Complete Service Manual coverage for late model year Mercedes-Benz vehicles requires three individual manuals:

Service Manual, Engine
Service Manual, Transmission
Service Manual, Chassis and Body

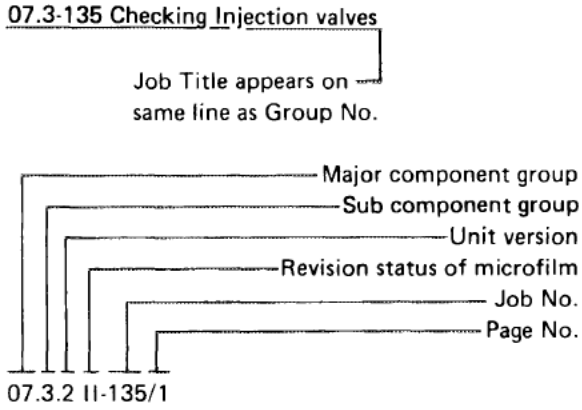
Throughout these manuals, the vehicles are identified by their chassis and engine numbers. These numbers are made up of the first six digits of the respective serial number. For the actual location of Chassis number and Engine number, see page 00–010/1. In cases where the repair instructions apply to all versions of the engine, only the first three digits of the respective number are referenced.

For example, engine 110 applies to all 2.8 liter 6 cylinder engines with dual overhead camshafts.

See the **engine and vehicle identification** table on page 00–010/1 for the engine installed in your vehicle.

Location of specific repair instructions

First locate the major component group in the Group Index. Individual groups are separated by an easily visible dividing page, which is followed by the job index page. Then check the job index for the exact job required. The first page of a typical job description looks like this:



Technical data, tightening torques and tools are listed at the beginning of each Job.

All the dimensions are in metric units, provided no other unit of measure is used. The indicated part numbers are serving exclusively for identification and better differentiation of individual versions. When odering spare parts, always use part numbers from the latest parts literature.

00 Engine number and vehicle indentification tag location

Installation Survey

6-Cylinder in-line engine with dual two-stage carburetor.

Model	Chassis type	Engine type
280	114.060	110.921
280 C	114.073	110.921
280 S	116.020	110.922

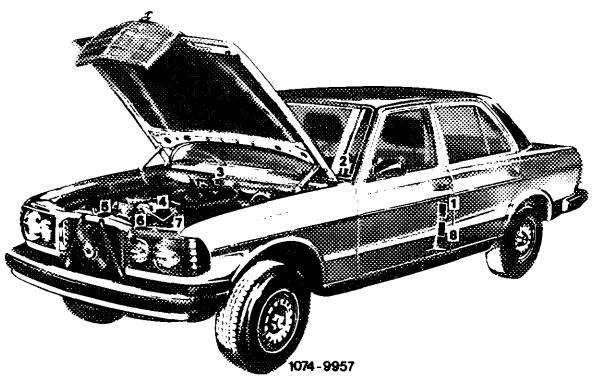
Engines with CIS (Continuous Injection System)

Model	Chassis type	Engine type
280 E	123.033	110.984
280 CE	123.053	110.984
280 SE	116.024	110.985

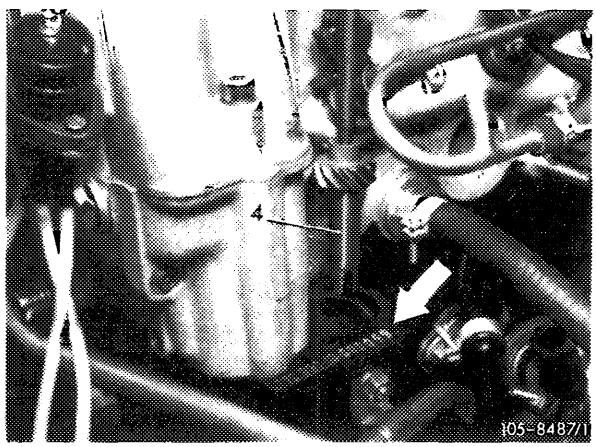
Identification of Vehicle

When ordering spare parts, please quote chassis and engine numbers.

With your MERCEDES-BENZ you receive two vehicle data cards listing all major vehicle data.



1 Certification Tag (left door pillar)
2 Identification Tag (left window post)
3 Chassis No.
4 Engine No.
5 Body No. and Paintwork No.
6 Information Tag
California Version
Vacuum line routing for emission control system
7 Emission Control Tag
8 Emission Control Tag
Catalyst Information



Engine No. stamped on left front of cylinder block (arrow)

Engine

Model	280	280 C	280 S	
Chassis Type	114.060	114.073	116.020	
Engine Type	110.921/922			
Year	1976	1975	1974	1973
Operation	Four stroke, gasoline engine with carburetor			
Number of cylinders	6			
Arrangement of cylinders	upright in line			
Bore/stroke mm(ins.)	86/78 (3.39/3.10)			
Total eff. piston displacement cm^3 (cu. ins.)	2746 (167.6)			
Compression ratio	9 : 1	8 : 1	9 : 1	8 : 1
Firing order	1-5-3-6-2-4			
Max. engine rpm	6500			
Engine output SAE net bhp/rpm	160/5500	145/5500	160/5500	130/5000
Max. torque SAE net ft. lb/rpm	165/4000	154/4000	165/4000	150/3500
Crankshaft bearings	7			
Valve arrangement	overhead			
Camshaft arrangement	DOHC			
Oil cooling	None			
Cooling	Water circulation pump, thermostat with by-pass line, finned tube radiator, fan with viscous coupling			
Lubrication	Forced oil circulation via gear-type oil pump			
Oil filter	Full-flow filter			
Air filter	Air filter with paper cartridge			

Filling Capacities

Model			280	280 C	280 S	
Chassis Type			114.060	114.073	116.020	
Engine Type			110.921/922			
Year			1976	1975	1974	1973
Engine	Initial filling	Engine oil approx. ltr. (US qt)	7 (7.4)			
	Oil and filter change	Engine oil approx. ltr. (US qt)	6.5 (6.9)			
	Oil pan up to max. marking on oil dipstick	Engine oil max. ltr. (US qt)	6 (6.3)			
	Oil filter	Engine oil approx. ltr. (US qt)	0.6 (0.62)			
Cooling system with heater		Coolant approx. ltr. (US qt)	11 (11.6)	10.5 (11)*		11 (11.6)
Water pump			maintenance free			
Brake system		Brake fluid approx. ltr. (US qt)	0.5 (0.53)			
Autom. Transmission	Initial filling/ fluid change	Autom. transmission fluid (ATF) approx. ltr. (US qt)	6.6/5.3 (7.0/5.6)			
Power steering		Autom transmission fluid (ATF) approx. ltr. (US qt)	1.4 (1.5)			

*110.922 (280 S) = 11 ltr./11.6 qt

Engine

Model	280 E	280 CE	280 SE		
Chassis Type	123.033	123.053	116.024		
Engine Type	110.984/985				
Year	1980/1981	1979	1978	1977	
Operation	Four stroke, gasoline engine, mechanical (CIS) fuel injection with airflow sensor				
Number of cylinders	6				
Arrangement of cylinders	upright in line				
Bore/stroke mm (ins.)	86/78 (3.39/3.10)				
Total eff. piston displacement cm^3 (cu. ins.)	2746 (167.6)				
Compression ratio	8 ± 0.4 : 1	8 : 1			
Firing order	1-5-3-6-2-4				
Max. engine rpm	6400	6500			
Engine output SAE net bhp/rpm	140/5500	142/5750[1]) 137/5750[2])			
Max. torque SAE net ft. lb/rpm	145/4500	149/4600[1]) 142/4600[2])			
Crankshaft bearings	7				
Valve arrangement	overhead				
Camshaft arrangement	DOHC				
Oil cooling	None				
Cooling	Water circulation pump, thermostat with by-pass line, finned tube radiator, fan with viscous coupling				
Lubrication	Forced oil circulation via gear-type oil pump				
Oil filter	Full-flow filter				
Air filter	Air filter with paper cartridge				

[1]) Federal
[2]) California

Filling Capacities

Model			280 E	280 CE	280 SE	
Chassis Type			123.033	123.053	116.024	
Engine Type			110.984/985			
Year			1980/1981	1979	1978	1977
Engine	Initial filling	Engine oil approx. ltr. (US qt)	6.5 (6.9)	7 (7.4)		
	Oil and filter change	Engine oil approx. ltr. (US qt)	6 (6.3)	6.5 (6.9)		
	Oil pan up to max. marking on oil dipstick	Engine oil max. ltr. (US qt)	5.4 (5.7)	6 (6.3)		
	Oil filter	Engine oil approx. ltr. (US qt)	0.6 (0.62)			
Cooling system with heater		Coolant approx. ltr. (US qt)	10 (10.6)*			
Water pump			maintenance free			
Brake system		Brake fluid approx. ltr. (US qt)	0.5 (0.53)			
Autom. Trans-mission	Initial filling/ fluid change	Autom. transmission fluid (ATF) approx. ltr. (US qt)	6.6/5.3 (7.0/5.6)			
Power steering		Autom transmission fluid (ATF) approx. ltr. (US qt)	1.4 (1.5)			

*110.985 (280 SE) = 11 ltr./11.6 qt

01–001 Engine and model survey

Engine	Model	Sales designation	kW at 1/min
110.921[1])	114.060	280	118/5500
110.921[1])	114.073	280 C	118/5500
110.922[1])	116.020	280 S	118/5500
110.923	123.030	280	115/5500
110.923 NV	123.030	280	105/5500
110.923	123.050	280 C	115/5500
110.923 NV	123.050	280 C	105/5500
110.924	126.021	280 S	115/5500
110.924 NV	126.021	280 S	115/5500
110.931 NV	114.060	280	107/5500
110.931 NV	114.073	280 C	107/5500
110.932 NV	116.020	280 S	107/5500
110.981	114.062	280 E	136/6000
110.981	114.072	280 CE	136/6000
110.982	107.022	280 SLC	136/6000
110.982	107.042	280 SL	136/6000
110.983	116.024	280 SE	136/6000
110.983	116.025	280 SEL	136/6000
110.984	123.007[2])	280 E Special body long	130/6000
110.984[1])	123.033	280 E	130/6000
110.984	123.053	280 CE	130/6000
110.984	123.093	280 TE	130/6000
110.985[1])	116.024	280 SE	130/6000
110.985[1])	116.025	280 SEL	130/6000
110.986	107.022	280 SLC	130/6000
110.986	107.042	280 SL	130/6000
110.987	126.022	280 SE	136/5800
110.987	126.023	280 SEL	136/5800
110.991 NV	114.062	280 E	125/6000
110.991 NV	114.072	280 CE	125/6000
110.992 NV	107.022	280 SLC	125/6000
110.992 NV	107.042	280 SL	125/6000
110.993 NV	116.024	280 SE	125/6000
110.993 NV	116.025	280 SEL	125/6000

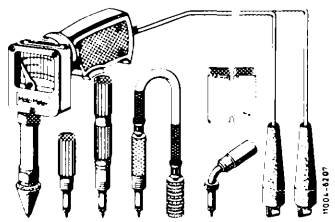
[1]) for USA
2) Sweden only
NV = low compression (SA 012.276)
SA = special equipment

01–010 Checking compression

Test values in bar for engine at operating temperature

Engine	Compression ratio ε : 1	Compression normal	Min. Compression	Max. difference between separate cylinders
Normal compression	9,0	10–12	approx. 8,5	
Low compression				max. 1,5
(USA) (S) (J) starting 1976 (AUS) starting 1977	8,0	9–10	approx. 7,5	

Special tool

Compression recorder with attachments and contact grip.		001 589 46 21 00

Notes

Check compression with coolant at temperature of 80° C.

Check cylinders for leaks if compression is less than the minimum specification (01–015).

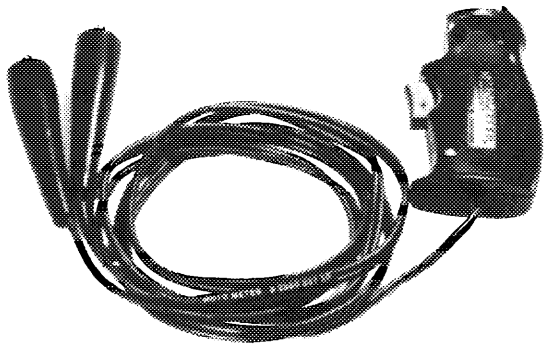
Unscrew all spark plugs for testing.

Checking

Models 107, 114 and 116

Connect contact handle to battery + and terminal 50 on starter.

Disconnect cable on ignition coil terminal 1.

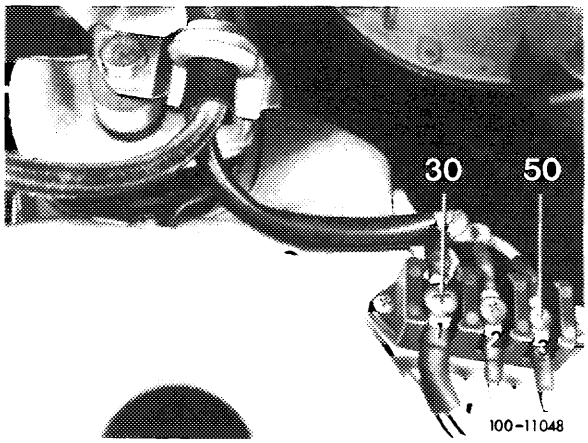


105-9061

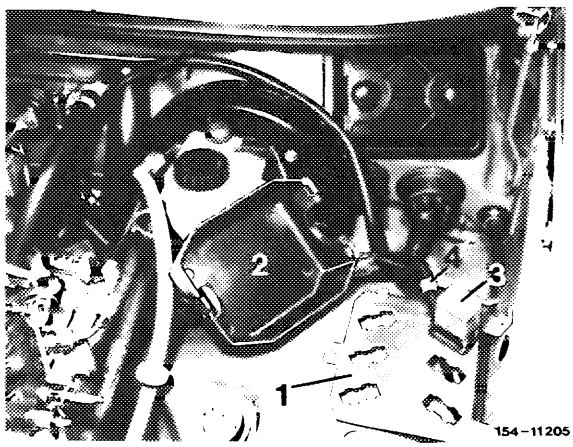
Model 123

Connect contact handle to terminal 30 and to terminal 50 on cable connector.

Disconnect cable on ignition coil terminal 1.

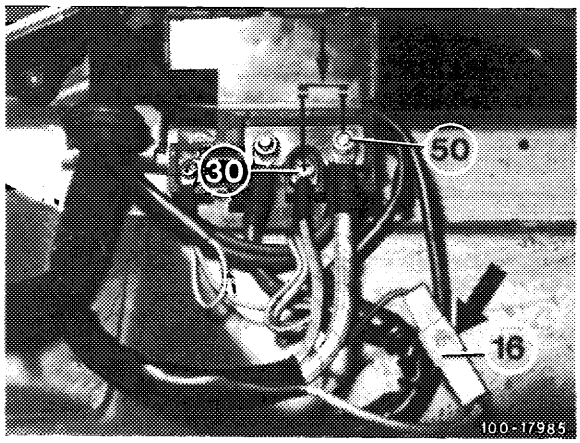


Attention!
On engines with CIS injection system, pull-off relay with code number 21 (3) for fuel pump—warm-up compensator.



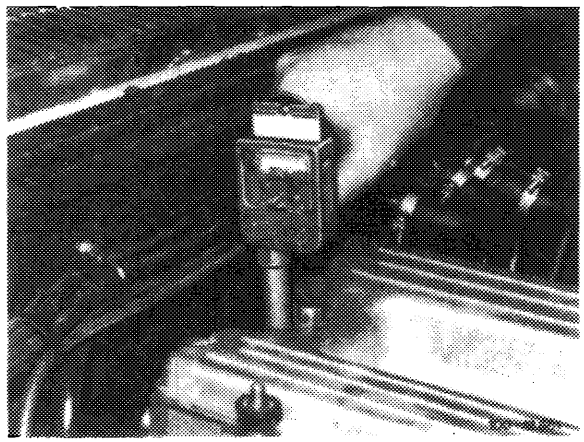
Model 126

Separate cable plug, arrow terminal 16, so that the ignition coil, and on engines with CIS the fuel pump, cannot be activated. Connect terminal 30 and 50.



1 Rotate engine for several turns with ignition switched off and idle speed or selector lever position „P" so that residue and soot will be blown out.

2 For testing, rotate engine for eight turns while opening throttle valve.

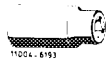


01–015 Checking cylinders for leaks

Data

Total pressure loss	max 25%
On valves and cylinder head gasket	max 10%
On piston and piston rings	max 20%

Special tool

Socket 27 mm for rotating engine		001 589 65 09 00

Conventional tool

Cylinder leak tester	e.g. made by Bosch, EFAW 210 A made by SUN, CLT 228

Checking

1 Run engine up to operating temperature.

2 Unscrew spark plugs.

3 Remove radiator cap and add coolant.

4 Remove oil filler plug.

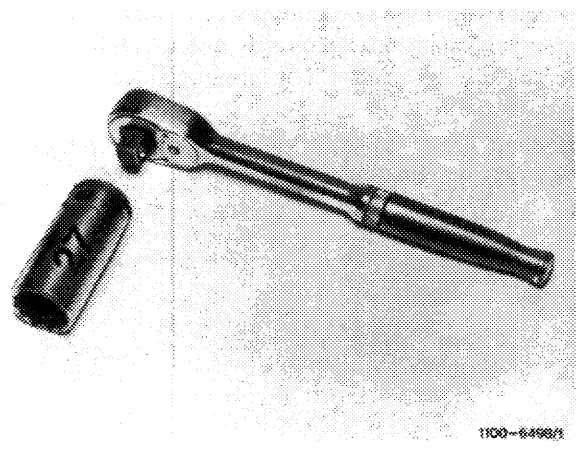
5 Remove air filter.

6 Connect cylinder leak tester to a compressed air source. Calibrate tester.

7 Set piston of cylinder 1 to ignition TDC.

For this purpose, turn engine on crankshaft by means of tool combination.

8 Set throttle valve to fully open.

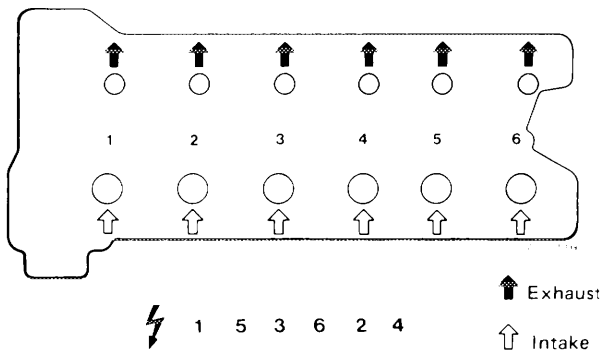


9 Screw connection hose into first spark plug bore and couple to connecting hose of tester. Crankshaft should not rotate.

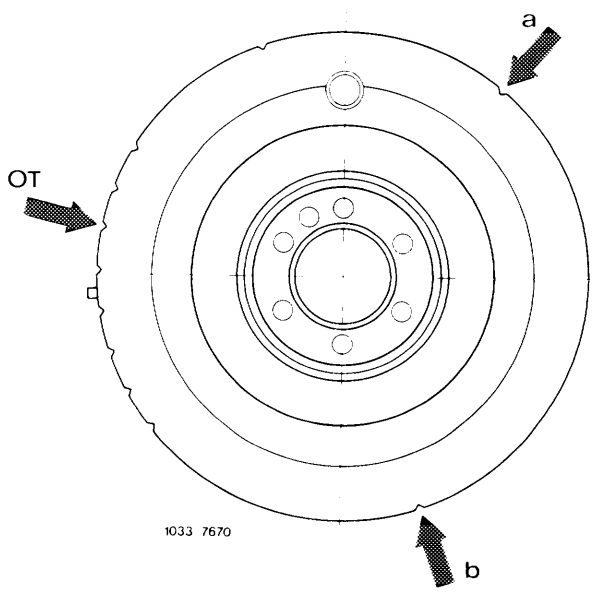
10 Read pressure loss on tester.

11 Check by listening whether pressure escapes via intake pipe, exhaust, oil filler cap, spark plug bore of adjacent cylinder or radiator cap.

12 Check all cylinders in ignition sequence.



Note: The respective pistons are in TDC position when the markings on vibration damper as shown in adjacent drawing are below TDC indicator.



TDC position of pistons

TDC Piston 1 and 6
a Piston 3 and 4
b Piston 2 and 5

Note: There is the possibility that the piston ring gaps of individual pistons are directly one above the other, so that the test result will be misrepresented.

When in doubt, continue running vehicle and check cylinders for leaks once again later on.

01–020 Evaluating cylinder bores

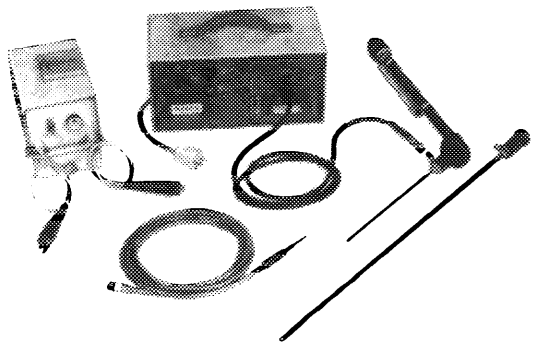
Conventional tool

Cylinder illuminating lamp	e.g. made by Karl Storz GmbH, 7200 Tuttlingen Motoskop TW (cold light) with lens attachment 210 mm long.

Note

Visual inspections can be made with a cylinder illuminating lamp on mounted cylinder head.

When illuminating because of oil consumption or blue smoke, run engine warm, shut off and illuminate cold, or immediately following deceleration (coasting).



103-15713

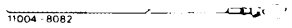
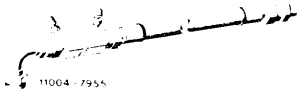
When evaluating scored or streaky cylinder walls, it is often no easy job for a workshop to decide whether the respective damage is bad enough to require removal of engine or repairs, or whether the marks are insignificant. The following information will help in making an expert and correct decision.

With regard to marks on cylinder walls the first important difference is between "optical streaks" and "seizure streaks". In most cases "optical streaks" are about 3 mm wide, they are produced by the piston ring gaps and the honing structure will still be visible; while "seizure streaks" will obliterate the honing structure.

"Longitudinal streaks" (in piston pin direction) are not the result of shaft scratches or seizure, since there is no contact between piston skirt and cylinder wall.

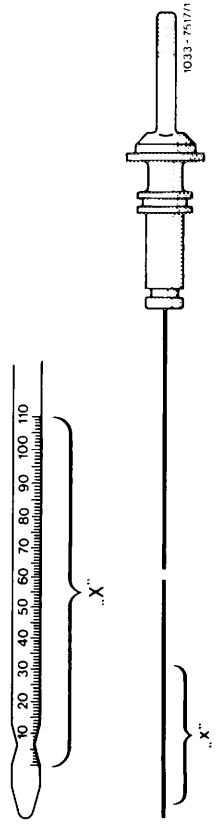
01–025 Measuring oil consumption

Special tools

Oil dipstick with millimeter scale for engines with oil suction		115 589 15 21 00
Oil dipstick with millimeter scale for engines without oil suction		110 589 11 21 00
Telethermometer		116 589 27 21 00
Valve for interrupting oil return flow from oil cooler		110 589 00 91 00

Note

The oil consumption can be measured by means of oil dipstick with millimeter scale and the pertinent diagram on back of data sheet.



Data sheets

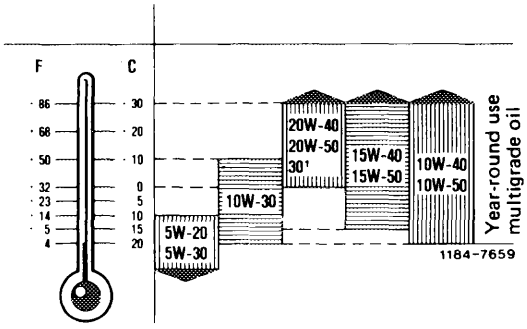
Engine 110	Print no.
Engines with oil suction	800 99 403 00 German/English 800 99 403 01 French/Spanish
Engines without oil suction	800 99 227 00 a German/English 800 99 227 01 a French/Spanish

The measuring procedure is explained on front page of data sheet.

To avoid faulty measuring, check engine oil for dilution by fuel prior to measuring.

01–030 Removal and installation of engine (oil filling capacity)

Specified viscosity classes
according to SAE
during constant outside temperatures



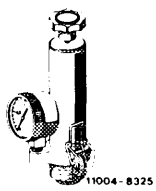
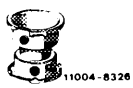
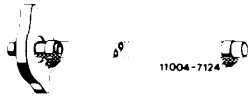
¹) During constant outside temperatures above + 30°C (+ 86° F) SAE 40 may be used.

Oil filling capacity in liters (for approved engine oil grades refer to specifications for service products)

Color code of oil dipstick	total capacity when refilling engine
Wine red pink brown (USA 1975/76 only)	7
yellow-green	6.5

Tightening torques		Nm
Oil drain plug to oil pan		40
Fastening screw for oil filter lower half		40
Screws for engine carrier on engine mount front	M 12	70
	M 10	40

Special tools

Tester for cooling system and radiator cap	 11004-8325	001 589 48 21 00
Double connection for radiator cap test in combination with tester	 11004-8326	000 589 73 63 00
Radiator cap with hose for leak test	 11004-7124	605 589 00 25 00

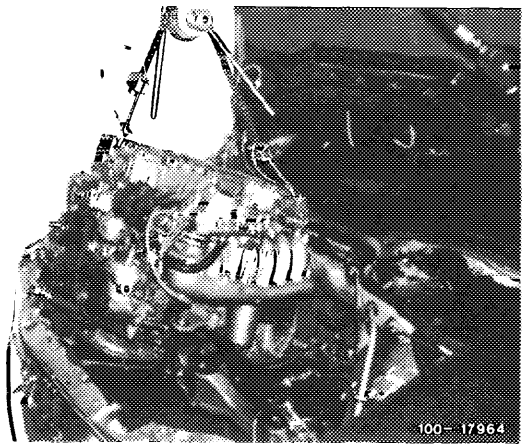
Conventional tool

Engine hoist (Motordirigent) size 1.5	e.g. made by Bäcker, D-5630 Remscheid order no. 3178

Note

Remove and install engine with transmission by means of an engine hoist in diagonal position.

If removal and installation is performed on a lifting platform, the engine of model 126 can be placed on cross yoke center piece at the rear during installation.

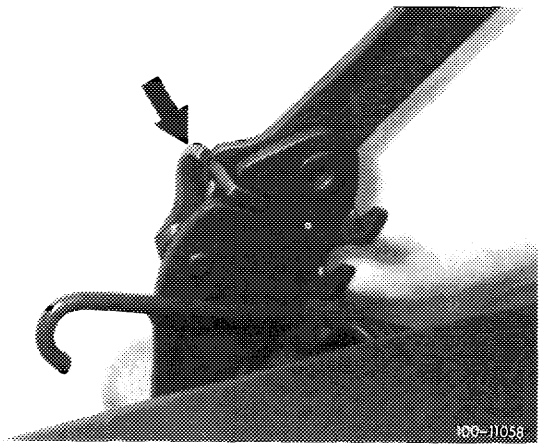


Removal

1 On model 123 and 126 move engine hood into 90° position and let left-hand locking lever (arrow) engage.

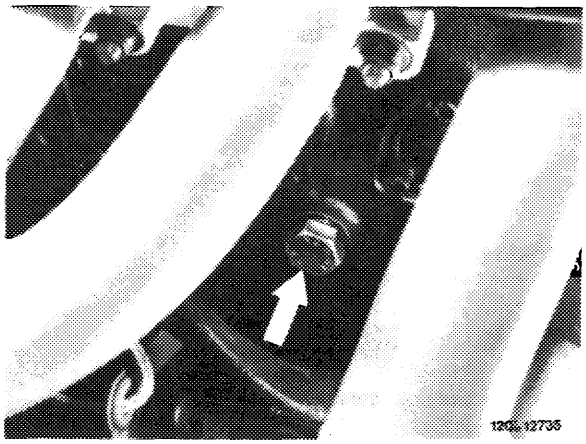
On other models, remove engine hood.

2 Disconnect battery cable.



3 Drain coolant (arrow).

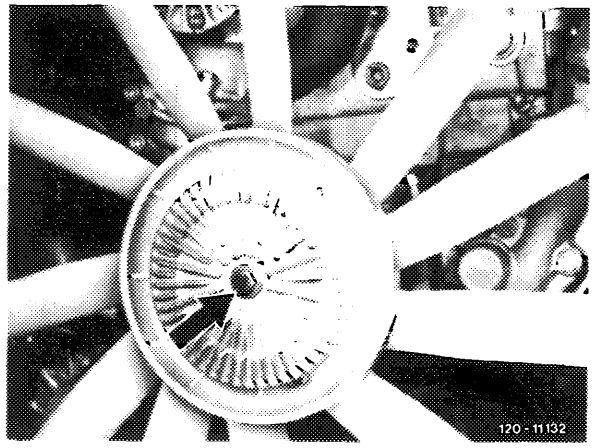
4 Disconnect and close lines for air oil cooler and transmission oil cooler on radiator and close, so that no oil will run out.



5 Remove radiator together with air oil cooler, while suspending fan cover over fan.

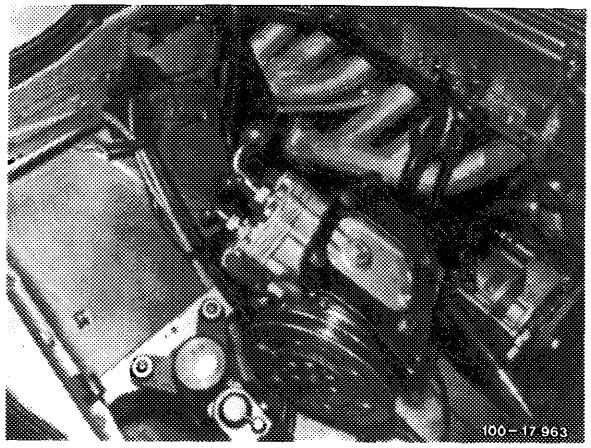
6 Remove fan.

For this purpose, loosen screw (arrow) on magnetic fan.

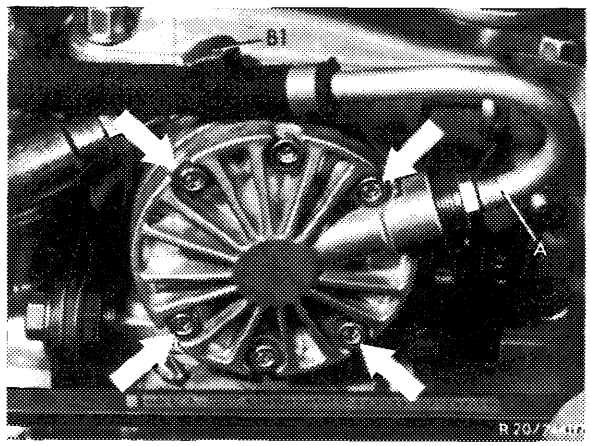


7 On vehicles with air conditioning, unscrew refrigerant compressor and put aside with lines connected.

When removing refrigerant compressor, drain air conditioning system (83–516).

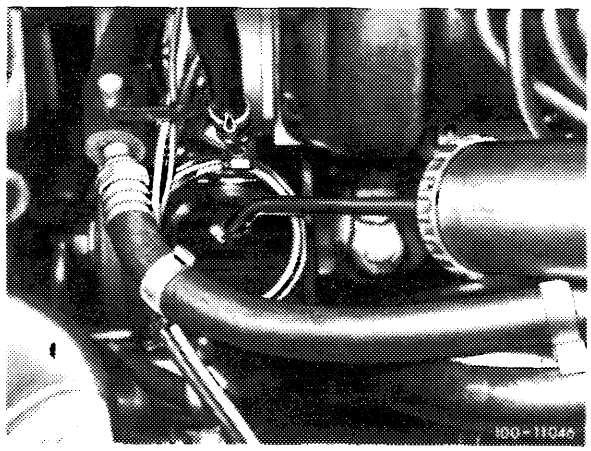


8 Disconnect lines at oil pressure pump. Only loosen bolts (arrows) to detach oil pressure pump.



9 Draw oil out of power steering pump tank.

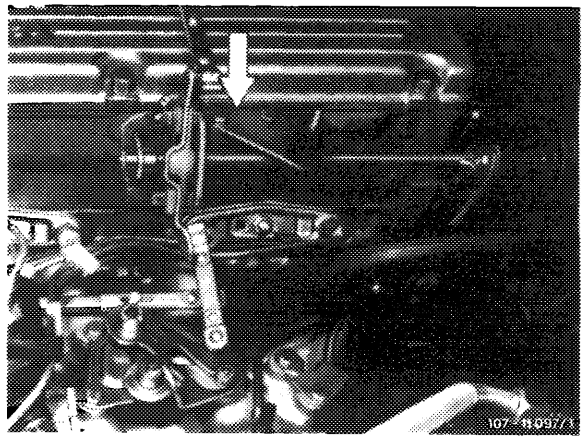
10 Disconnect hoses at power steering pump.



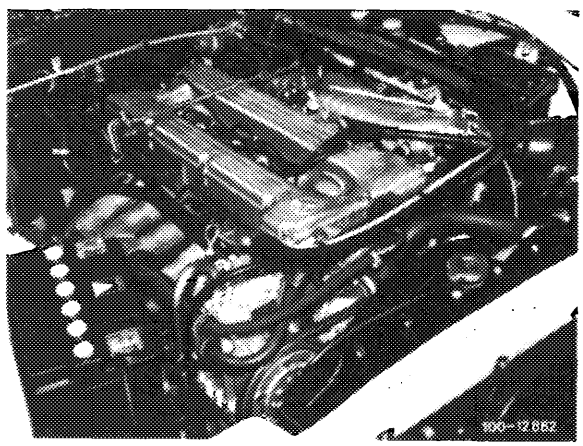
11 Disconnect electric harness for starter motor and alternator.

12 Disconnect all electric connections on engine.

13 Remove longitudinal control shaft.

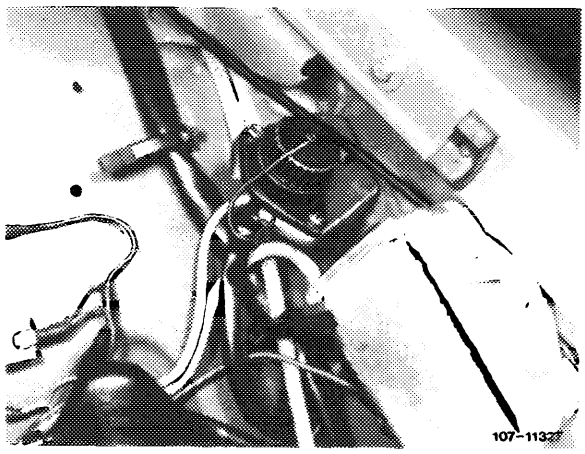


14 Disconnect all coolant, vacuum. oil and electric lines leading to the engine.

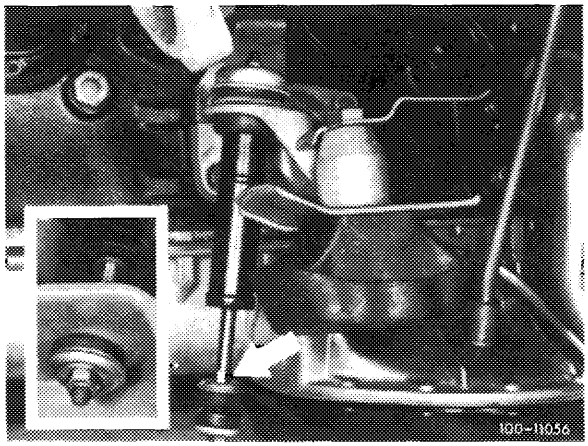


15 Pull off TDC transmitter wires at test socket. This requires unscrewing test socket at holder.

16 Detach exhaust pipes at exhaust manifold and exhaust strut at transmission.



17 Unscrew engine shock absorbers left and right (00–240).

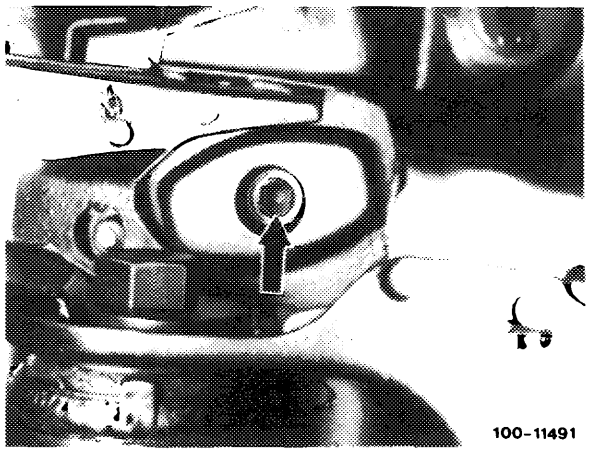


Model 123

18 Remove engine mounting bolts from engine mount.

Model 114 from above.

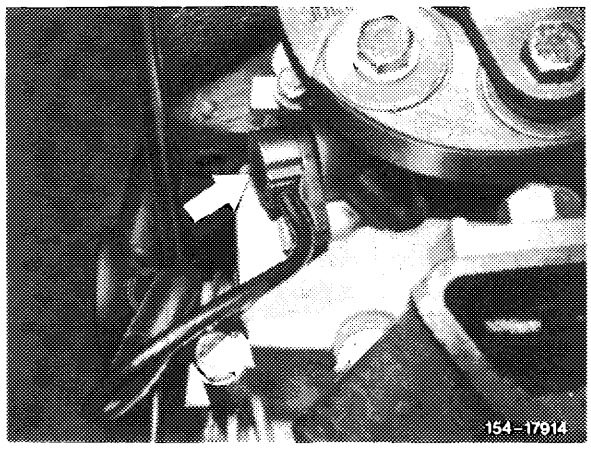
Models 107, 116, 123 and 126 from bottom of vehicle (arrow).



19 Remove rear engine carrier with engine mount.

20 Disconnect tachometer shaft on transmission.

Models with inductance transmitter (arrow): Disconnect inductance transmitter for tachometer. For this purpose, unscrew screw M 6 and pull out inductance transmitter.



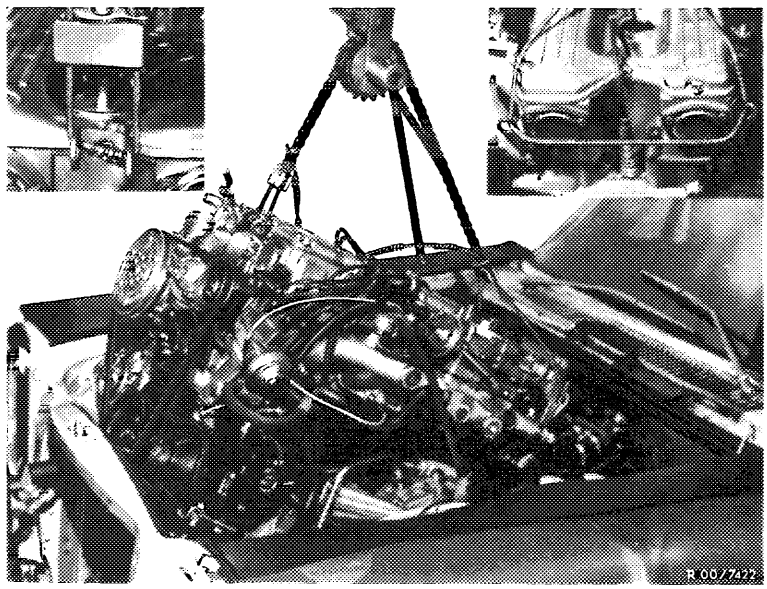
21 Disconnect propeller shaft on transmission and slide back.

Support propeller shaft, so that shaft will not abut against transmission flange when installing engine.

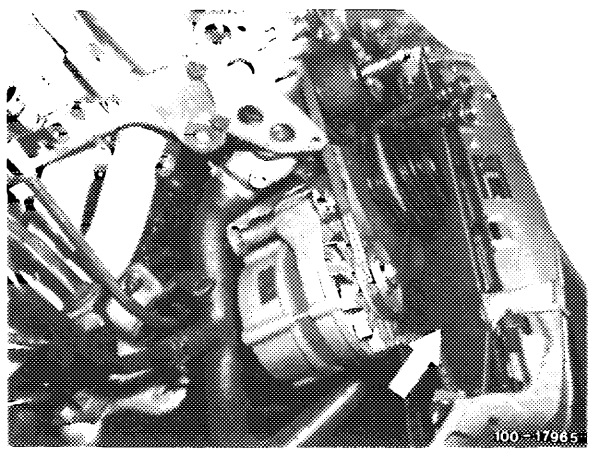
22 Loosen all connections and shift rods on transmission.

23 Attach engine at rear and front to suspension eyes.

24 Lift engine with transmission by means of engine hoist in an approx. 45° diagonal position. Make sure that the partition for unit compartment (model 126) is not damaged, since its damping effects will be lost by absorbed splash water.



Attention!
On vehicles with air conditioning, cover condenser with a hard fiber board (arrow).

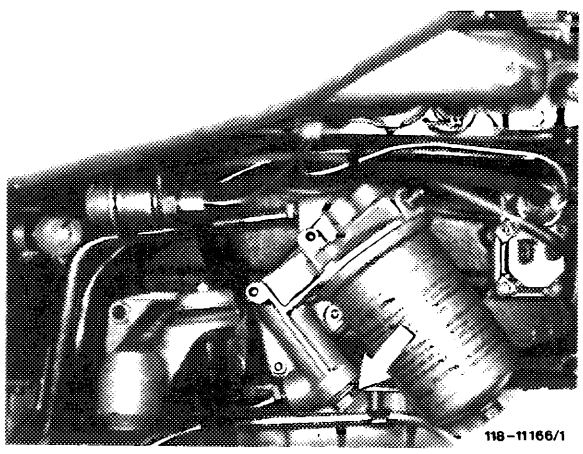


Installation

Attention!
When installing an engine because of previous bearing damage, flush out the oil cooler and oil hoses. Clean oil filter housing.

25 Check engine mounts, engine shock absorbers, coolant, oil and fuel hoses and replace them if necessary.

26 Prior to flanging-on manual transmission, check radial ball bearing in crankshaft and throw-out of clutch and renew, if required.



27 Install engine and connect.

28 Adjust rear engine mount free of tension (00–220).

29 Connect propeller shaft.

30 Check all drain plugs for tight seat.

31 Add oil and coolant (20–010).

32 Check cooling system for leaks with leak tester.

Note: On vehicles with auxiliary heater, bleed coolant circuit (refer to repair instructions auxiliary heater 83–415).

33 Check coolant for antifreeze.

34 Clean air filter and renew, if required.

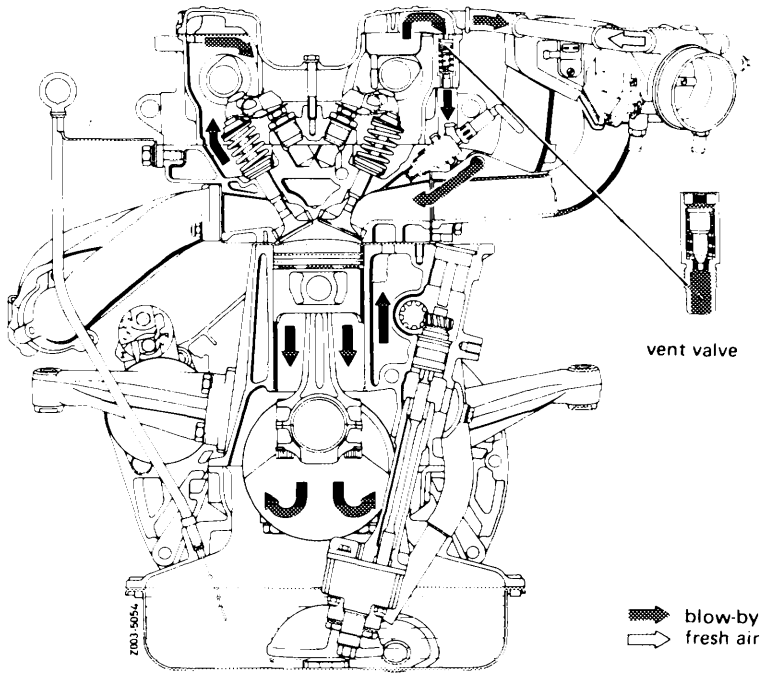
35 Check dwell angle and firing point.

36 Adjust idle speed and emission value (07.2–100).

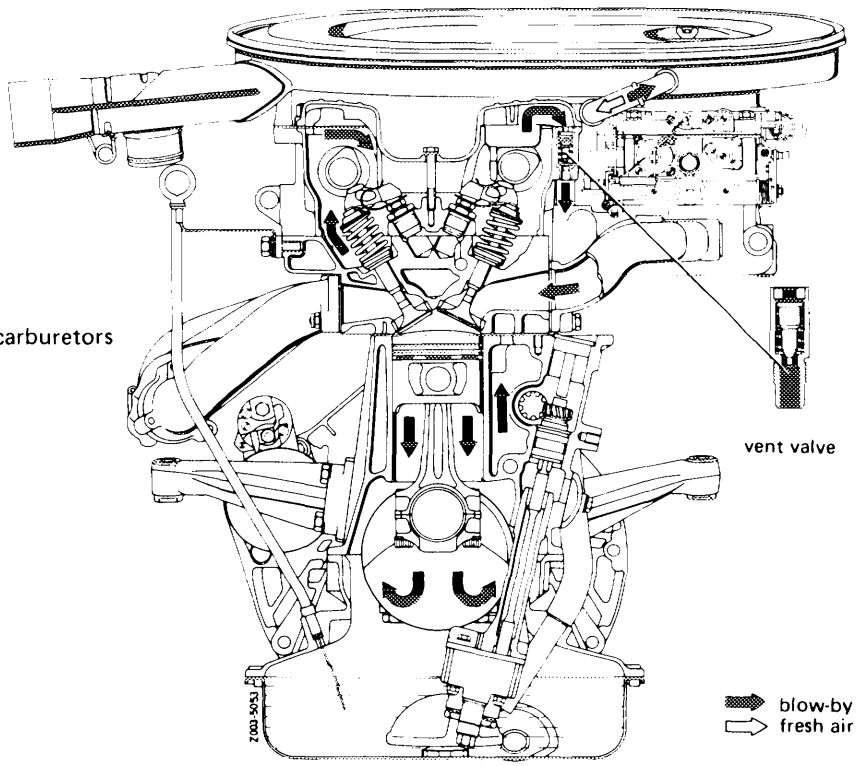
37 Check regulating shaft for function.

A. Engine with vent valve

This engine has a closed crankcase vent system which does not require maintenance.



Engine with electronic fuel injection system.

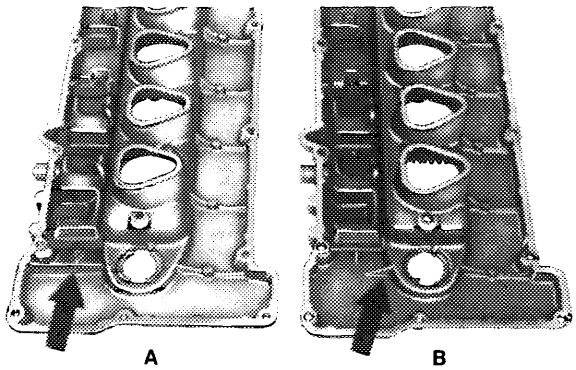


Engine with twin two-stage carburetors

First version with vent valve

The blow-by gases flow via an oil separator in the cylinder head cover to the vent valve.

Attention!
Only use cylinder head covers of version A with oil protection ribs.



101-9341

At idle speed and lower speed ranges the blow-by gas will enter the combustion chamber via the vent valve and intake manifold or idle air passage.

The vent valve spring works against the intake manifold vacuum pressure.

Depending on intake manifold vacuum pressure the valve cone will be pulled or pressed up by the valve spring and thus changes the through-flow cross section opening.

Since the through-flow capacity of the vent valve is larger than the amount of blow-by gas from the crankcase, fresh air is also drawn off from the air cleaner of a carburetor engine or from the throttle housing in front of the throttle valve via a pipe of an engine with fuel injection.

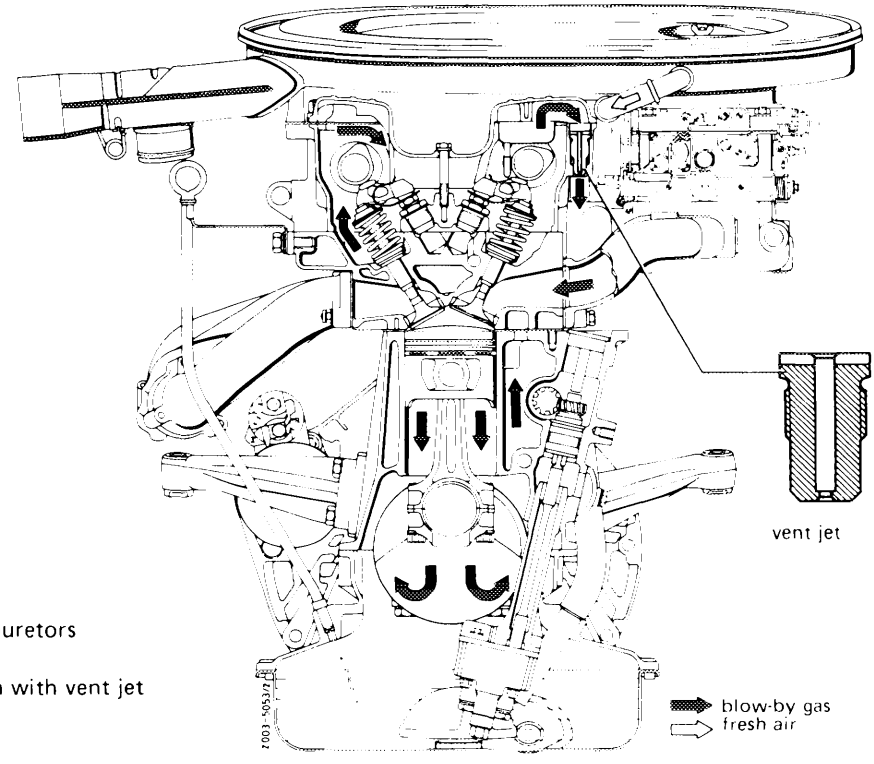
The additional fresh air is taken from an air cleaner of a carburetor engine via a hose.

When coasting the high intake manifold pressure will close the vent valve. The very slight amounts of blow-by gas in this case will now travel in reverse direction to the throttle housing via a pipe or the air cleaner via a hose and are drawn off at these points.

Note: Carburetor engines with a vent valve can also be equipped with a vent jet.

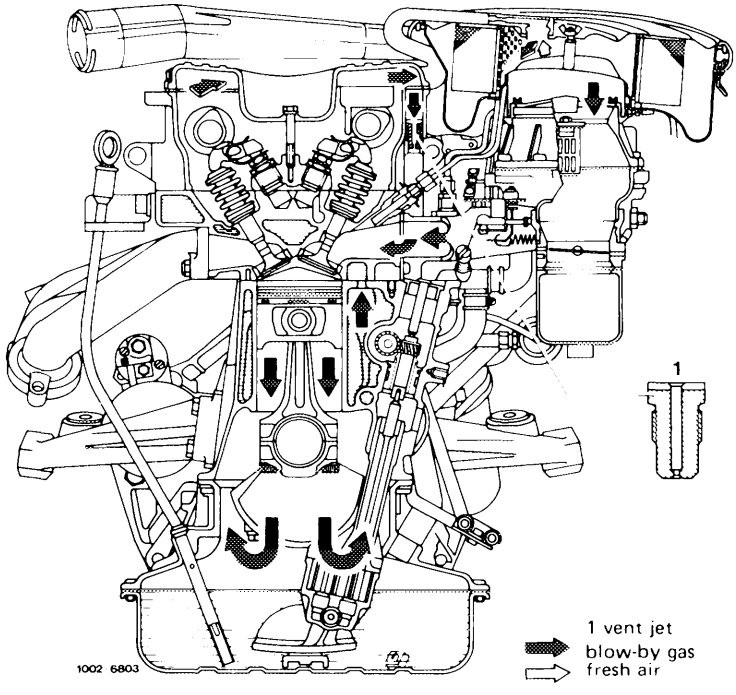
B. Engine with vent jet

This engine has a closed crankcase vent which does not require maintenance.



Engine with twin two-stage carburetors

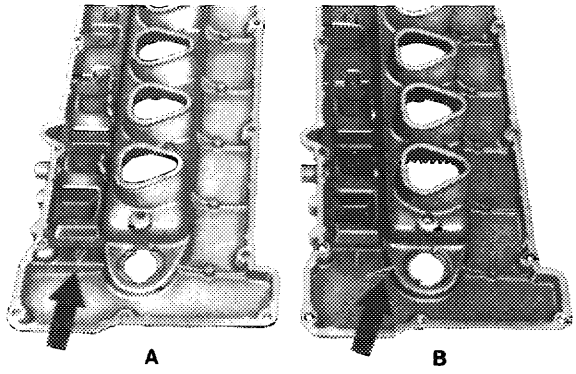
Second version and USA version with vent jet (including model year 1979).



Engine with continuous fuel injection

The blow-by gases flow to the vent jet via an oil separator in the cylinder head cover.

Attention!
Only use cylinder head covers of version A with oil protection ribs.



101-9341

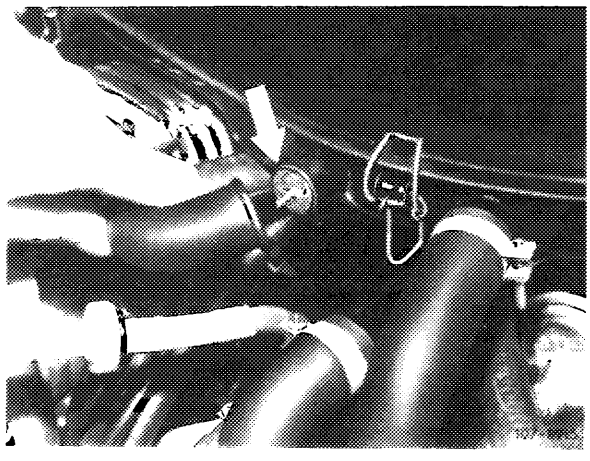
At idle speed and in low speed ranges the blow-by gas will enter into the combustion chambers via the vent jet and intake manifold or idle air passage.

In lower and medium speed ranges the intake manifold vacuum will cause fresh air to be drawn in from the air cleaner via a hose in addition to the blow-by gas.

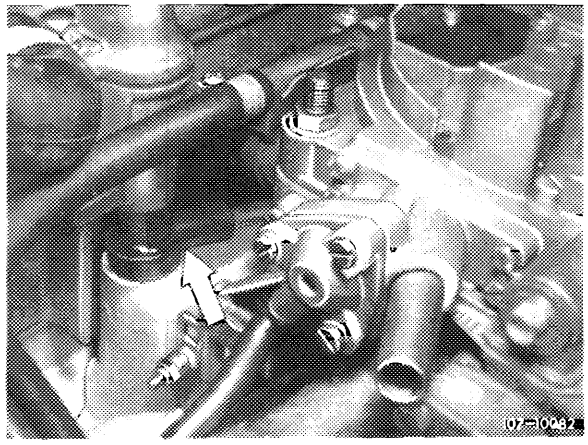
In the upper speed range blow-by gas will also flow from the fresh air side of the air cleaner depending on the blow-by quantity.

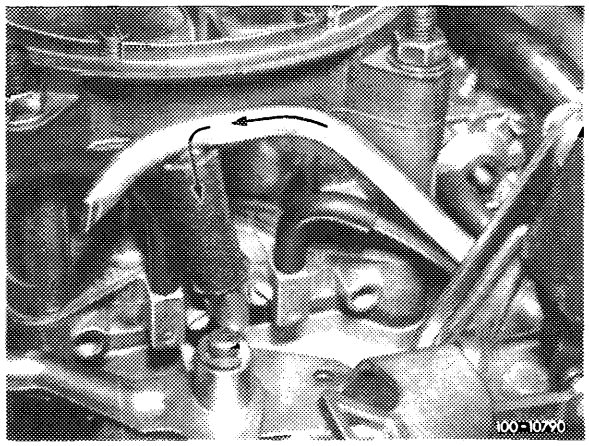
This is drawn off to the combustion chambers via the carburetor or air flow sensor and intake manifold.

Models for USA, Australia and Japan up to model year of 1977 have a flame guard (arrow) in the engine vent connection.

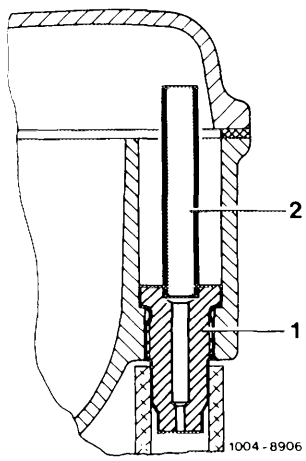


For 1975 and 1976 USA models, 1976 Sweden model and 1976 Japan models the blow-by gas is drawn off to the carburetor via an angle connector (arrow).





On USA vehicles starting model year 1980 the vent nozzle is mounted with an overflow pipe (2), so that no engine oil is carried along in idle speed air duct.



Data

Group number[1]		0	1	2
Standard dimension 86.0	piston dia.	85.970–85.982	85.980–85.992	85.990–86.002
	cylinder dia.	85.998–86.008	86.008–86.018	86.019–86.028
Repair stage 1 + 0.5	piston dia.	86.470–86.482	86.480–86.492	86.490–86.502
	cylinder dia.	86.498–86.508	86.508–86.518	86.519–86.528
Repair stage 2 + 1.0	piston dia.	86.970–86.982	86.980–86.992	86.990–86.002
	cylinder dia.	86.998–86.008	87.008–87.018	87.019–87.028

[1]) Decisive for association is the smallest measured cylinder dia. and the largest measured piston dia.

Max. wear limit in driving or transverse direction of cylinder bores at upper reversing point of 1st piston ring		0,10
Piston clearance	When new	0,025–0,035
	Wear limit	0,08

Machining tolerances

Permissible deviation (radial distance) from cylinder shape	When new	0,007
	Wear limit	0,025
Permissible deviation from square with reference to cylinder height		0,05
Mean height of roughness		0,002–0,004
Permissible height of waviness		50 % of roughness
Chamfer of cylinder bores		see fig. point 2

Conventional tools

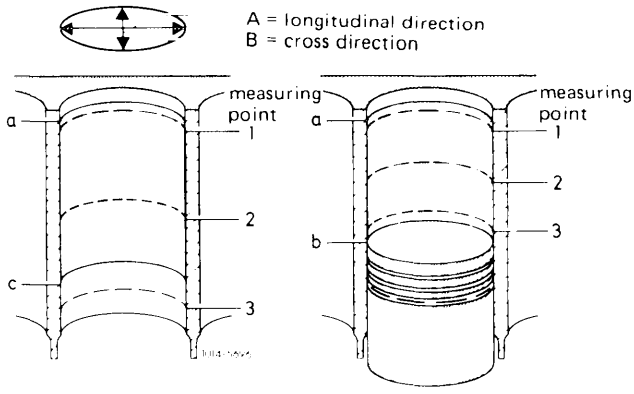
Inside measuring instrument for 50–150 mm dia., with 0.01 mm readout and measuring point pressure relief	e.g. made by Hommel Handel, 5000 Köln 71 Sunnen GRM-2125

Note

In particular for a complaint concerning "excessive oil consumption" a measurement of the cylinder bores is essential in addition to a visual inspection.

1 Measure the cleaned cylinder bores with an internal tester at measuring points 1, 2 and 3 in longitudinal direction A (piston pin axis) and in cross direction B.

When the pistons are installed measuring point 3 will be just barely above the piston, which must be at BDC.



a top reversing point of first piston ring
b BDC of piston
c bottom reversing point of oil scraper ring

The group number punched into crankcase (arrow), matches the group number of the pistons installed as standard equipment.

On used engines, the original cylinder dia. shows up after thorough cleaning of top land zone.

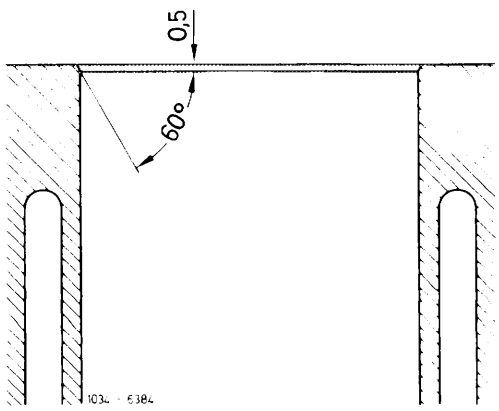
The difference in diameter of dimension shown on top land zone and the dimension at measuring point 1 generally indicates the respective max. wear.

In the event of repairs, hone cylinder bores according to dimensions of available pistons plus piston clearance.

The processing machines used for boring (pre-honing), finish-honing and polishing should be set in accordance with respective operating instructions.

Upon boring, the cylinder bores should be chamfered at upper cylinder end according to drawing.

The lower cylinder end should remain sharp edged without burr.



Data

Height of new crankcase	213.1—213.2
Min. height after removal of necessary material	212.8
Permissible deviation from parallel of upper parting surface in relation to lower parting surface in longitudinal direction	0,1
Permissible deviation from flatness of upper parting surface	0,03
Mean height of roughness of upper parting surface	0,005—0,020
Leak test with 1.5 bar air gauge pressure under water. Permissible leak rate in cc/min	10
Chamfer of cylinder bores	see note

Piston spacing in relation to parting surface

Engines with		normal compression		USA version and low compression	
Distance between piston crown and crankcase mating surface	Standard size piston	Below	min. 0.20 max. 0.70	above 0.25 below 0.15	
	Oversizes + 0.5 and 1.0	Below	min. 1.0 max. 1.5	below	min. 0.55 max. 0.95

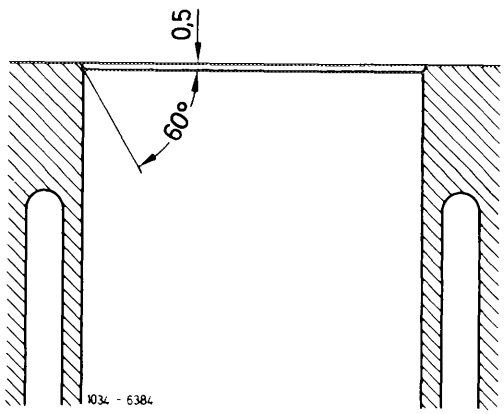
Conventional tools

Surface grinding machine	e.g. made by Ruaro u. Fi., Schio/Italy Scledum, type RTY
Knife-edge straightedge approx. 750 mm long	

Note

Chamfer cylinder bores after grinding.

Adjust valve timing (05—215), if crankcase mating surface has been machined.

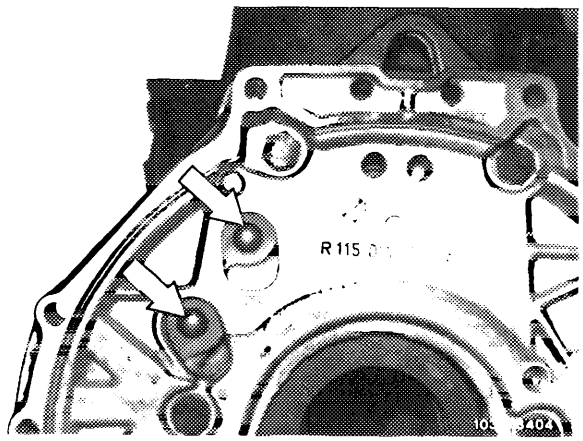


01–130 Knocking-out and inserting steel balls for main oil ducts

Tightening torques		Nm
Fastening bolts for intermediate flange		65
Closing plug for main oil duct		40
Pressure relief valve in main oil duct front		40
Closing plug pressure relief valve		50
Screw M 8 x 65 for vibration damper		35
Screw M 18 x 1.5 x 45 on crankshaft		400–450
Necked-down screw for driven plate and flywheel	initial torque	40
	torque angle	90°–100°

Note

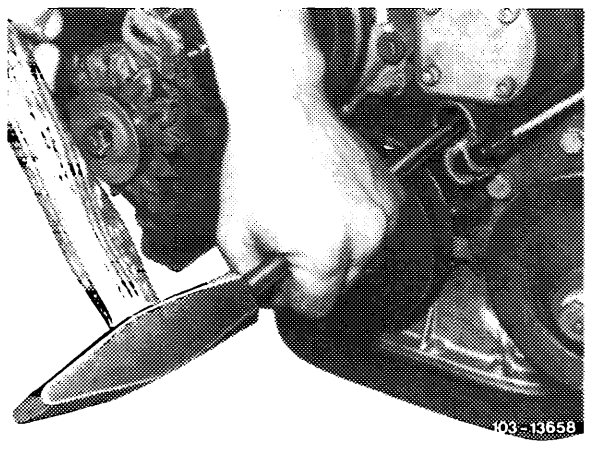
Since October 1976 the 2 main oil ducts (arrows) in cylinder crankcase at transmission end are closed by means of steel balls 15 mm dia. VO DIN 5401 part no. 005401 515001.



For cleaning main oil ducts during engine repairs, the steel balls must be knocked-out from direction of front end of engine.

Undamaged steel balls can be used several times without refinishing ball seat in crankcase.

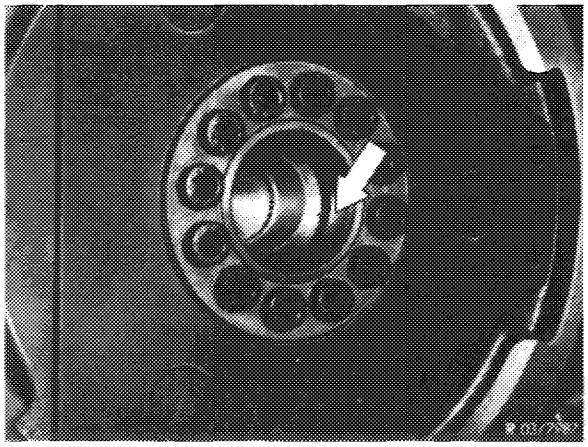
Damaged and rusty steel balls should be replaced.



Knocking-out steel ball in upper main oil duct

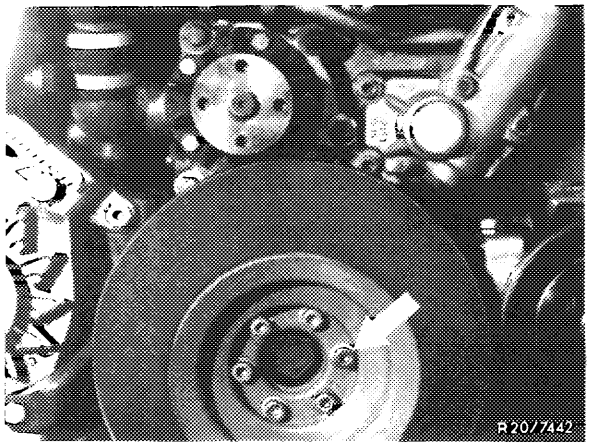
1 Remove transmission.

2 Remove flywheel (03–410).



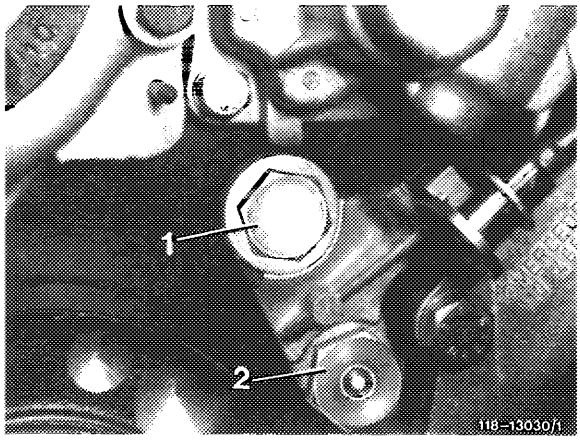
3 Remove radiator (20–420).

4 Remove vibration damper (03–340).



5 Unscrew closing plug (1) and screw oil pressure relief valve out of main oil duct.

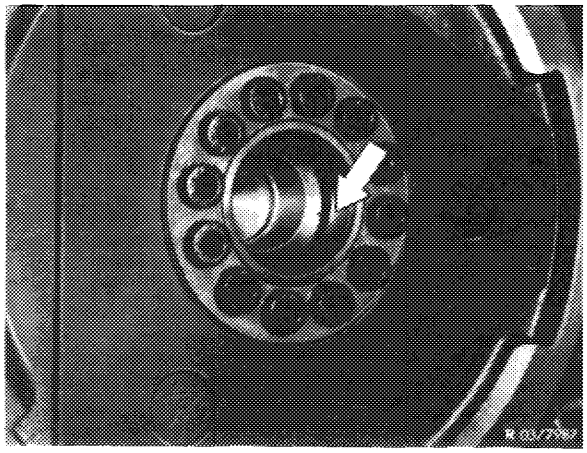
6 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.



Knocking-out steel ball in lower main oil duct

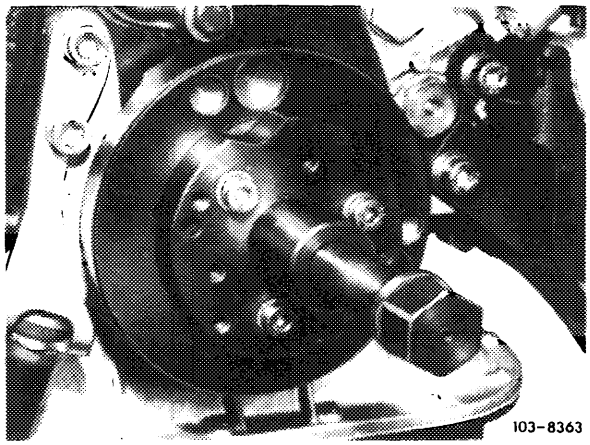
1 Remove transmission.

2 Remove flywheel (03–410).



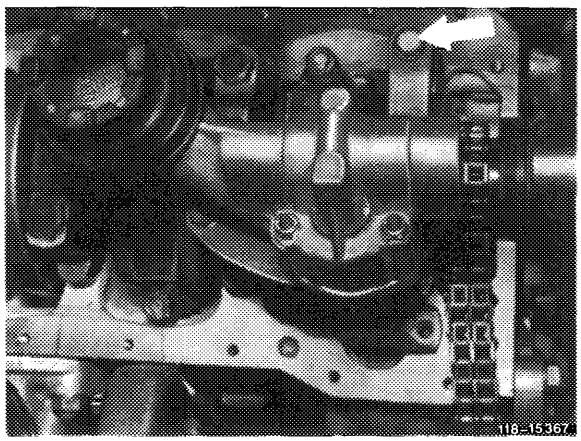
3 Remove radiator (20–420).

4 Remove vibration damper and compensating weight (03–340).



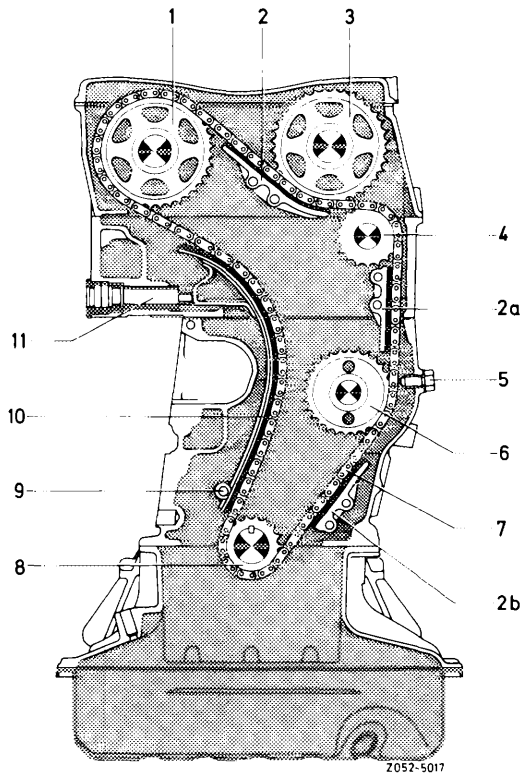
5 Remove complete oil pan (01–310).

6 Remove oil pump (18–210).



7 Remove slide rail (2b) in crankcase (05–340).

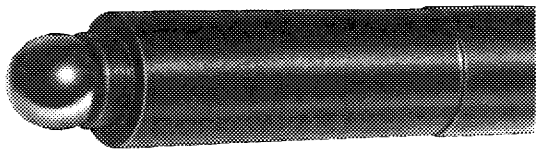
8 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.



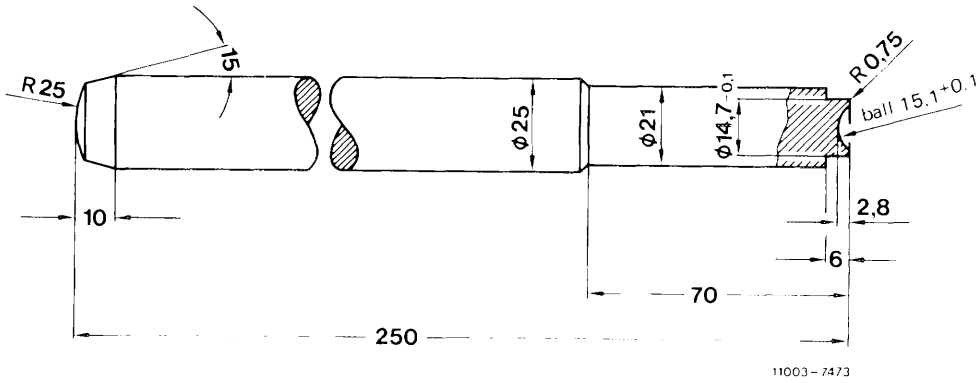
Closing main oil duct

1 Thoroughly clean ball seat and bore in main oil duct.

2 Coat up on self-made knocking-in mandrel with grease and place steel ball into cup.



103-13405



11003-7473

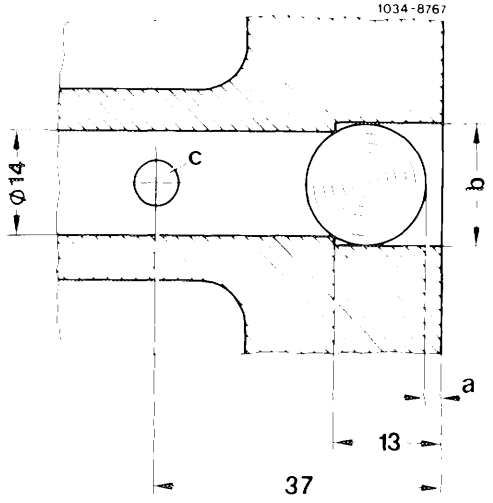
Material: C 45

3 Position steel ball with knocking-in mandrel and knock-in up to stop on mandrel.

103-14075

If the mandrel has no stop, do not exceed dimension a = max. 3 mm to prevent cracking of crankcase.

a = max. 3 mm
b = dia. 14.75 to 14.86 mm
c = oil ducts to crankshaft bearing



4 Mount all parts taken off or removed.

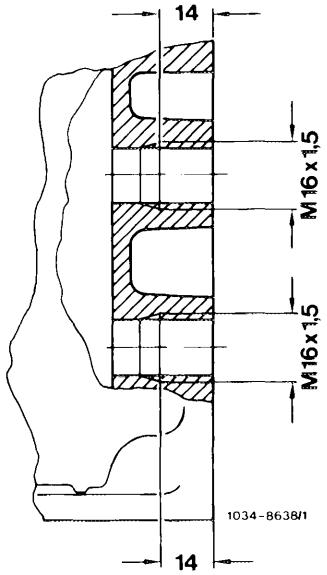
5 Run engine warm and check for leaks.

Note: If oil flows out as the result of a leaking ball seat, knock-out respective steel ball and close main oil duct with a closing plug after cutting the required threads into duct.

Closing main oil duct with closing plug

1 Cut threads M 16 x 1.5 mm approx. 14 mm deep into respective main oil duct.

2 Carefully clean main oil duct.



3 Screw closing plug M 16 x 1.5 mm DIN 908, part no. 000 908 016 001 with aluminum sealing ring A 16 x 22 mm DIN 7603 – AL, part no. 007 603 016 102, and tighten to 40 Nm.

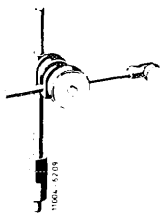
01–220 Installation and centering of intermediate flange

Data

Radial runout of intermediate flange		max. 0.10
Permissible axial runout of intermediate flange when mounted in crankshaft bearing basic bore during one full turn.		0.10

Tightening torques		Nm
Intermediate flange mounting bolts		65
Drive plate and flywheel expansion bolt	Torque pressure	40
	Torque angle	90–100°

Special tool

Dial gage holder (two required)		121 589 00 21 00

Self-made tool

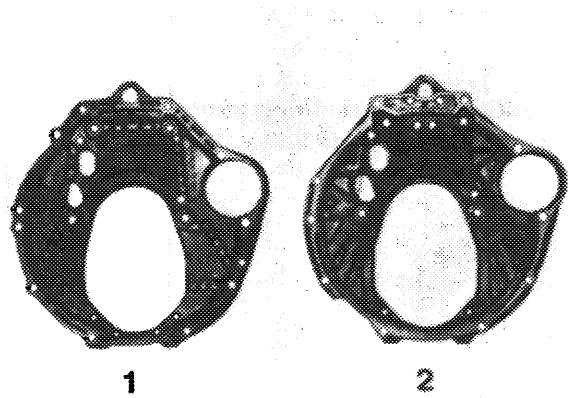
Threaded pin	see fig, point 3

Conventional tool

Dial gauge A 1 DIN 878	e.g. made by Mahr, 7300 Esslingen order no. 810

Note

A replaced intermediate flange must be centered. The automatic transmission W4A040 requires the intermediate flange (1) with fitted pin and all-around centering system, which can be used as a replacement for the formerly used intermediate flange (2) with all-around centering system.



1 2

1 Modified intermediate flange 110 011 15 45
2 Former intermediate flange 115 011 11 45

Series installation of intermediate flange
110 011 15 45 starting end of november 1979

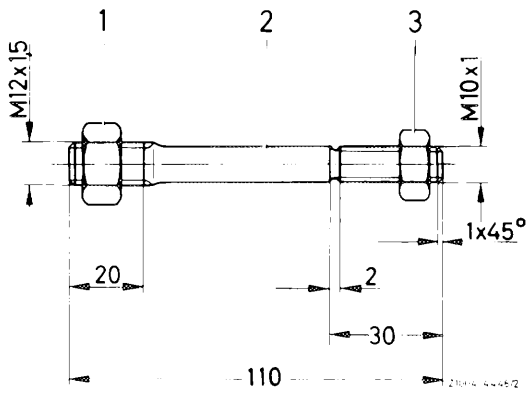
	Starting engine end no.	Starting chassis end no.
110.923	–10–014 453	123.030–028 448
	–12–017 710	123.050–003 543
110.984	–10–021 092	123.033–067 904
	–12–070 620	123.053–018 127
110.922	–10–040 775	
	–12–067 894	116.020–121 410
110.932	–10–010 365	
	–12–002 796	
110.985	–10–014 287	116.024/025–154 967
	–12–073 060	
110.986	–10–003 392	107.042–007 301
	–12–007 701	107.022–007 921

Installing and centering

1 Place intermediate flange over dowel pins in crankcase.

2 Tighten the four mounting bolts slightly.

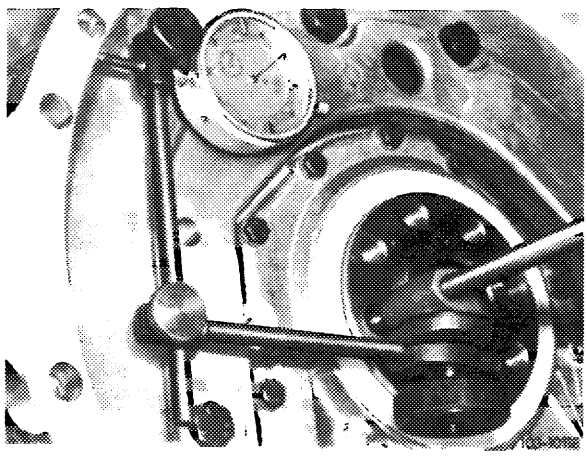
3 Screw threaded bolt (self-made) into crankshaft and counterlock with hex nut.



1 Hex nut M 12 x 1.5
2 Threaded bolt 10 mm dia
3 Hex nut M 10 x 1

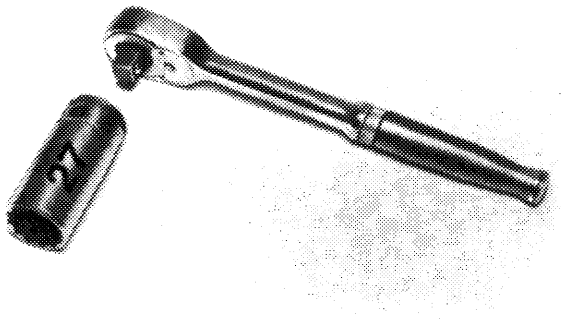
4 Attach dial gauge holder with dial gauge to threaded bolt.

5 Position feeler pin at fitting point of centering surface. Set dial gauge to 0.



6 Rotate crankshaft for one full turn by means of tool combination. Vertical runout should not exceed max 0.10 mm.

Note: When rotating crankshaft, make sure that the feeler pin of the dial gauge is not getting stuck.



1100-6498/1

7 Correct vertical runout by light blows against intermediate flange.

8 Tighten fastening screws.

Note: If the vertical runout exceeds 0.10 mm, remove intermediate flange.

9 Increase diameter of both fitted bores in intermediate flange to 12.1 mm.

10 Repeat item 1–8.

01–310 Complete removal and installation of oil pan

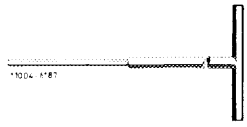
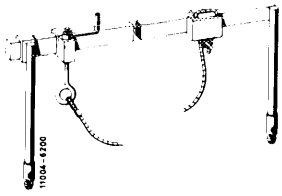
Oil capacity in liters

Oil dipstick color code		wine red, pink brown[1])	yellow-green
Oil pan		6	5.5
Oil filter		0.5	
Air oil cooler	Model 107, 114, 116	0.7	
	Model 123, 126	0.40	

1) (USA) model year 1975/76

Tightening torques	Nm
Oil drain plug on oil pan	40
Oil drain plug on air oil cooler	35
Filter lower section mounting bolt	45
Oil pan lower section to upper section	11

Special tools

Stud/ring wrench 13 x 14 mm		117 589 02 07 00
Stud wrench 5 mm, 300 mm long		116 589 02 07 00
Stud wrench 6 mm, 440 mm long		116 589 03 07 00
Engine support		107 589 02 61 00
Knocking-in tool for oil dipstick guide tube		117 589 00 31 00
Knocking-out mandrel 9 mm dia		110 589 02 15 00

Conventional tool

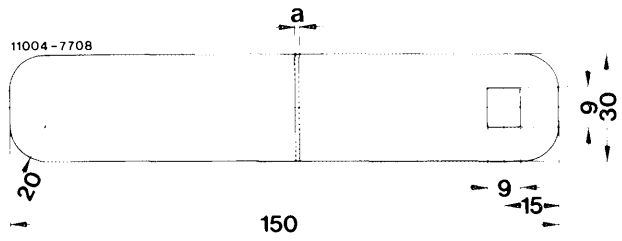
Engine hoist (Motordirigent) size 1.5	e.g. made by Bäcker, D-5630 Remscheid, order no. 3178

Self-made tools

Gauges for cutting-off radial sealing rings

Radial sealing ring graphite-grey
Part no. 000 997 65 41 a = 1 mm

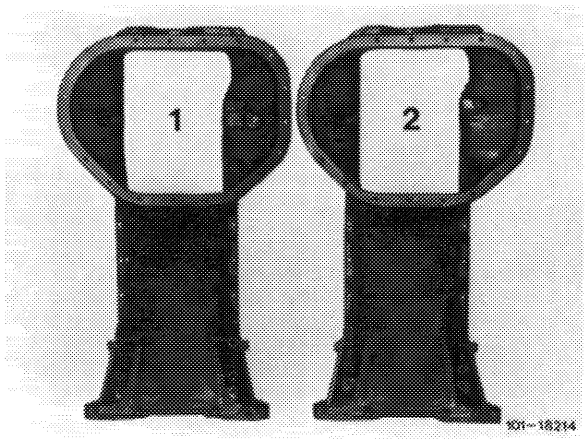
Radial sealing ring yellow-brown a = 0.5 mm



Note

The modified oil pan (1) is installed on models 107, 116 and 123 since October 1979 and model 126 since begin of series.

For this purpose, the rear 3 fastening threads on cylinder crankcase have been changed on both sides from M 6 to M 8 mm.

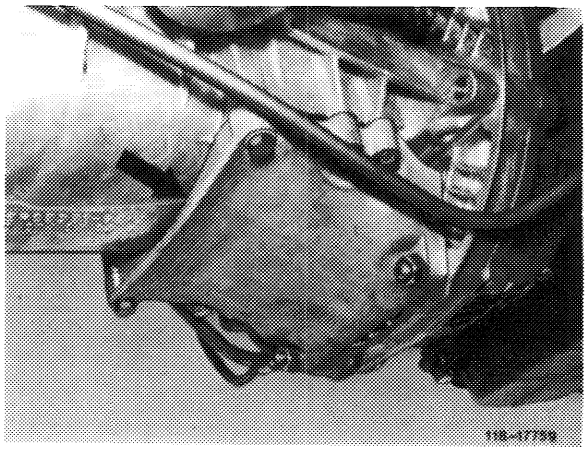


Begin of series: October 1979

Model	Engine	Engine end no. manual transm.	automatic transm.	chassis end no.
107.022				007709
107.042	110.986	003225	007317	006965
116.020	110.922	040571	067591	120830
116.020	110.932	010337	002781	
116.024/025	110.985	014120	070947	152618
123.030	110.923	014163	017466	028051
123.033	110.984	020182	068009	065415
123.050	110.923	014163	017466	003470
123.053	110.984	020182	068009	017451
123.093				004597

This modified oil pan is screwed to cylinder crankcase at the rear with 6 screws M 8 x 95 mm, formerly 4 screws M 6 x 40 mm and 2 screws M 6 x 25 mm.

On model 126 the modified oil pan is screwed to cylinder crankcase together with supporting tray (arrow) by means of 6 screws M 8 x 110 mm.



If a modified oil pan is installed in the course of repairs, the respective threaded bores in cylinder crankcase should be enlarged from M 6 to M 8 mm.

In the event of repairs, use radial sealing ring 000 997 90 41 (yellow-brown) with a projection of 0.5 mm on both sides, except when a new or newly ground crankshaft with new crankshaft bearings is installed. In such a case, use radial sealing ring 000 997 69 41 (graphite-grey) with a projection of 1 mm on both sides. This will protect the rear bearing journal of crankshaft against being overheated under influence of a low crankshaft bearing play and excessive pressure against yellow-brown radial sealing ring.

Removal

Model 107

1 Remove front axle (33–100).

2 Detach oil return pipe at cylinder head and pull off at oil pan.

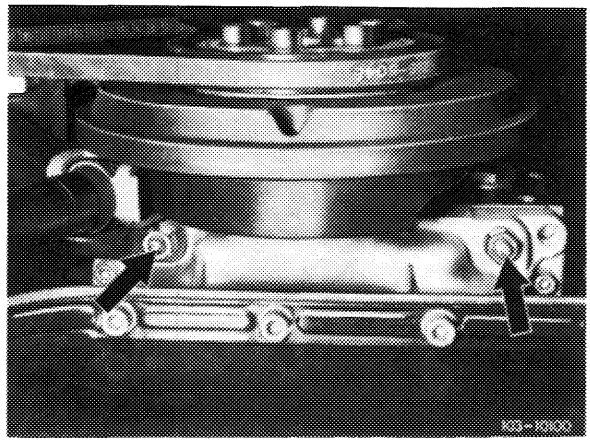
3 Detach oil dipstick guide tube at cylinder head.

4 Detach steering rod at one side.

5 Detach alternator holder strut at oil pan.

6 Remove oil pan downward.

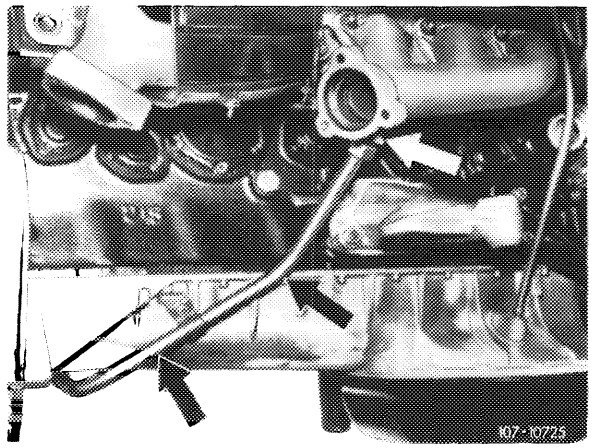
Note: Hold engine with engine support when working underneath engine.



Model 114

1 Remove front axle (33–100).

2 Remove exhaust gas recirculation line (arrows) for USA models.



3 Remove oil lines for automatic transmission.

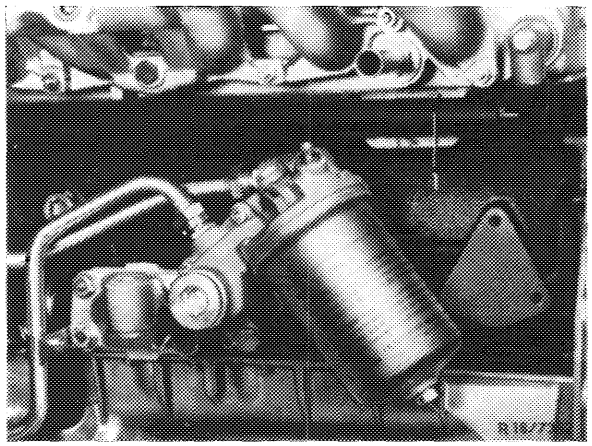
4 Detach oil dipstick guide tube at cylinder head.

5 Pull oil return line (1) off of oil pan (18–030).

6 Drain engine oil.

7 Remove oil pan.

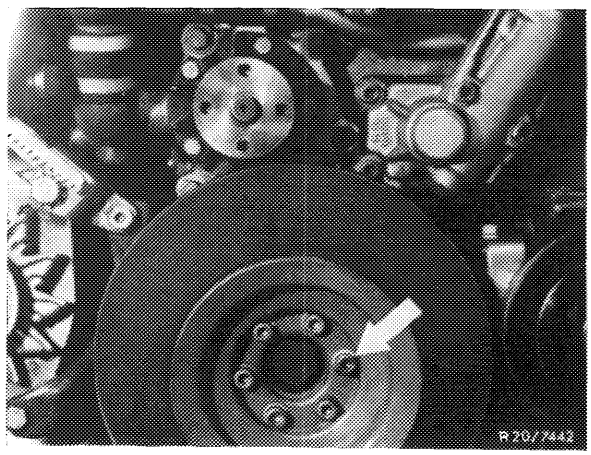
Note: Hold engine with engine support while working underneath engine.



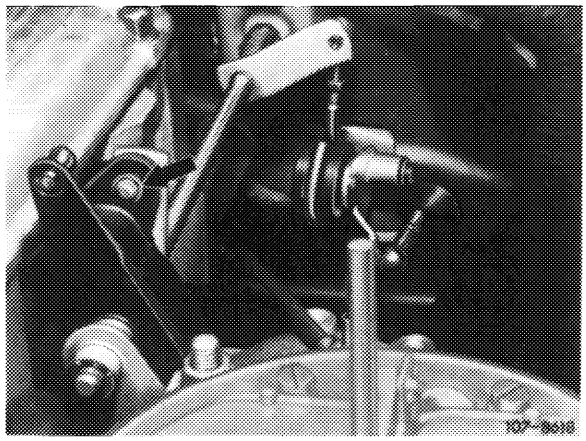
Model 116

1 Remove radiator.

2 Remove vibration damper (03–340).



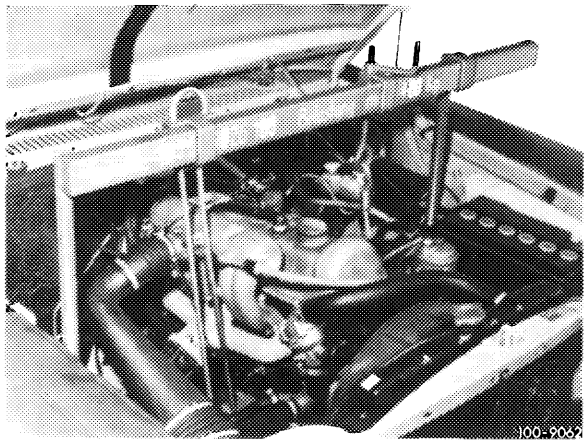
3 Detach control shaft (07.2–442).



4 Detach both front engine mounts and engine dampers.

5 Pull oil return line off of oil pan (18–030).

6 Drain engine oil.



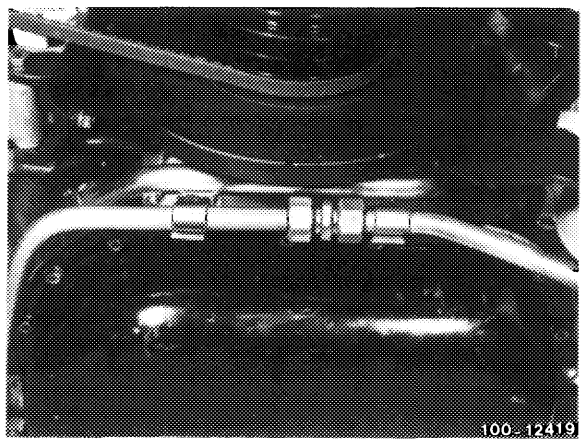
7 Remove oil pan lower section and oil pump. Remove fuel pump of carburetor engines.

8 Remove oil lines for automatic transmission.

9 Detach oil dipstick guide tube at cylinder head and drive it out from below with a 7.5 mm dia. mandrel.

Knock-out oil guide tube for drawing off oil with knocking-out mandrel 9 mm.

USA version



10 Detach rear engine mount, lift engine and place an approximately 40 mm thick piece of wood underneath.

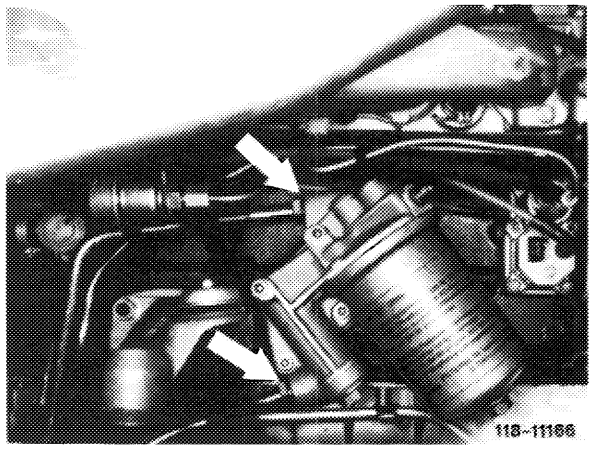
11 Lift front of engine and place approximately 60 mm thick pieces of wood on both sides between the engine carrier and engine mounts.

12 Detach oil pan and remove forward.

Model 123

1 Remove engine (01–030).

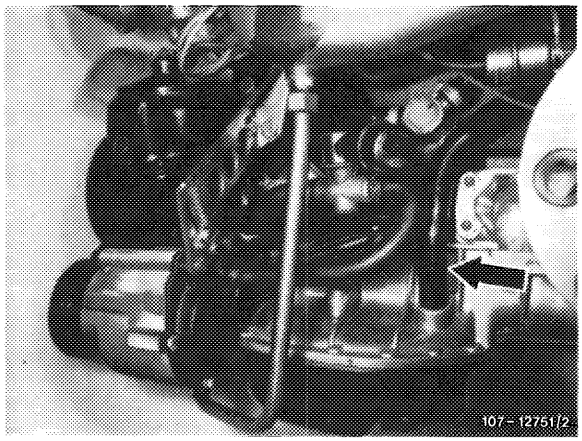
2 Remove oil filter complete with lines.



3 Pull-off oil return pipe (arrow).

4 Loosen strut for alternator bracket on oil pan.

5 Remove oil pan.



USA version

Model 126

1 Pull-off oil return line on oil pan.

2 Remove supporting tray.

3 Turn wheels completely to the left.

4 Unscrew cover plate.

5 Remove vibration damper (03–340).

6 Unscrew lower holding bracket of alternator.

7 Unscrew oil pan upper half to the extent that it is still held to crankcase by 2 screws.

8 Remove oil pan lower half.

9 Remove oil pump (3 screws).

10 Pull oil dipstick guide tube at top out of holder and knock out of oil pan upper half from below by means of a plastic hammer.

11 On vehicles with refrigerant compressor, remove lower strut.

12 Disconnect regulating linkage.

13 Unflange propeller shaft at transmission and push back.

14 Unscrew engine shock absorber below.

15 Unscrew screws for engine carrier on engine mount.

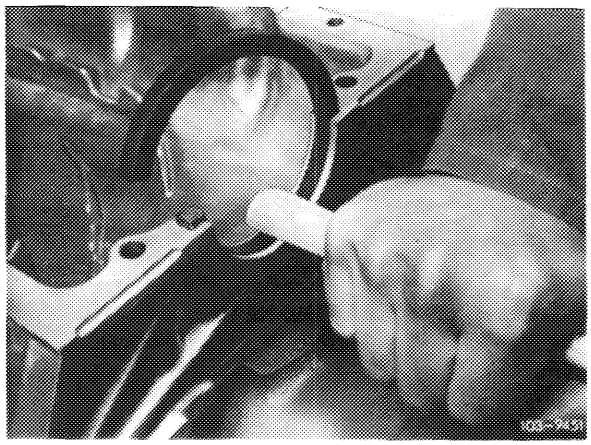
16 Suspend engine at the front and rear on engine removing eyes and lift until oil pan can be removed.

Installation, all models

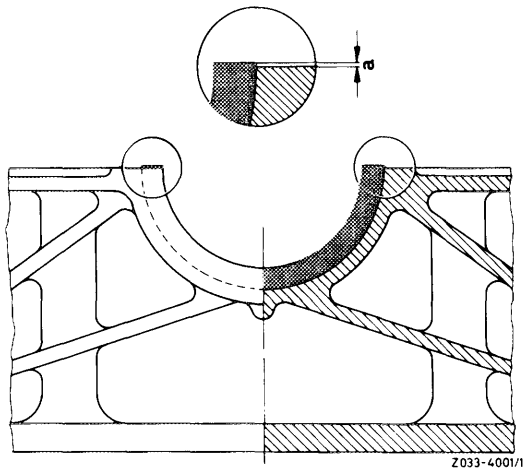
1 Clean parting surface on cylinder crankcase and oil pan.

2 Renew rear radial sealing ring in oil pan and work in.

Note: Do not install radial sealing ring 000 997 90 41 (yellow-brown) in engines which are provided with a new or refinished crankshaft and new crankshaft bearings in the event of repairs.



3 To arrive at an overlap, cut off radial sealing ring approx. 0.5 or 1.0 mm above parting surface. Use self-made gauge for this purpose.



Radial sealing ring, part no.	Dimension a (mm)
000 997 69 41 (graphite-grey)	1.0
000 997 90 41 (yellow-brown)	0.5

4 Provide radial sealing ring with engine oil.

5 Coat parting surface of oil pan with sealing compound.

6 Install oil pan and screw-on lightly at front and rear with 2 screws each.

Attention!
The oil pan should rest against or be screwed to intermediate flange prior to tightening fastening screws for crankcase.

7 For further installation proceed vice versa.

Attention!
Check regulating linkage for function.

Timing at 2 mm valve lift		Engine 110	Engine 110 California 1974	Engine 110 Federal 1973 and 1974
Camshaft code number[1])	Exhaust	24, 57, 71, 78	24	30, 95
	Intake	25, 67, 74	25, 74	33, 91
Intake valve	opens after TDC	7°		11°
	closes after BDC	21°		15°
Exhaust valve	opens before BDC	30°		22°
	closes before TDC			

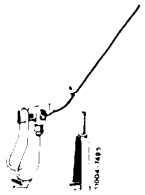
[1]) The camshaft code number is punched into rear end of camshaft.

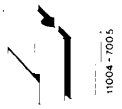
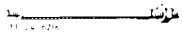
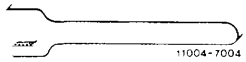
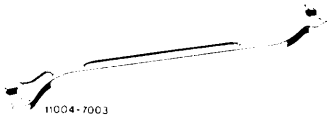
Valve clearance	on cold engine (approx. 20 °C)	on warm engine (60°C ± 15°C)
Intake	0.10[1])	0.15[1])
Exhaust	0.25	0.30

[1]) 0.05 mm larger during lasting outside temperatures below –20°C.

Tightening torques		Nm
Bolts and cap nuts for cylinder head cover		5
Necked-down screw for camshaft sprockets		80
Cylinder head bolts M 12 x 1.5 on cold engine	step 1	40
	step 2	70
	after 10 min. setting time	110
Bolts M 8 for cylinder head to crankcase		25
Closing plug chain tensioner		50
Threaded ring chain tensioner		50
Ball seat ring in chain tensioner		25

Special tools

Remover and installer for rocker arm		110 589 04 61 00

Rigid chain tensioner		110 589 03 31 00
Chain tensioner holder		110 589 02 31 00
Bearing pin impact extractor (basic unit)		116 589 20 33 00
M 6 x 50 bolt for impact extractor		116 589 01 34 00
M 6 x 150 bolt for impact extractor		116 589 02 34 00
M 10 x 100 bolt for impact extractor		116 589 03 34 00
Camshaft wrench		116 589 01 01 00
17 mm valve adjusting wrench		110 589 01 01 00
27 mm socket to turn engine, 1/2" square		001 589 65 09 00
Socket 10 mm 1/2" square 140 mm long		000 589 05 07 00

Conventional tools

Engine director size 1.5	e.g. made by Bäcker, D-5630 Remscheid Order No. 3178

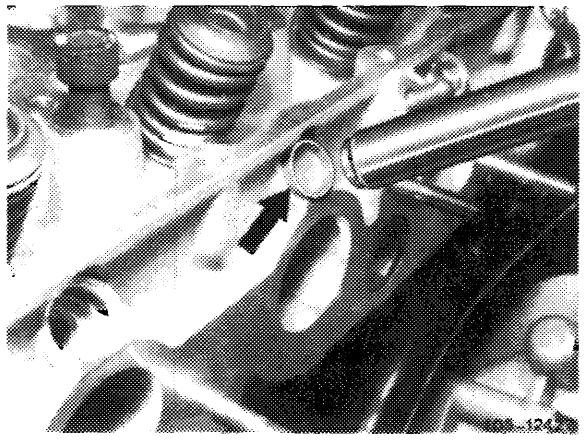
Note

A cylinder head may only be removed after the engine is cold. Removal is together with the camshaft housing, exhaust manifold and intake manifold.

There is only one type of cylinder head as a replacement part for carburetor and fuel injection engines.

If the cylinder head is used on a carburetor engine, the fuel injector bores must be plugged with 6 covers, part number 000 443 01 80 00.

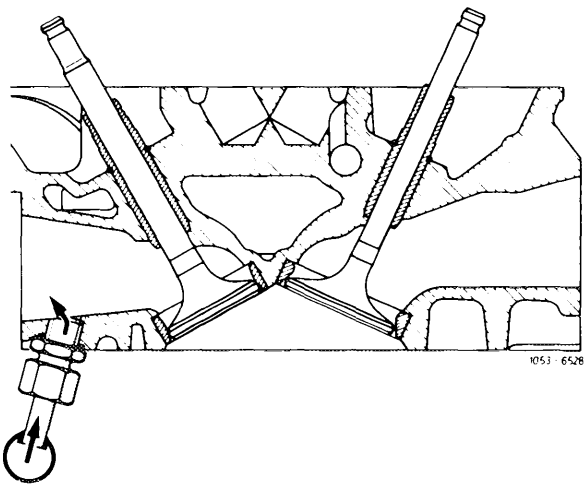
Starting April 1978 exhaust valve seat rings 42 mm OD and valve guides 9 mm ID are installed in cylinder head. Exception: engines national version.



Cylinder heads for engines with air injection are attached to exhaust ducts by means of threaded bores for air injection.

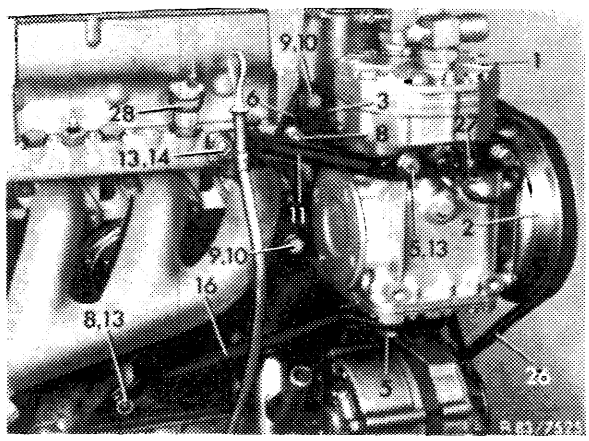
The diameter of the combustion chamber frame on cylinder head gaskets for the various repair stages varies:

Cylinder bore	Combustion chamber frame
86.00 ϕ 86.50 ϕ	86.70 + 0.5 mm ϕ
87.00 ϕ	87.20 + 0.5 mm ϕ

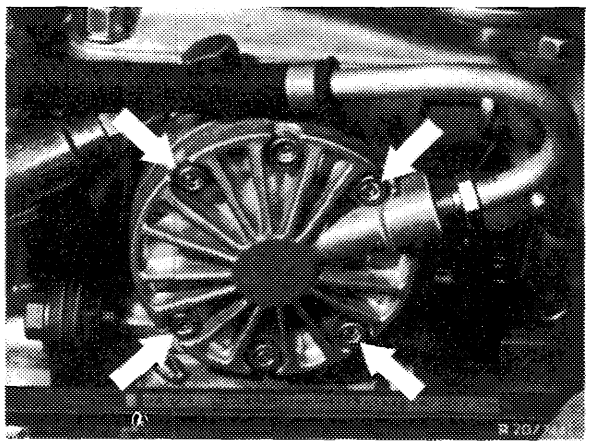


Removal

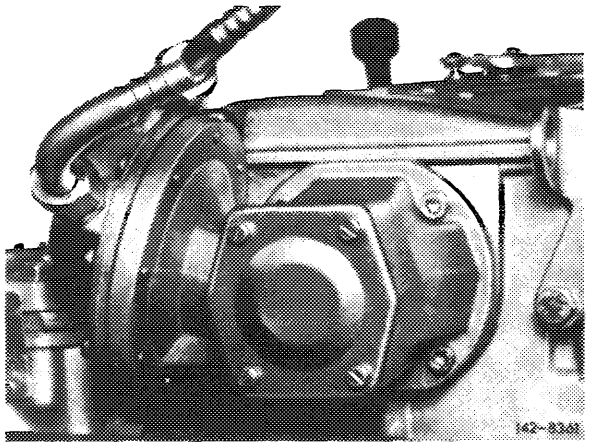
1 Remove compressor of models with an air conditioner.



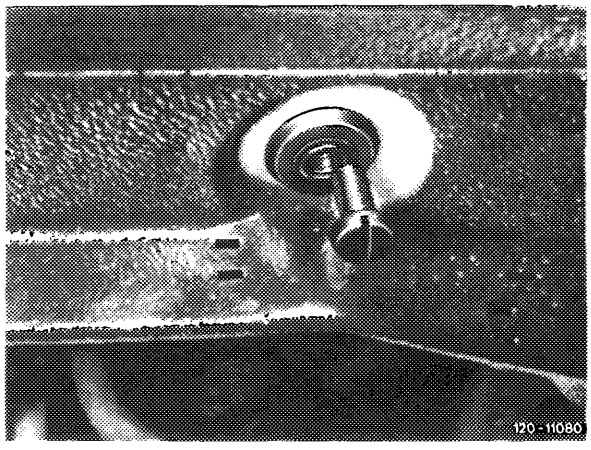
2 Remove oil pump of models with a level control system and place it to one side without undoing the lines. Only unscrew the bolts marked with an arrow for this purpose.



3 Remove vacuum pump of models for USA.

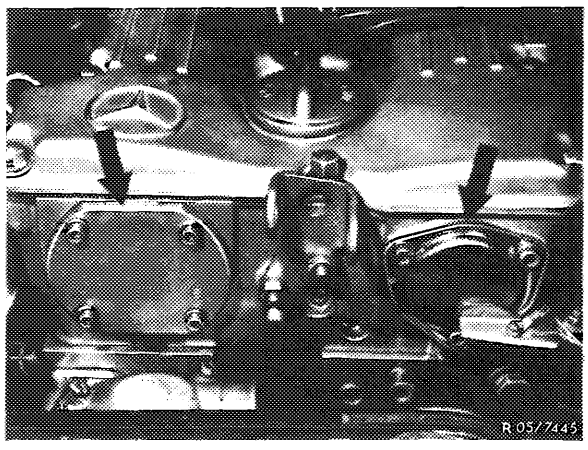


4 Drain coolant from radiator and engine.



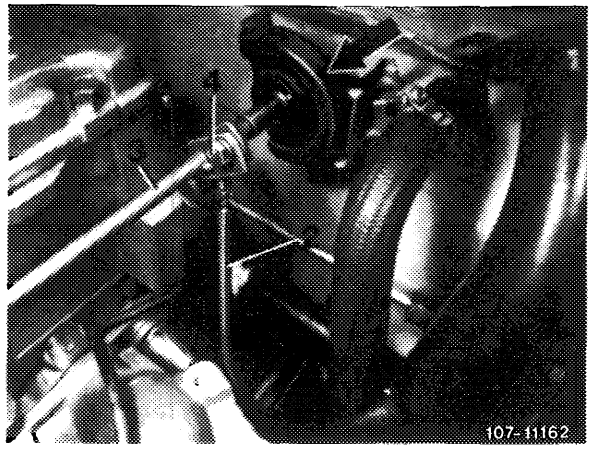
Model 123

5 Unscrew both covers at front of camshaft housing.

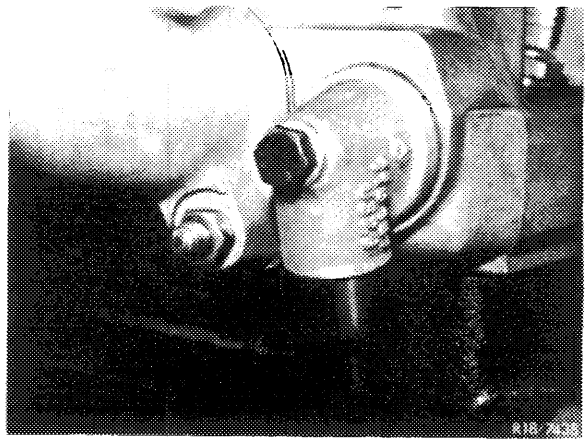


6 Disconnect all electric wires, heater water, fuel and vacuum lines which are connected to the cylinder head and intake manifold or carburetor.

7 Remove longitudinal regulating shaft (3).

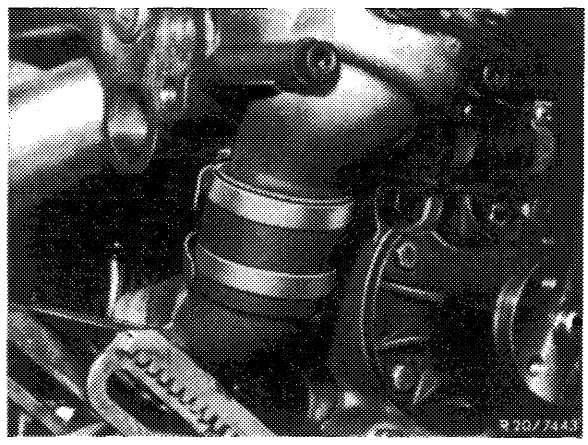


8 Disconnect oil return pipe at cylinder head.



9 Remove hose between thermostat housing and water pump.

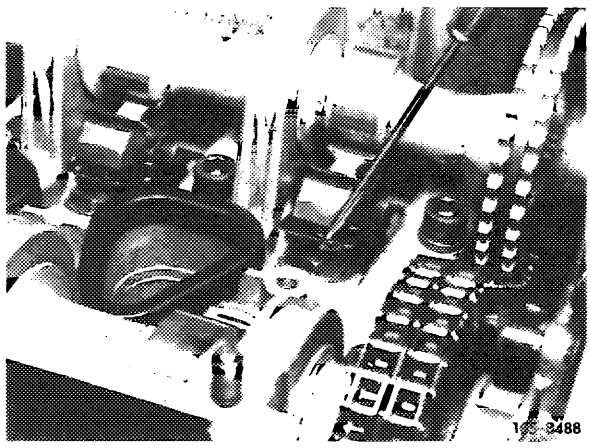
Disconnect bypass line at water pump.



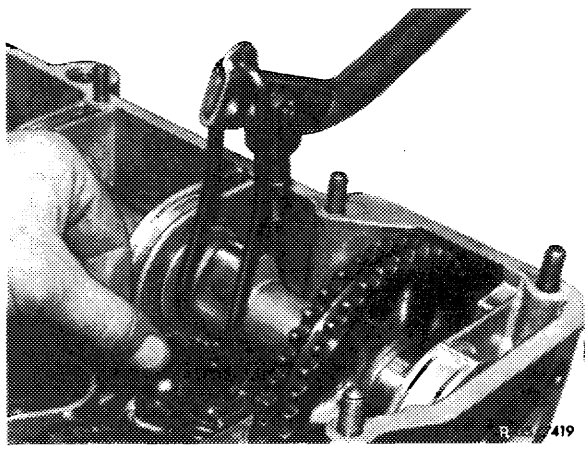
10 Disconnect oil dipstick guide tube from clamp on cylinder head and bend to one side.

11 Detach exhaust pipe at exhaust manifold and transmission. Unscrew pre-heating cowl of models with carburetor engines.

12 Press out all spring clamps with a wrench socket.

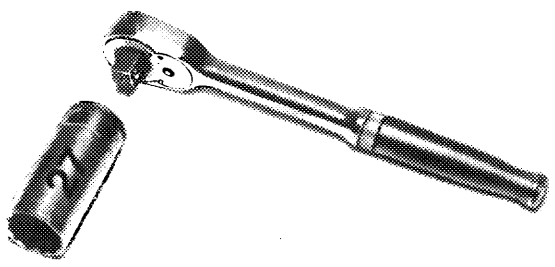


13 Remove all rocker arms with the remover and installer (05–230).



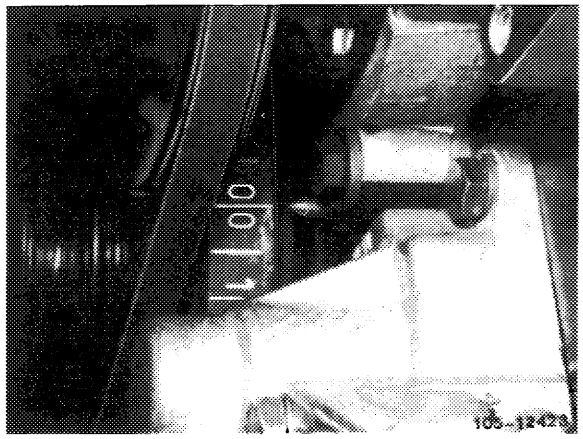
14 Turn crankshaft with combination tool.

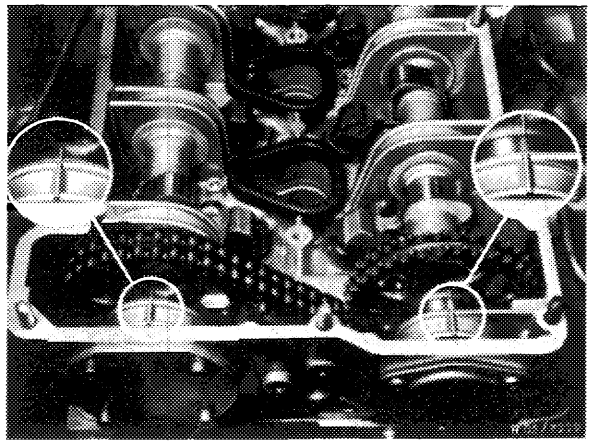
Attention!
Don't turn engine on **camshafts.** Don't turn engine in reverse direction of rotation.



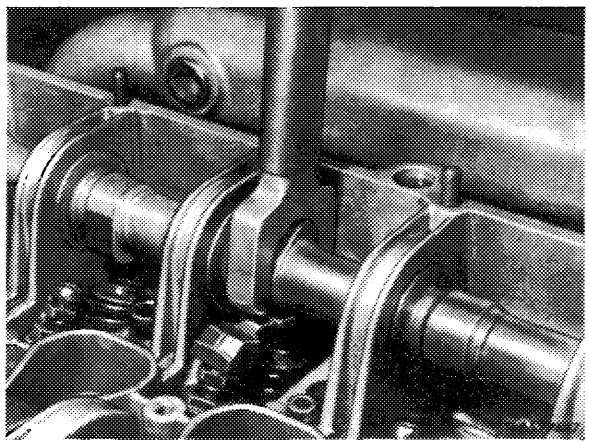
1100-6498/1

15 Position 1st cylinder of engine at ignition TDC. Marks on camshaft sprockets and camshaft housing must align.



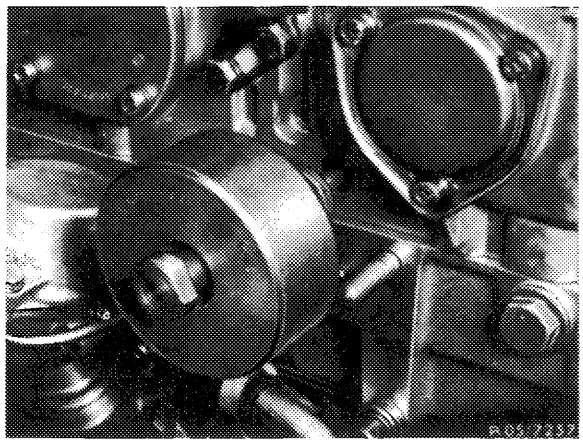


16 Remove both expansion bolts of camshaft sprockets. Counterhold camshaft with holder.



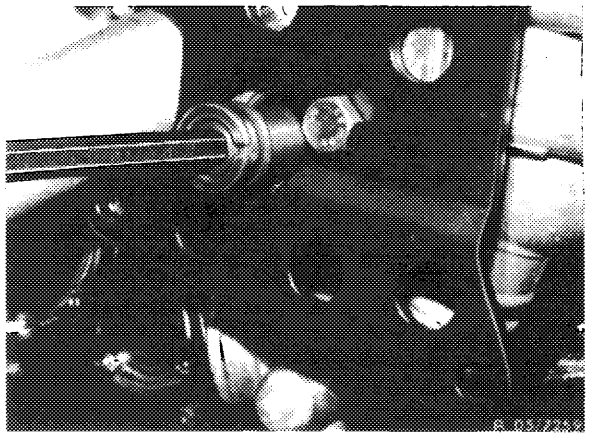
17 Remove upper slide rail in camshaft housing (05–340).

Knock out bearing pins with the impact extractor for this purpose.

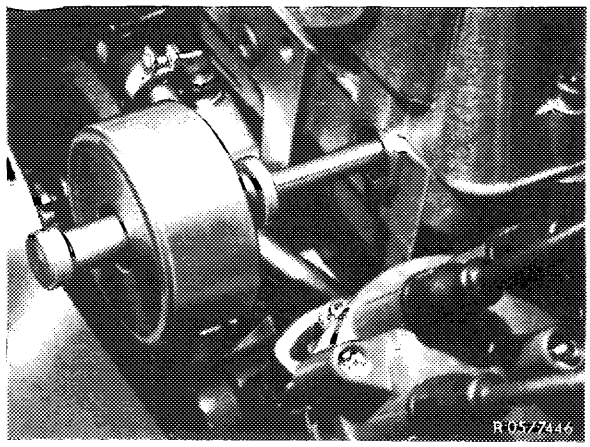


18 Remove chain tensioner (05–310).

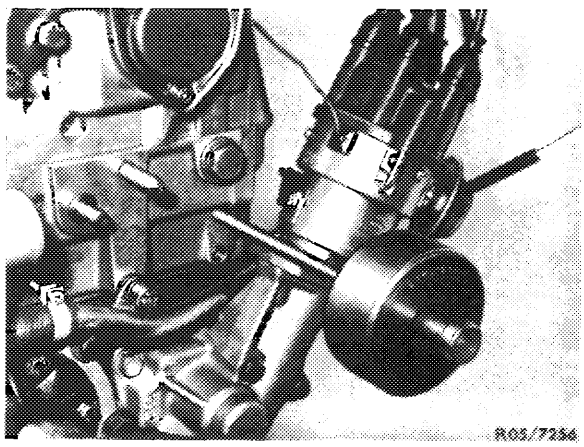
19 Push both camshafts to the rear and remove camshaft sprockets.



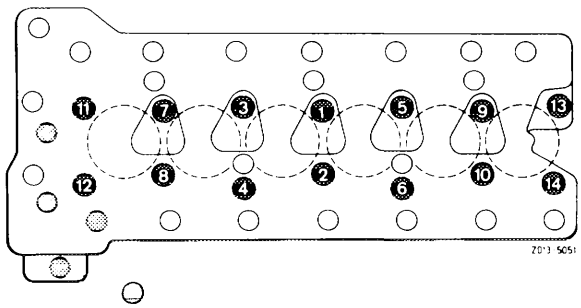
20 Remove guide wheel. Knock out bearing pins with impact extractor (M 10 bolts) for this purpose.



21 Remove guide rail in cylinder head. Knock out bearing pins with impact extractor (6 x 150 mm bolt) for this purpose.



22 Loosen and remove cylinder head bolts in reverse sequence of tightening diagram. Pull out the two **M 8 bolts in the timing case** with a magnet.



23 Pull up timing chain and press tensioning rail to center of engine. Lift off cylinder head straight up with a cable attached to the suspension eyes.

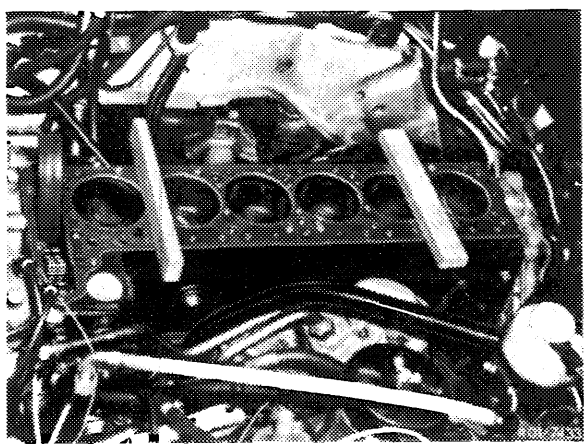
Installation

24 Clean cylinder head and crankcase mating surfaces thoroughly.

25 Install new cylinder head gasket.

Note: Two dowel sleeves are press-fit in the crankcase to locate the cylinder head.

26 Place two locally manufactured wooden boards (15 x 35 x 240 mm) on the cylinder head gasket, front upright and rear flat.



27 Place cylinder head on board, guide in timing chain and tensioning rail.

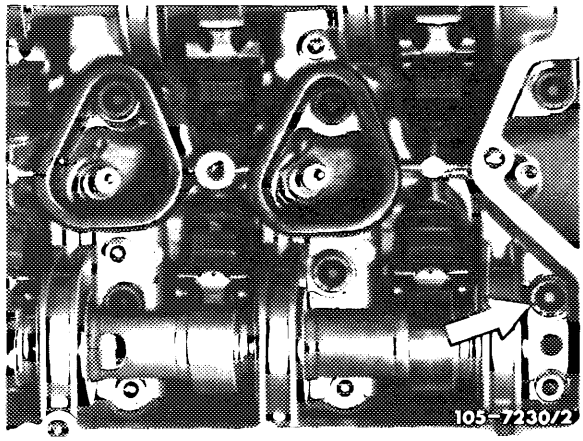
28 Lift front of cylinder head and pull out front wooden board toward exhaust side. Lower cylinder head until it fits on the dowel sleeve.

29 Lift rear of cylinder head slightly and pull out wooden board toward exhaust side. Lower cylinder head until it fits over rear dowel sleeve.

Note: If possible, connect cylinder head with camshaft housing to eyes for engine removal, carefully lower with a crane and set down.

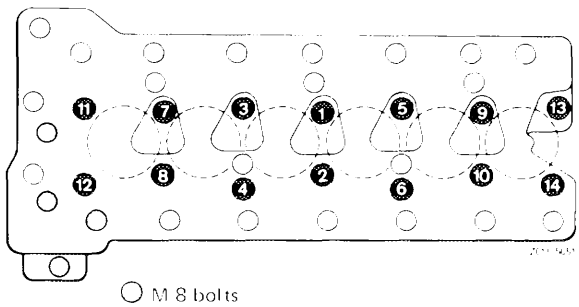
30 Lubricate threads and head surface of cylinder head bolts before installation.

Attention!
Since July of 1974 the clearance on the camshaft housing for the **22 mm dia. washer** of cylinder head bolt number 14 has been extended. The former **20 mm dia. washer** must be installed on older camshaft housings (arrow).



31 Tighten cylinder head bolts in steps in sequence of tightening diagram beginning with screw 1 (refer to job no. 01–415 removal and installation of cylinder head).

Tighten screws M 8 to 25 Nm (2.5 kpm).



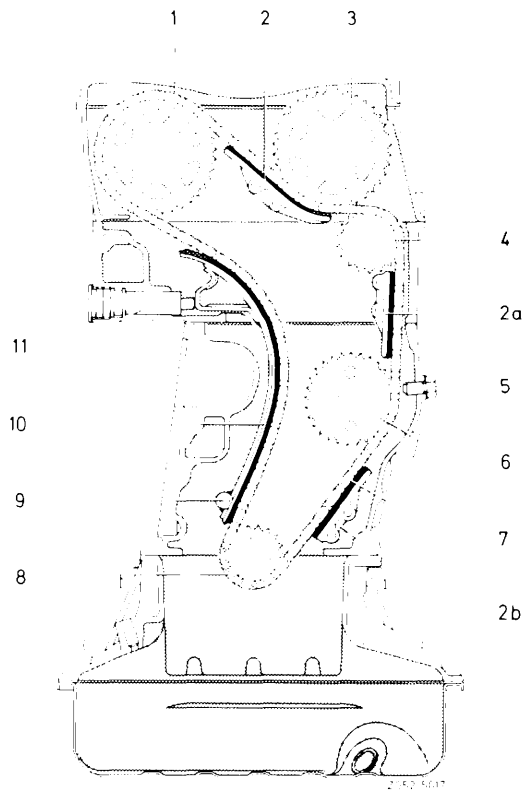
○ M 8 bolts

Attention!
After all bolts have been tightened, it must be possible to turn both **camshafts by hand.**

32 Install slide rail (2a). For this purpose, pull up timing chain while introducting slide rail with pliers and knocking-in bearing bolts with impact puller. Align slide rail laterally (equalize).

33 Pull up timing chain, position guide wheel (4) with left hand and knock-in lubricated bearing bolt by means of impact puller.

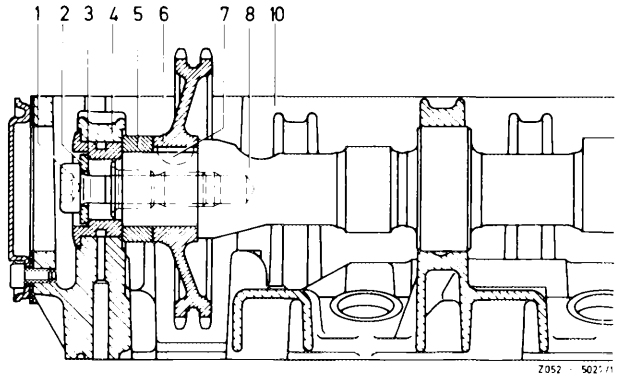
Screw-in screw connection with sealing ring.



Chain drive

1 Exhaust camshaft sprocket
2– 2b Sliding rail
3 Intake camshaft sprocket
4 Guide wheel
5 Lock bolt
6 Intermediate wheel
7 Timing chain
8 Crankshaft sprocket
9 Tensioning rail bearing pin
10 Tensioning rail
11 Hydraulic chain tensioner

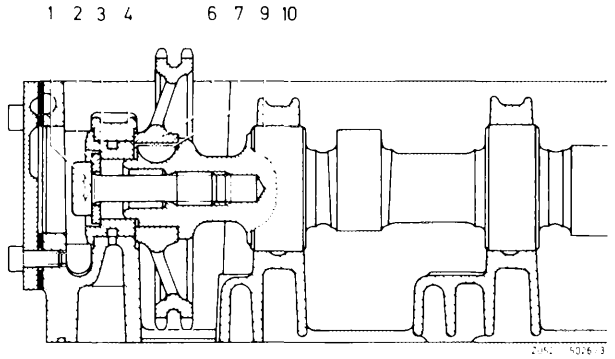
34 Install camshaft sprocket (6) of intake camshaft with spacer (5). Lubricate spacer (3) with engine oil and slide it into bearing (4).



Intake

1 Expansion bolt
2 Washer
3 Spacer
4 Bearing
5 Spacer
6 Camshaft sprocket
7 Woodruff key
8 Camshaft
10 Camshaft housing

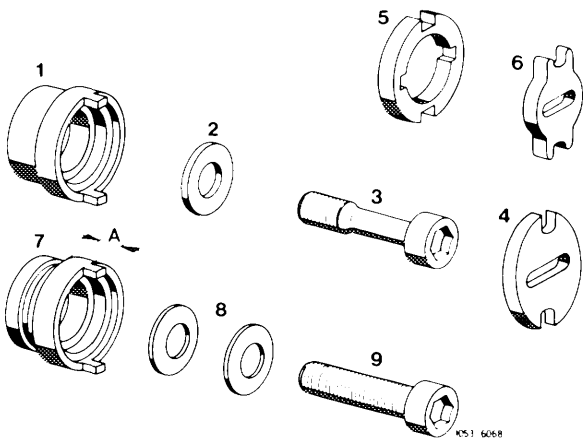
35 Install camshaft sprocket (6) of exhaust camshaft with timing chain. Lubricate spacer (3) with engine oil and slide it into bearing (4).



Exhaust camshaft

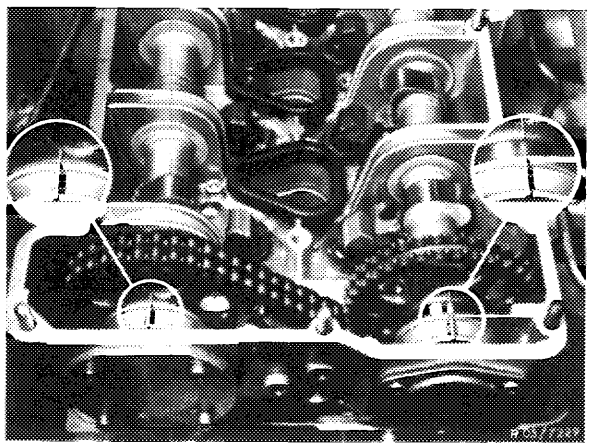
1 Expansion bolt
2 Washer
3 Spacer
4 Bearing
6 Camshaft sprocket
7 Woodruff key
9 Camshaft
10 Camshaft housing

36 During repair jobs, mount necked-down screw (3) with washer (2) only, but do not yet tighten.

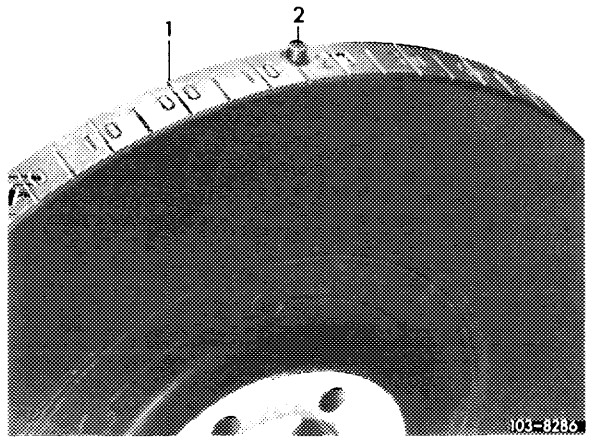


1 Spacer 2nd version without lubricating groove (for pressure oil pump and vacuum pump 2nd version)
2 Washer
3 Expansion bolt
4 Dog (for pressure oil pump and vacuum pump 2nd version)
5 Dog (for vacuum pump 1st version)
6 Dog 1st version with lubricating groove
A = 4.7 mm for vacuum pump 1st version
A = 8.3 mm for pressure oil pump and vacuum pump 2nd version
8 Spring washers (not valid)
9 Mounting bolt (not valid)

37 When 1st cylinder is at ignition TDC the adjustment marks on both camshaft sprockets and camshaft housing must align.

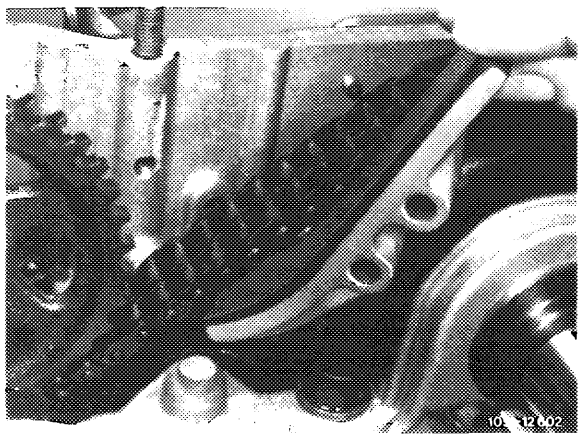


Attention!
If the vibration damper of an engine has a "00" mark for BDC in addition to TDC, the TDC mark is next to pin (2) in the vibration damper.



1 TDC mark

38 Install sliding rail in camshaft housing so that the timing chain cannot jump.

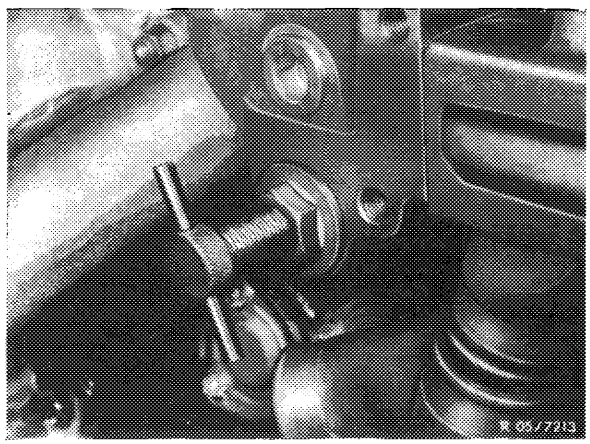


39 Install rigid chain tensioner and tighten by hand.

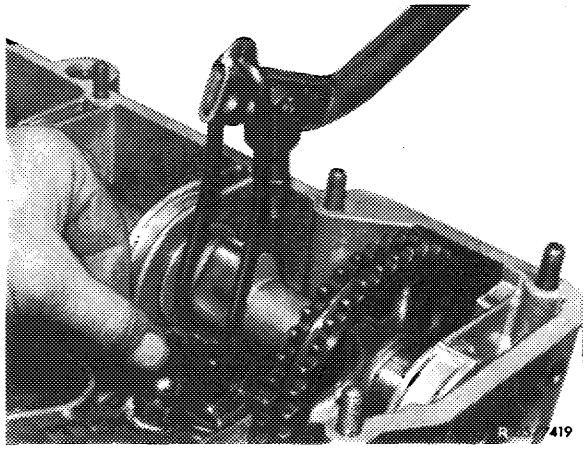
40 Turn crankshaft with combination tool and adjust to ignition TDC. Check adjustment marks (fig. of point 37).

Check timing, if cylinder head or camshaft housing surfaces have been faced (05–215).

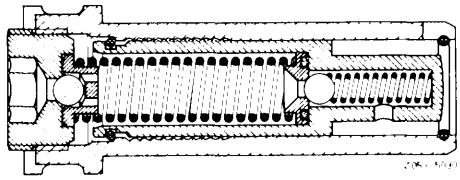
41 Tighten necked-down screw for camshaft sprocket to 80 Nm (8 kpm), while applying counterhold to camshaft by means of holding wrench.



42 Install rocker arms and spring clamps (05–230).

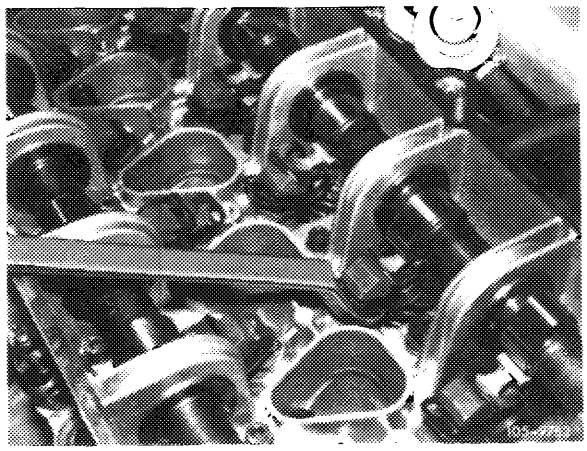


43 Position chain tensioner for insallation and install (05–310).



44 Adjust valve clearance (05–210).

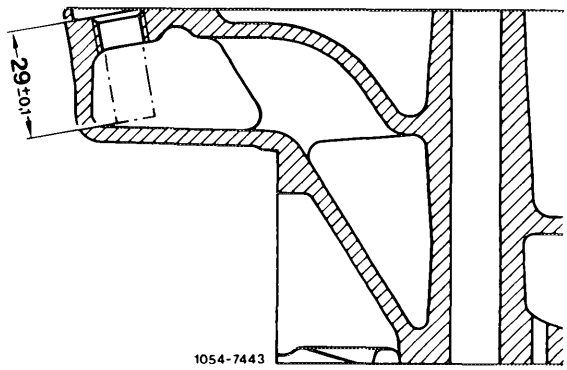
Further installation instructions in reverse sequence of removal.

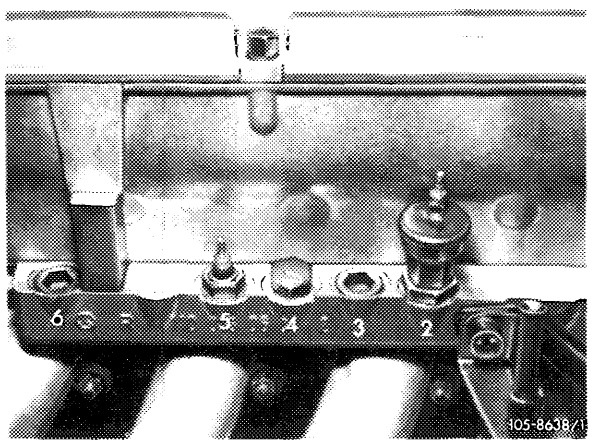


Note

The measuring sensor box must be equipped to agree with the engine version.

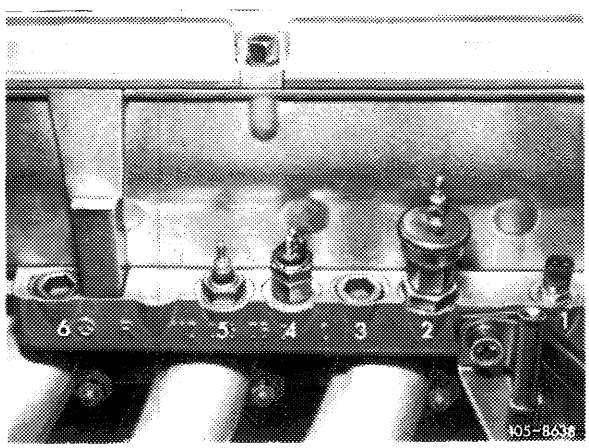
Note screwed depth and use seals of sufficient thickness.





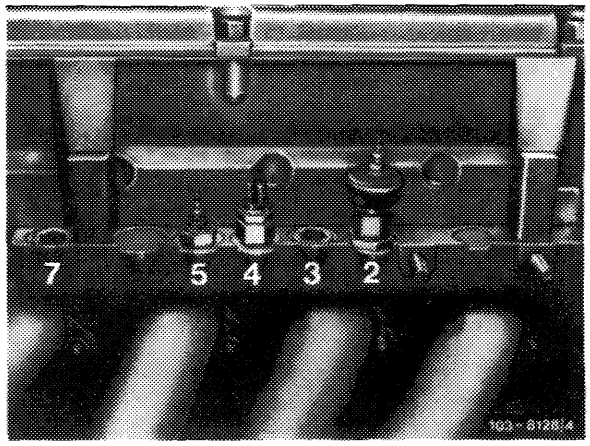
Measuring sensor box for **carburator engine** with **air conditioner**

2 100°C temperature switch and adaptor for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Plug M 14 x 1.5
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5



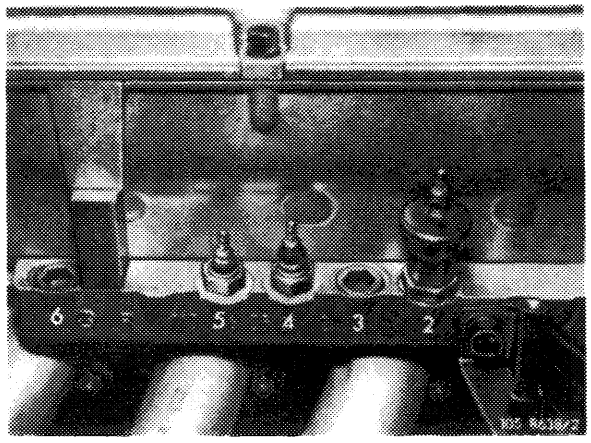
Measuring sensor box for **fuel injection engine** with **air conditioner**

1 Coolant temperature sensor for control unit
2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Temperature timing switch for cold starts
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5



Measuring sensor box for **continuous fuel injection engine** with **air conditioner**

2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner
3 Core plug M 22 x 1.5
4 Temperature timing switch for cold starts
5 Coolant temperature gage sensor
7 Core plug M 22 x 1.5



Measuring sensor box for **carburetor engine USA** with **air conditioner**

2 100°C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner and exhaust gas recirculation
3 Core plug M 22 x 1.5
4 65°C temperature switch (exhaust gas recirculation)
5 Coolant temperature gage sensor
6 Core plug M 22 x 1.5

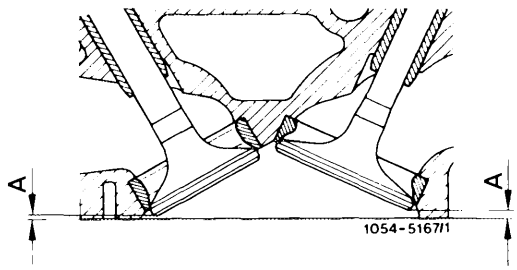
Data

Total cylinder head height		93.9–94.0
Min. height after machining		93.1
Permissible unevenness of mating surfaces	in longitudinal direction	0.08
	in cross direction	0.0
Permissible deviation in parallel of upper mating surface to lower mating surface in longitudinal direction		0.1
Peak to valley height		0.010
Pressure test with air under water in bar gauge pressure		2

		Minimum distance A with new valves and new valve seats, cylinder head parting surface not machined	Minimum distance A with new valves and new valve seats, cylinder head parting surface 0.4 mm milled off
Intake		3.3	2.9
Exhaust	Valve retainer dia. 37 mm	0.6	0.2
	Valve retainer dia. 39 mm	0.04	0.36 standout

		Max. distance A with new valves and machined valve seats, cylinder head parting surface not machined	Max. distance A with new valves and machined valve seats, cylinder head parting surface 0.4 mm milled off
Intake		4.2	3.8
Exhaust	Valve retainer dia. 37 mm	1.5	1.1
	Valve retainer dia. 39 mm	0.94	0.54

Max. distance A is reduced by the same dimension by which the cylinder head parting surface has been machined down.



Conventional tools

Surface grinding machine with milling equipment for light alloy surface	e.g. made by Ruaro u. Fi., Schio/Italy Scledum, type RTY
Knife-edged straightedge approx. 750 mm long	

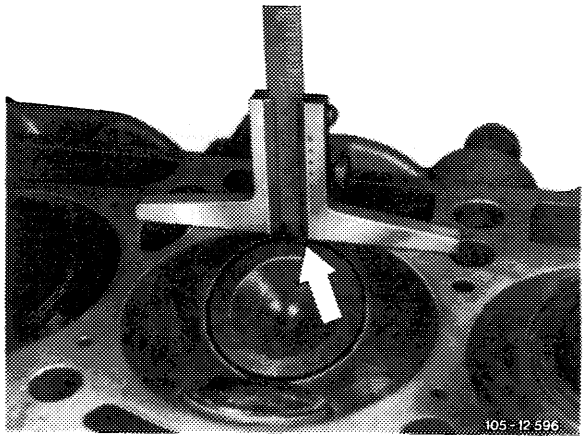
Facing

Only 0.4 mm material can be machined off of the cylinder head at the mating surfaces to the crankshaft and camshaft housing.

A distorted cylinder head must always be faced on both mating surfaces.

Machine valve seats until the permissible distance A between the valve head and cylinder head mating surface is reached.

The timing must be adjusted, if a cylinder head mating surface is faced (05–215).

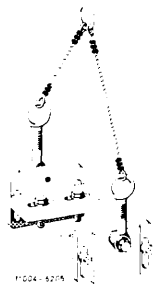


01–420 Pressure testing cylinder head

Data

Pressure test with air under water in bar gauge pressure	2

Special tools

Pressure testing plate		110 589 00 25 00
Suspension fixture		110 589 34 63 00

Conventional tool

Electrically heated sink	e.g. made by Otto Dürr, D-7123 Sachsenheim-Ochsenbach

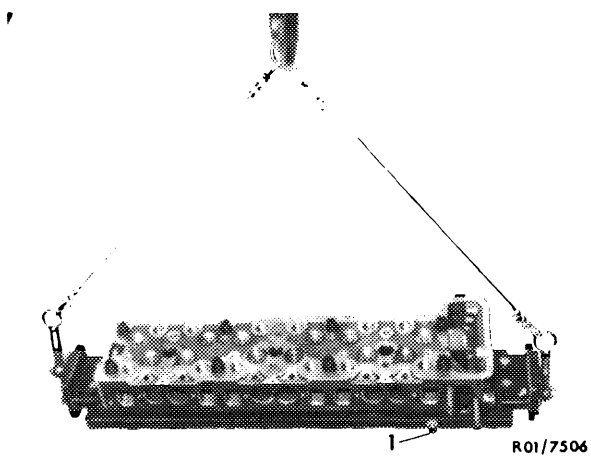
Pressure testing

If the loss of water indicates cracks, the cylinder head must be pressure tested.

1 Bolt pressure testing plate to a cleaned cylinder head.

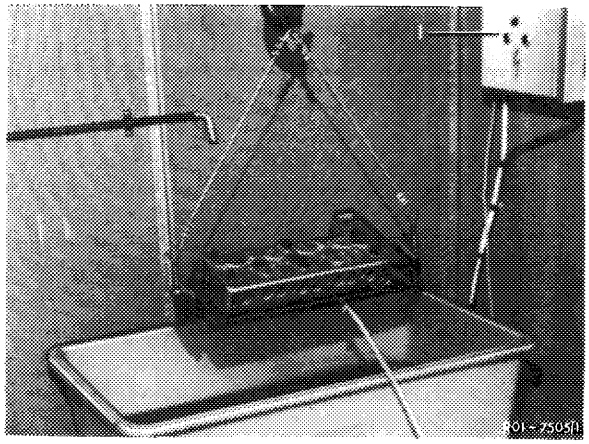
2 Plug holes and connections.

3 Connect compressed air hose (1) and regulate compressed air to 2 bar gauge pressure.



4 Attach cylinder head to suspension device and lower into heated water (80°C).

5 Find location of leaks, if air bubbles rise.



01–470 Removal and installation of camshaft housing

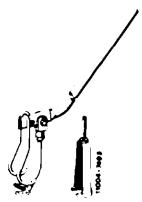
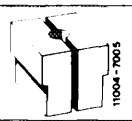
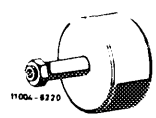
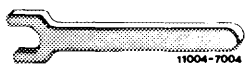
Data

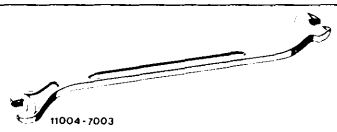
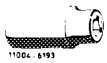
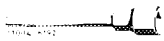
Valve clearance	Cold engine (ca. 20°C)	Warm engine (60°C ± 15°C)
Intake	0.10[1])	0.15[1])
Exhaust	0.25	0.30

[1]) 0.05 mm more for consistent outside temperatures below −20°C.

Tightening torques	Nm
Cylinder head bolts M 12 x 1.5	110
Bolts M 8 for camshaft housing to cylinder head and crankcase	25
Expansion bolt for camshaft sprockets	80
Ball locating ring in chain tensioner	25
Valve adjusting screw	20–40
Cylinder head cover bolts and capped nuts	5
Level control pump to camshaft housing	9

Special tools

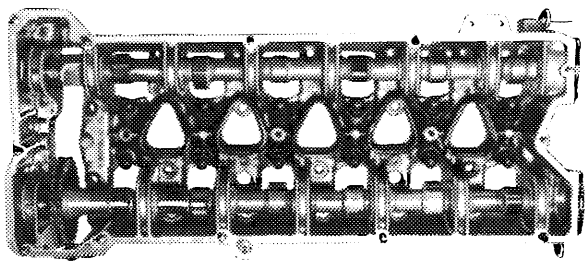
Rocker arm removal and installation tool		110 589 04 61 00
Rigid chain tensioner		110 589 03 31 00
Chain tensioner holder		110 589 02 31 00
Bearing pin impact extractor (basic unit)		116 589 20 33 00
M 6 x 50 bolt for impact extractor		116 589 01 34 00
Holding wrench for camshafts		116 589 01 01 00

Valve adjusting wrench 17 mm		110 589 01 01 00
Socket 27 mm to turn engine		001 589 65 09 00
10 mm wrench socket 1/2" square, 140 mm long		000 589 05 07 00

Note

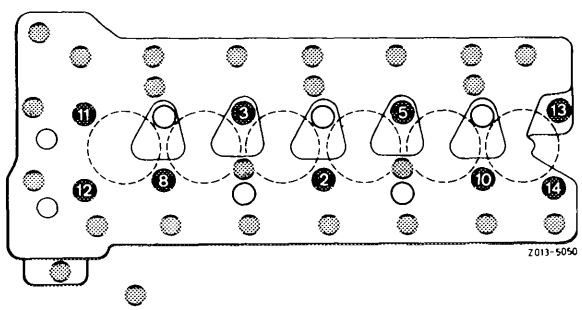
Camshaft housing may only be removed after engine is cold.

The camshaft housing must be removed to remove the camshafts and valve springs or to replace the valve seals.



105-8003

Attention!
On exchange engines starting unit no. 496.861 (starting October 1977) 9 cylinder head screws with a **length** of **150 mm** are used instead of 145 mm in combination with camshaft housings which are countersunk by 5 mm at the 9 bolt head supporting points 2, 3, 5, 8, 10, 11, 12, 13 and 14.
These cylinder head bolts must be installed together with a washer part no. 186 990 09 40 (5 mm high), since otherwise the thread lugs in cylinder crankcase may be forced off.



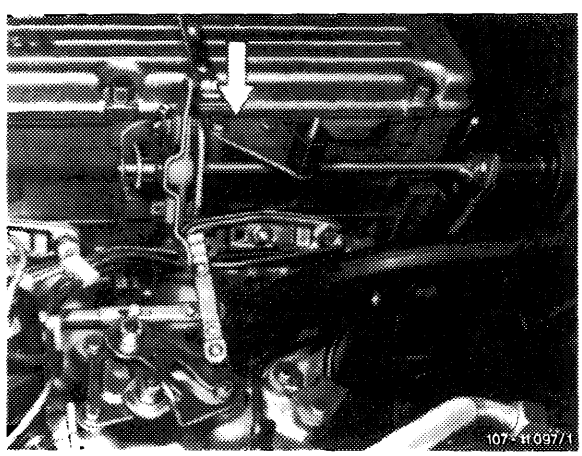
Z013-5050

For engines with CIS, use camshaft housing with lug for attaching air cleaner (arrow).

Camshaft housings with repair stages are available for camshaft with reground bearing journals (01–471).

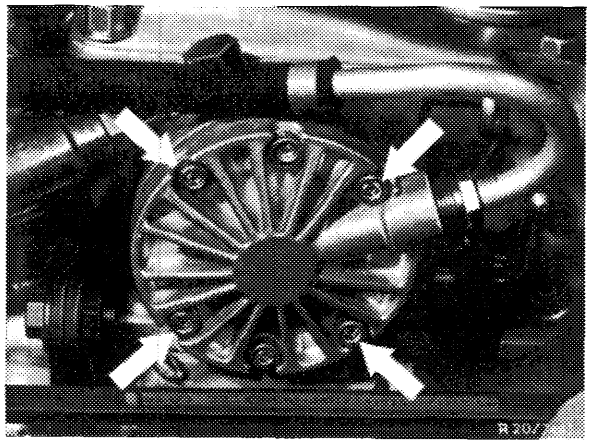
Exchange engines are in part supplied with camshaft bearing intermediate stages and repair stages (01–471).

Also refer to 01–471, association camshaft housing and camshafts.



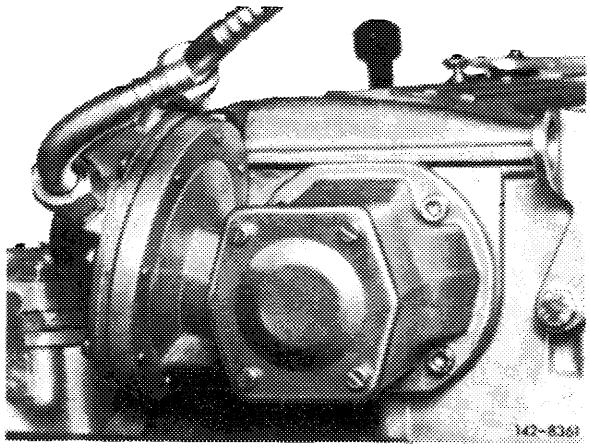
Removal

1 Remove pressure oil pump of models with level control and place to one side without disconnecting the lines. This requires loosening only those bolts marked with an arrow.

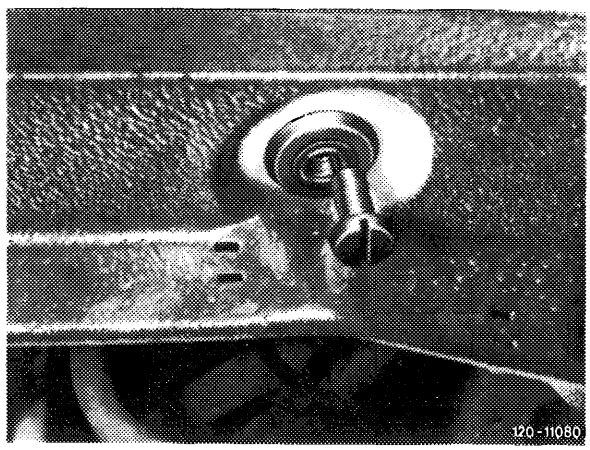


2 Remove compressor of models with an air conditioner.

3 Remove vacuum pump of models in USA version.

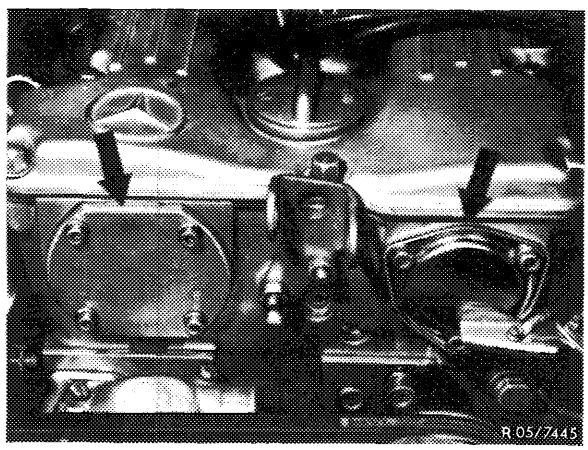


4 Drain coolant from radiator and remove upper water hose from engine to radiator. Remove cylinder head cover.

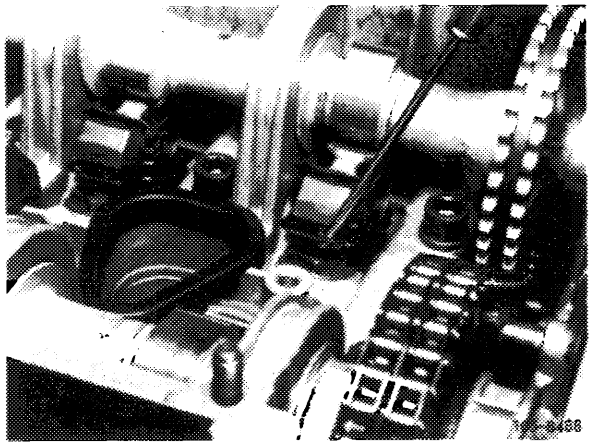


Radiator drain plug of type 123.

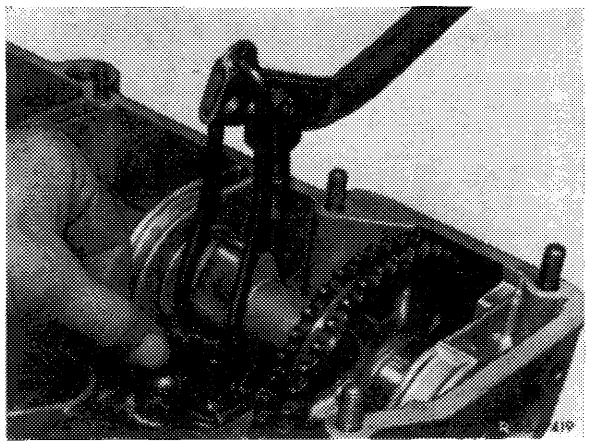
5 Unscrew right cover (arrow) on front of camshaft housing.



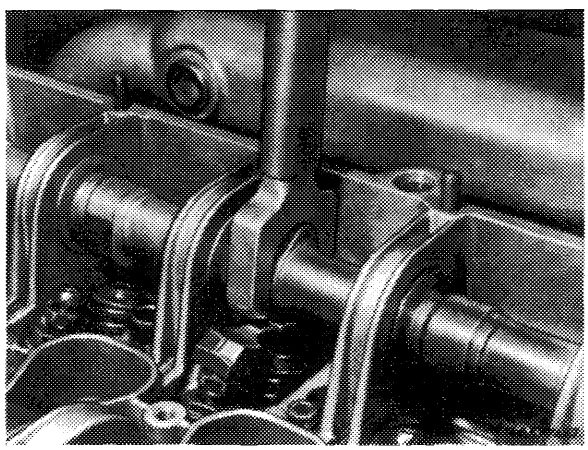
6 Remove all spring clamps with a wrench socket.



7 Remove all rocker arms with removal and installation tool.



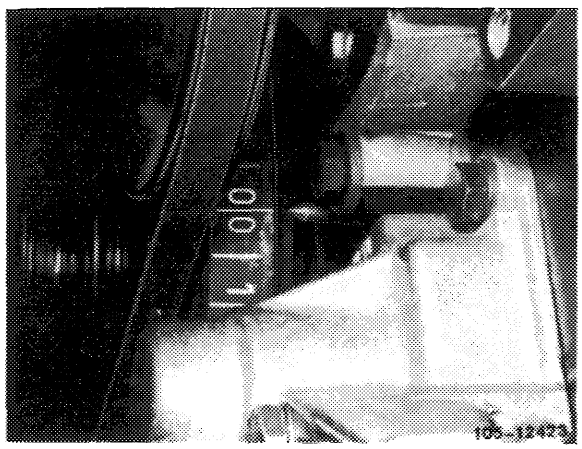
8 Counterhold only the right camshaft (exhaust) with the holding wrench and loosen the camshaft sprocket mounting expansion bolt.



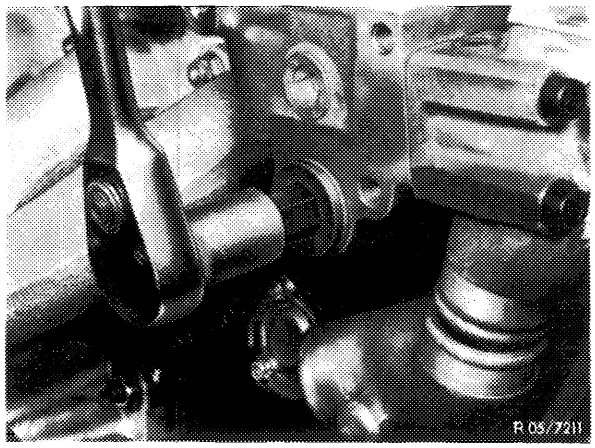
9 Position piston 1 at ignition TDC and both camshafts at marks.

This requires turning the crankshaft with the combination tool.

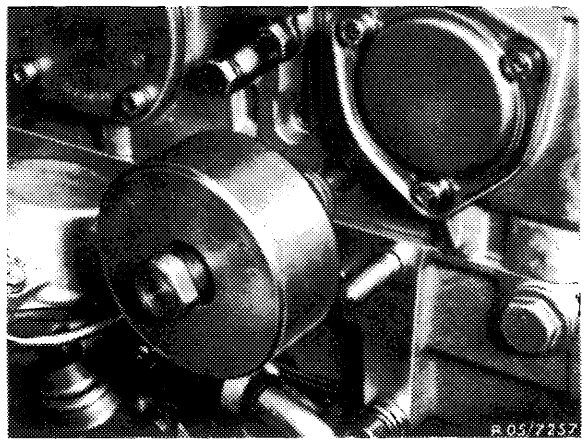
Attention!
Do not turn engine at the mounting bolts of the camshaft sprockets. Don't turn engine in **reverse direction** of rotation.



10 Remove chain tensioner and pressure spring (05–310).



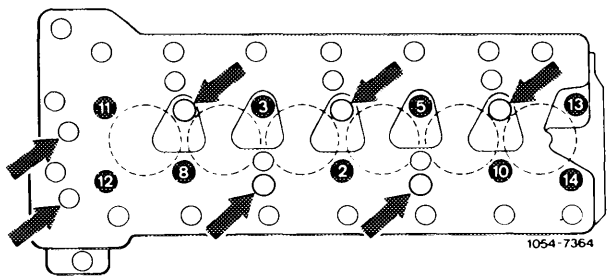
11 Remove sliding rail in camshaft housing. This requires knocking out bearing pins with an impact extractor.



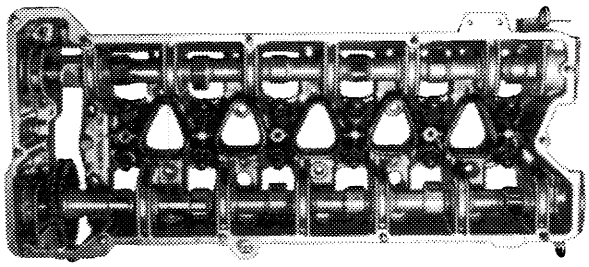
12 Push back righthand camshaft and remove camshaft sprocket.

13 Guide camshaft into bearings again. Unscrew M 8 bolts and cylinder head bolts in reverse sequence of tightening.

Do not loosen the 5 cylinder head bolts positioned deeper (arrows) and the 2 M 8 bolts (arrows).



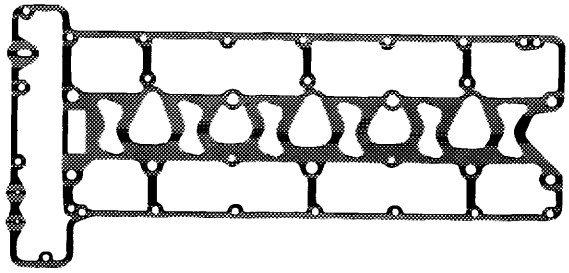
14 Remove camshaft housing with camshafts.



105-8003

Installation

15 Clean mating surface on cylinder head and camshaft housing to remove grease and install **sheet metal foil, part number 110 016 06 80,** without a sealing compound.

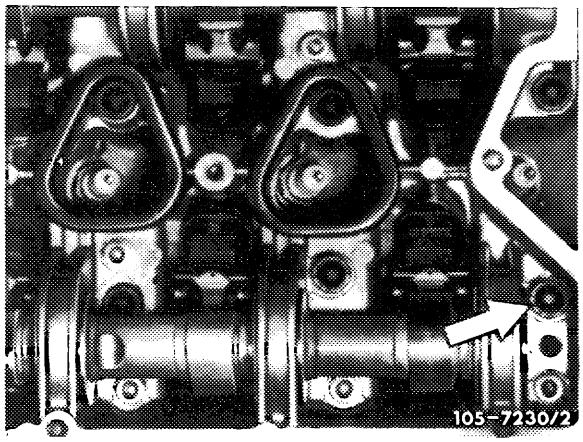


105 - 12 599

16 Install camshaft housing.

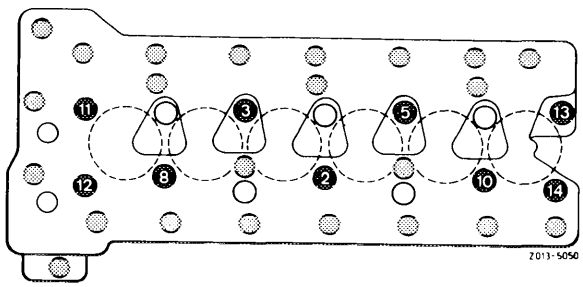
17 Lubricate threads and cylinder head surfaces of cylinder head bolts before installation.

Attention!
Since July of 1974 the clearance on the camshaft housing for **22 mm dia. washer** of cylinder head bolt No. 14 has been extended. Use the former 20 mm dia. washer (arrow) on former camshaft housings.



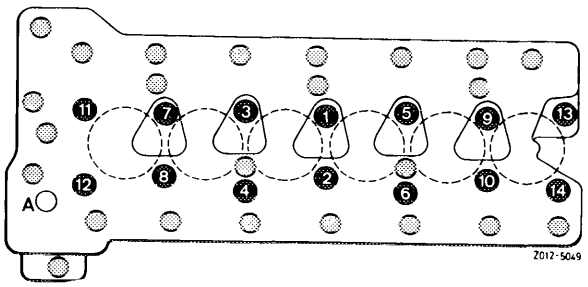
18 Tighten cylinder head bolts in steps in the sequence of tightening.

1st step: to **70 Nm** (7 kpm) starting with bolt No. 2.



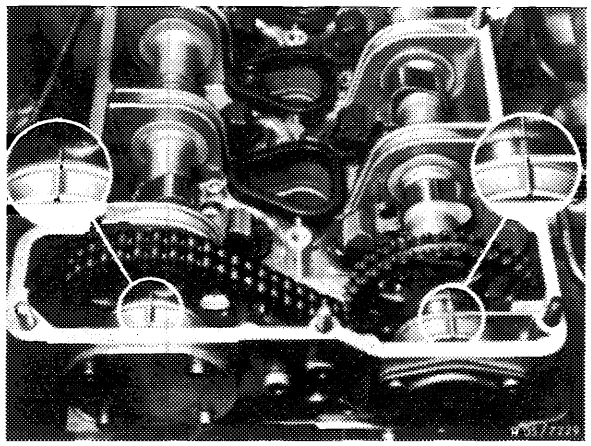
2nd step: all cylinder head bolts to **110 Nm** starting with bolt No. 1. This requires first loosening the five cylinder head bolts 1, 4, 6, 7 and 9 located deeper **separately** somewhat.

Tighten the M 8 bolts from inside to outside to 25 Nm.

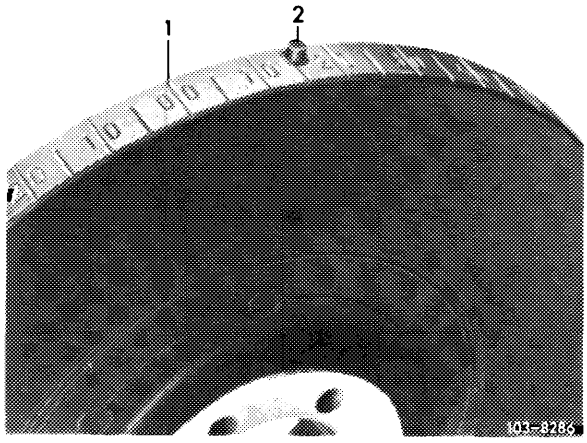


Attention!
After tightening all bolts, it must be possible to **turn both camshafts by hand.**

19 Install right camshaft sprocket making sure that the adjustment marks of both camshafts align when the crankshaft is at TDC.

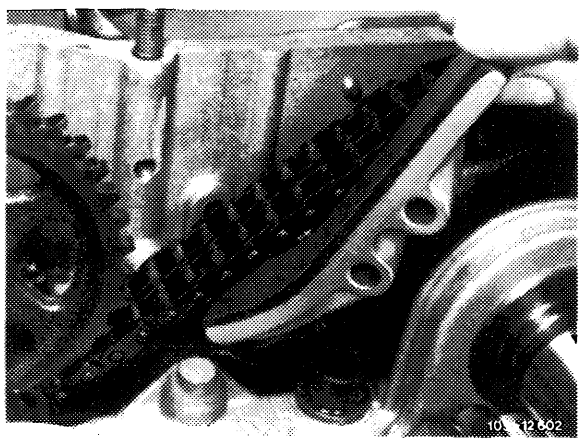


Attention!
When the vibration damper of an engine has a ,,0/0'' mark for BDC in addition to TDC, the TDC mark is next to the pin in the vibration damper.



1 TDC mark

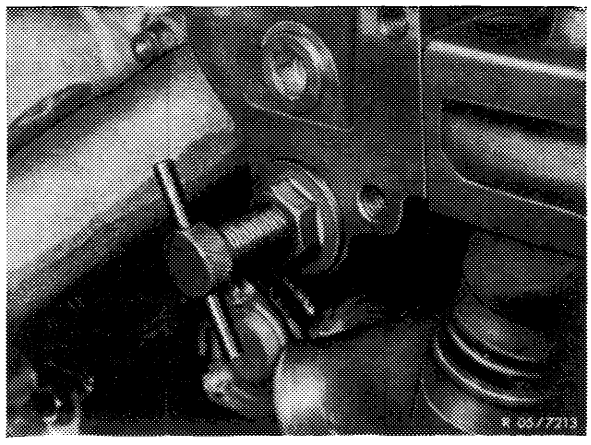
20 Install sliding rail so that the timing chain cannot jump.



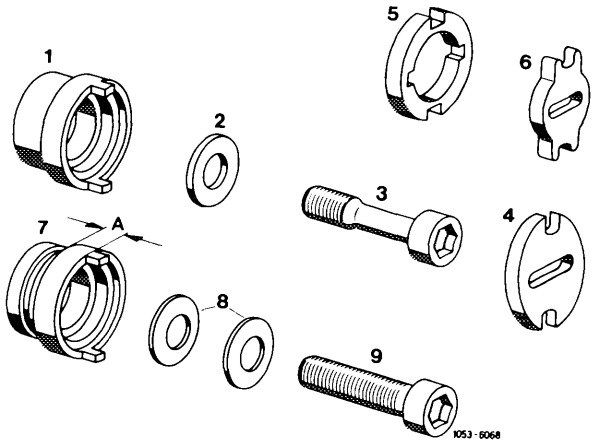
21 Install ,,rigid'' chain tensioner and tighten by hand.

Attention!
If camshaft housing has been ground, the timing must be adjusted.

22 Lubricate spacers with engine oil and slide them into camshaft housing.

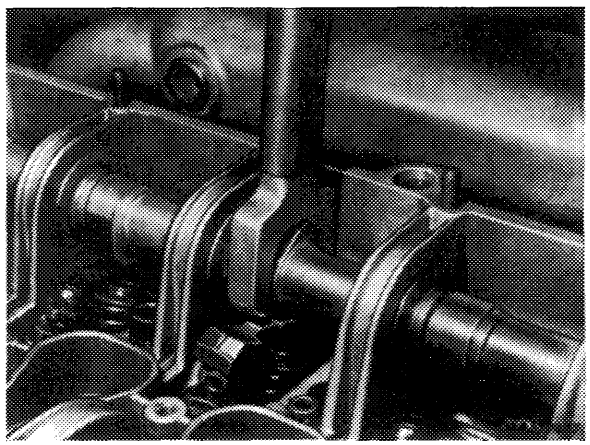


1 Spacer 2nd version without lubrication groove (for pressure oil pump and vacuum pump 2nd version)
2 Washer
3 Expansion bolt
4 Dog (for pressure oil pump and vacuum pump 2nd version)
5 Dog (for vacuum pump 1st version)
6 Dog 1st version (for oil pump)
7 Spacer 1st version with lubrication groove
A = 4.7 mm for vacuum pump 1st version
A = 8.3 mm for pressure oil pump and vacuum pump 2nd version
8 Spring washers (not valid)
9 Mounting bolt (not valid)

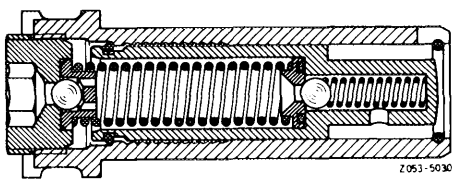


23 Torque expansion bolt for camshaft sprocket to 80 Nm (8 kpm), counterholding camshaft with the holding wrench.

Note: Washer (2) with 30 mm OD is not fitting into spacing sleeve for vacuum pump on USA vehicles up to January 1973. In such a case, machine OD of washer (2) down by approx. 1 mm.



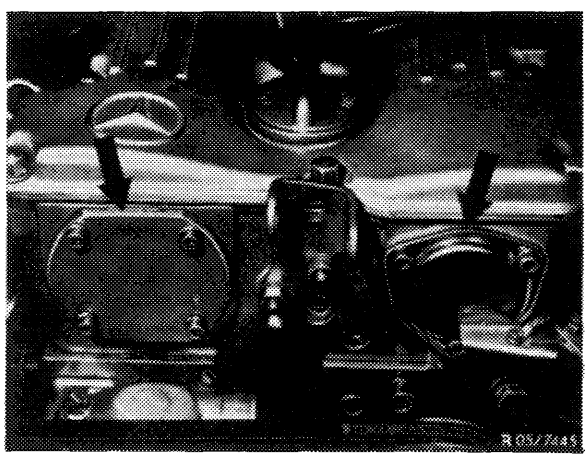
24 Position chain tensioner for installation and install. Also install pressure spring (05–310).



Chain tensioner in installation position

25 Install cover on front of camshaft housing and install level control pump or vacuum pump with gaskets.

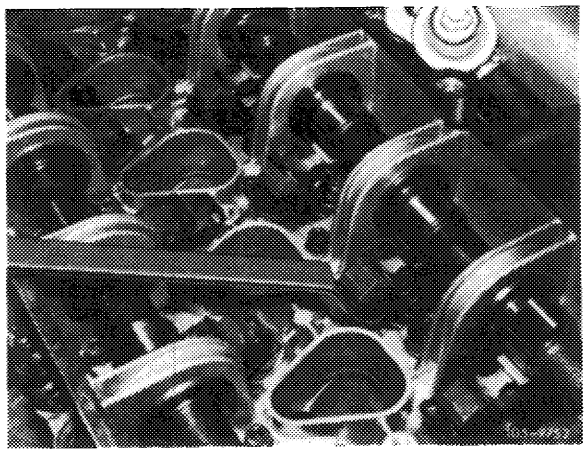
26 Install rocker arms (05–230).



27 Adjust valve clearance (05–210).

28 Complete engine.

Note: If the camshaft housing has been faced, readjust timing (05–215).



Note

Exchange engines are in part supplied with camshaft bearing intermediate stages and repair stages. In the event of repairs, install pertinent camshafts with reduced bearing dia. Also refer to table: Camshaft housing with 11 bearing points.

Camshaft housings with repair stages are available for camshafts with reground bearing journals. Also refer to table: Camshaft housing with 11 bearing points.

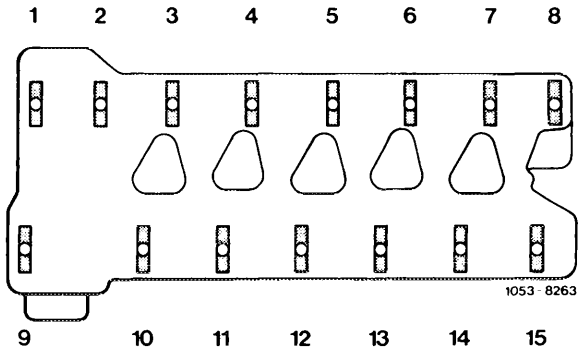
Camshaft housing with 15 bearing points

Bearing points		1, 9	2	3, 10, 11	4,5,12,13	6,7,14,15	8
Standard dimension	bearing dia.	38.016 38.000	50.066 50.050	50.016 50.000	51.519 51.500	53.019 53.000	54.019 54.000
	journal dia.	23.993 23.980	49.950 49.934	49.950 49.934	51.440 51.421	52.940 52.921	53.940 53.921
Intermediate stage –0.1 mm (exchange engines)	bearing dia.		49.966 49.950	49.916 49.900	51.419 51.400	52.919 52.900	53.919 53.900
	journal dia.		49.850 49.834	49.850 49.834	51.340 51.321	52.840 52.821	53.840 53.821
Repair stage 1 –0.25 mm	bearing dia.		49.816 49.800	49.765 49.750	51.269 51.250	52.769 52.750	53.769 53.750
	journal dia.		49.700 49.684	49.700 49.684	51.190 51.171	52.690 52.671	53.690 53.671
Repair stage 2 –0.50 mm	bearing dia.		49.566 49.550	49.516 49.500	51.019 51.000	52.519 52.500	53.519 53.500
	journal dia.		49.450 49.434	49.450 49.434	50.940 50.921	52.440 52.421	53.440 53.421
Camshaft bearing play	radial	0.057 0.124	0.100 0.132	0.050 0.082	0.060 0.098	0.060 0.098	0.060 0.098
	axial	0.050 0.120					
Sleeve for bearing a	OD	37.950 37.925	ID	24.013 24.000			

Combinations in the event of repairs

a) Camshaft housing with 15 bearing points intake-camshaft code number 25, 67 and 33 with 7 bearing journals.

Exhaust-camshaft code number 24, 30, 57 and 71 with 8 bearing journals.



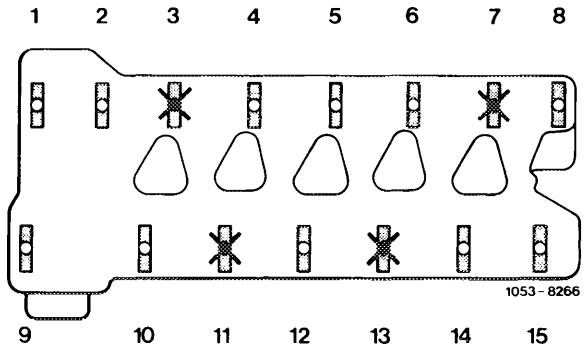
b) Camshaft housing with 15 bearing points, with bearing points 11 and 13 at intake end or 3 and 7 at exhaust end out of function.

Intake camshaft code number 74 and 91 with 5 bearing journals and intermediate stage or repair camshafts with reduced bearing dia.

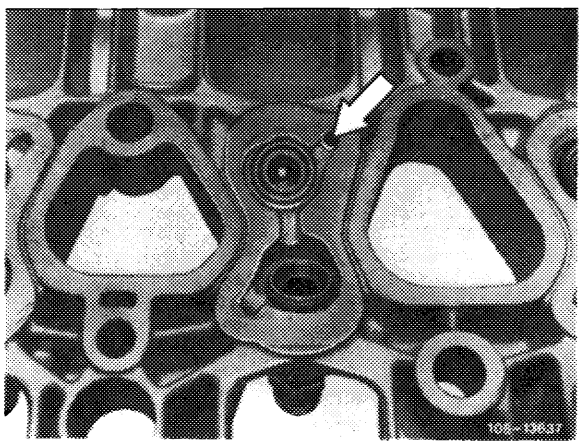
Exhaust camshaft code no. 78 and 95 with 6 bearing journals and intermediate stage or repair camshafts with reduced bearing dia.

In this case, the oil bores of bearing points 11 and 13 or 3 and 7 on removed camshaft housing must be closed.

For this purpose, cut threads M 6, approx. 10 mm deep from below into oil bores (arrow) and screw-in threaded plug 000 913 006 110 with sealing compound.



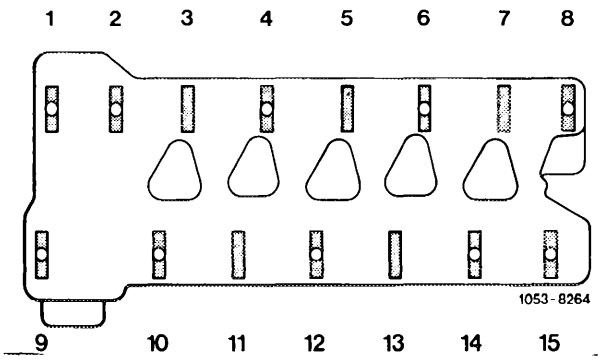
X close oil bores



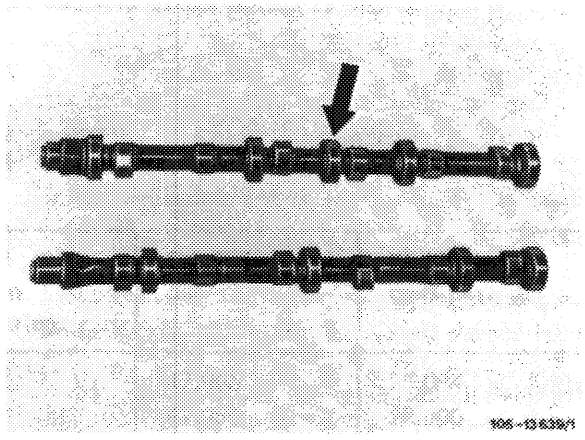
c) Camshaft housing with 15 bearing points, with bearing points 11 and 13 (intake end) or bearing points 3.5 and 7 (exhaust end) without oil supply.

Intake-camshaft code number 25, 67 and 33 with 7 bearing points, of which bearing points 11 and 13 with 1 mm machined off.

Exhaust-camshaft code number 24, 57, 71 and 30, of which bearing points 3, 5 and 7 machined off by 1 mm.



Exchange engines starting unit no. 464.130 are supplied in this version (c). When installing an exhaust-camshaft with code number 78 and 95 into camshaft housing version c, machine 1 mm from bearing journal 5 (arrow).

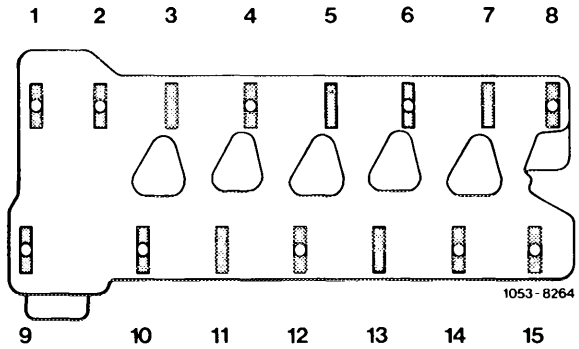


Camshaft housing with 15 bearing points of which 5 bearing points without oil bore

Bearing points		1, 9	2	3, 11	4, 12	5, 13	6, 14, 15	7	8	10
Bearing points	Bearing dia.	38.016 / 38.000	50.066 / 50.050	51.0	51.519 / 51.500	52.5	53.019 / 53.000	54.0	54.019 / 54.000	50.016 / 50.000
	Journal dia.	23.993 / 23.980	49.950 / 49.934	–	49.950 / 49.934	–	52.940 / 52.921	–	53.940 / 53.921	49.950 / 49.934

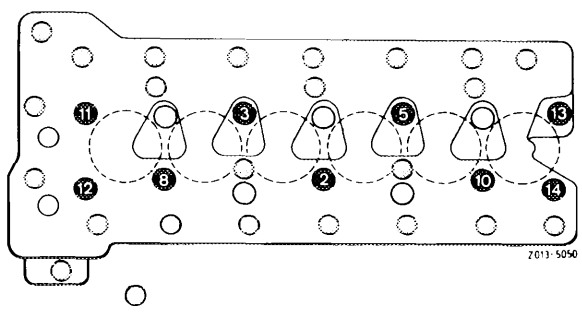
This camshaft housing is not manufactured as an intermediate or repair stage.

On this camshaft housing, the bearing points 3, 5, 7, 11 and 13 are without oil bore and their ID is 1 mm larger than the respective camshaft bearing journals. This camshaft housing can be used to install **all camshafts with normal dimension.**



This camshaft housing is attached together with cylinder head by means of 9 cylinder head bolts, M 12 x 145 mm (formerly M 12 x 150 mm), since the bolt head contact surfaces in camshaft housing were countersunk by 5 mm.

Attention!
On exchange engines starting unit number 496.861 (approx. starting October 1977) these 9 cylinder head bolts are installed with a length of 150 mm. Washers 5 mm thick part no. 186 990 09 40 are fitted to make sure that the thread lugs in cylinder crankcase are not forced off.



Camshaft housing with 11 bearing points, of which 1 bearing point without oil bore

Bearing points		1, 9	2	4, 12	5	6, 14, 15	8	10
Bearing points	Bearing dia.	38.016 / 38.000	50.066 / 50.050	51.519 / 51.500	52.5	53.019 / 53.000	54.019 / 54.000	50.016 / 50.000
	Journal dia.	23.993 / 23.980	49.950 / 49.934	51.440 / 51.421		52.940 / 52.921	53.940 / 53.921	49.950 / 49.934

Intermediate stage – 0.1 mm (exchange engines only)

Camshaft housing part no. 110 010 20 36
Intake camshaft part no. 110 051 **77** 01
Exhaust camshaft part no. 110 051 **98** 01

Bearing dia.	49.966 / 49.950	51.419 / 51.400	52.5	52.919 / 52.900	53.919 / 53.900	49.916 / 49.900
Journal dia.	49.850 / 49.834	51.340 / 51.321		52.840 / 52.821	53.840 / 53.821	49.850 / 49.834

Repair stage 1 – 0.25 mm

Camshaft housing part no. 110 010 21 36
Intake camshaft part no. 110 051 **75** 01
Exhaust camshaft part no. 110 051 **79** 01

Bearing dia.	49.816 / 49.800	51.269 / 51.250	52.5	52.769 / 52.750	53.769 / 53.750	49.765 / 49.750
Journal dia.	49.700 / 49.684	51.190 / 51.171		52.690 / 52.671	53.690 / 53.671	49.700 / 49.684

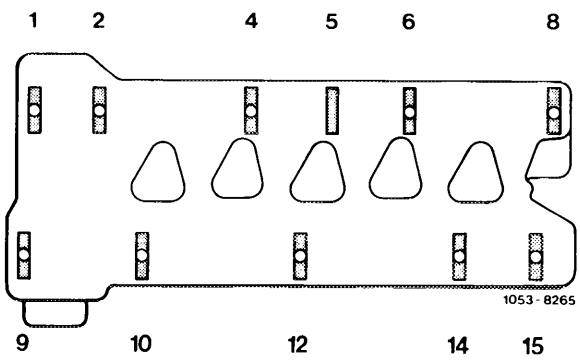
Repair stage 2 – 0.50 mm

Camshaft housing part no. 110 010 22 36
Intake camshaft part no. 110 051 **76** 01
Exhaust camshaft part no. 110 051 **80** 01

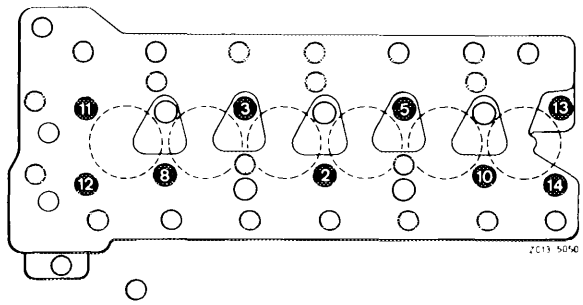
Bearing dia.	49.566 / 49.550	51.019 / 51.000	52.5	52.519 / 52.500	53.519 / 53.500	49.516 / 49.500
Journal dia.	49.450 / 49.434	50.940 / 50.921		52.440 / 52.421	53.440 / 53.421	49.450 / 49.434

On this camshaft housing bearing point 5 is without oil bore and its ID is 1 mm larger than the respective camshaft bearing journal.

This camshaft housing can be used to install camshaft without changes on bearing journals.



This camshaft housing is attached together with cylinder head by means of 9 cylinder head bolts M 12 x 145 (formerly M 12 x 150), since the bolt head contact surfaces in camshaft housing were countersunk by 5 mm.



Attention!
On exchange engines starting unit number 496.861 (approx. starting October 1977) these 9 cylinder head bolts are installed with a length of 150 mm. Washers 5 mm thick part no. 186 990 09 40 are fitted to make sure that the thread lugs in cylinder crankcase are not forced off.

01–472 Facing camshaft housing

Data

Total height of new camshaft housing	104.8–105.0
Min. height after machining	104.0
Permissible deviation from parallel between upper and lower parting surface in longitudinal direction	0.1
Mean height of roughness of parting surfaces	0.006–0.014

Conventional tools

Surface grinding machine with milling equipment for light alloy surfaces	e.g. made by Ruaro u. Fi., Schio/Italy Scledum, type RTY
Knife-edged straightedge approx. 750 mm long	

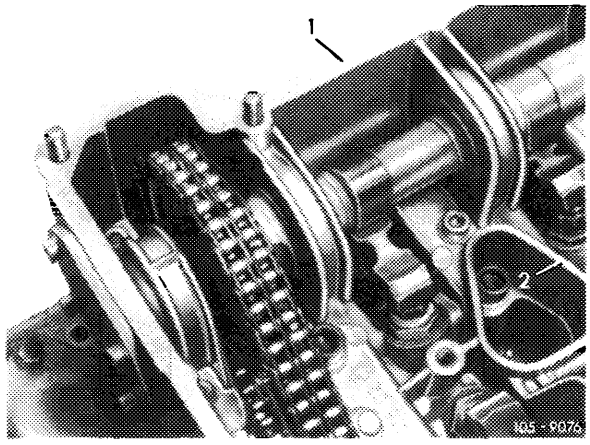
Note

The camshaft housing may only be faced, if mechanical damage is visible on the mating surfaces.

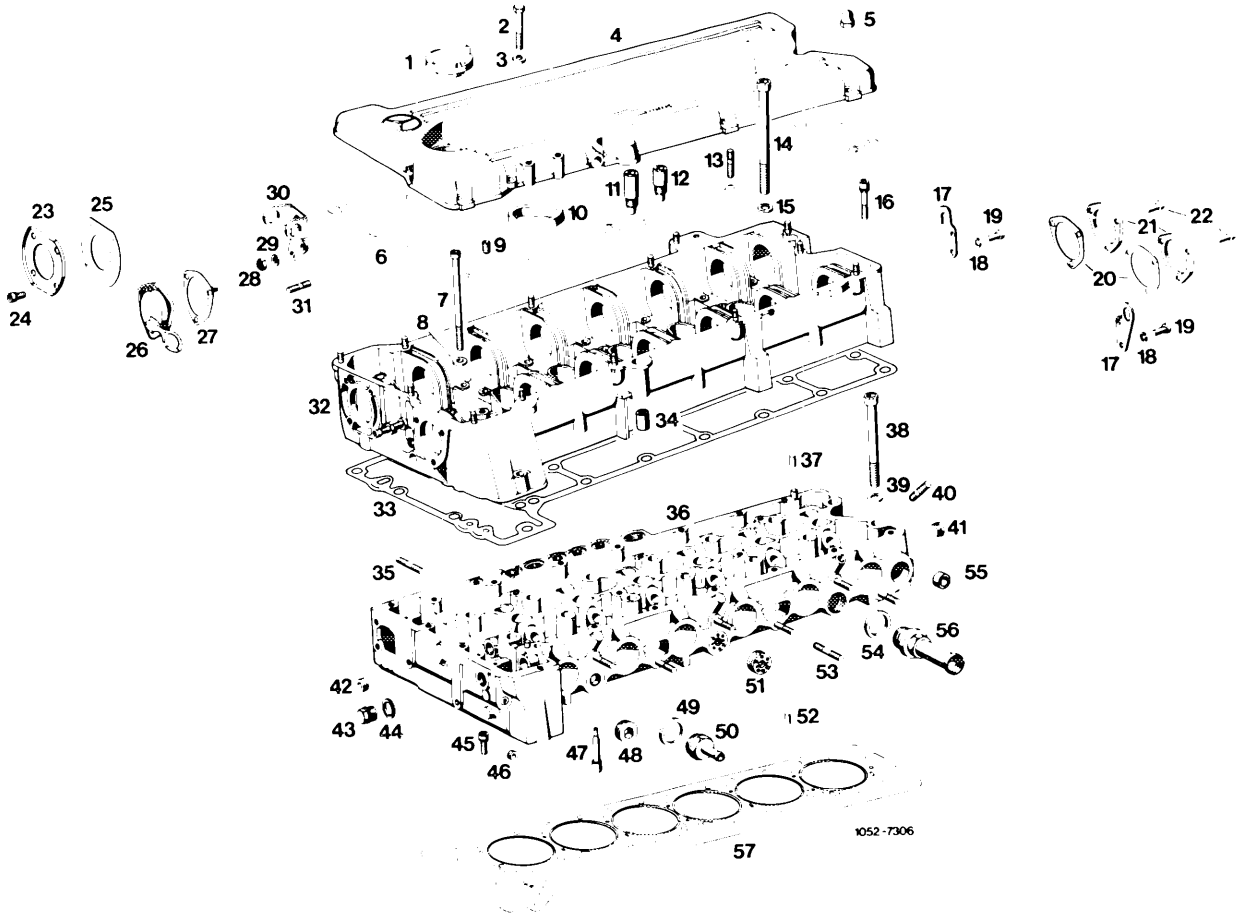
A distorted camshaft housing will align with the cylinder head when tightened.

Only 0.4 mm may be machined off of the camshaft housing mating surfaces to the cylinder head or cylinder head cover. The same amount of material must be removed from the bearing surfaces for the gaskets at the spark plugs (2) as was machined from the mating surface to the cylinder head cover (1).

If the camshaft housing was faced, the timing must be adjusted (05–215).



01–490 Cylinder head and camshaft housing illustrated table



1 Filler plug
2 3 bolts M 8 x 55
3 3 seals C 8 x 13
4 Valve cover
5 Capped nuts
6 Cylinder head cover gasket
7 2 bolts M 8 x 135
8 Plain washers 38 x 15
9 3 threaded inserts M 8 x 16
10 5 cylinder head cover gaskets
11 Vent valve
12 Vent jet
13 12 studs M 8 x 18
14 9 bolts
15 9 washers
16 21 combination bolts M 8 x 40
17 2 suspension eyes, rear
18 Circlip
19 4 bolts M 8 x 15
20 2 gaskets
21 2 covers
22 6 combination bolts
23 Cover
24 7 combination bolts M 6 x 15
25 Gasket
26 Cover with holder
27 Gasket
28 2 nuts M 8
29 2 circlips
30 Suspension eyes, front
31 2 studs M 8 x 18
32 Camshaft housing
33 Sheet metal foil for repairs
34 Engine vent connecting hose
35 Stud M 8 x 30
36 Cylinder head
37 2 dowel pins 8 x 16
38 5 bolts
39 5 washers
40 Studs M 8 x 20
41 2 plugs for oil bores
42 Plug AM 22 x 1.5
43 Plug M 18 x 1.5
44 Seal A 22 x 27
45 2 combination bolts M 8 x 20
46 Plug M 10 x 1 for oil connecting bore
47 Return flow oil jet
48 Plug OM 30 x 1.5
49 Seal A 30 x 36
50 Connector for pre-heating
51 Connectors for carburetor heating
52 2 dowel pins 8 x 16
53 Stud M 8 x 35
54 Seal A 30 x 36
55 Cover for injection bore
56 Heater connection
57 Cylinder head gasket

Conrod bolt sizes

Version	Part Number	Distance a and b (fig., point 1) a	b	Thread dia. d	Expansion stem dia. c when new (fig., point 1)	Min. Expansion stem dia.
1st version	110 038 01 71	5.5	3	M 10x1	8.4–0.1	8.0
2nd version	110 038 03 71		4.5			
3rd version	110 038 04 71	6.6				
Conrod bolt installation pressure					45000 N	

Conrod nut torque

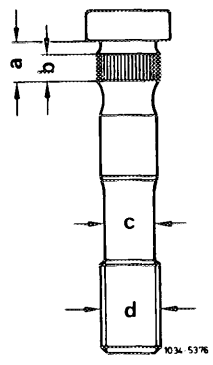
Initial torque	40–50
Torque angle	90–100°

Self-made tool

Steel plate	see fig., point 3

Checking

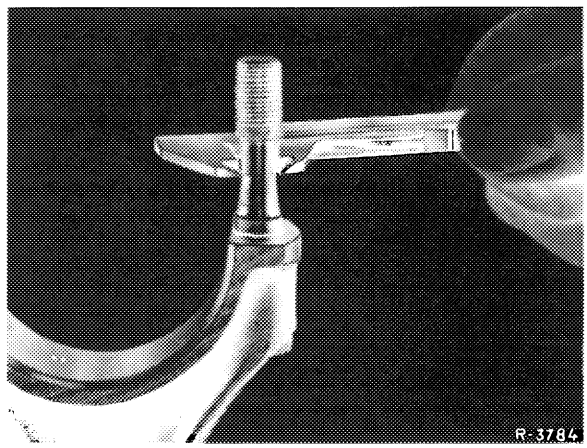
1 Measure smallest expansion stem diameter before reusing.



Note: If the minimum expansion stem diameter reaches or is less than 8.0 mm, **replace conrod bolt.**

Only knock out a conrod bolt to replace it.

Use third version conrod bolts for repairs.

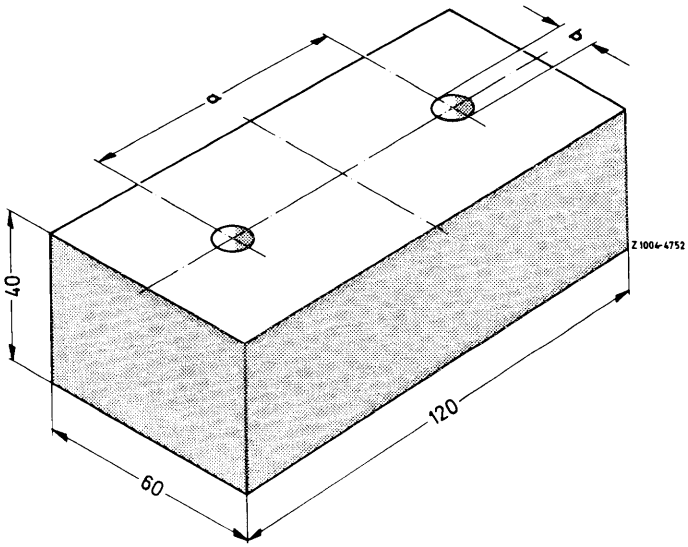


Replacing

2 Knock out conrod bolts.

3 Press new bolts into conrod with a pressure of about 45000 N, or knock in with a hammer and mandrel.

Place the connecting rod on a ground steel plate when knocking in or pressing in conrod bolts.



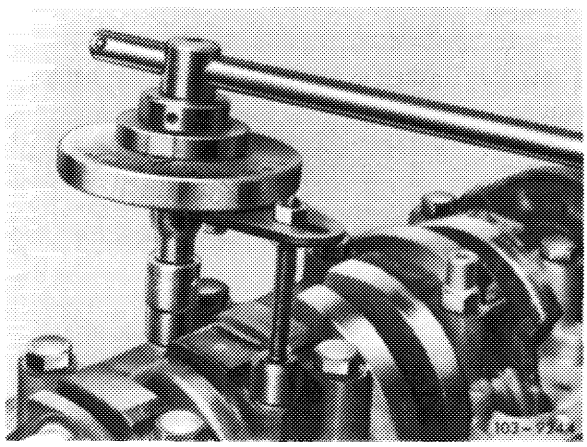
Distance between holes a = 64.6 mm
Bore b = 11 mm

Tightening

4 Lubricate nuts and threads.

5 Tighten conrod nuts to a torque pressure of 40–50 Nm and a torque angle of 90–100°.

Attention!
Tighten conrod bolts knocked in with a hammer to a torque pressure of 60–70 Nm and a torque angle of 90–100° for the first time.



Make sure that this instruction is observed, since otherwise the nuts **of the conrod bolts may** become loose.

Note: If no angle of rotation wrench is available, the connecting rod nuts can also be tightened by means of a normal socket wrench with toggle **in one step** by an angle of 90–100°. Estimate angle as accurately as possible. **To eliminate angle faults, do not use a torque wrench** for tightening according to angles of rotation.

Data

Center of conrod bearing bore to center of conrod bushing bore	131.950 / 130.050
Width of conrod at conrod bearing bore and conrod bushing bore	27.890 / 27.857
Basic bore for conrod bearing shells	51.619 / 51.600
Basic bore for conrod bushing	26.021 / 26.000
Conrod bushing inside dia.	23.013 / 23.007
Peak to valley height on inside of conrod bushing	0.004
Permissible stagger of conrod bore to conrod bushing bore in reference to a length of 100 mm	0.1
Permissible difference in parallel between axes: conrod bearing bore to conrod bushing bore in reference to a length of 100 mm	dia. 0.015
Permissible deviation of conrod bearing bore from true	0.020
Permissible difference in weight of all connecting rods of one engine	5 gr.

Tightening torque

Conrod nuts	Initial torque	40–50 Nm
	Torque angle	90–100°

Conventional tool

Connecting rod checking and straightening tool	Made by Krupp GmbH, 5309 Meckenheim e.g. Model CL 6

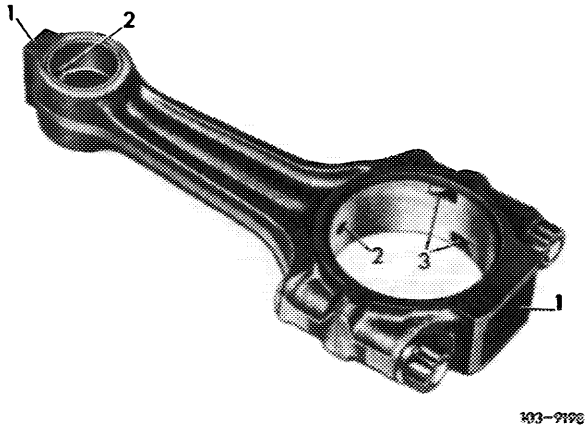
Note

Connecting rods, which are overheated (blue discoloration) due to bearing damage, may not be re-used.

The connecting rod and its cap are marked to fit together. The connecting rod stem must not show cross scoring and notches.

Connecting rods with a machined conrod bushing are delivered as replacement parts.

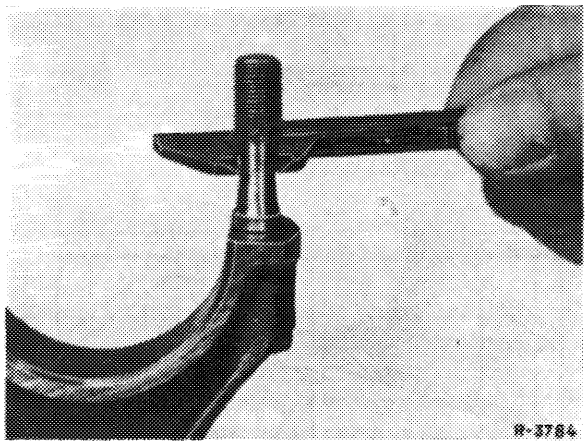
When renewing conrods pay attention to different weights of rods.



103–9198

Repairing

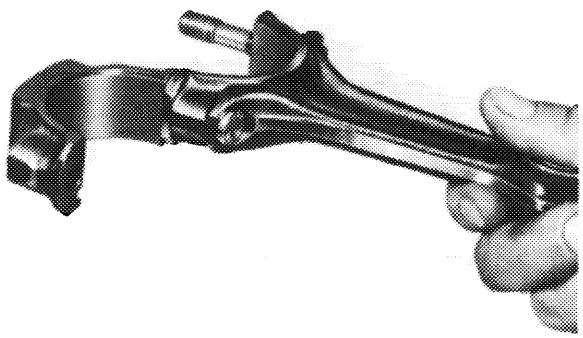
1 Check conrod bolts and replace if necessary (03–310).



8-3784

2 Check conrod bolt bores.

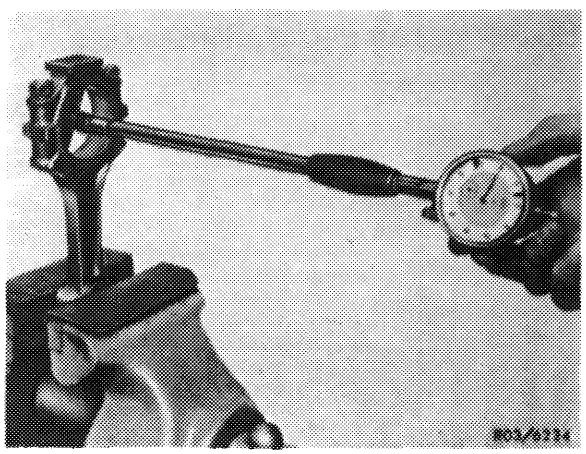
Place conrod cap on a conrod bolt. If the conrod cap moves down by its own weight, the connecting rod must be replaced.



103-9232

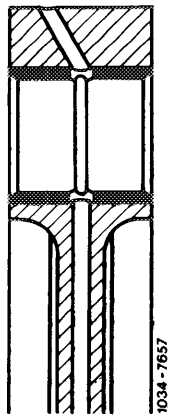
3 Mount connecting rod bearing cap and tighten to 40–50 Nm and 90–100° angle of rotation torque.

4 Measure conrod bearing basic bore. If a basic bore exceeds the value of 51.62 mm or shows conicity, hone bearing surface of bearing cap on a surface plate up to max. 0.02 mm.



5 Press in new conrod bushing that oil bores match.

Installation pressure 2500 Nm.



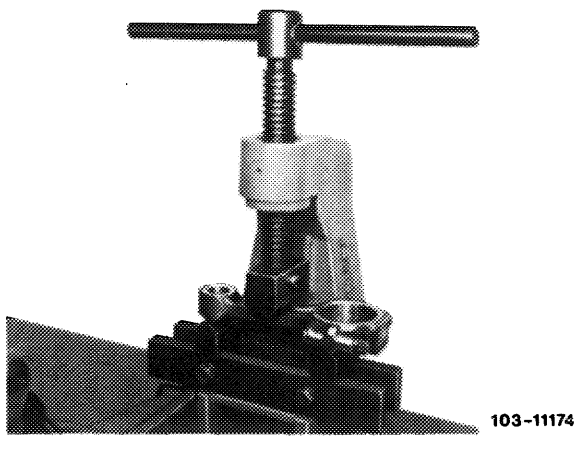
6 Mill or ream out conrod bushing.

7 Hone side bearing surfaces of connecting rod on a surface plate.

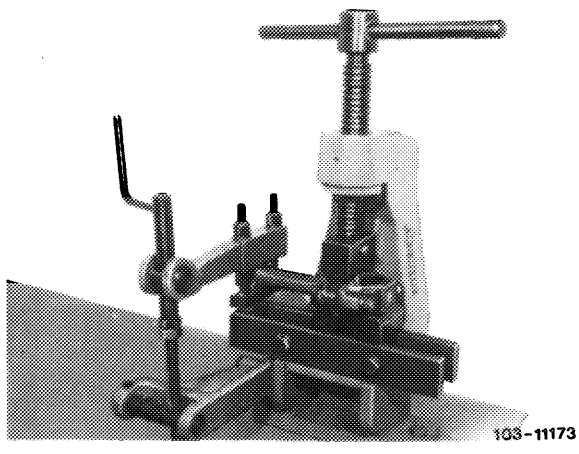
Squaring

8 Square connecting rod with a conrod tester.

9 Align parallel of conrod bore to conrod bushing bore.



10 Correct stagger of conrod bore to conrod bushing bore.



Association piston – cylinder[1])

Group number		0	1	2
Standard dimension	Piston dia	85.970–85.982	85.980–85.992	85.990–86.002
	Cylinder dia	85.998–86.008	86.009–86.018	86.019–86.028
1st repair stage + 0.5	Piston dia	86.470–86.482	86.480–86.492	86.490–86.502
	Cylinder dia	86.498–86.508	86.509–86.518	86.519–86.528
2nd repair stage + 1.0	Piston dia	86.970–86.982	86.980–86.992	86.990–86.002
	Cylinder dia	86.998–86.008	87.009–87.018	87.019–87.028

[1]) The smallest measured cylinder dia and the largest measured piston dia are decisive for association.

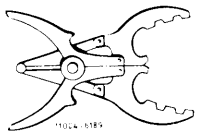
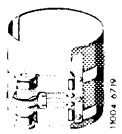
Piston code number and piston distance

Engine		Compression ratio ϵ : 1		Piston code number	Distance between piston crown and cylinder crankcase parting surface
Normal compression					
110.921	110.983		Std	37, 40, 50, 60, 64, 69 80[1]), 83, 86[1]), 89	Standback 0.20 to 0.70
110.922	110.984				
110.923	110.985				
110.924	110.986	9.0 ± 0.2	+ 0.5	38, 41, 51, 67, 70, 84, 90	Standback 1.0 to 1.50
110.981	110.987	8.7 ± 0.2			
110.982			+ 1.0	39, 42, 52, 68, 71, 85, 91	
Low compression					
110.921	110.984		Std	28, 54, 72, 75	0.25 standout up to 0.15 standback
110.922	110.985				
110.923	110.991	8.0–0.4			
110.924			+ 0.5	29, 55, 73, 76	Standback 0.55 to 0.95
110.931	110.992		+ 1.0	30, 56, 74, 77	
110.932	110.993				

[1]) Installed in engine 110.984, 110.985, 110.986 and 110.987 as standard equipment. Not available as repair stages. Use only together with piston of same piston code number.

Test values		New (Installation tolerance)	Wear limit
Piston clearance		0.016 to 0.040	0.08
Difference in weight of pistons in one engine		4 g	10 g
Piston pin dia.		22.996 to 23.00	
Piston pin clearance	in conrod bushing	0.007 to 0.017	
	in piston	0.002 to 0.011	
Piston ring gap	groove 1	0.30 to 0.45	1.0
	groove 2	0.30 to 0.45	0.8
	groove 3	0.25 to 0.40	0.8
Piston ring clearance	groove 1	0.05 to 0.08	0.15
	groove 2	0.03 to 0.06	0.08
	groove 3	0.01 to 0.04	0.08

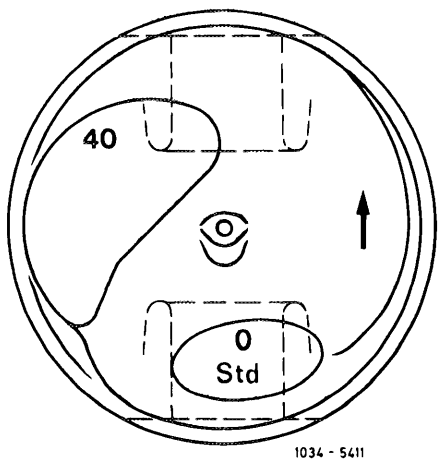
Tightening torque			
Connecting rod nuts		torque pressure	40–50 Nm
		torque angle	90–100°

Special tools		
Piston ring pliers		000 589 51 37 00
Piston ring compressor		000 589 04 14 00

Note

The piston version (std, + 0.5 or + 1.0), the group number (0, 1 or 2), the piston code (e.g. 40) and an arrow for forward direction are stamped in the piston crown.

The group number is also stamped in the crankcase mating surface.



The group number of pistons (e.g. 1) is the same as the group number of cylinder bores (production).

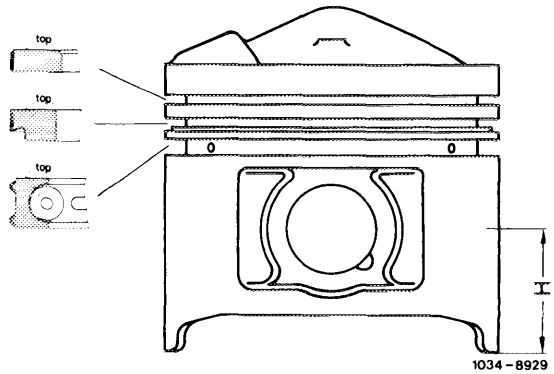
This will guarantee the specified piston clearance.

When repairing, the cylinder bores should be honed according to the sizes of the existing pistons plus the piston clearance.

Pistons and piston pins are matched.

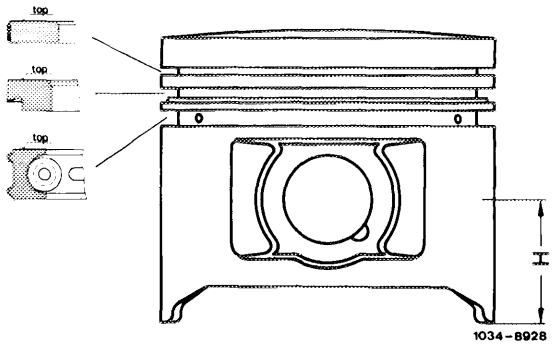
The measuring point for nominal diameter of pistons is offset by 90° in relation to piston pin axis at level H.

On used pistons the measured value does not necessarily correspond with nominal diameter of a new piston, since piston in range of measuring point and at shaft tab may "recede" already after a short operating period, that is, the nominal diameter may become smaller by up to 0.070 mm.



Piston normal compression
dimension H = 32 mm

If used pistons are used again, make sure that the oil drain bores in 3rd piston ring groove are cleaned.



Piston low compression and
USA version
dimension H = 32 mm

Removal

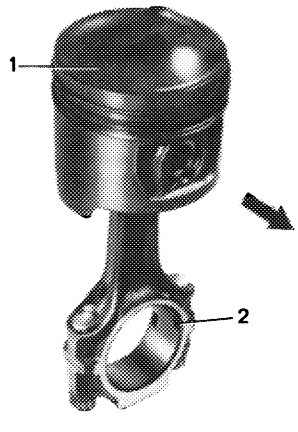
1 Take out connecting rod with piston from above.

2 Remove piston pin circlips and press out piston pin.

3 Repair and square connecting rod (03–313).

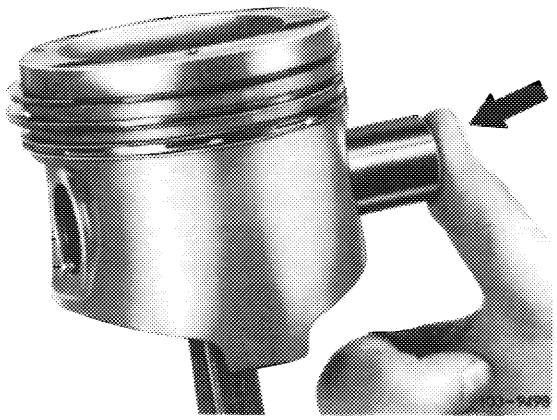
Installation

4 Place piston on connecting rod that arrow (1) faces in forward direction and circlip grooves (2) in connecting rod face to left side of engine (intake manifold).



Attention!
Don't heat piston.

5 Press in piston pin coated with engine oil **by hand.**

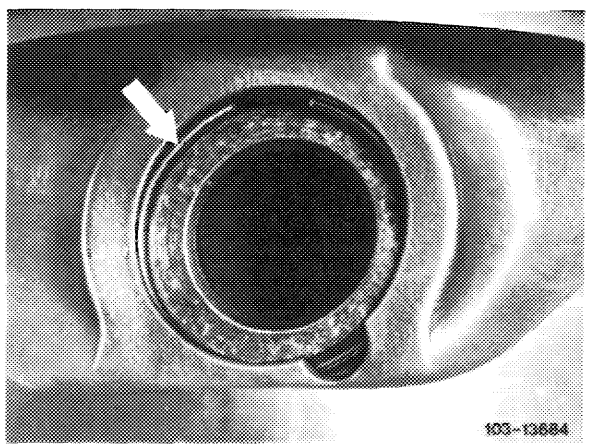


6 Insert piston pin circlips in grooves.

When installing used pistons, check piston ring gaps and clearances.

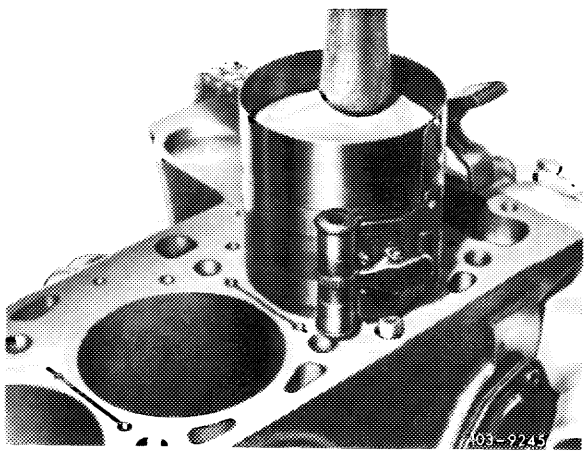
Check piston rings for easy movement.

7 Lubricate cleaned cylinder bores, conrod bearing journals, conrod bearing shells and the pistons.



8 Distribute gaps of piston rings around piston circumference evenly.

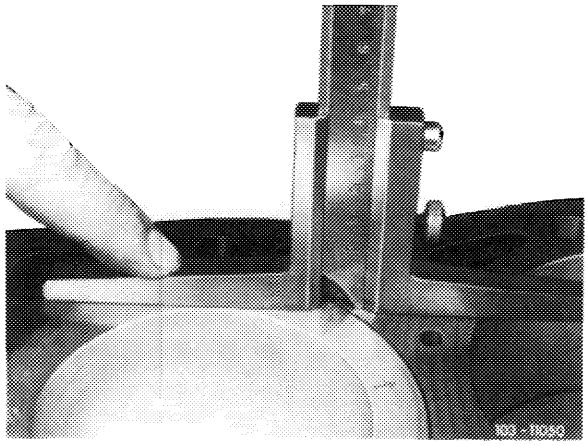
9 Install piston ring compressor and guide in piston with arrow facing forward.



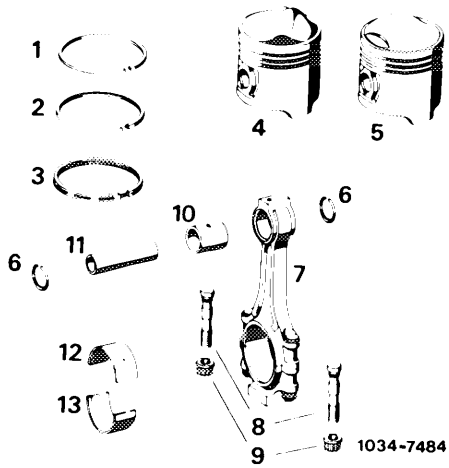
10 Place connecting rod bearing caps with code numbers facing each other on connecting rod and tighten connecting nuts to 40–50 Nm initial torque and to 90–100° angle of rotation torque.

11 Turn crankshaft and check clearance between piston pin boss and connecting rod.

12 Measure distance between piston crown and crankcase mating surface when piston is positioned at TDC (see chart).



Pistons and connecting rods



1 Plain compression ring
2 Oil scraper ring
3 Bevelled compression ring with hose lined spring
4 Piston
5 Piston, USA and low compression
6 Circlip
7 Connecting rod with conrod cap
8 Conrod bolt
9 Nut
10 Conrod bushing
11 Conrod pin
12 Conrod bearing upper half with oil bore
13 Conrod bearing lower half

Data

Crankshaft Standard size & undersizes	Crankshaft bearing journal dia.	Width of journal at thrust bearing	Conrod bearing journal dia.	Conrod bearing journal width
Standard size	59.96 59.95	29.00 29.02	47.96 47.95	28.00 28.08
1st Undersize	59.71 59.70	to 29.60	47.71 47.70	to 28.30
2nd Undersize	59.46 59.45		47.46 47.45	
3rd Undersize	59.21 59.20		47.21 47.20	
4th Undersize	58.96 58.95		46.96 46.95	

Crankshaft journal dia. for mounting compensating weight		0.030
Permissible deviation of crankshaft journal prior to mounting compensating weight	from cyl. shape	0.005
	from true[1)]	0.030
Permissible deviation of crank pins and crankshaft bearing journals from true		0.0025
Permissible deviation of crank pin cyl. line from parallel		0.010
Permissible deviation of running surfaces of fitted bearing from parallel[1)]		0.020
Permissible deviation of running surface of rear radial sealing ring from concentric true[1)]		0.015
Permissible deviation of flywheel flange from axial true[1)]		0.010
Permissible deviation of crankshaft bearing journal from concentric true[1)]	journal II, VI	0.070
	journal III, IV, V	0.100
Fillets on crankshafts and crank pins		2.5 to 3

Scleroscope hardness of crankshaft bearing journals and crank pins	when new	74–84
	boundary value	60[2]
Permissible unbalance of crankshaft		15 cmg

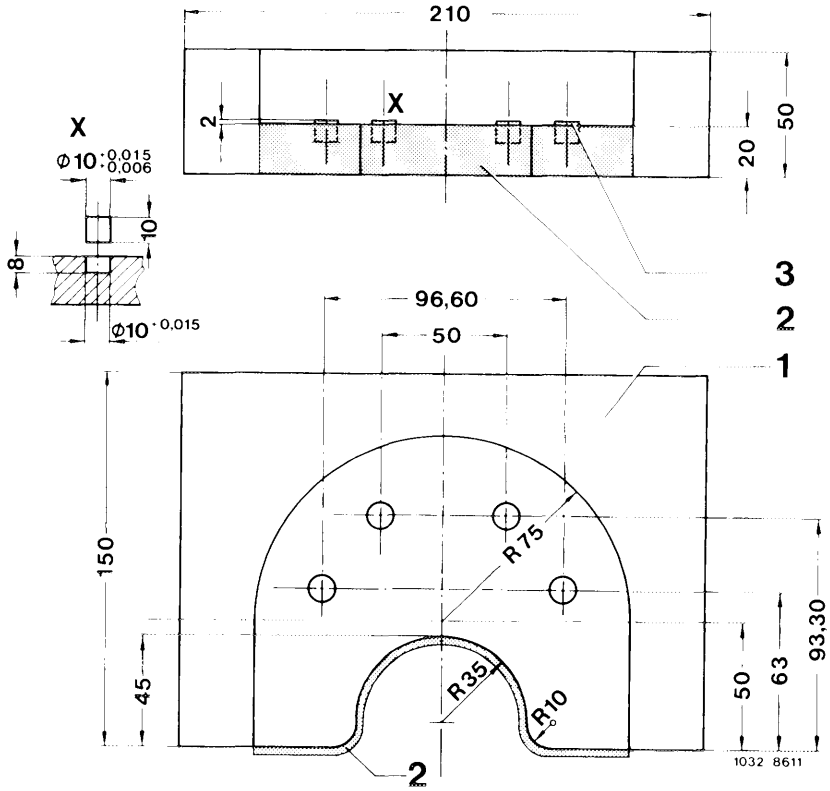
1) When mounting crankshaft on outer crankshaft bearing journal I and VII after one full turn.
2) Boundary value should be available at min. 2/3 of journal circumference.

Special tool

Impact hardness tester		000 589 20 21 00

Self-made tool

Rivet support for riveting counterweight to crankshaft.



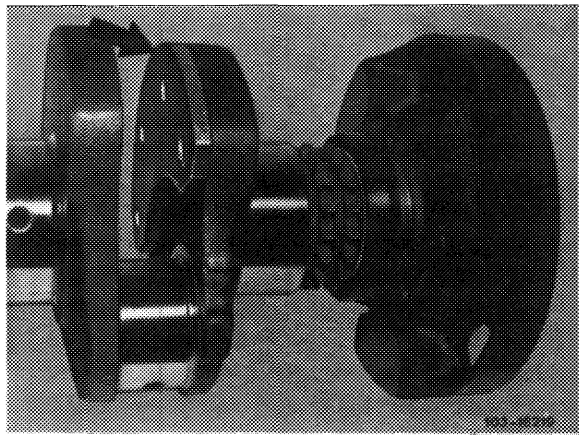
Note

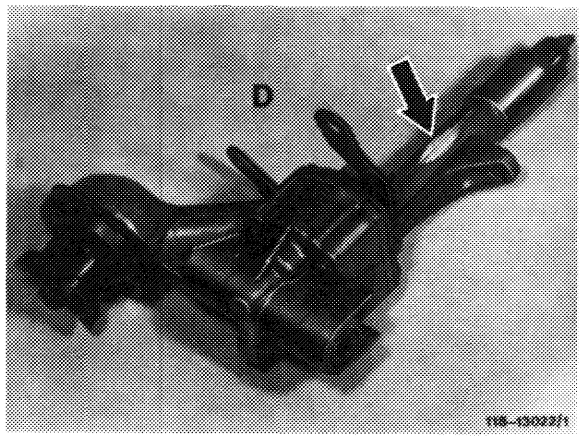
Since December 1978, the crankshaft of engine 110 is provided with an additional weight.
Remove additional weight when machining first crank pin.
After machining crank pin, rivet additional weight on again. Then check crankshaft for runout, and balance together with flywheel and balancing disc, also when re-using the old additional weight.

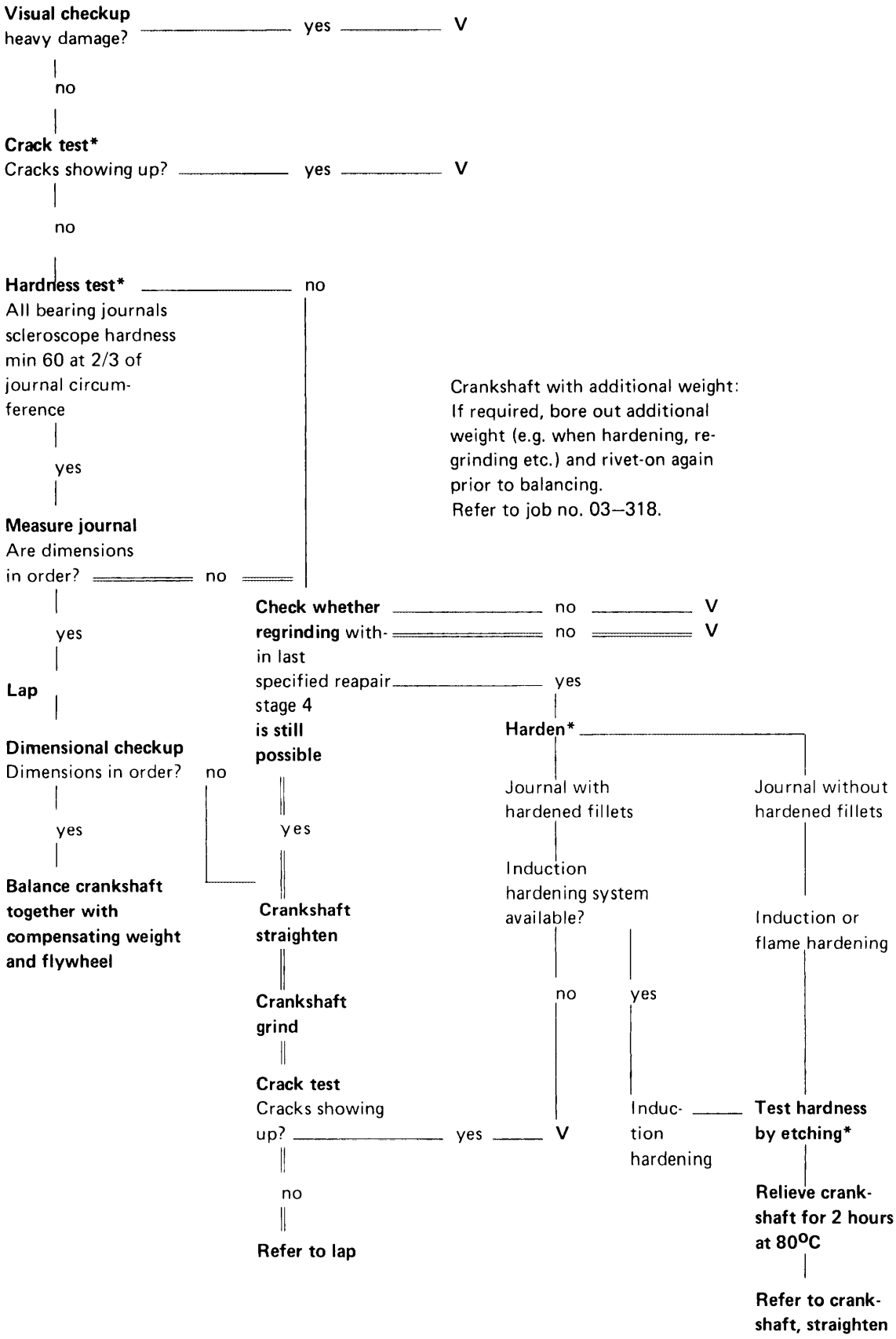
The crankshaft with riveted-on additional weight may be used only together with a modified oil pump which is provided with a recess (arrow) on housing shaft.

When checking and reconditioning crankshafts, proceed in sequence of the following diagram and pertinent explanations.

For grinding crank pins, a difference of only one repair stage per crankshaft is permitted.






Visual checkup
heavy damage?
yes
V
no
Crack test*
Cracks showing up?
yes
V
no
Hardness test*
no
All bearing journals scleroscope hardness min 60 at 2/3 of journal circum-ference
yes
Measure journal
Are dimensions in order?
no
yes
Lap
Dimensional checkup
Dimensions in order?
no
yes
Balance crankshaft together with compensating weight and flywheel
Crankshaft with additional weight: If required, bore out additional weight (e.g. when hardening, re-grinding etc.) and rivet-on again prior to balancing.
Refer to job no. 03–318.
Check whether regrinding within last specified reapair stage 4 is still possible
no
V
no
V
yes
yes
Crankshaft straighten
Crankshaft grind
Crack test
Cracks showing up?
yes
V
no
Refer to lap
Harden*
Journal with hardened fillets
Induction hardening system available?
no
yes
Induc-tion hardening
Journal without hardened fillets
Induction or flame hardening
Test hardness by etching*
Relieve crank-shaft for 2 hours at 80°C
Refer to crank-shaft, straighten

Explanations concerning diagram

Crack test

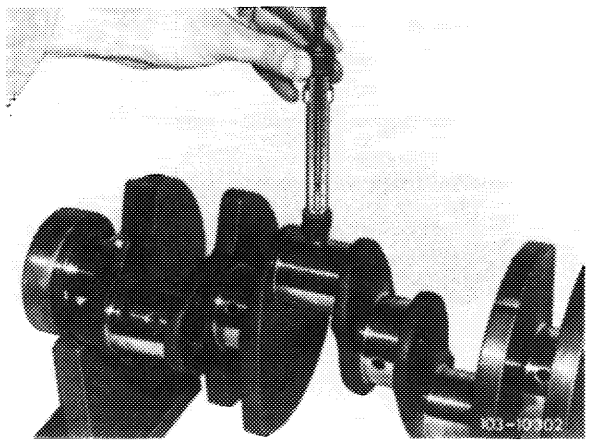
Clean crankshaft. Bearing journals should be free of oil and grease. Magnetize crankshaft and apply fluorescent powder (flux). A color penetration method (insertion in bath or with spray can) can also be applied.

Aids: paint or fluorescent powder,
cleaning agent,
developer.

Hardness test

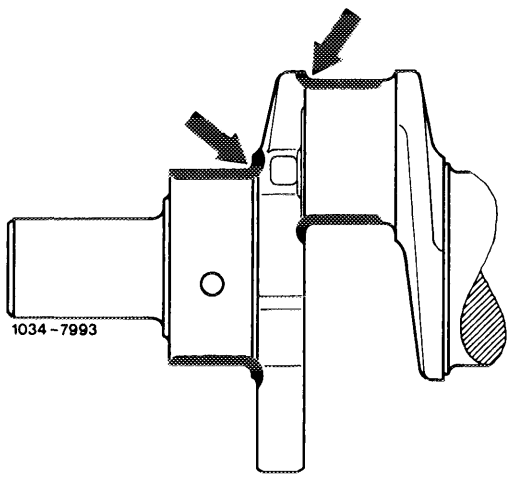
Test hardness with impact hardness tester (scleroscope hardness).

Scleroscope hardness of 60 should be available at 2/3 of journal circumference.

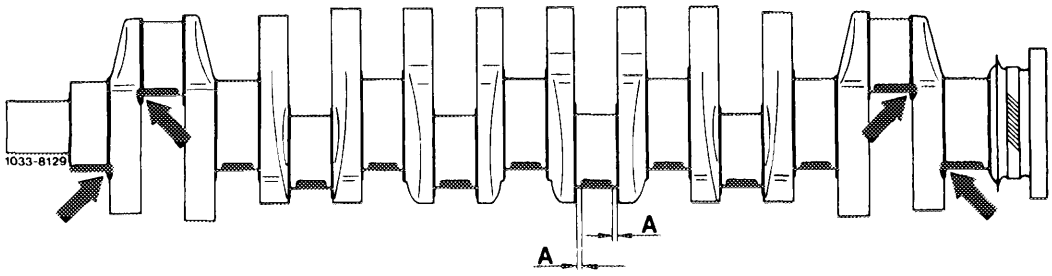


Hardening

Journals without hardened fillets can be hardened inductively or by flame hardening. Journals with hardened fillets (arrows) should be inductance-hardened on principle. If this is not possible, scrap crankshaft.



When hardening journals without hardened fillets, maintain distance A between runout of hardened surface and fillet (4–5 mm).



Checking hardening procedure

For a good hardening job, test adjustment of hardening plant by metallographic grinding tests.

These tests can be made by testing scrapped crankshafts.

Check hardening by etching surface of journal with a 2% alcoholic nitric acid (HNO_3).

No dark spots should show up at surface of journal.

Non-hardened fillets will become dark.

The hardened fillets, on the other hand, should be as bright as surface of journal.

For comparison, perform an etching job on a metallographically controlled journal.

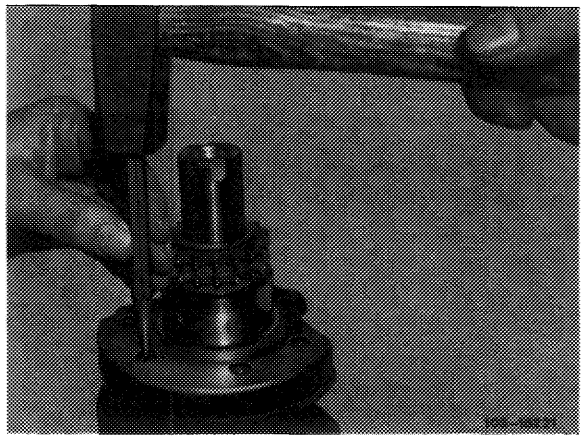
Then, carefully wash off nitric acid by means of alcohol.

Corrosion protection

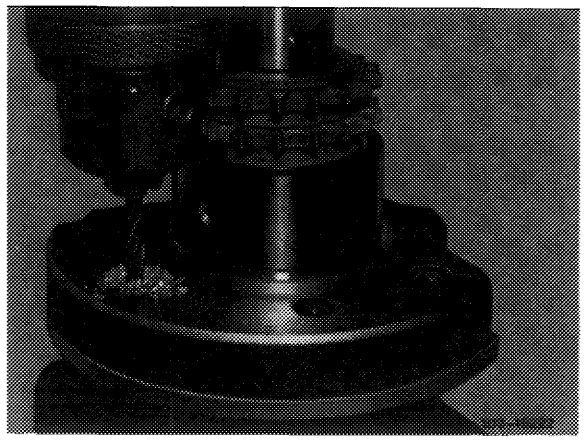
Crankshafts which are not immediately installed again should be lubricated with engine initial operation oil (SAE 30).

Riveting additional weight off and on

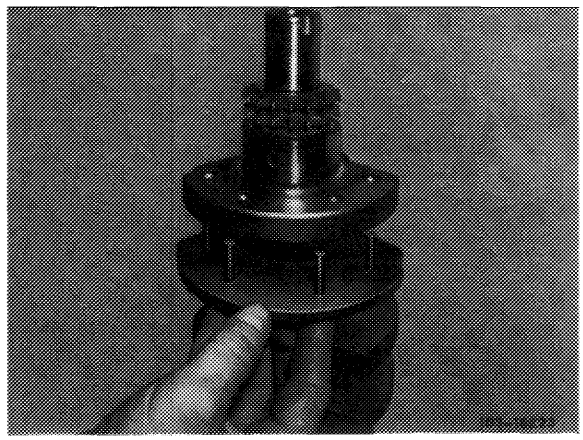
1 Punch mark countersunk rivet 6 x 28 mm accurately in center.



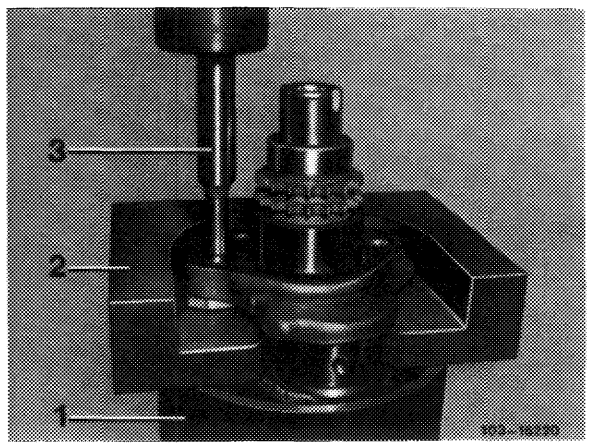
2 Drill into rivet heads with a 6.5 mm dia. drill and knock out.



3 Slip-on new or former, undamaged additional weight together with 4 countersunk rivets.



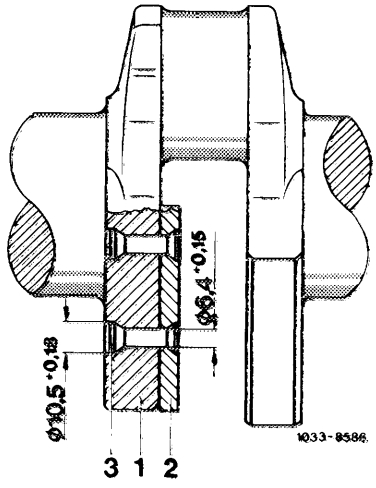
4 Introduce crankshaft into a suitable steel tube (approx. 165 mm dia. x 420 mm long) and place self-made rivet support (2) underneath.



1 Steel tube 165 mm dia. x 420 mm long
2 Self-made rivet support
3 Snap die

5 Rivet countersunk rivet by means of a hydraulic press. The additional weight should then rest fully against crankshaft cheek without leaving any intermediate space.

6 Then check crankshaft for runout of bearing journals and balance together with balancing disc and flywheel, even if the former additional weight is used again.



1 Crankshaft
2 Additional weight 110 031 05 01
3 Countersunk rivet 6 x 28 mm DIN 661 MUSt 34

Series production of riveted-on additional weight starting December 1978

starting engine end no.	starting chassis end no.
110.992 –10–038 031 –12–062 390	116.020–112 253
110.923 –10–012 665 –12–015 613	123.030–025 675 123.050–002 801
110.932 –10–009 748 –12–002 556	116.020–112 253
110.984 –10–014 634 –12–051 160	123.033–050 600 123.053–013 292
110.984 –10–014 634 –12–051 160	123.093–001 229
110.985 –10–011 106 –12–052 660	116.024/025–131 270
110.986 –10–002 276 –12–005 142	107.022–006 288 107.042–005 285

Data

Crankshaft standard dimension and repair stages	Crankshaft bearing journal dia	Width of journal on fitted bearing	Crankpin dia	Width of crankpin
Standard dimension	59.965 / 59.955	29.021 / 29.000	47.965 / 47.955	28.084 / 28.000
1st repair stage	59.715 / 59.705	up to 29.60	47.715 / 47.705	up to 28.30
2nd repair stage	59.465 / 59.455		47.465 / 47.455	
3rd repair stage	59.215 / 59.205		47.215 / 47.205	
4th repair stage	58.965 / 58.955		46.965 / 46.955	

Basic bore and bearing play		Crankshaft bearing	Connecting rod bearing
Basic bore dia		67.00 / 67.02	51.60 / 51.62
Perm. out-of-round and conicity of basic bore		0.01	
Radial bearing play	when new	0.031 to 0.053[1]	0.025 to 0.065[1]
	wear limit	0.08	
Axial bearing play	when new	0.10–0.24	0.11–0.23
	wear limit	0.30	0.50

[1]) Try for mean value of radial play (vertical runout).

Bearing shells	Wall thickness crankshaft bearing	Width of fitted bearing shells	Wall thickness connecting rod bearing
Standard dimension	3.500–3.513	28.78–28.90	1.804–1.814
1st repair stage	3.625–3.638	29.4–29.6[3]	1.929–1.939
2nd repair stage	3.750–3.763		2.054–2.064
3rd repair stage	3.875–3.888		2.179–2.189
4th repair stage	4.000–4.013		2.304–2.314

1) Measured at apex of bearing shell.
2) The fitted bearing shells for 1st to 4th repair stage are supplied in oversize width and should be refinished in accordance with ground crankshaft bearing journal.