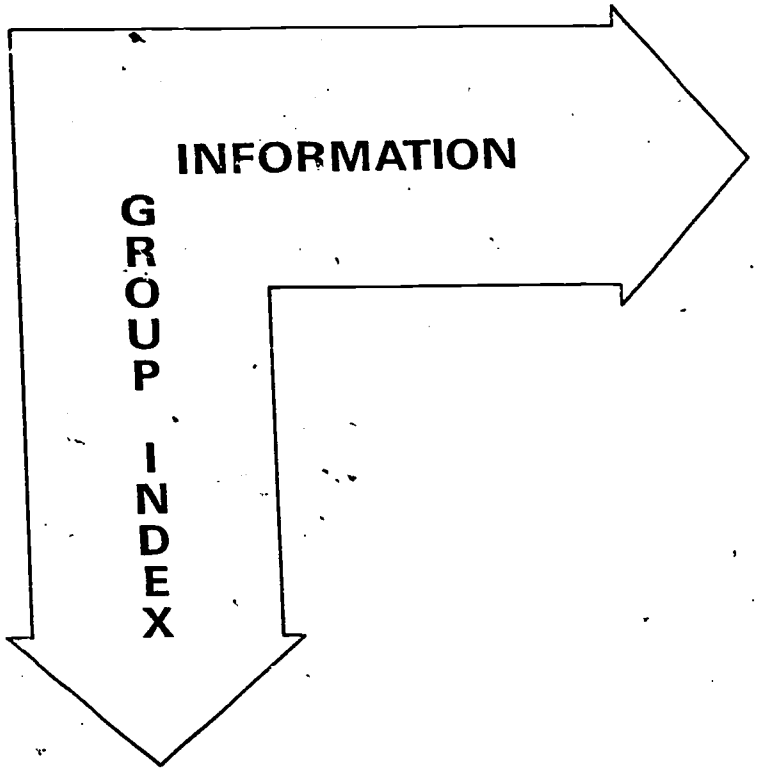


This workshop manual describes all of the important operations for which special instructions are required to assure proper completion. This manual is essential for the shop foremen and mechanics, who need this information to keep the vehicles in a safe operating condition. The basic safety rules, of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

The information is grouped according to repair numbers which are identical to the first two digits of the repair time and warranty code.

The repair group index, an alphabetical index and the register table are quick guides to find information in the manual.

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

This workshop manual will be kept up to date with Technical Information bulletins, which will be made part of the manual from time to time. We recommend that these workshop bulletins be filed in the special folder provided for this purpose.

Printed in Germany

NEW INTERNATIONAL UNIT SYSTEM

The "Legislation Concerning Units of Measurement" was passed in the Federal Republic of Germany on July 5, 1970. The new units have to be applied in official and business transactions by the end of the allocated transition period on December 31, 1977 (some even earlier).

The new units are derived from the international system of basic units.

Basic Units

Factor	Unit	
	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric strength of current	Ampere	A
Temperature	Kelvin	K
Intensity of light	Candela	cd
Substance quantity	Mol	mol

Decimal multiples and parts of units can be made by adding prefixes in front of the unit symbols.

Prefixes

Power of ten	Prefix	Prefix Symbol
10^{12}	Tera	T
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	Kilo	k
10^{2}	Hecto	h
10	Deka	da
10^{-1}	Deci	d
10^{-2}	Centi	c
10^{-3}	Milli	m
10^{-6}	Micro	µ
10^{-9}	Nano	n
10^{-12}	Pico	p

Examples:

1. Unit m (meter). By adding prefix k (kilo) we have km (kilometer = 1,000 m).

2. Unit s (second). By adding prefix m (milli) we have ms (millisecond = 1/1000 s).

The following list is a survey of important units used frequently in motor vehicle repair operations.

List of Units

Factor	Basic Unit	Other Acceptable Units	Remarks
Length	m	µm, mm, cm, dm, km etc.	No longer acceptable: µ for 0,001 mm
			0,001 mm = 1 µm
Area	m^2	mm^2, cm^2, dm^2 etc.	No longer acceptable: qm, qmm, qcm etc.
Volume	m^3	mm^3, cm^3, dm^3 etc. l, ml, cl etc.	No longer acceptable: cbm, cmm, ccm etc., ltr., Ltr.
			1 l = 1 dm^3
Plane angle	rad (radiant)	° (degree) ' (minute) " (second)	1 rad = 1 m/m 1° = π/180 rad 1° = 60' 1' = 60"
			" not acceptable for inch
Solid angle	sr (steradiant)	m^2/m^2	1 sr = 1 m^2/m^2
Mass	kg	g, mg, dag etc. t, kt, Mt etc.	No longer acceptable: pound, hundredweight, double-hundredweight
			1 t = 1000 kg
			Weight is given in kg

Factor	Basic Unit	Other Acceptable Units	Remarks
Density	kg/m^3	kg/dm^3, kg/l, g/cm^3 etc.	No longer acceptable: specific weight
Time	s	min (minute) h (hour) d (day) a (year)	3h = 3 hours 3^h = 3 o'clock For time data, e.g. $3^h40^m20^s$ min can be abbreviated in m
			No longer acceptable: Sec., sec., hr.
Volumetric flow (flow rate)	m^3/s	cm^3/min l/s, l/h etc.	
Frequency	Hz (Hertz)	kHz, MHz etc.	1 Hz = 1/s
Speed of revolvement	$1/s$ s^{-1}	1/min min^{-1}	No longer acceptable: U/min, Upm
Speed of travel	m/s	km/h	
Acceleration	m/s^2		g (acceleration of fall) $g = 9.81\ m/s^2$
Force	N (Newton)	kN, MN etc.	No longer acceptable: ?, kp, Mp, dyn
			1 N = 1 kg m/s^2 1 kp = 9.81 N ≈ 10 N
Pressure	N/m^2 Pa (Pascal)	bar, mbar etc.	No longer acceptable: kp/cm^2, atm., at, ata, atü, atu, mmHg, Torr, mWs
			Pressure or vacuum must be specified, e.g.: 2 atü ≈ 2 bar pressure = 3 bar 0,4 atu ≈ 0,4 vacuum = 6 bar 5 ata ≈ 5 bar

Factor	Basic Unit	Other Acceptable Units	Remarks
			1 N/m^2 = 1 Pa 1 mbar = 100 Pa 1 bar = 1 kp/cm^2 = 1 at 1 bar = 750 Torr
Mechanical stress (strength)	$N/n.^2$	N/m^2	No longer acceptable: kp/cm^2, kp/mm^2
Dynamic viscosity	Pa s	mPa s, µPa s	No longer acceptable: P (Poise), cP, kg s/m^2, dyn s/cm^2
			1 Pa s = 10 P = 0.1 kg s/m^2
Kinematic viscosity	m^2/s	cm^2/s, mm^2/s	No longer acceptable: St (Stokes), cSt, E (Engler degree)
	1		1 cm^2/s = 1 St
Torque	Nm	Ncm, Nmm	No longer acceptable: kpm, kpcm, etc.
			1 Nm = 0.1 kpm 1 Nm = 1 kgm^2/s^2
Work, energy, heat quantity	J (Joule)	mJ, kJ etc. Nm, kWh, Ws	No longer acceptable: kpm, erg, cal, kcal, PSh, We (thermal unit)
			1 J = 1 Nm = 1 Ws 1 J = 0.1 kpm 1 cal = 1 WE = 4.19 J 1 PSh = 0.736 kWh
Specific fuel consumption	kg/kWh	g/kWh, kg/J	No longer acceptable: g/PSh, kg/PSh
Power	W (watt)	mW, kW etc.	No longer acceptable: PS
			1 PS = 0.736 kW

Factor	Basic Unit	Other Acceptable Units	Remarks
Weight coefficient	kg/W	kg/kW	No longer acceptable: kg/PS
Temperature	K (Kelvin)	°C	No longer acceptable: °K (degrees Kelvin), grd. (temperature difference)
			1° C = 1 K
Electric current strength	A (ampere)	µA, mA etc.	
Electric voltage	V (volt)	µV, mV, etc.	1 V = 1 W/A
Electric resistance	Ω (Ohm)	mΩ, kΩ etc.	1Ω = 1 V/A
Electric charge, electrical quantity	C (Coulomb)	Ah, As	1 C = 1 As
Electric capacitance	F (Farad)	pF, µF, mF	1 F = 1 C/V
Sound level	phon	dB (decibel)	
Light flux	lm (Lumen)		1 lm = 1 cd sr
Light intensity	lx (Lux)		1 lx = 1 lm/m^2

General

Printed in Germany – May, 1988

TECHNICAL DATA

(adjusting values and wear limits appear in pertinent repair groups)
Note: USA values in brackets.

Engine		M 44/01 manuals – M 44/03 automatics (M 44/02 manuals – M 44/04 automatics) M 44/05 manuals – M 44/06 automatics (M 44/07 manuals – M 44/08 automatics)
Number of cylinders		4
Bore	mm/in.	100/3.94
Stroke	mm/in.	78.9/3.11
Displacement (actual)	cm^3/$in.^3$	2479/151.26
Displacement (fiscal)	cm^3	2449
Compression ratio		10.6 : 1 (9.5 : 1)
Max. engine power to 80/1269/EC	kW/HP	120/163 (110/150)
Net power, SAE J 1349	kW/HP	116/156 (105/143)
At engine speed	rpm	5800 (5500)
Max. torque to 80/1269/EC	Nm/kpm	205/20.9 (192/19.6)
Net torque, SAE J 1349	Nm/ft. lbs.	199/151.3 (186/137)
At engine speed	rpm	3000
Max. specific power output	kW l / HP l	48/66 (44.4/60.5)
Net power to SAE J 1349	kW l / HP l	48/63 (42.4/57.7)
Fuel grade		96 RON (91 RON – unleaded fuel only)
Engine speed limit	rpm	6500
Engine weight (dry)	kg/lbs.	166/366
Engine Design		
Type		Water-cooled, axial, 4 cylinder, 4 stroke, in-line, internal combustion engine with toothed belt driven overhead camshaft and two compensating shafts
Crankcase		Two-piece, light alloy
Crankshaft		Forged steel
Crankshaft bearings		Five

Connecting rods		Forged steel/cast since February, 1984
Conrod bearings		Plain
Piston pin bearings		Press-fit brass bushings
Pistons		Cast light alloy
Piston pins		Floating installation, secured with circlips
Piston rings		2 compression rings and 1 oil scraper ring
Cylinders		Light alloy
Cylinder head		Light alloy
Valve seat inserts (shrink-fit)		Intake: FCr 330 Exhaust: CoMo 75
Valve guides		Press-fit special brass
Valve arrangement		1 intake 1 exhaust, overhead, in-line
Exhaust valves		With armored seat
Valve springs		2 coil springs per valve
Valve timing		By overhead camshaft and hydraulic cam followers
Camshaft		Shell hard cast
Camshaft bearings		Camshaft runs in camshaft case without bearing shells
Camshaft drive		Toothed belt with tensioning roller
Valve clearance		Automatic hydraulic adjustment
Timing with 1 mm lift and zero valve clearance		Intake opens 1^{o} after TDC Intake closes 49^{o} after BDC Exhaust opens 43^{o} before BDC Exhaust closes 3^{o} before TDC
Engine Cooling		Closed cooling system, electric fan with thermo switch, antifreeze for – 25^{o} C
Engine Lubrication		
System		Pressure circulation with sickle-type pump, oil filter and oil/water heat exchanger in oil full flow and water bypass integrated in crankcase
Oil pressure at 5,000 rpm		Approx. 4 bar at operating temperature
Oil pressure display		Indicator lamp and pressure gage
Max. oil temperature		140^{o} C
Oil consumption	ltr./1000 km	Up to 1.5

Exhaust System		Manifold, single pipe up to primary muffler, primary and final mufflers (manifold, single pipe up to 3-way catalytic converter, final muffler)
Heating		Warm water heat. ..ith heat exchanger and blower
Fuel System		DME (Digital Moto. Electronics)
Fuel supply		1 electric delivery pump
Fuel grade	RON/MON	96/86 (91/82 unleaded)
Fuel consumption to 80/1268/EC in	ltr./100 km	Manuals / Automatics at 90 km/h 6.4 / 6.5 at 120 km/h 8.0 / 8.1 city cycle 11.5 / 11.3
Also official specifications for France and Great Britain - ECE A 70 -		
Electrical System		
Interference suppression		ECE - R 10 and 72/245/EC or VDE 0879
Battery voltage	V	12
Battery capacity	Ah	50 (63)
Battery capacity (M-eq.)	Ah	63
Alternator output	A/W	90/1260, 115/1610 since 1985/2 models
Ignition		Via DME
Spark plug connectors		Without booster gap
Firing order		1 - 3 - 4 - 2
Ignition timing control		Via DME
Body Type		Coupe with integral steel body, 2 doors, bolted front fenders, rear window and spoiler tailgate, concealed headlights; removable hardtop roof as optional extra equipment

Dimensions (at DIN curb weight)		
Length	mm/in.	4200/165.354 (4290/168.898)
Length with US bumpers as optional equipment	mm/in.	4290/168.898
Width	mm/in.	1735/68.307
Height	mm/in.	1275/50.197
Wheelbase (designed)	mm/in.	2400/94.488
Front track	mm/in.	7J x 15/7J x 16 1477/58.150 6J x 15/6J x 16 1452/57.165 5 1/2J x 15 1440/56.693
Rear track	mm/in.	7J x 15/7J x 16 1451/57.126 6J x 15/6J x 16 1426/56.142 5 1/2J x 15 1414/55.669
Ground clearance (at max. weight)	mm/in.	125/4.921 120/4.72 since 1985/2 models
Bed clearance	mm/in.	53/2.087
Front overhang angle (limited by spoiler)		14°
Rear overhang angle (limited by exhaust)		15°
Weights (to DIN 70020)		
Curb weight	kg/lbs	1180/2601 (1260/2779) since 1985/2 models: 1210/2668 (1260/2779)
Curb weight axle force Front Rear	 kg/lbs kg/lbs	 580/1279 (620/1367) 600/1323 (640/1411) since 1985/2 models: 630/1389 (640/1411)
Max. total weight	kg/lbs	1500/3307 (1550/3418) since 1985/2 models: 1530/3373 (1550/3417)
Max. front axle load	kg/lbs	720/1588
Max. rear axle load	kg/lbs	880/1940, 900/1984 since 1985/2 models
Payload	kg/lbs	320/706 (290/639)
Max. roof load, incl. roof carrier	kg/lbs	35/77 or 75/165 with roof transporting system
Max. trailer load without brakes*	kg/lbs	500/1103
with brakes*	kg/lbs	1200/2646
Max. car/trailer weight	kg/lbs	2700/5952 since 1985/2 models: 2730/6019 (2750/6063)
Max. drawbar load	kg/lbs	50/110

* Gradients up to 16%

Filling Capacities

Engine oil (volume depends on measurement with oil dipstick - see Owner's Manual)	brand name HD oil to API Cl. SE or SF - see Owner's Manual
Engine oil volume	approx. 6.0 ltr.
Engine coolant volume	approx. 7.8 ltr.
Transmission with differential volume	approx. 2.0 ltr. of hypoid gear lube SAE 80 to MIL-L 2105, API Classification GL 4
Fuel tank volume	approx. 66 ltr., of which 9 ltr. in reserve since 1985/2 models: approx. 80 ltr., of which 8 ltr. in reserve
Brake fluid volume	approx. 0.2 ltr.
Washing fluid volume for windshield and headlights	approx. 6.0 ltr.

Performance

Top speed	km/h / mph	220/137 (210/130)	
		Manuals	Automatics
Acceleration from 0 to 100 km/h*	sec	8.4 (9.3)	9.6
(0 to 60 mph)*	sec	(8.3)	(9.8)
(1/4 mile)*	sec	(16.2)	(17.2)
Kilometer from standing start*	sec	28.8(30.1)	30.5(31.4)

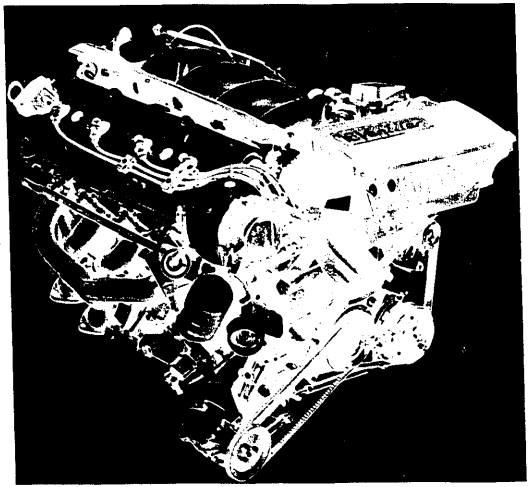
Hill Climbing

		Manuals	Automatics
In % (slip limit)	1st gear	63	55 (38.5)
	2nd gear	36 (34)	25 (19)
	3rd gear	23 (21)	15 (11)
	4th gear	15 (14)	
	5th gear	10 (8)	

* DIN curb weight + 1/2 of payload

DESIGNACION DE LOS CILINDROS

TYPE 944 S (16-VALVE ENGINES) - '87 MODELS ONWARD



TECHNICAL DATA

(Adjustment specifications and wear data are stated in the appropriate Repair Groups)

Note: US values are stated in parentheses

DRIVE UNIT

Internal engine designation		M 44/40
Number of cylinders		4
Bore	mm/in.	100/3.94
Stroke	mm/in.	78.9/3.11
Displacement (actual)	cc/in.^{3}	2479/151
Compression ratio		10.9 : 1
Max. engine output to 80/1269/EC	kW/PS	140/190 - 135/184 Australia
Net power, SAE J 1349	kW/HP	140/188
at engine speed	rpm	6000
Max. torque to 80/1269/EC	Nm/kpm	230/23.5 - 225/22.9 Australia
at engine speed	rpm	4300
Net torque, SAE J 1349	Nm/lbft	230/170
Max. spec. power output	kW l/HP l	56.5/76.6-54.5/74.2 Australia
Net power, SAE J 1349	kW l/HPI	56.5/75.8
Fuel octane rating	RON/MON	95/85 - 92/82 unleaded Australia (95/85 premium unleaded)
Max. perm. engine speed	rpm	6840
Engine weight (dry)	kg/lbs	175/386

ENGINE DESIGN

Type	4-cylinder, 4-stroke in-line spark ignition engine with two balance shafts

Crankcase		Two-part light alloy crankcase
Crankshaft		Forged, 5 bearings
Crankshaft bearings		Plain
Connecting rods		Cast, opt. sinter-forged
Connecting rod-bearings		Plain
Pistons		Light alloy, cast
Balance shafts		Forged
Balance-shaft bearings		Plain bearings with bearing shells
Cylinders		Light alloy
Cylinder head		Light alloy
Valve guide		Press-fit, special brass
Valve arrangement		2 intake, 2 exhaust overhead V
Valve timing		Two overhead camshafts, hydraulic bucket tappets
Camshaft		Without bearing shells, carried in cylinder head
Camshaft drive		Toothed belt and internal chain
Balance-shaft drive		Toothed belt
Valve clearance		Self-adjusting (hydraulic)
Timing	Intake opens	4° after TDC
	Intake closes	40° after BDC
	Exhaust opens	36° before BDC
	Exhaust closes	4° before TDC

ENGINE COOLING		Sealed cooling system, electric fan with thermoswitch, antifreeze effective to - 25°C
ENGINE LUBRICATION		
Lubrication		Forced-feed lubrication with sickle-type pump, oil filter and oil-water heat exchanger in main oil flow and secondary water flow integrated in crankcase
Oil pressure	n = 5000 rpm	Approx. 4 bar, at operating temperature
Oil-pressure indicator		Pilot lamp and pressure gage
Max. oil temperature		140°C
Oil consumption	1/1000 km	Up to 1.5
EXHAUST SYSTEM		Standard 2 double-wall manifolds, branch pipe to primary muffler, 1st and 2nd secondary mufflers Option: M298 or M299 and USA and Australia as standard, catalytic converter instead of primary muffler
EMISSION CONTROL		Standard: engine-internal Option: M298 or M299 and Australia heated oxygen sensor with 3-way catalytic converter
HEATING		Hot-water heating with heat exchanger and blower

FUEL SYSTEM

Injection		DME Digital Motor Electronics
Fuel delivery		1 electric fuel pump
Fuel octane rating	RON/MON	Standard: 95/85 - European standard premium unleaded possible Opt./M298: 95/85 unleaded - European standard premium - Australia: 91/82 unleaded
Fuel consumption to 80/1268/EC or ECE R 15/04		Standard:
Constant 90 km/h	1/100 km	6.7
Constant 120 km/h	1/100 km	8.3
EC exhaust urban cycle	1/100 km	12.5

ELECTRICAL SYSTEM

Suppression		ECE-R 10 and 72/245/EC
Battery voltage	V	12
Battery capacity	Ah	50 - optional 63, sports package 36
Alternator (output)	A/W	115/1610 - sports package: 90/1260
Ignition		8y DME
Firing sequence		1-3-4-2
Ignition timing		8y DME

BODY DESIGNS

Integral all-steel body with front air dam and rear spoiler
- as coupé, opt.: removable hardtop panel, also available with fog lamps set in PU front air dam as optional extra.

DIMENSIONS (at DIN curb weight)

Length	mm/in.	4230/165.354 (4290/168.90)	
Length with opt. extra US bumpers	mm/in.	4290/168.90	
Width	mm/in.	1735/68.31	
Height	mm/in.	1275/50.20	
Wheel base (in design pos.)	mm/in.	2400/94.49	
Track:			Rim size
Front	mm/in.	1477/58.2	7 J x 15
		1477/58.2	7 J x 16
		1477/58.2	8 J x 16
Rear	mm/in.	1451/57.1	7 J x 15
		1451/57.1	7 J x 16
		1451/57.1	8 J x 16
		1442	9 J x 16
Ground clearance (at per. total weight)	mm/in.	120/4.72	
Bed clearance (at per. total weight)	mm/in.	53/2.09	
Overhang angles:			
Front		14°	
Rear		15°	

WEIGHTS - to DIN 700 20 -

Curb weight		Standard	Sports package	Australia, standard
Front	kg/lbs	640/1411 (650/1433)	630/1389	640/1411
Rear	kg/lbs	640/1411 (650/1433)	610/1345 (630/1389)	640/1411
Total	kg/lbs	1280/2822	1240/2734 (1260/2778)	1280/2822
Per. axle load				
Front	kg/lbs	730/1609	730/1609 (720/1587)	730/1609
Rear	kg/lbs	900/1984	900/1984	920/2028
Per. total weight	kg/lbs	1600/3527	1600/3527 (1550/3417)	1620/3571
Per. trailer load				
Braked trailer	kg/lbs kg/lbs	1200/2646 1200	up to 16% gradient for Italy	
Unbraked trailer	kg/lbs kg/lbs	500/1102 500	up to 16% gradient for Italy	
Max. car/ trailer weight	kg/lbs kg/lbs	2760/6085 2760	for Italy	
Max. drawbar load	kg/lbs kg/lbs	50/110 50	for Italy up to 100 km/h	
Per. roof load	kg/lbs	35/77		
With genuine Porsche roof transport system	kg/lbs	75/165		

CAPACITIES

Engine (measurement with dipstick as per Driver's Manual is definitive)		Proprietary HD oils to API classification SE or SF, see Driver's Manual
Engine oil		Approx. 6.0 l
Engine coolant		Approx. 8.5 l
Transmission with differential		Approx. 2.0 l hypoid oil, SAE 80 to MIL-L 2105, API classification GL 4
Fuel tank		Approx. 80 l, including approx. 8 l reserve
Brake-fluid reservoir		Approx. 0.2 l
Windshield and headlight washing fluid reservoir		Approx. 6.0 l

PERFORMANCE

Maximum speed	km/h/mph	228/142
Acceleration from 0-100 km/h*	s	7.9
(0-60 mph)*	s	(7.7)
(1/4 mile from standing start)*	s	(15.4)
Kilometer from standing start*	s	27.8

CLIMBING PERFORMANCE

In % (slip limit)	1st gear	62%
	2nd gear	35.6%
	3rd gear	21.5%
	4th gear	13.3%
	5th gear	9.4%

*DIN curb weight and half of payload

TOLERANCES AND WEAR LIMITS

		New Part	Wear Limit
Cooling System			
Thermostat	Opening temperature	81 – 85 °C (178 – 185 °F)	
Radiator cap High pressure valve	Opening pressure	$1\ ^{+0.15}_{-0.10}$ bar ($14{,}5\ ^{+2.1}_{-1.5}$ psi)	
Low pressure valve	Opening pressure	0.1 bar (1.5 psi)	
Oil Circuit			
Oil consumption	ltr./1000 km (600 mi./US qt)		approx. 1.5
Oil pressure at 80 °C (176 °F) oil temperature and at 5000 rpm	Pressure	approx. 4 bar (58 psi)	
Oil dipstick Upper mark Lower mark	 Capacity Capacity	 5.5 ltr. (5.8 US qt) 4.2 ltr. (4.4 US qt)	
Valve Timing			
Camshaft bore	Inside dia.	$60.5\ ^{+0.03}_{-0}$	
Camshaft	Diameter	$60.5\ ^{-0.04}_{+0.055}$	
Camshaft	End play	0.10 – 0.18	
Cam follower bore in camshaft housing	Inside dia.	$38\ ^{+0.027}_{+0.007}$	
Cam follower	Diameter	$38\ ^{-0.018}_{-0.034}$	
Camshaft	Runout	0.02	

TOLERANCES AND WEAR LIMITS

		New Part	Wear Limit
Cylinder Head and Valves			
Mating surface	Distortion		max. 0.08
Valve seat:			
Intake	Width	1.7	
Exhaust	Width	2.0	
Intake	Seat angle	45°	
Exhaust	Seat angle	45°	
Outer correction angle		30°	
Inner correction angle		60°	
Valve guides:			
Intake and exhaust	Inside dia.	9 + 0.015	
Valve stem:			
Intake	Diameter	8.97 – 0.012	
Exhaust	Diameter	8.95 – 0.012	
Valve guide/valve stem	Clearance		
Intake		0.8	
Exhaust		0.8	
Compression	Pressure	10 bar (145 psi) or more	

TOLERANCES AND WEAR LIMITS

			New Part		Wear Limit
Pistons and Connecting Rods					
Cylinder/piston	Clearance		0.008 – 0.032		approx. 0.080
			Mahle	KS	
Piston rings	Side clearance	Groove 1	0.05 – 0.082	0.05 – 0.082	
		Groove 2	0.04 – 0.072	0.05 – 0.082	
		Groove 3	0.023 – 0.137	0.023 – 0.137	
Piston rings	End gap	Groove 1 = 0.20 – 0.45 Groove 2 = 0.20 – 0.45 Groove 3 = 0.38 – 1.40			
Connecting rod bushing	Diameter		$24^{+0.018}_{+0.028}$		
Piston pin	Diameter		24 – 0.004		
Connecting rod bushing/ piston pin	Radial play		0.018 – 0.032		
Crankshaft and Engine Block					
Crankshaft	Runout		0.04 – 0.06		max. 0.08
Connecting rod bearing journal	Diameter		51.971 – 51.990		
Connecting rod bearing/ crankshaft	Radial play End play		0.034 – 0.082 0.100 – 0.400		
Crankshaft bearing journal	Diameter		69.971 – 69.990		
Crankshaft bearing/crankshaft	Radial play End play		0.020 – 0.098 0.110 – 0.312		 0.40
Cylinder bore	Out-of-round		0.010		0.020
Bore for balance shaft bearing shells in crankcase and balance shaft cover	Diameter		35.000 – 35.019		
Bore for bushing in bearing housing	Diameter		34.000 – 34.019		
Balance shaft	Diameter		30.975 – 30.991		

10

Engine – crankcase, suspension

Engine/Crankcase

Printed in Germany – May, 1988

TIGHTENING TORQUES FOR ENGINE

Location	Tightening Procedures	Torque Nm (ftlb)	Threads
Crankcase upper and lower halves (stud bolts)	3 stages: 1st stage	20 (14)	M 12x1.5
	2nd stage	50 (37)	
	3rd stage	90 (66)	
	2 stages: 1st stage	20 (14)	M 10
	2nd stage	50 (37)	
		10 (7)	M 6
		20 (14)	M 8
Rotation element on compensating shaft		10 (7), locked with Loctite 270	M 6
'82 - '85 models Compensating-shaft housing cover to upper crankcase half	Bolt lightly oiled	8 (5.9)	M 6
Hex bolt	2 stages: 1st stage	15 (12)	M 8
	2nd stage	20 (14)	
Stud bolt	2 stages: 1st stage	15 (12)	M 8
	2nd stage	30 (22)	
'85 models onward Compensating shafts with separate bearing bridges:			
Bearing bridges (nuts) of compensating shafts to upper crankcase half	2 stages: 1st stage	15 (12)	M 8
	2nd stage	33 (24)	
Compensating-shaft housing cover to crankcase upper half, hex bolt		10 (7)	M 6
	2 stages: 1st stage	15 (12)	M 8 x 55
	2nd stage	20 (14)	

Location	Tightening Procedures	Torque Nm (ftlb)	Threads
'87 models onward Hex bolt (bearing bridge) for compensating-shaft housing to crankcase upper half	2 stages: 1st stage	15 (12)	M 8 x 58
	2nd stage	33 (24)	
Mounting, bearing housing left and right to crankcase upper half		20 (14)	M 8
Connecting-rod bolt with Verbusrip ribbed nut		75 + 5 (55 + 3.6)	M 10 x 1.25
Connecting-rod bolt with smooth contact surface		57 + 5 (41 + 3.6)	M 10 x 1.25
Water drain plug in upper crankcase half		20 (14)	M 8
Oil pan to crankcase mounting	3 stages: 1st stage	handtight	M 6
	2nd stage	4 (2.9)	
	3rd stage	10 (7)	
Oil-pan insert to oil pan		5.6 (4.1) locked with Loctite 270	M 5
Oil drain plug		50 (37)	M 20 x 1.5
Engine support mounting, l + r to crankcase		48 (35)	M 10
Flywheel to crankshaft mounting		90 (66)	M 10 x 1.25
Holders for sensors to crankcase		20 (14)	M 8

Location	Tightening Procedures	Torque Nm (ftlb)	Threads
Sprocket to crankshaft		210 (154)	M 16 x 1.5
Sensor to holder		8 (5.9)	M 6
Pulley to sprocket		13 (10)	M 6 x 25 Material 10.9
Cylinder head to crankcase upper half	Tightening cylinder head gasket: 1st stage 2nd stage 3rd stage Threads of studs must be oiled lightly	 20 (14) 50 (37) 90 (66)	
Cylinder head to crankcase upper half in conjunction with 12 mm thick nut	Tightening cylinder head gasket: 1st stage 2nd stage 3rd stage Threads of studs must be oiled lightly	 20 (14) 90° of turn 90° of turn	
Intake pipe to cylinder head		20 (14)	M 8
16-VALVE ENGINES Bearing bridges of camshafts to cylinder head		20 (14)	M 8
16-VALVE ENGINES Hex-socket-head bolts for chain tensioner		10 (7)	M 6

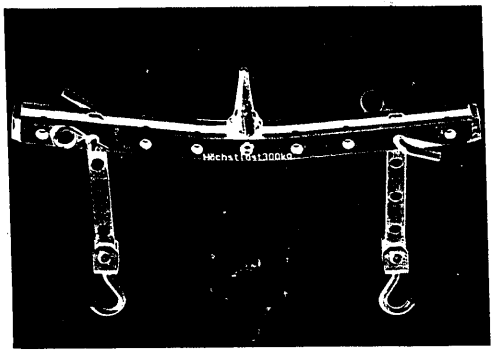
Location	Tightening Procedures	Torque Nm (ftlb)	Threads
16-VALVE ENGINES Hollow bolt/chain tensioner		10 (7)	M 8 x 1
Heater feed connector to cylinder head		20 (14)	M 8
Adapter for coolant pipe		20 (14)	M 8
16-VALVE ENGINES Cover to cylinder head		10 (7)	M 6
Camshaft housing to cylinder head		20 (14)	M 8
Aluminum plugs in camshaft housing		40 (30)	M 18x1.5
Camshaft bearing to camshaft housing		8 (5.9)	M 6
Camshaft sprocket to camshaft Hex socket-head bolt Multispline bolt		 45 (34) 65-70 (48-52)	 M 10 M 10
Bracket to camshaft bearing		8 (5.9)	M 6

Location	Tightening Procedures	Torque Nm (ftlb)	Threads
Connector to carrier		5 (3.6)	M 5
Distributor rotor to connector		4 (2.9)	M 4
Transport holder to cylinder head		8 (5.9)	M 6
Sprocket to compensating shaft		45 (33)	M 10
Tensioning roller to bearing housing		45 (33)	M 10
Water pump to crankcase		8 (5.9) Locked with Loctite 270	M 6
Roller to water-pump housing		45 (33)	M 10
Toothed-belt cover to cylinder head		8 (5.9)	M 6
16-VALVE ENGINES Knock sensor	Use original bolt without washer	20 (14)	M 8
16-VALVE ENGINES Hall sender		8 (5.9)	M 6
Tensioning roller to oil-pump housing		45 (33)	M 10
Oil pump to crankcase		8 (5.9) 45 (33)	M 6 M 10
Toothed-belt tensioner to crankcase		20 (14)	M 8

Location	Tightening Procedures	Torque Nm (ftlb)	Threads
Tensioning roller to toothed-belt tensioner		45 (33)	M 10
Belt cover		8 (5.9)	M 6
Spark plugs		25 - 30 (18 - 22)	M 14x1.25
Bracket for generator to crankcase		45 (33)	M 10
Remote thermo-meter sender		35 (26)	M 10x1
Temperature sensor (NTC 11)		15 (11)	M 12x1.5
Oil-pressure sender		35 (26)	M 18x1.5
Diaphragm damper and pressure regulator to fuel collection pipe		30 (22)	M 16x1.5
Capped nut to fuel collection pipe		22 (16)	M 12x1.5
Acorn nut to catalytic converter		30 (22)	M 14 x1.5
Housing insert in oil-pump housing	Seal mating face with Loctite 574	8 (5.9)	M 6
Radiator housing/ thermostat housing to crankcase		20 (14)	M 8
Plug in oil-water cooler housing		35 (26)	M 18 x 1.5

Location	Tightening Procedures	Torque in Nm (ftlb)	Threads
Coolant bleed screw		12 + 3 (9 + 2.2)	M 8x1
Pressure relief valve Oil filter		45 (33) 20 (14)	M 20x1.5
Oil separator mounting to crankcase		20 (14)	M 8
All other nuts and bolts:			
M 6 M 8 M 10		8 + 2 (5.9 + 0.7) 20 + 2 (14 + 0.7) 40 + 5 (30 + 3.6)	

TOOLS



No.	Description	Special Tool	Remarks
1	Chain sling	US 1105	

REMOVING AND INSTALLING ENGINE
(Manual Transmission)

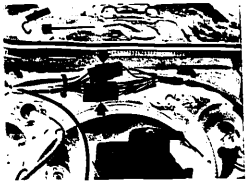
Engine removed from underneath.

Clutch bell housing remains on engine.

Removing

1. Set up hoist and lift car on the pick-up points.
2. Use fender covers.
3. Remove front wheels.
4. Disconnect battery ground cable.
5. Disconnect battery positive cable and push through splash wall with the rubber grommet.

6. Disconnect two plugs for engine wire harness. Remove wire clamps.

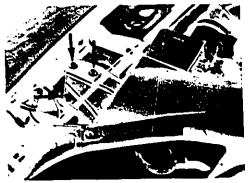


7. Pull off wire plugs on control unit (in area of steering column).

8. Push wires and plugs through splash wall. Detach bracket with sensor wire on intake pipe to make engine removal easier.

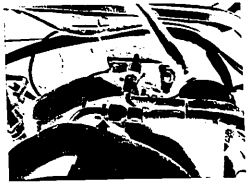
9. Disconnect throttle operating cable. Disconnect and pull off vacuum hose on brake booster.

10. Disconnect air cleaner with air flow sensor on body and on coolant hose, and lay aside.

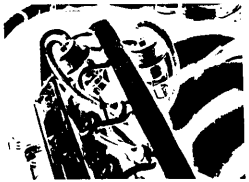


11. Remove distributor cap, distributor rotor and dust cap (to avoid damage).
12. Disconnect ground wire on splash wall.

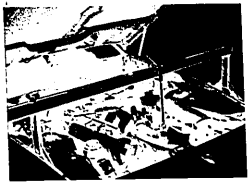
13. Pinch fuel return line with a standard hose clamp. Unscrew fuel feed line while counterholding.



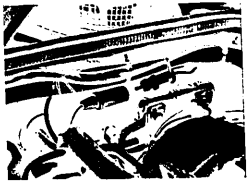
14. Unscrew fuel return line.



15. Attach Special Tool VW 10-222 on front transport bracket of engine and hold engine tight in installed position.



16. Open heater regulating valve. Remove cap on coolant expansion tank.
17. Remove splash shield.
18. Remove exhaust assembly, by unscrewing flange, exhaust manifold/exhaust pipe connections and suspension points.
    USA cars:
    Also disconnect oxygen sensor plug and wire in metal lug on firewall.



19. Disconnect electric wires for starter. Remove starter.

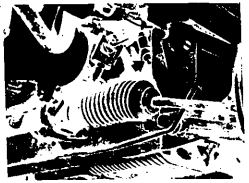
20. Remove clutch line clamp on engine.

21. Remove clutch slave cylinder on clutch housing (line remains connected).

22. Unscrew stabilizer on body and control arms, and remove.

23. Remove shield for right engine mount on front axle cross member.

24. Unscrew universal joint on steering gear, tie rods on steering arms, upper hydraulic engine mount on engine braces, left and right control arms on front axle cross member, and remove front axle cross member with steering from underneath.



25. Cars with Air Conditioner: Unscrew poly-rib belt tensioner and take off belt.

26. Remove compressor on mount (don't disconnect refrigerant hoses). Suspend compressor from the spring strut with a piece of wire.

27. Drain coolant through drain plug bore in radiator or the coolant hose and catch coolant.

28. Remove coolant hose on bottom of radiator.

29. Remove upper central tube mounting bolts.

30. Lower car.

31. Remove coolant hose on heater valve.

32. Remove coolant return hose for heater.

33. Remove coolant feed hoses on expansion tank.

34. Remove A/C fast idle hose.

35. Remove charcoal venting hose.

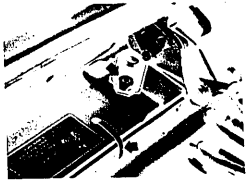
36. Remove vacuum line to vent valve and vacuum line to thermo valve at back of engine.

37. Remove upper radiator hose.

38. Remove radiator vent hose.

39. Remove wiring to temperature switch and both cooling fans.

40. Remove top radiator brackets and lift out radiator with cooling fans.



41. Attach Special Tool US 1105 on engine (shorter end towards rear of engine).

42. Lift engine slightly and remove VW 10-222.

43. Remove lower central tube mounting bolts.

44. Lower engine, pull forward and remove from underneath.

Installing

Note the following for installation.

1. First insert transaxle/clutch housing mounting bolts, but do not tighten.

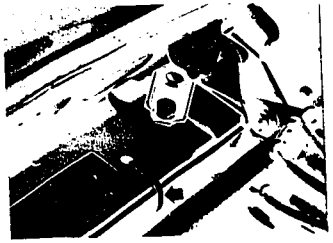
Note

Only tighten mounting bolts to final torque after hydraulic engine mount and front axle cross member have been mounted.
Torque for mounting bolts: 42 Nm (30 ft lb).

Front wheel alignment . .ed not be checked after removal and installation of engine.

2. Make sure radiator fits correctly in rubber mounts.

3. Secure coolant hose (between radiator and expansion tank) on lock carrier with two straps.



4. Tighten bolts and nuts to specified torque.

5. Fill and bleed cooling system (see page 19-1).

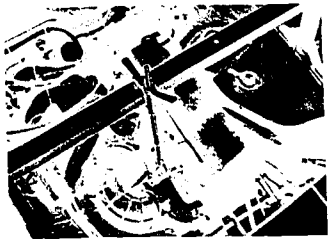
REMOVING AND INSTALLING HYDRAULIC ENGINE MOUNTS

Removing

1. Disconnect battery ground lead.

2. Suspend engine from front transport bracket with Special Tool VW 10 - 222 or VW 10 - 222 A and hold firmly in installed position.

   Pull off plug on air flow sensor and vent hose on air cleaner to have access to the transport bracket.



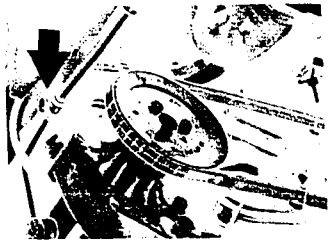
3. Remove splash guard.

4. Remove stabilizer after unscrewing stabilizer mounts on control arms and stabilizer suspension on side members.

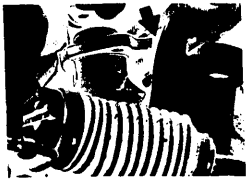
5. Unscrew shield for right engine mount on front axle cross member.

6. Unscrew hydraulic engine mount on front axle cross member.

7. Cars with power steering:
   Disconnect return line of hydraulic steering system on side member.
   In cars prior to 1984 models first unclip brake pad wear indicator wire and remove clip on bolt.

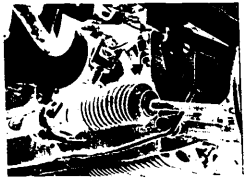


8. Unscrew universal joint on steering gear, hydraulic engine mount on engine brackets and front axle cross member on side members.



Note:

Mark installed position of universal joint to steering gear.
Do not unscrew control arm mounting bolts, since otherwise front wheel alignment would have to be checked and adjusted.



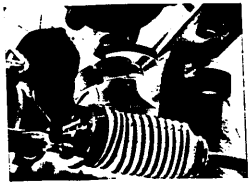
9. Pull down front axle cross member and remove universal joint (drive shaft) on steering gear.

Note:

Only pull down front axle cross member far enough to permit removal of the hydraulic engine mount.

10. Move top of hydraulic engine mount out of front axle cross member (see arrow).

11. Remove hydraulic engine mount toward front. If necessary because of limited space first turn mount 180°.



Installing

1. Insert hydraulic engine mount that twist lock (arrow) is positioned on the stop (stop is at rear on the right-hand side). With hydraulic engine mount in this position press top of it into front axle cross member (see point 10 of removing).

2. Push correctly positioned universal joint (drive shaft) on to steering gear (steering pinion).
Mount front axle cross member.
Center front axle cross member before tightening mounting bolts to 85 Nm.

Note:

Lift front axle cross member with an universal transmission jack, e. g. Hahn Metallbau GmbH, Ringstr. 12 – 18, 7012 Fellbach, or some other suitable lifting fixture to be able to insert the bolts.

3. Install mounting nuts and bolts for hydraulic engine mounts, but do not tighten.

4. Remove Special Tool VW 10 - 222 or VW 10 - 222 A.
Connect plug on air flow sensor and vent hose on air cleaner.

5. Tighten self-locking mounting nuts in the order given below.
Hydraulic engine mount to front axle cross member.
Hydraulic engine mount to engine brackets.
Universal joint to steering gear.
Use new self-locking nuts and torque to 30 Nm.

6. Cars with power steering:
Secure return line and, if applicable, brake pad wear indicator wire on side member.

7. Mount right engine mount shield, stabilizer and splash guard.
Tightening torque for stabilizer to body and control arms: 23 Nm.
Connect ground lead on battery.

CHECKING HYDRAULIC ENGINE BELTS

General Information

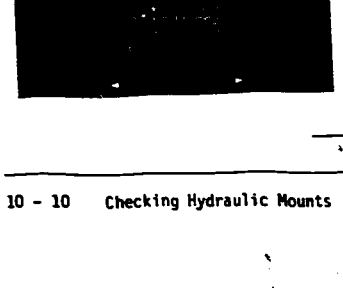
Hydraulic engine mounts cannot be tested 100% with conventional workshop equipment. However, the test procedures listed below can be used to determine whether hydraulic engine mounts are defective or seriously impaired in effectiveness.
Of the two hydraulic engine mounts, the one on the right is subjected to greater thermal loading and thus more likely to give cause for complaint.

Checking

Symptoms indicating a damaged engine mount:

- Clearly-discernible knocking or vibration while starting and/or turning off the engine.
- severe engine vibration in idle (with engine in perfect condition and balance shafts adjusted correctly).
- no or insufficient spring travel when pulling down on engine. Specification: 2 - 3 mm. (Do not check left and right hydraulic engine mounts together. Use exhaust pipes for leverage).
- Visual inspection shows leaks (mounts are filled with a damping fluid), rubber peeling off, cracks, or notching.
- Height of removed and de-tensioned hydraulic engine mount is less than 65 mm (new 70 $\pm$ 1 mm) measured between bearing surfaces.

  (Height of installed hydraulic engine mount not less than 62-2 mm)



13

Engine – crankgear, pistons

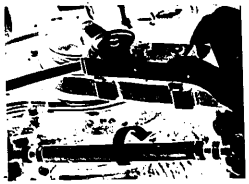
Engine/Crankshaft, Pistons

Printed in Germany – May, 1988

CHECKING AND ADJUSTING TIGHTNESS OF POLYRIB DRIVE BELT FOR ALTERNATOR OR A/C COMPRESSOR (FIVE RIB POLYRIB BELT)

C' cking

1. Prepare Special Tool 9201 for checking. Pull out lockpin on special tool and slide out testing pin opposite the lock-pin completely. Place drag needle on indicator needle.
2. Slide special tool on to the drive belt. Push in testing point (arrow) slowly until the lockpin is felt to engage, and read the displayed value from the dial gage.
   Adjusting value: 9.5 ± 0.3 scale units.
   Correct belt tightness if necessary.

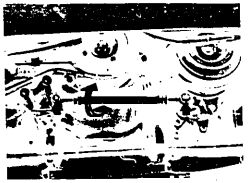


Note

The slides must have complete contact on the belt surface.
The special tool must not be turned nor moved on the belt while checking.

Adjusting

1. Loosen hexagon head bolts of connecting rod slightly.
2. Loosen lock nuts of connecting rod and turn connecting rod accordingly until the correct belt tightness is reached.



Six Rib Polyrib Belt

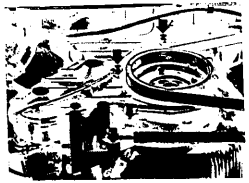
Adjusting

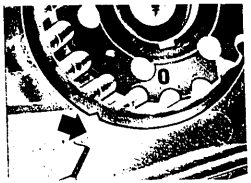
1. Loosen hexagon head bolts of connect-rod slightly. Loosen lock nuts of connecting rod and turn back connecting rod one turn (reduces tension).
2. Prepare Special Tool 9201 for checking.
3. Turn connecting rod accordingly until adjusting value of 9.5 scale units is Turn the connecting rod two more turns from this position (increases tension).

CHECKING ADJUSTMENT OF BALANCE SHAFTS

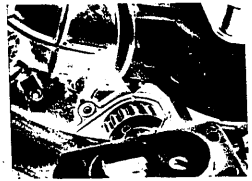
1. Remove splash shield.
2. Turn crankshaft clockwise until TDC mark on camshaft sprocket is aligned with cast mark in mount for ignition cap.
   TDC marks on flywheel and cast clutch housing must also be aligned.

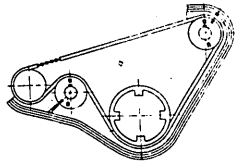
3. Take off upper drive belt cover.





4. Mark on upper balance shaft sprocket must be aligned with mark of rear drive belt cover.





5. Remove end cap in lower drive belt cover.
   Check position of mark on lower balance shaft sprocket through this hole.
   Mark on sprocket must be aligned with mark of rear drive belt cover.

CHECKING AND ADJUSTING TIGHTNESS OF POWER STEERING PUMP DRIVE BELT

Checking

Check tightness by applying thumb pressure on belt at point midway between two pulleys.
Deflection: approx. 5 mm.

Adjusting

1. Remove splash shield.

2. Loosen upper mounting bolt or nut slightly.

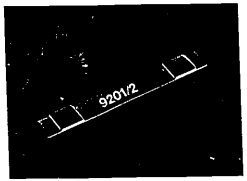
3. Loosen bolts of pressure rod slightly.

Unscrew lock nuts of pressure rod and turn rod accordingly until correct belt tightness is reached.

4. Tighten mounting bolts and nuts after finishing adjustment.

CALIBRATING SPECIAL TOOL 9201

TOOL



The testing gage is designed for a display of 4.0 scale units and permits the checking and calibrating of Special Tool 9201 to 4.0 scale units.

The tool must be calibrated after:

- about 100 measurements,
- hard jolts or knocks
- slight damage.

Calibration will not be sufficient in case of greater damage or display deviation of more than 2.0 scale units. These special tools can be sent to the supplier for repairing.

Address:

Fritz Staeger
Zossener Str. 56/58
D-1000 Berlin 61
Tel.: 030 / 693 1204

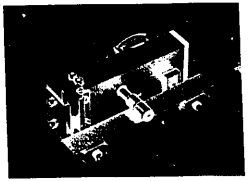
CALIBRATING

Tools Required:

Small screwdriver 1.6 x 40 x 0.4 mm
Gage 9201/2

1. Adjust to zero point by turning the dial gage's scale ring until the needle and zero point are aligned.

2. Insert gage 9201/2, checking for centered position of both test bearing surfaces on the sliding shoes.



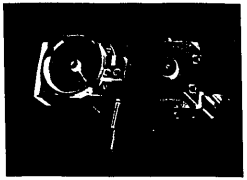
3. Proceed to same procedures for use on toothed belt, i.e. press in testing point slowly until the lock pin is felt to engage and then read the displayed value from the dial gage.

Note

Sliding shoes of older manufacture might be bored offcenter. Depending on the position of the sliding shoes there could be different displayed values when checking with this tool.

Consequently the measurement with a gage should be repeated with different sliding shoe positions. Find the position, where the scale value is closest to the 4.0 adjusting value. Mark sliding shoe (e.g. with paint or an electric inscriber) and perform the calibration as well as all measurements later at this position.

4. If the display is outside of the test value of 4.0 ± 0.3 scale values, readjust the gage dial. This is done by turning the calibration screw with a small screwdriver until the specified value of 4.0 scale units is reached. In so doing the gage 9201/2 remains between the test sensor of the tester.



5. Recheck after finishing calibration.

CHECKING AND ADJUSTING TIGHTNESS OF DRIVE BELT FOR BALANCE SHAFTS (ROLLER WITH SLOT)

Note:

Only check and adjust drive belt tightness on a cold engine (ambient temperature approx. 20°C/68°F).

1. Remove splash shield.

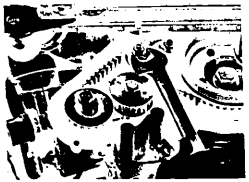
2. Remove poly-rib belt.

Note

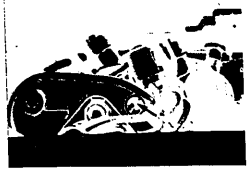
Always first loosen bolts of pressure rod slightly prior to unscrewing locknuts.

3. Unscrew vent hose and take off drive belt cover.

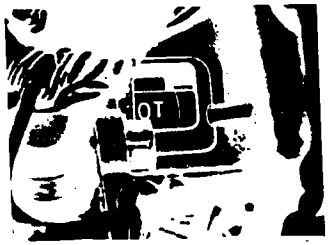
4. Loosen idler pulley so that pulley does not touch drive belt.



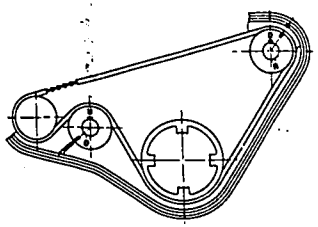
5 a. Turn crankshaft clockwise until TDC mark on camshaft sprocket is aligned with cast mark in mount for distributor cap.



5 b. TDC marks on flywheel and cast clutch housing must also be aligned.



6. Check basic position of balance shaft sprockets. Marks on sprockets should be aligned with marks of rear drive belt cover.



7. Prepare special tool P 9201 for testing. Pull out lockpin on special tool and push out gauge pin opposite the lockpin completely. Zero telltale needle.

8. Slide special tool on to belt. Push in gauge needle (arrow) until lockpin is heard to engage and read value from dial gauge.

Note:

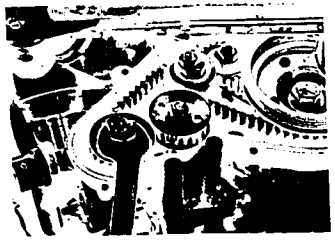
Always zero telltale needle on gauge after lockpin has engaged (turned anticlockwise) to exclude wrong gauge readings.

Specifications:

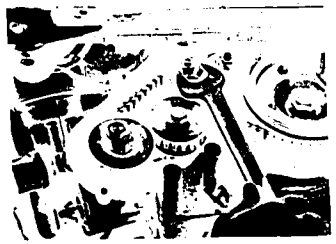
2.7 $\pm$ 0.3 dial value

If necessary, correct belt tightness.

9. Adjusting:
Turn tensioner clockwise to tighten.
Turn tensioner counterclockwise to loosen.
Tighten nut to specified tightening torque.



10. After adjusting drive belt tension, adjust idler pulley. Use special tool 9207 or 0.5 mm feeler gauge so there is a clearance of 0.5 mm between drive belt and pulley when upper portion of drive belt is preloaded 0 to 1 mm (see sketch). Tighten idler pulley in this position.
If correct gap cannot be reached, turn idler pulley 180 degrees and repeat adjustment. Tighten mounting nut to specified torque.



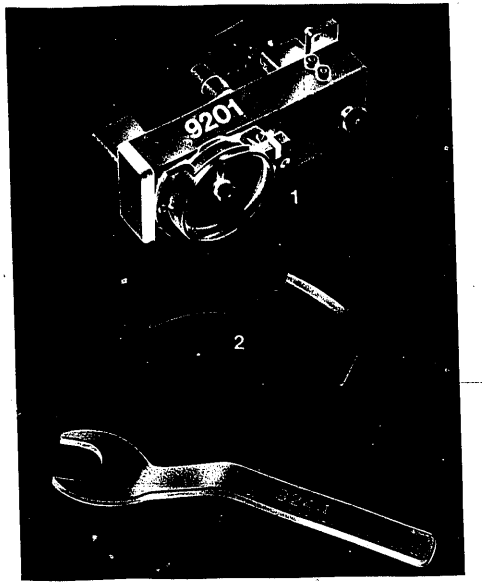
11. Install Poly-Rib belt and adjust; see page 13 - 1

Note:

ides must make full-surface
tact with belt.

While measuring, do not allow the Special Tool to turn or move on the belt.

TOOLS



No.	Description	Special Tool	Remarks
1	Tester for belt tension	9201	
2	Gage	9207	
3	Wrench	9244	

CHECKING AND ADJUSTING TENSION OF DRIVE BELT FOR BALANCE SHAFTS (ROLLER WITH SLOT)

Note:

Do not check or adjust drive-belt tension unless engine is cold (at room temperature).

1. Remove air-cleaner assembly, unbolt and remove engine underguard.

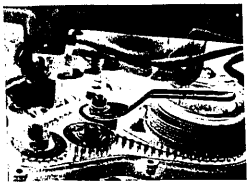
2. Remove Poly-rib belt and servopump belt.

Note:

Always first loosen hex bolts of linkage slightly before unscrewing locknuts.

3. Remove breather hose at top and remove drive-belt cover.

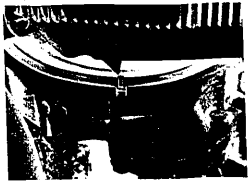
4. Slacken pulley so that it no longer tensions drive belt.



5a. Turn crankshaft clockwise until TDC mark on camshaft sprocket is aligned with mark on drive-belt cover.

Illustration shows 16-VALVE ENGINE

b. TDC mark on flywheel must also be aligned.



6. Check basic position of balance-shaft sprockets. Marks on sprockets must be aligned with marks on rear drive-belt cover.

7. Prepare Special Tool 9201 for testing. Pull lockpin from Special Tool and push gage pin opposite lockpin out as far as it will go. Align telltale and measuring needles.

8. Slide Special Tool on to belt. Press measuring key (arrowed) in slowly until lockpin is heard to engage and read the value from dial gage.

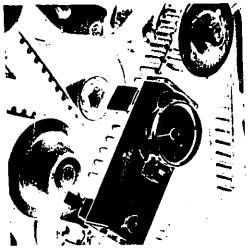
Note:

To exclude errors in reading the gage, always align telltale needle and measuring needle once the lockpin is engaged (turn anticlockwise).

Specified value:

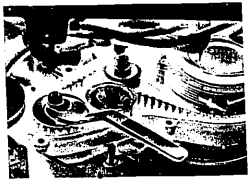
(new or used belt)
2.7 ± 0.3 scale gradations

If necessary, correct belt tension.

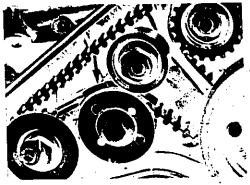


Adjusting

9. Turn tensioning roller clockwise to increase tension. Turn anti-clockwise to slacken. Tighten hex nut to 45 Nm (33 ftlb) while countering.



10. After adjusting drive-belt tension, adjust idler pulley. Using Special Tool 9207 or feeler gage (0.5 mm) set pulley so that there is a clearance of 0.5 mm between belt and pulley at the lower balance shaft when 0 to 1 mm pretension is applied to upper run of toothed belt. Tighten pulley in this position. If correct clearance cannot be reached, turn pulley through 180°C and repeat adjustment. Tighten hex nut to 45 Nm (33 ftlb) while countering.

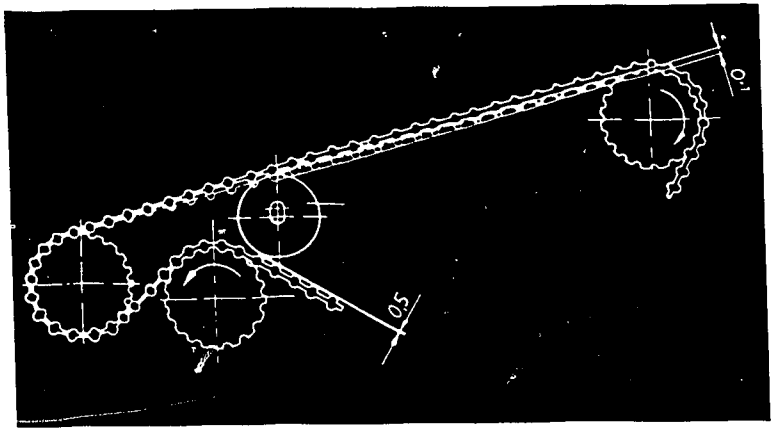


11. Install Poly-rib belt, servopump belt and adjust.

Note:

Slides must make full-surface with contact belt.

While measuring, do not allow the Special Tool to turn or move on the belt.



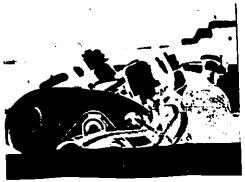
INSTALLING DRIVE BELT FOR BALANCE SHAFTS

Note

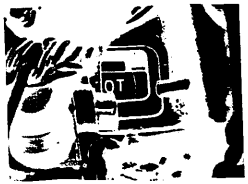
Handle balance shaft drive belts carefully. Lateral twisting or turning could impair quiet running. Store separately.

Do not unscrew mounting bolts of balance shaft sprockets to replace a drive belt. (Some pictures were taken without washers and mounting bolts for better understanding.)

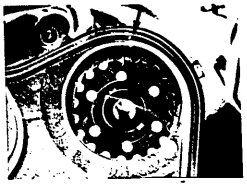
1 a. Turn crankshaft clockwise until TDC mark on camshaft sprocket is aligned with mark (cast) in mount for distributor cap.

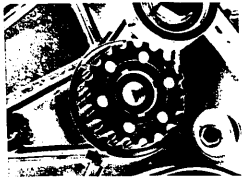


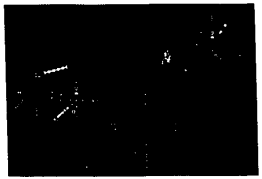
b. TDC marks on flywheel and cast clutch housing should also be aligned.



2. Turn both balance shafts until marks of balance shaft sprockets align with marks on rear drive belt cover.

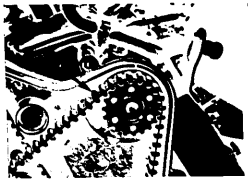






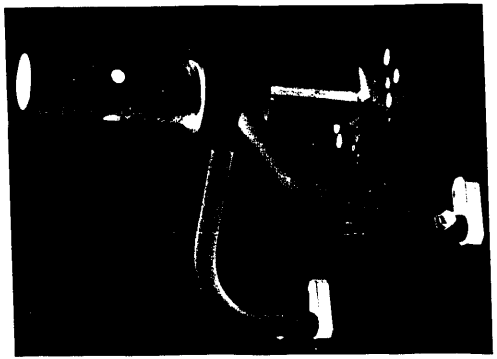
3. Installing drive belt:

Install drive belt so that side of belt with color coded tooth faces out.



4. Adjust drive belt tightness; see page 13 - 3.

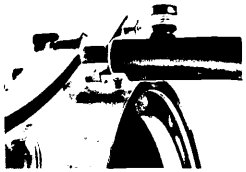
TOOLS



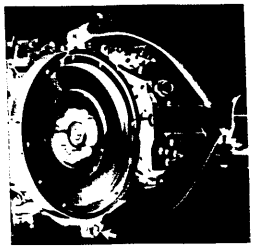
No.	Description	Special Tool	Remarks
1	Assembly stand	VW 540	Machine holding arm in area of stud (reference mark sensor)

APPLICATION OF VW 540 ASSEMBLY STAND

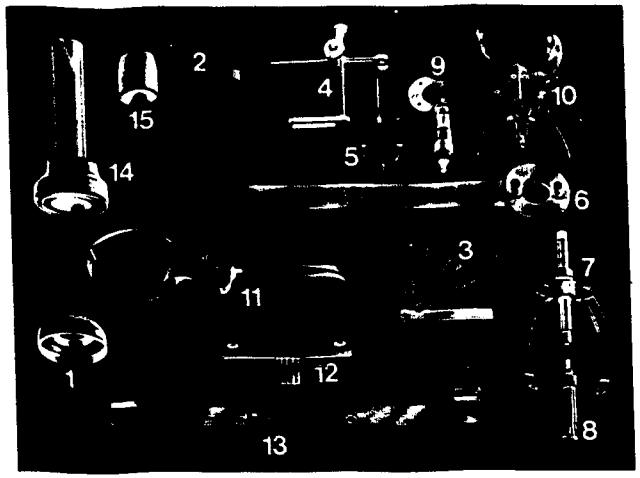
1. Make sure holding arm is machined in area of stud (reference mark sensor).



2. Mount assembly stand on engine after first removing cylindrical pin (arrow) on right hand side looking forward. Use pliers to grip the pin.

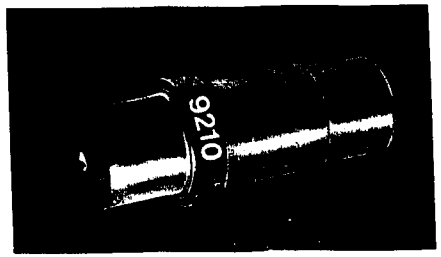


TOOLS



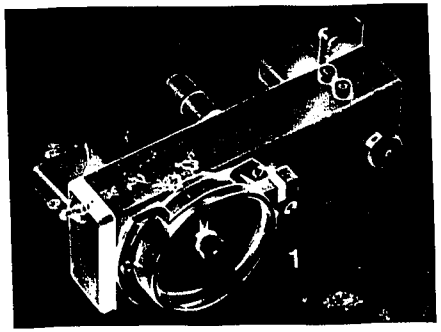
No.	Description	Special Tool	Remarks
1	Assembly sleeve	9203	
2	Pressure pad for crankshaft seal on flywheel end	9126	
3	Feeler gauge		standard tool
4	Dial gauge holder	VW 387	
5	Dial gauge	US 1026 or 1027	standard tool
6	Holding wrench	9200	
7	Support	US 1039	standard tool, e. g. Kukko
8	Internal claw puller	US 8028	standard tool, e. g. Kukko No. 21/2 (14.5 to 18.5 mm)
9	Micrometer	US 1025	standard tool
10	Piston ring pliers	VW 121 b	standard tool, e. g. Hazet 790-1 a
11	Piston ring compressor	US 1008 a	standard tool, e. g. Hazet 794-U-3
12	Locking element	9206	
13	Flywheel holder	s 130	
14	Pressure pad	9202	
15	Pipe	32-111	

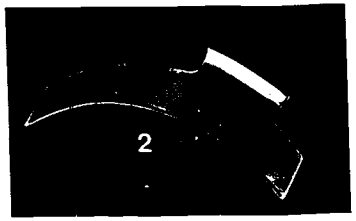
TOOLS



No.	Description	Special Tool	Remarks
	Thrust pad	9210	To install bearing sleeve for balance shaft bearing housing

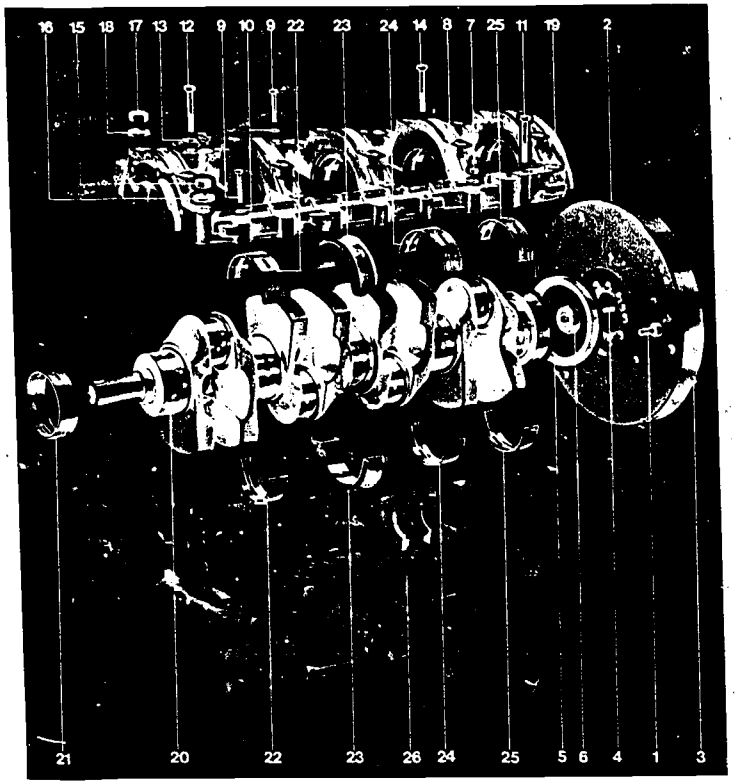
TOOLS





No.	Description	Special Tool	Remarks
1	Belt tightness tester	9201	
2	Adjusting gauge for roller with slot	9207	

DISASSEMBLING AND ASSEMBLING CRANKCASE AND CRANKSHAFT



13

Engine – crankgear, pistons

Engine/Crankshaft, Pistons

Printed in Germany – May, 1988

No.	Description	Qty.	Note When: Removing	Note When: Installing	Special Instructions
1	Bolt	9		Torque: 90 Nm (65 ft lb)	
2	Flywheel	1			
3	Stud M 6 x 16 (reference mark sensor)	1			see page 13 - 24
4	Pin	1			
5	Shaft seal	1		Replace	see page 13 - 22
6	Pilot bearing	1			see page 13 - 23
7	Nut	1			
8	Plain washer A 6.4	1			
9	Bolt M 6 x 35	5			
10	Plain washer A 6.4	5			
11	Bolt M 8 x 55 for oil intake pipe	1			
12	Bolt M 8 x 50	6			
13	Washer	6			
14	Bolt M 8 x 50	1			
15	Nut M 10	7			
16	Washer	7		rounded side faces up	
17	Nut M 12 x 1.5	10		lettering faces up	
18	Washer	10		rounded side faces up	

No.	Description	Qty.	Note When: Removing	Note When: Installing	Special Instructions
19	Crankcase lower section	1		Clean sealing surface and remove grease in area of oil intake and flywheel. Seal with Loctite 574	see page 13 - 21
20	Crankshaft	1		Check axial and radial play	see page 13 - 18
21	Closed main bearing no. 1	1		Make sure bearing engages in pin	
22	Main bearing no. 2	1			
23	Thrust bearing no. 3	1			
24	Main bearing no. 4	1			
25	Main bearing no. 5	1			
26	Crankcase upper section	1		Clean sealing surface and remove grease in area of oil intake and flywheel	see page 13 - 21

DISASSEMBLING AND ASSEMBLING CRANKCASE AND CRANKSHAFT SINCE 1985/2 MODELS

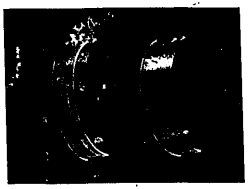
Main Bearing No. 1

The closed main bearing sleeve for bearing no. 1 now only has a lubricating groove around one half.

Old New

Main Bearings No. 2, 4 and 5

The bottom halves of the bearings are designed without lubricating grooves. When installing it is important, that bearing shells with lubricating grooves are placed in the upper crankcase section and bearing shells without lubricating grooves in the lower crankcase section.



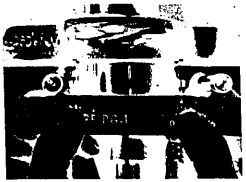
These bearing shells may also be used in engines before 1985/2 models.

CHECKING CRANKSHAFT BEARING CLEARANCE

The "Plastigage" method is a simple way of checking bearing clearance.

Plastigage is available in three different sizes for measuring ranges from 0.025 to 0.23 mm.

Type	Color	Measuring Range
PG-1	green	0.025 to 0.075 mm
PR-1	red	0.05 to 0.15 mm
PB-1	blue	0.10 to 0.23 mm



Checking Radial Clearance

1. Remove crankcase lower section.
2. Remove oil from bearing shell and bearing journal.
3. Place Plastigage having width of bearing on crankshaft journal in axial direction. Install crankcase lower section carefully and tighten to specified torque.

Note

Do not turn crankshaft while measuring.

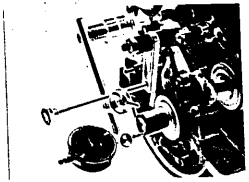
4. Remove crankcase lower section. Read width of flattened Plastigage from measuring scale. Corresponding value on measuring scale equals the bearing clearance.

Play of new bearings: 0.020 to 0.098 mm
Wear limit: 0.16 mm

Checking Axial Clearance

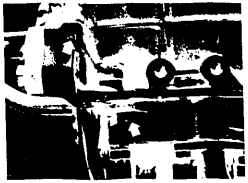
Use Special Tool VW 387 to check axial clearance.

Play of new bearings: 0.110 to 0.312 mm
Wear limit: 0.40 mm

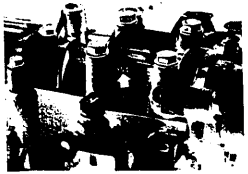


CODES OF CRANKCASE UPPER AND LOWER SECTIONS AS WELL AS BALANCE SHAFT COVER

1. Crankcase upper and lower sections as well as the balance shaft cover are machined together and must always be installed together. Check codes.



2. Codes of both balance shaft covers must be visible from above after installation.



SEALING UPPER AND LOWER CRANKCASE SECTIONS

Note

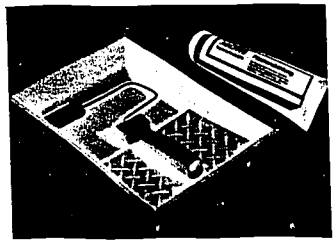
Only Loctite 574 (orange) should be used as a sealant. Loctite 574 will dry only in conjunction with metal and exclusion of air. After applying a coat of sealant the bolts should be installed and tightened within 10 minutes, since the sealant on the metal will start to dry.

Removing Old Sealant

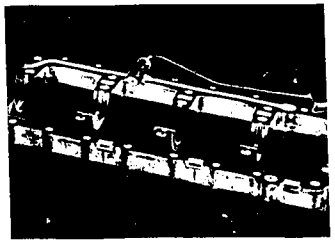
The old sealant does not have to be removed for repairs. It is only necessary to remove grease from the surface, so that after the cleaning solution has dried the new coat of sealant can be applied. The new Loctite will dissolve the old sealant in the surface finish and dry again after assembling.
We recommend a fine steel brush or Loctite 80646 adhesive remover for removing old sealant, if this is ever necessary.

Applying Sealant

1. We recommend a short-pile velour roller for application by hand. A tray will also be required for the sealant and should have a raised section to squeeze excess sealant from the roller.

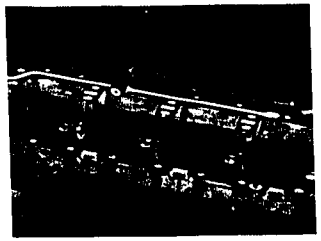


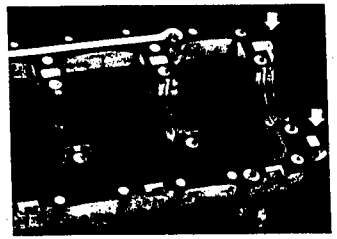
2. Roll on a very thin coat of sealant with a velour roller.



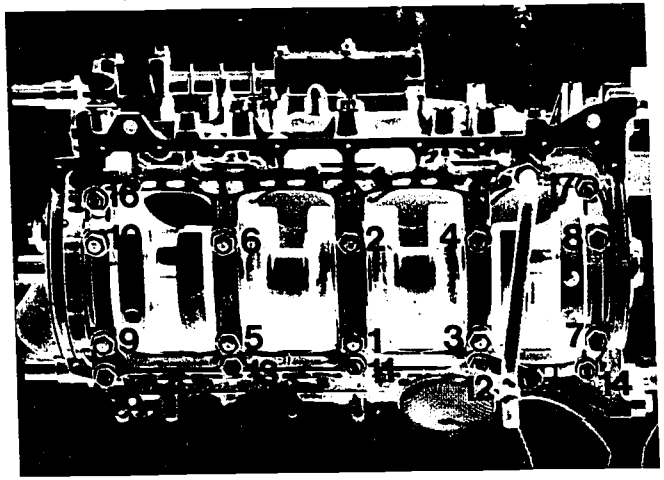
INSTALLING UPPER AND LOWER CRANKCASE SECTIONS

1. Coat lower crankcase section with Loctite 574 in areas of oil intake and sealing surface in areas of flywheel.



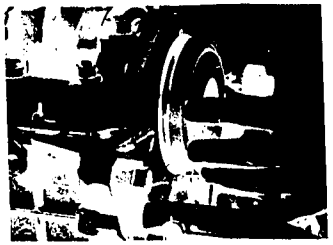


2. Install lower crankcase section.
See page 10-03 for tightening procedures.
Order for tightening:

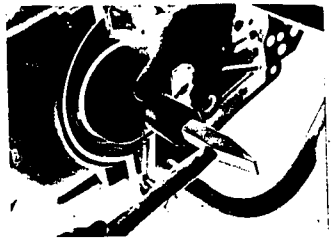


INSTALLING CRANKSHAFT OIL SEAL (FLYWHEEL END)

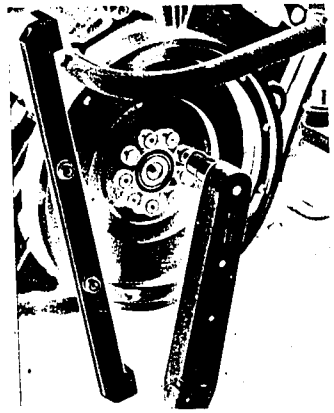
1. Lubricate sealing lip with oil and slide oil seal over Special Tool 9203 on to crankshaft.



2. Remove special tool and drive in oil seal against stop with Special Tool 9126.



REMOVING AND INSTALLING FLYWHEEL



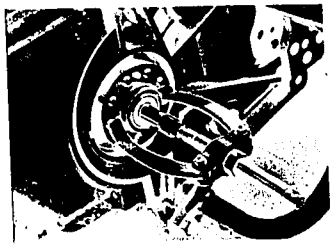
Removing

Mount Special Tool 9130 on flywheel with two hex. head bolts and loosen socket head bolts.

Installing

Torque socket head bolts to 90 Nm (65 ft lb).

REMOVING AND INSTALLING PILOT BEARING



Removing

Pull out pilot bearing with an internal extractor, e. g. Kukko 21/2 (14.5 to 18.5 mm).

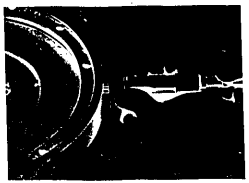
Installing

Drive in bearing against stop with Special Tool VW 32-111.

REPLACING STUD (REFERENCE MARK SENSOR)

1. Heat stud locally to about 200 °C (400 °F) to unseal Loctite 270. Unscrew stud.

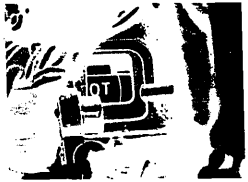
2. Screw in new stud with Loctite 270 and adjust to 5 ± 0.1 mm.



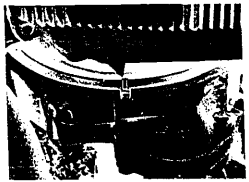
SETTING CRANKSHAFT TO TDC IN CYLINDER NO. 1

Crankshaft Position (Engine Installed)

TDC mark on flywheel and cast boss on clutch housing must be aligned.

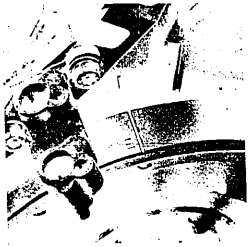


Additional TDC mark on flywheel, seen from underneath car. TDC is reached, if the approx. 5 mm wide groove in the flywheel is in the middle of the opening of the clutch housing.



Crankshaft Position (Engine Removed)

TDC mark on flywheel and cast mark on upper crankcase section must be aligned.



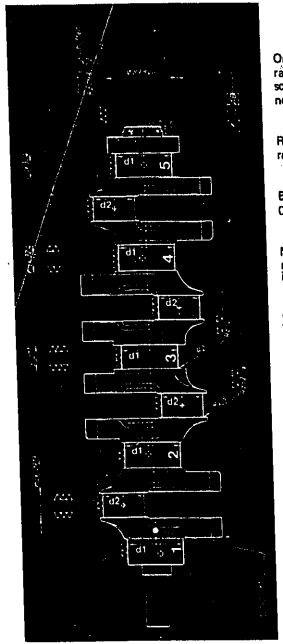
CRANKSHAFT – Standard and Machined Sizes

Size	Crankcase Bore Dia. in mm	Crankshaft Bearing Journal d 1 Dia. in mm	Crankshaft Conrod Bearing Journal d 2 Dia. in mm	Thrust Bearing 3 Width in mm
Standard	Standard size 75.000...75.019	69.971...69.990	51.971...51.990	30.00 ... 30.052 *
– 0.25	Oversize 75.250...75.269	69.721...69.740	51.721...51.740	
– 0.50		69.471...69.490	51.471...51.490	

* Thrust bearing no. 3
Machined size: 30.200 ... 30.239 mm

Note

We recommend to check the sizes of bearings which can be delivered prior to machining the crankshaft.



Only grind the bearing surface for the radial oil seal to size 89.8 mm, when scoring is too deep. Otherwise, when necessary, polish Rz = 0.8 ... 2 mm.

Round off edges of oil bores with a radius of R = 0.5 mm after grinding.

Break sharp edges with a radius of R = 0.2 ... 0.5 mm.

Max. permissible radial runout in reference to take-up in —— – – —— is 0.04 mm

Color Codes for Machined Sizes

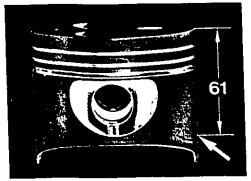
Machined size 1 = blue paint dot

Machined size 2 = green paint dot

CHECKING PISTONS AND CYLINDER BORES

Checking Pistons

Measure approx. 61 mm from piston crown, 90° offset from piston pin axis.

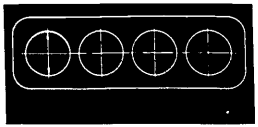


Checking Cylinder Bores

Measure approx. 61 mm from upper edge of cylinder bore, in transverse direction to engine block.

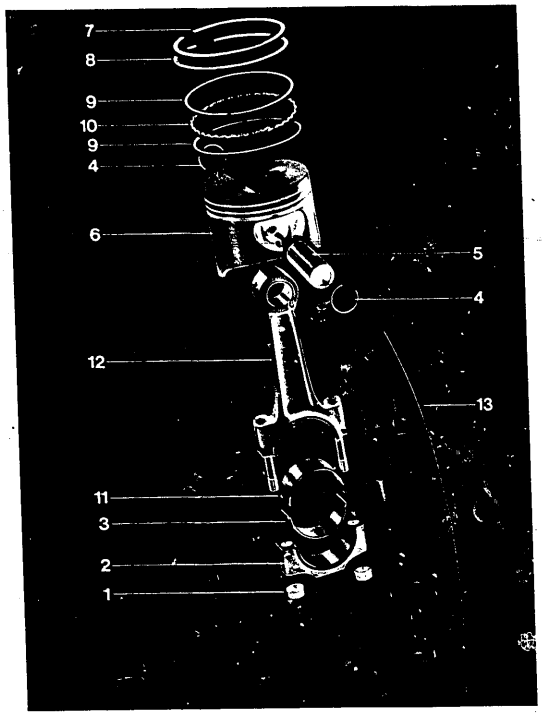
Note

Mount lower crenkcase section and tighten bolts to specified torque for measuring.



Repair Size	Piston Dia. (mm) Mahle	Piston Dia. (mm) Kolbenschmidt	Cylinder Bore Dia. (mm)	Tolerance Group Code
Standard size	99.980 +0.005	99.980 +0.007	100.000	0
	99.990	99.990	100.010	1
	100.000	100.000	100.020	2
Oversize 1	100.480 +0.005	100.480 +0.007	100.50	I0
	100.490	100.490	100.51	I1
	100.500	100.500	100.52	I2
Oversize 2	100.980 +0.005	100.980 +0.007	101.00	II0
	100.990	100.990	101.01	II1
	101.000	101.000	101.02	II2

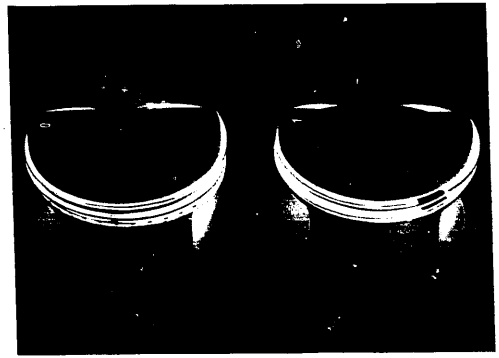
DISASSEMBLING AND ASSEMBLING PISTONS AND CONNECTING RODS



No.	Description	Qty.	Note when: Removing	Installing
1	Connecting rod nut	8		Replace, tighten to specified torque. Lubricate threads and bearing surface
2	Connecting rod cap	4		Pay attention to pair numbers
3	Lower bearing shell half	4		Always renew worn bearing shells
4	Circlip	8	Pry out	Position correctly
5	Piston pin	4		
6	Piston	4		Give light coat of oil; position correctly; note tolerance group
7	Piston ring Groove 1 Tapered face	4		
8	Piston ring Groove 2 Tapered face scraper ring	4		
9	Oil scraper ring Groove 3	8		
10	Spring Groove 3	4		First install spring; after installing oil scraper rings check whether end gaps of springs are offset

No.	Description	Qty.	Note when: Removing	Installing
11	Upper conrod bearing shell half	4		Always renew worn bearing shells
12	Connecting rod with conrod bolts	4		
13	Upper crankcase section	1		Check cylinder bores after mounting lower crankcase section and tightening bolts to specified torque

PISTON SURVEY



Europe and Rest of World USA, Canada, Japan

INSTALLING PISTON AND CONNECTING ROD

Connecting Rod

The material of connecting rods was changed since February, 1984. This did not change the weight. New and old connecting rods can be installed together in one engine.

Old

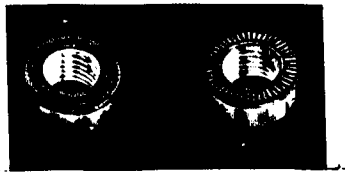
Sintered connecting rod, Part No. 944 103 001 00 (rough part number on inside of conrod shaft).

New

Cast connecting rod, Part No. 944 103 001 01 (rough part number reduced on both sides on conrod base and conrod cap).

Connecting Rod Nuts

The bearing surface of conrod nuts was also changed due to the connecting rod material change.



Old

Smooth bearing surface, Part No. 928 103 172 01.

New

Ribbed bearing surface, Part No. 928 103 172 02.

After depletion of stocks, only the new version (ribbed bearing surface) conrod nuts will be available.

Note

The old (smooth) conrod nuts must never be used with the new cast connecting rods.

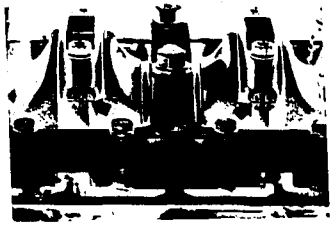
It is recommended to use the new connecting rod nuts each time the engine is repaired. Tightening torque: 75 Nm.

The tightening torque of 57 + 5 Nm is still applicable to smooth connecting rod nuts used together with sintered steel connecting rods.

INSTALLING PISTON AND CONNECTING ROD

Installed Position of Connecting Rods

Codes of connecting rod upper and lower sections must be mounted together and all face one side.



Make sure that piston is positioned correctly when pre-assembling the connecting rod and piston. Piston must be installed so that rounded edges of valve reliefs face right side (forward direction).

Installing Piston with Connecting Rod

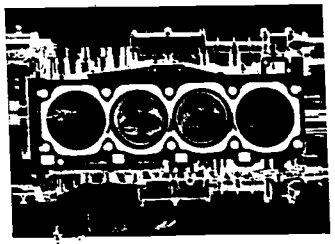
1. Install both upper piston rings so that their gaps are offset by 120°.
2. Install three-piece oil scraper ring as follows.

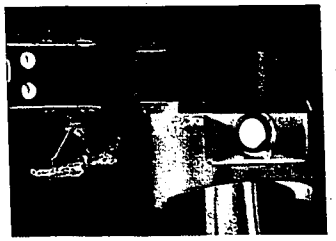
   Spring offset to oil rings by approx. 45° and oil rings offset to each other by at least 90°.

Note

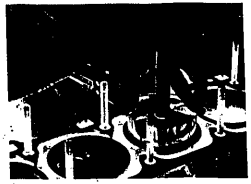
Mount by first installing the spring and then the upper and lower oil rings. Make sure in particular that ends of spring are not slid over each other. Paint ends of springs in different colors to make checking easier. Both ends should be visible when spring was installed correctly.

3. Give piston and cylinder bore a light coat of oil.
4. Apply piston ring compressor.





5. Install piston with connecting rod in cylinder bore and knock into cylinder by applying light taps from hammer handle and applying firm pressure to edge of ring compressor.



Note

Installation must be performed carefully. If too much resistance is encountered, interrupt installing procedures, check rings and start again.

Installing:

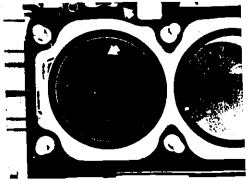
1. Always only use pistons of same make in one engine.

2. Piston pins are matched with pistons and must not be mixed up even within same engine. Mark pistons and pins for disassembly and assembly of engine.

Tolerance Group of Pistons and Cylinders

1. Only match pistons and cylinders having the same tolerance group.

2. Note codes for cylinder on engine block and codes for pistons on piston crown.



Note

Different tolerance groups could be used in one engine.

Checking Connecting Rod Bearing Clearance

1. Remove connecting rod cap, clean bearing shell and connecting rod bearing journal to remove oil. Place Plastigage having width of bearing on crankshaft in axial direction. Install bearing cap carefully and tighten to specified torque.

Note

Do not turn crankshaft while measuring.

2. Remove connecting rod cap. Width of flattened Plastigage is read off of measuring scale which corresponds with bearing clearance.

New bearing play: 0.02 to 0.07 mm
Wear limit: 0.10 mm

STOPPING FLYWHEEL FOR INSTALLATION WORK
(with installed engine)

1. Remove starter.

2. Insert and mount Special Tool 9206.

13

Engine – crankgear, pistons

Engine/Crankshaft, Pistons

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