointing towards the flywheel). Refer to explosion drawing, part no. 14.

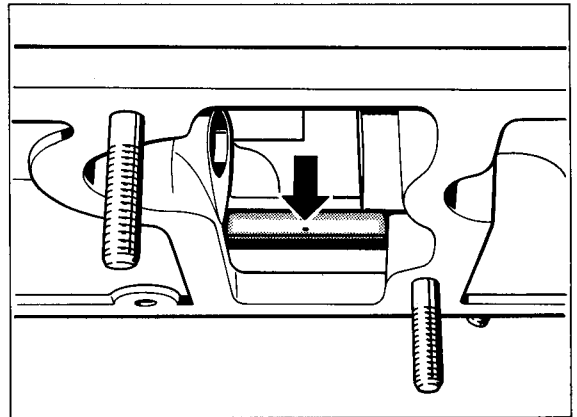
2. Punch centering pin and drill with a 2.5 mm dia. drill, tap an M 3 thread and use an M 3 bolt and spacing sleeve to pull out pin.

Installation

1. Install spray tube in correct position, making sure the locating bore for the lock pin is oriented correctly, e.g. use a piercing awl to check. Coat centering pin lightly with Loctite 270 and press in.

Note

Individual bores must point up towards the inlet valve covers. Twin bores (not visible on figure) point towards the cam sliding surface.



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2. Coat new lateral plugs with Optimoly HT and press in plugs.

Note

Align bevelled edge of the plugs so that it points towards the bore. If the plugs cannot be press-fitted in the housing, upset them before fitting them.

3. Press in the plugs until they are approx. 0.3 mm below the sealing surface.

Refacing the cylinder head

The cylinder head may be refaced twice (0.1 ± 0.02 mm each). Refaced cylinder heads must be identified by a "- 10" or "- 200" mark on the flange of the inlet port (I).

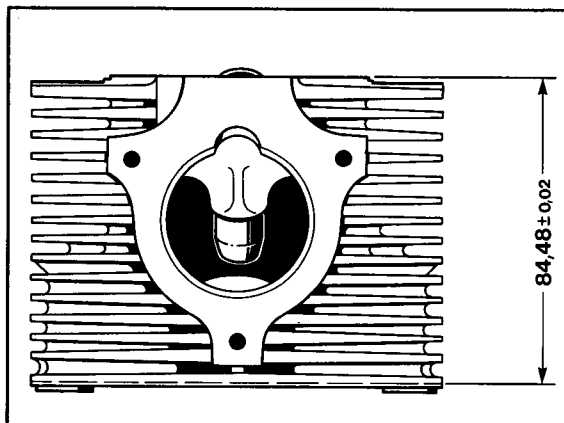
To achieve a uniform component height, all cylinders on one side must **always** be refaced to the same dimension, i.e. refacing of one single cylinder only is not permitted.

Repair notes:

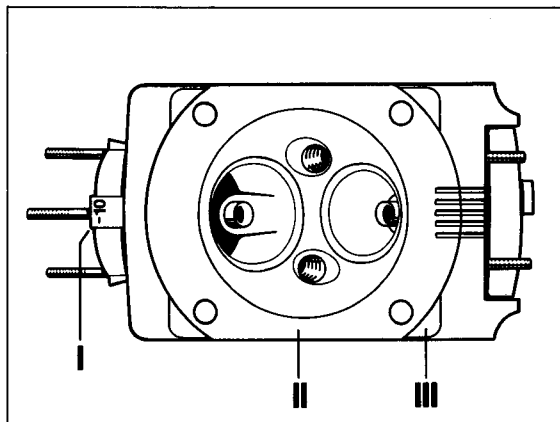
The sealing face cannot be refaced with the usual shop equipment. Shops with the required equipment (vertical or universal milling machines or lathes) should observe the following procedures:

1. Clean cylinder head, sandblast if req.
2. Chuck cylinder head flush to milling machine. Machine $0,10 \pm 0,02$ mm off both the inner (II) and outer surfaces (III). The cylinder heads may be refaced twice by 0.10 mm each.
3. Bevel edges of machined surfaces slightly and mark cylinder head with "-10" or "-20" , respectively.

New dimension 84.48 ± 0.02 mm



1125-15

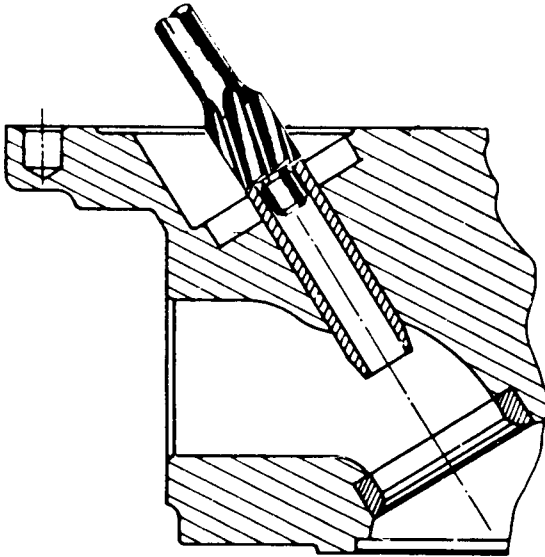


729-13

Replacing valve guides

Removal

Use a spot facer to cut protruding valve guides from the camshaft side until the valve guides are flush with the cylinder head. Apply a short hammer blow to the valve guides and press out remains of valve guides towards combustion chamber using a suitable press.



2. Machine outer diameter of valve guides on a lathe to match diameter of bore in cylinder head. Experience has shown that usual value for machining is:
13.08 to 13.09.
Press fit for inlet and exhaust valve guides must be **0.06 to 0.08 mm**.

3. Apply a coat of tallow to machined valve guides and press into cylinder head from camshaft side, using a shop-made mandrel.

4. Using a broach or a fine boring tool, bore to dimension "g" = 9.00 to 9.015 mm. If required, the valve guides may also be reworked with a suitable reamer.
Important: To press the valve guides into place and to rework them, position and/or chuck the cylinder head at the correct angle. After having replaced the valve guides, check seating surface of valve seats and rework valve seats if required.

Installation

Removal of the valve guides causes the valve guide bores in the cylinder head to be enlarged slightly.

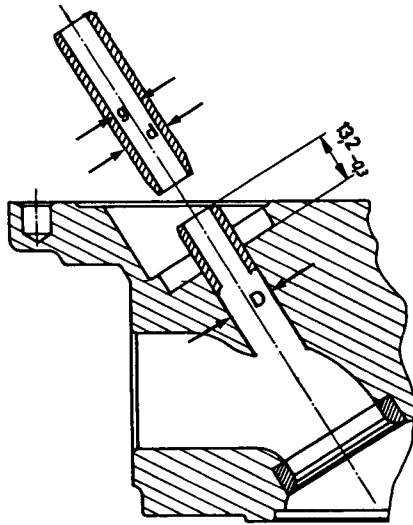
When fitting new valve guides, use suitable oversize guides and fit them in place accordingly (refer to dimensional chart).

1. Measure bores for fitting of valve guides.

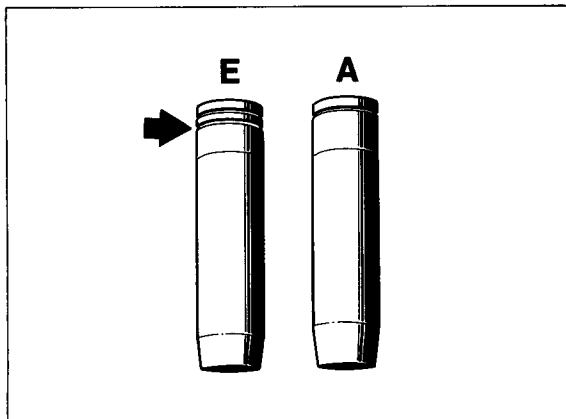
Dimensional chart for fitting of valve guides

Valve guide	Valve guide outside dia. d *	Cylinder head bore dia. D
Standard (production)	13.060	13.000 - 13.018
1st oversize	13.260	13.000 - 13.200

* Machine valve guide dia. d according to relevant bore dia. D - observe correct press fit.



Identifiers

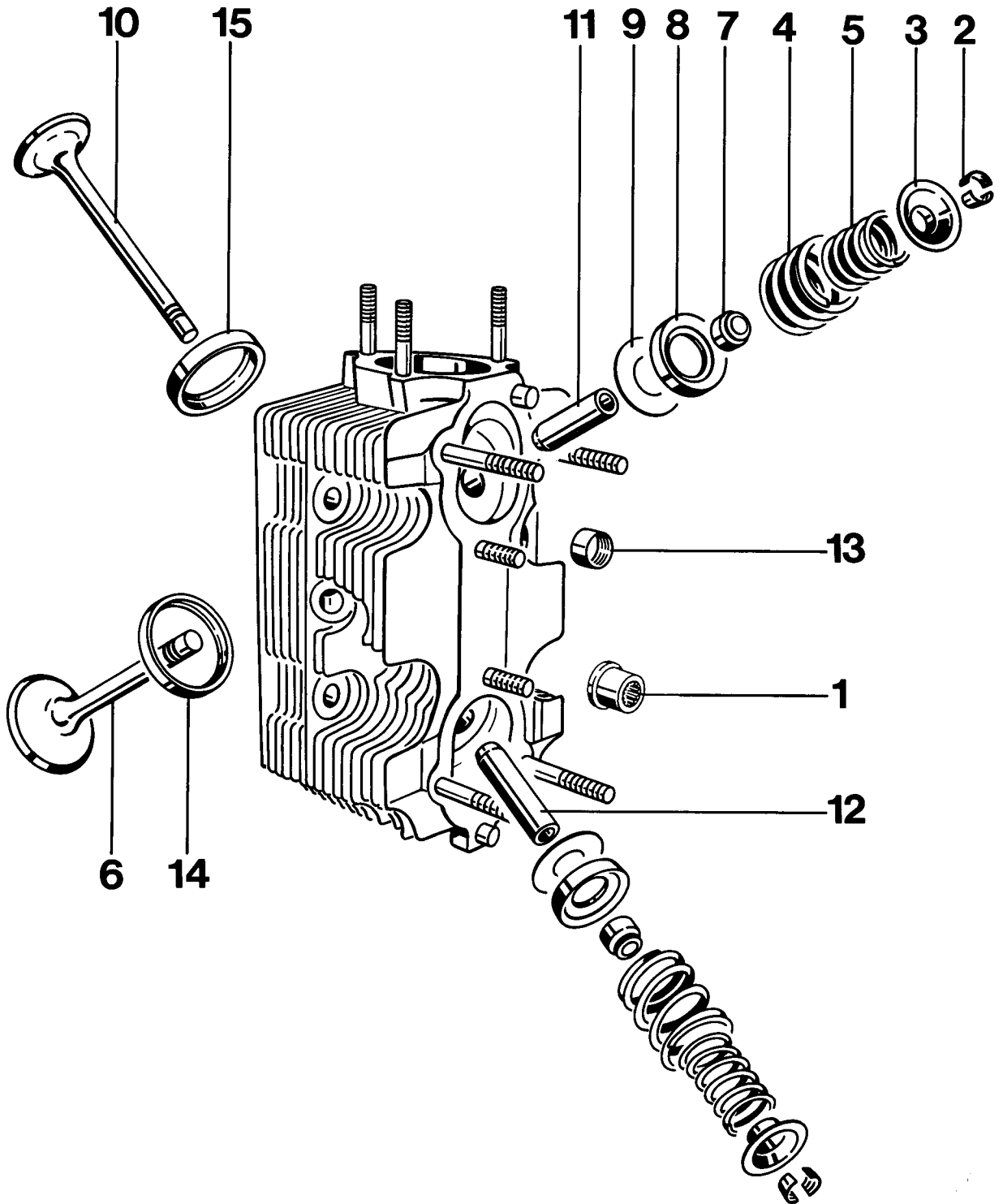


The inlet valve guide is identified by an additional groove (cf. arrow).

1005-30

Disassembling and Assembling Cylinder Head

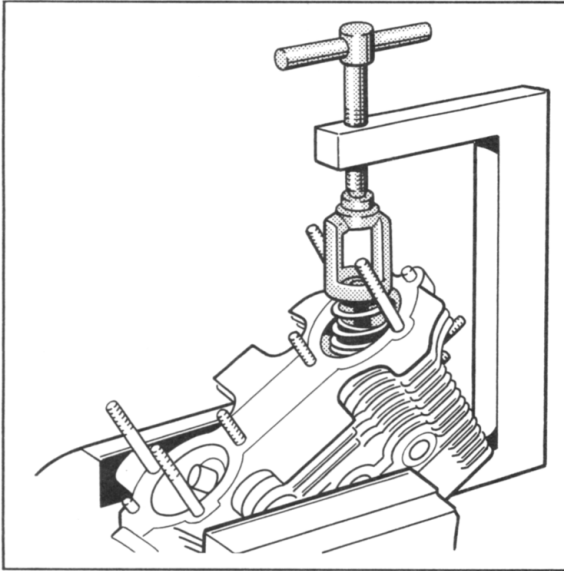
Disassembling and Assembling Cylinder Head



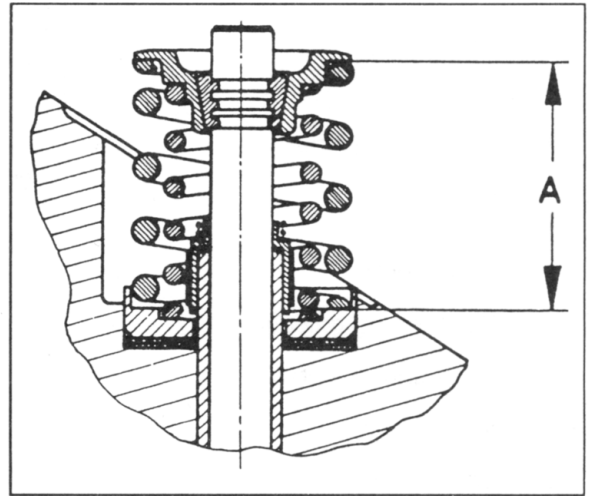
No.	Description	Qty.	Note When:	
			Removing	Installing
1	Cylinder head nut	24	Use screwdriver socket 9295 for multi-tooth nuts	Apply thin coat of Opti-moly HT on cylinder head nut bearing surface
2	Valve collet	24		
3	Valve spring retainer	12		
4	Valve spring, outer	12		
5	Valve spring, inner	12		
6	Intake valve	12		
7	Valve stem seal	12		Replace, use plastic assembly sleeve
8	Valve spring ring	12		
9	Washer	X		Determine thickness with Special Tool P10c
10	Exhaust valve	12		
11	Valve guide, intake	6		
12	Valve guide, exhaust	6		
13	Helicoil	6		
14	Valve seat insert, intake	6		
15	Valve seat insert, exhaust	6		

Removing and Installing Valve Springs

Installing Information



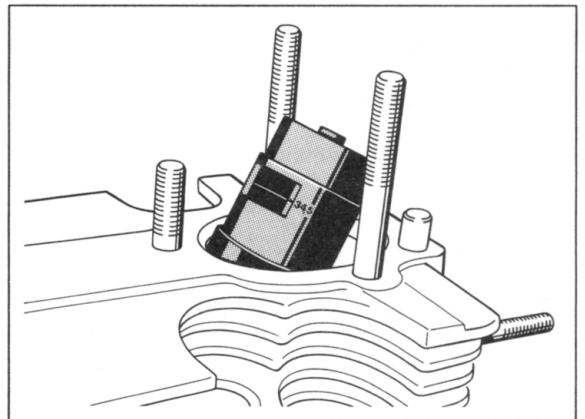
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Note

Check for perfect seating of spring retainer in the special tool, machining the special tool if necessary.



319/15

Remove and install valve springs with P200a.

Checking Installed Length of Valve Springs

1. Install Special Tool P10c with shims, spring ring, spring retainer and both collets belonging to a pertinent valve.
2. Read distance "A" on Special Tool P10c and, if necessary, correct by adding or removing shims.

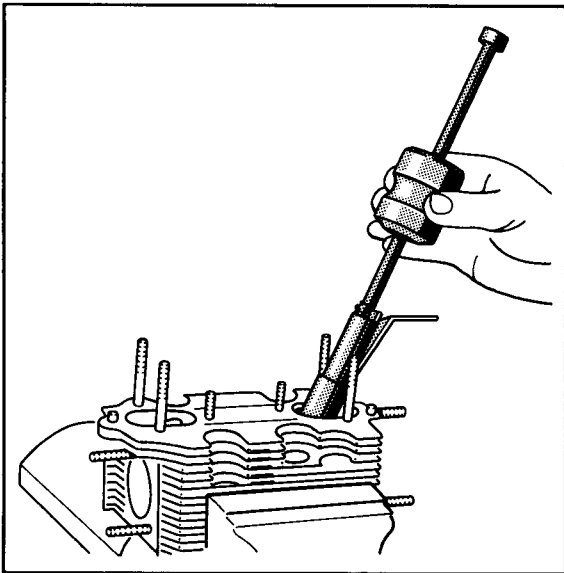
Installed Distance

Intake valve	$34.5 \pm 0.3 \text{ mm}$
Exhaust valve	$33.5 \pm 0.3 \text{ mm}$

Installing Valve Springs

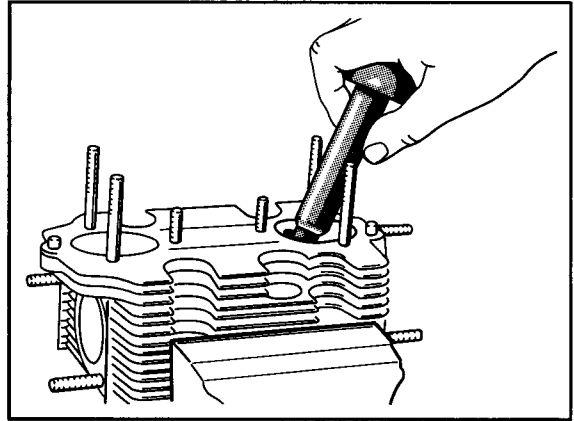
The coils of outer valve springs are wound progressively; the tighter wound coils must bear on the cylinder head. There is no special installed position for inner valve springs.

Removing and Installing Valve Stem Seals



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Lubricate sealing lip of valve stem seal lightly with oil and push on to valve guide carefully and with feeling, using pressure pad of Special Tool 10-204.



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Pull off valve stem seals with Special Tool 3047.

Installing

Slide a plastic installing sleeve on the valve stem to avoid damaging new valve stem seals.
Part number of plastic installing sleeve
00 043 084 00.

Mounting Cylinder Head / Torque Angle Tightening Method**Tools**

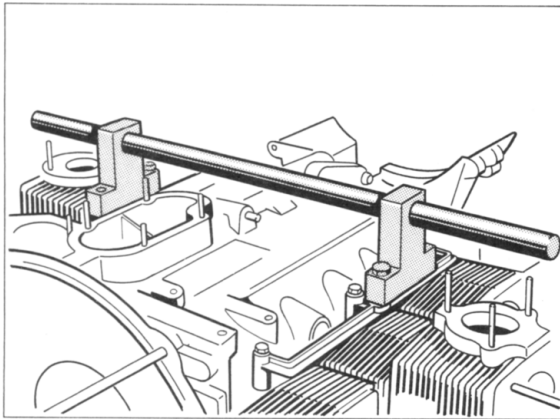
No.	Description	Special Tool	Order Number	Remarks
	Degree-scope			Standard, e.g. Stahlwille No. 715/20

Disassembling cylinder heads

Note

If only the cylinder heads are removed during partial assembly of the engine, the cylinder banks must be fixed first under all circumstances to avoid damage of the O-rings at the cylinder base. For this purpose, the assembly bracket for valve spring assembly from Messrs. Sauer-Werkzeug, Hamburg, can be used.

Single parts: Assembly bracket No. 602 451
Supports (2 ea.) No. 602 562



434-15

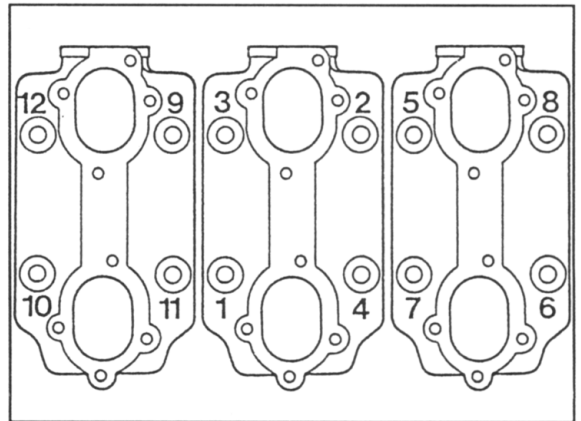
Note

Before tightening the cylinder heads, the hexagon screws of the knock sensor brackets must be only applied and not tightened.

Tighten in two stages:

1st stage: 15 Nm in accordance with specified tightening sequence

2nd stage: $1 \times 90^\circ \pm 2^\circ$ in same order



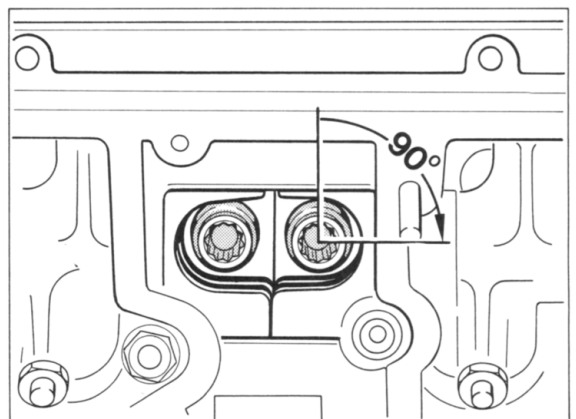
327-13

Assembling the cylinder heads

Tighten the cylinder heads by means of the torquing angle-controlled tightening method.

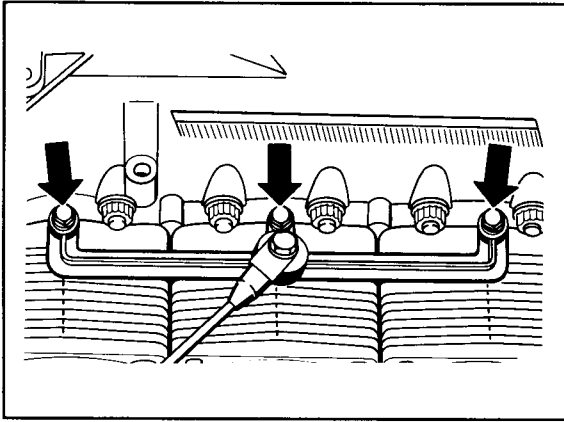
Assembly instructions

1. Provide the thread of the stud bolts in the crankcase with a thin coating of Optimoly HT.
2. Assemble the cylinder heads.
3. Coat the contact surfaces of the cylinder head nuts thinly with Optimoly HT and tighten as follows;



435-15

4. Finally tighten knock sensor brackets with 9.7 Nm



436-15

Removing and installing the knock sensor

Installing

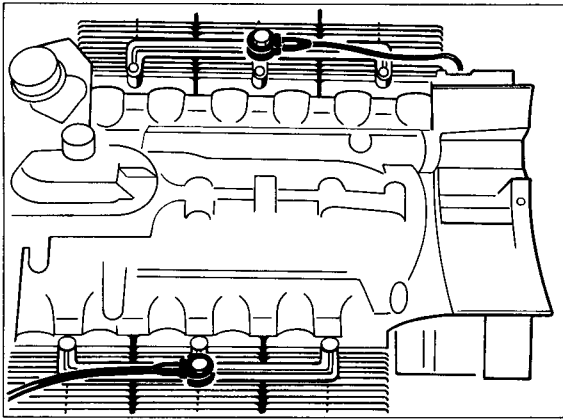
Always renew the micro-encapsulated hexagon screws (M 6 x 30).

Spare part No. 999 217 082 02.

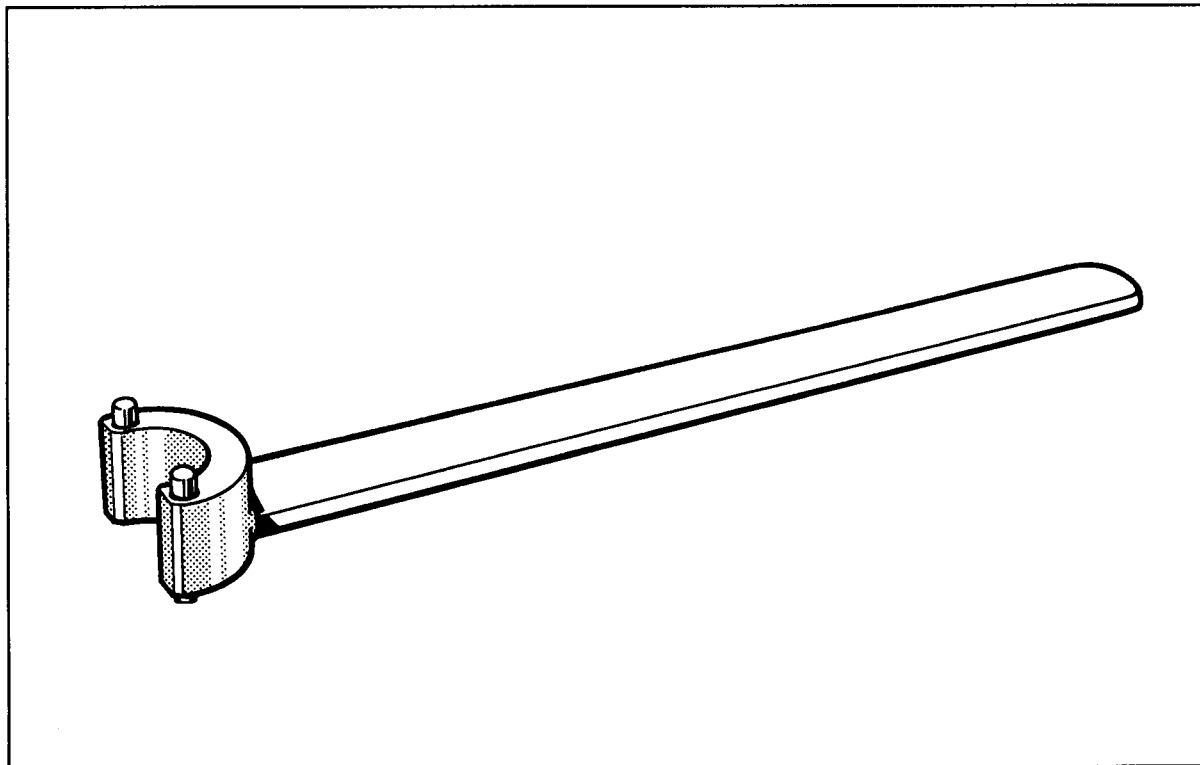
Deburr and degrease the contact surface.

The hexagon screws are fitted **without** washers.

Tightening torque 20 ± 5 Nm.



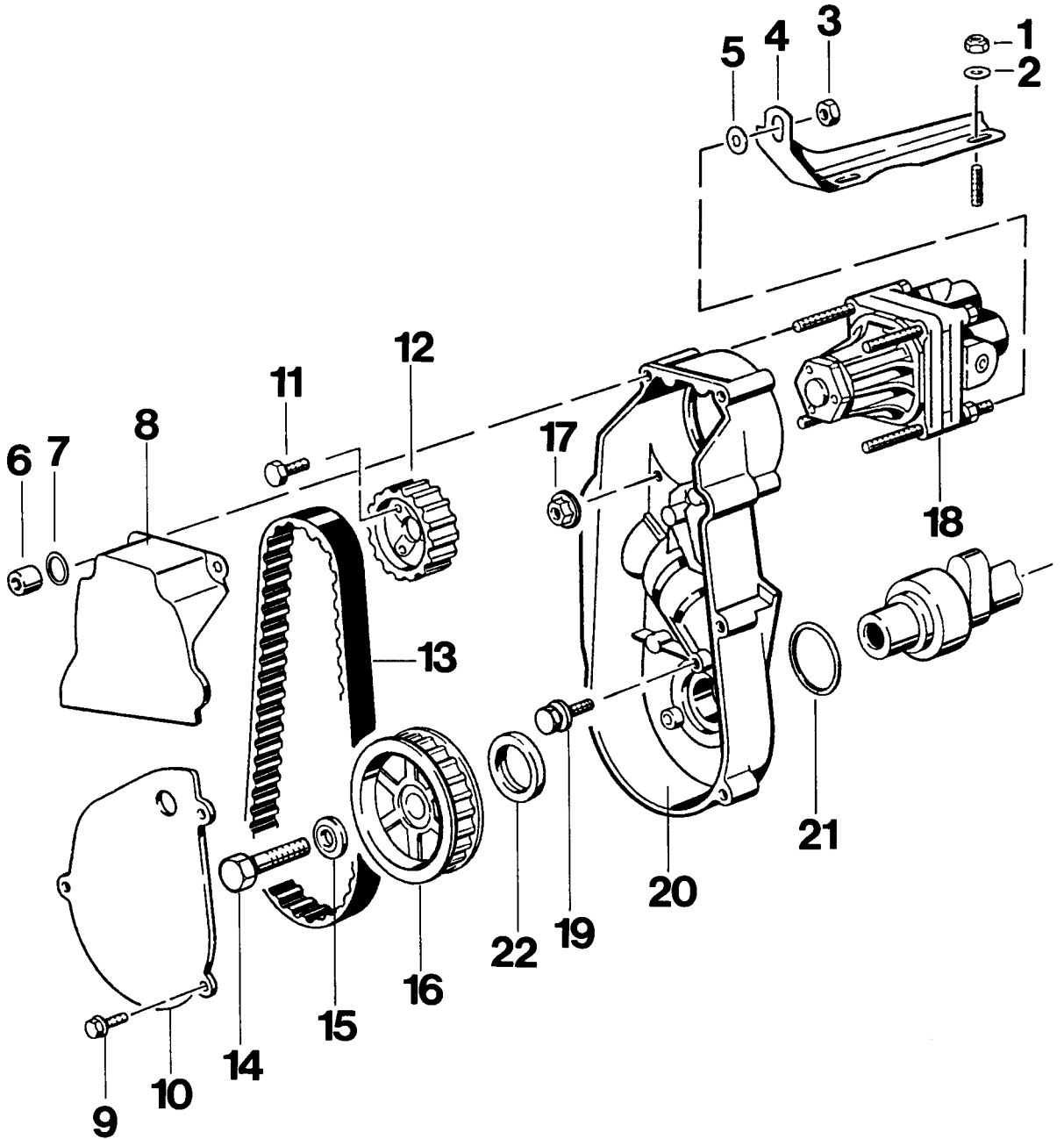
437-15

Dismantling and assembling hydraulic pump drive (power steering)**Tools**

730-15

No.	Designation	Special tool	Order number	Explanation
1	Mounting fixture	9236	000.721.923.60	

Dismantling and assembling hydraulic pump drive (power steering)

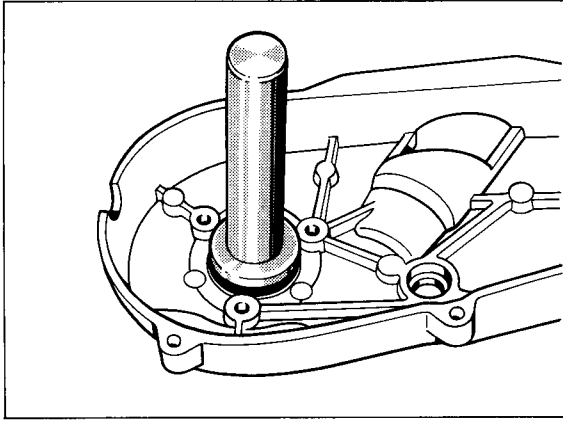


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Lock nut			
2	Washer B 6.4			
3	Hexagon head nut M 8			
4	Mounting bracket	1		
5	Washer B 8.4	1		
6	Hex socket nut	2		
7	Spring washer B 8	2		
8	Cover	1		
9	Hexagon head bolt	3		
10	Cover	1		
11	Hexagon head bolt M 6 x 12	3		
12	Sprocket	1		Install in correct position, fit with toothed belt mounted in place
13	Toothed belt	1	Install in correct position	Inspect, check visually for damage
14	Hexagon head bolt M 12 x 1.5 x 50	1		Coat threads with Optimoly HT. Tightening torque 120 Nm (88 ftlb). Use Special Tool 9236 to lock.
15	Washer	1		flat side faces sprocket
16	Sprocket	1		
17	Collar nut	2		
18	Hydraulic pump	1		
19	Hexagon head bolt M 6 x 28 (self-locking)	3		Replace and/or use Loctite 270 to insert

No.	Designation	Qty.	Note:	
			Removal	Installation
20	Support console	1		
21	O ring 40 x 4	1		Replace, oil lightly
22	Sealing ring A 30 x 42 x 7	1		

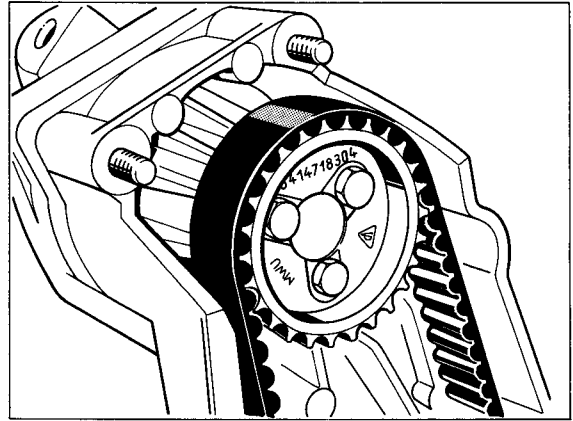
Reassembly notes

Use Special Tool 9119 to press in sealing ring to stop.



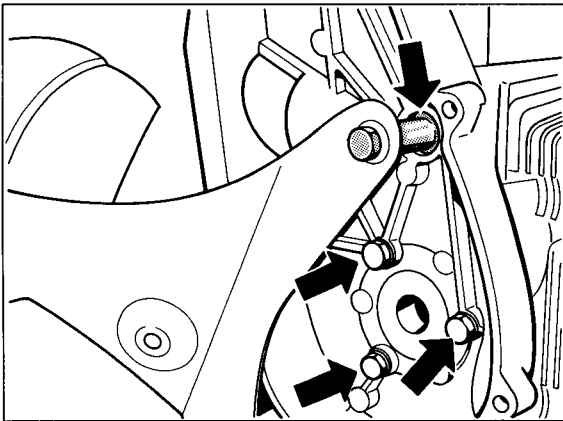
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Fit upper sprocket with the toothed belt fitted in place. Lettering must point to the front.



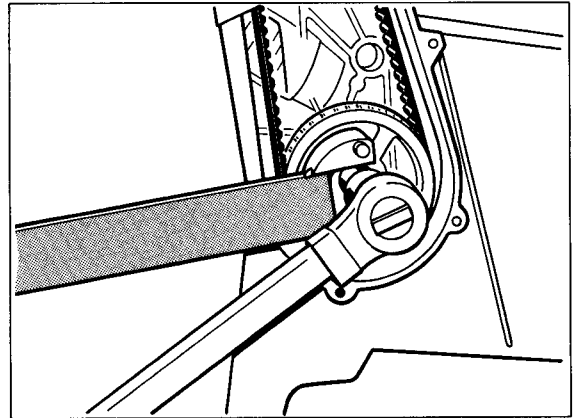
724/15

Following elimination of the retaining pin at the camshaft housing, the support console may be centered using the muffler retaining strut. Then tighten hexagon head bolts.



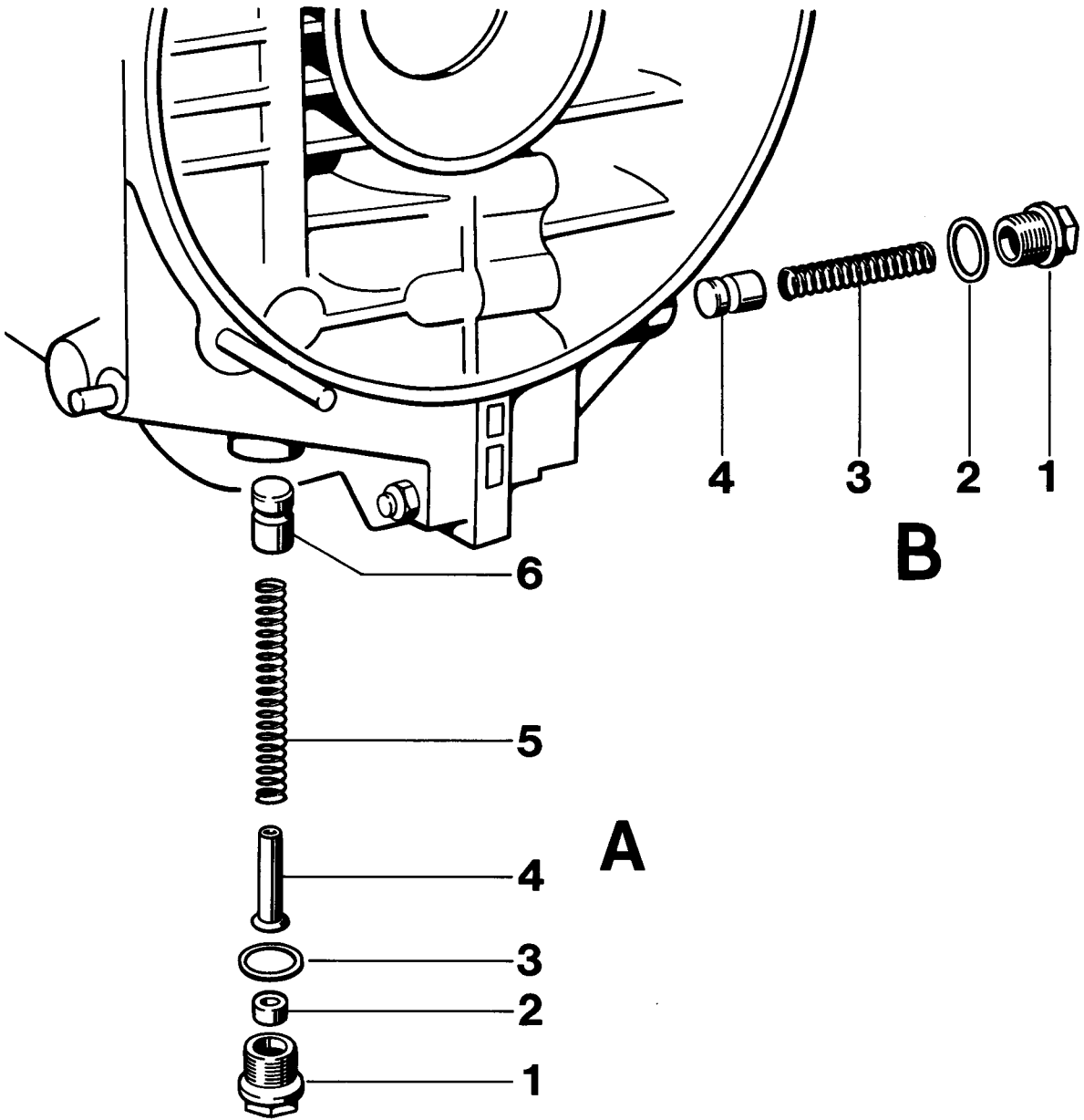
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Tighten lower sprocket with 120 Nm (88 ftlb). When tightening, lock with Special Tool 9236.



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Assignment - Relief valve - Safety valve



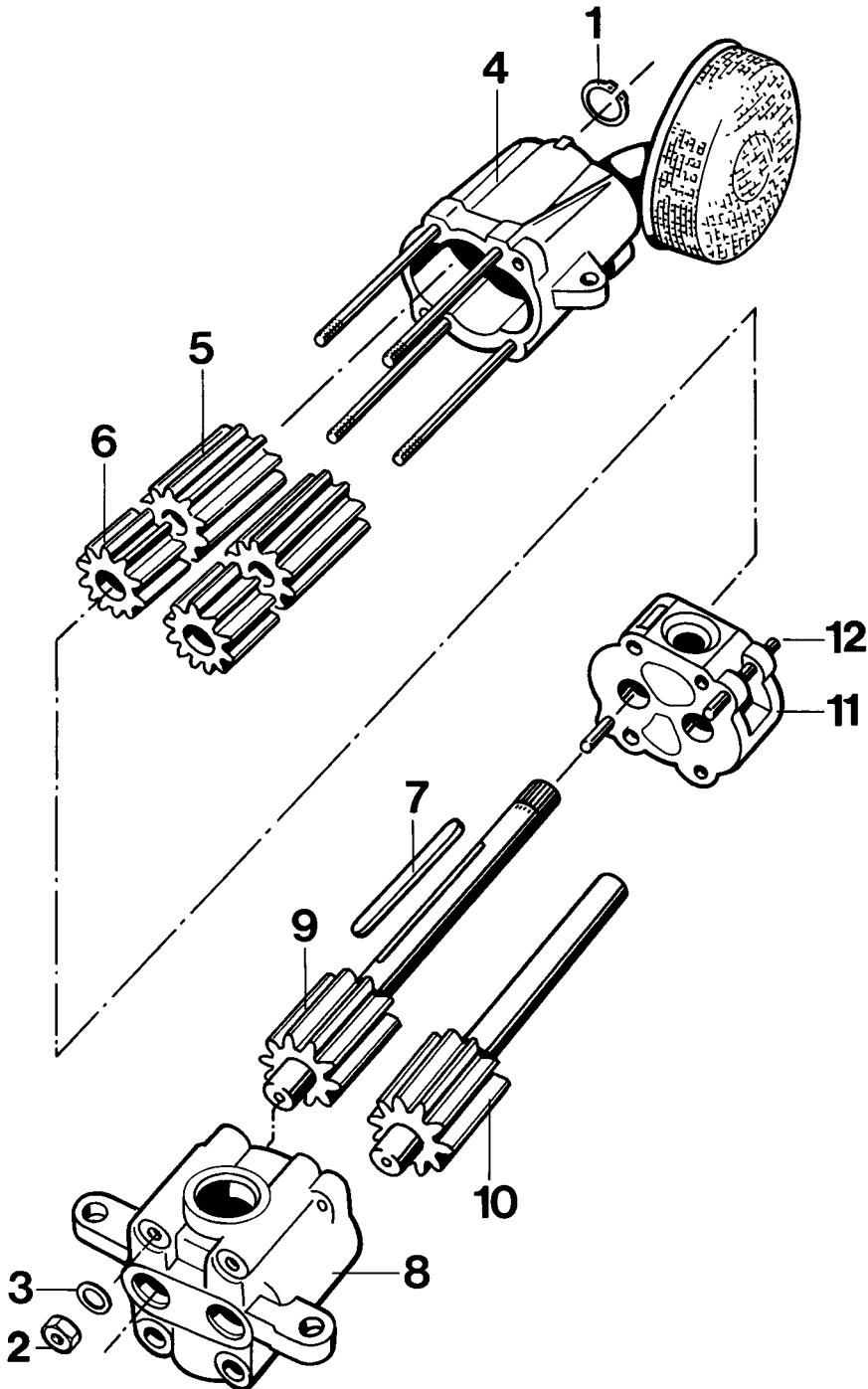
432-17

No.	Designation	Qty.	Note:	
			Removal	Installation
	Relief valve A (Crankcase half, right)			
1	Screw plug M 18 x 1.5	1		Tightening torque 60 Nm
2	Spacer ring	1		
3	Sealing ring A 18 x 24	1		Renew
4	Guide bush	1		
5	Pressure spring 89 mm	1		
6	Piston	1		Examine piston and bore in case for score grooves, carefully remove score grooves or replace piston if necessary.
	Safety valve B (crankcase half, left)			
1	Screw plug M 18x1,5	1		Tightening torque 60 Nm
2	Sealing ring A 18x24	1		Renew
3	Pressure spring 70 mm long	1		
4	Piston	1		Examine piston and bore in case for score grooves, carefully remove score grooves or replace piston if necessary

Dismantling and assembling the oil pump

Note

If possible, dismantle and assemble the oil pump only in case of bearing damage

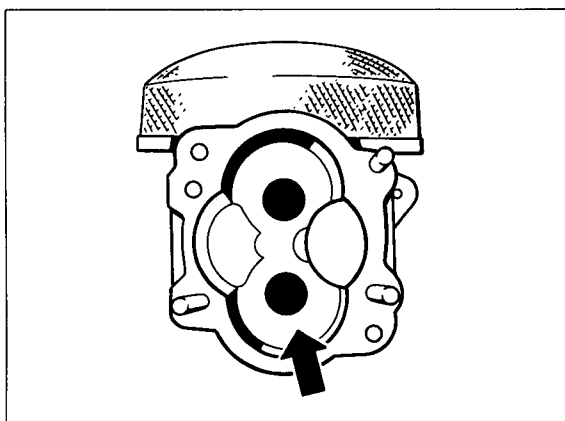


464-17

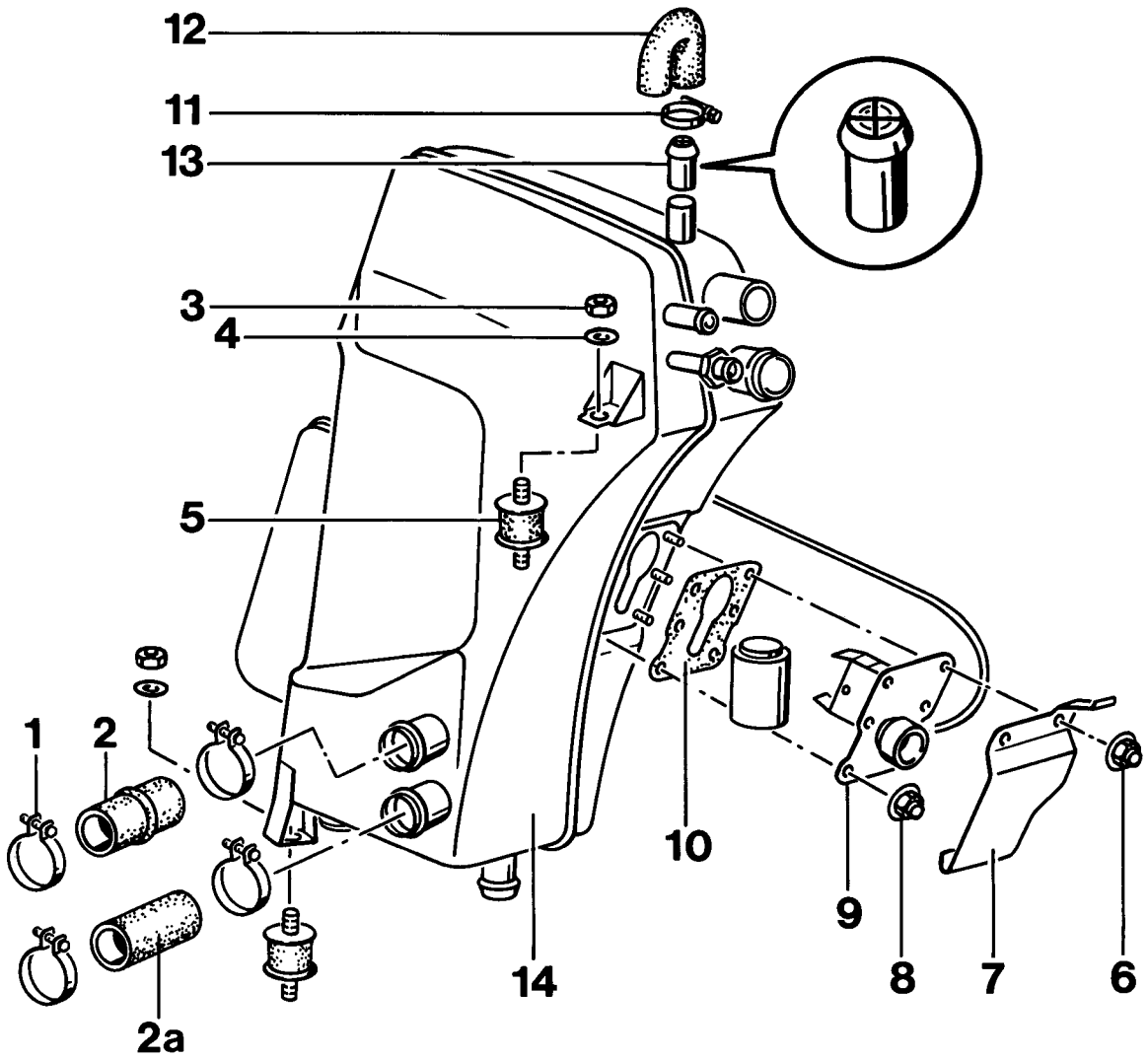
No.	Designation	Qty.	Note:	
			Removal	Installation
1	Snap ring 13x1	1		Check for correct seating
2	Hexagon nut	4		Use Loctite 270, tighten to 8 Nm (6 ftlb)
3	Washer	4		
4	Housing	1	Separate with plastic mallet	
5	Oil pump gears, long	2		Oil lightly
6	Oil pump gears, short	2		Oil lightly
7	Woodruff key	1		
8	Housing	1	Separate with plastic mallet	
9	Oil pump shaft I	1		Oil lightly
10	Oil pump shaft II	1		Oil lightly
11	Intermediate flange			
12	Pin	2		If required, drive in flush and secure with bolt lock- ing compound suitable for temperatures up to 160 deg. C

Note

If severe score marks are found, replace oil pump as a unit.



Replacing oil tank



2037-17

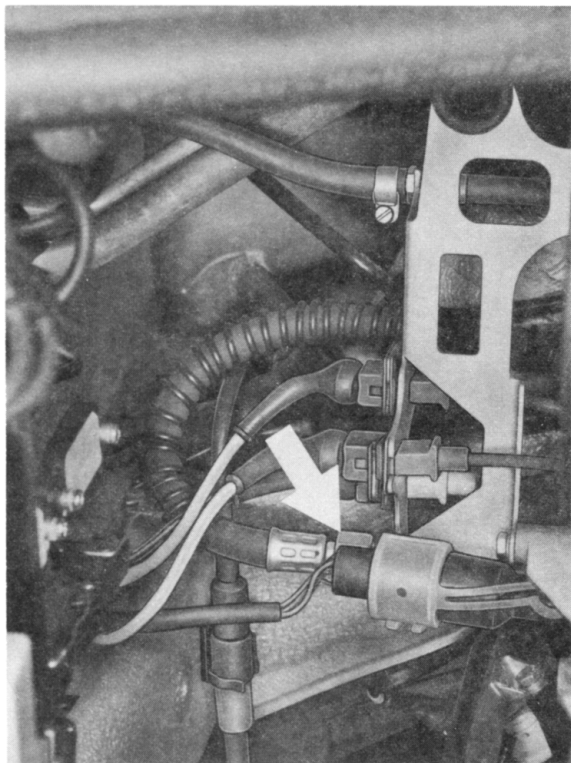
No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hose clamp	4		
2	Union	1		
2a	Oil hose	1		
3	Lock nut M 6	2		
4	Washer	2		
5	Rubber-metal block	2		
6	Flange nut	2		
7	Cover panel	1		
8	Flange nut	4		
9	Sender for oil level gauge	1		
10	Gasket	1		Replace
11	Hose clamp or tie-wrap	1		
12	Molded hose	1		
13	Pressure relief valve	1	Pull out with suitable pliers	Check, valve opening pressure must be 180 ± 20 mbar, install with Loctite 574 sealant
14	Oil tank	1		

Checking the delivery rate of the fuel pump

Precondition:

Fuel filter and power supply in perfect condition.

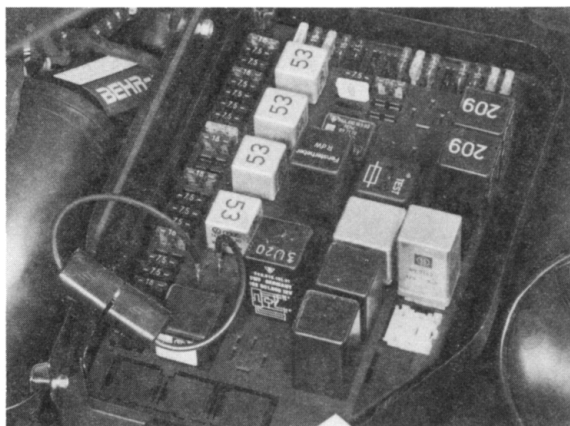
1. Remove the hot-air blower on the left-hand side to the rear of the engine compartment.
2. Undo the fuel return line from the distributor while bracing. Catch escaping fuel.



88/500

3. Hold a test hose comprising:
 - 1.5 m low-pressure hose and a 90° angled 10 mm hose stem with M 16 x 1.5 thread in a measuring receptacle.

4. Disconnect the DEE relay from the central electric system and bridge terminals 30 and 87 b with a piece of cable.

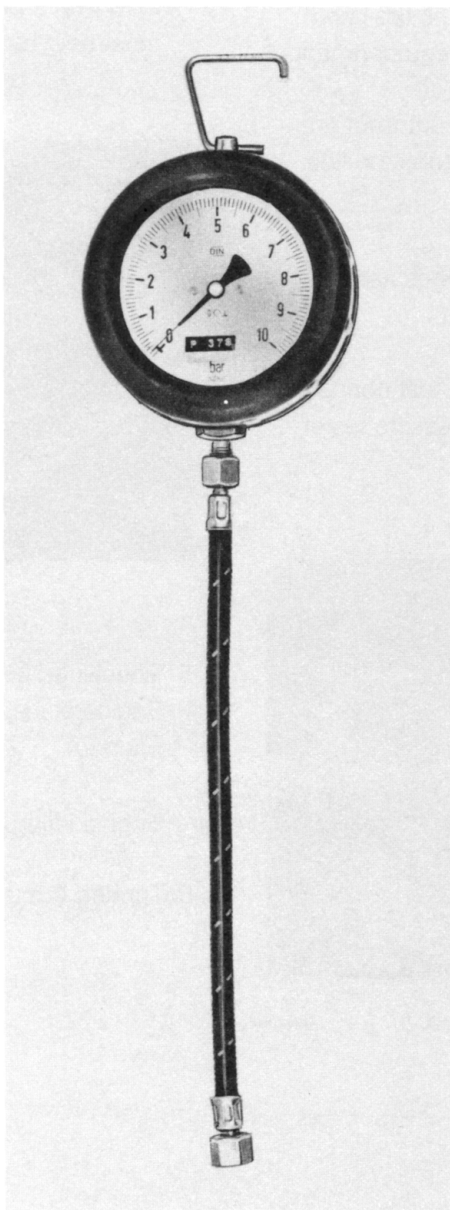


88/439

Allow fuel to run into the measuring receptacle for 30 seconds. The delivered quantity must be at least 850 cm³/30s.

Checking the fuel pressure

Tools



8005

No.	Description	Special Tool	Order number	Remarks
	Pressure gauge with hose from pressure tester	P 378 or V.A.G 1318	000.721.378.00 Z 401 111 WE	

Checking the fuel pressure

1. Remove the hot-air guide on the left-hand side to the rear of the engine compartment.
2. Unscrew and remove the cap nut from the test connection of the fuel distribution line.

Note

Make sure that the sealing ball does not fall out when the cap nut is removed.

3. Connect the dial gauge to the test connection with the hose from the pressure tester P 378 or VW 1318 .

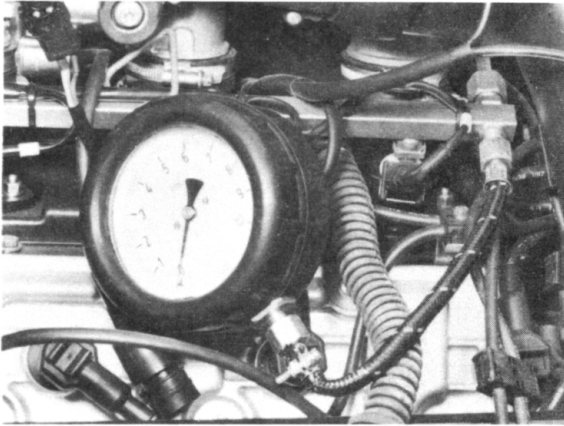


Illustration shows engine removed.

88/460

4. Disconnect the DEE relay from the central electric system and bridge terminals 30 and 87 b with a piece of cable. The fuel pump must now run.



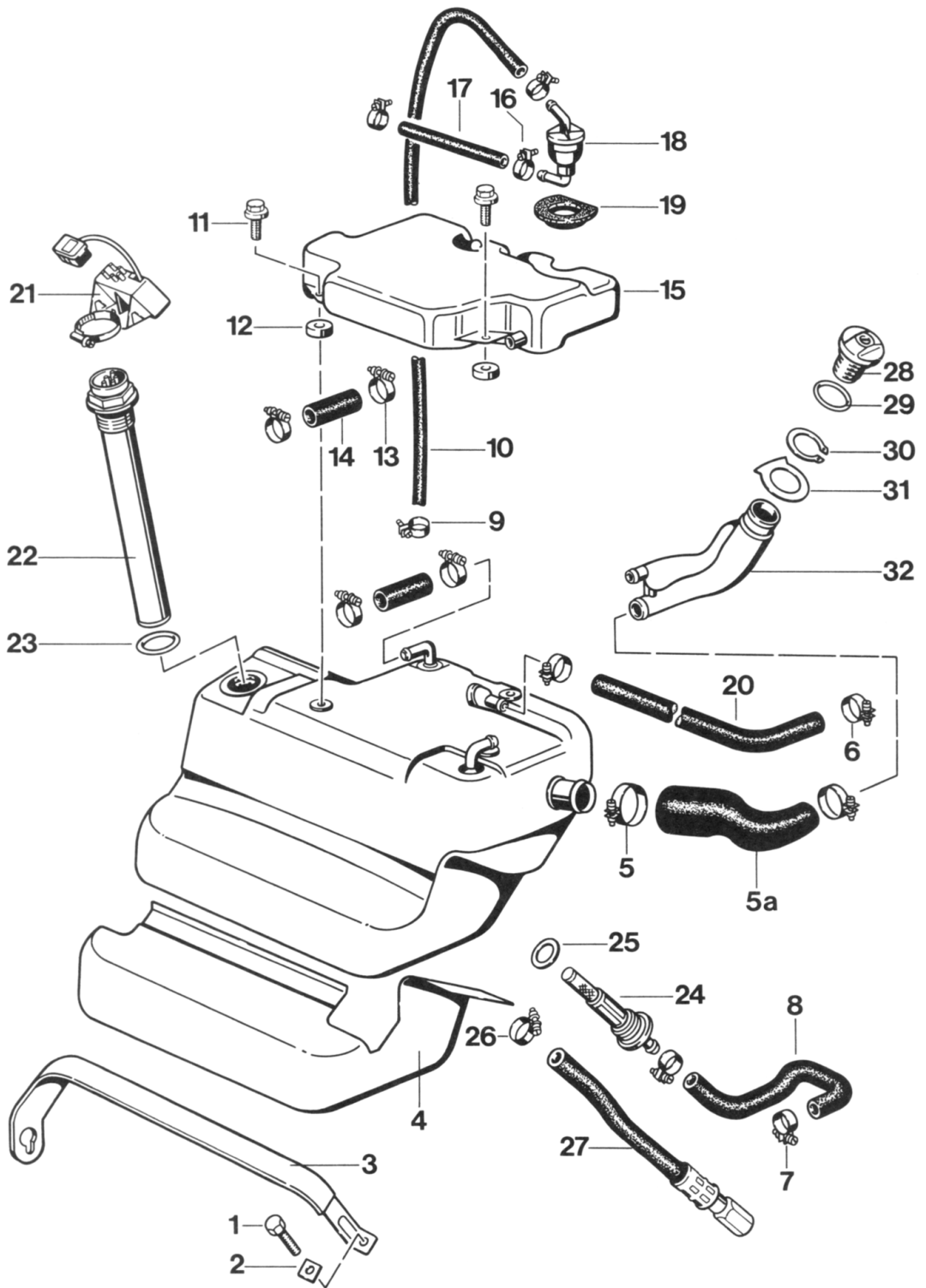
88/439

5. Checking specification:
Engine stationary 3.8 ± 0.2 bar (DEE relay bridged)

Engine idling approx. 3.3 ± 0.2 bar
6. Turning torque for the cap nut 12 Nm (9 ftlb).

Removing, dismantling and assembling fuel tank

Removing, dismantling and assembling fuel tank



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Hexagon head bolt M 8 x 40	1		
2	Support plate	1		
3	Restraining strap	1		
4	Protective cover	1		
5	Hose clamp 26 x 12	1		
5a	Molded hose	1		
6	Hose clamp 26 x 9	1		
7	Hose clamp 19 x 9	1		
8	Suction hose	1	Pinch with hose clip	
9	Hose clamp 15 x 9	1		
10	Hose 8 x 3.5, length 870 mm	1		
11	Screw with washer assy M 6 x 22	3		
12	Spacer (plastic)	3		
13	Hose clamp 26 x 9	4		
14	Hose, length 80 mm	2		
15	Expansion tank	1		
16	Hose clamp 14 x 9	2		
17	Hose 9.5 x 15.5, length 170 mm	1		
18	Shutoff valve	1		
19	Grommet	1		
20	Molded hose	1		
21	Electronics unit	1		
22	Sender unit	1		Tighten with wrench socket 9277 (Special Tool). Tightening torque 30 Nm (22 ftlb)
23	Sealing ring	1		Always replace when reassembling; coat light- ly with acid-proof grease

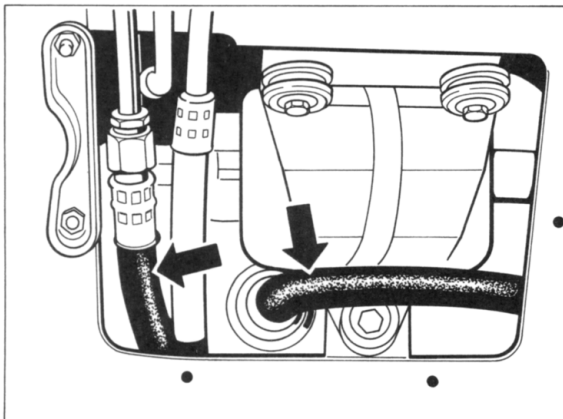
No.	Designation	Qty.	Note:	
			Removal	Installation
24	Fuel filter	1		Clean, coat threads lightly with Optimoly TA, tightening torque 25 Nm (18 ftlb)
25	Flat gasket	1		Always to be replaced
26	Hose clamp 16 x 9	1		
27	Return hose	1		
28	Tank lock	1		
29	Seal	1		Check, replace if required
30	Circlip 37 x 2	1		
31	Support pad	1		
32	Filler neck	1		

Assembly notes

Removing and installing fuel tank

Removing

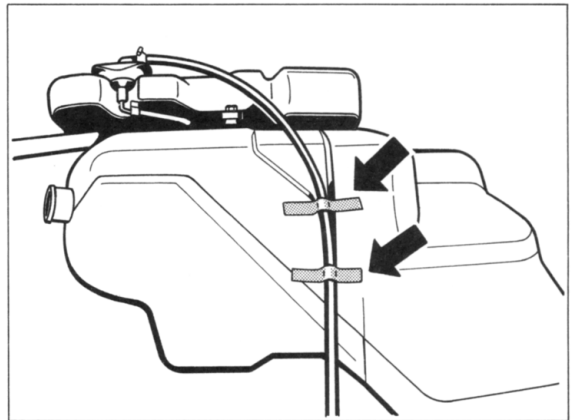
1. The fuel contents may be drawn off via the fuel level sender hole. For this purpose, the fuel tank must not be filled by more than 3/4.
2. Disconnect battery.
3. Pinch off fuel hose using hose clips. Disconnect hose clamp from bleeder hose and pull off from Tecalan line.



743-15

Installing

Before locating in its final assembly position, the bleeder hose must be fixed with hose band clamps.



744/15

Testing and adjusting specifications

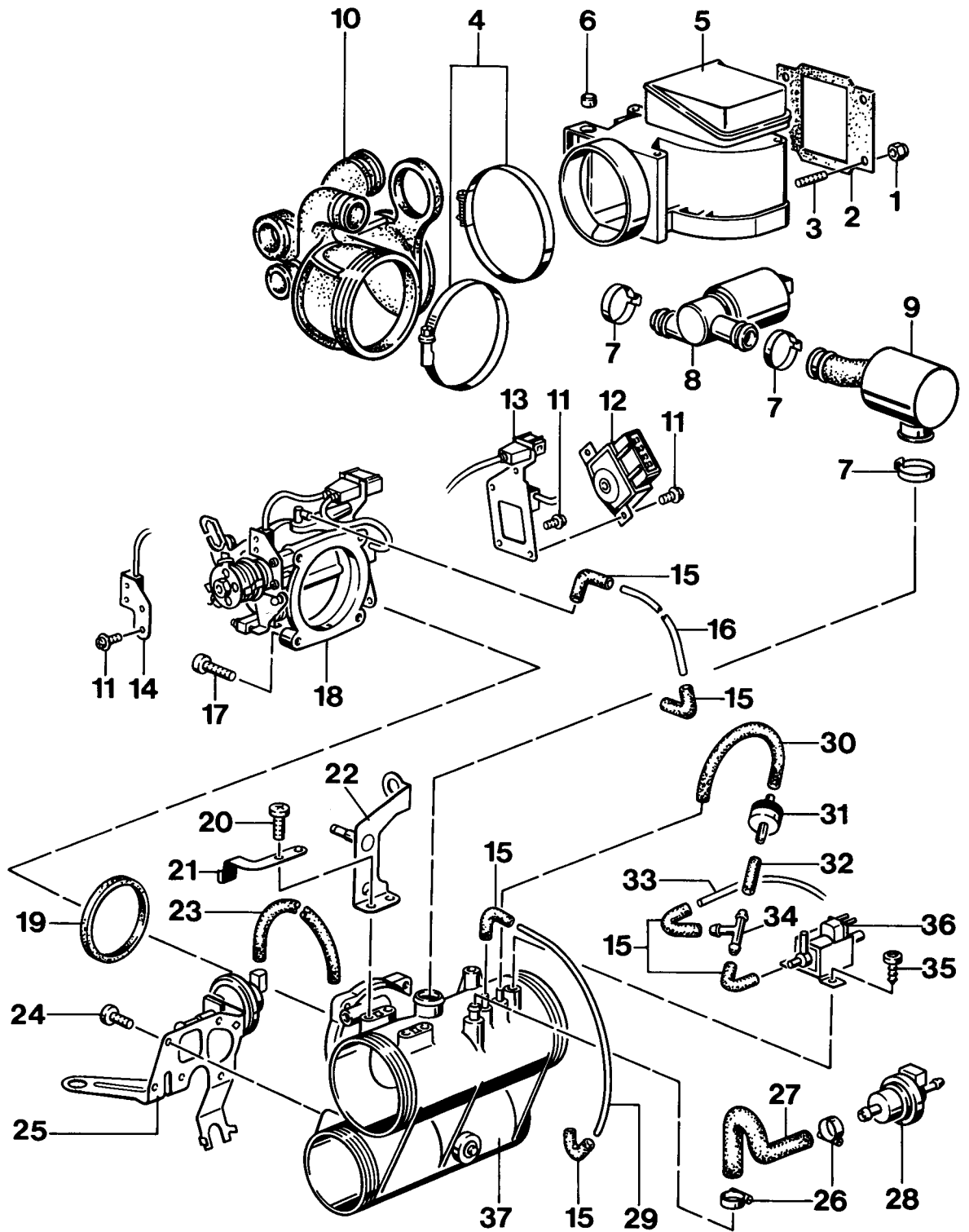
As from Model 89
engine type M 64/01

Test	Specification	Remarks	
Electric fuel pump delivery rate	at least 850 cm ³ / 30s		
Fuel pressure (Engine stationary) Fuel pump relay bridged	3.8 ± 0.2 bar		
Control value, engine idling	approx. 3.3 ± 0.2 bar		
Leak test Minimum pressure after 20 min.	3.0 bar		
Idle speed rpm	Without catalytic conv. 880 ± 40**	With catalytic converter 880 ± 40**	*Measured upstream of catalytic converter and Lambda probe connector <u>not</u> separated. No CO adjustment
CO values %	0.5 - 1.0	0.4 - 1.2*	
HC values ppm	≤ 300	≤ 300*	

** The idle speed can be checked only. There is no idle speed adjustment.

Injection system components - Removing and installing DME center section

Injection system components - Removing and install. DME center section

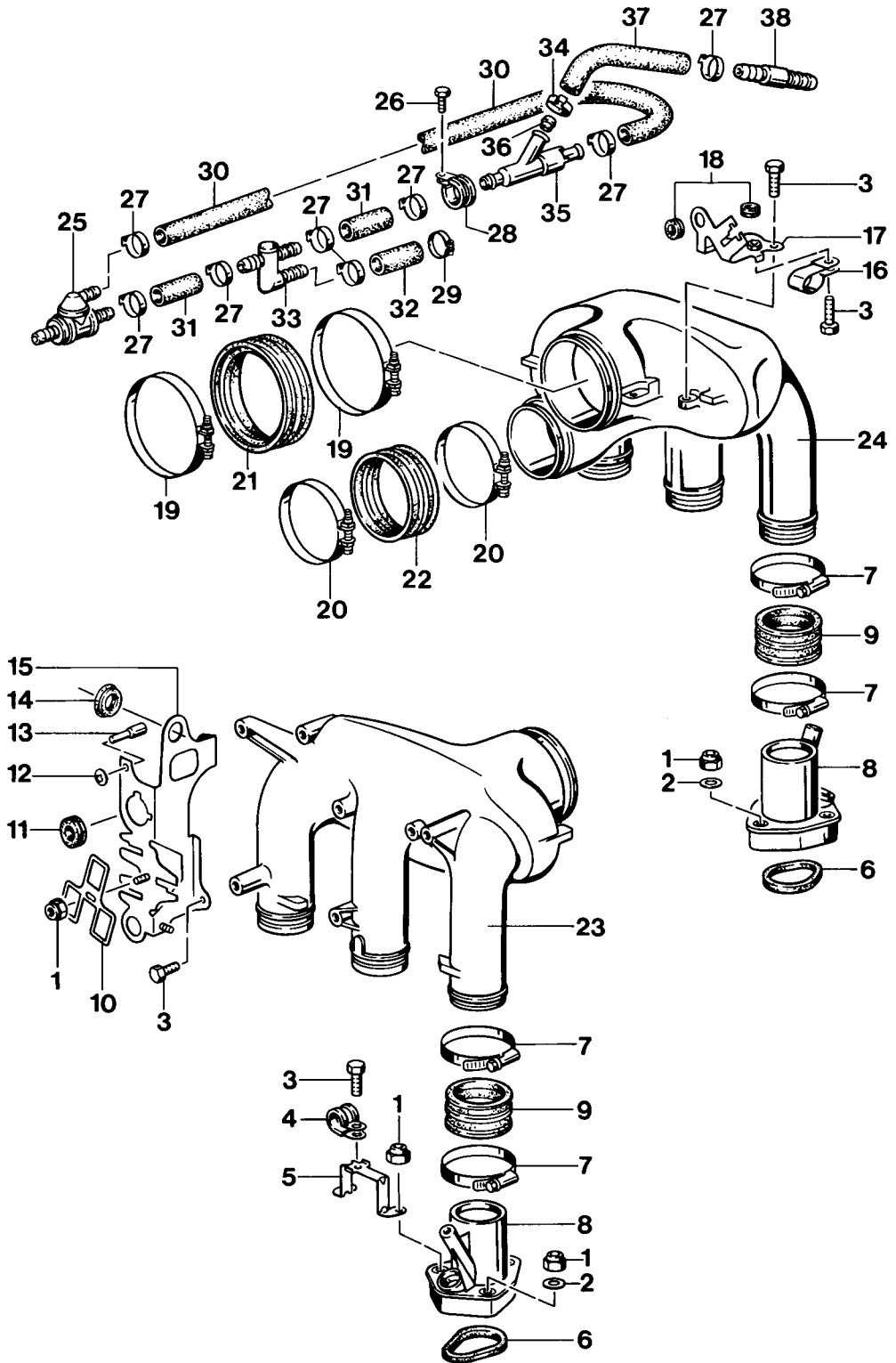


No.	Designation	Qty.	Note:	
			Removal	Installation
1	Lock nut	4		
2	Gasket	1		always to be replaced
3	Stud M 6 x 16	4		lock with Loctite 270
4	Hose clamp	2		
5	Air flow sensor	1		
6	Plug	1		replace aluminum plug
7	Hose clamp	3		
8	Idle speed positioner	1		
9	Muffler	1		
10	Rubber shroud	1		
11	Philips screw M 4 x 10	4		
12	Potentiometer for Tiptronic transmission	1		
13	Microswitch for full-load contact	1		
14	Microswitch for idle contact	1		
15	Rubber hose	6		
16	Polyamide tube	1		
17	Pan-head screw M 5 x 18	4		
18	Throttle body	1		
19	Seal	1		always to be replaced
20	Philips screw M 5 x 10	2		
21	Bracket	1		
22	Bracket for Tiptronic cable	1		
23	Rubber hose	1		
24	Philips screw M 5 x 10	5		
25	Bracket with vacuum unit	1		
26	Hose clamp	2		

No.	Designation	Qty.	Note:	
			Removal	Installation
27	Rubber hose	1		
28	Venting valve	1		
29	Polyamide tube	1		
30	Rubber hose	1		
31	Check valve	1		
32	Rubber hose	1		
33	Polyamide tube	1		
34	Branch piece	1		
35	Philips screw M 5 x 12	2		
36	Solenoid valve	1		
37	Connector tube	1		

Injection system components - Removing and installing lower DME section

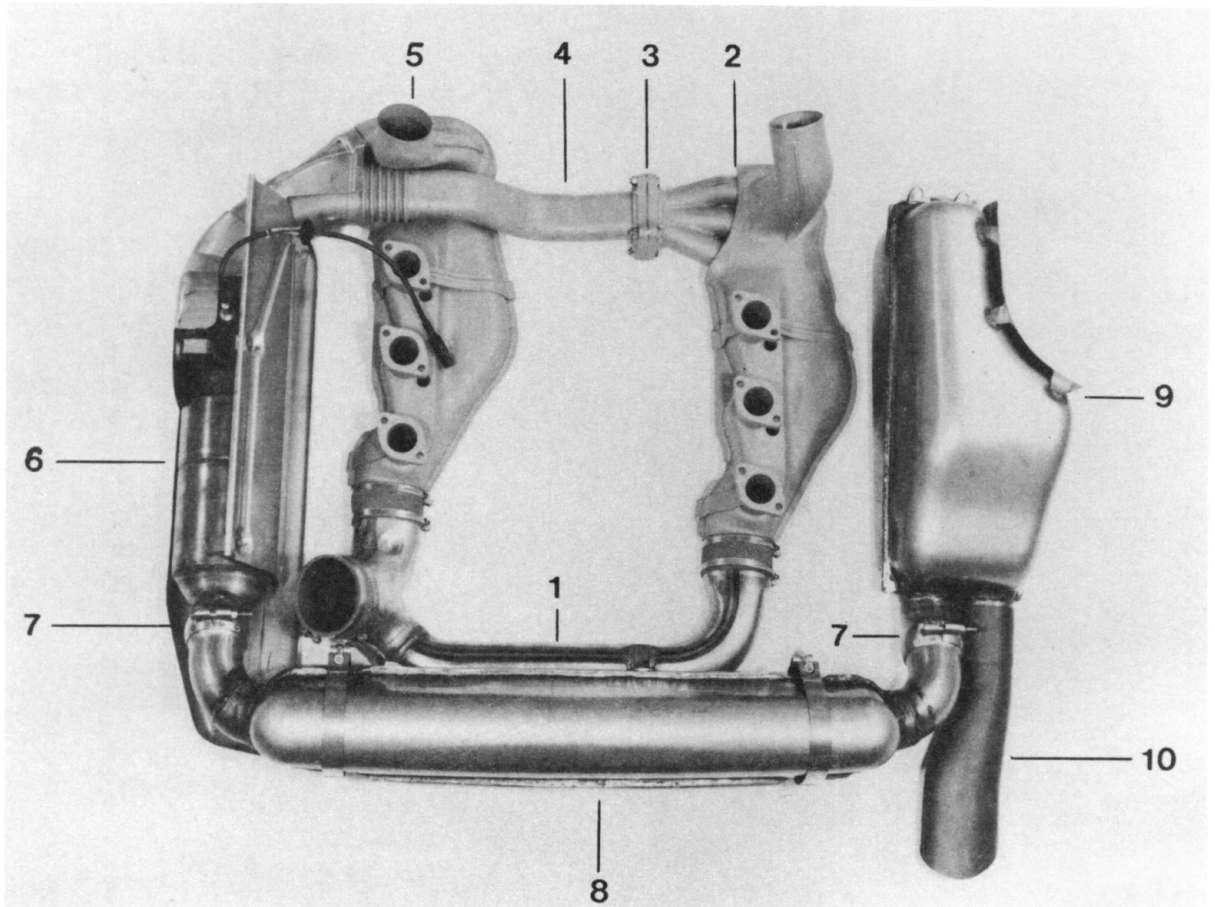
Injection system components - Removing and install. lower DME section



No.	Designation	Qty.	Note:	
			Removal	Installation
1	Lock nut	19		
2	Washer	14		
3	Hexagon head bolt M 6 x 12	6		
4	Hose clamp	1		
5	Bracket	2		
6	Seal	6		always to be replaced
7	Hose clamp	12		
8	Intake flange	6		
9	Rubber sleeve	6		
10	Tab washer	1		
11	Rubber grommet	1		
12	Clamping washer	1		
13	Connecting flange	1		
14	Rubber grommet	1		
15	Bracket	1		
16	Hose clamp	1		
17	Bracket	1		
18	Rubber grommet	2		
19	Hose clamp	4		
20	Hose clamp	4		
21	Rubber sleeve	2		
22	Rubber sleeve	2		
23	Intake distributor, LH	1		
24	Intake distributor, RH	1		
25	Check valve	1		
26	Hexagon head bolt M 6 x 18	1		
27	Hose clip	8		
28	Hose clamp	2		

No.	Designation	Qty.	Note:	
			Removal	Installation
29	Hose clamp	1		
30	Rubber hose	1		
31	Rubber hose	2		
32	Rubber hose	1		
33	Branch piece	1		
34	Hose clamp	1		
35	Suction-jet pump	1		
36	Orifice	1		
37	Rubber hose	1		
38	Connecting piece	1		

Exhaust system



88/130

1 - Hot-air distributor pipe
 2 - Heat exchanger, right
 3 - Flat flange gasket
 4 - Exhaust cross pipe
 5 - Heat exchanger, left

6 - Catalytic converter
 7 - Spherical flange dip
 8 - Intermediate muffler
 9 - Final muffler
 10 - Removable end pipe

Removing and Installing Starter

Removing

1. Disconnect battery ground lead.
2. Remove engine splash guard.

Procedures – Left Side

1. Unscrew and disconnect drive shaft on flange of differential.
2. Remove heater hose.
3. Remove holder for engine splash guard.
4. Unscrew and lay clutch slave cylinder aside with the connected hose (use a 1/4 inch ratchet).
5. Unscrew upper starter hexagon socket nut with a 3/8 inch ratchet and 10 mm INHEX socket (e.g. Stahlwille - 49/10).

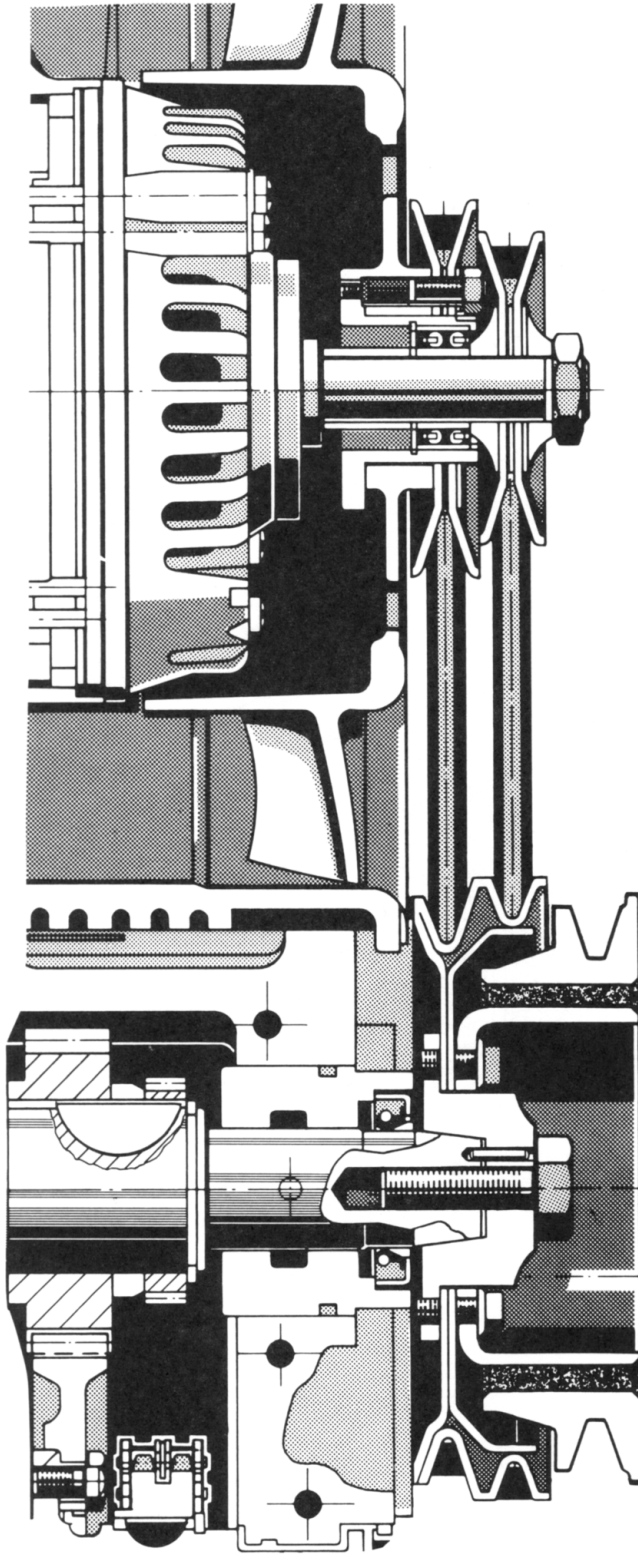
Procedures – Right Side

1. Unscrew and disconnect drive shaft on flange of differential.
2. Unscrew upper holder for engine splash guard.
3. Remove heater hose.
4. Disconnect term. 30 and 50 leads.
5. Disconnect ground strap between the body and lower starter mounting point and remove starter.

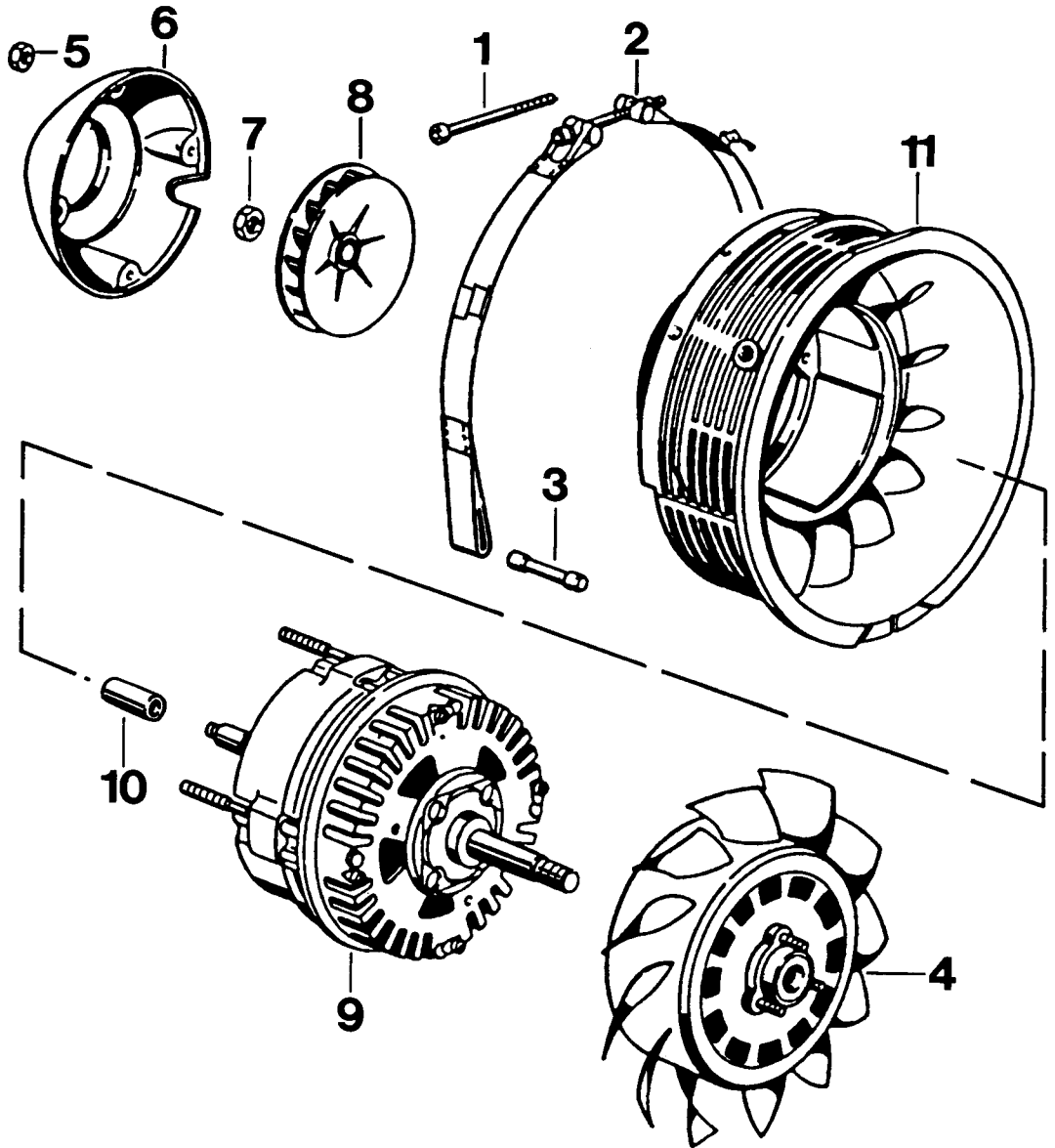
Installing

1. Mount term. 30 and 50 leads with sufficient spacing between each other. Install protective cap on terminal 30.
2. When mounting the transmission end drive shaft flange, make sure that bearing surfaces are absolutely clean and without grease. Only lubricate bolt threads with a minimum amount of Optimoly HT (copper grease).

Removing and installing generator



Removing and installing generator

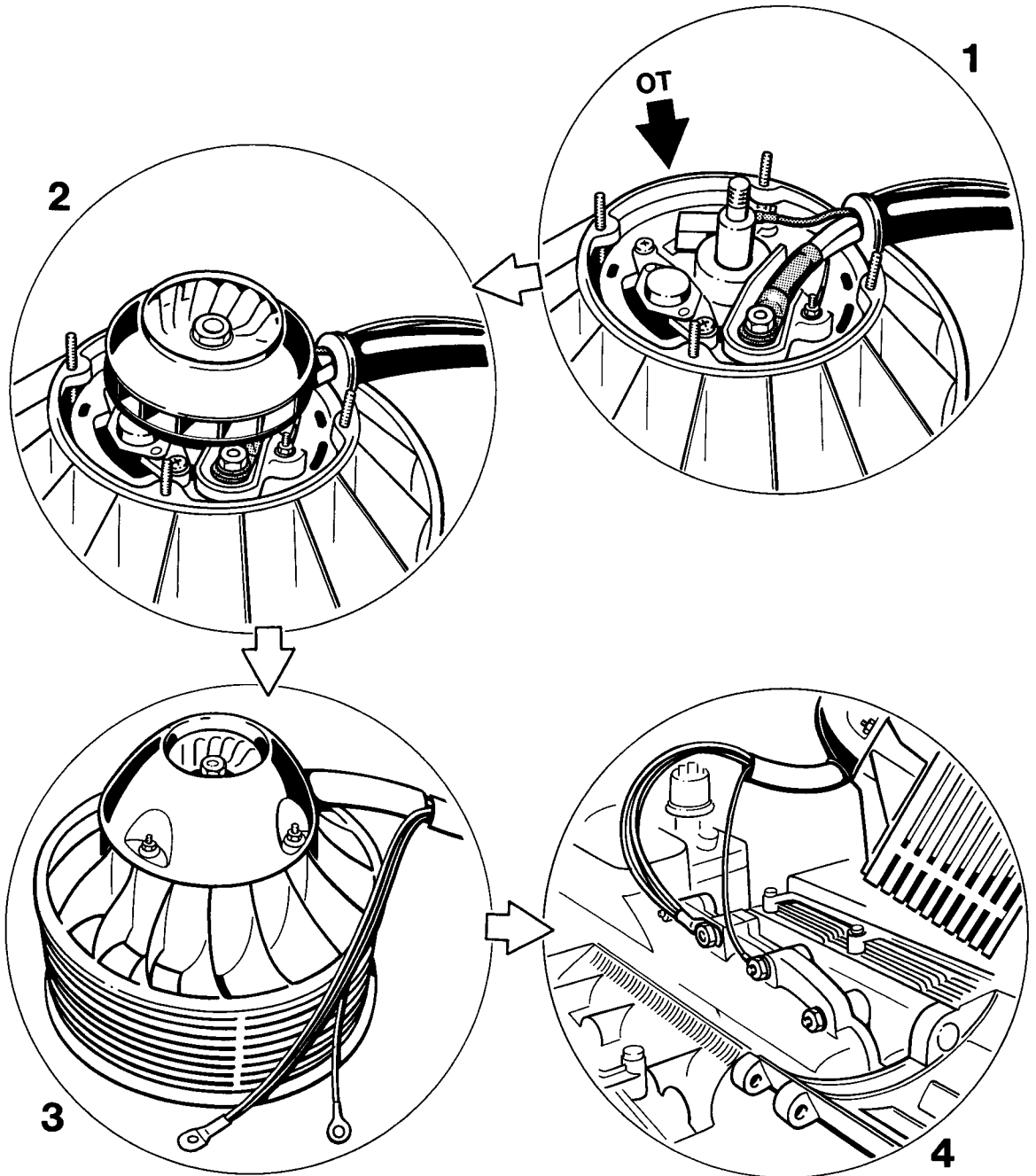


1404 - 27

Removing and installing generator

No.	Designation	Qty.	Note:	
			Removal	Installation
1	Cylinder bolt M 8 x 55	1		Tightening torque 8 Nm (6 ftlb.)
2	Restraining strap	1		Observe installation position
3	Pin	2		
4	Fan wheel	1	Pull off	
5	Fastening nut	4		
6	Air guide shroud	1		Install in correct position
7	Hexagon head nut	1		Use Loctite 270 to lock Tightening torque 14 ± 1 Nm (10 ± 0.73 ftlb.)
8	Fan wheel for generator cooling	1		
9	Generator	1		Observe installation position
10	Spacersleeve	1		
11	Cooling fan housing	1		Observe installation position

Removing and installing generator



Removing and installing generator

Removing generator

No.	Operation	Instructions
	Disconnect battery	Unscrew negative terminal from battery and cover terminal.
	Take off V-belt	Take off protective cap. Undo hexagon head nut (24 mm A/F), using a multi-tooth wrench (included in car tool kit) to lock.
	Press off fan wheel	Press fan wheel off generator, using puller VW 202 if required. Adjust both puller hooks as required.

Installing generator

No.	Operation	Instructions
1	Fit generator into cooling fan housing	Install generator. Make sure the connections for terminal B+ and terminal D+ are positioned opposite the TDC line mark (located on the edge of the cooling fan housing).
2	Fit fan wheel for generator cooling	Apply a thin coat of Loctite 270 to generator shaft threads and tighten to 14 ± 1 Nm (10 ± 0.73 ftlb.).
3	Fit air guide shroud	Apply grease to rubber grommet of generator wiring harness, e.g. Contifix tire assembly compound, to facilitate fitting of the air guide shroud. Push cutout of air guide shroud into rubber grommet and screw air guide shroud into place using 4 fastening nuts.
4	Reconnect ground cable	Locate ground cable on studs provided on crankcase and tighten to 23 Nm (17 ftlb.).
	Align cooling fan housing with crankcase	Place cooling fan housing onto locating pin on crankcase. Push cooling fan housing up to the stop (in direction of travel) and tighten retaining strap at the same time.

Note: When the generator is fitted correctly, the wiring harness must exit from the air guide shroud towards the right (in direction of travel)!

Accident hazards on electronic ignition systems

Increased demands on the ignition systems made by modern engines and the desire for maintenance-free components have led to electronic ignition systems being used in series vehicles for some time now. As a rule, the ignition performance of electronic systems is higher than that of conventional systems and further increases in the performance are forecast for the future. This means that electronic ignition systems are entering into an area where contact with current-carrying parts or terminals can be fatal (on both primary and secondary sides).

In this respect we must draw your attention to the fact that the VDE regulations, particularly VDE 0104/7.67 and respective national regulations must be observed when checking or working on the ignition system.

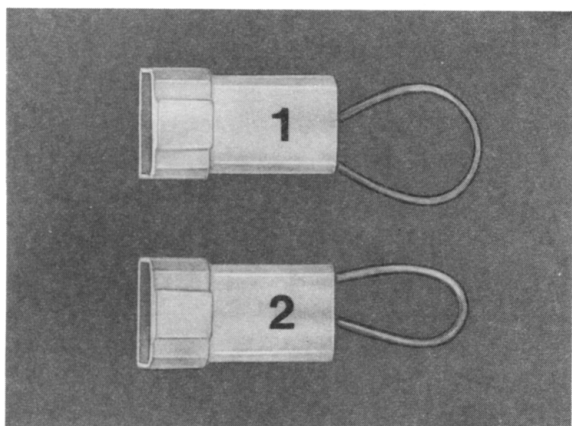
The ignition must always be switched off before working on the ignition system (deactivate the ignition or voltage source). This type of work includes:

- Connecting engine testers (timing lights, dwell-angle speed testers, ignition oscilloscopes, etc.)
- Replacing ignition system components (spark plugs, ignition coils, distributors, ignition cables, etc.)

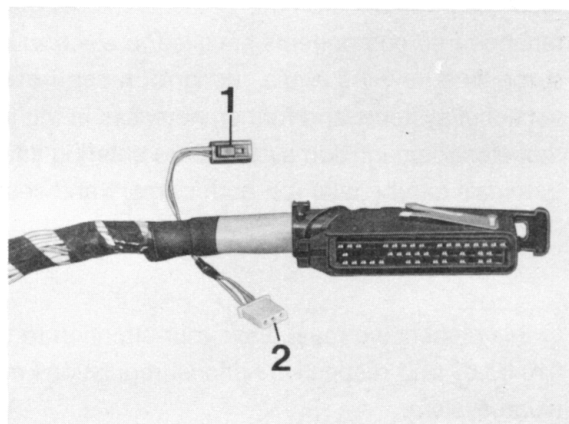
If it is necessary to switch on the ignition when checking the ignition system or for measuring adjustments to the engine, then the above-mentioned dangerous voltages will be present throughout the entire system.

The accident hazard is therefore not just restricted to the individual assemblies in the ignition system (e.g. distributor, ignition coil, switchgear, ignition wiring) but also in the cable harness (e.g. rev. counter connector, diagnosis connector), at plug connections and testers.

DEE control-unit coding



86/746 B



86/733

1 - 928.607.421.00

1 - Connector for performance data switch

2 - 928.607.422.00

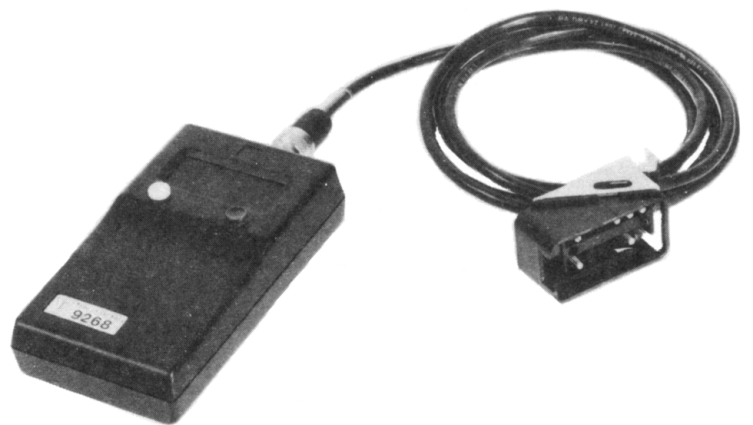
2 - Connector for variant switchr

Country	Perf. data switch Term. 54	Variant switch Term. 39
USA, Rest of world with catalytic converter	—	—
California, Japan	—	928.607.421.00
Rest of world without catalytic converter	—	928.607.422.00

DME diagnosis / Troubleshooting



Carrera 2
Carrera 4



Dr. Ing. h.c. F. Porsche Aktiengesellschaft

Test point	Description	Page
	Precautions	2
	Important vehicle information	3
	Testing requirements	4
	Effect of faults (cross reference list)	7
	DME control unit plug connections	8
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2	Idle speed contact	10
3	Full load contact	11
4	Engine temperature sensor	12
5	Air flow sensor	13
6	Idle speed control activation	14
7	Oxygen regulation stop	15
8	Oxygen sensor	16
9	Intake air temperature sensor	16
10	Knock sensor I	17
11	Knock sensor II	17
12	Control unit faulty	18
13	Hall signal	18
14	Control unit faulty	18
15	DME relays	19
16	Tank ventilating valve	19
17	Resonance plate	20
18	Check Engine warning lamp	21
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20	Fuel pressure	23
21	Intake system leaks	24
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	CO and idle speed test	31
	Coding of control unit	32
	Check-Engine Lamp	33

Precautions

Greater demands placed by modern engines on ignition systems and a desire for freedom from maintenance led to use of electronic ignition systems in series production some time ago. Normally, the ignition power of electronic systems (almost all makes) is greater than that of conventional systems, and further power increases can be expected in the future. This places electronic ignition systems in a power range where touching live parts or terminals may be dangerous to life (both primary and secondary circuits).

In this context, we must point out that VDE regulations, particularly VDE 0104/7.67, or the respective country-specific regulations must be observed for work on or inspection of the ignition system. The ignition must always be switched off (switch off ignition or power source) for work on the ignition system. Such work includes:

- Connecting engine testers, e.g.
(timing light, dwell angle/speed tester, oscilloscope etc.).
- Replacement of ignition system components, e.g.
(spark plugs, ignition coils, distributors, ignition leads etc.)

The above-mentioned dangerous voltages will be present in the entire system should it be necessary to switch on the ignition for ignition tests or engine adjustments.

Consequently, there is not only danger from the individual components of the ignition system (e.g. distributor, ignition coil, control unit, ignition tackle), but also at the wiring harnesses, plug connections and testers.

Important vehicle information

- Always turn off the ignition or disconnect the battery for resistance tests (if this is not done, the measuring device may be destroyed).
- Always disconnect the speed sensor plug for compression tests. (If this is not done, dangerous high voltages and insulation damage to the ignition coil, high-voltage distributor and ignition leads may result. In addition, the remaining spark plugs of the 2nd ignition circuit could ignite.)
- The specified ignition coil (refer to Order No.) must not be replaced by a different ignition coil.
- Never connect a suppression capacitor to ignition coil terminals 1 and 15.
- Never connect ignition coil terminal 1 to ground for the burglar alarm. (The ignition coil and control unit could be destroyed.)
- Never connect battery plugs or a test lamp to ignition coil terminal 1 (the control unit will be destroyed).
- Never disconnect the ignition lead from ignition coil terminal 4 to high-voltage distributor terminal 4 during operation.
- Voltage flashover from ignition coil terminal 4 to ignition coil terminals 1 and 15 must not occur. (The control unit could be destroyed.)
- In order to avoid destruction of the control unit, the secondary circuit of the ignition system must be suppressed with at least 4 k Ω , whereby the original distributor rotor with 1 k Ω suppression resistance must be installed.
- Disconnect the DME control unit and ignition output stage plugs only after turning off the ignition.
- Flashover or destructive discharge in the area of the high-voltage distributor cap (poor insulation) could destroy the control unit.
- Never disconnect the battery when the engine is running.
- Battery polarity reversal could lead to destruction of the ignition output stage, ignition coil and DME control unit.
- External engine starting with more than 16 V or with a boost battery charger is forbidden.
- Always follow the accident prevention regulations when working on the fuel system.

Equipment required for DME testing:

- Diagnostic tester 9288 (9268) with connecting leads
 - 1 oscilloscope approved by Porsche
 - 1 digital display multimeter, internal resistance min. 10 M Ω
 - 1 Bosch L-Jetronic test lead, Bosch No. 1684 463 093 (Check leads for correct polarity in plugs.)
 - 2 control units plug test leads (self-manufactured) equipped with 2 tab connectors No. 17.457.2 in order to avoid damage to the plug contacts in the control unit plug during testing.
 - 2 adapter test leads, consisting of: 4 plug connectors N 017.483.1 with 2 leads approx. 150 mm long, soldered.
 - 1 3-pin test lead (e.g. VW VAG 1501).
 - 2 control unit plug test leads (self-manufactured) equipped with 4 tab connectors N 17.457.2.
 - The test leads must be used under all circumstances in the tests!
- All sensor and ignition timing signals of Porsche vehicles can be checked with the engine testers recommended by Porsche. Since there are different instructions for the tester connections to the vehicle, depending on the manufacturer in question, these instructions must always be followed to ensure correct tester connection.

The following sensor signals can be checked with an oscilloscope:

- Speed sensor signal
 - t_i signals
 - Idle speed control activation signal
 - Hall sensor signal
 - Ignition trigger signal to ignition output stage
 - Tank venting activation signal
 - Activation signal for resonance plate
- as well as:
- Reed switch signal (speedometer)
 - ABS wheel sensor signals

DME control unit with diagnostic capability

A self-diagnosis function with fault memory is integrated in the DME control unit which permits certain faults in the injection, ignition and knock regulating systems to be detected and stored.

The DME control unit has a permanent positive connection to prevent deletion of detected and stored faults when the ignition is turned off. Detected faults remain stored in the fault memory for at least 50 engine starts (exception: idle speed switch interruption faults).

Important:

If the DME control unit plug or battery is disconnected, the fault memory and system adaption will be cleared.

Tester connections:

The vehicles are equipped with a 19-pin plug-in connection in the passenger footwell to allow diagnosis to be performed.

The system tester 9288 or the flashing code tester 9268 (via adapter lead 9268/2) can be connected to this plug-in connection. Operation of the testers is explained in the tester instructions:

Note:

The respective test point is supplemented by the corresponding fault flashing code of the tester 9268.

Example:

Test point 2 = Idle speed contact (1_12)

2nd digit display

"1" fault exists or

"2" fault does not exist

The following actual engine data can be read directly in the „Actual value“ menu with the system tester 9288 as from tester module version 2.0:

Intake air temperature	Engine temperature
Ignition timing	Engine speed
Oxygen sensor voltage	Power supply
Version code	Air flow sensor signal
Idle speed control duty ratio	Load signal

Operating conditions for start of DME diagnosis

Diagnosis may be started with the "ignition on" and with the engine standing still or running at up to 2,000 rpm.

This DME diagnosis/troubleshooting plan is based on the contents of the fault memory.

Paths not included in self-diagnosis can be diagnosed with conventional equipment (test points 20 – 26, refer to adjacent fault list)

Preconditions for troubleshooting are that the person performing the tests

- is familiar with the location of components and the functioning and technical relationships of the systems being tested (model information)
- can read and evaluate Porsche wiring diagrams
- knows the functions of circuits and relays
- is capable of using testers, such as oscilloscope, voltmeter, ohmmeter and ammeter, as well as of evaluating the results.

Important:

A fault text on the display (fault list for flashing code) does **not** always indicate a fault in this component, but could also indicate a fault in the corresponding control unit and the connecting leads (paths) between the component and control unit.

No troubleshooting in the form of plug disconnection etc. must be performed with the engine running before the fault memory has been read out, because this may be stored as a fault in the fault memory.

Note for the system tester 9288

If the tester display shows

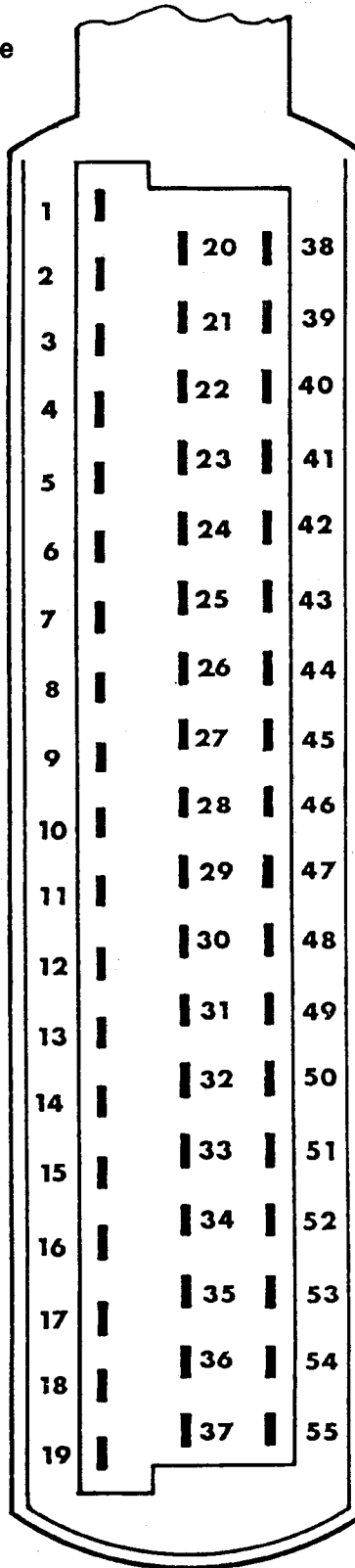
fault does not exist, this could mean:

- Fault did not exist at the time of testing (loose contact)
Remedy: Visual inspection of the path
- Conditions under which the fault is tested do not correspond to the conditions under which the fault occurred.
Remedy: Conform with conditions displayed on the tester.

Signal not plausible:

The signal of the monitored components does not fit in the tolerance range of the calculated value in the control unit

- 1 Ignition pulse to output stage
- 2 Ground - output stage shield
- 3 DME relay ground (fuel pump)
- 4 Idle speed control
- 5 Tank venting valve
- 6 Engine speed to tachometer
- 7 Signal from air flow sensor
- 8 Signal from Hall sensor
- 9
- 10 Ground - oxygen sensor shield
- 11 Knock sensor I
- 12 Power supply, air flow sensor
- 13 Lead L from diagnostic plug
- 14 Ground
- 15 ti signal, cyl. 3
- 16 ti signal, cyl. 6
- 17 ti signal, cyl. 1
- 18 Permanent positive
- 19 Ground
- 20
- 21 Diagnostic plug, knocking yes + no
- 22 Check engine control
- 23 Resonance plate
- 24 Ground
- 25
- 26 Ground for air flow meter



- 27
- 28 Oxygen sensor signal
- 29 Knock sensor II
- 30 Shield, for knock sensors, Hall sensor and ground for knock sensors
- 31 Positive to Hall sensor
- 32 Consumption gauge
- 33 ti signal, cyl. 5
- 34 ti signal, cyl. 4
- 35 ti signal, cyl. 2
- 36
- 37 Voltage from DME relay with ignition
- 38
- 39 Version coding
- 40 Air-conditioning compressor
- 41 AC switch
- 42
- 43
- 44 Intake air temperature NTC I
- 45 Engine temperature NTC II
- 46 Altitude potentiometer
- 47 Speed/reference mark positive
- 48 Speed/reference mark negative shield
- 49
- 50 Heating/air-conditioning regulation
- 51
- 52 Idle signal - throttle valve
- 53 Full load signal - throttle valve
- 54 Coding plug, characteristic map
- 55 Diagnostic plug, lead K

Test point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Engine mechanically O.K.																										
Battery charged																										
Starter motor cranks the engine																										
Terms in bold letters = Fault memory display or fault path																										
Supply voltage																										
Idle speed contact ground short Idle speed contact break																										
Full load contact																										
Engine temperature sensor II																										
Air flow sensor																										
Idle speed control activation																										
Oxygen regulation stop																										
Oxygen sensor (sensor signal)																										
Intake air temperature sensor																										
Knock sensor I																										
Knock sensor II																										
Control unit faulty (Knock computer)																										
Hall signal																										
Control unit faulty																										
DME relay																										
Tank venting valve																										
Resonance plate																										
Check Engine warning lamp (Calif. as from mod. '91)																										
Injection valve - injection control unit																										
Fuel pressure																										
Intake system leak																										
Ground and plug connections																										
Speed/reference mark sensor																										
Ignition system and output stage																										
Alternator/regulator																										
Leads K and L																										

V = Voltmeter Ω = Ohmmeter ≅ = Oscilloscope

See inner page for plug terminal assignment of DME control unit

Fault, Fault Code	Possible Causes, Elimination, Remarks
-------------------	---------------------------------------

Test point 1a

Power supply for DME control unit (V)

a) **Permanent positive (B+)** If there is no B+, the fault memory is cleared.

Test procedure:

Connect a voltmeter to terminal 24 (-) and terminal 18 (+) of the control unit plug with the help of test leads.

Display: Battery voltage

No display, check current flow and ground paths in accordance with wiring diagram

Test point 1b

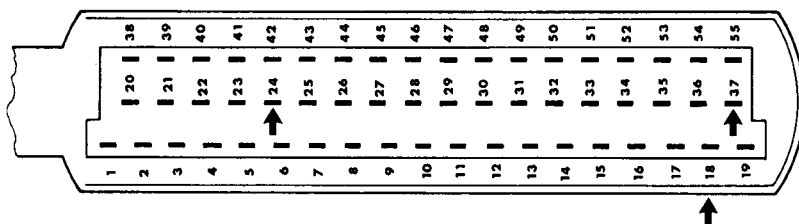
Power supply for DME control unit (V)
too high/too low
Fault code 1_11

b) **Power supply via DME relay**

Connect a voltmeter to terminal 24 (-) and terminal 37 (+) of the control unit plug with the help of test leads. Turn on the ignition.

Display: Battery voltage

No display: Check current path in accordance with wiring diagram



Note:

Cars with burglar alarm: Check power supply from ignition lock to terminal 86 of the DME relay via the burglar alarm control unit in accordance with the wiring diagram.

Cars without burglar alarm: Check the plug jumpers on plug section (provided for installation of a burglar alarm control unit).

Fault, Fault Code	Possible Causes, Elimination, Remarks
-------------------	---------------------------------------

Test point 2:

Idle speed contact (Ω)

Ground short

Fault code 1_12

Check by means of circuit input test with system tester 9288 or Tester9268

Select test step and operate accelerator pedal.

9288 display: Idle speed contact closed
Idle speed contact open.

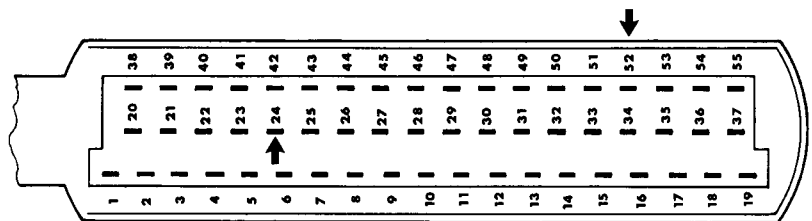
9268 display: 1332 (idle speed contact closed)
0000 (idle speed contact open).

No display:

Disconnect plug from DME control unit.

Connect ohmmeter between terminal 52 and terminal 24 using test leads.

Bridge Ground to terminal 30



Display:

Throttle valve closed <math><10 \Omega</math>

Throttle valve opening angle >math>>1^\circ = \infty\Omega</math>

If the values of the idle speed contact are not reached in this test, the test should be repeated directly at the throttle valve switch:

Disconnect the plug on the throttle valve switch. Connect an ohmmeter between terminals 1 and 2 of the throttle valve switch using test leads.

Display:

Throttle valve closed <math><10 \Omega</math>

Throttle valve opening angle >math>>1^\circ = \infty\Omega</math>



Idle speed contact (Ω)

Break

Fault code 1_15

Test procedure same as for ground short.
(Fault will be stored in memory as from '91 models)

Check whether setting is correct and adjust if necessary.
Cause may be incorrectly set throttle valve switch or accelerator cable, for example.

Fault, Fault Code

Possible Causes, Elimination, Remarks

Test point 3

Full load contact (Ω)

Ground short

Fault code 1_13

Check by means of circuit input test with a system tester 9288 or tester 9268

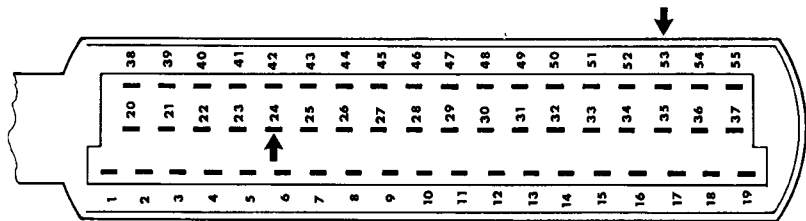
Select test step and operate the accelerator pedal.

Display 9288: Full load contact open
Full load contact closed.

Display 9268: 1333 (full load contact open)
0000 (full load contact closed).

No display:

After disconnecting the DME control unit plug, connect the ohmmeter to terminal 53 and terminal 24 by means of test leads.



Display:

Throttle valve closed $\infty \Omega$

Throttle valve after approx.
2/3 opening travel $< 10 \Omega$

If the values of the full load contact are not reached in this test, the test should be repeated directly on the throttle valve switch:

Disconnect plug at throttle valve switch. Connect ohmmeter between terminals 3 and 2 of the throttle valve switch by means of test leads.

Display:

Throttle valve closed $\infty \Omega$

Throttle valve after
2/3 opening travel $< 10 \Omega$



Note::

If the full load contact fails, the control unit produces a load threshold via the air flow sensor. Values below this load threshold are the same as the switch being opened and values above the load threshold the same as the switch being closed.

Fault, Fault Code

Possible Causes, Elimination, Remarks

Test point 5a:

Air flow sensor (V/Ω)

Fault code 1_21

The ratio between U_p (potentiometer voltage) and U_v (supply voltage) can be displayed in the „Actual value – menu with the system tester 9288.

The ratio must be approx. 0.0 to 1 when the air flow sensor plate is opened. If not:

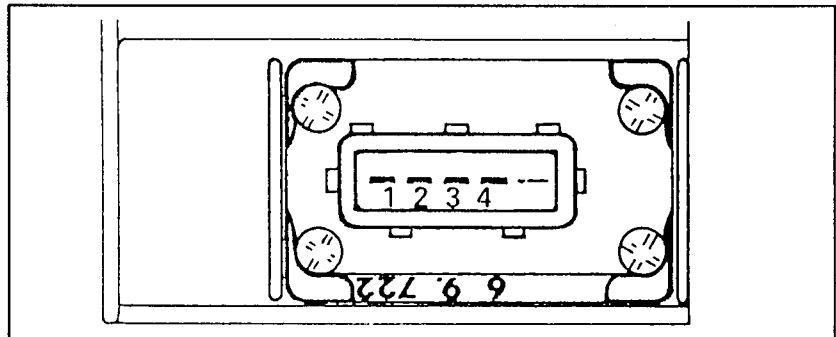
a) Voltage supply

Connect a voltmeter to terminal 3 and ground of the disconnected plug of the air flow sensor using test leads. Turn on ignition.

Display: 5 ± 0.3 Volt

Test point 5b:

**b) Voltage drop
across the air flow sensor plate potentiometer (V)**



Disconnect the air filter connecting hose. Using test leads, connect pin 3 of the disconnected air flow sensor plug with air flow sensor plug terminal 3 and pin 4 with air flow sensor plug terminal 4.

Connect a voltmeter to air flow sensor terminal 2 and ground (turn on ignition).

Display: approx. 250 - 260 mV

Using a non-metallic tool (e.g. screwdriver handle), press the air flow sensor plate to full load position.

It must be possible to move the air flow sensor plate easily and without jamming. Observe the voltmeter's display at the same time. It must not be possible to observe voltage jumps or a voltage drop during the opening or closing operations of the air flow sensor plate.

Air flow sensor plate at full load: Display approx. 4.60 Volt

Fault, Fault Code	Possible Causes, Elimination, Remarks
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If the voltage values are achieved, switch off the ignition and connect the plug again.

Note:

In the event of failure of the air flow sensor, substitute values are formed by the control unit (emergency running program).
In idling operation, t_i signal from nominal air of the idle speed volumetric efficiency regulator. In partial and full load ranges, a constant t_i signal in each case.

Test point 6:

Idle speed control (V)

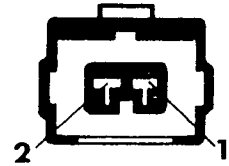
Fault code 1_22

Drive link activation menu

If no pulse is audible, check:

Power supply

Connect the voltmeter to terminal 2 and ground of the disconnected plug of the idle speed control using test leads. Switch ignition on.



Display: Battery voltage

If no display:

Check power supply in accordance with wiring diagram.

Control signal test

Using the system tester 9288, it is possible to read the pulse duty factor in percent directly in the „Actual value“ menu.

Function test: Switch on loads during idle operation. The pulse duty factor must change, while the idling speed remains constant. If not:

Fault, Fault Code

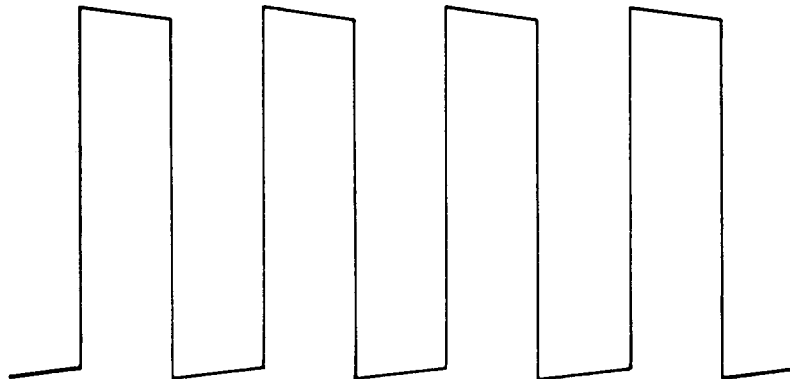
Possible Causes, Elimination, Remarks

Connect a 2-pin DME test lead (Bosch No. 1 684 463 093) between the speed control and plug.

Connect and adjust engine tester in accordance with manufacturer's instructions.

Ensure that the lead connections do not have any ground contact with the vehicle. (Danger of short-circuit)

The following display must be visible when the engine is running:



Frequency approx. 100 Hz.

If no audible pulse exists in spite of the voltage and signal being present, replace the idle speed control.

Test point 7

Oxygen regulation stop

Fault code 1_23

The oxygen regulator cannot operate in its control range owing to problems with mixture preparation, e.g. too lean because of additional air or too rich because of a sticking injection valve. The oxygen regulator then moves up to the stop position.

Test 1: Check CO level with running engine and connected CO tester (between 0.4 – 1.2 %)

too lean: Check intake system for leaks (Test point 21)

too rich: Test system pressure (test point 20)
Test injection valves for leaks (test point 20)

Fault, Fault Code	Possible Causes, Elimination, Remarks
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Test point 8:

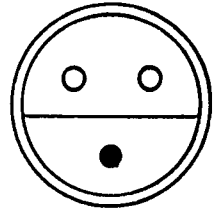
Oxygen sensor (V)
(Sensor signal)
Fault code 1_24

Sensor signal test

Using the system tester 9288, the sensor voltage can be read directly in the „Actual value“ menu.

If not:

Disconnect the oxygen sensor plug. Connect a digital voltmeter with the test connection (voltage signal air sensor) and ground at the sensor end.



Start the engine and allow to warm up so that the oxygen sensor reaches its operating temperature. When the mixture is enriched, e.g. acceleration, a change in the voltage signal must be displayed.

Voltmeter display:
approx. 150 mV - 900 mV (depending on mixture composition).

Note:

If the control unit detects an oxygen sensor voltage signal of more than 1 V or less than 0.1 V, the control unit will switch over to operation without oxygen sensor (short-circuit or break).

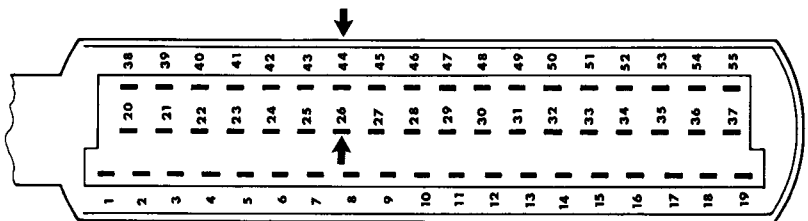
If the regulator is not functioning and the sensor voltage signal is O.K., check the coding of the control unit before replacing it.

Test point 9

Air temperature sensor
NTC I (Ω)
Fault code 1_25

The intake air temperature can be read directly in the „Actual value“ menu using the tester system 9288.

If not, or if no plausible value is displayed, then connect terminal 44 and terminal 26 of the disconnected DME control unit plug with an ohmmeter.



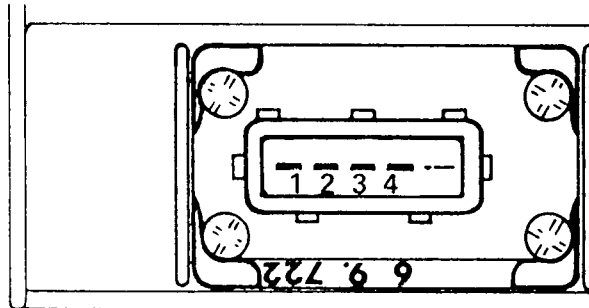
Display at:	0°C	=	4.4–6.8 kΩ
	15–30°C	=	1.4–3.6 kΩ
	40°C	=	1–1.3 kΩ

Fault, Fault Code

Possible Causes, Elimination, Remarks

If there is no display, disconnect the plug at the air flow sensor. Connect an ohmmeter to air flow sensor terminals 1 and 4 using test leads.

Note: In the event of a discontinuity, there will a substitute value equal to an intake air temperature of 20° C (emergency running program).



Test point 10

Knock sensor I
Fault code 1_31

Knock sensor I: Knock signal not plausible. Check:

- Knock sensor mounting (check torque and type of screw)
- Wiring harness and plug connections in accordance with wiring diagram
reconnecting the sensors eliminates contact resistances.
- Replace knock sensor

In the event of a faulty knock sensor, ignition timing retarded by 6° on the crankshaft

Test point 11

Knock sensor II
Fault code 1_32

Knock sensor II: Knock signal not plausible. Check:

- Knock sensor mounting (check torque and type of screw)
- Wiring harness and plug connections in accordance with wiring diagrams
Reconnecting the sensors eliminates contact resistances.
- Replace knock sensor

In the event of a faulty knock sensor, ignition timing retarded by 6° on the crankshaft

Fault, Fault Code**Possible Causes, Elimination, Remarks****Test point 12**

Control unit:
(Knock computer)
Fault code 1_33

Ignition timing is retarded by 6° if this fault occurs.
Replace control unit.

Test point 13:

Hall signal
Fault code 1_34

The Hall sensor is supplied with voltage (approx. 12 V) and ground by the control unit.

The signal is supplied to the control unit via the line 0.

In the event of a fault display: Check voltage supply, ground supply and signal line in accordance with wiring diagram.

Plug connections Hall sensor (designation at plug)	Connections Control unit plug
--	----------------------------------

(1) -	—————→	30
(2) 0	—————→	8
(3) +	—————→	31

If voltage, ground and continuity exist, replace Hall sensor

Test point 14:

Control unit faulty
Fault code 1_41

Replace control unit.

Fault, Fault Code

Possible Causes, Elimination, Remarks

Test point 15:

DME relay
(fuel pump) (V)

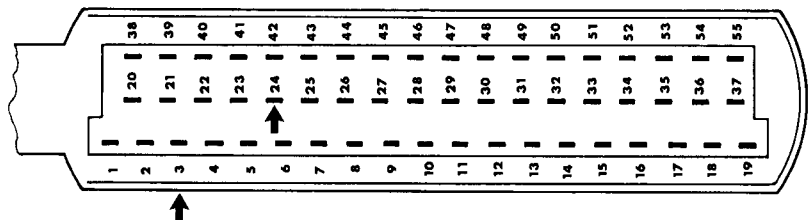
Start engine - the fuel pump must run during engine starting.

If not:

Switch off ignition. Disconnect control unit plug. Connect terminal 3 and terminal 24 on control unit plug with the help of a test lead. Switch on ignition - pump must run.

If not:

Check current-ground path, DME relay and fuel pump in accordance with wiring diagram



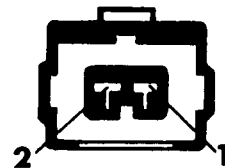
Test point 16:

Tank venting valve (V)
Fault code 1_43

The electrical valve at the intake air distributor is opened for a longer or shorter period as a function of the load during engine operation at operating temperature. The opening period is determined by a ground pulse from the control unit.

a) Activation test

Activate the tank venting valve in the „Drive link activation“ menu of the tester. If there is no audible pulse, check voltage supply at terminal 1 of the solenoid valve plug in accordance with the wiring diagram.



b) Control signal test

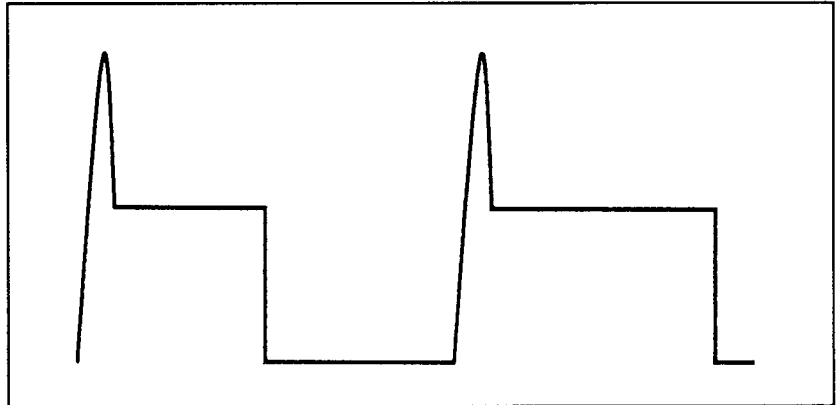
Connect DME test lead (Bosch No. 1 684 463 093) between solenoid valve and plug connection. Connect and adjust engine test in accordance with manufacturer's instructions.

Fault, Fault Code	Possible Causes, Elimination, Remarks
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Tank venting valve is not activated permanently.

The test must be performed within 7 minutes after starting an engine at operating temperature. (After this, interrupt tank venting valve activation for approx. 75 s and then continue.)

Start engine and accelerate. The following display must be visible on the tester for an engine which is at operating temperature.



The signal becomes wider as the air throughput increases. If there is no signal, check the path in accordance with the wiring diagram. Replace control unit if necessary.

Test point 17:

Resonance plate Fault code
1_44

Each time the ignition is switched on, a ground pulse is supplied by the control unit to the solenoid valve of the resonance plate. If there is a vacuum in the system, the resonance plate is audibly opened and closed. The pulse can also be triggered by means of the "Drive link activation" menu. If there is no audible pulse, check:

- Is there a vacuum?
- Does the resonance plate move easily?
- Control signal test:

Disconnect the plug at the solenoid valve (sensor of intake air distributor). Connect and adjust an engine tester using test leads in accordance with the manufacturer's instructions. A signal must be visible when the ignition is switched on or for the "Drive link activation" menu. If not:

- Check paths in accordance with wiring diagram.
- Replace control unit if necessary.

Fault, Fault Code	Possible Causes, Elimination, Remarks
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Test point 18

**Check Engine
warning lamp**

Fault code 1_45
(Calif. as from Mod. '91)

A ground signal is supplied from control unit plug 22 to the „Check Engine lamp“ and switches on this lamp if a component influencing emission control fails.

If the „Check Engine“ warning lamp fails, the fault is stored in the fault memory.

Check by supplying ground to disconnected control unit plug 22 and switching on ignition.

If the display lamp is faulty, always use a specified lamp for replacement.

Test point 19:

Injection valve (V/ Ω)

Fault code 1_15 for cyl. 1
to 1_56 for cyl. 6

Drive link activation menu:

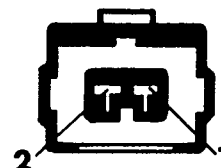
Each injection valve can be activated individually by means of the selective injection function. Opening of the injection valve can be heard only with extreme difficulty (damped).

If no pulse can be heard, check:

a) Voltage supply

Disconnect valve plug, connect voltmeter with the valve plug terminal 2 and ground using test leads. Switch on ignition.

Display: Battery voltage



If no battery voltage is displayed, check current path in accordance with wiring diagram.

Fault, Fault Code**Possible Causes, Elimination, Remarks****b) Check coil resistance of the injection valve**

Disconnect valve plug. Check the coil resistance at the terminal contacts of the injection valves with an ohmmeter.

Test value: 16 Ω

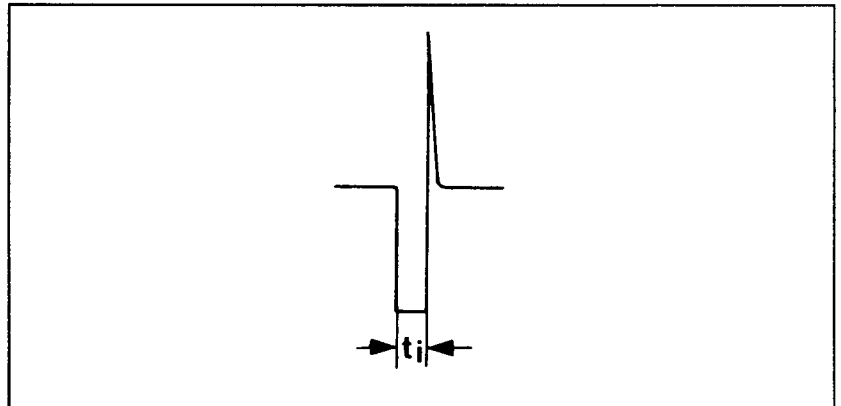
c) Injection output stage

Adjust the oscilloscope in accordance with the manufacturer's instructions. Connect a Bosch test lead (1 684 463 093) between an injection valve and plug. Connect the tester lead with the test lead in accordance with manufacturer's instructions.

Important:

Tester leads must not have any contact with ground.

Start the engine. The following displays must appear if the injection output stage is working perfectly and the test connections are correct:

Starter speed**Note:**

If the engine does not start or if the idle speed drops, change round tester connections to test lead and check tester adjustment.

Test point 20: Fuel pressure

The fuel collection pipe has a test connection at cyl. 1. Unscrew the cap nut of the test connection.

Important: The inserted ball seal could fall out!

Connect the pressure gauge P 378 to the test connection. Start the engine and run at idle speed with vacuum at the pressure regulator:

Test pressure 3.3 ± 0.2 bar

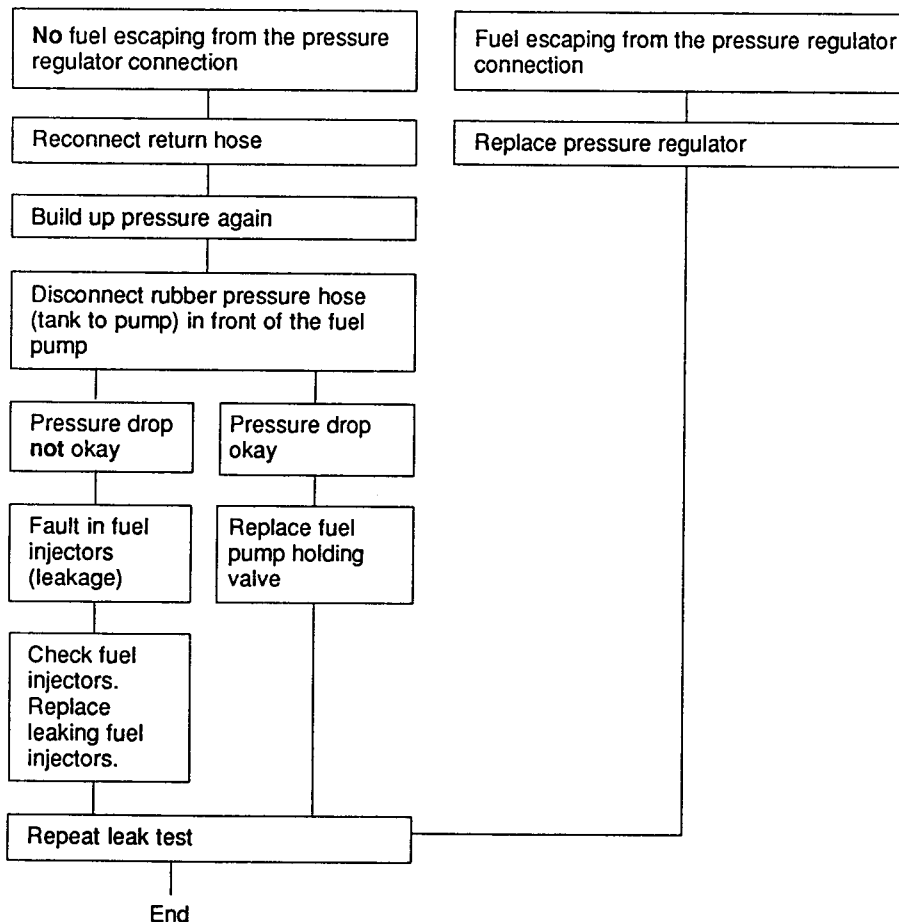
In the case of hot starting problems:

Perform the test with the engine stationary and with running fuel pump without a vacuum at the pressure regulator (to do this; remove the DME relay and jumper terminal 87b and terminal 30):

Test pressure 3.8 ± 0.2 bar

- Switch off the fuel pump. Read off the pressure value on the pressure gauge (nominal 3.8 ± 0.2 bar).
- Max. permissible temperature drop with warm engine: **0.5 bar in 30 min.**
- If the pressure drops below the specified value, proceed as described below:

Build up pressure again by switching on the fuel pump briefly. Remove the return pipe (fuel pump must not be switched on).



Test point 21: Intake system leaks

Check all connections after the air flow sensor for leaks. Remove the air filter bottom section with air flow sensor and lay aside. Close the hose to the activated carbon canister. Apply special tool 9264/5 to the connection hood and build up a pressure of approx. 0.5 bar in the intake system. In the event of leaks, the pressure in the intake system will fall rapidly.

Note:

Fault flashing code 1_23 (oxygen regulator at stop) appears in cars with oxygen regulation and very large leaks in the intake system (e.g. intake pipe gasket).

Test point 22: Ground connections/plug connections

- Ground point II
fuel pump, wheelhouse front right (end tip)
- Ground point IV
power ground under the seat, left
- Ground point V
electronics ground under the seat, left
- Ground point VI
central electrical ground on side member, right (under lid hinge)
- Ground point X
battery ground
- Ground point XI
grounding strip transmission-body (at the starter)
- Ground point XII
ignition output stages, engine compartment, rear left (between ignition coils)

Are ground connections tight and not corroded? Loosen, clean and retighten ground connections as specified.

Note:

**Never start the engine as long as the ground lead between the body and transmission is disconnected!
This will destroy the control unit immediately!**

Plug connections

Are all plugs connected correctly, not loose and not corroded? Disconnect plug connections: the pins and sleeves of the plugs must not be bent or corroded.

- The 55-pin plug on the DME control unit (under the driver's seat).
- 14-pin plug (under the driver's seat).
- A 12-pin plug at the rear left in the engine compartment.
- A 14-pin plug at the rear left in the engine compartment.
- A 3-pin plug for the reference mark/speed sensor and a 3-pin plug for the oxygen sensor on the left side of the engine.
- A 3-pin plug on the throttle valve switch.
- A 2-pin plug on the solenoid valve for tank venting (center of intake air distributor).
- A 4-pin plug on the air flow sensor.
- A 2-pin plug on the NTC II on the left side of the engine. (The temperature sensor is screwed into the cylinder head 3, accessible from below.)
- Two 7-pin plugs at the ignition output stages at the rear of the engine compartment.
- 3-pin plug on the Hall sensor (at the ignition distributor).
- 3-pin plug on knock sensor I (on the left side of the engine).
- 3-pin plug on knock sensor II (center of intake air distributor).
- A 2-pin plug on the idle speed control (at the intake air distributor).
- The two-pin plug on the solenoid valve of the resonance plate (center of the intake air distributor).
- A 2-pin plug in each case at the injection valves.

Since the Carrera is supplied worldwide with only one standard control unit and the control unit is coded correspondingly depending on the country equipment, this coding must be checked in the event of a complaint.

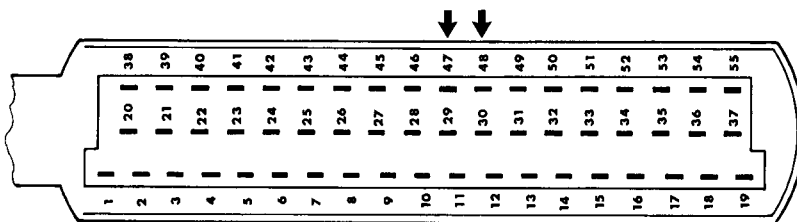
To allow calling up of the different characteristic maps, a 2-pin or 3-pin plug connection is brought out of the DME wiring harness near the plug receptacle.

The DME control unit is supplied with power via terminal 30 (battery +) as well as via ignition lock terminal 15.

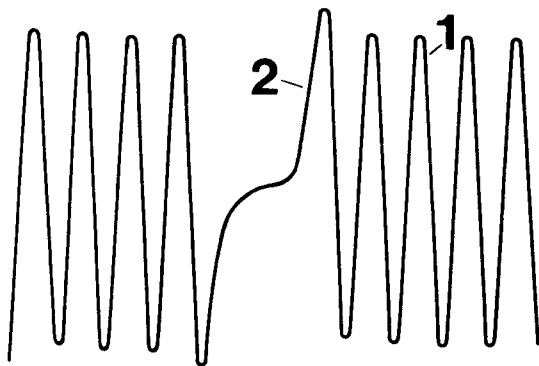
Test point 23: Speed/reference mark sensor

This test can only be performed with an oscilloscope. For this purpose, connect and adjust a workshop oscilloscope in accordance with the manufacturer's instructions.

Connect the positive tester lead via a test lead to the control unit plug terminal 47 and the negative tester lead via a test lead to control unit plug 48.



Crank the engine with the starter. Sinusoidal oscillations of at least 3 V (speed pulses) and an intermediate higher amplitude (reference mark) must be displayed on the screen.



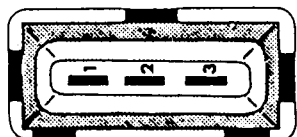
If the voltage signal is too small ($< 3V$), the distance between the sensor and the gear ring may be incorrectly adjusted.

Sensor distance: Between gear ring and sensor: $1 \text{ mm} \pm 0.2 \text{ mm}$.

- 1 – Speed signal
- 2 – Reference mark signal

If there is no display:

Disconnect the plug of the speed sensor at the terminal strip in the engine compartment. Connect tester leads to the middle and outer plug contacts of the plug (terminals 1 and 2, pin end) on the plug section to the sensor with test leads. Start the engine. Sinusoidal oscillations must be visible on the screen.



Speed sensor plug

Note:

If terminal 3 is connected to ground, the display must remain unchanged.

If this is not the case, check sensor for continuity, spacing and soiling.

Test point 24: Ignition system

In the case of dual ignition engines, each ignition circuit should be checked independently; the other ignition circuit is deactivated by disconnecting the plug of the respective ignition output stage for this. The remaining steps correspond to the sequence described in the test plan.

a) Secondary ignition display

Set the secondary ignition display on the oscilloscope. Connect the test leads according to the manufacturer's instructions.

Note:

If a fault is displayed for all cylinders, this is located in the primary or secondary circuits from the ignition coil to the distributor rotor. If a fault is displayed for one cylinder, the fault is located after the distributor rotor.

Primary resistor: Terminals 1 + 15 = 0.4-0.6 Ω
Secondary resistor: Terminals 1 + 4 = 5-7.2 kΩ

b) Spark plug connectors (Ω)

Suppression resistor: 3 kΩ

Visual inspection for damage; traces of burning

c) Distributor

Distributor rotor, distributor cap: Suppression resistor 1 k Ω each

Visual inspection for damage, soiling, incorrect installation position.

d) Ignition timing test

The ignition timing test is performed when the engine is at operating temperature.

The ignition timing and engine speed can be read directly in the „Actual value“ menu with the system tester 9288.

Test values:

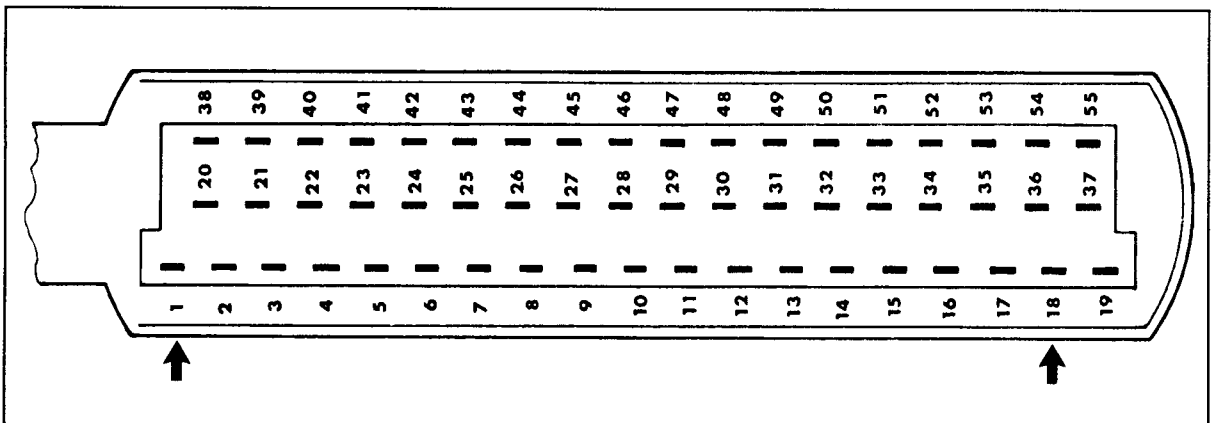
At 880 \pm 40 rpm 0° \pm 3°

e) Activation of the high-voltage end (if ignition sparks are not triggered)

The ignition trigger signal can be simulated for rapid troubleshooting at the ignition end. For this purpose, connect the oscilloscope tester lead terminal 4 to the ignition lead from the ignition coil to the high-voltage distributor (terminal 4).

Disconnect the DME control unit plug.
Switch on ignition.

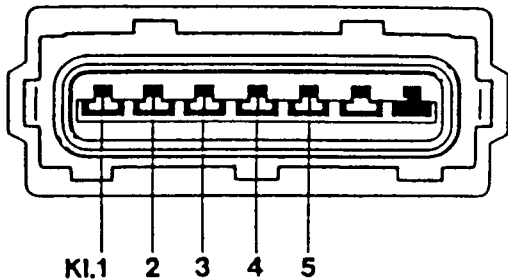
If a battery voltage is now applied intermittently to terminal 1 of the control unit plug with a test lead (e.g. control unit plug terminal 18), a high-voltage peak must be displayed on the oscilloscope each time (ignition triggering).

**If there is no signal, check:**

- Power supply to ignition output stages and ignition coils
- Ground point for ignition output stages (ground point at rear left of engine compartment).
- Plug connections to ignition output stages, ignition coils and high-voltage distributor.
- The components responsible for high voltage (e.g. ignition coil, ignition leads, spark plug connectors ...).
- Lead continuity from the control unit plug to the ignition output stage terminal 5.

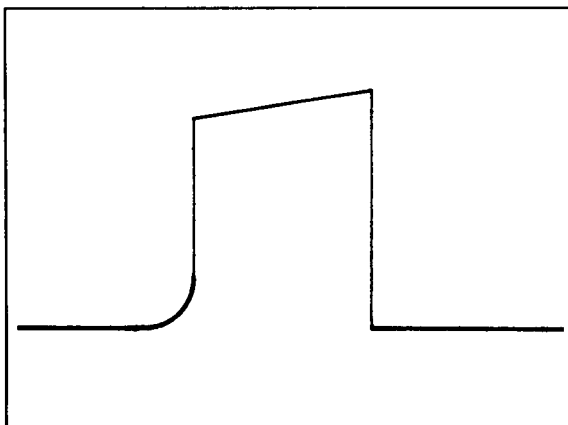
f) Testing the control signal for the ignition output stages

Connect the DME control unit plug.



Connect the positive tester lead of the oscilloscope to terminal 5 and the negative test lead to terminal 2 of the disconnected output stage plug.

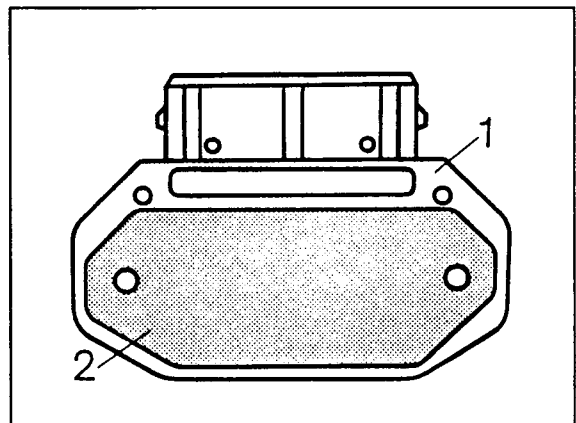
Operate the starter motor.
The oscilloscope must show the control signal of the DME control unit.



Please note:

Coat the baseplate with a heat-conducting paste prior to installation of the ignition output stage. Do not apply heat-conducting paste to painted parts.

Heat-conducting paste:
Bosch No. 5 942 860 003.



- 1 – Output stage
- 2 – Baseplate

Test point 25: Alternator, regulator

Misfiring of the engine may be caused by alternator voltage peaks.

Remove the drive belt from the alternator and start engine.

If the faults have been eliminated, check the alternator and regulator.

Prüfpunkt 26: Leads K and L

The diagnosis connection between the DME control unit and testers is established by means of the two leads K and L.

If no diagnosis is possible, run the test points indicated on pp. 03-43 to 03-45

Notes on idling speed and idle speed CO testing:**a) Idling speed**

The Carrera possesses an adaptive idle speed volumetric efficiency regulator. This means that it is not necessary to adjust the idle speed of any version. In vehicles with adaptive idle speed volumetric efficiency regulation, system adaption should be performed after disconnection of the DME control unit from permanent positive and after each inspection.

Idle speed control value for engines at operating temperature:

880 ± 40 min

b) Idle speed CO of cars without catalytic converter

The CO level is still adjusted at the CO adjusting screw in the air flow sensor. The following preconditions must be observed:

- Engine at operating temperature
- Engine mechanically in order and ignition system O.K.
- All loads switched off
- CO tester at operating temperature, calibrated and adjusted correctly.

After exhaust gas adjustment, perform system adaption. In the case of vehicles without catalytic converter, it must be ensured that the adapter plug (911.612.422.8) is plugged onto the oxygen sensor connecting lead in order to avoid interference (see wiring diagram).

c) Idle speed CO of vehicles with catalytic converter

In these vehicles, adaption of the idle speed CO content takes place as well as adaptation of the idle speed. Consequently, it is only necessary to check the actual condition in such vehicles. The following preconditions must be observed when performing the checks:

- Engine at operating temperature
- Mechanically in order and ignition system O.K.
- All loads switched off
- CO tester at operating temperature, calibrated and adjusted correctly.
- **Oxygen sensor plug connected**

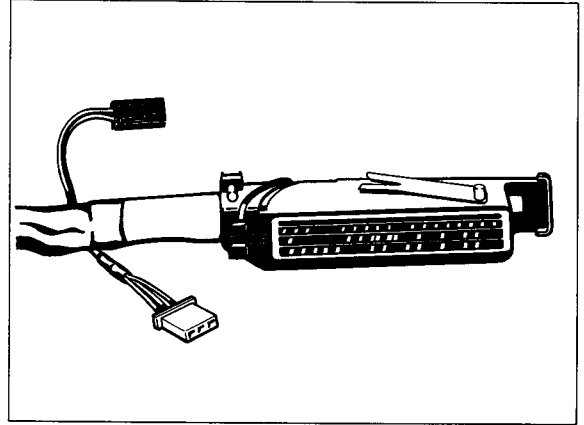
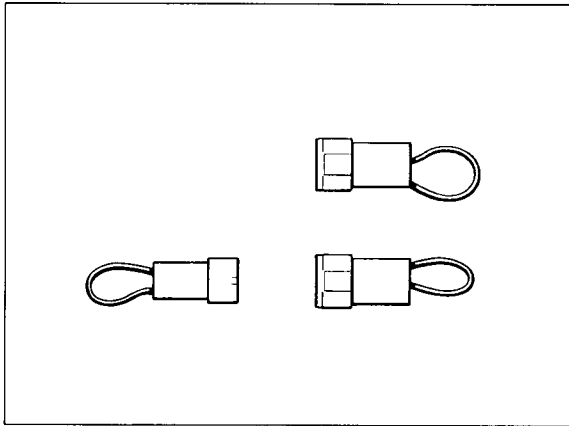
Test value: 0.4 - 1.2 % CO

at 880 ± 40 rpm and ignition timing of $0^\circ \pm 3^\circ$.

After disconnection of the control unit plug or the battery, the engine must run for at least 10 min. at idle speed before these values can be rechecked. In addition, system adaption must be performed.

Coding the DME control unit

Various characteristic maps are integrated in the DME control unit in order to cover the different country-specific legislation and different vehicle types. These characteristic maps can be read directly in the „Actual value“ menu with the system tester 9288.



In order to permit calling up of these characteristic maps, a 2-pin plug connection and a 3-pin plug connection are brought out of the DME wiring harness. These must be jumpered differently, depending on the country-specific version.

Transmission type/country	Transmissions code Terminal 54, 2-pin plug, black	Country code Terminal 39, 3-pin plug, white
TIPTRONIC–with catalytic converter <u>except</u> USA (whole) + Japan	Jumper to ground 944.612.525.01	open
TIPTRONIC USA (whole) + Japan	Jumper to ground 944.612.525.01	Jumper to battery voltage (+) 928.607.421.00
TIPTRONIC– without catalytic converter	Jumper to ground 944.612.525.01	Jumper to ground 928.607.422.00
MANUAL TRANSMISSION with catalytic converter, <u>except</u> USA (whole) + Japan	open	open
MANUAL TRANSMISSION USA (whole) + Japan	open	Jumper to battery voltage (+) 928.607.421.00
MANUAL TRANSMISSION without catalytic converter	open	Jumper to ground 928.607.422.00

As from model year '91, the code for California and Japan is being deleted (identical worldwide).

Check-Engine Lamp

(Malfunction Indicator Light M.I.L.)

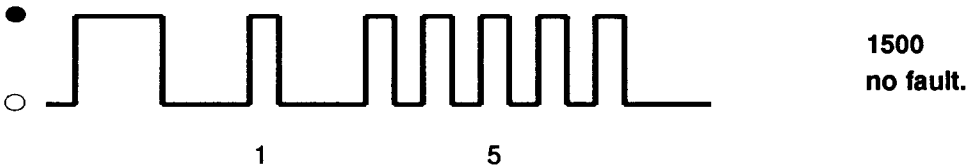
As from model year '91, Californian legislation prescribes a warning lamp which lights up if a part relevant to the exhaust gas fails.

As a function check of the warning lamp, it lights up when the Ignition is switched on and goes out once the engine is running when this is started without depressing the accelerator.

The warning lamp has a flashing code to indicate a defective fault path.

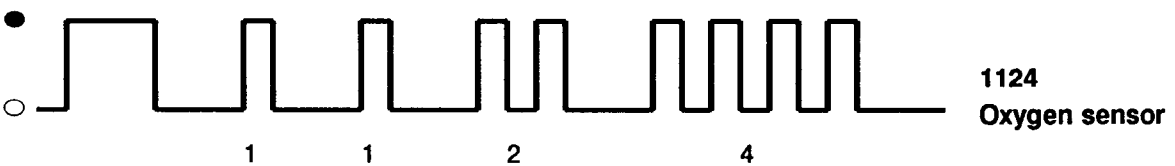
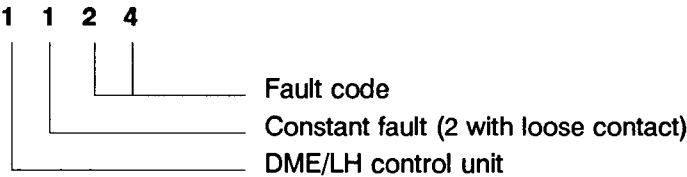
To trigger off the flashing code, fully depress the accelerator pedal with the engine off and the ignition on for 3 seconds until the Malfunction Indicator Lamp flashes. Then remove foot from accelerator.

If no fault is recorded, i.e. no warning came from the indicator light, there appears the flashing code



● = Lamp on ○ = Lamp off

If the warning light did indicate a warning, i.e. there is a fault, there appears a flashing code, e.g.



The flashing code is listed in the Diagnosing/Troubleshooting plan on page D 24/28-7.

The fault can also be read direct using System Tester 9288. After a repair the fault memory must be erased using the System Tester.

DME control units

Model	Standard control unit	Introduction date	Remarks
89	911.618.124.00 911.618.124.02	approx. May '89	
90	911.618.124.02 911.618.124.01 911.618.124.03 911.618.124.04	approx. Oct. '89 approx. Feb. '90 approx. March '90	
91	964.618.124.00 964.618.124.02 964.618.124.01	approx. March '90	except M 114* except M 114* M 114*
92	964.618.124.02 964.618.124.03 964.618.124.01 964.618.124.04	approx. Nov. '91	RoW, while stocks last control units except M 114* M 114*, RS M 114*, RS

*M 114 – Taiwan version

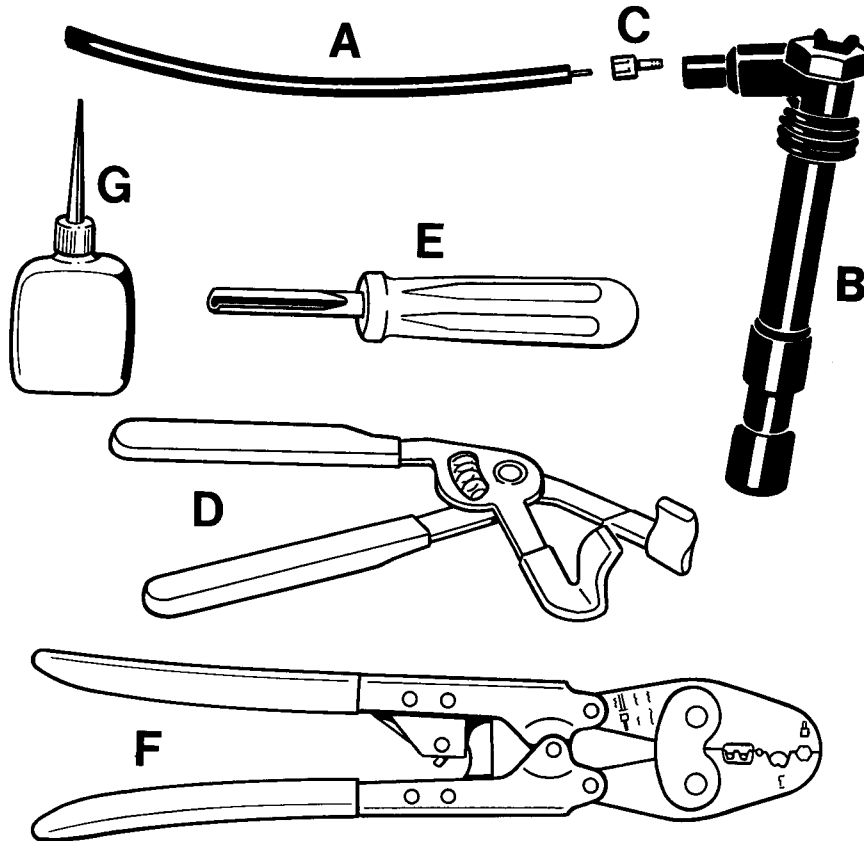
Spare control units

USA: up to MY '91: 964.618.124.02
as of MY '92: 964.618.124.03

RoW 964.618.124.03
M 114, 911 Carrera RS: 964.618.124.04

Replacing plug connectors, plug leads and threaded sleeve

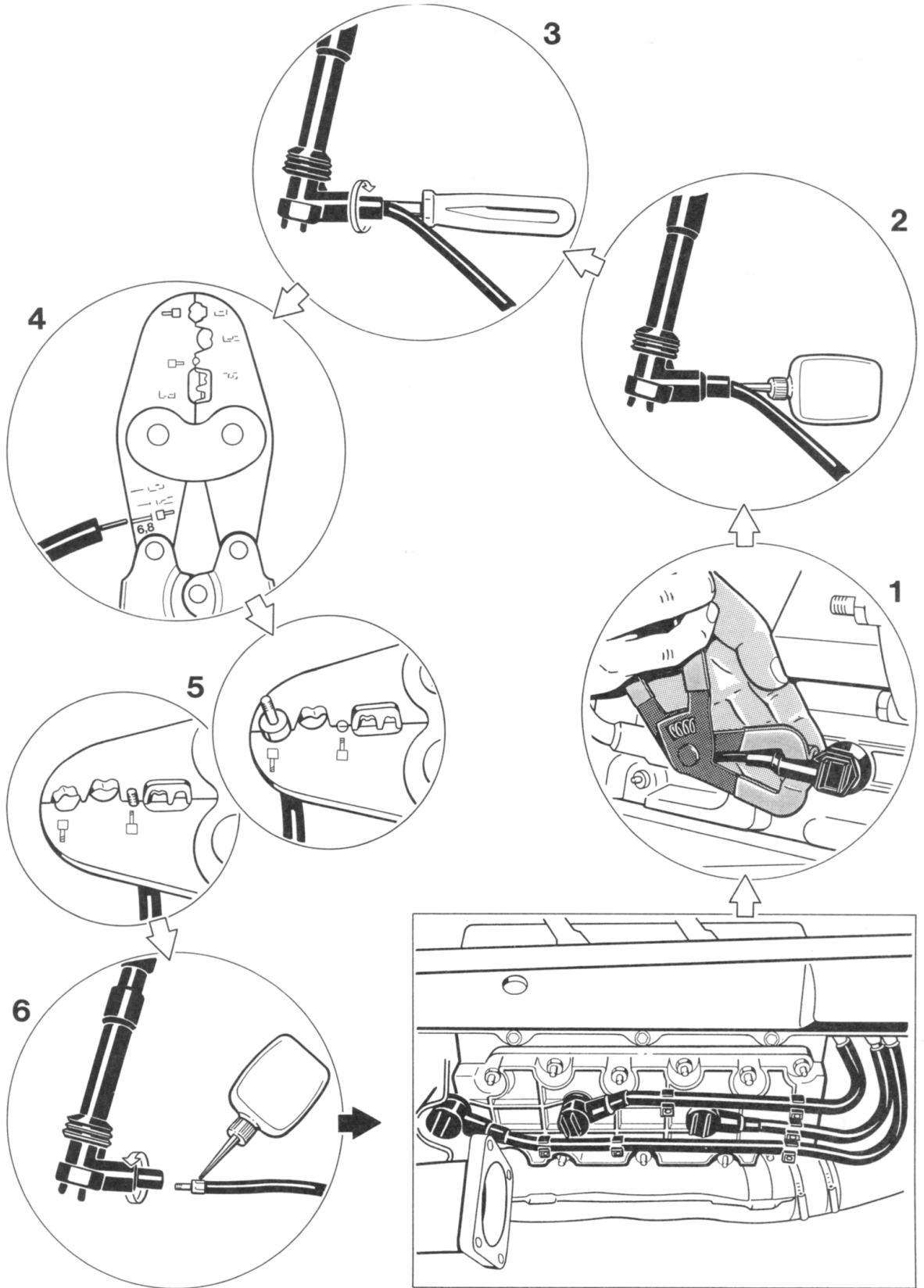
For the "Plug connectors, plug leads and threaded sleeve replacement" repair operation, the following spares, materials and tools are required:



1077 - 28

A	Plug lead		Porsche parts service
B	Spark plug connector		
C	Threaded sleeve	911.609.310.00	
D	Special Tool 9513	000.721.951.30	
E	Assembly tool EFS7	089.030.000.2	e.g. BERU Ruprecht GmbH&Co KG
F	Stop pliers ZAZ 3	089.030.000.1	P.O. Box 229 D - 7140 Ludwigsburg
G	Sliding compound	White oil (paraffine)	e.g. Fahrzeugtechnik Vogt Reichertshalde 35 D - 7140 Ludwigsburg

Replacing plug connectors, plug leads and threaded sleeve

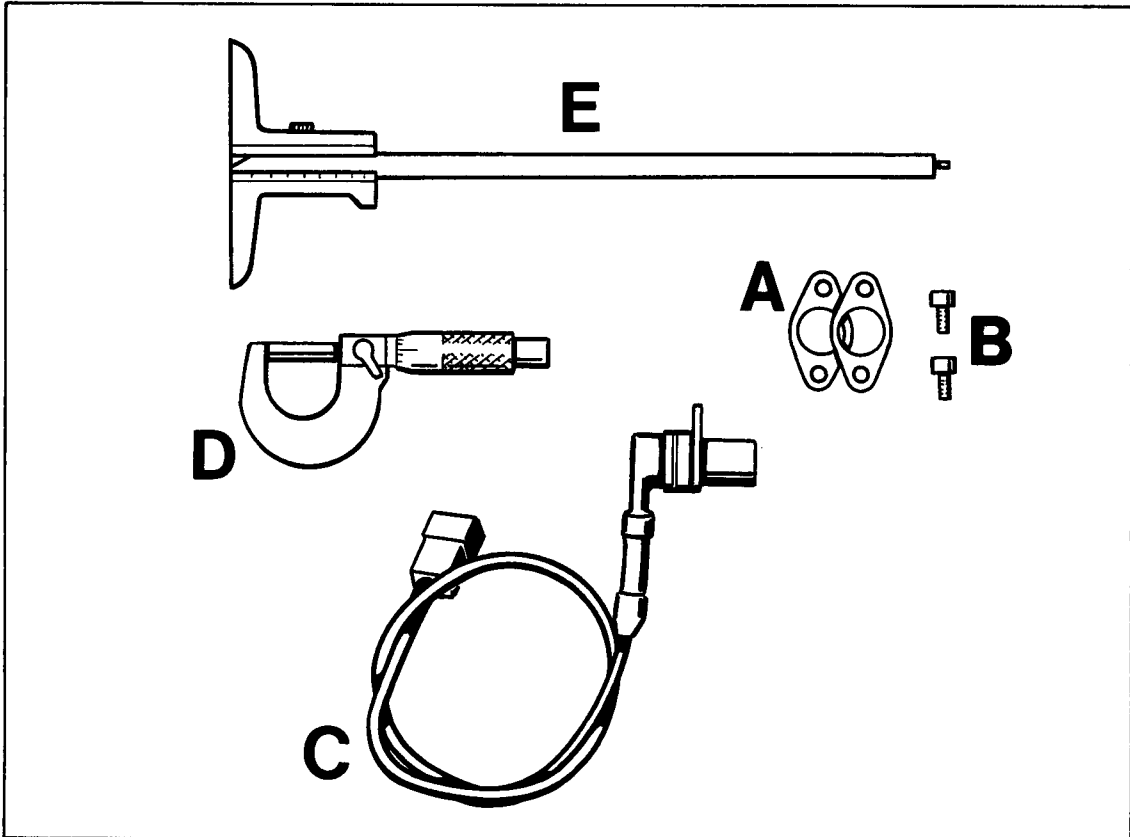


Replacing plug connectors, plug leads and threaded sleeve

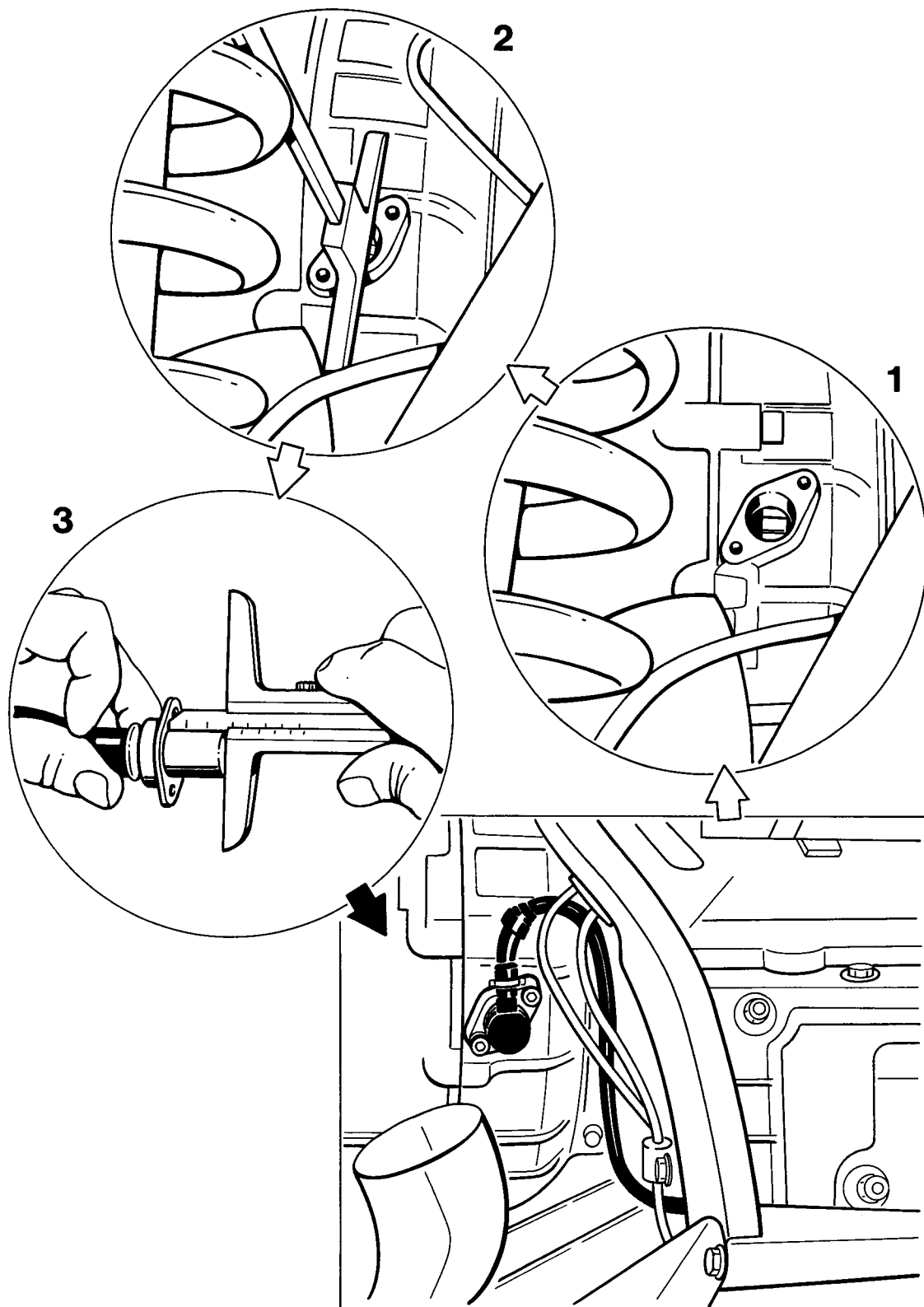
No.	Operation	Instructions
Removal:		
1	Pull plug connector off the spark plug	If connector does not pull off easily, use Special Tool 9513 (D). Note: To facilitate pulling with removal pliers, press with your free hand.
2	Apply sliding compound	Apply sliding compound (G) between plug lead and plug connector.
3	Disconnect plug lead from plug connector	Place assembly tool (E) along plug lead into plug connector. Use assembly tool to keep plug lead in place and unscrew plug connector.
Conversion:		
4	Strip plug leads	Shorten insulation of plug lead (A) by approx. 6.8 mm. The dimension of 6.8 mm can be checked by placing the lead against the corresponding spot marked on the stop pliers (F).
5	Fit threaded sleeve	Place threaded sleeve (C) up to the stop onto the plug lead. Place plug lead along with threaded sleeve into stop pliers. Connect wire to threaded sleeve by pressing the stop pliers until they disengage by themselves. Fit strain relief clamp by crimping the threaded sleeve in the stop pliers, making sure the pliers profile is flush with the end of the threaded sleeve on the plug lead side.
Fitting:		
	Apply sliding compound	Apply sliding compound (G) to plug lead (A) or plug connector (B)
6	Connect plug lead to plug connector Push plug connector onto spark plug	Place plug lead into assembly tool (E), place into plug connector and screw in place.

Determining engine speed sender clearance (Tiptronic vehicles)

The following spare parts and tools are req. for the "Determining engine speed sender clearance" operation:



<p>A</p>	<p>Spacer Thickness 0.1 mm Thickness 0.4 mm</p>	<p>964.606.217.00 964.606.217.02</p>	<p>Porsche parts service</p>
<p>B</p>	<p>Pan head screws for fitting of sender and spacers</p>	<p>999.218.005.02</p>	
<p>C</p>	<p>Engine speed sender</p>	<p>911.606.217.03</p>	
<p>D</p>	<p>Depth gauge</p>		<p>commercially available</p>
<p>E</p>	<p>Outside micrometer</p>		

Determining engine speed sender clearance (Tiptronic vehicles)

Determining engine speed sender clearance (Tiptronic vehicles)

Remove right-hand rear wheel and take off right heater hose from heat exchanger!

No.	Operation	Instructions						
	Remove sender	Undo upper M 6 x 16 pan head screw.						
1	Align flywheel	Rotate crankshaft or flywheel, respectively, and align a tooth of the flywheel to the center of the sender housing.						
2	Measure clearance	Determine the clearance between the spacers and the toothed head using a depth gauge. Record the value determined.						
3	Measure plug-in depth of the sender	Determine plug-in depth on the removed sender, using a depth gauge. Record the value determined.						
	Determine actual value	<p>Example:</p> <table style="margin-left: 20px;"> <tr> <td>Dimension from spacers to toothed head</td> <td style="text-align: right;">24.7 mm</td> </tr> <tr> <td>Sender plug-in depth</td> <td style="text-align: right;">- 24.0 mm</td> </tr> <tr> <td>Difference</td> <td style="text-align: right; border-top: 1px solid black;">0.7 mm</td> </tr> </table> <p>The difference between the depth value and the sender plug-in depth must be 1 ± 0.2 mm.</p> <p>In this case, insert a spacer with a thickness of 0.1 mm to achieve the specified value.</p>	Dimension from spacers to toothed head	24.7 mm	Sender plug-in depth	- 24.0 mm	Difference	0.7 mm
Dimension from spacers to toothed head	24.7 mm							
Sender plug-in depth	- 24.0 mm							
Difference	0.7 mm							
	Establishing the specified value: 1 ± 0.2 mm	To achieve the specified value, spacers available in thicknesses of 0.1 mm and 0.4 mm from the spares department may be used.						
	Correct setting	Undo bottom M 6 x 16 pan head screw and correct spacer thickness according to the dimension determined.						

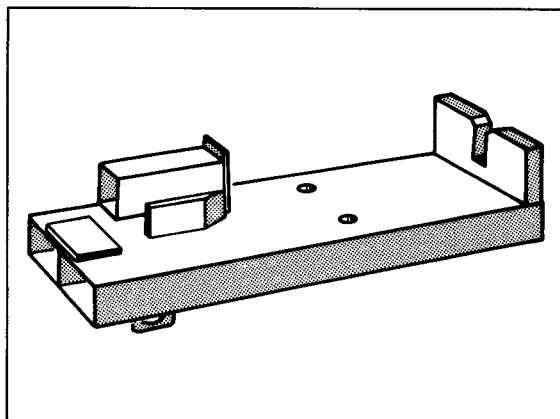
Note:

When making a new setting, try to achieve a difference of 1.0 mm!

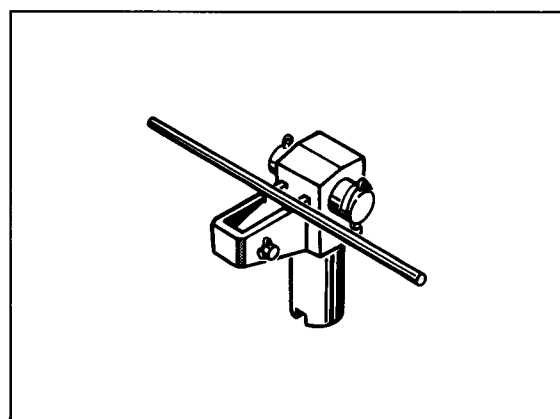
	Page
Engine, crankcase, suspension	
Removing and installing the engine (Tiptronic vehicles)	10 - 101
Removing and flange-mounting the engine-transmission assembly	10 - 111
Starter, power supply, cruise control	
Removing and installing the starter	27 - 101

Removing and installing the engine (Tiptronic vehicles)

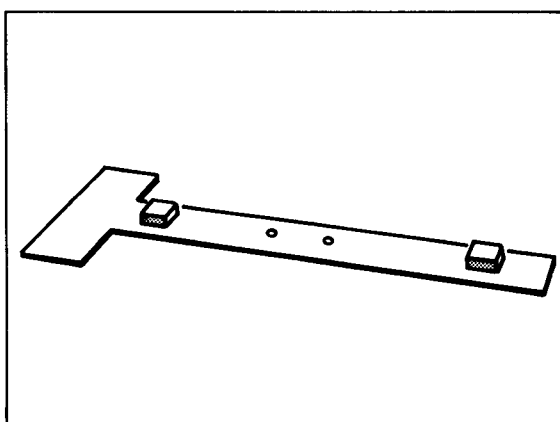
Special tools



440-10



441-10

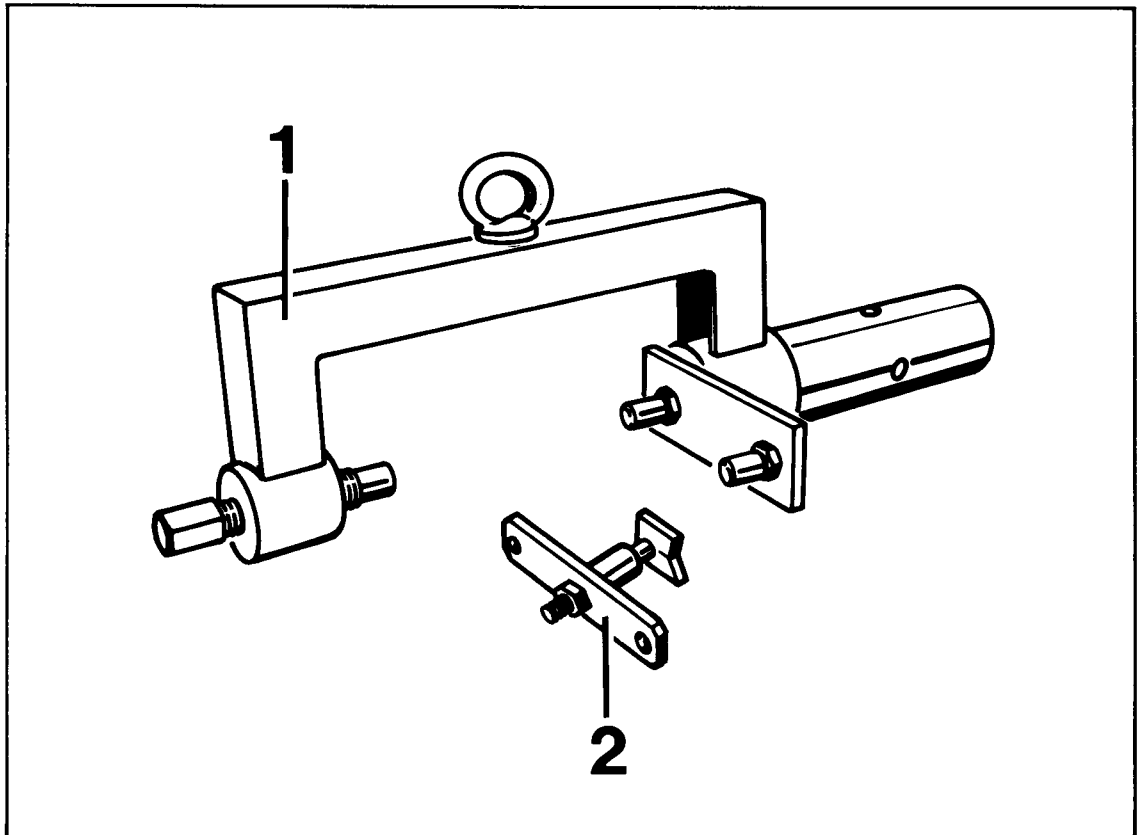


442-10

No.	Description	Special Tool	Order Number	Remarks
1	Engine support plate	9111/3	000.721.911.13	
2	Adapter for engine support plate	9111/1	000.721.911.11	
3	Support plate	9111/2	000.721.911.12	

Removing and installing the engine (Tiptronic vehicles)

Special tools



414-37

No.	Designation	Special tool	Order number	Explanation
1	Transmission holder	9324	000.721.932.40	
2	Holding device for torque converter	9325	000.721.932.50	

Removing and installing the engine Tiptronic vehicles

The engine-transmission assembly is removed completely downwards.

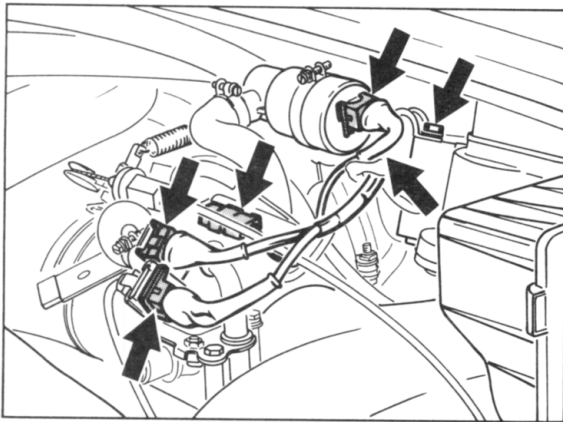
Removing

1. Support the vehicle at the support points.

Note:

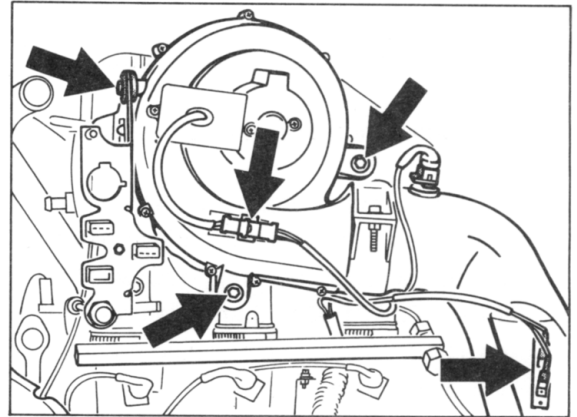
Align the rear right supports so that the transmission underbody cladding can be removed later on.

2. Disconnect the battery ground cable.
3. Disconnect the connectors (6 each) at the intake distributor and remove the cable clip on the air flow sensor.
Pay attention to connector sealing.



452-10

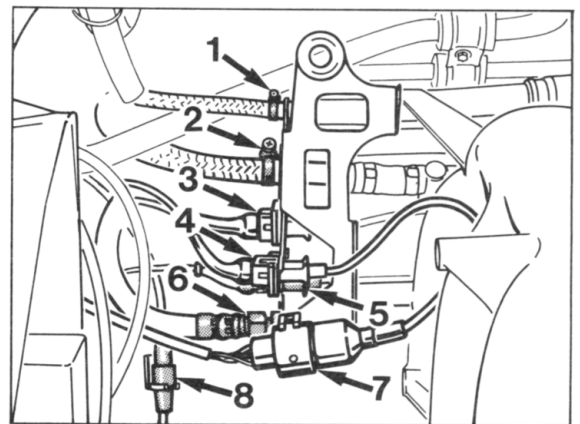
4. Remove hot-air blower



The drawing shows the engine in dismantled condition

454-10

5. Undo the following plug-in connections and cables on the left of the engine compartment:



453-10

1 - to the active-carbon container

2 - to the brake booster

3 - to the reference mark sensor

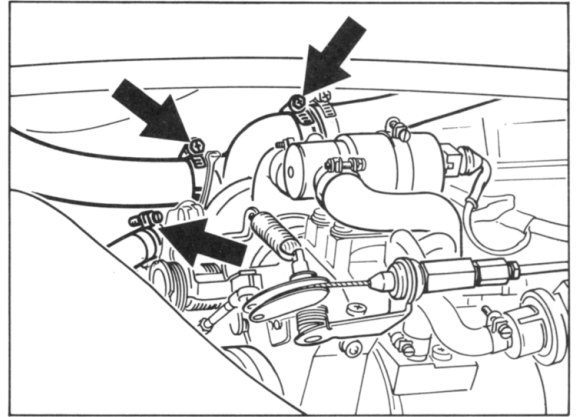
4 - to the knock sensor

- 5 - to temperature sensor II (cyl.3)
- 6 - Fuel return line*
- 7 - Plug-in connection, cruise control
- 8 - Plug-in connection, oxygen sensor

* In order to avoid discharge of fuel when the fuel tank is full, connect disconnected hose with special tool connecting hose 9507 Order No. 000 721 950 70 and clamp off the connecting hose with a standard commercially available hose clamp.

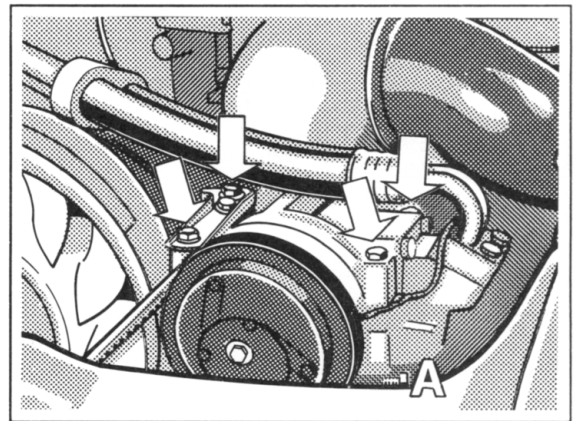
- 6. Remove the cover on the engine electrics board. Disconnect both multiple connectors.
- 7. Disconnect both ignition cables 2 and the connector from the double ignition distributor.
- 8. Disconnect the connector from the belt monitoring device.

- 9. Undo bleeding hoses. These can also be disconnected after lowering the engine-transmission assembly.



451-10

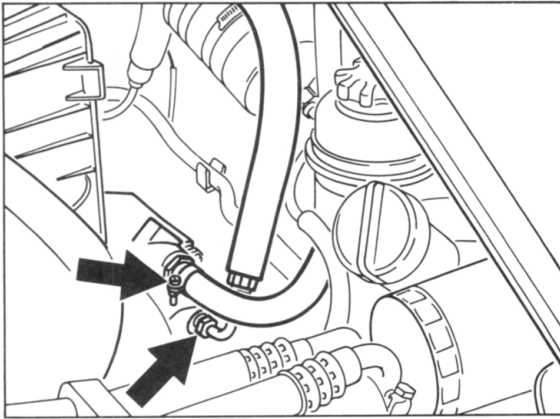
- 10. On vehicles with air-conditioning system, dismantle the compressor from the bracket and put down on a suitable surface at the left rear fender with connected hoses.



465-10

- 11. Remove air filter cover with filter insert.

12. Undo fuel supply line at fuel filter, counteracting at the same time. Collect residual fuel.
13. Empty supply reservoir of the power steering pump. Draw off fluid.
 - a. Undo hose clamp and pull off top hose, collect remaining oil.
 - b. Undo bottom line and remove with holder. Collect remaining oil.

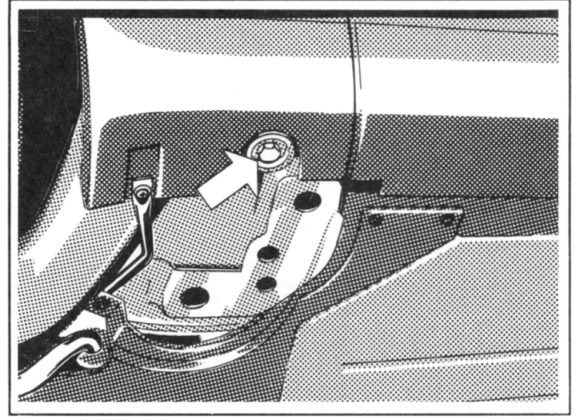


455-10

14. Remove wheels at rear.
15. Disconnect the actuating pull of the throttle valve at the reversing lever of the foot controls, unlock ball head and unscrew.
16. Remove engine, transmission underbody cladding.
17. Drain engine oil at thermostat housing.

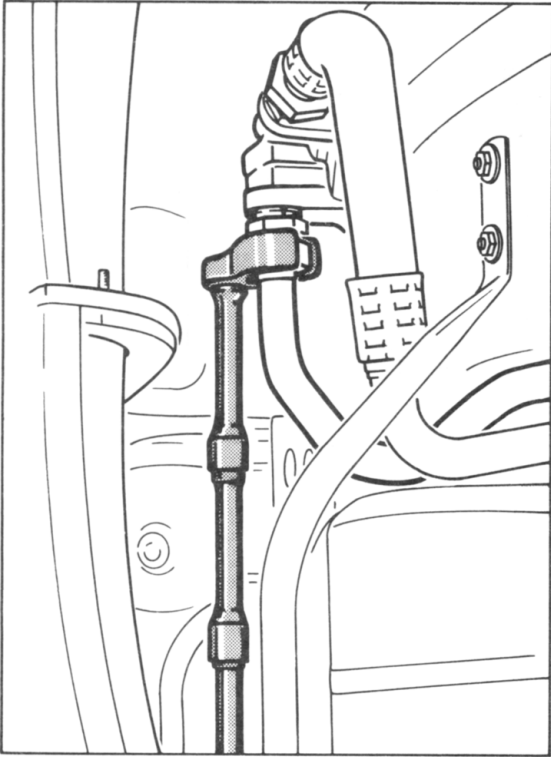
Note

In the case of engine overhauls, additionally drain engine oil at crankcase



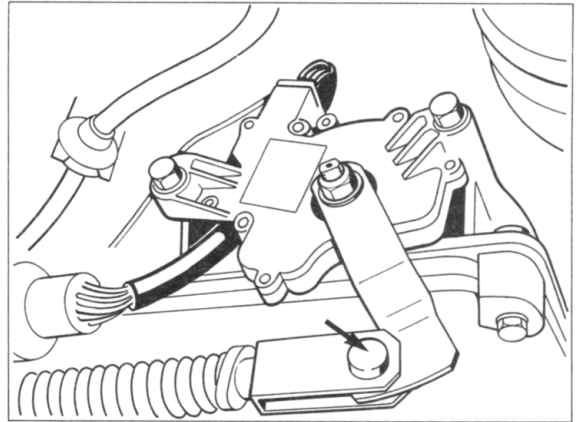
88/511

18. Undo oil line in rear right wheel house with special tool 9501, countering under all circumstances. Remove line retaining clip at wheel house. Block off line.



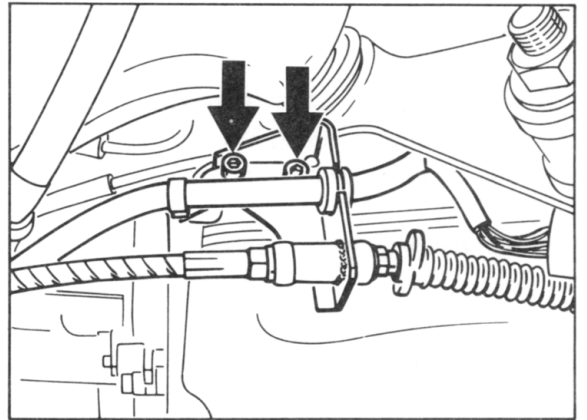
461-10

22. Disconnect cable, terminal 30, at starter
23. Pull throttle valve actuating pull out of guide tube of the underfloor assembly and disconnect.
24. Disconnect selector lever cord pull.



381 B-37

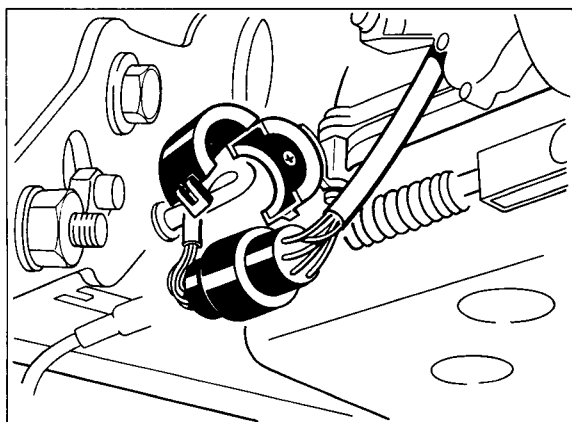
25. Undo holder for selector lever cord pull and disconnect completely.



456-10

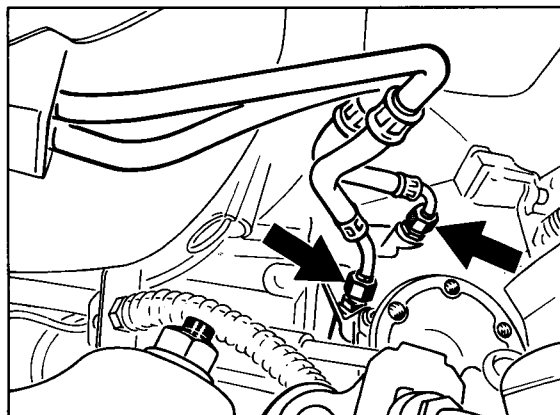
19. Disconnect universal shaft from the differential at the flange and hang up.
20. Undo heating hoses at the heat exchanger.
21. Undo the ground strap between the body and starter at the bottom starter mounting point.

26. Unlock cable holder, remove plug-in connection and disconnect.



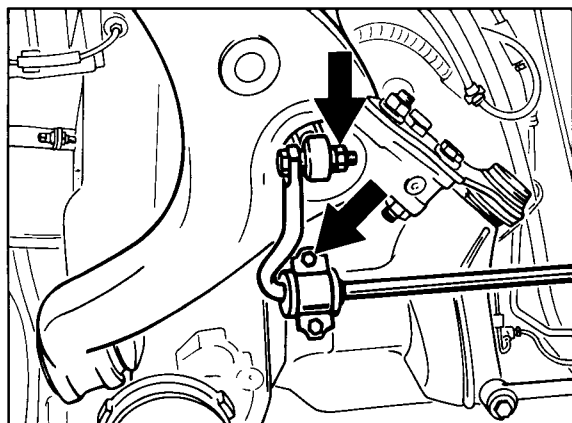
397-37

28. Undo oil lines and block off.



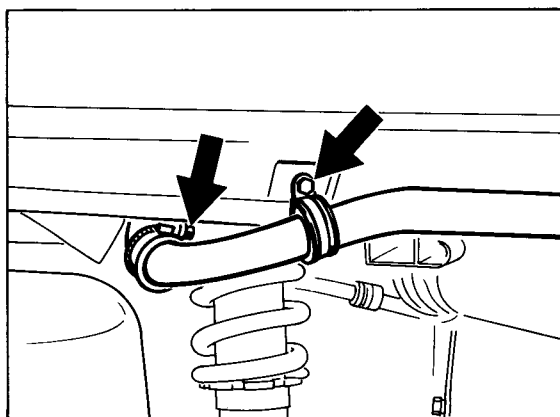
458-10

27. Undo and remove stabilizer.



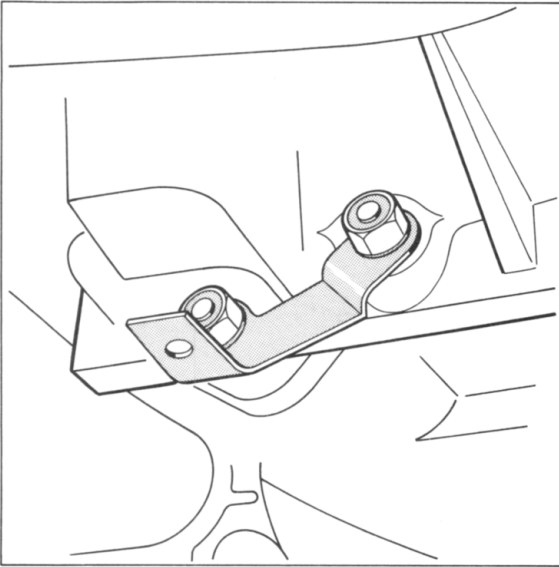
460-10

29. Undo oil hose of oil line in rear right wheel house and block off oil lines.



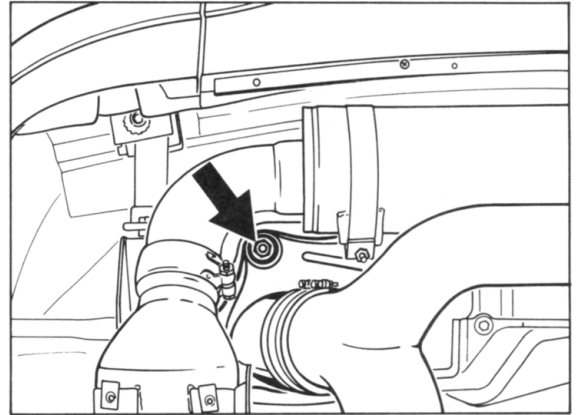
457-10

30. Undo securing holder for engine underbody cladding, remove and secure hexagon nut or hexagon screw again. (Bearing surface for engine support plate)



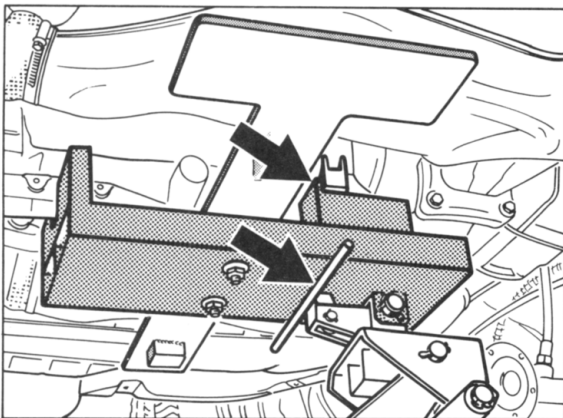
147-10

32. Undo transmission transverse member (6 screws).
33. Remove cover on assembly bore of the engine suspension in the rear engine end plate and undo hexagon nuts of the engine mountings from below.



462-10

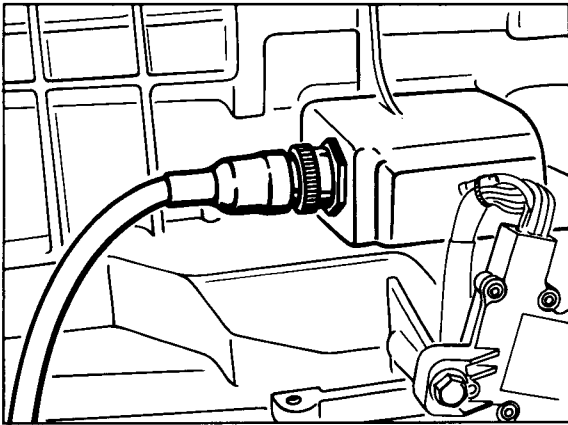
31. Place a jack with engine support plate underneath with a small amount of preloading. Pay attention to adapter position. (Engine-transmission horizontal).



459-10

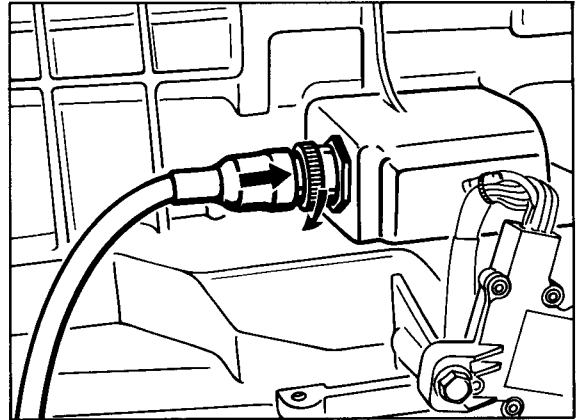
34. Lower engine-transmission assembly by approx. 10 cm:

- a. Disconnect multiple connector at air flow sensor.
- b. Disconnect connector from transmission socket. To do this, turn bayonet lock to left and disconnect connector.



387-38

- a. Plug multiple connector onto air flow sensor.
- b. Connect wiring harness with transmission socket. To do this, carefully insert the connector in the socket (fits only in one position) and lock by turning the bayonet lock to the right.



387-38

35. Carefully lower engine-transmission assembly.

Note

Pay attention to universal shaft, selector lever cord pull and throttle valve actuating pull.

Installation

The following points must be observed for installation.

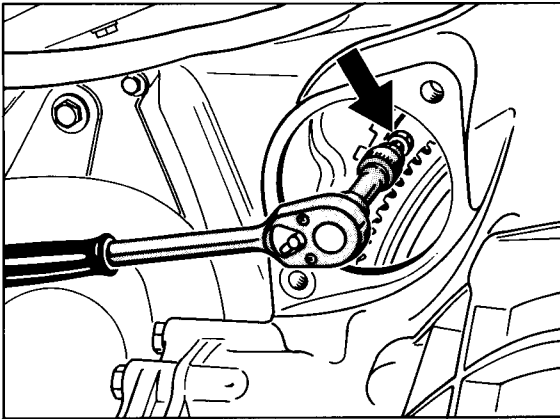
1. Before final positioning of the engine-transmission assembly in the installation position, the following connections must be made:

2. Make sure that the inner rubber seals of the plug-in connections are fitted properly.
3. Make sure that the profile seals between the engine paneling and body are properly fitted.
4. When tightening the oil line in the rear right wheel house, make sure that the oil line does not turn as well and repeat tightening if necessary.

Removing and flange-mounting the engine-transmission assembly

Removing from flange

1. Remove starter.
2. Undo torque converter fixing screws (M 6 x 16) and unscrew. (8 each).

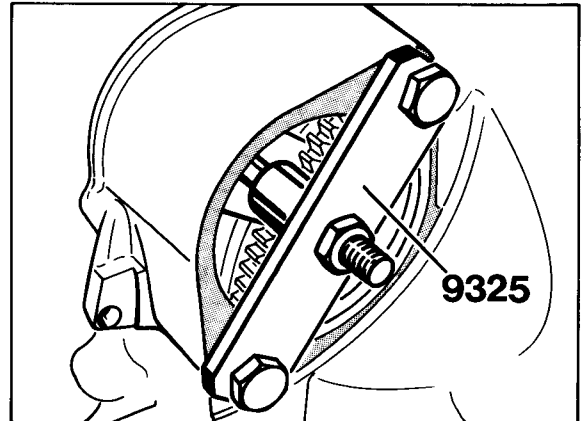


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3. Hang holding device 9325 behind the starter gear ring.

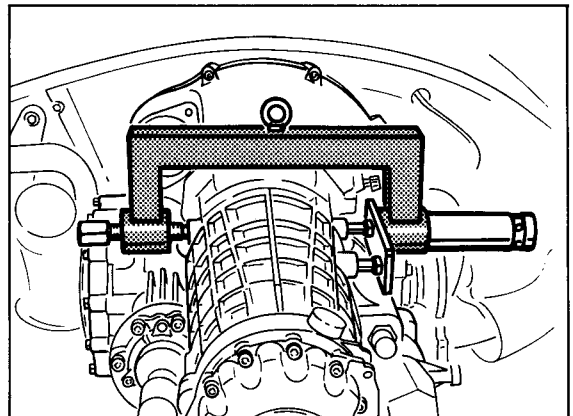
Note

During removal and flange-mounting, the holding device prevents the torque converter from falling out.



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4. Hook transmission holder 9324 in the mounting bores of the transmission case. Make sure that it is fitted correctly.

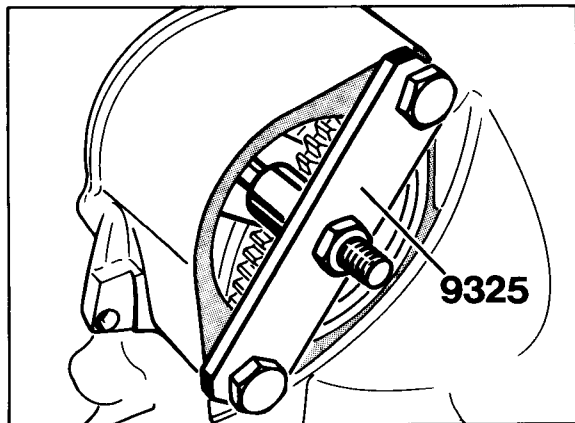


445-10

5. Suspend transmission holder from workshop crane and slightly pre-tension workshop crane.
6. Undo transmission ring screw connection and disconnect or pull off Tiptronic transmission from engine.

Flange-mounting

1. Hook holding device 9325 behind the starter ring gear.



413-32

2. Tighten the transmission ring screw connection fillister head screw M 8 x 35 (8.8) with 23 Nm.
Tighten fixing screws for torque converter M 6 x 16 (12.9) with 18 Nm.

Removing and installing the starter

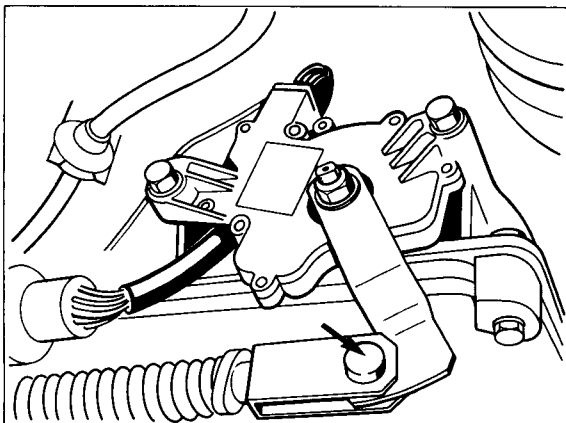
Tiptronic vehicles

Removing

1. Disconnect battery ground cable.
2. Remove engine-transmission underbody cladding

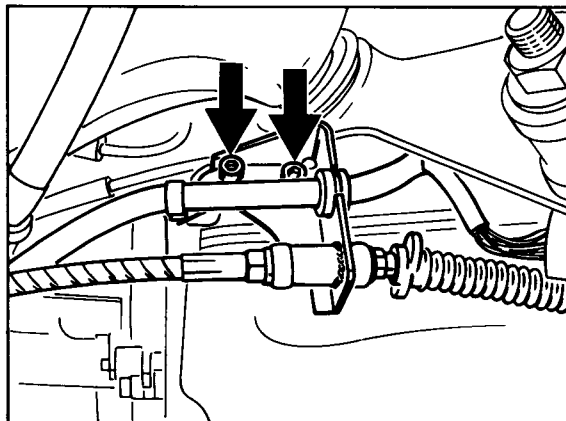
Assembly work – left side

1. Undo the universal shaft at the flange of the differential and disconnect.
2. Remove heating hose.
3. Disconnect selector lever cord pull.



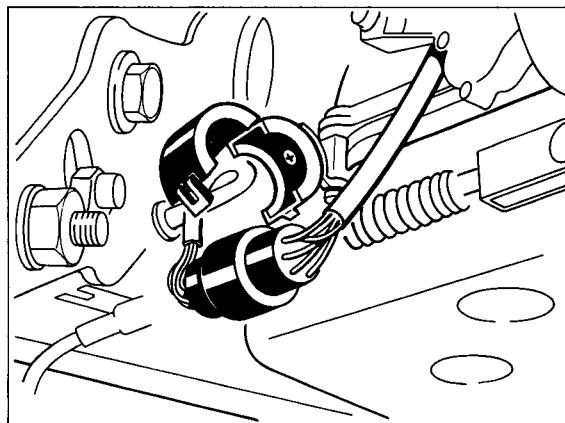
381 B-37

4. Undo holder for selector lever cord pull and disconnect completely.



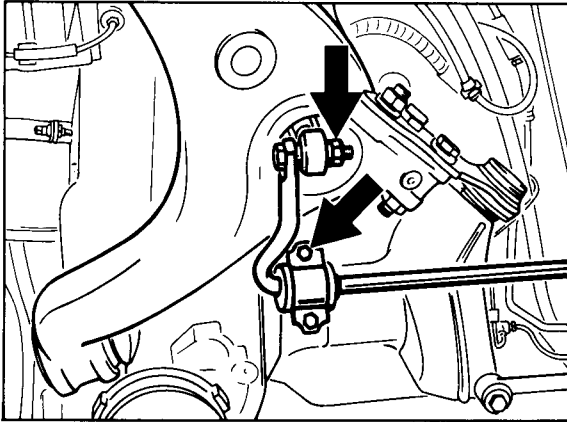
456-10

5. Unlock cable holder, remove plug-in connection and disconnect.



397-37

6. Undo and remove stabilizer.



460-10

7. Place a transmission jack under the transmission support and undo fixing screws (6 ea.).
8. Carefully lower transmission by approx. 5 cm.
9. Undo the hexagon socket screw of the upper starter mounting over the transmission case from the left side with a 3/8 inch ratchet and 8 mm INHEX insert (e.g. Messrs. Stahlwille - 49/8) .

Assembly work - right side

1. Undo the universal shaft at the flange of the differential and disconnect.
3. Remove heating tube.
4. Undo cables at terminals 30 and 50. Disconnect cable holder.
5. Undo ground strap between body and bottom starter mounting point and remove starter.

Installing

1. Assemble cables at terminals 30 and 50 with sufficient space between them. Fit protective cap on terminal 30.
2. When assembling the transmission-side joint flanges, make sure that the contact surfaces are extremely clean and free of grease. Only grease the screw thread with a minimum coating of Optimoly HT (copper paste).
3. Perform system adaption.

Note

The sintered bush for the starter bearing must not be greased or oiled and must not be cleaned with solvents (e.g. benzine).